BSAI Halibut Abundance-based Management (ABM) of PSC Limits
Initial Review Draft
September 2019[1]

This document analyzes proposed management measures to index Pacific halibut prohibited species catch (PSC) limits in the Bering Sea and Aleutian Islands (BSAI) groundfish fisheries to halibut abundance. PSC limit modifications are considered for various sectors, including the BSAI trawl limited access (TLAS) sector, the Amendment 80 sector, longline catcher vessels (CVs), longline catcher processors, and the Community Development Quota (CDQ) sector (i.e., a reduction to the CDQ's allocated prohibited species quota reserve). The objective of modifying PSC limits is to index PSC limits to halibut abundance which may achieve different goals of providing flexibility to the groundfish fisheries in times of high halibut abundance, protecting spawning biomass of halibut especially at low levels, and stabilizing in inter-annual variability in PSC limits, all of which may provide additional harvest opportunities in the commercial halibut fishery.

This document is a preliminary draft Environmental Impact Statement (DEIS) for initial review by the Council. A preliminary DEIS provides assessments of the environmental impacts of an action and its reasonable alternatives, the economic benefits and costs of the action alternatives, as well as 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 North Pacific Fishery Management Council (Council) and the National Marine Fisheries Service (NMFS) Alaska Region to provide the analytical background for decision-making.

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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
A80	Amendment 80 Sector
BTS	Bottom Trawl Survey
CAS	Catch Accounting System
CDQ	Community Development Quota
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
EBS	Eastern Bering Sea
EFH	essential fish habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESU	endangered species unit
FMA	Fisheries Monitoring and Analysis
FISS	Fishery Independent Setline Survey (IPHC)
FMP	fishery management plan
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FRFA	Final Regulatory Flexibility Analysis
ft	foot or feet
HALCV	Hook and Line catcher vessel
HALCP	Hook and line catcher processor
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

Acronym or Abbreviation	Meaning
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
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
OM	Operating Model
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
SIR	Supplemental Information Report
SRKW	Southern Resident killer whales
TAC	total allowable catch
U.S.	United States
TLAS	Trawl Limited Access Sector
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
VMS	vessel monitoring system

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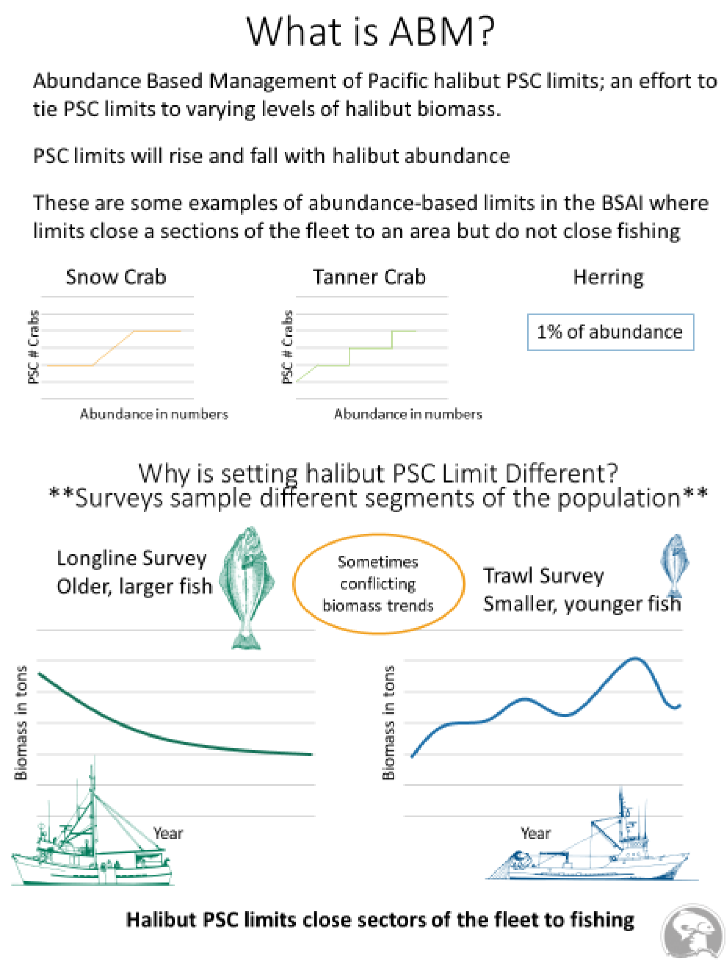
Executive Summary



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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 in the BSAI groundfish fisheries. Currently halibut PSC limits are specified as 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. 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 management (ABM) of halibut PSC limits as a potential management approach to address these concerns.

The Council has been reviewing multiple discussion papers and revising a suite of alternatives for this action since 2016. The Council has previously set other PSC limits (crab, herring) based upon abundance of the stock in the BSAI. However, this action was complicated by consideration of a broad range of sources of information with which to index the BSAI portion of the coastwide halibut stock (see inset on ABM and issues). The Council selected two abundance indices to track Pacific halibut abundance and guide PSC limit setting in the BSAI groundfish fisheries. These are the NMFS AFSC EBS shelf bottom trawl survey (BTS) and from the IPHC setline survey covering IPHC Areas 4ABCDE (also referred to as the fishery independent setline survey or FISS) which select different segments of the halibut populations (younger and older fish respectively). Both indices represent the best available scientific information.

Roadmap for understanding EIS structure

The document has been structured to streamline required information in a preliminary DEIS and to organize it so it is most easily understood by the reader. As such the biological and economic sections (often included as separate stand-alone sections), for both background and impacts have been organized together. For example, all background information on groundfish stock status, specifications and fishery descriptive information is combined into a groundfish chapter (Chapter 3). Likewise, all halibut information on biology, stock status, management and fishery is contained in Chapter 4. Impacts of the alternatives on groundfish and halibut stocks and fishery participants are contained in Chapter 6.

Purpose and Need

The Council's purpose and need statement for this action is:

The current fixed yield-based halibut PSC caps are inconsistent with management of the directed halibut fisheries and Council management of groundfish fisheries, which are managed based on abundance. When halibut abundance declines, PSC becomes a larger proportion of total halibut removals and thereby further reduces the proportion and amount of halibut available for harvest in directed halibut fisheries. Conversely, if halibut abundance increases, halibut PSC limits could be unnecessarily constraining. The Council is considering linking PSC limits to halibut abundance to provide a responsive management approach at varying levels of halibut abundance. The Council is considering abundance-based PSC limits to control total halibut mortality, particularly at low levels of abundance. Abundance based PSC limits also could provide an opportunity for the directed-halibut fishery and protect the halibut spawning stock biomass. The Council recognizes that abundance-based halibut PSC limits may increase and decrease with changes in halibut abundance.

The Council derived the following objectives from the purpose and need statement for this action to guide the development of appropriate management measures:

- Halibut PSC limits should be indexed to halibut abundance
- Halibut spawning stock biomass should be protected especially at lower levels of abundance
- There should be flexibility provided to avoid unnecessarily constraining the groundfish fishery particularly when halibut abundance is high
- Provide for directed halibut fishing operations in the Bering Sea.
- Provide for some stability in PSC limits on an inter-annual basis.

These objectives have not been prioritized by the Council and may contradict each other thus designing a management program which meets all of them equivalently may be challenging. The goal of this analysis of the Council's alternatives, is to evaluate how well each alternative meets the purpose and need statement, these competing objectives and the National Standards.

The Council has been managing Pacific halibut bycatch by a range of measures since the inception of the FMP (Figure ES-1).

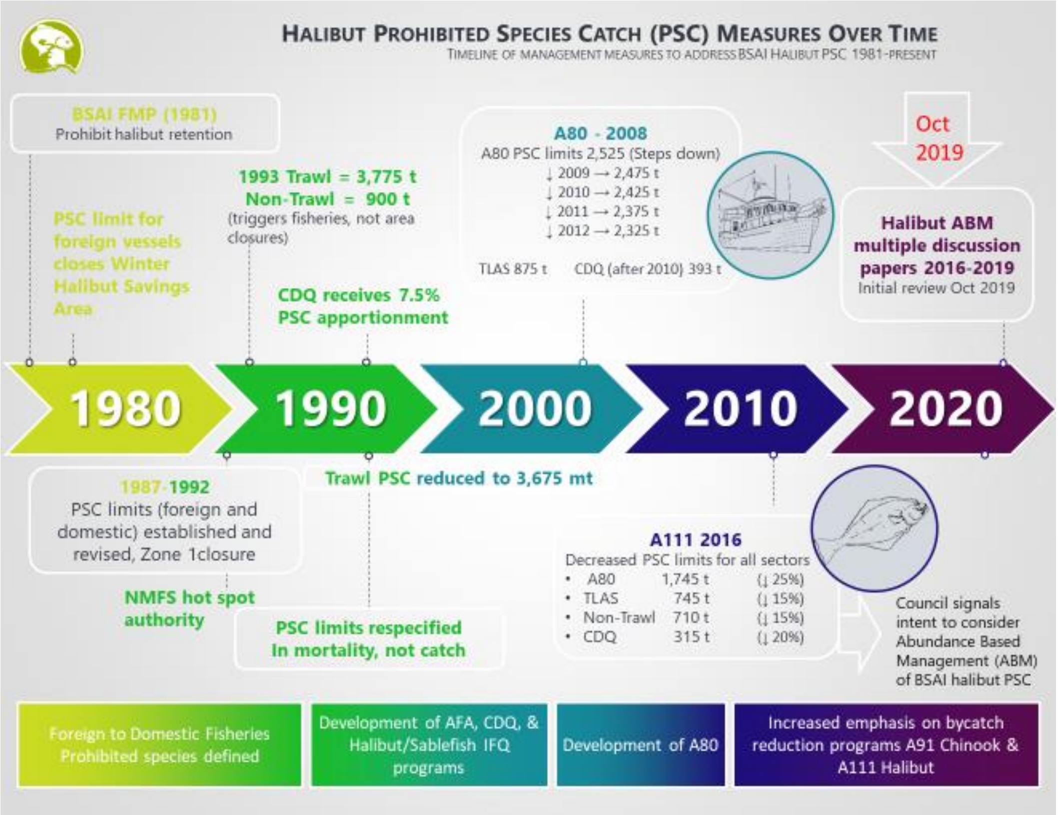


Figure ES-1 Timeline of management of BSAI halibut PSC

Alternatives

Alternatives 1 through 3

There are three overarching Alternatives under consideration by the Council. These have been developed through multiple discussion papers and Council considerations, and consultation with stakeholders. These Alternatives range from status quo with fixed halibut PSC limits by sector to a range of gear-specific PSC limits indexed to BSAI halibut abundance. These are described in detail in **Chapter 2** of this analysis and summarized below.

Alternative 1: Status Quo. BSAI halibut PSC limits are fixed at a total of 3,515 t for all sectors with individual sector level limits as follows: Amendment 80 cooperatives (A80) 1,745 t, BSAI Trawl limited access fisheries (TLAS) 745 t, non-trawl fisheries 710 t, and community development quota fisheries (CDQ) 315 t. Further apportionment of limits to seasons and sectors occurs during the annual harvest specifications process by the Council (Figure ES-2)

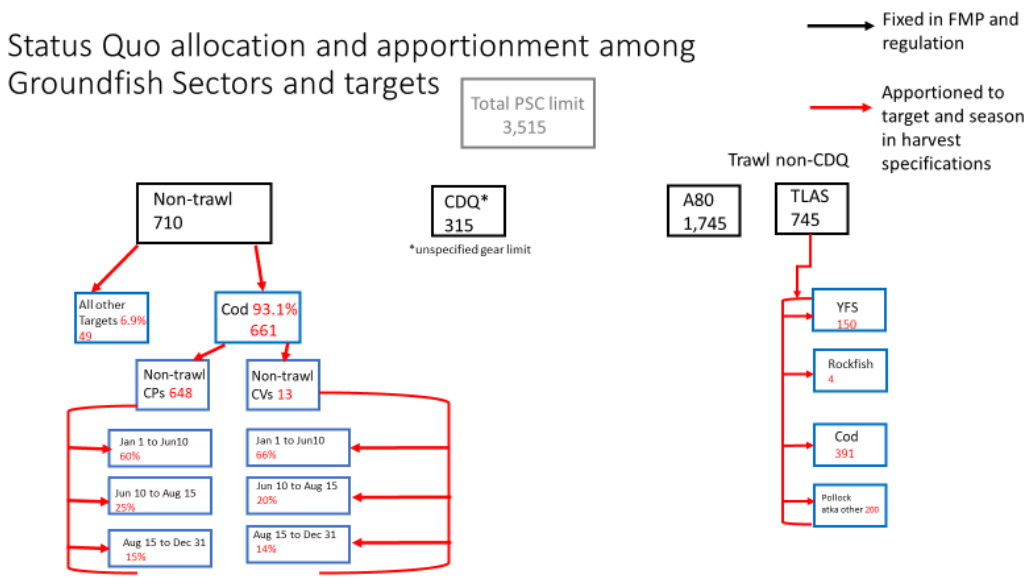
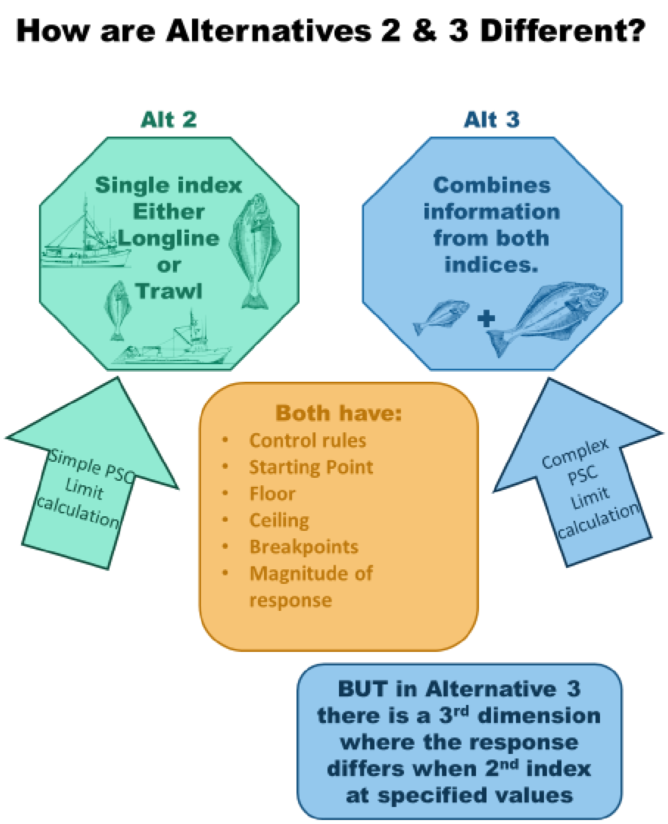
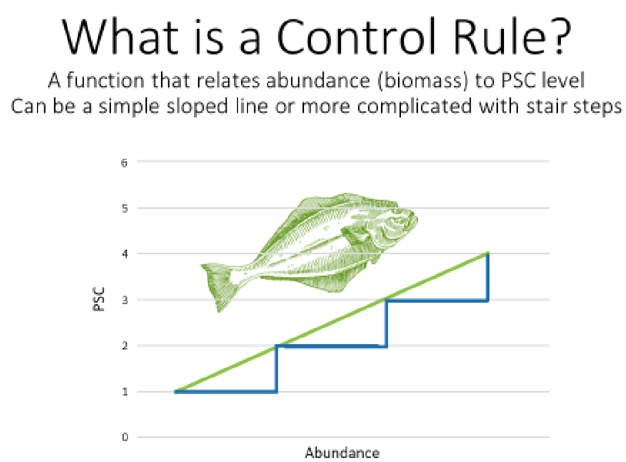


Figure ES-2 Flow Chart of BSAI Halibut PSC Limits for 2019

Alternatives 2 and 3

In Alternatives 2 and 3, PSC limits are established by gear type (aggregate trawl PSC limit and an aggregate non-trawl PSC limit) using a control rule applied to one or two biomass. The indices are the NMFS EBS bottom trawl survey index and the IPHC Area 4 setline survey index.

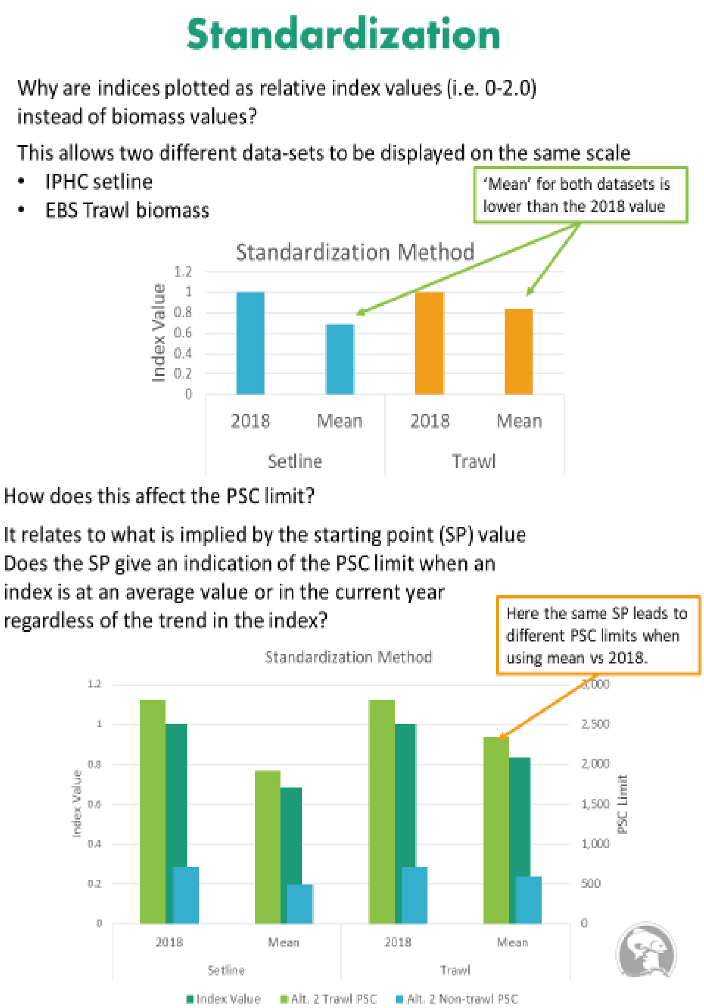


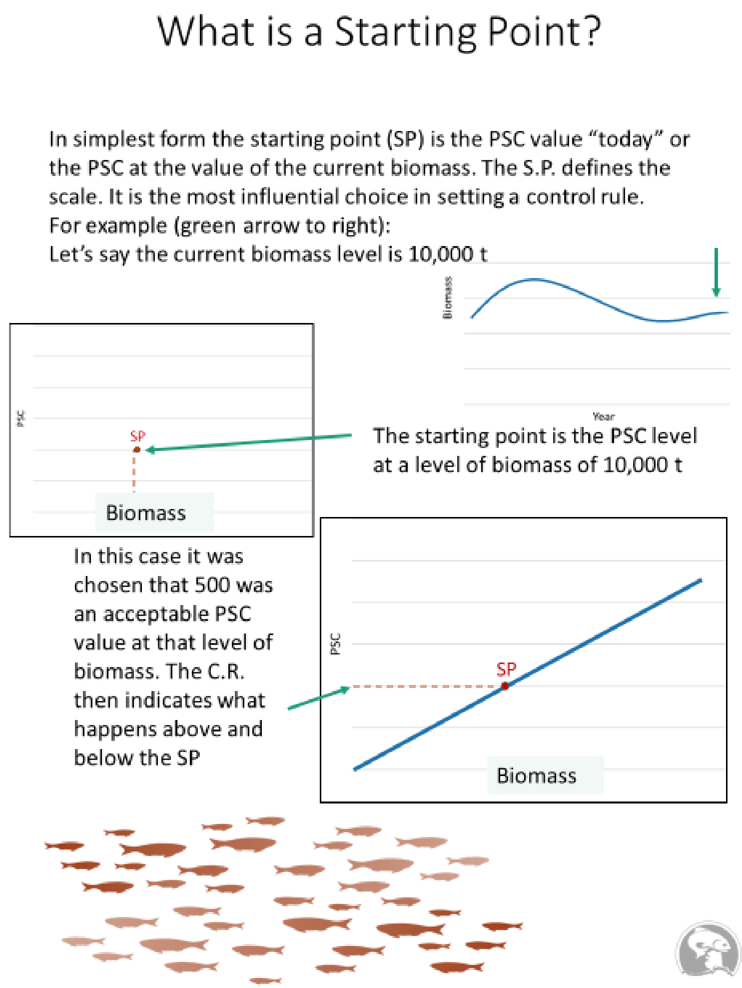


The Council requested that the indices be considered from 1998-2018 and by default standardized to the most recent year (2018). Note that an additional option is provided for the time period over which the indices are standardized (mean from 1998-2018 or 2018 only) which affects the PSC limit implied by the starting point.

The main distinction between these two alternatives lies in whether a PSC limit by gear type employs a single index (**Alternative 2**) or both a primary and a secondary index to set the PSC limit (**Alternative 3**). Under Alternative 3 the secondary index modifies the PSC limit established by the primary index at a specified value or 'breakpoint". The extent to which the secondary index influences the PSC limit above or below selected breakpoints is determined by selection of options within the alternative. Either index may be selected as the primary or secondary index.

Both Alternatives 2 and 3 have a similar suite of Elements and Options to define the shape and behavior of the control. The Elements and Options are decision points to establish the overall control rule. These decisions include the Starting Point (Element 1) which defines the value of the PSC limit prescribed by the control rule when the index or indices are at the current year value.

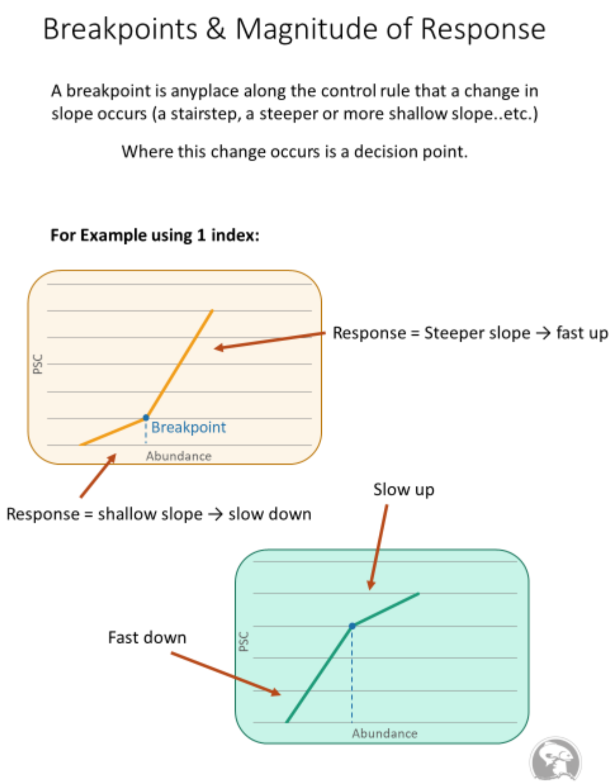


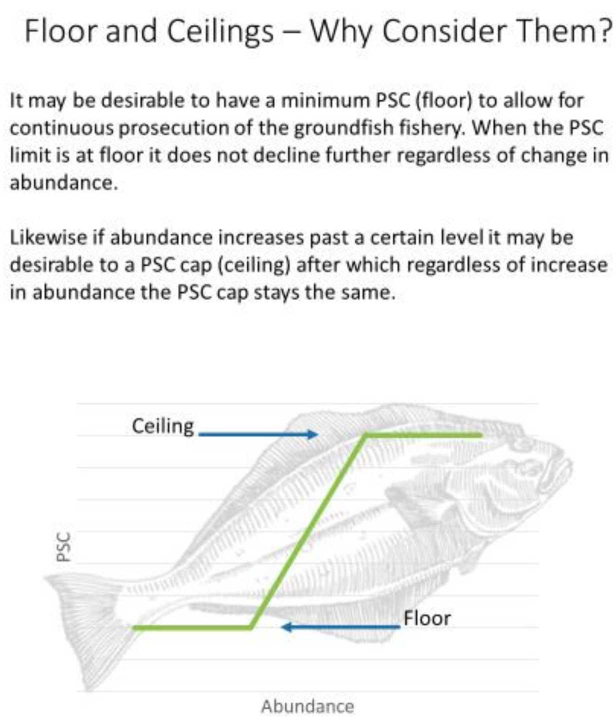


Additional decisions include where to set the maximum PSC limit or 'ceiling' (Element 2) and the minimum PSC limit or 'floor' (Element 3). These two elements define the bounds over which the maximum and minimum PSC limit can vary regardless of levels of abundance.

An additional Element (Element 4) may be selected if breakpoints for either the primary and/or the secondary index are desired. The magnitude of the response (Element 5) must be specified for either the primary or secondary index which is applicable to both Alternatives 2 and 3. The response (or slope) is defined as the change in the PSC limit relative to the change in the index.

Element 6 offers an optional provision for responsiveness to abundance changes by limiting the possible interannual percentage change in PSC limits. Finally, under Element 7, breakpoints may be specified in a lookup table rather than breakpoints and responsiveness in Elements 4 and 5 (where the PSC limit is defined continuously along the control rule). Element 7 includes options for standardizing each index.





Decision steps for Alternatives 2 and 3

A summary of different decisions related to Alternative indices, Elements and Options as well as which are options or required to formulate alternatives is provided in Table ES-1.

Table ES-1 Summary of selection of Elements and options under Alternatives 2 and 3

Alternative	Primary index	Secondary index	Standardization
2	Trawl or Setline	Not applicable	2018 (default); 2 year average
3	Trawl or Setline	Trawl or Setline	Primary: 2018 (default); 2 year average Secondary: mean

Element	Description	Range	Optional?
1	Starting Point	1,958-3,515 t	No
2	Ceiling	3,515-4,426 t	No
3	Floor	1,000-2,354 t	No
4	Breakpoint	Breakpoint occurs when index value is greater than or less than one of the 2 values below: 25% average of index or average value of index	Yes For Alt 2 No for Alt 3 (unless Element 7 selected)
5	Response	1:1 >1:1 <1:1	N (unless Element 7 selected)
6	Constraint	5-25%	Y
7	Look up Table	Up to 12 breakpoints; standard to mean or 2018	Y

Given the range of multiple Elements and Options for Alternatives 2 and 3 as described above, a subset of Alternatives was simulated which were selected based upon input from stakeholders, Council, SSC and workgroup members. In total 16 were simulated (Table ES-2) including a forward simulation of status quo limits under Alternative 1[2]. Section 2.7 of this analysis provides additional explanation of the Elements and Options and notations included in this table.

[2] In addition, 4 fixed limit suboptions proposed by the SSC and the working group to contrast the effect of fixed limits versus abundance-based limits were simulated. These are shown in some of the results in Chapter 6 for contrast but are not included in the Council's suite of Alternatives.

Table ES-2. Combination of alternatives included in analysis. Numbering for each alternative shows the Overarching Alternative (1,2,3) then secondary numbering to group sub-sets by similar elements and options (e.g., 201, 3-1). See Section 2.7 (and Table 2.4) for further explanation of the Elements and Options and notations included in this table.

	Indices used			Elements						
				1	2	3	4	5	6	7
Alternative	Source	Primary	Secondary	Starting point	Ceiling	Floor	Break points	Responsiveness	Constraint	Type
1	Status quo	NA	NA	3,515						
2-1	WG	By gear	NA	3,515	4,426	1,758	none	1:1	15% max	Continuous
2-1.a	WG	By gear	NA	3,515	4,426	1,758	none	1:1	none	Continuous
2-1.b	SSC	By gear	NA	1,958	4,426	1,758	none	1:1	15% max	Continuous
2-2	Stakeholder	By gear	NA	3,515	4,426	2,354	specified	Stairsteps	2 yr avg	Continuous
2-3	Stakeholder	By gear	NA	3,515	4,426	2,354	none	1:1	15% max	Continuous
2-4	Stakeholder	By gear	NA	2,018	3,515	1,000	Start	1:1 (low) 0.5:1 (high)	15% max	Continuous
3-1	WG	By gear	Other (mean)	3,515	4,426	1,758	±25%	1:1	15% max	Continuous
3-1.a	WG	By gear	Other (mean)	3,515	4,426	1,758	±25%	1:1	none	Continuous
3-1.b	WG	By gear	Other (mean)	3,515	4,426	1,758	±25%	2nd Index 0.5:1 (low),1.5:1 (high)	15% max	Continuous
3-1.c	WG	By gear	Other (mean)	3,515	4,426	1,758	±25%	1:1	15% max	Discrete
3-1.d	SSC	By gear	Other (mean)	1,958	4,426	1,758	±25%	1:1	15% max	Continuous
3-2.a	Stakeholder	Gear (mean)	Other (mean)	2,941	4,124	1,758	none	Interpolated	15% max	Discrete
3-2.b	WG	Gear (mean)	Other (mean)	2,941	4,124	1,758	none	1:1	15% max	Discrete
3-3a	Stakeholder	Setline	Trawl (mean)	1,958	3,515	1,000	S.P	Secondary 0.35:1	20% max	Continuous
3-3b	WG	Trawl	Setline (mean)	1,958	3,515	1,000	S.P	Secondary 0.35:1	20% max	Continuous

A simplified example of the selected control rules for Alternative 2 is shown in Figure ES-3. Here the control rules for a range of sub-alternatives are shown to demonstrate how these control rules are modified (by selection of options for Elements 1-5) at different values of the relative index (EBS bottom trawl survey for trawl PSC and Setline survey for non-trawl PSC). A companion table shows the value of the PSC limits calculated at the reference index level of '1.0' (i.e. standardized to 2018) for Alternative 2 as well as ones calculated for the simulated sub-alternative for Alternative 3(Alternative 3 is not pictured in Figure ES-3 but PSC limits are shown in Table ES-3). Note that these limits shown are the values calculated prior to application of the Element 6 constraint (as shown in Table ES-1).

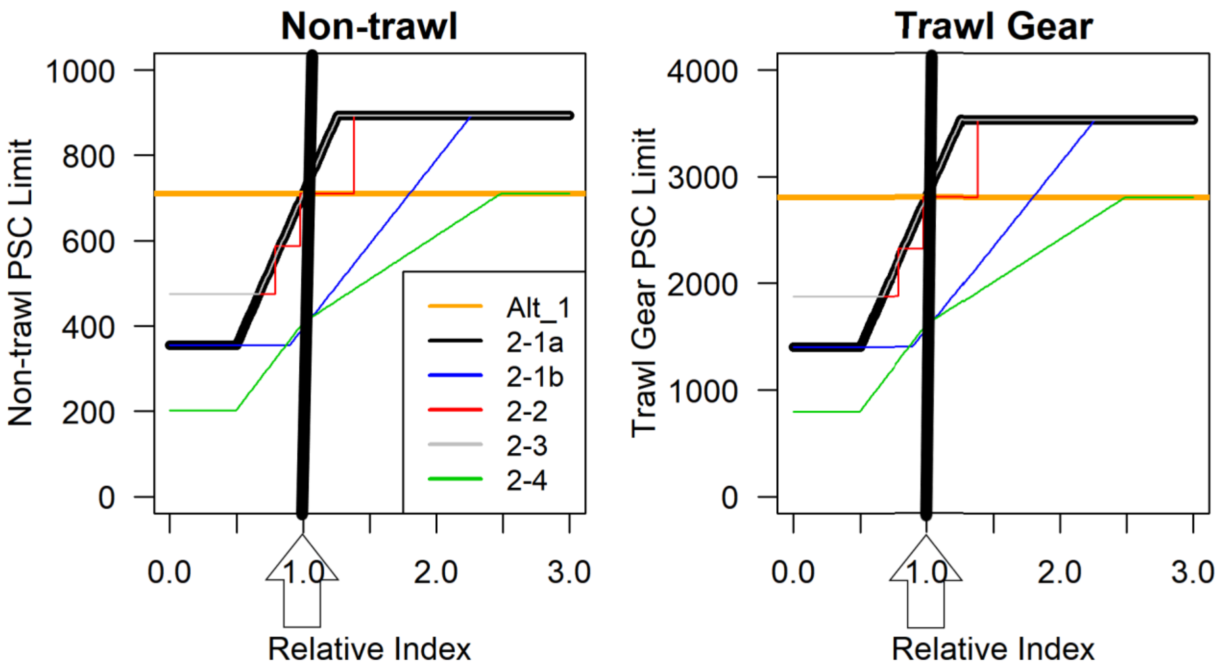


Figure ES-3 An example of PSC limit control rules for multiple versions of Alternative 2 which will vary by values of the relative index (EBS bottom trawl survey for trawl PSC and Setline survey for non-trawl PSC). These are shown for similar control rules by gear according to the colored legend as compared to static PSC limits by gear for Alternative 1 (shown in orange). Also shown is a black reference line with an arrow at the relative index level of '1.0' as these indices have been standardized to the 2018 value thus all control rules to read what the corresponding PSC limit should be where they intersect with that reference line.

Table ES-3 PSC limits by gear type associated with the Alternative 2 control rules shown in Figure ES-3 as well as calculated PSC limits under the sub-alternatives for Alternative 3 (not pictured in Figure ES-3). Note that these are the limits calculated prior to application of the constraints under Element 6.

Alternative	Trawl PSC limit	Non-Trawl PSC limit
Alt 1	2,805	710
Alt 2-1	2,805	710
2-1.a	2,805	710
2-1.b	1,563	395
2-2	2,805	710
2-3	2,805	710
2-4	1,610	408
Alt. 3-1	2,619	710
3-1.a	2,619	710
3-1.b	1,712	710
3-1.c	2,468	732
3-1.d	1,459	395
3-2.a	1,781	451
3-2.b	1,403	355
3-3a	1,473	372
3-3b	1,390	351

Allocation to sectors for Alternatives 2 and 3

Allocations of the gear-specific PSC limits under Alternatives 2 and 3 are intended to reflect the current (Status Quo) allocation proportions to the extent possible. As such proportional allocations of the trawl limit to the Amendment 80, TLAS and CDQ fisheries are provided in this analysis similar to the status quo[3]. Seasonal and target apportionments are based upon the 2019 specifications (Figure ES-4). Therefore and as described in Chapter 5 Section 5.7, the relative proportion of the trawl gear limit to the Amendment 80, TLAS and CDQ sectors is proportionally divided to approximate status quo CDQ with the remaining to the other trawl sectors (62.2% to Amendment 80, 26.6% to TLAS and 11.2% to CDQ). This is done consistently for all trawl PSC limits for the analysis but implies a proportional allocation to sectors that should be specified by the Council. Additional information showing the individual PSC limits by gear and sector associated with Table ES-3 are described in Section 2.7, Table 2-6). As with status quo, decisions on the seasonal and target apportionments would continue to be made during the annual harvest specifications process by the Council.

[3] The Council provided direction in February 2019 that the CDQ limit should vary with the trawl limit.

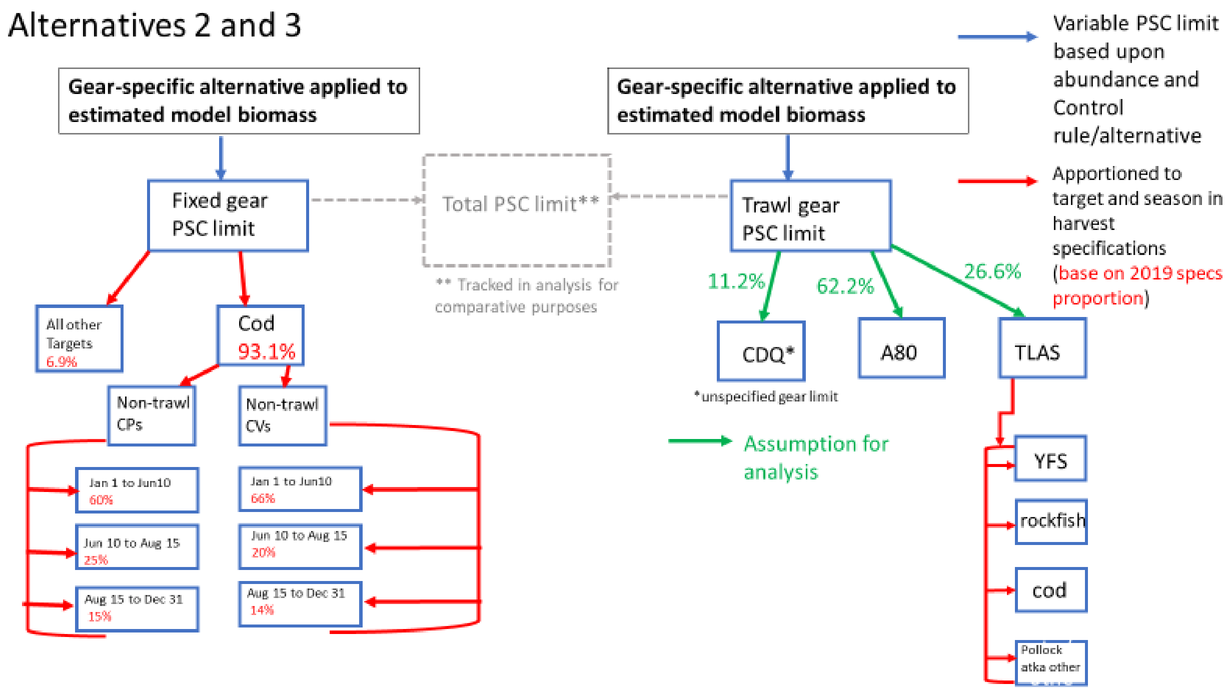


Figure ES-4 Alternative 2 and 3 analytical assumptions on proportional allocation of the Trawl PSC limit to sectors and apportionments to targets of the fixed gear PSC and TLAS PSC limits based upon 2019 harvest specifications proportions

The Pacific halibut simulation model

A simulation framework was used to compare the Pacific halibut stock trends and PSC limits across the set of alternatives. 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.

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. Weight-at-age is assumed to be constant and equal to 2018 values used in the 2018 IPHC assessment models. The model included five fishing fleets: the halibut fishery in the BSAI, the halibut fishery in the other area, the BSAI trawl PSC fishery, the BSAI hook-and-line (HAL) PSC fishery, and the bycatch fishery in the other area. Many values for halibut population dynamics were fixed based on results from the 2018 IPHC coastwide long assessment model.

Additional details on model assumptions, formulations as well as detailed model validation discussion and results are contained in **Chapter 5** as well as in **Appendices 3, 4 and 5** to the preliminary DEIS.

Comparison of Alternatives

Comparative analyses were completed to evaluate multiple sub-alternatives under Alternatives 2 and 3 with both the current status quo fixed PSC limit as well as some lower fixed PSC limits to compare performance in relation to more complex control rule formulations under Alternatives 2 and 3. In total 20 different alternative sub-alternatives were simulated. Specific combinations of Elements and Options to form these sub-alternatives for Alternatives 2 and 3 were selected based upon input from Stakeholders, the Council, the SSC and the analysts. Multiple sub-alternatives are shown to best demonstrate which features of the control rules have the most influence on the results. Broadscale results are characterized according to variability in PSC limits, PSC usage, impacts on halibut spawning stock biomass (SSB) and directed halibut fishery catch over a 20-year timeframe.

A summary of the broadscale results across all of the alternatives is provided in the bullets below.

- PSC and directed halibut fishery catch are most sensitive to the starting point value.
- The additional constraint of Element 6 (a 15% constraint on changes to PSC limits) results in a slow trajectory to low starting point values when starting at the 2018 value.
- Floors and ceilings further dampen variability as some of the Alternatives result in control rules which are stuck on floors and ceilings.
- The majority of both the trawl and non-trawl PSC limits are highly correlated with the indices that were used as the primary index for those limits. Where PSC limits do not track abundance closely, it is due to the additional constraints that limit variability (floors, ceiling, percentage change constraint).
- Impacts to spawning stock biomass (SSB) in the BSAI is minimal across all alternatives at the PSC levels realized within the range of the alternatives because total mortality is balanced between PSC usage and halibut fishery catch. SSB does decline when very high PSC levels (10,000 t) are simulated which is outside of the range of alternatives currently considered. This scenario also shows that spawning biomass in the BSAI would decline dramatically, but that there would still be spawning biomass in the 'other' area. The bottom trawl survey index would also be non-zero, as there is some recruitment allocation to the BSAI from the coastwide stock every year included in model specification.
- There is limited impact on the overall performance (in relation to SSB and directed fishery catch) from the addition of a secondary index however there was additional variability in PSC limits and usage. Features of the control rules are more influential than combining two indices under the current trajectory of SSB simulated.
- There is a trade-off between PSC usage and halibut fishery catch because the mortality limit of over 26" (O26) halibut (TCEY) is composed of halibut fishery catch and O26 PSC usage. The halibut fishery catch is the TCEY minus the O26 PSC usage.
- Under nearly all of the alternatives, the halibut fishery catch limits are reduced from 2018 levels. This is driven by the fact that the TCEY is reduced due to declines in the SSB trajectory. A different model validation scenario with an increase in SSB may show an increase in halibut fishery catch relative to 2018 levels.
- The alternatives illustrate tradeoffs between PSC limits and halibut catch limits, and present tradeoffs between sectors of the groundfish fishery. Projected median values of PSC limits are summarized for 2024 and 2030 and represent reductions from current limits for the non-trawl fishery in every alternative, although these represent reductions from current PSC limits, none represent reductions from recent PSC use. Under the projected median values of PSC limits for those years, the trawl fishery receives reductions in PSC limits under only seven of the 15 calculated alternatives (See Section 6.3). This is related to the different surveys and relative trends in those surveys used to calculate PSC limits. In particular:
    - The non-trawl PSC limits are established by the setline survey (with the exception of Alternative 3.3b), which is highly correlated to the spawning biomass because the survey gear catches larger, older fish that are more likely to be mature.

  - The trawl PSC limits are related to the bottom trawl survey, which tends to catch smaller, younger fish that are less likely to be mature. In addition, the biomass of smaller fish is a function of incoming recruitment. Recruitment in the BSAI in the model is a function of spawning biomass, but is also highly variable. Additionally, the proportion of recruitment between the BSAI and the other area is variable, and doesn't show the consistent downward trend in spawning biomass at the start of the simulation.

- The 2030 non-trawl PSC limits are generally larger than those in 2024, consistent with the fact that spawning biomass (and thus the setline trend) stabilizes in the BSAI and show a very slight increase between 2025 and 2030.

Performance metrics

Performance metrics were developed to evaluate each of the 5 Council-defined objectives for ABM. These objectives are listed by gear type in Table ES-4 with results characterized by color coding across objectives and Alternatives. A key to colors is listed below the table. Note that the order of listing these objectives does not convey prioritization:

- Halibut PSC limits should be indexed to halibut abundance
- There should be flexibility provided to avoid unnecessarily constraining the groundfish fishery particularly when halibut abundance is high
- Provide for some stability in PSC limits on an inter-annual basis.
- Provide for directed halibut fishing operations in the Bering Sea.
- Halibut spawning stock biomass should be protected especially at lower levels of abundance

A small set of metrics are calculated for each alternative over the full 20 years of the simulation to provide some additional comparison across the different alternatives to assess how well each alternative (or sub-alternative) met a subset of the Council objectives. These performance metrics can be used to evaluate trade-offs amongst alternatives.

A big picture summary of Alternatives relative to performance metrics is provided in Table ES-4. Additional information on the actual metrics calculated is provided in Chapter 5 Section 5.4 and results presented in Chapter 6 Section 6.1.4 and not repeated below. **These general trends were summarized from the metrics that were simulated after 20 years and detailed results are contained in Table 6-2 through Table 6-4**. This summary table below is intended to reflect general performance for a given metric (only one was selected from Table 6-2 through Table 6-4 when multiple metrics were calculated) to show the variability amongst the Alternatives at addressing the Council's chosen objectives. As anticipated Alternatives meet varying objectives to different degrees. In general, many of the performance metrics calculated do not show a great deal of contrast for a given objective across alternatives and consideration of different performance metrics may be necessary to best indicate how well alternatives meet different objectives.

Table ES-4 Summary of relative performance of Alternatives against Council objectives for this analysis. Note that trawl and non-trawl performance is listed separately. These trends are generally summarized from information contained in Table 6-2 through Table 6-4 of this document.

	Index to abundance (trawl)	Flexibility (trawl)	Stability (trawl)	Index to abundance (non-trawl)	Flexibility (non-trawl)	Stability (non-trawl)	Directed halibut catch	Protect SSB*
Alt_1								
Alt_2.1								
Alt_2.1a								
Alt_2.1b								
Alt_2.2								
Alt_2.3								
Alt_2.4								
Alt_3.1								
Alt_3.1a								
Alt_3.1b								
Alt_3.1c								
Alt_3.1d								
Alt_3.2a								
Alt_3.2b								
Alt_3.3a								
Alt_3.3b								

*as noted in the document the SSB performance metric was not calculated due to low variation amongst alternatives.

Legend:

	Metric = best value Biomass= high correlation
	Metric = metric was somewhat met but did not produce the 'best' value
	Metric= worst value for that metric Biomass= low correlation
	Metric= improvement over the worst value but still in a lower range

Here dark blue indicates which alternative had the best value for that metric as a measure that it met that objective (based on the selected metrics employed) more so than other Alternatives that are shaded differently. Light blue indicates that the metric was somewhat met but did not produce the 'best' value of the suite of Alternatives. Dark orange indicates that it was the worst value for that metric over all of the Alternatives while light orange was an improvement over the dark orange value but still in a lower range for meeting the metric. No shading indicates it was neither near the best nor near the worse of the range. For the objective relating to "Index to Abundance" a correlation analysis with the indices was provided to inform how well the alternatives address this objective. Here blue indicates well correlated while orange indicates that the alternative does not correlate well (due to characteristics of the Alternative) with the gear-specific survey (BTS for trawl and FISS for non-trawl). Generally, all of the Alternatives were well correlated with the survey index with a few exceptions.

Additional sections contained in this preliminary DEIS

Chapters 3 and 4 of this preliminary DEIS contain comprehensive background information on the groundfish and halibut fisheries, resources, management and characteristics. This for important context for the alternative management measures under consideration.

Appended separately (**Appendix 1**) is a social impact assessment (SIA) which evaluates community and regional participation patterns in the Bering Sea/Aleutian Islands (BSAI) groundfish and halibut fisheries as well as potential community level impacts from the various action alternatives and the no-action alternative. Potential impacts to subsistence and sport halibut fisheries are also evaluated.

As noted previously, appended separately are details on the comprehensive suite of indices considered during the process of identifying the two indices for this analysis (**Appendix 2**), model validation overview (**Appendix 3**), complete model results by alternative (**Appendix 4**) and sensitivity runs on the operating model (**Appendix 5**).

Where are we in the process?

The Council has reviewed several discussion papers and drafted a suite of alternatives for analysis. Figure ES-5 shows where this initial review of this preliminary DEIS fits into the overall Council and NEPA process and how decisions at this meet might affect scheduling moving forward.

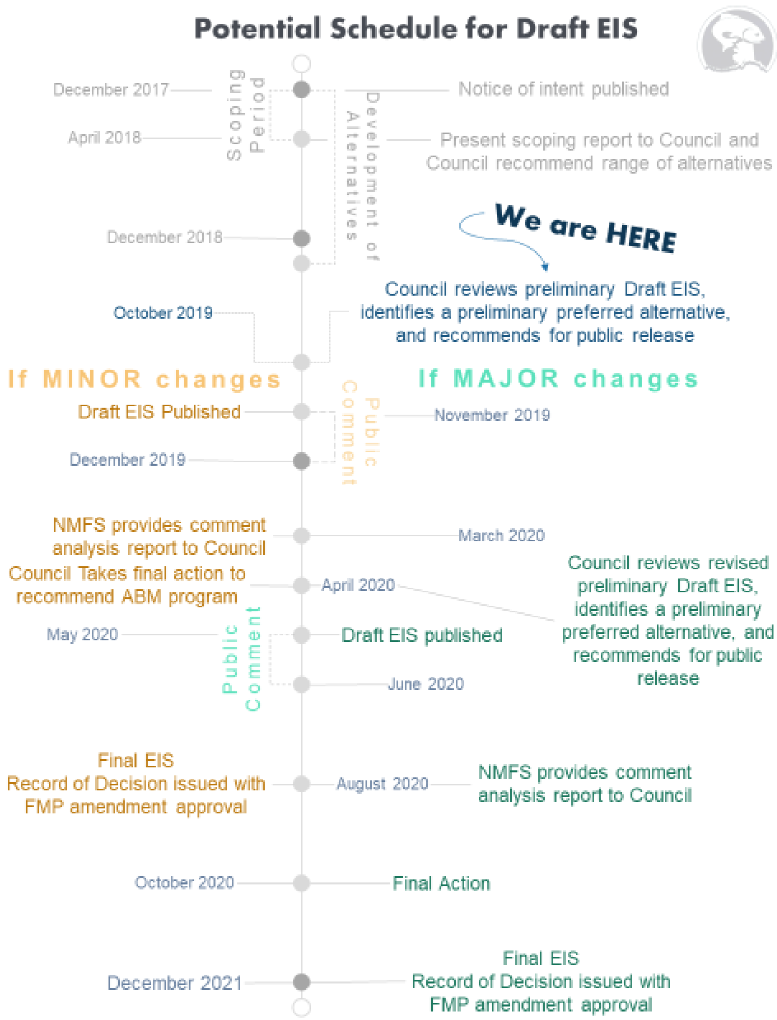


Figure ES-5 Previous Council considerations (grey), proposed NEPA schedule and potential Council schedule for DEIS

Key discussions and decision points at this meeting include the following:

- Review the suite of Alternatives and provide any revisions as desirable. Key considerations include:
    - Do these Alternatives as currently constructed meet the intent of the Council's action?
    - Could complexity and redundancy be reduced and still address the Council's intent?
- Review the halibut simulation model, including analytical assumptions and application for purposes of informing the Council's policy decisions for this analysis.
- Review the suite of draft performance metrics and revise as needed. Revised performance metrics may better characterize results across alternatives to indicate where they address conflicting Council objectives.

The analysts are also looking for input from the stakeholders on the background information provided in Chapters 3 and 4 to understand the operational and management issues within both the directed halibut fishery and directed groundfish fisheries as well as the context within which this analysis is being considered among other Council BSAI groundfish analyses and priorities.

1 Introduction

This document analyzes proposed management measures to index Pacific halibut prohibited species catch (PSC) limits in the Bering Sea and Aleutian Islands (BSAI) groundfish fisheries to halibut abundance. PSC limit modifications are considered for various sectors, including the BSAI trawl limited access (TLAS) sector, the Amendment 80 sector, longline catcher vessels (CVs), longline catcher processors, and the Community Development Quota (CDQ) sector (i.e., a reduction to the CDQ's allocated prohibited species quota reserve). The objective of modifying PSC limits is to index PSC limits to halibut abundance which may achieve different goals of providing flexibility to the groundfish fisheries in times of high halibut abundance, protecting spawning biomass of halibut especially at low levels, and stabilizing in inter-annual variability in PSC limits, all of which may provide additional harvest opportunities in the commercial halibut fishery.

This document is a preliminary draft Environmental Impact Statement (DEIS). A preliminary DEIS provides assessments of the environmental impacts of an action and its reasonable alternatives, the economic benefits and costs of the action alternatives, as well as 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 North Pacific Fishery Management Council (Council) and the National Marine Fisheries Service (NMFS) Alaska Region to provide the analytical background for decision-making.

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 in the BSAI. Currently halibut PSC limits are 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. 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 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 fishery management plan (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)).

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 and non-trawl groundfish fisheries; (2) apportioning those halibut PSC limits to groundfish sectors, 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 objectives to minimize bycatch to the extent practicable and achieving, on a continuing basis, optimum yield from the groundfish fisheries. Halibut PSC limits in the groundfish fisheries provide an additional constraint on halibut PSC mortality and promote conservation of the halibut resource. With one limited exception, groundfish fishing is prohibited once a halibut PSC limit has been reached for a particular sector or season. 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's purpose and need statement for this action is:

The current fixed yield-based halibut PSC caps are inconsistent with management of the directed halibut fisheries and Council management of groundfish fisheries, which are managed based on abundance. When halibut abundance declines, PSC becomes a larger proportion of total halibut removals and thereby further reduces the proportion and amount of halibut available for harvest in directed halibut fisheries. Conversely, if halibut abundance increases, halibut PSC limits could be unnecessarily constraining. The Council is considering linking PSC limits to halibut abundance to provide a responsive management approach at varying levels of halibut abundance. The Council is considering abundance-based PSC limits to control total halibut mortality, particularly at low levels of abundance. Abundance based PSC limits also could provide an opportunity for the directed-halibut fishery and protect the halibut spawning stock biomass. The Council recognizes that abundance-based halibut PSC limits may increase and decrease with changes in halibut abundance.

The Council derived the following objectives from the purpose and need statement for this action to guide the development of appropriate management measures:

- Halibut PSC limits should be indexed to halibut abundance

- Halibut spawning stock biomass should be protected especially at lower levels of abundance
- There should be flexibility provided to avoid unnecessarily constraining the groundfish fishery particularly when halibut abundance is high
- Provide for directed halibut fishing operations in the Bering Sea.
- Provide for some stability in PSC limits on an inter-annual basis.

These objectives have not been prioritized by the Council and may be in opposition to others thus designing a management program which meets all of them equivalently may be challenging. The goal of this analysis of the Council's alternatives, is to evaluate how well each alternative meets the purpose and need statement, these competing objectives and the National Standards.

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, as 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 and subsistence catches, before setting commercial halibut catch limits each year. Specifically, the IPHC uses the current year's projection of the PSC amount to establish the following year's commercial halibut fishery catch limit. Recently, there have been concerns about the levels of halibut PSC in the commercial groundfish trawl and hook-and-line (longline) sectors. First, the spawning biomass of Pacific halibut in the 1990s was the highest seen in many decades, and has since declined to levels that are likely more common since the 1940s. Second, the declining biomass from these unusually high levels has resulted in decreases in the 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 concern by reducing halibut PSC limits for the BSAI groundfish fisheries implemented by Amendment 111 to the FMP.

The Council recognizes efforts by the groundfish industry to reduce total halibut PSC in the BSAI. The continuing low levels of halibut biomass have however, continued to result in reduced directed fishery catch limits in Area 4 relative to catch limits from the 1990s through 2010. Based on the IPHC management objectives as well as recent projections of halibut biomass and estimates of PSC, 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 by Amendment 111 to the FMP. Therefore, the Council is considering the new approach described here to link PSC limits to halibut abundance.

The Council does not have authority to set catch limits for the directed halibut fisheries. The Council does set halibut PSC limits in the groundfish fisheries, and this is one of the factors that affects harvest limits for the directed halibut fisheries. Halibut PSC in the groundfish fisheries are a significant portion of total mortality in BSAI IPHC areas and affect 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 provide additional harvest opportunities in the BSAI directed halibut fishery, particularly at low levels of abundance.

Under 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, and with 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 abundance-based halibut PSC limits must minimize halibut PSC in the commercial groundfish fisheries to the extent practicable, while preserving the potential for the optimum harvest of the groundfish total allowable catch (TACs). Abundance-based halibut PSC limits should minimize halibut PSC to the extent practicable in consideration of the regulatory and operational management measures currently available to the groundfish fleet, and the need to ensure that catch in the trawl and non-trawl fisheries contributes to the achievement of optimum yield in the groundfish fisheries. 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, abundance-based halibut PSC limits may provide harvest opportunities in the Area 4 commercial halibut fishery that meet IPHC and Council management objectives, particularly at low levels of halibut abundance. This would be consistent with the Council's objective to provide for directed halibut fishing operations and IPHC's objective to maintain the Pacific halibut stock at a level that will permit optimum yield from the directed fishery. 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 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 from 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, abundance-based halibut PSC limits may provide the groundfish fisheries with higher PSC limits and increased groundfish harvests. This would be consistent with the Council's objective to avoid constraining groundfish harvests, particularly at higher levels of abundance. Finally consideration is given to the inter-annual variability in abundance-based halibut PSC limit with option to constrain this so that it does not fluctuate above desirable levels. This is consistent with the Council's objective to provide for some stability in PSC limits on an inter-annual basis.

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. 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).

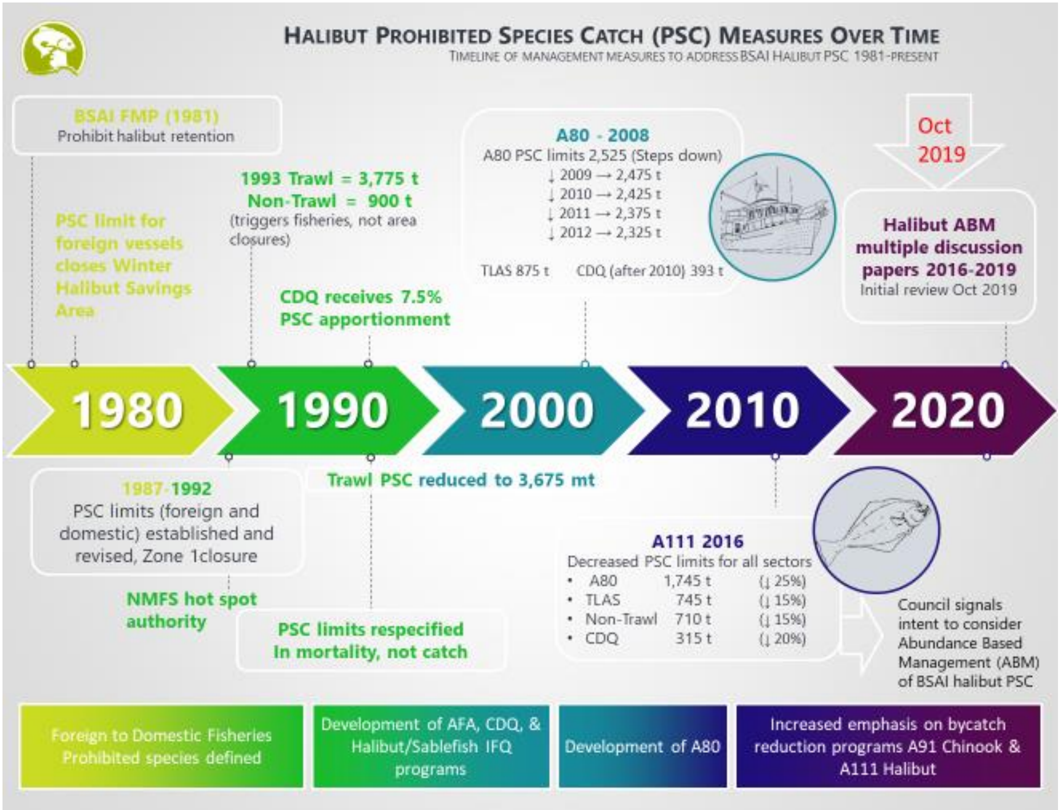


Figure 1-1 Historical overview of BSAI halibut PSC measures 1981-present.

Table 1-1 shows the changes in the PSC limits by sector pre-Amendment 80 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 CDQ limit was increased by 50 metric tons in 2010.

Table 1-1 Evolution of Pacific halibut PSC limits in metric tons (t) by main sectors in the BSAI region, 1999-2019 (see schematic 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 this table.

	Trawl	Non-trawl	Am80	BSAI TLAS	Non-trawl	CDQ	Total PSC limit
1999-2007	3,675	900	NA	NA			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
2012-2015			2,325	875	833	393	4,426
2016-2019			1,745	745	710	315	3,515

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. Following the Council's February 2015 request, IPHC staff took the lead on drafting a paper examining several aspects of exploring 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). This paper was presented to the AP and the Council at the December 2015 Council meeting[4].

The Council then initiated subsequent discussion papers and requested that analysts from within the different agencies (IPHC, NMFS AFSC, NMFS RO and NPFMC staff) collaborate to provide additional information on appropriate indices for use in indexing halibut abundance to PSC in the Bering Sea. Table 1-2 provides a brief summary of the papers reviewed by the Council and the focus of these papers from 2016-2019 leading up to this DEIS. A brief recap by year is also provided below.

In April 2016, the analysts provided a discussion paper which addressed a number of different issues including a range of indices, information on establishing control rules and data on current usage of halibut bycatch by sector and gear type in the groundfish fisheries. Following review, the Council adopted a Purpose and Need Statement.

In October 2016, the Council reviewed a discussion paper which addressed characteristics of a range of indices and control rule combinations as well as provided an overview of how to develop performance metrics. These control rule combinations and indices were explored further in the April 2017 discussion paper where strawmen alternatives, or draft Abundance Based Management Alternatives (ABMs) were developed. Performance metrics for the analysis of alternatives were discussed at a public workshop in February 2017 as well as in the June 2017 discussion paper along with characteristics of indices. A comprehensive review of all of the discussion papers was then provided in October 2017.

In 2018 several discussion papers were provided in April, June and October to discuss modeling approaches, control rule options, performance metrics and consideration of an O26 performance standard. In June 2018, the SSC reviewed a paper on proposed methodology for impact analysis. Following adoption of a revised set of alternatives in October 2018, the Council initiated a stakeholder committee tasked with providing the analysts with specific scenarios from the broad group of Alternatives, Elements and options for analysis as well as providing feedback on recommended performance metrics. The Stakeholder Committee convened two meetings to provide input to the Council and the Council moved to amend its suite of alternatives in February 2019 to incorporate all of the recommended scenarios.

[4] The paper, Exploring index-based PSC limits for Pacific halibut by S. Martell, I. Stewart and C. Wor can be accessed at: http://goo.gl/hFPRpf

Table 1-2 Information contained in previous materials provided April 2016-February 2019

Topic	**Information**	**Link**
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 1.3, the Council has already reviewed several discussion papers and drafted a 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 meet might affect scheduling moving forward.

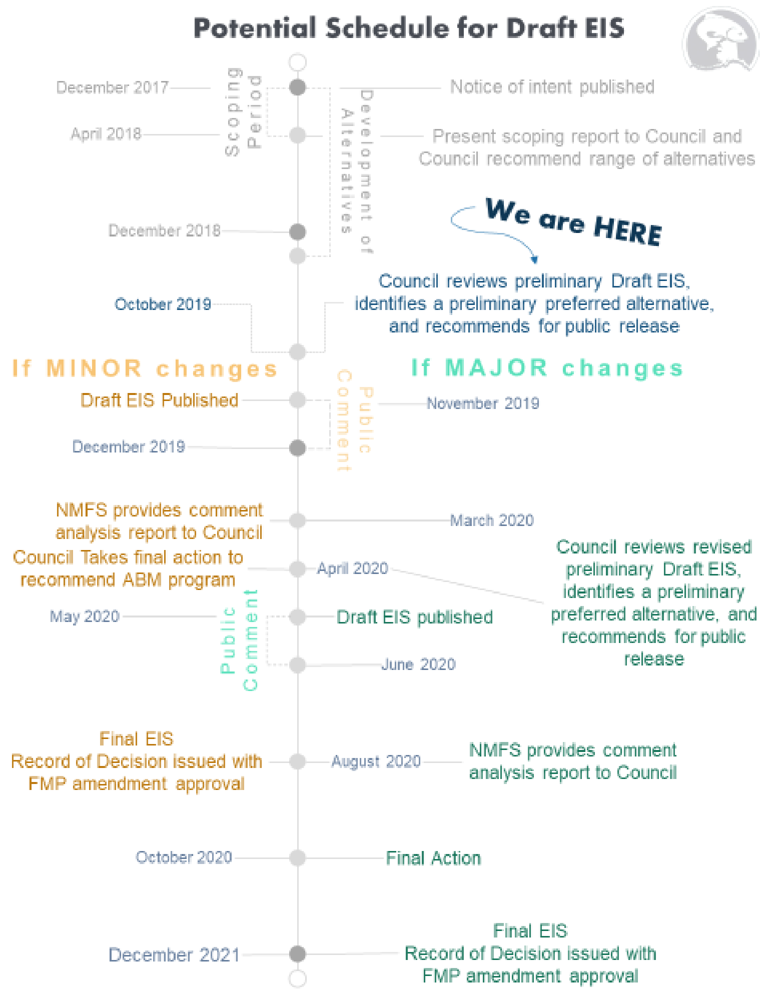


Figure 1-2 Previous Council considerations (grey), proposed NEPA schedule and potential Council schedule for DEIS

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).

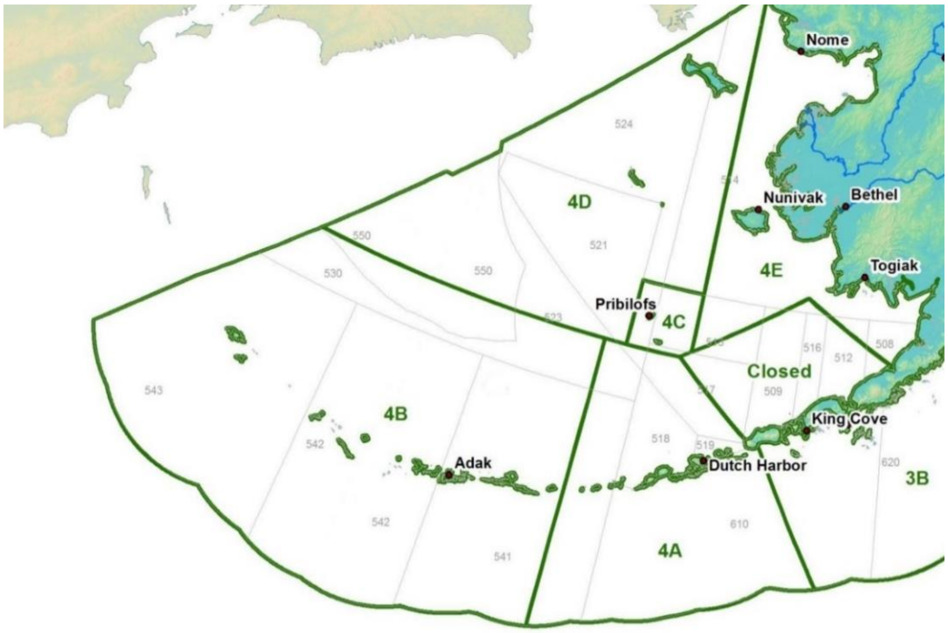


Figure 1-3 Alaska groundfish reporting areas and IPHC regulatory areas for Pacific halibut. Source: Adapted from NMFS Alaska Region map by Northern Economics Inc.

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.

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

NMFS Areas	IPHC Area	Region
517, 518, 519	4A	BSAI
541, 542, 543	4B	
513, 514, 521, 523, 524	4CDE and Closed area	
508, 509, 512, 516		

1.6 Abundance indices

The Council selected two abundance indices to track Pacific halibut abundance and guide setting PSC limits in the BSAI groundfish fisheries[5]. These are from the NMFS AFSC EBS shelf bottom trawl survey and from 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 which index halibut PSC to abundance.

1.6.1 AFSC EBS shelf bottom trawl surveys

The NMFS Alaska Fisheries Science Center (AFSC) has conducted the eastern Bering Sea shelf bottom trawl survey (EBS shelf survey) annually 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 and 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 and 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 sampled annually. The AFSC added 20 stations to the northwest sector in 1987, resulting in a total of 376 stations.

[5] Additional indices were considered and not carried forward as candidate indices see Section 2.8 and Appendix XX for more information on those indices.

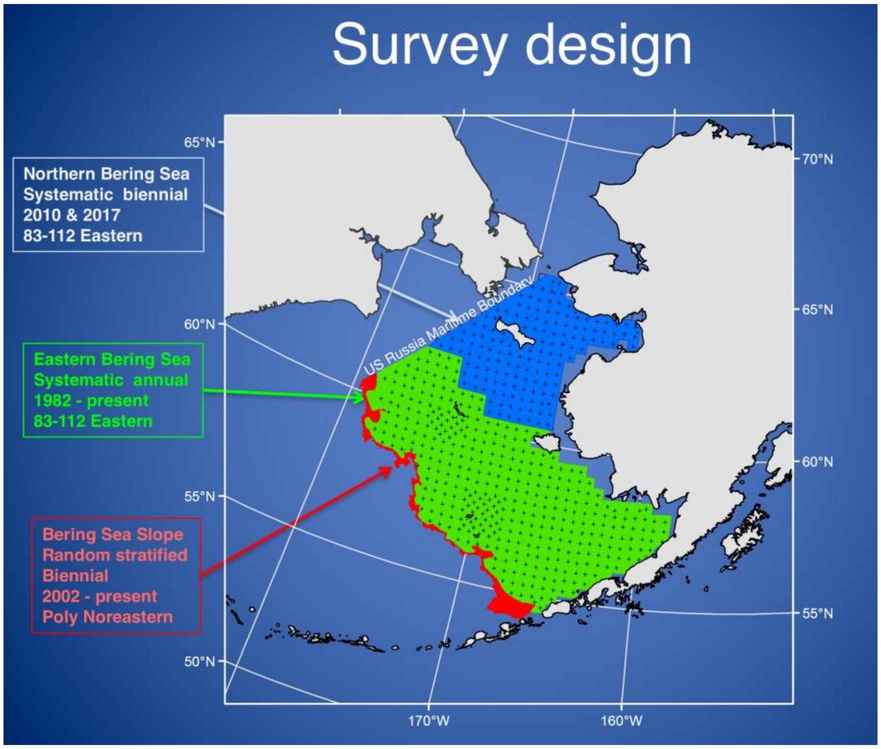


Figure 1-4. Layout of NMFS trawl survey designs (Source: Bob Lauth, AFSC).

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, provided for each taxon code appearing in the survey database, are 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 gather 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. And as described above, 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 of 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

The EBS shelf survey is conducted annually. The data from the survey is available each year in the fall and is 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.

1.6.1.5 Halibut Abundance data from survey

The IPHC estimate of total Pacific halibut abundance in the EBS using the shelf bottom trawl survey catches in 2016 was 66 million halibut, 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 closer to 50 million halibut in 2017. In contrast, biomass estimates were down in 2018 with a total of 338.8 million pounds (125,702 t) compared to 380 million pounds (195,535 t) in 2010.

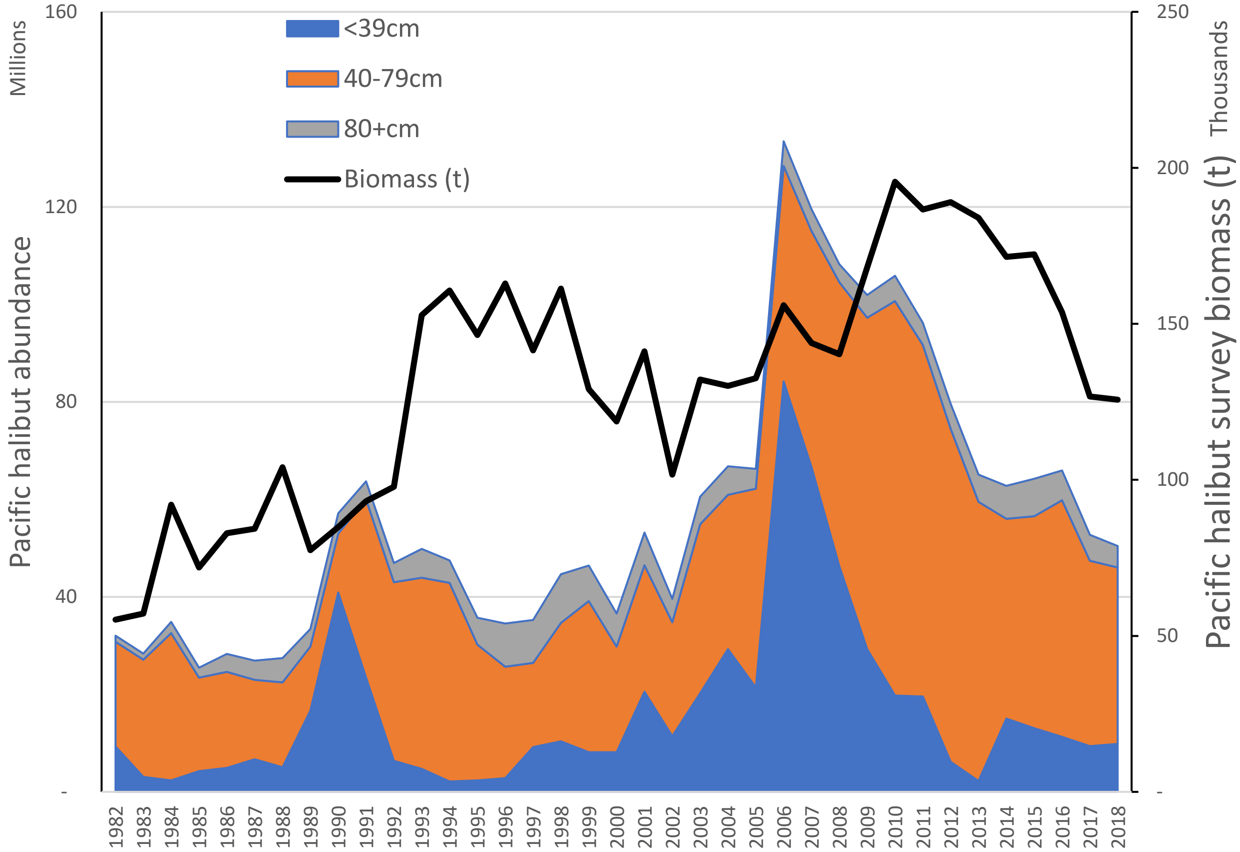


Figure 1-5 Estimated abundance (numbers of Pacific halibut) by length category, total biomass (pounds) as estimated by the NMFS Bering Sea Trawl survey data, 1982-2018. The trawl survey index was the area-swept biomass (catch-per-unit-effort multiplied by stratum area) estimated for the EBS by the annual NMFS EBS trawl survey during 1998–2018.These include all the standard core area strata (10+20+31+32+41+42+43+50+61+62) (Table 1-4), but not the northwest area strata (82 + 90).

Table 1-4 Estimated trawl survey index (metric tons t) for the year 1998–2018.

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	125,702
2008	140,247		

1.6.2 IPHC Fishery-Independent Setline Survey (FISS) or Setline Survey

The IPHC's annual fishery-independent setline survey (referred to as FISS or 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 main priority of the setline survey is to measure catch rates and biological information for Pacific halibut, but many other projects are included such as tagging of halibut, collection of environmental data, collecting data from other species, and recording observations of seabirds.

1.6.2.2 Technical design

The survey typically charters 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 range 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) are often surveyed as part of expansion studies.

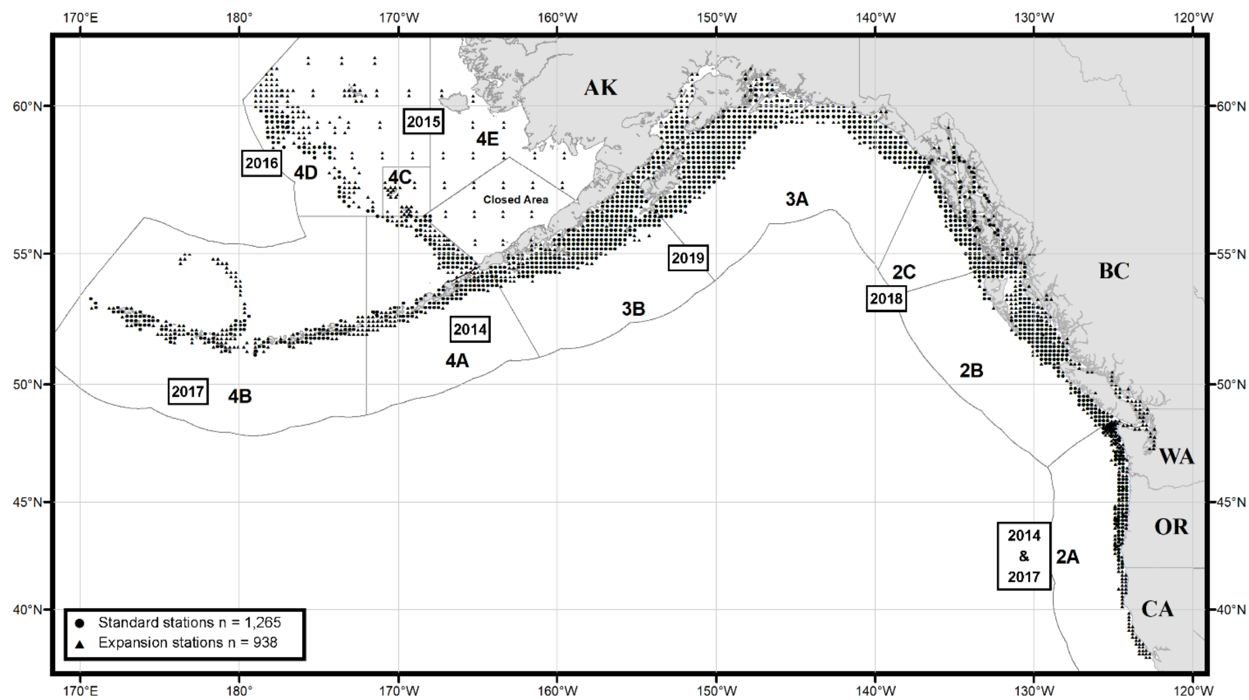


Figure 1-6 Standard stations (circles) and expansion stations (triangles, 2014–2019) for the IPHC setline survey.

The standard grid of survey stations has been in place since 1998, with the addition of stations around the Pribilof and St. Matthew Islands beginning in 2006, and twelve stations in the Washington/Oregon regions beginning in 2011. Prior to 1997, the survey had less coverage, but data are available for many Regulatory Areas (Stewart & Monahan 2016). Certain areas include expansion stations (additional stations to cover additional area) in some years to investigate catch rates outside of the normal survey area and to calibrate with other surveys (e.g., the eastern Bering Sea trawl survey).

The fishing gear used in the setline survey data generally catches halibut that are O26 and encountered in the directed fishery. Six skates of baited gear were fished in 2016, but 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.

1.6.2.3 Effective Assessment of halibut

Pacific halibut observations are recorded by IPHC sea samplers on the vessel. The fork lengths of all Pacific halibut were recorded to the nearest centimeter. Each length was 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 were directly observed during the sampling process. Average O32 WPUE, expressed as net pounds per skate, was 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. Finally, the presence and abundance of seabird species within a 50-meter radius of the vessel's stern are recorded (Geernaert 2017).

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, we not only have information about density at a location and time from a direct observation, but from other data 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 include stations on the eastern Bering Sea flats, except for those around St. Matthew Island and the Pribilof Islands. Instead, data from annual National Marine Fisheries Service (NMFS) trawl surveys are calibrated to the 2006 and 2015 IPHC setline surveys in the eastern Bering Sea (Webster et al. 2016). The annual NMFS 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.

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. In the past, only WPUE for O32 and NPUE for all fish (Total) has been reported, but since 2017, WPUE for all years 1993 to current will be 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)) See Sections 4.3.1 for additional information on TCEY.

1.6.2.5 Halibut abundance from setline survey

The space-time model provides WPUE and NPUE for each IPHC Regulatory Area, where 4CDE is 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 1-7 along with an appropriately combined Total WPUE for all three areas (4ABCDE). The correlation between all of these index time-series is high, and we consider the 4ABCDE total WPUE index of abundance a potential ABM index. However, the index for any of the individual areas can easily be substituted.

Table 1-5 IPHC 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 (1998-2018) for comparison, except for "Index 4ABCDE," which is the calculated weight-per-unit-effort index (WPUE) for all sizes of Pacific halibut.

Year	Coastwide	4A	4B	4CDE	4ABCDE	Index 4ABCDE
1998	1.51	2.15	2.55	1.00	1.77	18,502
1999	1.40	1.88	2.04	0.97	1.55	16,201
2000	1.44	1.89	1.87	1.05	1.55	16,203
2001	1.30	1.58	1.38	1.03	1.32	13,780
2002	1.29	1.42	1.03	0.96	1.16	12,104
2003	1.17	1.22	0.84	0.97	1.04	10,866
2004	1.16	1.09	0.76	0.93	0.96	9,987
2005	1.05	0.99	0.71	0.94	0.91	9,550
2006	0.99	0.85	0.82	1.08	0.94	9,802
2007	0.98	0.80	1.01	1.01	0.93	9,673
2008	0.92	0.93	1.01	1.02	0.98	10,264
2009	0.85	0.90	0.84	1.03	0.94	9,834
2010	0.81	0.77	0.73	1.06	0.88	9,146
2011	0.81	0.69	0.75	1.02	0.83	8,669
2012	0.86	0.68	0.63	1.02	0.80	8,403
2013	0.74	0.53	0.75	1.01	0.76	7,989
2014	0.79	0.56	0.65	1.04	0.77	7,995
2015	0.80	0.56	0.67	1.05	0.78	8,130
2016	0.82	0.51	0.68	1.03	0.75	7,826
2017	0.68	0.52	0.62	0.91	0.69	7,250
2018	0.64	0.47	0.69	0.90	0.68	7,141

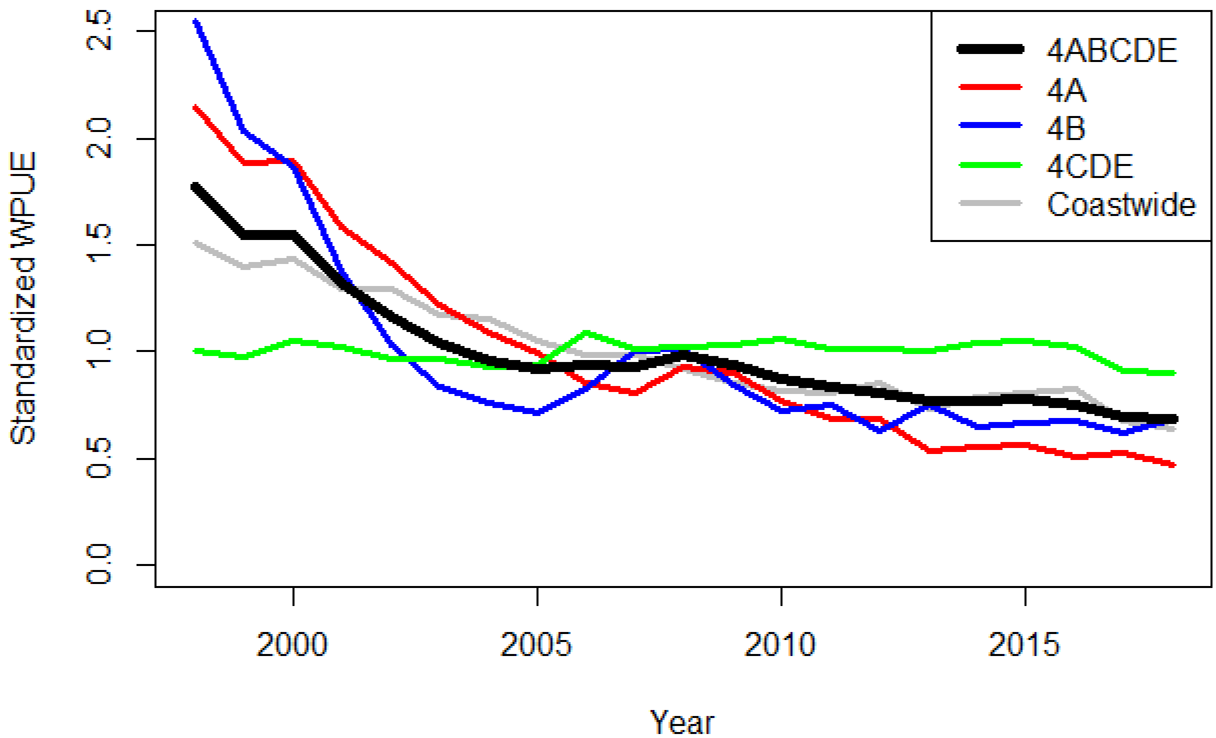


Figure 1-7 WPUE all Pacific halibut (Total) for IPHC Regulatory Areas in Area 4 standardized to the mean of the time series (1998-2017) for each Area. Area 4ABCDE is the sum of Areas 4A, 4B, and 4CDE, and Coastwide is all IPHC Regulatory Areas summed. Summed indices are appropriately weighted by bottom area.

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 index PSC limits to halibut abundance. The current halibut PSC limits for Amendment 80[6] and BSAI TLAS sectors are established in the BSAI Groundfish FMP, along with the total apportionment of halibut PSC limit (from trawl and non-trawl) to the Community Development Quota (CDQ) Program and the combined non-trawl fisheries (e.g. hook-and-line CPs and CVs which primarily target Pacific cod). Changing these PSC limits (under Alternatives 2 and 3) requires an FMP (and regulatory) amendment.

There are three overarching Alternatives under consideration by the Council. These have been developed through multiple discussion papers and Council considerations, and consultation with stakeholders. These Alternatives range from status quo with fixed halibut PSC limits by sector to a range of gear-specific PSC limits indexed to BSAI halibut abundance.

Alternative 1: Status Quo. BSAI halibut PSC limits are fixed at 3,515 t total for all sectors.

Alternative 2: A single index is used to set trawl and/or[7] non-trawl halibut PSC limit. There are two options for selection of an index.

Option 1: NMFS EBS bottom trawl survey index.

Option 2: IPHC Area 4 setline survey index.

Alternative 3: Both primary and secondary indices are used to set trawl and/or non-trawl[3] PSC limit. The secondary index modifies the PSC limit after the primary index is applied when the secondary index is in a "high state" or a "low state" (as defined by Element 4 breakpoint options). The extent to which the secondary index influences the PSC limit above or below these breakpoints is determined by selection of options under Element 5. In some scenarios, the primary and secondary indices may act at all levels of abundance (i.e., no breakpoints). There are two options for specifying which index is the primary index and which is the secondary index under this alternative.

Option 1: Primary index is EBS trawl survey, secondary index is Area 4 setline survey.

Option 2: Primary index is Area 4 setline survey, secondary index is EBS trawl survey.

Under both Alternatives 2 and 3 there are five Elements (with Options) that must be specified under any alternative formulation and two additional that are optional. Additional information for each Element and option is contained in Section 2.2 and Section 2.3.

2.1 Alternative 1, No Action

Under Alternative 1, the No Action or status quo alternative, 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. The following four BSAI halibut PSC limits are established, which total 3,515 t: Amendment 80 sector—1,745 t; BSAI trawl limited access sector (TLAS)—745 t; BSAI non-trawl sector—710 t; and CDQ Program—315 t (established as a PSQ reserve) (Table 2-1). The CDQ program is not apportioned by gear or fishery. The

[6] See Section 3.3 for a description of the Amendment 80, Trawl limited access, CDQ and Non-trawl sectors and the target groundfish prosecuted by these fisheries.

[7] Analysts assumed that the "and/or" in Alternative 2 and 3 pertains to the ability to use either one index for both gear types or different indices for each gear type within this Alternative. The analysts did not assume that under Alternative 2 and 3 one gear type could be indexed to abundance while the other remained at status quo. Unless the Council indicates otherwise at initial review, this will be the understanding moving forward.

Amendment 80 trawl PSC limit is specifically allocated to the Amendment 80 cooperatives or the Amendment 80 limited access sector. The TLAS and non-trawl PSC limits can then be annually apportioned in the harvest specifications process to the target fishery categories specified in regulations based on anticipated halibut PSC in the upcoming year and the need to optimize the amount of total groundfish harvested. Harvest specification adjustments can be made to sectors' annual or seasonal allocations. Figure 2-1 illustrates how the PSC limits are currently apportioned. All vessels fishing in that fishery category (sector) or target fishery must stop fishing for the remainder of the year or season when an annual or seasonal PSC limit is reached. One exception is that NMFS does not have authority to close the TLAS pollock and Atka mackerel fisheries if the PSC limit for that fishery is reached.[8]

Table 2-1 Status quo BSAI Halibut PSC limits by sector (metric tons, t, mortality)

	Current PSC limit
Amendment 80 cooperatives	1,745 t
BSAI trawl limited access fisheries	745 t
Non-trawl fisheries	710 t
CDQ fisheries	315 t
TOTAL	3,515 t

[8] If the pollock/Atka mackerel/"other species" fishery category will reach its halibut PSC allowance, NMFS does not have the authority to close the pollock/Atka mackerel/"other species" fishery category. By a regulation adopted in 1992, if the PSC allowance for the pollock/Atka mackerel/"other species" category will be reached, NMFS only has authority to close directed fishing for pollock to trawl vessels using nonpelagic trawl gear (57 FR 43926, 43935, September 23, 1992; § 679.21(e)(7)(i)). However, in 2000, NMFS prohibited directed fishing for pollock in the BSAI with nonpelagic trawl gear at all times and extended that prohibition to CDQ sector vessels in 2006 (65 FR 31105, May 16, 2000; 71 FR 36694, June 28, 2006; § 679.24(b)(4)). Thus, if the halibut PSC allowance for the trawl fishery category of pollock/Atka mackerel/"other species" will be reached, NMFS does not have authority to take additional action.

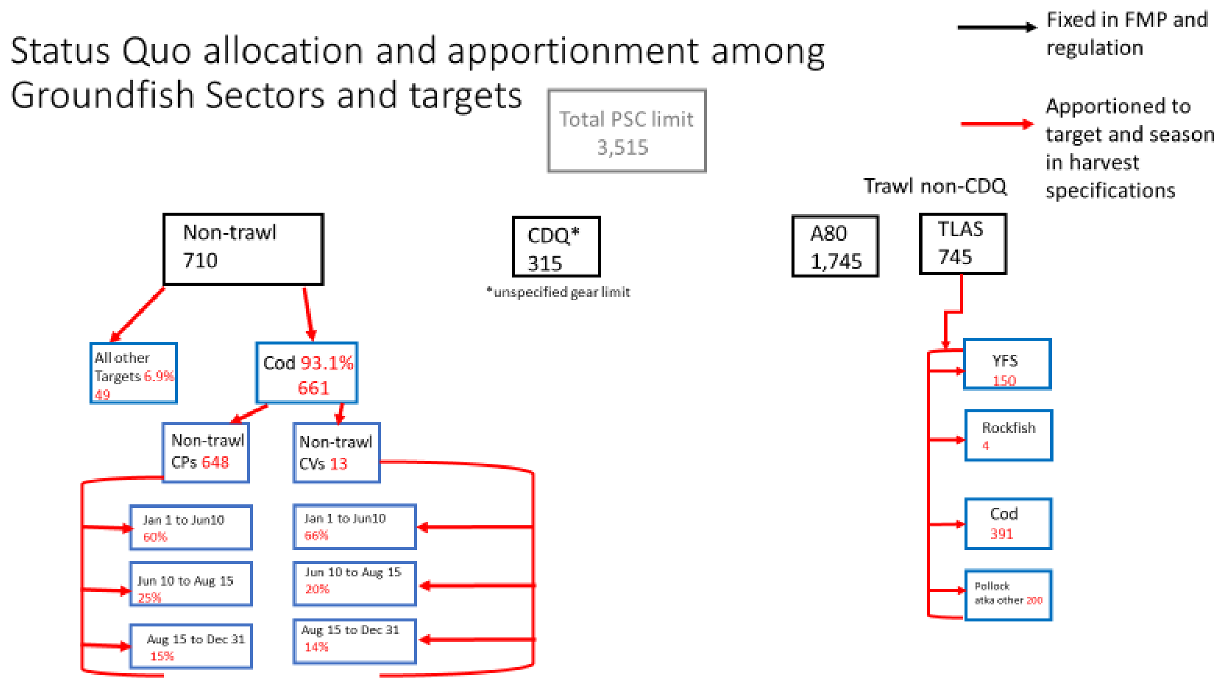


Figure 2-1 Flow Chart of BSAI Halibut PSC Limits for 2019

Federal regulations establish the current total BSAI TLAS and non-trawl PSC limit and authorize NMFS to apportion each to the established fishery categories through the annual harvest specifications process. The regulations do not specify halibut PSC limits for the non-trawl sectors (i.e., hook-and-line Pacific cod CV, hook-and-line Pacific cod CP, and hook-and-line and other target fisheries CV and CP). Establishing the halibut PSC limits for these sectors through the harvest specifications process enables the Council to annually determine the PSC apportionment among these sectors after considering relevant information such as changes in seasonal distribution of halibut or target groundfish species, changes in halibut biomass or groundfish TACs, and variations in fishing effort that could occur during the upcoming year. Under status quo, the BSAI trawl limited access sector's PSC limit is apportioned among target fishery categories during the annual harvest specifications process.

The non-trawl CV sector includes both hook-and-line and pot gear vessels. If the hook-and-line CVs reach the current halibut PSC limit of 13 t then those vessels would no longer be able to directed fish for Pacific cod during that season. Halibut caught by pot gear vessels does not accrue to a PSC limit due to low halibut bycatch mortality, pursuant to Section 3.6 of the BSAI Groundfish FMP. However, NMFS does estimate halibut catch and mortality in pot gear and reports it to IPHC for use in the annual specifications process. Some fixed-gear vessels that do not possess a Federal Fisheries Permit (FFP) and operate solely in state-waters fisheries also encounter halibut. The halibut mortality recorded by those vessels accrues to the relevant sector limit if one exists (e.g., non-trawl CV).

For CDQ, a single halibut PSC limit is identified in the FMP and annually apportioned to CDQ entities as prohibited species quota (PSQ). That halibut PSC can be used by both trawl and non-trawl fishing operations to prosecute groundfish.

	APICDA	BBEDC	CBSFA	CVRF	NSEDC	CDQ Group YRFDA
Allocation of Aggregate CDQ PSC limit	22%	22%	9%	12%	12%	23%

2.2 Alternative 2: Single index used to set trawl and/or non-trawl halibut PSC limit

Under Alternative 2, the groundfish fishery halibut PSC limits would be calculated by gear type using a control rule applied to one of two indices: NMFS EBS bottom trawl survey index (**Option 1**) or IPHC Area 4 ABCDE setline survey index (**Option 2**). Here the intent is to index the PSC limit to the index which samples by the same gear type or to use one index for both gear types.

In this alternative, an aggregate trawl fishery PSC limit would be calculated based upon the selected control rule (from amongst the elements and options below) applied to the estimated halibut biomass from either the EBS trawl survey or the IPHC setline survey in Area 4ABCDE. Likewise, the non-trawl fishery PSC limit (in aggregate) would be calculated based upon the selected control rule (from amongst the elements and options below) applied to the estimated halibut relative biomass from either the IPHC setline survey in Area 4ABCDE or the EBS trawl survey biomass estimate. Once the aggregate limits by gear type are calculated, sectors within the trawl category would be allocated PSC limits proportional to their status quo proportions. The entire CDQ limit would be derived from the aggregate trawl PSC limit component although the CDQ PSQ could be used to prosecute either trawl or fixed gear fisheries. Amendment 80 would be allocated 64% of the trawl total, TLAS 27% and CDQ 9% (see Section 2.4 for additional details on the allocations to sectors and targets under Alternatives 2 and 3).

The elements and options described below define the control rule and the responsiveness to fluctuations in inter-annual changes in the biomass indices (see Figure 2-2- Figure 2-3for additional information on control rules and features). The first three elements address specifying the starting point for the PSC limit (Element 1). maximum PSC limit (Element 2 Ceiling), and minimum PSC limit (Element 2 Floor 3).

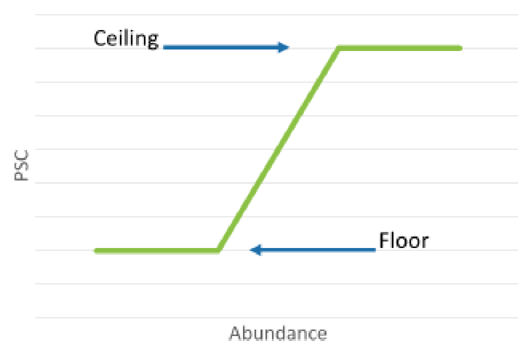


Figure 2-2 Example control rule (1:1 slope) with imposed ceilings and floors

An additional Element (Element 4) may be selected if breakpoints for either the primary and/or the secondary index are desired. The magnitude of the response (Element 5) must be specified for either the primary or secondary index which is applicable to both Alternatives 2 and 3. The response (or slope) is defined as the change in the PSC limit relative to the change in the index.

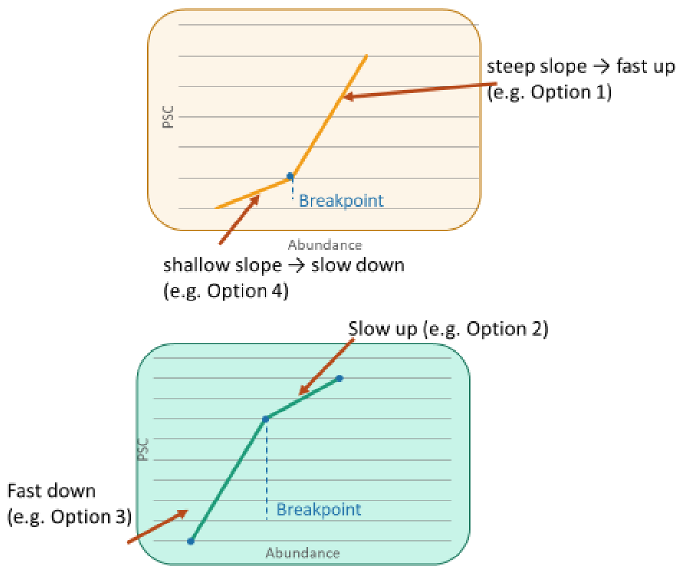


Figure 2-3. Different options for modifying the response under Element 5 across breakpoints to suit different policy objectives

For example, 1:1 means that a one unit increase in the standardized index would result in an increase to the PSC limit equal to the value of the starting point. Therefore, when the responsiveness is defined as 1:1 the PSC limit is equal to the starting point at a standardized index value of 1 (as is for all alternatives) and is at a value of zero if the standardized index was zero. A change of less than one unit in the standardized index would result in a change in the PSC limit equal to the product of the proportional change in the index and the starting point PSC limit. For example, a 0.2 unit decrease in the standardized index would result in a reduction in the PSC limit of 20% of the starting point PSC limit. A responsiveness of 0.5:1 means a slower change and a responsiveness of 1.5:1 means a faster change (Figure 2-3).

Element 6 offers an optional provision for responsiveness to abundance changes by limiting the possible year-on-year percentage change in PSC limits.

Finally, under Element 7 breakpoints may be specified in a lookup table rather than breakpoints and responsiveness in Elements 4 and 5(where the PSC limit is defined continuously along the control rule). Element 7 includes options for standardizing (e.g., making the index relative to a particular value such as the mean or a specific year) each index (note the indices may be equally weighted under this Element).

Of these, selection of an option under Elements 1, 2, 3 and 5 are required; Elements 4, 6 and 7 are optional. If Element 7 is selected there is no need to select options under Elements 4 and 5.

Standardizing indices to a time frame

Council direction indicated that the indices shall be based on the timeframe 1998-2018 and the primary index shall be standardized to the most recent year. Two options are included:

Option 1: Standardize the secondary index to the most recent year (Alternative 3 only).

Option 2: Do not standardize the primary index and use the average of the most recent two years.

Standardizing the indices and plotting them as relative values allows these two different data-sets to be displayed on the same scale. The Council options include standardizing to the mean value over 1998-2018 or standardizing to the 2018 value. This results in different values for the relative index (Figure 2-4). This is important as it relates to what is implied by the starting point that is selected. For example is the starting point selected is intended to give a PSC limit value when the index is at its average value then use of the mean would be appropriate. In contrast if the starting point is intended to be as close as possible to what the PSC limit would equate to in the most recent year and is not a reflection of whether the index itself is in a low, average or high state, then standardizing to the most recent year would be appropriate. The time frame for standardizing the index will lead to different PSC limits for the same starting point (Figure 2-6).

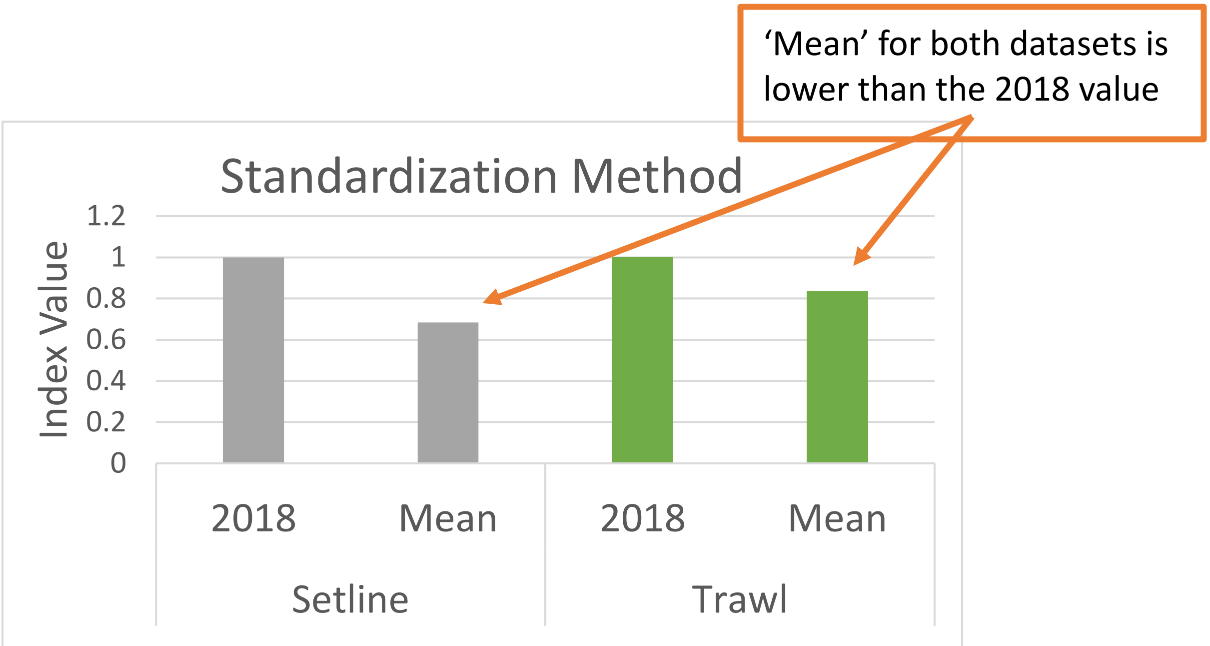


Figure 2-4 Comparison of index values for Setline survey (left) and trawl survey (right) when standardized to 2018 (value of 1.0) as compared to the mean from 1998-2018 (resulting in 0.68 setline survey and 0.84 trawl survey respectively).

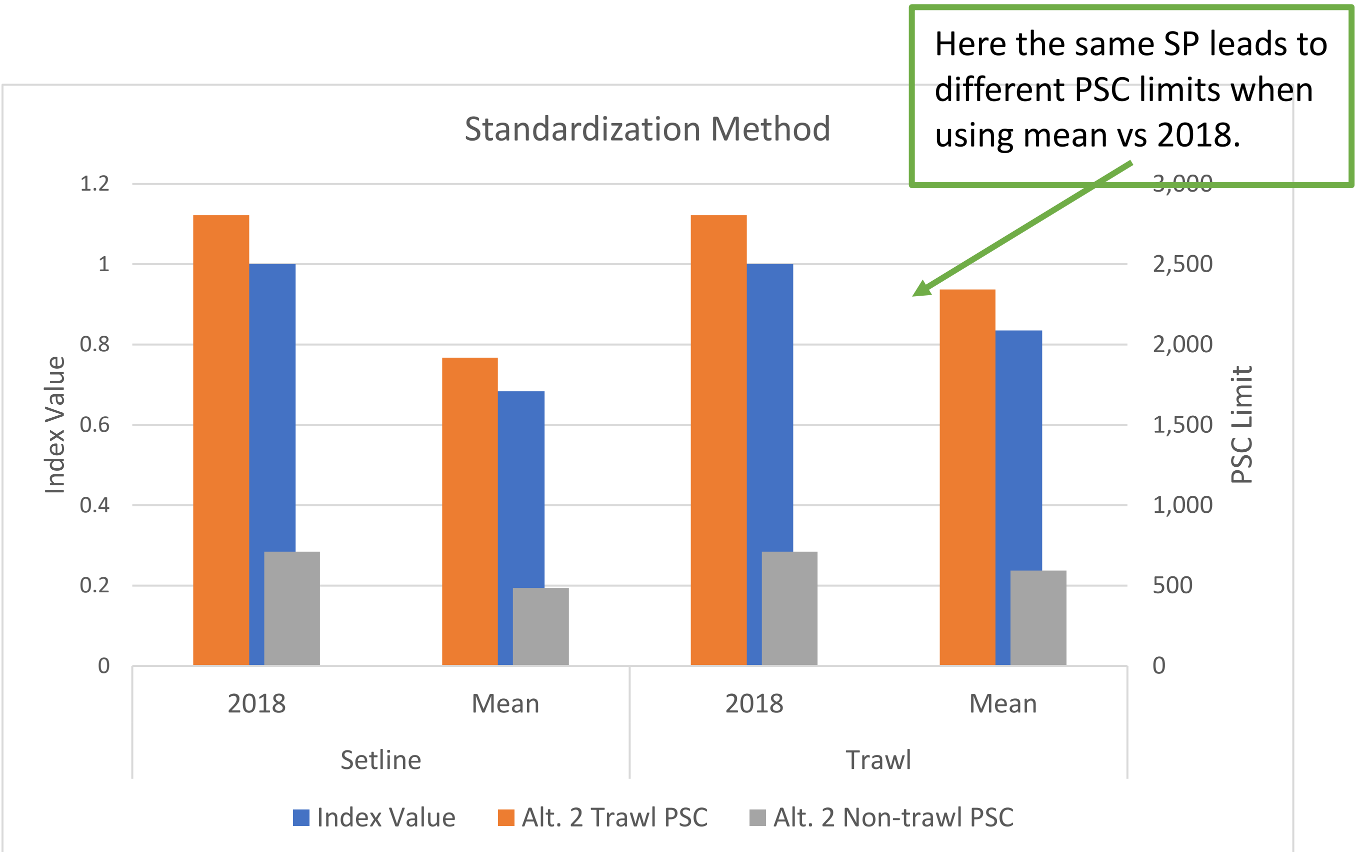


Figure 2-5 Example application of the same starting point (SP) to indices standardized to the 2018 value as compared to the mean of 1998-2018)

2.2.1 Element 1: Starting point for PSC limit

The starting point is the value of the limit prescribed by the control rule when the indices are at the current year value (2018)[9] (note additional options for standardization are provided in the Council motion). Three options are provided. One option must be selected to formulate the control rule alternative.

Option 1. 2016 PSC limit (3,515 metric tons (t))

Option 2. 2016 PSC use (2,354 t)

Option 3. 2017 PSC use (1,958 t)

2.2.2 Element 2: Maximum PSC limit (ceiling)

Element 2 defines the maximum level of the PSC. Under this element the PSC limit would remain static at that level for all values of the index above that which provides for this PSC limit. Two options are provided. One option must be selected.

Option 1. 2016 PSC limit (3,515 t)

Option 2. 2015 PSC limit (4,426 t)

[9] For purposes of consistency in this and subsequent drafts of this analysis the most current year is considered to be fixed at 2018.

2.2.3 Element 3: Minimum PSC limit (floor)

Element 3 defines a minimum level of PSC annually, regardless of whether the control rule prescribes a lower value. Four options are provided under this element. One option must be selected.

Option 1. 2016 use (2,354 t)

Option 2. ½ of 2016 PSC limit (1,758 t)

Option 3. ½ of 2016 PSC use (1,177 t)

Option 4. 1,000 t

2.2.4 Element 4: Breakpoint for index

Two options are considered for setting the breakpoints. Breakpoints would modify the response or slope of the control rule depending on the level of an index. The breakpoints are then associated with the magnitude of the response to be selected under Element 5. One option must be selected if a breakpoint is desirable unless Element 7 is selected.

Option 1. Index is 25% below or above average

Option 2. Index is above or below average

2.2.5 Element 5: Magnitude of the response to the index

This element describes the magnitude of the response to changes in the index (i.e. whether the slope is a constant 1:1 as with option 5 or varies at a steeper slope or shallower slope). At least one option may be selected under this element unless Element 7 is selected. Each option defines the modification that would occur when crossing a breakpoint (as specified in Element 4) or the slope in the absence of a breakpoint. There are five possible options.

Option 1. Up faster than 1:1

Option 2. Up slower than 1:1

Option 3. Down faster than 1:1

Option 4. Down slower than 1:1

Option 5. 1:1

2.2.6 Element 6: PSC limit responsiveness to abundance changes (optional)

This element is optional. Three options are considered to modify how responsive the calculated PSC limit is to inter-annual changes in the selected index or indices. Options 1 through 3 may be selected if the Council wishes to limit the inter-annual variability of the PSC limit. This element is imposed *after* the PSC limit itself is calculated. A sub-option may be specified to limit the amount of change between the current (status quo) PSC limit and the limit in the first year of newly specified ABM PSC limits as a result of this action to reduce the potential variability in Year 1 of implementation.

Option 1: PSC limit varies no more than 5% per year

Option 2: PSC limit varies no more than 15% per year

Option 3: PSC limit varies no more than 25% per year

Sub-option: This element could be applied to limit the amount of change between the current PSC limits and the limit at the point of this action’s implementation.

2.2.7 Element 7: Look-up Table Breakpoints (optional)

This element is optional and would replace Elements 4 and 5. Here breakpoints would be defined in a look-up table with a maximum of 12 breakpoints (creating up to an 11X11 look-up table). This would result in different breakpoints and responsiveness than what would occur under Elements 4 and 5. If Element 7 is selected it would not be necessary to select Elements 4 and 5. Here the index may be specified in one of two ways:

Option 1: standardize to the average of 1998-2018

Option 2: standardize to the current year (2018)[10]

2.3 Alternative 3: Primary and secondary indices are used to set trawl and/or non-trawl PSC limit

Under Alternative 3, the PSC limit is set by gear type and indexed to both the EBS trawl survey and the setline survey. Here the primary index may be the EBS trawl survey with the secondary index as the Area 4 setline survey (**Option 1**) or the primary index may be the Area 4 setline survey with the secondary index as the EBS trawl survey (**Option 2**). The secondary index modifies the final PSC limit according to breakpoints and responsiveness as determined by Elements 4 and 5. The primary index may be aligned to be similar to the fishing and survey gear but is not required to be.

The PSC limit is still directly indexed to a primary biomass index in Alternative 3, but the primary difference between Alternatives 2 and 3 is that when the index for the other gear type ("the secondary index") is above or below a breakpoint value then that index exerts an additional change on the PSC limit. The secondary index modifies the PSC limit in conjunction with the primary index when the secondary index is in a "high state" or a "low state" (as defined by Element 4 breakpoint options). The extent to which the secondary index influences the PSC limit when above or below the breakpoints is determined by the selected options under Element 5. Element 5 is also used in Alternative 3 to define the responsiveness of the primary index when the secondary index is not above or below a breakpoint value.

As with Alternative 2, once the aggregate limits by gear type are calculated, sectors within those categories (e.g., Amendment 80, trawl limited access, non-trawl fisheries, and CDQ fisheries) would be allocated PSC limits relative to their status quo proportions. As noted previously in the Council's motion, the CDQ limit would be derived from the aggregate trawl PSC limit component.

The Alternative 3 elements and options described below define the control rule and the responsiveness to fluctuations in inter-annual changes in the biomass indices. Of these, selection of an option under Elements 1 through 5 are required while Elements 6 and 7 are optional. If Element 7 is selected there is no need to select options under Elements 4 and 5.

2.3.1 Element 1: Starting point for PSC limit

The starting point is the value of the limit prescribed by the control rule when the indices are at their current year value (2018)[11] (note additional options for standardization are provided in the Council motion, see section 2.2). Three options are provided. One option must be selected to formulate the control rule alternative.

Option 1. 2016 PSC limit (3,515 t)

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[10] For purposes of consistency in this and subsequent drafts of this analysis the most current year is considered to be fixed at 2018.

[11] For purposes of consistency in this and subsequent drafts of this analysis the most current year is considered to be fixed at 2018.

Option 2. 2016 use (2,354 t)

Option 3. 2017 use (1,958 t)

2.3.2 Element 2: Maximum PSC limit (ceiling)

Element 2 defines the maximum level of the PSC. Under this element the PSC limit would remain static at that level for all values of the index above that which provides for this PSC limit. Two options are provided. One option must be selected.

Option 1. 2016 PSC limit (3,515 t)

Option 2. 2015 PSC limit (4,426 t)

2.3.3 Element 3: Minimum PSC limit (floor)

Element 3 defines a minimum level of PSC annually, regardless of whether the control rule prescribes a lower value. Four options are provided under this element. One option must be selected.

Option 1. 2016 use (2,354 t)

Option 2. ½ of 2016 PSC limit (1,758 t)

Option 3. ½ of 2016 PSC use (1,177 t)

Option 4. 1,000 t

2.3.4 Element 4: Breakpoint for the primary or secondary index

Two options are considered for setting the breakpoints. Breakpoints would modify the response or slope of the control rule depending on the level of an index. The breakpoints are then associated with the magnitude of the response to be selected under Element 5. One option must be selected unless Element 7 is selected.

Option 1. Index is 25% below or above average (i.e. a delayed response)

Option 2. Index is above or below average (i.e. an instantaneous response)

2.3.5 Element 5: Magnitude of the response for the index

This element describes the magnitude of the response for the index (i.e. whether the slope is a constant 1:1 as with Option 5 or varies at a greater or smaller slope). At least one option may be selected under this element unless Element 7 is selected. Each option defines the modification that occurs when crossing a breakpoint (as specified in Element 4). There are five possible options. These options may be applied differently to the primary and secondary indices (i.e., Option 5 only for primary, and another option for the secondary index).

Option 1. Up faster than 1:1

Option 2. Up slower than 1:1

Option 3. Down faster than 1:1

Option 4. Down slower than 1:1

Option 5. 1:1

2.3.6 Element 6: PSC limit responsiveness to abundance changes (optional)

Three options are considered to modify how responsive the calculated PSC limit is to inter-annual changes in the selected index or indices. Options 1 through 3 may be selected if the Council wishes to limit the inter-annual variability in the PSC limit. This is imposed *after* the PSC limit itself is calculated.

A sub-option may be specified to limit the amount of change between the current PSC limit and the limit in the first year of newly specified ABM PSC limits as a result of this action to reduce the potential variability in Year 1 of implementation.

Option 1: PSC limit varies no more than 5% per year

Option 2: PSC limit varies no more than 15% per year

Option 3: PSC limit varies no more than 25% per year

Sub-option: This element could be applied to limit the amount of change between the current PSC limits and the limit at the point of this action's implementation.

2.3.7 Element 7: Look-up Table Breakpoints (optional)

This element is optional and would replace Elements 4 and 5. Here, breakpoints would be defined in a look up table with a maximum of 12 breakpoints (for a maximum of an 11x11 lookup table). This would result in different breakpoints and magnitude of response than those listed under Elements 4 and 5. As such, if Element 7 is selected it would not be necessary to select Elements 4 and 5. Here each index may be specified in one of two ways[12]:

Option 1: standardize to the average of 1998-2018

Option 2: standardize to the current year (2018)

2.4 First year of implementation

Given the lag time in final action (April 2020 or later see section XX) and implementation of regulations for the new ABM PSC management system, there may be a difference in estimated PSC limits and realized limits in the first year. Element 6 addresses responsiveness from one year to the next within the ABM program to address issues of stability in PSC limits. The suboption to Element 6 addresses the lag in potential implementation. In addition to any action the Council may wish to take to smooth inter-annual variability in PSC limit (by selecting options in Element 6) there may be a desire to smooth the potential jump in PSC limits from that which is estimated in the analysis to the realized PSC limits in the first year of implementation due to a change in one or both indices. This suboption to Element 6 could be selected in addition to other smoothing mechanisms simply to address potential lag in implementation.

2.5 Apportionments of PSC limits under Alternatives 2 and 3

The Council has indicated that initial allocations to the sector level for the analysis should closely follow the status quo allocation proportions as shown in Figure 2-1. Understanding that the CDQ unspecified gear limit is prosecuted by both fixed and trawl gear, the Council also directed that the CDQ PSC cap should vary with abundance in the same manner as the trawl sector[13]. Therefore and as described in Chapter 5 Section 5.7, the relative proportion of the trawl gear limit to the Amendment 80, TLAS and CDQ sectors is proportionally divided to approximate status quo CDQ with the remaining to the other trawl sectors (62.2% to Amendment 80, 26.6% to TLAS and 11.2% to CDQ). This is done consistently for all trawl PSC limits for the analysis but implies a proportional allocation to sectors that should be specified by the Council. Further proportional apportionments from TLAS to targets for the analysis are based upon the percentages adopted in the specifications process for 2019 and held constant throughout the analysis. Similarly, the fixed gear PSC limit is apportioned to target and gear following the 2019

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[12] Note that equally weighting the indices in a lookup table was also considered by analysts to be consistent with the intent of this element.

[13] Council motion February 2019 D-3 Halibut ABM Motion February 2019

apportionments for purposes of this analysis and held constant at those proportions (Figure 2-6). Apportionments to target and season are done during the annual specifications process and the alternatives under consideration do not propose to change that process but merely incorporate the apportionment made in 2019 rather than assume a change to those percentages (See Section 5.7).

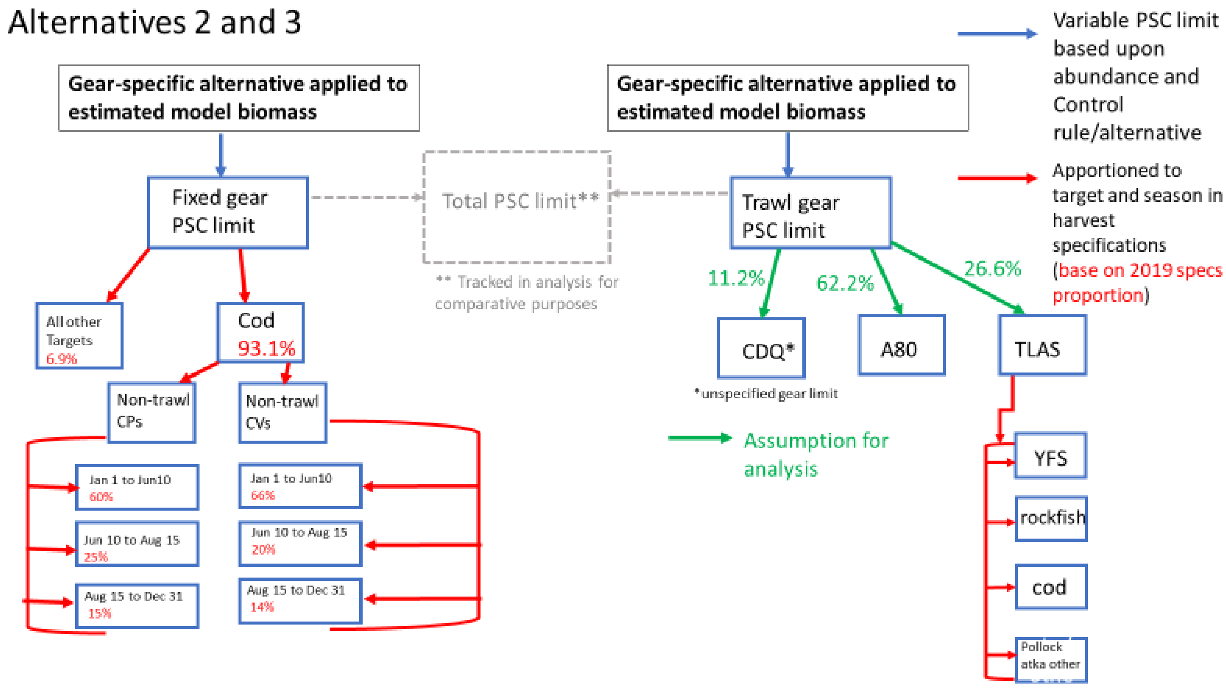


Figure 2-6 Alternative 2 and 3 analytical assumptions on proportional allocation of the Trawl PSC limit to sectors and apportionments to targets of the fixed gear PSC and TLAS PSC limits based upon 2019 harvest specifications proportions

The Council provided direction in February 2019 that the CDQ PSC limit should be calculated from the aggregate trawl PSC limit under Alternatives 2 and 3. If the Council wishes to modify how the CDQ PSC limit is calculated (for instance to consider it as a proportion from trawl PSC limit and fixed gear PSC limit and then re-aggregated into a single unspecified gear CDQ limit) the Council should modify the alternative set to accommodate this. Information in Table 2-2 shows the proportion of CDQ PSQ usage by gear from 2010-2018. On average, usage over this period is 79% trawl and 21% non-trawl. Additional information on usage by other sectors is contained in Chapter 3.

Table 2-2 Percentage usage of CDQ PSQ by gear type from 2010-2018.

Year	Trawl		Non-Trawl		Total
2010	85	52%	79	48%	164
2011	173	71%	70	29%	243
2012	215	79%	59	21%	274
2013	207	77%	60	23%	267
2014	206	84%	39	16%	245
2015	108	83%	23	17%	130
2016	149	86%	24	14%	173
2017	135	88%	18	12%	154
2018	144	92%	12	8%	156
Average	158	79%	42.67	21%	200.67

2.6 Annual process for specifying PSC limits under Alternative 2 or 3

Alternatives 2 and 3 would necessitate annually specified PSC limits. 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.

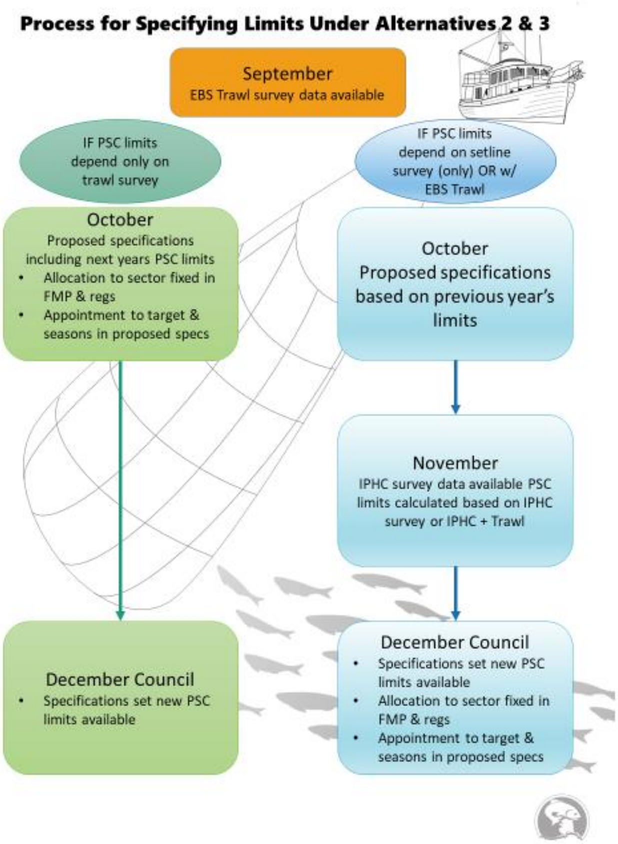


Figure 2-7 Annual process for specifying halibut PSC limits under Alternatives 2 and 3

As discussed in Section 1.6.1, EBS trawl survey biomass estimates are available for the September Groundfish Plan Team meetings thus trawl alternatives could be calculated at that time for the subsequent fishing year. 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 be informed by the previous year's limits. This is standard practice for the other BSAI biomass-based PSC limits during proposed specifications when information to update the calculations is not yet available. One possibility would be to calculate a combined index PSC limit using the most recent EBS trawl survey data and the previous year's IPHC setline survey data. This would be particularly important if biomass in either survey was declining.

If information to calculate the PSC limits is available mid-November, then the BSAI Plan Team could review them during their regular November meeting. Regardless, final specifications would be adopted at the December Council meeting for the subsequent fishing year. As indicated in Figure 2-7, no change to the specifications process would occur under these alternatives. PSC limits would be annually calculated. Depending upon the choice of alternative for calculating limits, sector allocations could be fixed in the FMP by gear type, however if fixed gear and trawl gear PSC limits are calculated separately there would be no explicit allocation between those gears as they would vary independently. Assuming the Council fixes an allocation to CDQ, Amendment 80 and TLS and they vary according to the same alternative, these could be fixed in the FMP and regulations as with status quo. Apportionments to targets and seasons would continue to be specified under the Specifications process at the Council.

If either of the revised limits 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 6.4.4 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.

2.7 Scenarios for analysis

Given the number of elements and options under Alternatives 2 and 3, a sub-set of these combinations is proposed for analysis. This subset combines scenarios presented to the Council by stakeholders in February 2019 as well as additional scenarios proposed by analysts and the SSC to frame the analysis of impacts. The individual sub-alternatives to be analyzed under each main alternative are listed following the general description of each alternative. Figure 2-8 shows the choices and options for creating 'sub-alternatives' from the broad choices of Elements and Options in Alternatives 2 and 3. Note that here the choice of index is for each gear type.

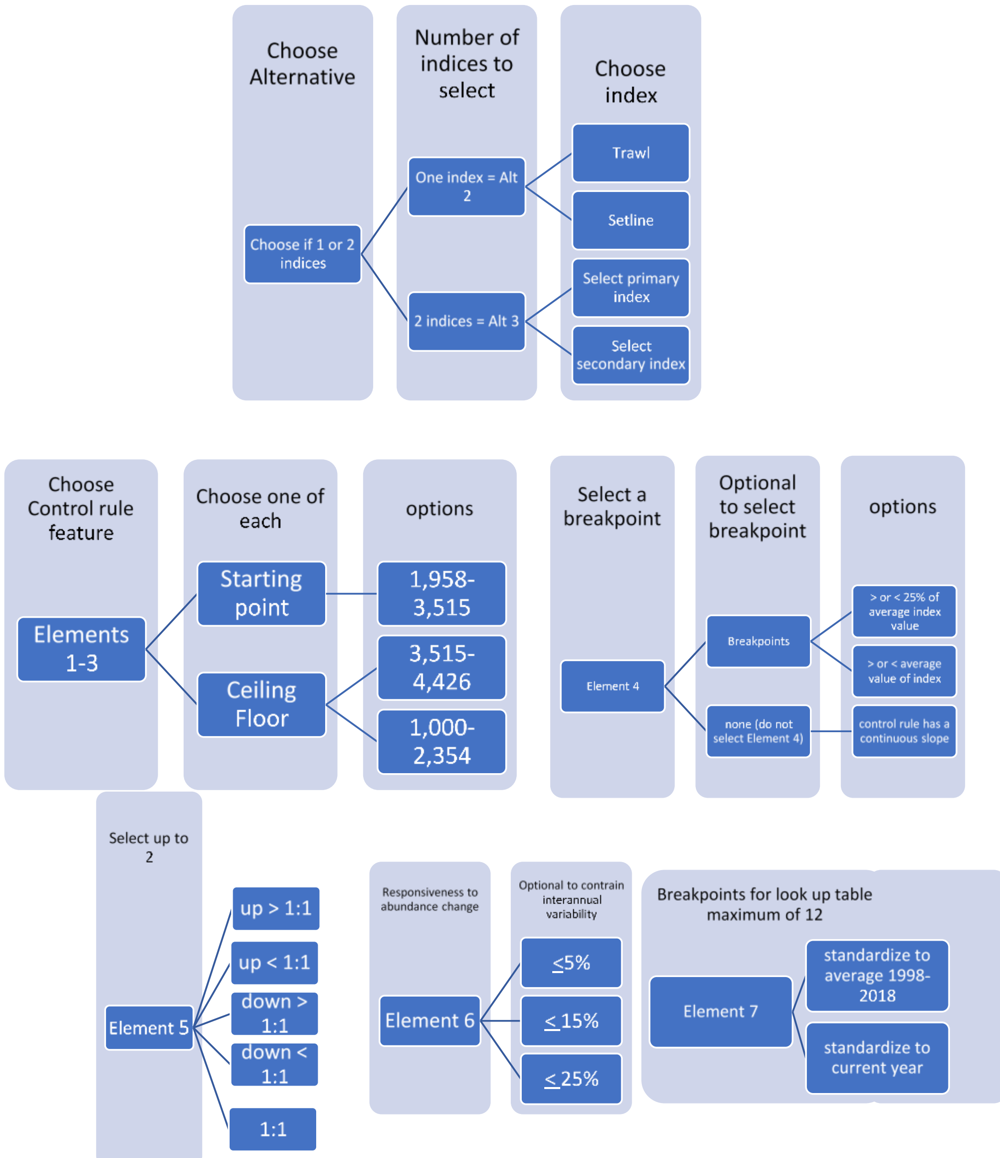
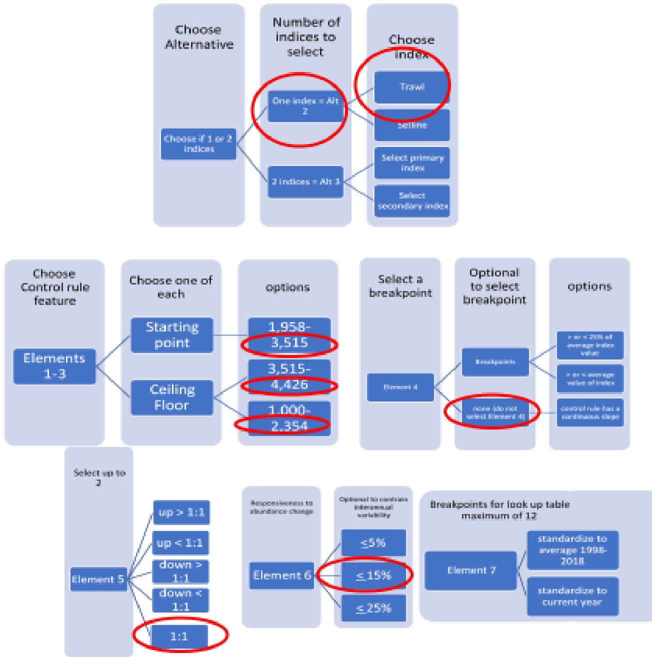


Figure 2-8 Schematic of choices in creating an alternative from the broad Elements and Options in Alternatives 2 and 3



	Indices used			Elements						
				1	2	3	4	5	6	7
Alternative	Source	Primary	Secondary	Starting point	Ceiling	Floor	Break points	Responsiveness	Constraint	Type
2.1	WG	By gear	NA	3,515	4,426	1,758	none	1:1	15% max	Continuous

Figure 2-9 Example of selection of Elements and Options to create Alternative 2-1 (trawl portion) for analysis as shown in Table 2-4. Note that a similar figure for the non-Trawl component would show the same selection for Alternative 2.1 but would select the setline index for the "by gear" choice. Here as with table 2-3 Elements 1-3 apply a 20:80 ratio between non-trawl and trawl gears.

In order to demonstrate contrast for analysis and decision-making, a discrete subset of all of the potential candidate alternative/element/option combinations has been selected from the combinations contained within Alternatives 2 and 3. These scenarios span the widest range of contrast to show potential impacts across these alternatives. Table 2-3 defines status quo (Alternative 1) as well as four sub-alternatives that are analyzed to provide contrast on the effects of a static PSC limit that is set at a high or a low value. Alternatives 1a, 1b, 1c, and 1d are only included for the purpose of demonstrating the behavior of the operating model, and to help the reader understand the dynamics in the plots provided in Appendix 4. Table 2-4 lists the selected scenarios for analysis under each alternative while Table 2-5 provides an example of the calculated PSC limit for the non-trawl and trawl sectors given the index value in 2018 for each of the alternatives for analysis. Sector allocations for a range of these alternatives are shown in Table 2-6.

Table 2-3 Alternative 1 (status quo) and suboptions proposed by the SSC and the working group to contrast the effect of fixed limits versus abundance-based limits. Alternatives 1.c and 1.d are provided by the workgroup to show bookends of maximum and minimum effects of PSC catches on the directed halibut fishery and stock status.

	Gear			Non-trawl	Trawl
Alternative	**Source**	**Primary Index**	**Secondary Index**	**Starting Point**	**Starting Point**
Alt. 1	Status quo	Gear	NA	710	2,805
1.a	SSC	Gear	NA	475	1,879
1.b	SSC	Gear	NA	395	1,563
1.c	WG	Gear	NA	0	0
1.d	WG	Gear	NA	10,000	10,000

Table 2-4. Combination of alternatives included in analysis. Numbering for each alternative shows the Overarching Alternative (1,2,3) then secondary numbering to group sub-sets by similar elements and options (e.g., 201, 3-1). See Figure 2-8 for further explanation of selections of Elements and Options to formulate each alternative shown. Each index is standardized to the most recent year, unless "mean" is specified which implies it is standardized to the mean of the series from 1998 to the current year. "By gear" means that the trawl index is linked to the trawl fishery and likewise for non-trawl gear. **Elements (1-3) apply 20:80 ratio between non-trawl and trawl PSC to calculate gear-specific starting points (S.P. Element 1), Ceilings (Element 2) and floors (Element 3).** "Constraint" indicates how much a PSC limit can change from one year to the next (Element 6) while "type" indicates whether it is a continuous control rule with or without breakpoints or a 'Look up Table" from Element 7 and shown as "discrete".

				Elements						
		Indices used		1	2	3	4	5	6	7
Alternative	Source	Primary	Secondary	Starting point	Ceiling	Floor	Break points	Responsiveness	Constraint	Type
1	Status quo	NA	NA	3,515						
2-1	WG	By gear	NA	3,515	4,426	1,758	none	1:1	15% max	Continuous
2-1.a	WG	By gear	NA	3,515	4,426	1,758	none	1:1	none	Continuous
2-1.b	SSC	By gear	NA	1,958	4,426	1,758	none	1:1	15% max	Continuous
2-2	Stakeholder	By gear	NA	3,515	4,426	2,354	specified	Stairsteps	2 yr avg	Continuous
2-3	Stakeholder	By gear	NA	3,515	4,426	2,354	none	1:1	15% max	Continuous
2-4	Stakeholder	By gear	NA	2,018	3,515	1,000	Start	1:1 (low) 0.5:1 (high)	15% max	Continuous
3-1	WG	By gear	Other (mean)	3,515	4,426	1,758	±25%	1:1	15% max	Continuous
3-1.a	WG	By gear	Other (mean)	3,515	4,426	1,758	±25%	1:1	none	Continuous
3-1.b	WG	By gear	Other (mean)	3,515	4,426	1,758	±25%	2nd Index 0.5:1 (low),1.5:1 (high)	15% max	Continuous
3-1.c	WG	By gear	Other (mean)	3,515	4,426	1,758	±25%	1:1	15% max	Discrete
3-1.d	SSC	By gear	Other (mean)	1,958	4,426	1,758	±25%	1:1	15% max	Continuous
3-2.a	Stakeholder	Gear (mean)	Other (mean)	2,941	4,124	1,758	none	Interpolated	15% max	Discrete
3-2.b	WG	Gear (mean)	Other (mean)	2,941	4,124	1,758	none	1:1	15% max	Discrete
3-3a	Stakeholder	Setline	Trawl (mean)	1,958	3,515	1,000	S.P	Secondary 0.35:1	20% max	Continuous
3-3b	WG	Trawl	Setline (mean)	1,958	3,515	1,000	S.P	Secondary 0.35:1	20% max	Continuous

Table 2-5. PSC limit for non-trawl and trawl given the index value in 2018 for each of the alternatives for analysis. Note that constraints by applications of Element 6 are enforced using current PSC limits of 710 and 2,805 for non-trawl and trawl, respectively. Values of the standardized indices for 2018 are 1.0 because they are standardized to the value in 2018. Values for the indices standardized to the mean of 1998 to 2018 are 0.68 and 0.84 for the setline survey and bottom trawl survey, respectively.

Alternative	**Trawl PSC limit**		**Non-trawl PSC limit**	
	Without Element 6	**With Element 6**	**Without Element 6**	**With Element 6**
Alt 1	2,805	2,805	710	710
Alt 2-1	2,805	2,805	710	710
2-1.a	2,805	2,805	710	710
2-1.b	1,563	2,384	395	604
2-2	2,805	2,805	710	710
2-3	2,805	2,805	710	710
2-4	1,610	1,610	408	408
Alt. 3-1	2,619	2619	710	710
3-1.a	2,619	2619	710	710
3-1.b	1,712	2712	710	710
3-1.c	2,468	2468	732	732
3-1.d	1,459	2384	395	604
3-2.a	1,781	2384	451	604
3-2.b	1,403	2384	355	604
3-3a	1,473	2244	372	568
3-3b	1,390	2244	351	568

Table 2-6 Sector allocations in metric tons (t) for alternatives in Table 2-5 given the index values in 2018. Shown in parentheses () are values for the PSC limit absent application of the constraint in Element 6. As noted in Figure 2-6 these proportional fixed allocation percentages by sector are based upon proportions from the 2019 specifications.

	Trawl				Non-Trawl		
Alternative	**A80 (62.2%)**	**TLAS (26.6%)**	**CDQ (11.1%)**	**Total**	**Cod (93.1%)**	**Other (6.9%)**	**Total**
1 (SQ)	1,745	745	315	2,805	661	49	710
2-1	1,745	745	315	2,805	661	49	710
2-1a	1,745	745	315	2,805	661	49	710
2-1b	1,483*(972)*	633*(415)*	268*(176)*	2,384*(1,563)*	562*(368)*	42*(27)*	604*(395)*
2-2	1,745	745	315	2,805	661	49	710
2-3	1,745	745	315	2,805	661	49	710
2-4	1,002	428	181	1,610	380	28	408
3-1	1,629	696	294	2,619	661	49	710
3-1a	1,629	696	294	2,619	661	49	710
3-1b	1,687*(1,065)*	720*(455)*	305*(192)*	2,712*(1,712)*	661	49	710
3-1c	1,535	655	277	2,468	681	51	732
3-1d	1,483*(908)*	633*(388)*	268*(164)*	2,384*(1,459)*	562*(368)*	42*(27)*	604*(395)*
3-2a	1,483*(1,108)*	633*(473)*	268*(200)*	2,384*(1,781)*	562*(420)*	42*(31)*	604*(451)*
3-2b	1,483*(873)*	633*(373)*	268*(158)*	2,384*(1,403)*	562*(331)*	42*(25)*	604*(355)*
3-3a	1,396*(916)*	596*(391)*	252*(165)*	2,244*(1,473)*	529*(346)*	39*(26)*	568*(372)*
3-3b	1,396*(865)*	596*(369)*	252*(156)*	2,244*(1,390)*	529*(327)*	39*(24)*	568*(351)*

The selected contrasting candidate alternatives were selected based upon stakeholder input, Workgroup suggestions and SSC recommendations[14]. These include alternative fixed limits (for analytical purposes only) to illustrate contrast relative to the current status quo limit. (Alternative 1). Here, for comparison with Alternatives 2 and 3 where the PSC limit is linked to an abundance estimate from one or two indices, the fixed PSC limits in Figure 2-10 are shown by gear as a solid line that does not vary with changes in the relative index.

[14] SSC Minutes April 2019

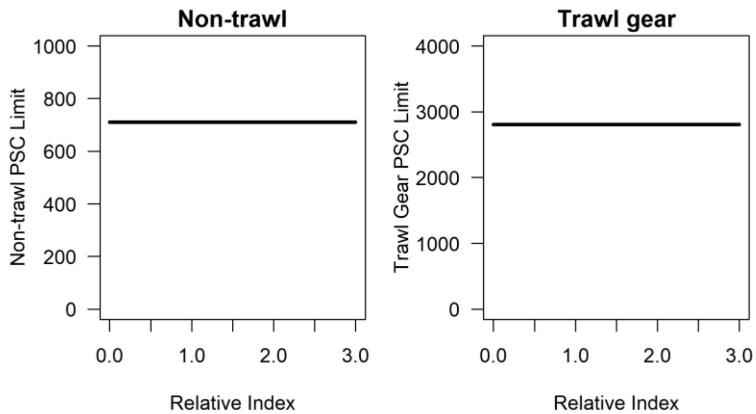


Figure 2-10 Alternative 1 (divided by gear types) shown as a straight line that does not vary with changes to the relative index (which could be either the EBS trawl survey or Bering Sea setline survey). The black line is the status quo limit by gear type.

For Alternatives 2 and 3, selected combinations of elements and options were considered to show contrast in which Elements and options are the most influential on results, as well as to incorporate specific combinations of elements and options that were proposed for analysis by stakeholders. For each alternative shown in Table 2-4 there is a ‘base case’ alternative by gear type (Alternative 2-1 and Alternative 3-1). Each base case contains the 1:1 option under Element 5 for comparative purposes and a default (and identical) set of selections under all of the other Elements and options. Next are a series of ‘one change only’ (all else equal) modifications to each ‘base case’ by selecting a different option under one element only. Hence Alternative 2-1a is equivalent to Alternative 2-1 in Elements 1 through 5 but does not include Element 6 (Table 2-4). Likewise, Alternative 2-1b is equivalent to 2-1 but incorporates a different starting point under Element 1. Per SSC requests, additional scenarios were added for both Alternatives 2 and 3; those scenarios specify the Element 1 starting point at the minimum and maximum values defined by the options.

Alternatives 2-2 through 2-4 have specific selections of elements and options that are based on what was presented by stakeholder groups during the Council’s February 2019 Halibut Stakeholder Committee process (as noted in Column 2 ‘source’) and are thus presented separately without ‘one change only’ cases for contrast. Alternative 2-2, a stakeholder proposed alternative, incorporates a set of breakpoints that define the PSC limit in a stairstep fashion (Figure 2-11). The index is calculated using a recent two-year average to smooth annual variation. Breakpoints for setting the fixed gear PSC limit were assumed to be equal to the standardized breakpoints used for the trawl PSC limit. Alternative 2-3, another stakeholder proposed alternative, is similar to Alternative 2-1 except with different options for the floor and ceiling elements (elements 2 and 3). Alternative 2-4 was proposed by another stakeholder group and incorporates a different starting point, floor, and ceiling than other alternatives with only a primary index, and defines a slow responsiveness when the index is above its standardized value (a 0.5:1 change in the PSC limit relative to the change in the index) and a fast response (1:1) when below the standardized value of the index. All of the stakeholder proposed alternatives incorporate a constraint under element 6.

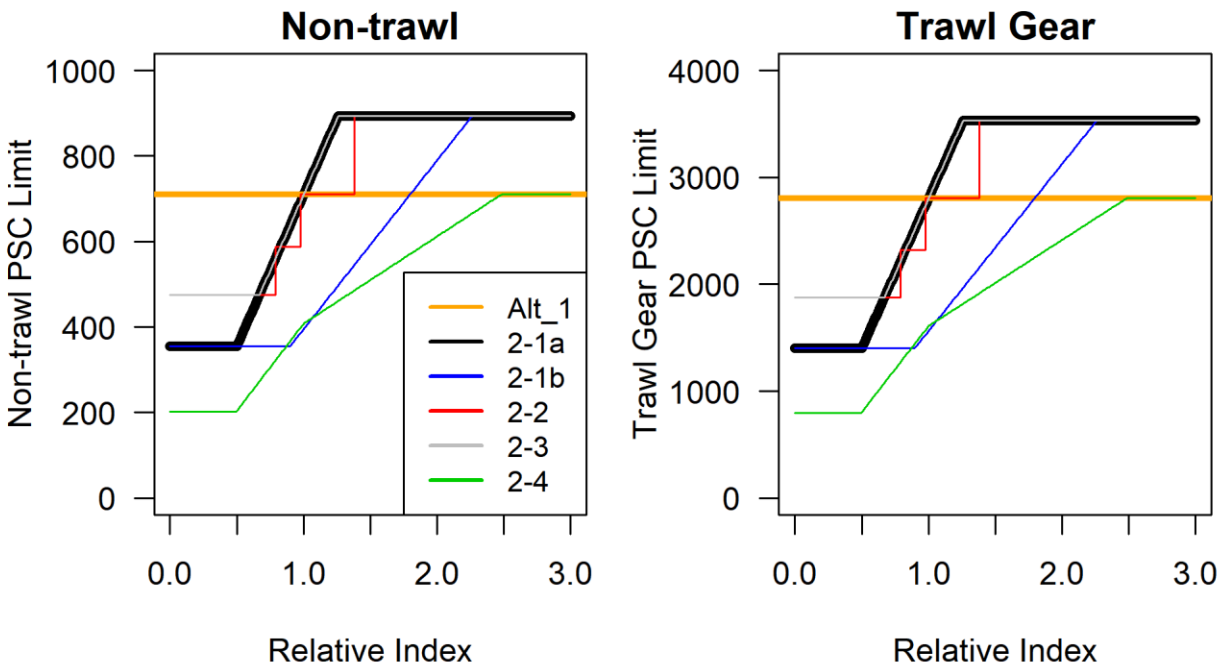


Figure 2-11 Alternative 2 control rules depicted for 2-1a (black line), 2-1b (blue line), 2-2 (red line), 2-3 (grey line) and 2-4 (green line). These are plotted with the relative index matching the gear type (i.e. for non-trawl on the left panel the relative index is the setline survey, for trawl gear on the right the relative index is the EBS trawl survey). The Elements and options which align with these control rules are show in Table 2-4. Note that Element 6 (percentage constraint on PSC limit annual change) is not depicted in this schematic as it is applied after the PSC limit is determined by the control rule, thus 2-1a is equivalent to 2-1 (See Chapter 5 methodology for more details).

Under Alternative 3, two indices are applied to the control rule, so three-dimensional plots are necessary to characterize the range of outcomes. Alternative 2-1 (base case) and Alternative 2-1a (which for purposes of visualization is functionally equivalent to 2-1 since Element 6 is imposed after the PSC limit is calculated) are presented in a three-dimensional 'heat map' format (Figure 2-13) for comparison to various Alternative 3 configurations. Here, the left-hand panel shows this alternative plotted with two indices, however it only varies along the primary index (x-axis) as also shown in Figure 2-11.

Figure 2-12 provides some guidance on how best to view the plots that are provided for each alternative to "read" the resulting PSC limit. Examples for Alternatives 2 and 3 are shown.

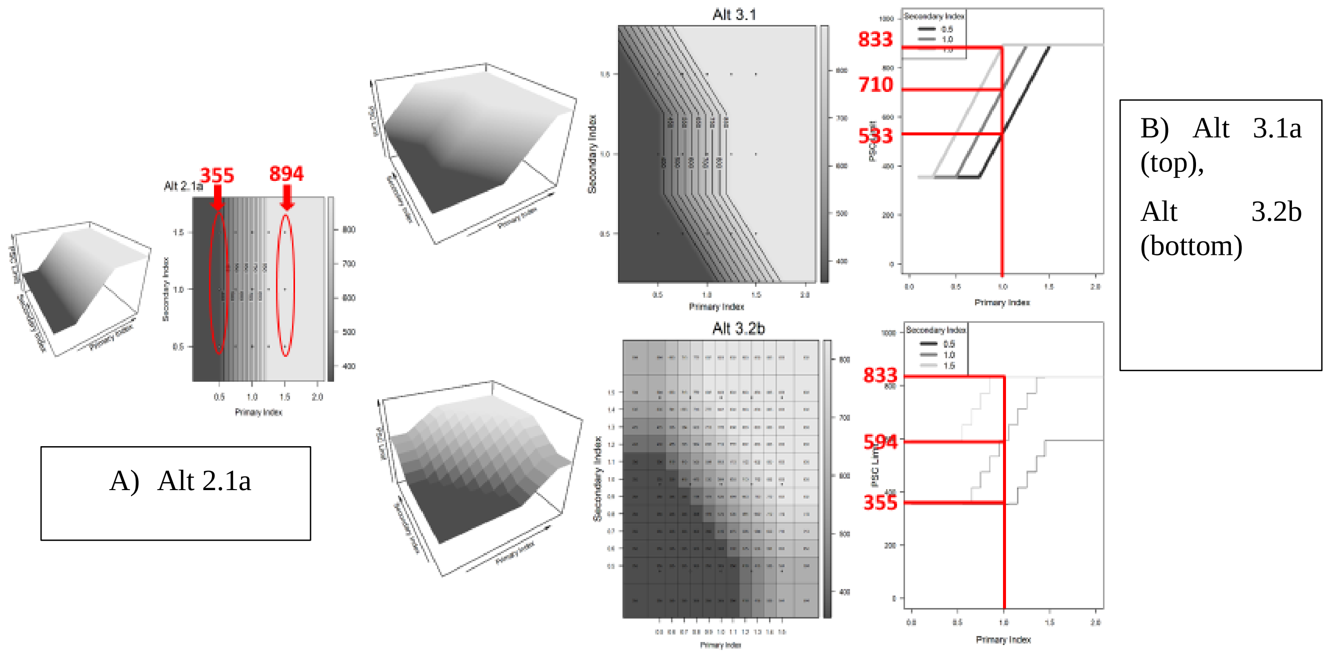


Figure 2-12 Understanding how to read PSC limits from Alternative plots. Here Alternative 2.1a (A) left panel) is shown with two indices for purposes of comparison with Alt 3 plots. However PSC limits in alt 2 are not a function of the secondary index thus PSC limits are established solely based on the primary index. This is shown by dots and shading. For Alt 3.1 and 3.2, (panel B) three figures are provided with the far right showing the PSC limit as a function of the primary index (x-axis) with three examples of the secondary index values (0.5, 1.0 and 1.5) overlaid on the primary index. The bold lines show how to look up the PSC limit at a primary index value of 1.0 and three levels of the secondary index. All example plots are shown for the non-trawl PSC limit.

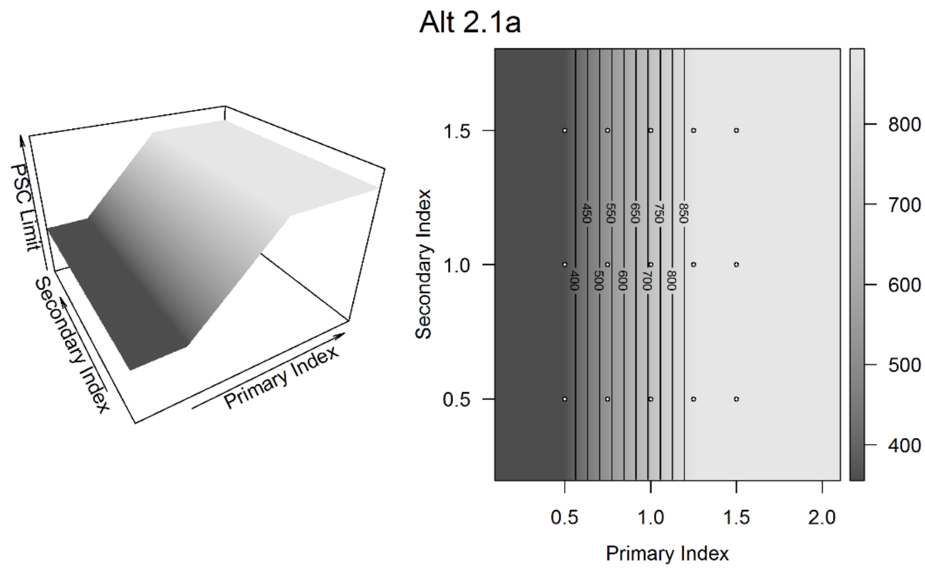


Figure 2-13 Three-dimensional and 'heat map'/look-up table schematic of Alternative 2-1 for the non-trawl PSC limit. The contour plot on the right shows points at which the PSC limit is reported in Table 2-7.

Table 2-7 PSC limits for non-trawl as determined for various alternatives using specific values of the primary index and the secondary index. Each slice along the primary axis is shown in the corresponding three-dimensional plot for the alternative.

Alternative	Secondary Index	Primary Index 0.5	0.75	1.0	1.25	1.5
2.1	0.5	355	533	710	888	894
	1.0	355	533	710	888	894
	1.5	355	533	710	888	894
3.1a	0.5	355	355	533	710	888
	1.0	355	533	710	888	894
	1.5	533	710	888	894	894
3.1b	0.5	355	444	521	799	894
	1.0	355	533	710	888	894
	1.5	621	799	894	894	894
3.1c	0.5	355	355	517	678	894
	1.0	355	517	732	894	894
	1.5	517	732	894	894	894
3.2a	0.5	355	427	474	546	594
	1.0	474	546	594	666	714
	1.5	594	666	714	785	833
3.2b	0.5	355	355	355	475	594
	1.0	355	475	594	772	833
	1.5	594	772	833	833	833
3.3	0.5	355	408	586	763	894
	1.0	355	533	710	888	894
	1.5	479	657	834	894	894

For Alternative 3 a similar 'one change only' approach is applied to analytical scenarios, as was done to illustrate Alternative 2 (Table 2-4). Notably, starting with a 'base case' alternative by gear type (Alternative 3-1) whereby the 'primary' index is the one similar to the gear type for the PSC (i.e. EBS trawl survey for the trawl PSC and Setline survey for the non-trawl PSC) while the secondary is the index similar to the opposite gear type.

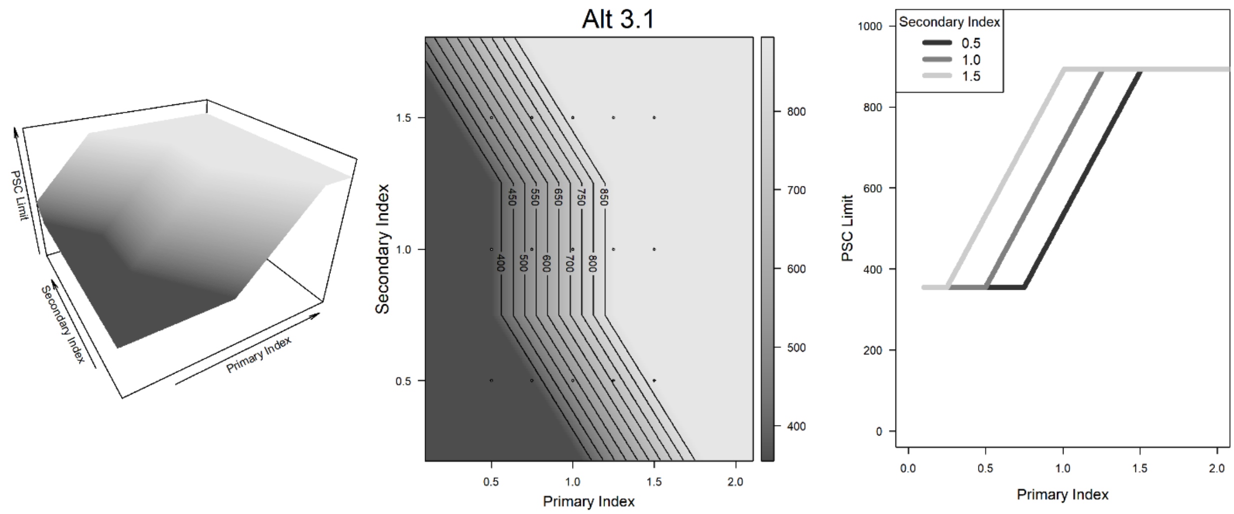


Figure 2-14 Alternative 3-1 (Base Case) for both indices and the control rule in a heat-map snapshot view (right-middle panel) and multi-dimensional (left panel) for the non-trawl PSC limit. The contour plot on the far right shows points at which the PSC limit is reported in Table 2-7. The plot at the bottom (to the right) shows the PSC limit for secondary index values of 0.5, 1.0, and 1.5 over all values of the primary index.

With two indices included in Alternative 3, there is a built-in response mechanism when the secondary index is (for this example) 25% above or below its average value (the average is shown as a value of 1.0 on the y-axis of Figure 2-14, thus 25% below would be 0.75 and 25% above would be 1.25). Therefore, between 0.75 and 1.25 on the secondary index (y-axis) there is no additional response (as represented by vertical lines) and Alternative 3-1 is the same as Alternative 2-1. Above and below those secondary index breakpoints there is a change in slope of the response as a result of the influence of the secondary index (shown in the right hand panel of Figure 2-14). When the secondary index is below the lower breakpoint, the PSC limit would be less for a given value of the primary index, and the PSC limit would be greater for a given value of the primary index when the secondary index is above the upper breakpoint. A three-dimensional view of the entire control rule is shown in the left-hand panel of Figure 2-14.

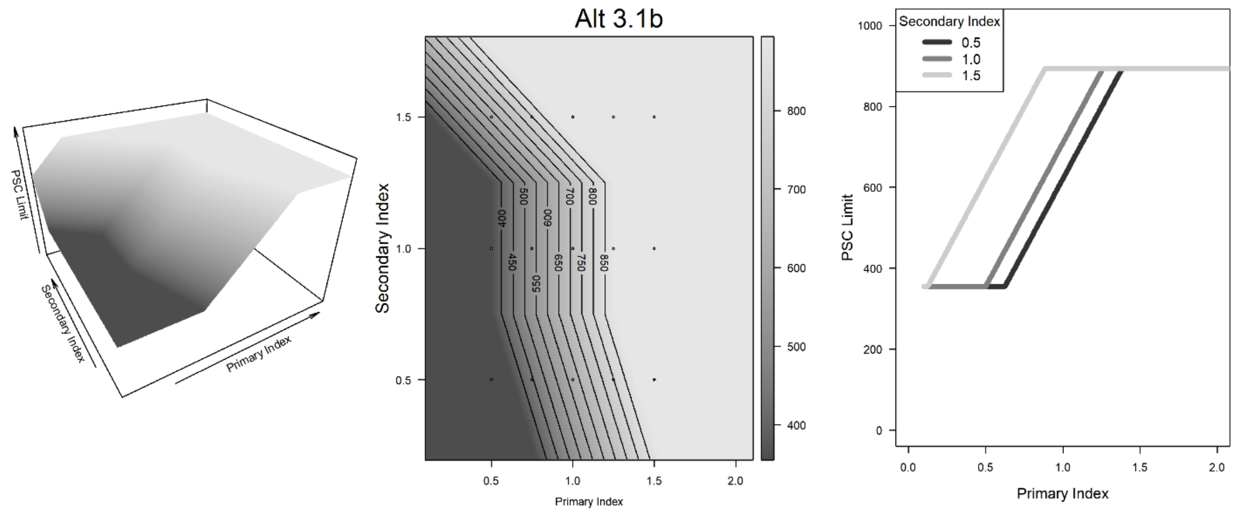


Figure 2-15 Alternative 3-1b in a heat-map snapshot view (right-middle panel) and multi-dimensional (left panel) which is similar to 3-1 for all elements but Element 5 (responsiveness) where a 'fast up, slow down' response is incorporated instead of the 1:1 response in 3-1. The contour plot on the right shows points at which the PSC limit is reported in Table 2-7. The plot (to the far right) shows the PSC limit for secondary index values of 0.5, 1.0, and 1.5 over all values of the primary index. This is for the non-trawl PSC limit.

Next, Alternative 3-1b is equivalent to Alternative 3-1 but incorporates a different response mechanism under Element 5. Instead of a 1:1 response above and below the breakpoints, a 'fast-up, slow-down' response is incorporated where the response is 0.5:1 when the secondary index is below the lower breakpoint, and is 1.5:1 when the secondary index is above the upper breakpoint. This can be observed by the change in slope above 1.25 on the secondary index (y-axis Figure 2-15) with a steeper slope and the more gradual slope change below 0.75 on the same axis (right-hand panel of Figure 2-15).

An additional scenario, Alternative 3-1c, is the same as 3-1 but is displayed as discrete values for the primary index that result from a look-up table (Figure 2-16). The secondary axis is still continuous and only affects the PSC limit when less than 0.75 or greater than 1.25. This can be thought of as a lookup table for the primary index, but the lookup table is modified depending on the secondary index.

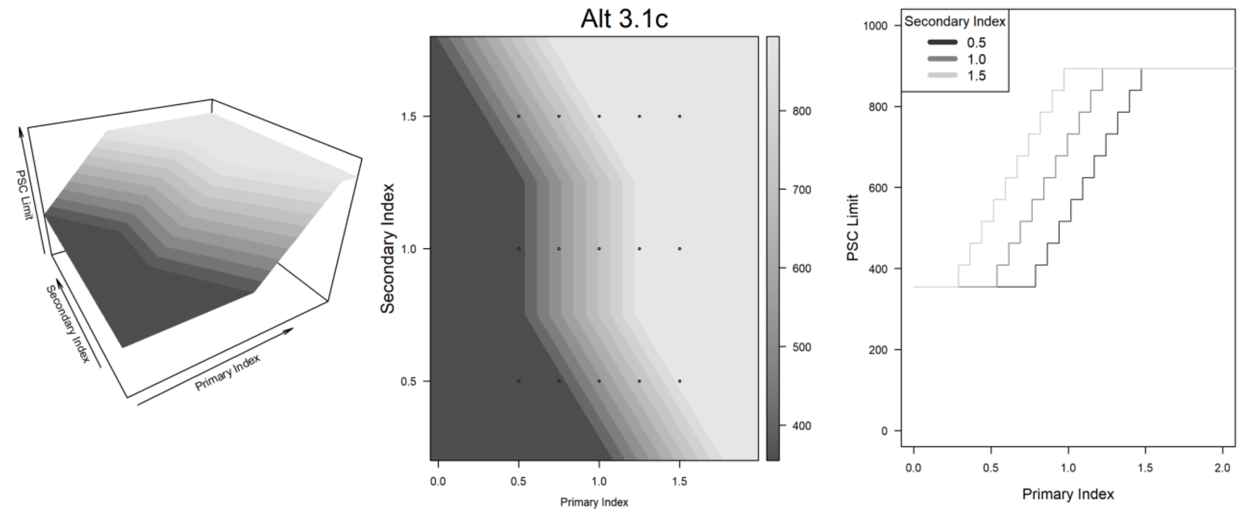


Figure 2-16 Alternative 3-1c in a heat-map snapshot view (right-middle panel) and multi-dimensional (left panel) which is similar to 3-1 for all elements but Element 7 (lookup table) for only the primary index. The contour plot on the far right shows points at which the PSC limit is reported in Table 2-7 for secondary index values of 0.5, 1.0, and 1.5 over all values of the primary index. This is for the non-trawl PSC limit.

Alternative 3-1d differs from Alternative 3-1 in the Element 1 starting point only and is not plotted.

Alternatives 3-2 and 3-3 reflect specific selections of elements and options that were presented to the Council by stakeholder groups during the Council's February 2019 Halibut Stakeholder Committee process (as noted in Column 2 'Source'). For contrast a 'one change only' scenario was provided for each.

Alternative 3-2a, a stakeholder proposal, uses an 11X11 lookup table to specify the PSC limit. A lookup table is simply a matrix of cells associated with breakpoints that define the PSC limit within a range of the primary index and the secondary index. The breakpoints are determined by creating equal spaces to create 11 cells with midpoints from 0.5 to 1.5 for both indices. The primary index and secondary index values of 1.0 correspond to the center cell which defines a PSC limit equal to the starting point. Both index values equal to 1.5 define a PSC limit equal to the ceiling and both index values equal to 0.5 define a PSC limit equal to the floor. Given those PSC limits, the PSC limit in each of the remaining cells of the lookup table can be interpolated to have an equal change in the PSC limit between cells. Figure 2-17 shows the lookup table for Alternative 3.2a, which is easily seen in the center of the plots, and for values greater than 1.5 or less than 0.5, the PSC limit remains constant along that axis. Alternative 3.2a also incorporates a constraint of no more than a 15% annual change which is not shown in Figure 2-17.Alternative 3-2b used the same cell midpoints but was modified from Alternative 3.2a to illustrate a 1:1 response for both indices. This means that for each change of 0.1 in an index (a jump between cells) the non-trawl PSC limit changes by 59 t in Alternative 3.2b and 24 t in Alternative 3.2a. Therefore, the ceiling and floor are reached at index values closer to 1 in Alternative 3-2b. As with Alternatives 2-2 and 2-3, the proposals only addressed one gear type (non-trawl) so the analysts approximated a similar application of the proposal to the other gear.

The PSC limit for non-trawl and trawl gear types as determined from each alternative given the 2018 index values (Table 2-5). When applying the annual percentage change constraint, prior PSC limits of 710 and 2,805 were used for non-trawl and trawl, respectively.

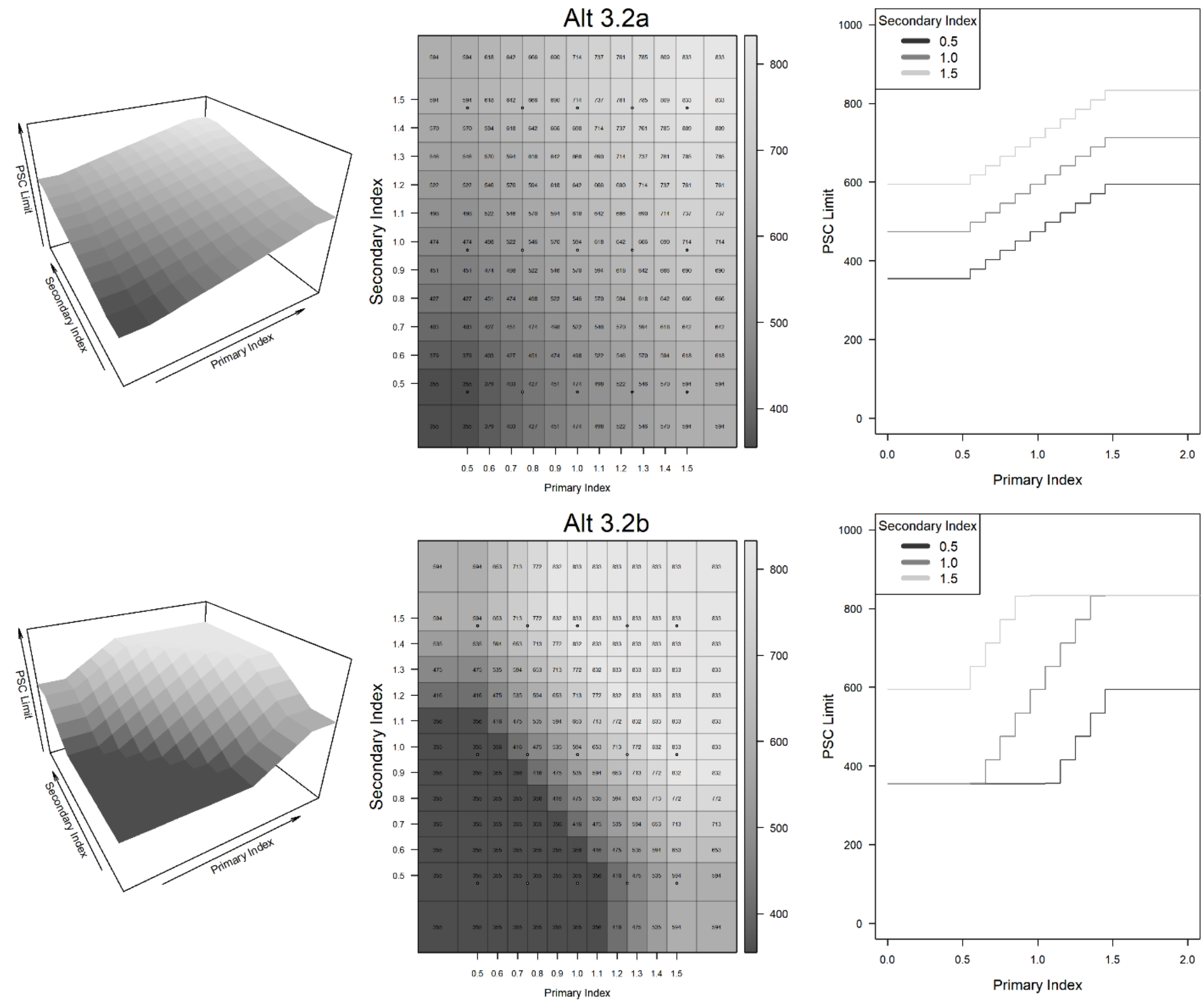


Figure 2-17. The lookup tables for Alternatives 3-2a (top) and 3-2b (bottom) in a heat-map snapshot view (right-middle panels) and multi-dimensional (left panels) for the non-trawl PSC limit. The contour plots on the right show points at which the non-trawl PSC limit is reported in Table 2-7 for secondary index values of 0.5, 1.0 and 1.5.

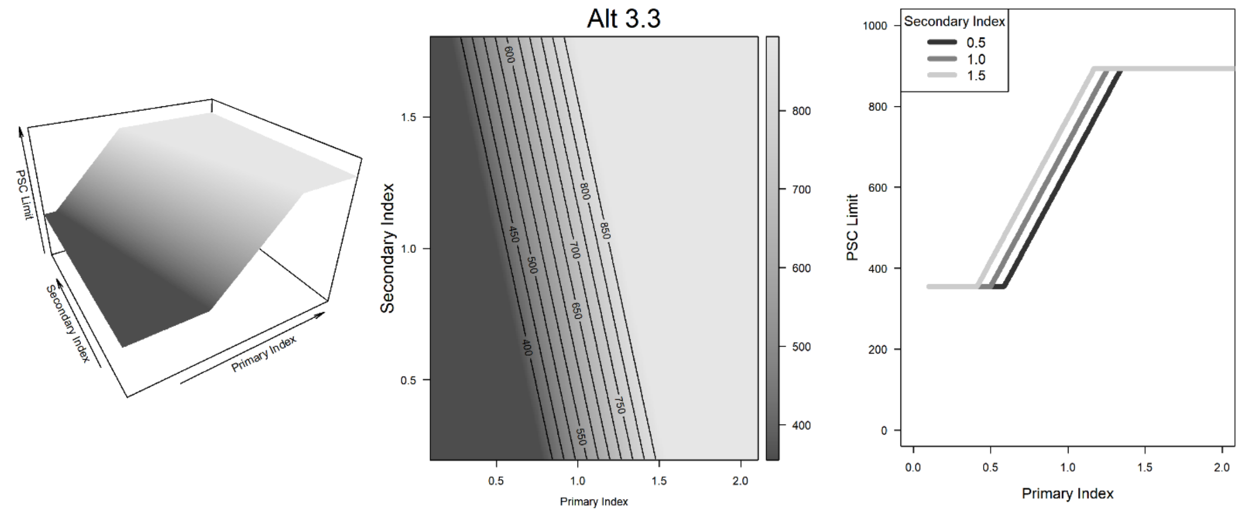


Figure 2-18 Alternatives 3-3a and 3-3b which set the primary index the same for establishing the PSC limit for both gear types. In Alternative 3-3a the primary index is set to the setline survey; for contrast, in Alternative 3-3b the primary index is set to the trawl survey for both gear types. The contour plot on the right points at which the PSC limit is reported in Table 2-7 for the non-trawl PSC limit.

2.8 Alternatives considered but not carried forward for analysis

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.**

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.

3 Groundfish Stock Status and Fishery Description

3.1 Description of Groundfish resources

The Council recommends annual catch limits and allocations 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.

3.1.1 Annual Stock Assessment Fishery Evaluation (SAFE) report and Ecosystem Status Report (ESR) for 2018

The annual BSAI Groundfish SAFE Report (NPFMC 2018), which is considered by the Council during its annual December meeting for its determination of the biennial final harvest specifications, provides a detailed discussion of the status of individual groundfish stocks, and is incorporated by reference. The Council also receives an Ecosystem Status Report (ESR) on an annual basis in conjunction with setting harvest specifications. A brief summary of environmental conditions in 2018 is summarized below.

The Bering Sea experienced an unprecedented marine heatwave in 2018 resulting in an exceptionally low amount of winter sea ice during the 2017/2018. The Chukchi experienced the warmest year on record; there was little to no salinity stratification (no >32 ppm salinities), which led to more water column mixing. The northern Bering Sea had >+5°C anomalies in January–April 2018 and anomalously warm conditions persisted in summer 2018 with both the SE Bering Sea (SEBS) and NE Bering Sea (NEBS) experiencing water temperatures that were well above the long-term expected range. Sea ice formation in 2018 reached an unprecedented minimum extent, with a near-complete lack of sea ice in the northern Bering Sea due to: (i) residual heat that delayed freeze-up, (ii) a large high-pressure system that shifted the position of the Aleutian Low Pressure System (ALPS) northwest, and (iii) winds from the southwest that brought warm air over the Bering Sea. The cold pool for summer 2018 was nearly non-existent. The response of the Bering Sea ecosystem to highly anomalously warm conditions in the SEBS 2016, near average conditions in 2017, and a return to highly anomalously warm conditions in 2018 was evident across multiple trophic levels, with some lags and divergent responses that are species- and sub-region specific.

In the SEBS an unprecedented lack of winter sea ice resulted in a near absent cold pool, which has never been observed in the 37 year timeseries. The cold pool was the lowest areal coverage in the 37-year time-series and 2018 was the first time that bottom temperatures <0°C were not observed in any location within the standard bottom trawl survey area. Multiple indices point to SEBS conditions that are unfavorable for cod and pollock recruitment of the 2018 year class relative to slightly favorable conditions in for 2017 year classes. There are continued declines or continued below average fish conditions (defined as Length-Weight residuals) observed for multiple species in the SEBS. Notably, there has been a negative trend in Pacific cod condition since a peak in 2003. Condition of age-1+ pollock in 2018 was the second lowest on record and continued a decreasing trend. While cod and pollock in the SEBS were in poor condition, NEBS cod and pollock north of St. Lawrence were “fat and healthy”.

Overall, despite anomalous environmental conditions, the present status of the BSAI stocks continues to appear mostly favorable. Nearly all stocks are above B_{MSY} or the B_{MSY} proxy of $B_{35\%}$ (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 B_{MSY} or the B_{MSY} proxy of $B_{35\%}$ in 2019 while Sablefish and Blackspotted/Rougheye rockfish remain below this target level.

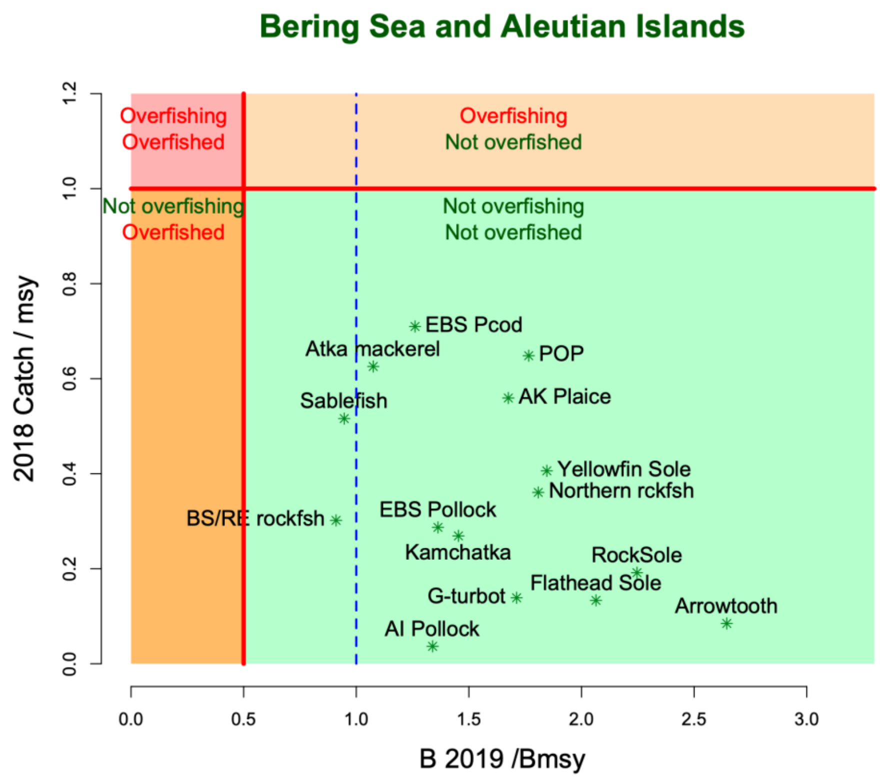


Figure 3-1. Summary of Bering Sea stock status next year (spawning biomass relative to B_{msy}; horizontal axis) and current year catch relative to fishing at F_{msy} (vertical axis) where F_{OFL} is taken to equal F_{msy}.

Commercial groundfish catch levels (TACs) in the BSAI are set at 2 million metric tons each year corresponding 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 groundfish species. In 2018 the sum of the ABCs was 3,752,125. The sum of 2018 catches was 1.911 million t (Figure 3-2). Pollock continues to be the majority of the catch in the BSAI region.

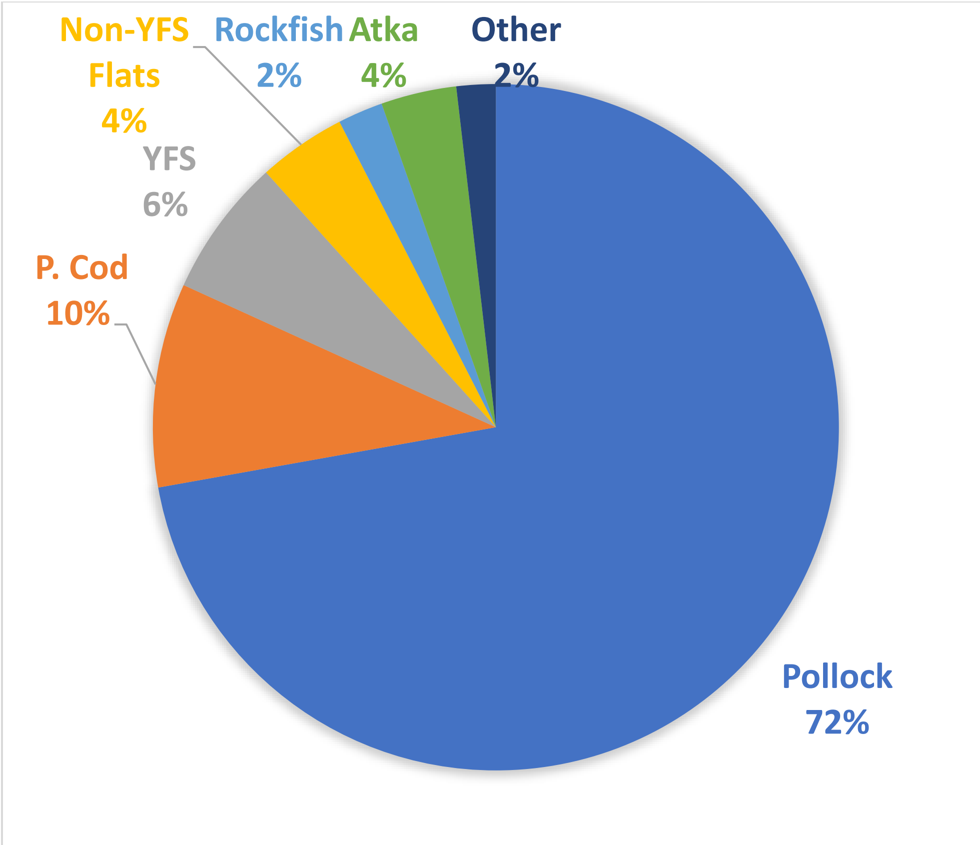


Figure 3-2. BSAI 2018 catch by different species. The total summed to 1.91 million t.

Some additional discussion of Pacific cod and flatfish stocks is summarized below to augment information in the SAFE reports for consideration in the impacts of alternatives based upon the combination of stock trends, TAC-setting and alternative halibut PSC limits in BSAI fisheries.

3.1.1.1 Pacific cod

Pacific cod (*Gadus macrophalus*) is a demersal species found in the Eastern Bering Sea (EBS) and the Aleutian Islands (AI) . Pacific cod are distributed over the continental shelf at depths from shoreline to 500 meters. Mature fish tend to concentrate on the outer continental shelf and prefer muddy or sandy soft sediment substrate. Pacific cod are a relatively fast growing and short-lived fish. Longevity can extend to 19 years. Adults form spawning aggregations from January to May in the Bering Sea (BS).

In the EBS, the Pacific cod assessment has shown a consistent decline in the population in recent years with Age-0 biomass on a consistent decline since 2017 (Figure 3-3; Thompson et al 2018). Recruitment is also estimated in the assessment to have been below average since the 2014 year class. The assessment is based on a Stock Synthesis model that uses both length-structured and age-structured data. This model incorporates fishery data and fishery-independent data from the NMFS EBS trawl survey and more recently some information from the Northern Bering Sea (NBS) survey.

The survey index for the EBS expanded area declined from 2017 to 2018. The NBS was surveyed in 2010 and 2017 and a rapid-response survey conducted in 2018 covered a truncated area in 2018 (Figure 3-3). This figure also shows that survey biomass estimates continued to decline in the EBS in 2018 (a 21% drop compared to 2017). In the NBS, the biomass almost doubled and was higher than what was surveyed in the South EBS (SEBS). Combined, these 2018 survey estimates show a lower sampling density in the

NBS and EBS which point to a decline in numbers of cod, but a slight increase in cod biomass in 2018 compared to 2017. Larger fish were observed in the NBS than in the EBS in 2018.

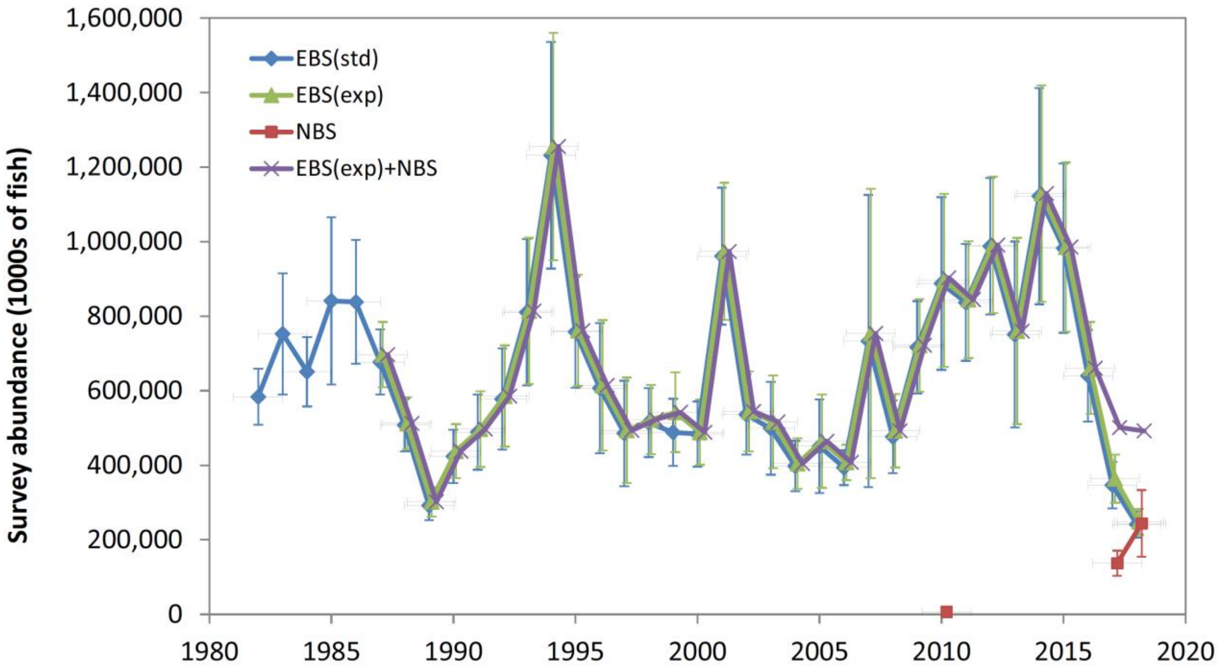


Figure 3-3. EBS trawl survey (standard and expanded areas), NBS trawl survey, and combined EBS (expanded) and NBS trawl survey numerical abundance estimates, with 95% confidence intervals. (Source: Thompson 2018a).

The stock assessment will continue to address observed distributional changes and how best to consider the recent environmental conditions. Further, similar environmental conditions are expected to persist in 2019. A survey of the NBS is anticipated for the summer of 2019 and will provide additional information on relative population trends of Pacific cod in that region

Cod was managed as a single BSAI stock through 2013 with an increasing population trend through 2012 (Figure 3-3Figure 3-4). 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 (Thompson et al. 2018b).

Catch specifications for EBS Pacific cod, over-fishing level (OFL), acceptable biological catch (ABC), and TAC have declined for the last several years due to overall estimated population declines (Figure 3-3; Table 3-1). In setting TACs for both the AI and BS, the Council takes into consideration the State GHL fishery (See Section 0 for additional information on cod allocations and reductions for State GHL fisheries).

Table 3-1 Catch specifications for BS cod 2017-2019

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

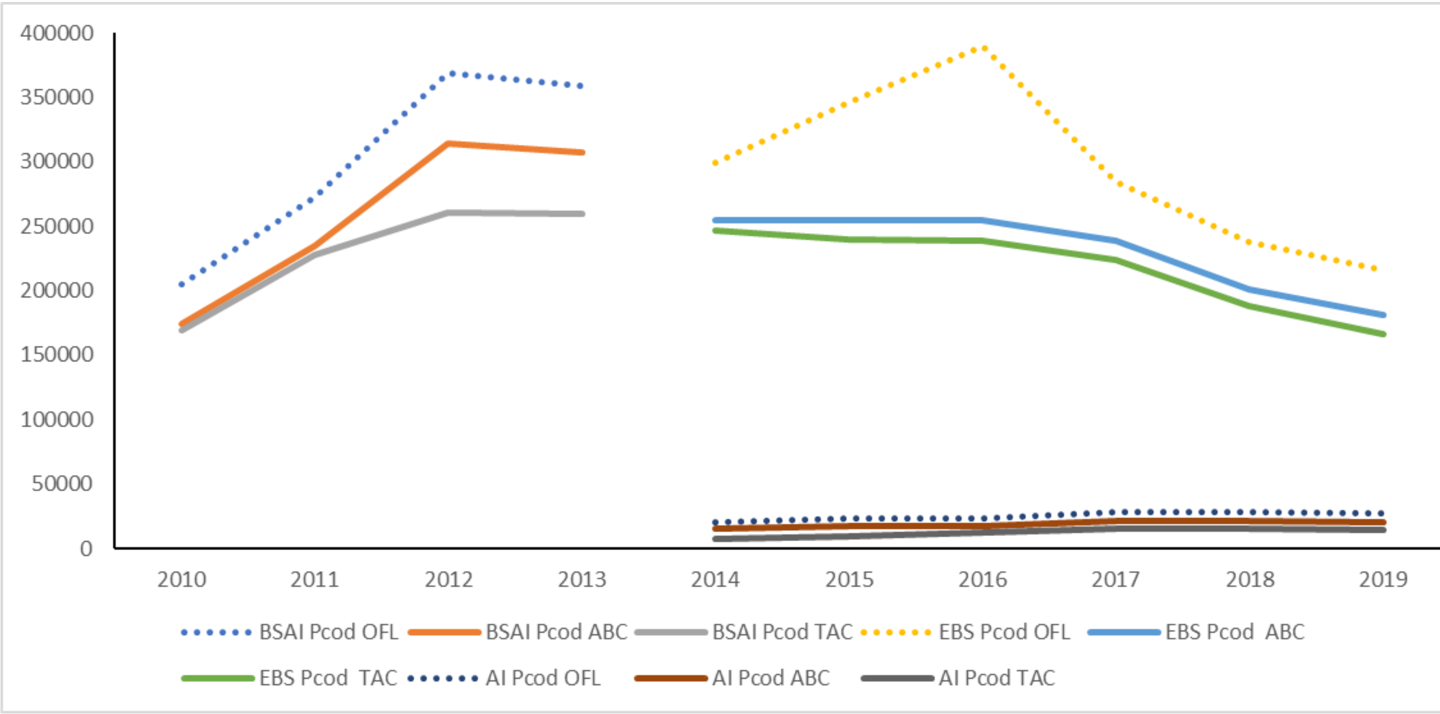


Figure 3-4. BSAI, Bering Sea (BS) and Aleutian Island (AI) Pacific cod OFL, ABC and TAC 2010-2019.

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 both market as well as halibut bycatch considerations. OFL, ABC and TACs in recent years for yellowfin sole, northern rock sole and flathead sole are shown in are shown in Table 3-2 through Table 3-4 below. 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). Additional information on OFLs, ABC and TACs from 2010-2019 for key flatfish species are shown in Figure 3-5. Yellowfin sole continues to comprise the majority of flatfish harvested in the BSAI.

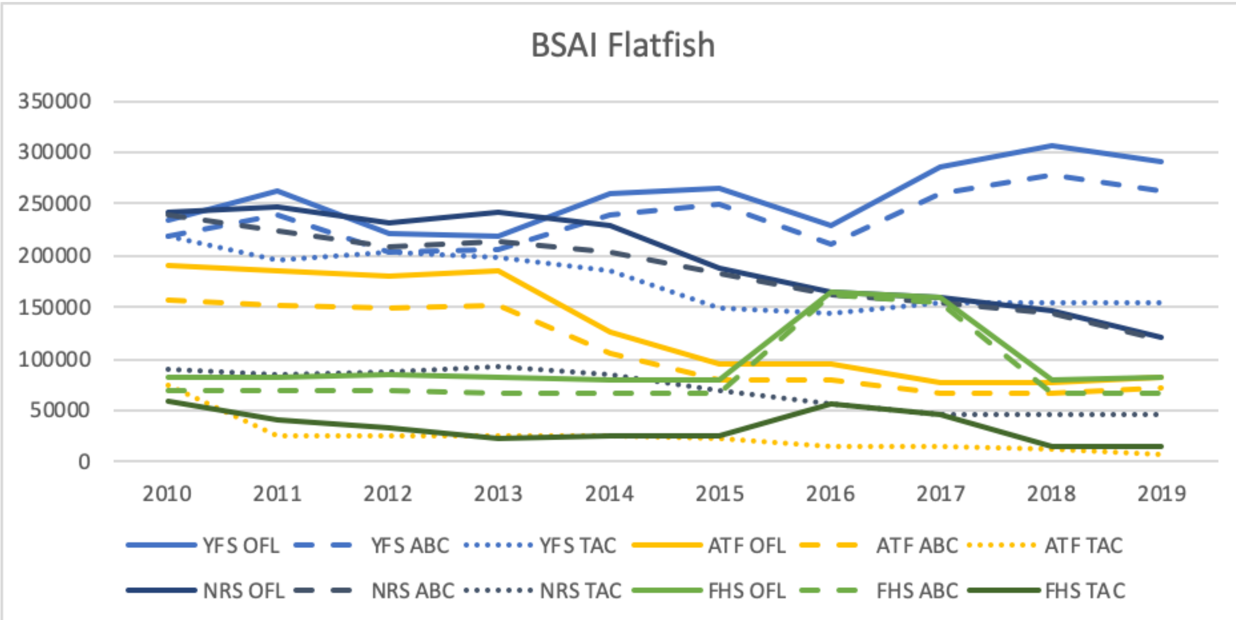


Figure 3-5. OFL, ABC and TAC levels for key flatfish species in the BSAI. Here YFS is yellowfin sole, NRS is northern rock sole, ATF is arrowtooth flounder and FHS is flathead sole.

Table 3-2. Catch specifications for yellowfin sole 2017-2019

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

Table 3-3. Catch specifications for northern rock sole 2017-2019

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

Table 3-4. Catch specifications for flathead sole 2017-2019

Year	Age 3+Biomass	OFL	ABC	TAC
2017	747,557	81,654	68,278	14,500
2018	762,513	79,862	66,773	14,500
2019	673,718	80,918	66,625	14,500

Additional information on these stocks in relation to the flatfish flexibility program and harvest specifications process is contained in Section 3.2.1.1.

3.2 Management of the NMFS groundfish fisheries

3.2.1 Groundfish harvest specification process

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 2018-2019 OFLs, ABCs and TACs for BSAI Groundfish

		2018			2019		
Species	**Area**	**OFL**	**ABC**	**TAC**	**OFL**	**ABC**	**TAC**
Pollock	EBS	4,797,000	2,592,000	1,364,341	3,914,000	2,163,000	1,397,000
	AI	49,289	40,788	19,000	64,240	52,887	19,000
	Bogoslof	130,428	60,800	450	183,080	137,310	75
Pacific cod	BS	238,000	201,000	188,136	216,000	181,000	166,475
	AI	28,700	21,500	15,695	27,400	20,600	14,214
Sablefish	BS	2,887	1,464	1,464	3,221	1,489	1,489
	AI	3,917	1,988	1,988	4,350	2,008	2,008
Yellowfin sole	BSAI	306,700	277,500	154,000	290,000	263,200	154,000
Greenland turbot	BSAI	13,148	11,132	5,294	11,362	9,658	5,294
	BS	n/a	9,718	5,125	n/a	8,431	5,125
	AI	n/a	1,414	169	n/a	1,227	169
Arrowtooth flounder	BSAI	76,757	65,932	13,621	82,939	70,673	8,000
Kamchatka flounder	BSAI	11,347	9,737	5,000	10,965	9,260	5,000
Northern rock sole	BSAI	147,300	143,100	47,100	122,000	118,900	47,100
Flathead sole	BSAI	79,862	66,773	14,500	80,918	66,625	14,500
Alaska plaice	BSAI	41,170	34,590	16,100	39,880	33,600	18,000
Other flatfish	BSAI	17,591	13,193	4,000	21,824	16,368	6,500
Pacific Ocean perch	BSAI	51,675	42,509	37,361	61,067	50,594	44,069
	BS	n/a	11,861	11,861		14,675	14,675
	EAI	n/a	10,021	9,000		11,459	11,009
	CAI	n/a	7,787	7,500		8,435	8,385
	WAI	n/a	12,840	9,000		16,025	10,000
Northern rockfish	BSAI	15,888	12,975	6,100	15,507	12,664	6,500
Blackspotted/ Rougheye Rockfish	BSAI	749	613	225	676	555	279
	EBS/EAI	n/a	374	75	n/a	351	75
	CAI/WAI	n/a	239	150	n/a	204	204
Shortraker rockfish	BSAI	666	499	150	722	541	358
Other rockfish	BSAI	1,816	1,362	845	1,793	1,344	663
	BS	n/a	791	275		956	275
	AI	n/a	571	570		388	388
Atka mackerel	BSAI	108,600	92,000	71,000	79,200	68,500	57,951
	EAI/BS	n/a	36,820	36,500		23,970	23,970
	CAI	n/a	32,000	21,000		14,390	14,390
	WAI	n/a	23,180	13,500		30,140	19,591
Skates	BSAI	46,668	39,082	27,000	51,152	42,714	26,000
Sculpins	BSAI	53,201	39,995	5,000	53,201	39,995	5,000
Sharks	BSAI	689	517	180	689	517	125
Squids	BSAI	6,912	5,184	1,200	n/a	n/a	0
Octopuses	BSAI	4,769	3,576	250	4,769	3,576	400
Total	BSAI	6,235,729	3,779,809	2,000,000	5,340,955	3,367,578	2,000,000

Sources: 2018-2019 OFLs, ABCs, and TACs are from harvest specifications adopted by the Council in December 2017 and December 2018.

Generally TAC setting is driven by tradeoffs between availability of pollock, BS cod, key flatfish species and adherence to the 2 million metric ton cap. High value, low volume species such as sablefish and rockfish have TACs set equal to ABC while lower volume flatfish stocks such as arrowtooth flounder have TACs set well below ABC for both market reasons as well as halibut bycatch. Trends in ABCs and TACs between three key stocks (EBS pollock, BS cod and yellowfin sole) are shown in Figure 3-6. At lower levels of rollock ABC (2010-2012 as shown) the TAC is set equal to the ABC. However at higher levels of ABC the TAC for pollock remains relatively stable from year to year and additional higher TAC levels are available for other species. BS cod ABC is reduced by the state 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 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 trend since 2010.

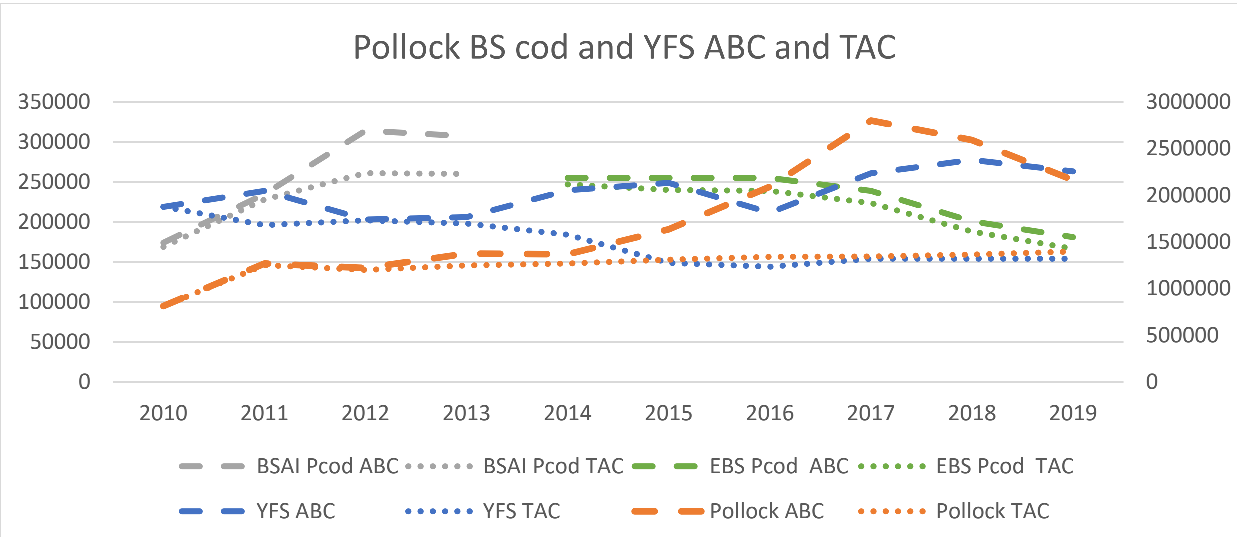


Figure 3-6. ABC and TAC for EBS pollock, BS cod and yellowfin sole (YFS)

POP TACs have generally been set close to or equal to the ABC (Figure 3-7). Atka mackerel TACs have fluctuated based primarily upon Stellar sea lion regulations which limit the available TAC by area.

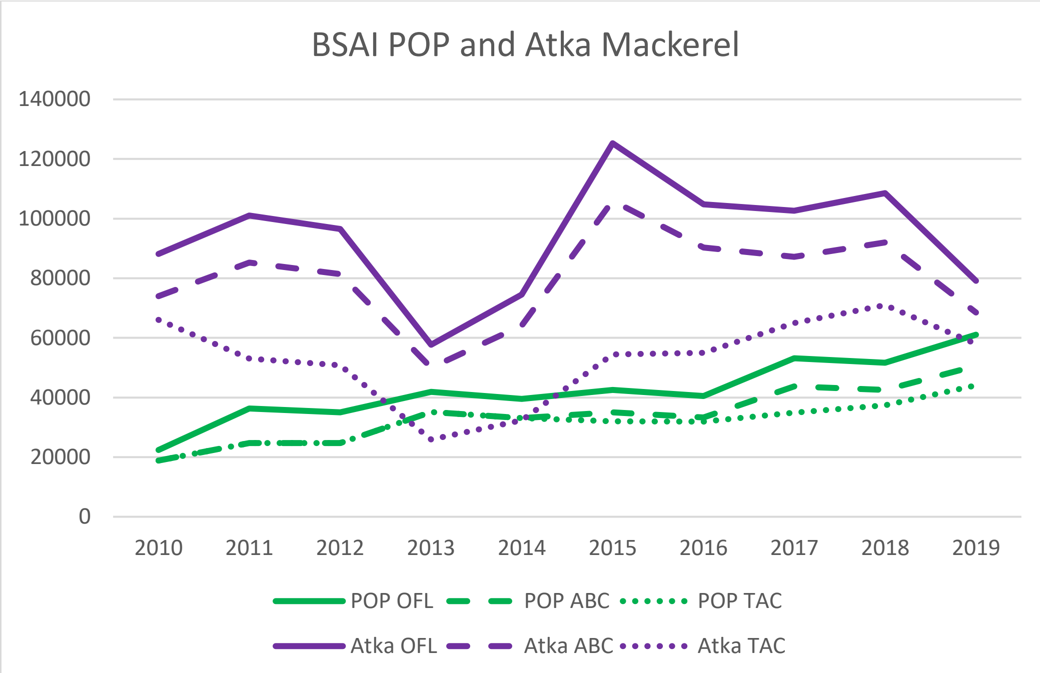


Figure 3-7. OFL, ABC and TAC levels for BSAI Pacific ocean perch (POP) and Atka mackerel 2010-2019

3.2.1.1 Flatfish flexibility

Since 2014, an ABC reserve is annually specified for flathead sole, rock sole, and yellowfin sole, which is allocated to CDQ groups and Amendment 80 cooperatives using the same formulas that are used in the annual harvest specifications process. The ABC reserve for each species is specified by the Council, by evaluating the ABC surplus for the species (i.e., the difference between the ABC and TAC), considering whether the amount 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 3-8shows the ABC and TAC for these three stocks under the flatfish flexibility.

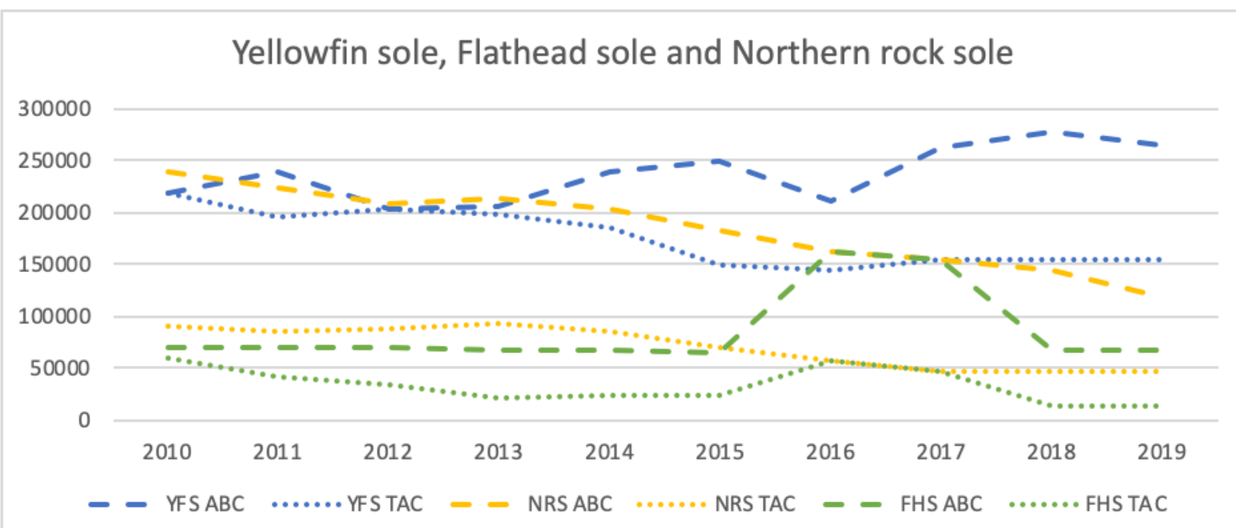


Figure 3-8 ABC and TAC levels for the three flatfish species managed under flatfish specifications (since 2014): yellowfin sole (YFS), northern rocksole (NRS) and flathead sole (FHS).

NMFS annually provides the Council with a report on the flatfish exchanges by the Amendment 80 cooperatives, to inform the Council's decision on future annual harvest specifications as to whether to establish a buffer by reducing the amount of the ABC reserve available to be exchanged by eligible entities.

In 2017 there were exchanges made within the yellowfin sole TAC and the flathead sole TAC. For YFS The Flatfish Flexibility Exchange Program increased the 2017 TAC from 154,000 t to 154,699 t. Through November 3, 2018 the Flatfish Flexibility Exchange program has increased the TAC from 154,000 t to 155,545 t for 2018. For flathead sole The Flatfish Flexibility Exchange Program decreased the TAC from 14,500 t to 14,076 t in 2017. The TAC was increased from 14,500 t to 17,105 t in 2018. Exchanges for 2018 will be reported during the harvest specifications process in the fall of 2019.

3.2.1.2 Pacific cod allocation issues

Pacific cod has some specific allocation issues which influence the overall prosecution of the fishery and resulting catch levels. Due to population distinctions between the EBS and AI, assessment and specifications occur separately for each area. However, due to regulatory sector allocations specified BSAI-wide, allocations are made of the summed non-CDQ BSAI TAC. The process of allocation of TAC begins reducing the ABC to account for the State GHL in each area and the deduction of Area-specific CDQ from EBS and AI prior to sector and seasonal allocations (Figure 3-9).

The State manages three GHL fisheries for Pacific cod, two that occur within State waters in the BS and one that occurs within State waters in the AI. Under current State regulations, each year the DHS GHL fishery for pot gear in the BS is set at 8 percent of the BS ABC with annual 1 percent increase, if 90 percent is harvested, until it reaches 15 percent of the BS ABC. The Board of Fish also created 100,000 lb. (just over 45 t) GHL jig fishery in the DHS that will begin in 2019. The AI GHL fishery was set at 27 percent of the 2018 ABC specified for AI Pacific cod. The 2019 AI GHL was increased to 31 percent of the AI Pacific cod ABC, with annual 4 percent "step-up" provisions that increases the amount of the GHL fishery if it was fully (90 percent) harvested in the previous year. The AI GHL fishery can increase to a maximum of 39 percent of the AI ABC or to a maximum of 15 million pounds (6,804 t), whichever is less. Pacific cod TACs are specified at levels that take into account the GHL fisheries so that the combined harvest limits from GHL fisheries and the TACs do not exceed the ABCs specified for the BS or AI. Section 2.3 of the December 2017 discussion paper[15] provides additional discussion of the GHL fisheries in the BSAI.

Once the TACs are established, regulations at § 679.20(a)(7)(i) allocate 10.7 percent of the Bering Sea Pacific cod TAC and 10.7 percent 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 after deducting the 10.7 percent allocation for CDQ Program is the ITAC. For the HAL and pot gear sectors, NMFS estimates an incidental catch allowance (ICA) that will be deducted from the aggregate portion of Pacific cod TAC allocated to the HAL and pot gear sectors before the allocations to these sectors. For the 2019 BSAI Pacific cod fishery, the ICA was 400 t.

[15] http://npfmc.legistar.com/gateway.aspx?M=F&ID=14769180-2558-4acc-9290-1facf916e0a7.pdf

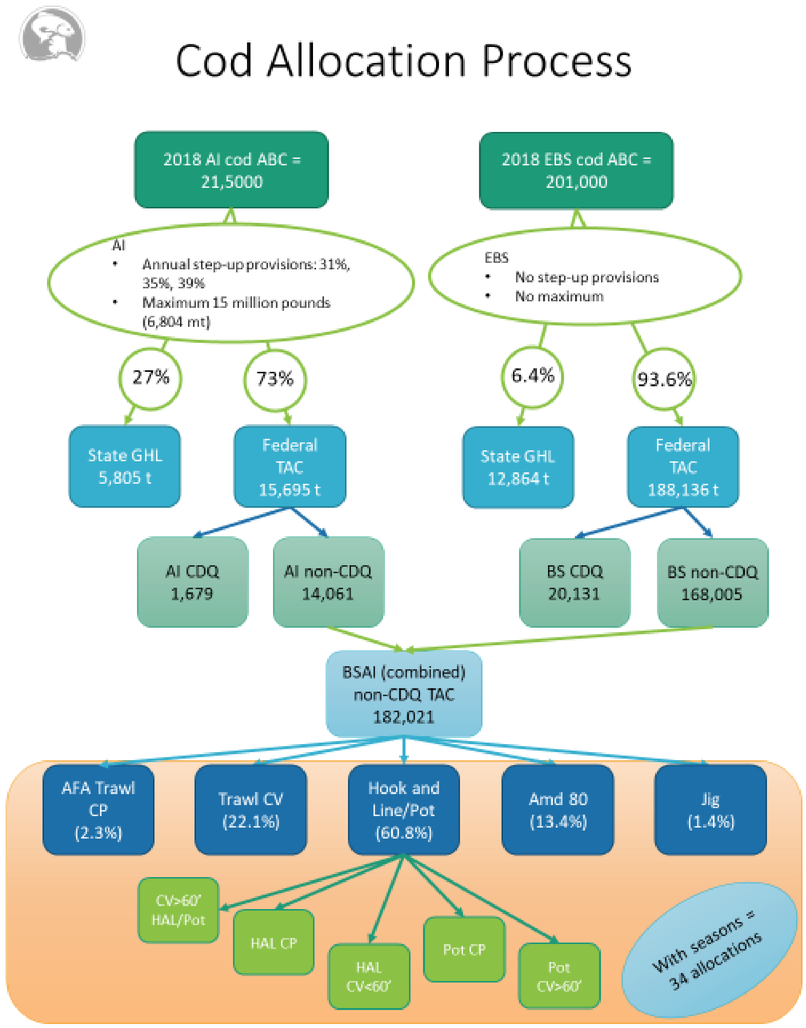


Figure 3-9. BSAI cod allocation beginning with area-specific ABCs in AI and EBS, deduction of the state GHL, CDQ allocations and recombined BSAI TAC for sector and seasonal allocations. In the end there are 34 separate allocations to sectors and seasons.

After subtraction of 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. The non-CDQ fishery sectors are defined by a combination of gear type (e.g., trawl, HAL), operation type (i.e., CV or C/P), and vessel size categories (e.g., vessels greater than or equal to 60 ft in length overall). Through the annual harvest specifications process, NMFS allocates an amount of the combined BSAI non-CDQ TAC to each of these nine non-CDQ fishery sectors.

NMFS manages each of the non-CDQ fishery sectors to ensure harvest of Pacific cod does not exceed the overall annual allocation made to each of the non-CDQ fishery sectors. 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). For the non-AFA trawl C/P sector, also known as the Amendment 80 sector, NMFS allocates exclusive harvest privileges to these vessels participating in an Amendment 80 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 or will be reached in either the BS or AI, NMFS will prohibit directed fishing for Pacific cod in that subarea for all non-CDQ fishery sectors.

Allocations of Pacific cod to the CDQ Program and to the non-CDQ fishery sectors are further 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 Program or non-CDQ fishery sector allocation, between 40 percent and 70 percent of the Pacific cod allocation is apportioned to the A-season, 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 (Figure 3-9). To help ensure the efficient management of these allocations, regulations allow NMFS to reallocate (rollover) any unused portion of a seasonal apportionment from any non-CDQ fishery sector (except the jig 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.

3.2.2 Pacific halibut discard mortality rate (DMR) estimation

3.2.2.1 Description of main DMR estimation process

Pacific halibut discard mortality rates (DMRs) for in-season management of GOA and BSAI groundfish fisheries are annually updated within the specifications process. The approach to establishing DMRs has changed in recent years. The new methodology was presented to and approved by the Plan Teams, SSC and Council in December 2016[16]. 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. Additionally, while the previous approach used a 10-year reference period for DMR estimates, a reduced reference period (2-3 years) is currently used to better incentivize improvement in halibut handling practices.

The estimation process uses weighted averages of halibut mortality (condition data) to expand estimated DMRs from the 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 with changes from the previous year's estimate noted.

DMRs specified for 2018 and 2019 are shown in Table 3-6. These are specified for a two-year period (with the 2019 DMRs applying to 2020) however as with the catch specifications DMRs are annually updated.

[16] See 2017-2018 Halibut DMR Recommendations provided by the inter-agency Halibut DMR Working Group.

Table 3-6 DMRs specified in 2018 and 2019 for groundfish fisheries by gear and sector as applicable in the BSAI and GOA showing the number of viabilities collected, whether or not the DMR is estimated and the resulting DMR for each year.

2018						
Operational Group						
Area	Gear	Sector	RPP	Mean Annual $N_{\_viabilities}$	Estimate DMR?	DMR
BSAI	POT	None	N	548	Y	9%
	HAL	CP	N	9,547	Y	8%
		CV	N	832	Y	17%
	NPT	CP	N	2,025	Y	84%
		CV	N	2,456	Y	60%
GOA	POT	None	N	602	Y	7%
	HAL	CP	N	1,631	Y	10%
		CV	N	3,286	Y	17%
	NPT	CP	N	132	N	84%
		CV	N	755	Y	67%
		CV	Y	176	Y	62%

2019						
Operational Group						
Area	Gear	Sector	RPP	Mean Annual $N_{\_viabilities}$	Estimate DMR?	DMR
BSAI	POT	None	N	380	Y	19%
	HAL	CP	N	6,886	Y	8%
		CV	N	360	Y	4%
	NPT	CP	N	2,844	Y	78%
		CV	N	2,736	Y	59%
GOA	POT	None	N	450	Y	4%
	HAL	CP	N	1,672	Y	11%
		CV	N	2,367	Y	21%
	NPT	CP	N	1,300	Y	79%
		CV	N	1,106	Y	67%
		CV	Y	389	Y	49%

3.2.2.2 CAS Pacific halibut PSC accounting for vessels participating in deck sorting EFP

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: When deck sorting occurs, the observer identifies a sample of halibut for taking length and viability measurements. In 2018 for example, a systematic random sample of discarded fish is selected-- one out of every five halibut (20%)-- and in addition the first 15 halibut are sampled, unless the observer is able to sample additional fish. 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 systematic random sample; note that the additional 15 fish are not included in the computation of mortality rate. The qualitative viabilities assessed by the observer correspond to a quantitative post-capture mortality rate. For each deck sorted haul, a weighted average discard mortality rate (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.

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**. 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

For trawl gear, there are also several closure areas in place which may afford protection to halibut spawning and nursery grounds (Figure 3-10). Many of these overlap the 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 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 during March 15 through June 15, and the subarea of the Red King Savings Area is closed to non-pelagic trawling under certain conditions. Also, parts of Federal reporting areas 509 and 517 are part of the Catcher Vessel Operation Area (CVOA), and a catcher processor authorized to fish for BSAI pollock under § 679.4 is prohibited from conducting directed fishing for pollock in the CVOA during the pollock B season, defined at § 679.23(e)(2)(ii), unless it is directed fishing for pollock CDQ.

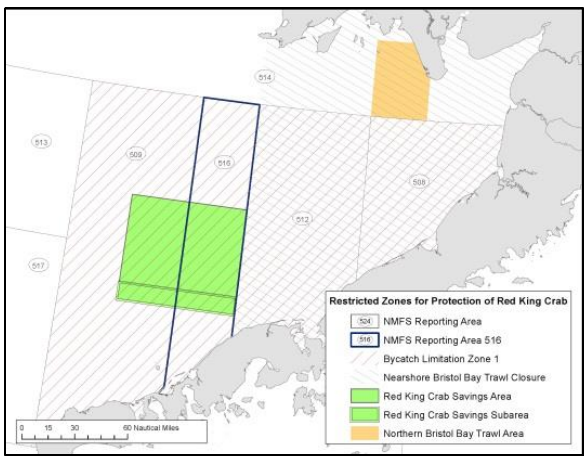


Figure 3-10 Bering Sea fishery closures for the protection of red king crab

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 abundance of BBRKC (Table 3-7).

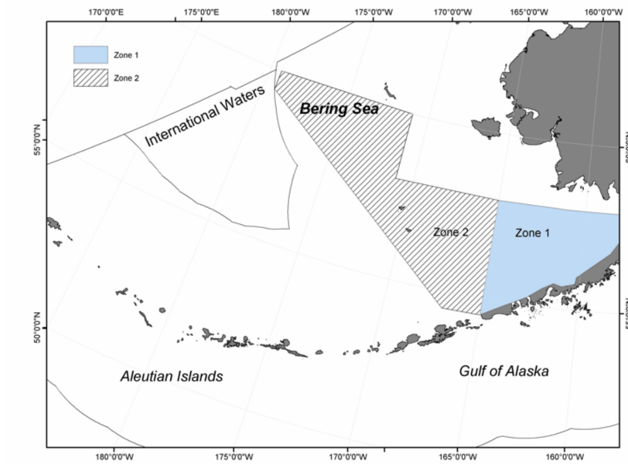


Figure 3-11 Zones 1 and 2 area for closures (Bristol Bay red king crab and EBS Tanner crab).

Table 3-7 PSC limits for red king crab.

PSC limits for Zone 1 red king crab (No Zone 2 RKC)	
Abundance	PSC Limit
Below threshold or 14.5 million lbs of effective spawning biomass (ESB)	33,000 crabs
Above threshold, but below 55 million lbs of ESB	97,000 crabs
Above 55 million lbs of ESB	197,000 crabs

A summary of all red king crab trawl closure measures in shown in Table 3-8

Table 3-8 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 162º 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 3-9).

Table 3-9. 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 abundance
	150-270 million crabs	750,000
	270-400 million crabs	850,000
	over 400 million crabs	1,000,000
Zone 2	0-175 million crabs	1.2% of abundance
	175-290 million crabs	2,100,000
	290-400 million crabs	2,550,000
	over 400 million crabs	3,000,000

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.

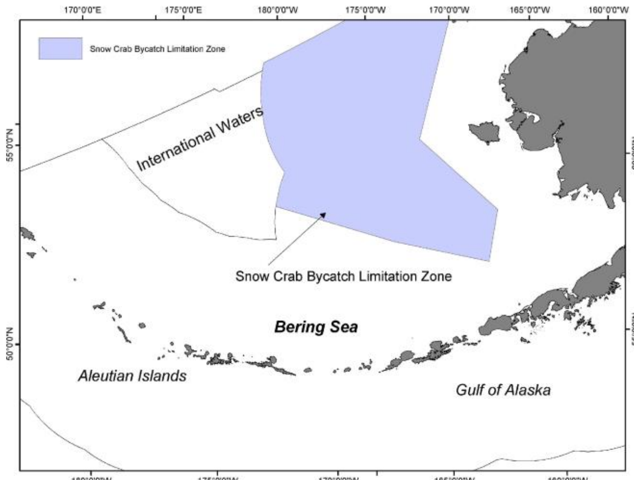


Figure 3-12. *C. opilio* Bycatch Limitation Zone (COBLZ)

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 snow crab abundance index, with a minimum of 4.5 million snow crabs and a maximum of 13 million snow crabs; the cap is further reduced by 150,000 crabs.

A summary of all of these trawl closures, 2019 PSC limits as well as other fixed closures to groundfish sectors and gears in the BSAI for crab bycatch management are shown in Table 3-10.

Table 3-10 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 2019	**How catch accrues**	**2019 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	11,916,450 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 Description of halibut PSC-limited groundfish fisheries in the BSAI

Key Federal BSAI groundfish sectors that are managed under halibut PSC limits include Amendment 80 non-pollock trawl catcher-processors (A80), the BSAI trawl limited access sector (TLAS), the hook-and-line catcher processors (HALCP), the non-IFQ Community Development Quota fleet (CDQ), and hook-and-line catcher vessels (HALCV). These sectors are interlinked in many ways including company affiliation, operational interdependency, shared fishing grounds, annual harvest limits and inseason rollovers for key groundfish species. In 2018 these sectors consisted of 19 A80 CPs, eight of which also participated in CDQ sector operations, 70 TLAS vessels, nine of which participated in CDQ sector operations, 25 HALCPs, 11 of which participated in CDQ, 49 CDQ vessels (including the aforementioned overlapping participants in TLAS, A80 and HALCP) and five HALCV vessels (Figure 3-13). Many of the vessels in the TLAS and CDQ fisheries also participate in the American Fisheries Act (AFA) pollock fishery (Table 3-11) and while this action doesn't directly affect the AFA fishery, this description considers the American Fisheries Act (AFA) pollock fishery in terms of its relationship with the TLAS fleet (participation) and the A80 sector (availability of inseason reallocations of non-pollock groundfish TAC and halibut PSC).

While these sectors overlap in many ways, they also have many distinct characteristics such as the gears they use, their processing operations, the species they are allocated, target and derive revenue from, the size and scope of their operations and the amount of revenue generated. Table 3-12 shows annual revenue, by sector for years 2010 through 2018. While some sectors are heavily reliant on single species, other sectors have more varied portfolios of species from which they derive revenue. As such, these sectors are affected differently by trends in availability and prices of different species. Table 3-12 shows annual average prices in nominal dollars for the major species targeted by groundfish sectors. Annual price variability differs by species, as well as gear type, price type or processing sector within a single species. Note that shoreside processing wholesale prices by gear type are not available.

Additionally, seasonal openings of different groundfish species have differential impacts on different groundfish sectors based on their portfolio of allocations and target species. Figure 3-14 shows the typical BSAI non-pollock groundfish seasons for species that are targeted by the PSC-limited sectors potentially affected by the ABM action. This information is adapted from the NMFS Alaska Region website, as updated on 4/2/2019[17] and is not meant to represent actual fishery data. The figure reflects that trawl fisheries generally open on January 20 and close by regulation on November 1. Hook-and-line (HAL) and pot gear fisheries open on January 1 and close on December 31. For Pacific cod, the figure shows that the A80 and HAL CP sectors operate continually throughout most of the calendar year. 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. In contrast, the TLAS sector fishes for Pacific cod during shorter, seasonally allocated periods but might also encounter the species when fishing for yellowfin sole at other times of the year. This analysis recognizes that the active fishing period for TLAS Pacific cod has been condensed in recent years due to increased participation and lower available TAC (see also, Section 3.5.1 on the Council's rationale for current consideration of a BSAI Pacific cod LAPP).

The other non-pollock groundfish species highlighted in Figure 3-14 are primarily targeted by A80 vessels (except yellowfin sole, which is also targeted by the TLAS). This is evident by the season opening date depicted in mid-January. 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

[17] https://www.fisheries.noaa.gov/alaska/resources-fishing/federal-fishery-seasons-alaska Link to 'Groundfish >> BSAI'

desirable or more valuable when roe is present. 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. 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, and POP at a given point during the year.

The scale of each sector differs by the number and types of vessels participating (as discussed above), and this also impacts the number of crew involved in fishing operations. Table 3-14 shows the average of annual, median crew size from 2010-2018 for a vessel in each of the ABM groundfish sectors. Sectors dominated by CVs, TLAS and hook and line, have smaller crew sizes while CPs have much larger sized crews. The data are drawn from fish tickets, which are filled out by shoreside processors for CVs and by CPs themselves. Fish ticket data on crew size is not audited, but the results in the table conform to the analysts' understanding of the fisheries based on experience with the fleets. The crew size range for CVs in the halibut IFQ fishery is cited from the IFQ Program 20 Year Review; a range was used to acknowledge the diversity in fishing platforms across the three CV vessel classes (B, C, and D).

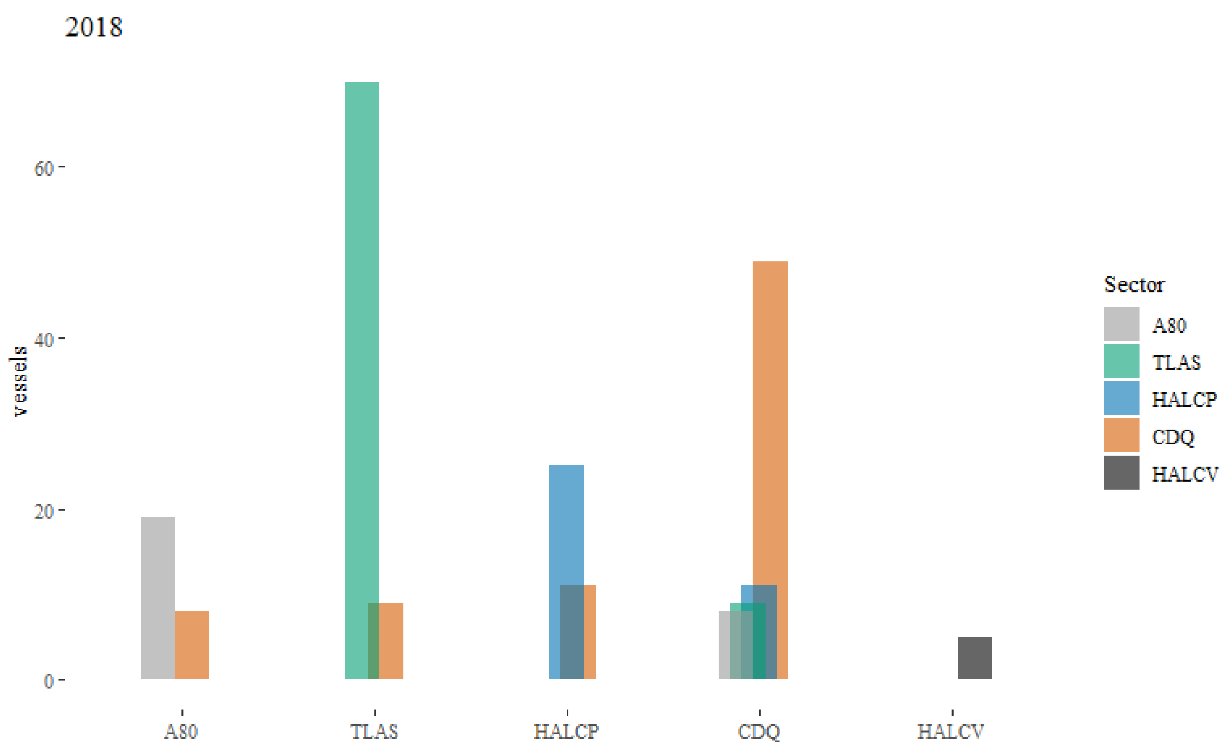


Figure 3-13 Number of vessels that made trips associated with each sector in 2018. Overlapping bars show vessel participation in additional sectors. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

Table 3-11 Number of vessels participating in each sector in 2018. *Note some vessels participate in multiple processing sectors therefore sector total is not a sum of rows. Vessels are reported in each sector they participated in (i.e. an A80 boat that fishes CDQ is counted in each sector). **There are an additional 7 boats that fished in the CDQ sector using pot gear that are not included in this table as that PSC does not accrue to the sector. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

Sector	Gear	Groundfish Processing Sector	AFA	Vessels*	Sector total
A80	TRW	CP	N	18	
A80	TRW	CP	Y	1	19
TLAS	TRW	CP	Y	4	
TLAS	TRW	M	N	7	
TLAS	TRW	M	Y	5	
TLAS	TRW	S	N	11	
TLAS	TRW	S	Y	46	70
HALCP	HAL	CP	N	25	25
CDQ	HAL	CP	N	11	
CDQ	HAL	S	N	2	
CDQ	TRW	CP	N	7	
CDQ	TRW	CP	Y	17	
CDQ	TRW	M	N	5	49**
HALCV	HAL	S	N	5	5

Table 3-12. Annual groundfish revenues by sector 2010-2018 (millions nominal dollars, non-pollock, non-IFQ). Note for sectors dominated by CPs (A80, HALCP, CDQ) first wholesale value is reported, for sectors dominated by CV (TLAS, HALCV) ex-vessel value is reported. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

Sector	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
A80	282.04	342.50	360.30	283.73	297.53	275.78	294.18	351.54	379.61
TLAS	22.26	37.54	47.05	40.52	38.01	26.99	34.46	42.28	43.96
HALCP	116.92	175.92	182.35	132.59	159.39	188.51	175.45	200.78	189.17
CDQ	155.55	215.08	221.33	189.23	198.20	204.11	213.92	233.46	230.96
HALCV	0.21	0.35	0.46	0.65	1.38	0.48	c	c	0.72

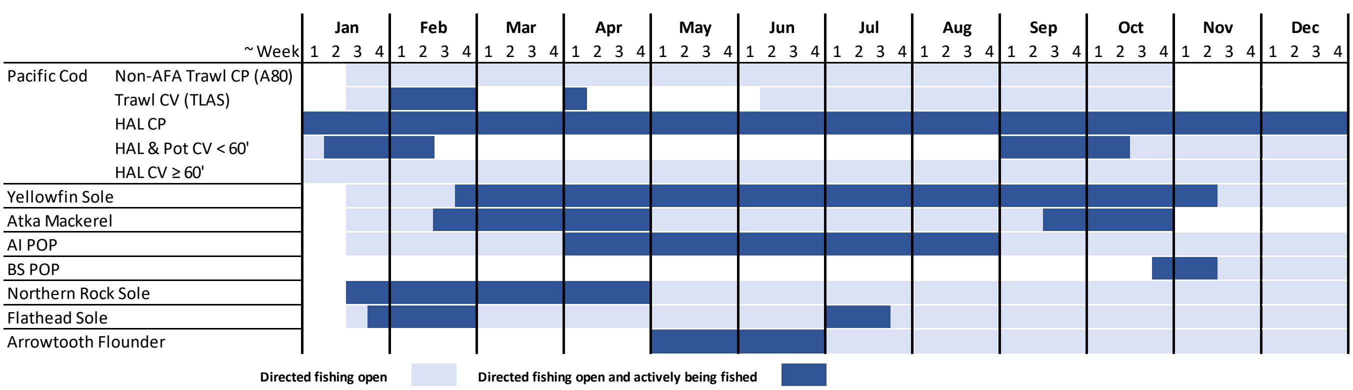


Figure 3-14. Typical BSAI non-pollock groundfish seasons for selected target fisheries. Source: https://www.fisheries.noaa.gov/alaska/resources-fishing/federal-fishery-seasons-alaska

Table 3-13. Annual average prices for groundfish species in BSAI (nominal dollars). Source: NMFS Alaska Region At-Sea Production Reports, data compiled by AKFIN in Comprehensive_WPR and NMFS Alaska Region Shoreside Production Reports, data compiled by AKFIN in Comprehensive_SPR

Species	Gear	Price Type	Processor	2010	2011	2012	2013	2014	2015	2016	2017	2018
Arrowtooth	TRW	ex-vessel		0.05	0.02	0.05	0.04	0.06	0.08	0.10	0.03	0.15
Arrowtooth	TRW	wh_value	At sea	0.48	0.72	0.85	0.63	0.82	0.74	0.85	1.29	0.87
Arrowtooth		wh_value	Shoreside	0.56	1.32	0.64	0.78	0.57	0.41	0.77	0.80	0.68
Atka	TRW	ex-vessel		0.04	0.14	0.14	0.33	0.13	0.19	0.08	0.08	0.13
Atka	TRW	wh_value	At sea	0.84	1.03	1.12	1.22	1.37	1.02	1.02	1.37	1.35
Atka		wh_value	Shoreside	0.62	0.90	0.66	1.37	0.60	0.86	0.65	0.87	0.73
Flathead sole	TRW	ex-vessel		0.02	0.02	0.02	0.06	0.06	0.08	0.06	0.06	0.19
Flathead sole	TRW	wh_value	At sea	0.69	0.89	0.91	0.90	0.70	0.64	0.74	0.86	0.99
Flathead sole		wh_value	Shoreside	0.52	1.05	0.39	1.15	0.59	0.84	0.62	0.63	0.61
Pacific cod	HAL	ex-vessel		0.29	0.35	0.36	0.30	0.31	0.31	0.32	0.34	1.14
Pacific cod	HAL	wh_value	At sea	1.46	1.60	1.41	1.11	1.37	1.46	1.37	1.62	1.80
Pacific cod	TRW	ex-vessel		0.24	0.28	0.32	0.24	0.26	0.24	0.26	0.29	0.35
Pacific cod	TRW	wh_value	At sea	1.11	1.33	1.29	0.90	1.01	1.17	1.13	1.36	1.72
Pacific cod		wh_value	Shoreside	1.27	1.58	1.50	1.34	1.31	1.32	1.63	1.89	2.31
POP	TRW	ex-vessel		0.10	0.05	0.24	0.19	0.16	0.11	0.07	0.07	0.30
POP	TRW	wh_value	At sea	1.16	1.72	1.41	1.07	1.20	1.06	0.92	1.11	1.04
POP		wh_value	Shoreside	0.68	0.92	0.72	0.61	0.56	0.61	0.61	0.56	0.89
Rock sole	TRW	ex-vessel		0.02	0.03	0.05	0.05	0.15	0.08	0.08	0.03	0.21
Rock sole	TRW	wh_value	At sea	0.61	0.77	0.91	0.58	0.55	0.55	0.62	0.72	0.89
Rock sole		wh_value	Shoreside	0.55	0.87	0.40	1.20	0.87	0.87	0.73	0.71	0.55
Yellowfin sole	TRW	ex-vessel		*NA*	0.05	0.21	0.03	0.18	0.09	0.07	0.06	0.07
Yellowfin sole	TRW	wh_value	At sea	0.52	0.63	0.63	0.58	0.46	0.48	0.55	0.65	0.81
Yellowfin sole		wh_value	Shoreside	0.96	0.85	0.88	1.29	0.90	0.87	0.73	0.80	0.64

Table 3-14 Average Median Annual vessel crew size by sector

Sector	Crew Size
A80	29
HALCP	20
CDQ	23
TLAS	4*
HALCV	4
IFQ Halibut CV	2-4**

*Note that although some TLAS vessels are CPs, this crew size only applies to CVs in the TLAS sector
** estimate based on Hartley & Fina (2001), cited in IFQ Program 20 Year Review (NPFMC 2016)

3.3.1 Amendment 80 (A80)

3.3.1.1 Background

The Amendment 80 Program, implemented in 2008, enabled the formation of fishery cooperatives for trawl catcher/processors (CPs) that are not eligible under the American Fisheries Act (AFA) to participate in directed pollock fisheries. This group of Trawl CPs is hereafter referred to as the A80 CPs or the A80 Sector. A80 allocated several Bering Sea and Aleutian Islands (BSAI) non-pollock trawl groundfish species among trawl fishery sectors and facilitated the formation of harvesting cooperatives in the non-AFA trawl catcher/processor sector. A80 allocates a portion of the TAC for Pacific ocean perch in the AI, Atka mackerel, yellowfin sole, rock sole, and flathead sole in the BSAI, along with an allowance of PSC quota for halibut and crab to the sector. In addition, Amendment 85 allocated the sector a 13.4 percent allocation of the BSAI Pacific cod.

The Council adopted Amendment 80 to meet the broad goals of: (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 catcher/processors to expand their harvesting capacity into other fisheries not managed under a LAPP.

Amendment 80 established criteria for harvesters in the Amendment 80 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 could 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 opportunity to trade harvest privileges among cooperatives encourages efficient harvesting and discourages waste. Each Amendment 80 cooperative receives an exclusive allowance of crab PSC and halibut PSC, amounts which the cooperative may not exceed while harvesting groundfish in the BSAI. This halibut and crab PSC cooperative quotas are assigned to a cooperative in an amount proportionate to the amounts of Amendment 80 groundfish quota shares held by its members, and is not based on the amount of crab or halibut PSC historically removed by the cooperative members. A cooperative structure allows Amendment 80 vessel operators to better manage PSC rates than operators who must race to harvest groundfish as quickly as possible before PSC causes a fishery closure. By reducing PSC through more efficient cooperative operations (such as through gear modifications or “hot spot” avoidance), Amendment 80 vessel operators may also increase the harvest of valuable targeted groundfish species and improve revenues that would otherwise be foregone.

3.3.1.2 Fleet composition

Since 2010, the A80 fleet has consisted of 18-20 catcher processors, four to eight of which have also participated in the CDQ fishery depending on the year (Figure 3-15). A majority of these vessels are owned by companies registered in Washington. In 2018, nine A80 CPs acted as motherships in the TLAS fishery, taking at-sea deliveries from CVs. Council action that is currently in the rulemaking process would limit the number of CPs that can receive deliveries of TLAS Pacific cod and the CVs that can deliver TLAS yellowfin sole to CPs acting as motherships. Only one A80 CP would be allowed to receive TLAS Pacific cod deliveries (as would one AFA CP). Eight CVs would be 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 market to which they would likely deliver; the others are independent CVs. Given the restriction on CPs taking Pacific cod deliveries from CVs, the extent to which a TLAS yellowfin sole mothership market will be sustained on its own is unknown at this time.

From 2010 through 2017, A80 consisted of two cooperatives that received annual allocations from NMFS, the Alaska Seafood Cooperative (AKSC) and the Alaska Groundfish Cooperative (AGC). In 2018 the Fishing Company of Alaska terminated operations and sold its remaining vessels, leading to the consolidation into one cooperative, the AKSC. Apart from this, vessel ownership and cooperative membership has remained relatively stable through the years (Figure 3-16).

A80 companies vary in the number of CPs they own, whether or not they own the CVs with which they partner in the TLAS fisheries (vertical integration), and – most 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) (Concepcion and Fina 2018). 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 (i.e. Atka mackerel) based on the qualified catch history that they bring to their cooperative.

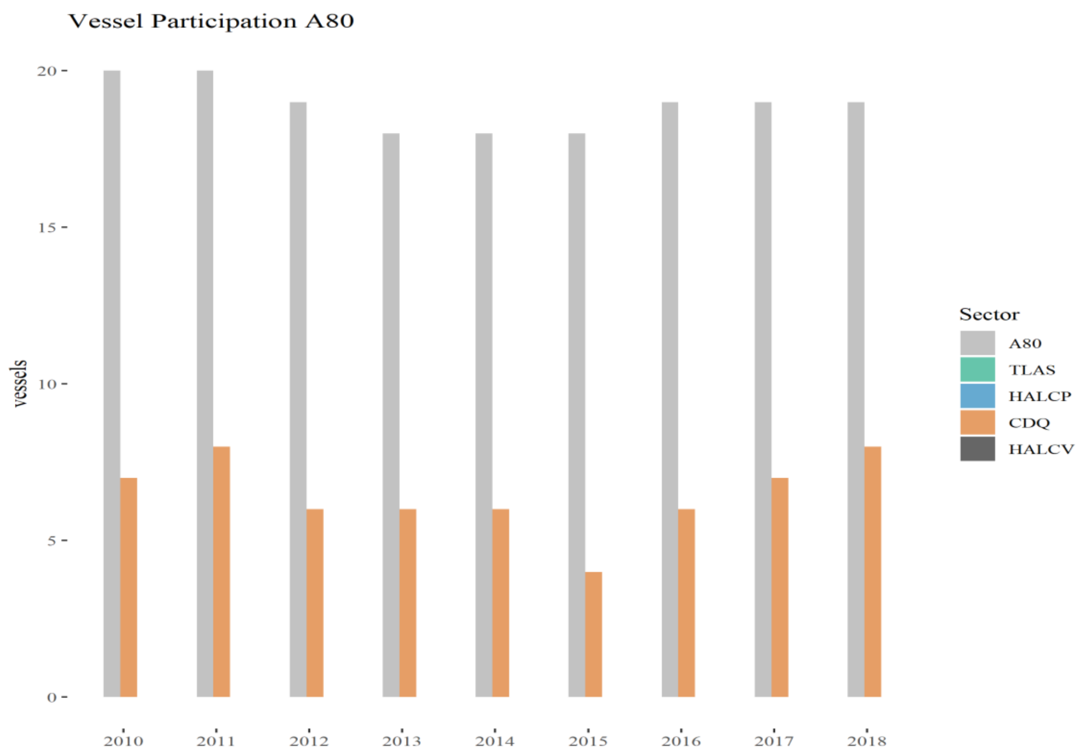


Figure 3-15. Number of vessels in Amendment 80 fleet and cross participation in CDQ fisheries 2010-2019. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

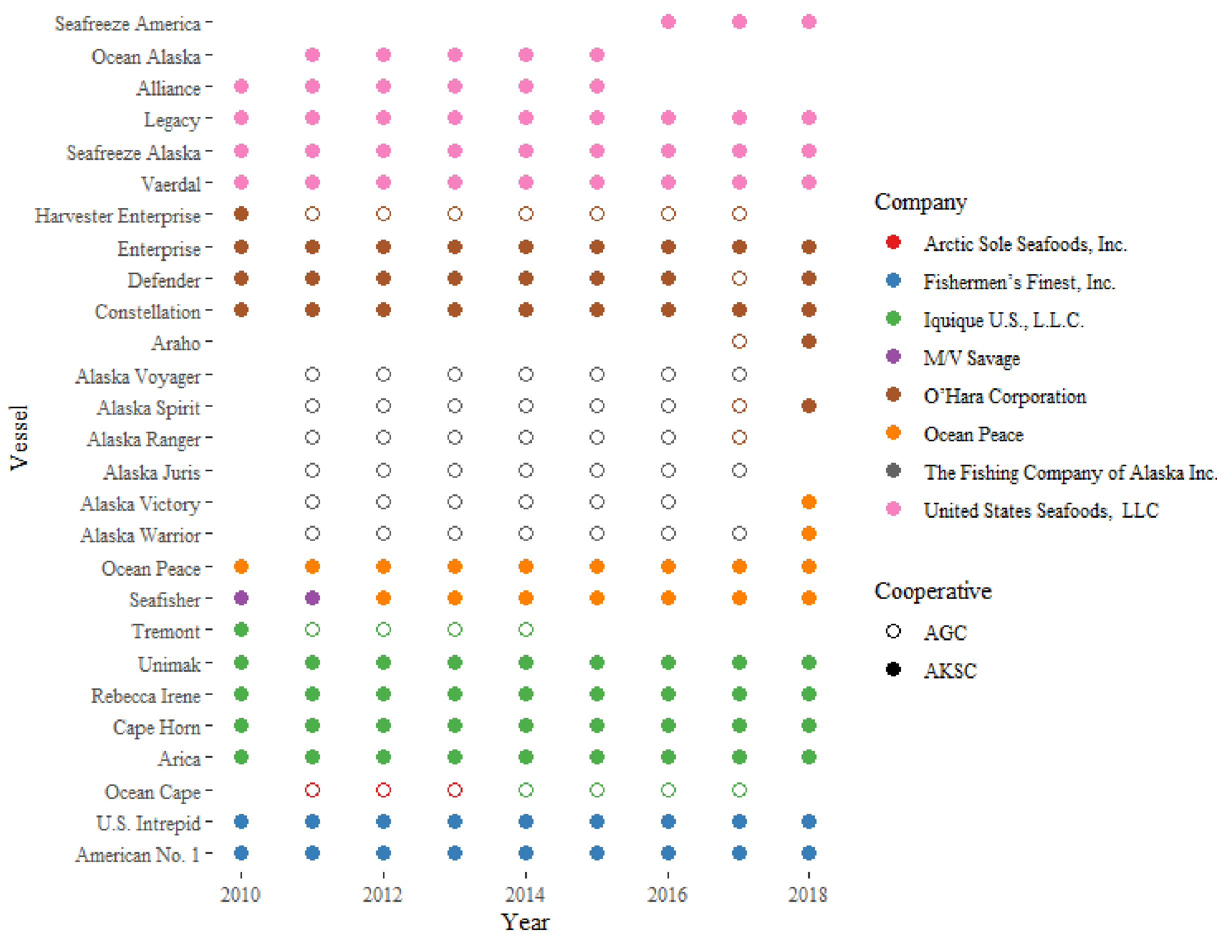


Figure 3-16. A80 Vessels by Company and Cooperative, 2010-2018. Source: Adapted from information published in annual Cooperative Reports.

3.3.1.3 Catch/Revenue

A80 CPs target an array of flatfish and roundfish species. A80 cooperatives are allocated yellowfin sole (YFS), rock sole, flathead sole, Atka mackerel, Pacific cod, and AI Pacific ocean perch (POP). A80 vessels also derive revenue from sablefish, Greenland turbot, arrowtooth/Kamchatka flounder, and Alaska plaice. Typically the highest grossing target species for the sector are YFS, Atka mackerel, and rock sole (Figure 3-17). A80 vessels can generally be characterized by two different types of operations: those heavily dominated by flatfish catch and those with a more balanced portfolio of flatfish and Atka mackerel. Specific vessel catch information is confidential, however between 2010-2018 seven or eight vessels consistently received over a third of their revenue from Atka mackerel and POP, while the rest of the fleet are more dependent on flatfish. Both types of operations also harvest differing amounts of pacific cod, pollock and rockfish to round out the catch. According to the BSAI Pacific cod allocation review (NPFMC 2019) most of the targeted Pacific cod originates from test tows for Amendment 80 species that were not intended as Pacific cod target tows. The few intended Pacific cod target tows are mainly to assist in facilitating a vessel's mothership processing activity. Recognizing this hard cap limitation and the importance of BSAI Pacific cod as a bycatch species while targeting its Amendment 80 species, the Amendment 80 sector manages its BSAI Pacific cod allocation so as not to lose its opportunity to harvest its primary Amendment 80 species since Pacific cod incidental catch can be variable.

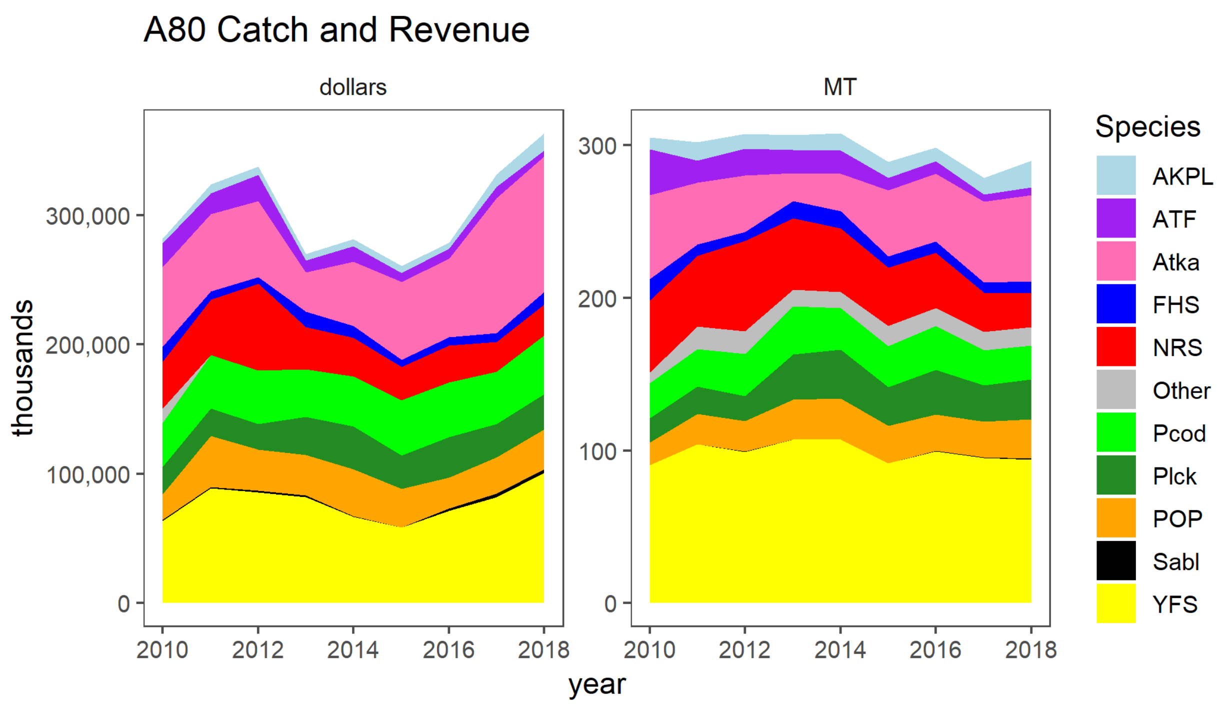


Figure 3-17. Amendment 80 fleet catch (metric tons) and first wholesale value (nominal dollars) in thousands from 2010-2018. AKPL=Alaska Plaice, ATF=Arrowtooth Flounder, Atka=Atka Mackerel, FHS=Flathead Sole, NRS=Rock Sole, Pcod= Pacific cod, Plck=Pollock, POP=Pacific Ocean Perch, Sabl=Sablefish, YFS=Yellowfin Sole. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

3.3.1.4 Operations

A qualitative understanding of the A80 fishing year and the diversity of business plans within the sector is especially important because the sector works with the most varied portfolio of allocated target species as well as profitable groundfish species that are not allocated. A simple data report on *annual* harvest volume and gross revenue – either by Catch Accounting System (CAS) "target species" or by individual species – does 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 indicate that fishing occurred in the YFS target based on volume, but the fishing was made profitable by the value of other retainable species. Annual data also gloss over calendar-based decision factors like roe content, flesh quality, aggregation (CPUE), fishing conditions (e.g., water temperature or lunar cycles), market demand, and the timing of inseason TAC reallocations from other fisheries.

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. By the same token, 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 or 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 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 5-Year Review notes 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 cites 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. While cod rates are low in the YFS fishery, managing cod quota is important due to the high YFS TAC. 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 qualifying catch history.

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 – and might be excluded de facto if fishing grounds are preempted by fixed-gear vessels in Federal or state-waters fisheries. Vessel operators might not be able to follow a school of "clean" (low-bycatch) A80 species if it moves into a prohibited or preempted area. Other constraints might be temporal. An A80 vessel that is experiencing intolerable Pacific cod bycatch or halibut PSC rates in an early-season flatfish target might wish to switch focus to an unallocated target that is not yet open to directed fishing. Those unallocated species might include arrowtooth/Kamchatka flounder and 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. "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 fish 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). Broadly speaking, alternatives to BS flatfish for A80 vessels are not an option to consider until May or June. Non-regulatory constraints that affect how A80 operations might respond to a bycatch or PSC challenge are described in the following sketch of "annual planning."

Finally, the correct baseline for regulatory impact analysis should consider the evolving makeup of the A80 sector in terms of business ownership (Figure 3-16) and the portfolios of species being fished on certain platforms. Fishery data from recent years would not reflect the transfer of some vessels and quotas to companies that might use the assets differently – i.e., increased utilization of flatfish quotas (Figure 3-18).

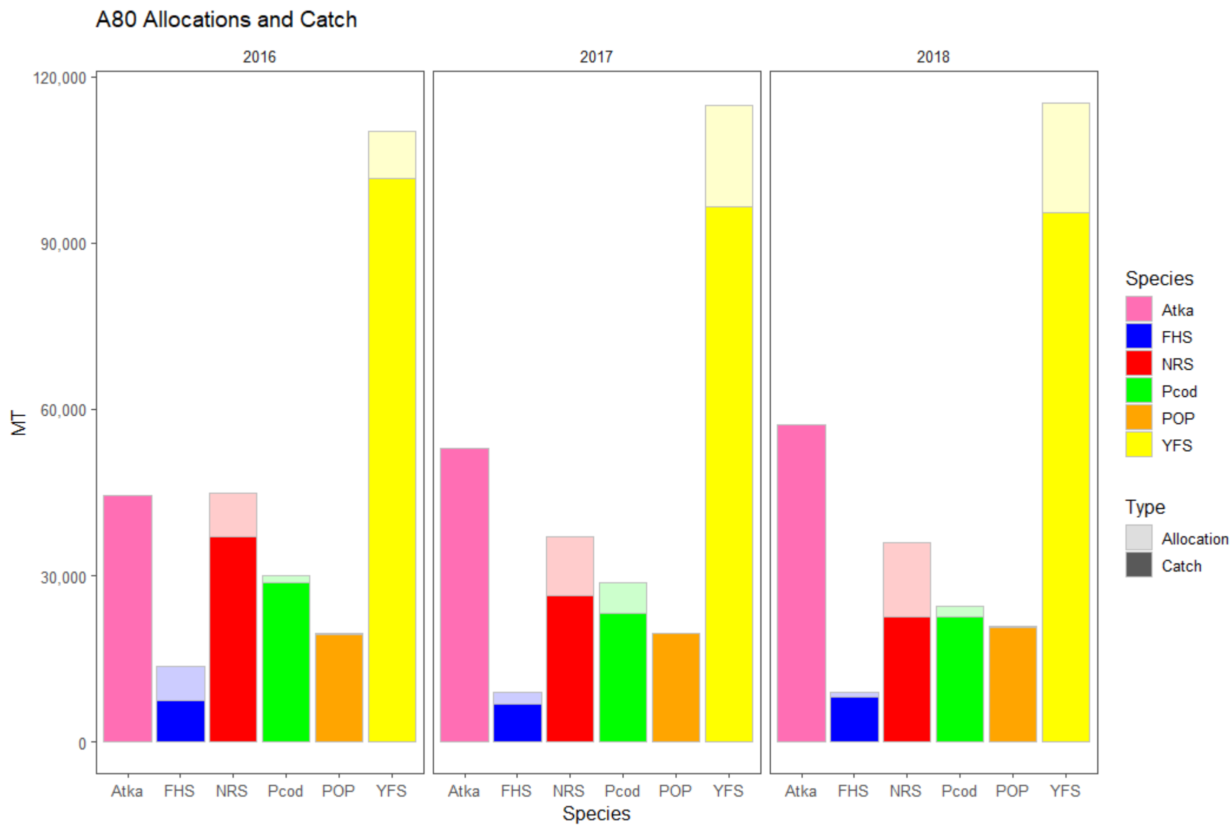


Figure 3-18. A80 allocation and catch 2016-2018. Atka=Atka Mackerel, FHS=Flathead Sole, NRS=Rock Sole, Pcod= Pacific cod, POP=Pacific Ocean Perch, YFS=Yellowfin Sole. Source: Adapted from information published in annual Cooperative Reports.

3.3.1.5 Annual Planning

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 3-19). 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 3-19). The focus on cod and rock sole early in the year is driven in part by fish aggregation (cod) and roe content (rock sole).

While staff has no insight into 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 where 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 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 many complicating factors, A80 vessels are unlikely to preemptively cease fishing under a 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 transfer rock sole TAC to 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 which is reported to carry a relatively high Pacific cod bycatch rate. Monthly catch data display this pattern with generally higher catch of rock sole and Pacific cod early in the year and tailing off by May (Figure 3-19). 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 in regards to targeting at a given time of year.

Operators must also manage their catch of unallocated species that NMFS accounts for under the “non-specified reserve.” 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 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 particular endorsements, CGOA Rockfish Program or other GOA rockfish and flatfish participation. Opportunities to diversify in the case of constraining bycatch expand in June as AI fisheries are pursued. 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. Finally, A80 vessels will also 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 3-19).

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. 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. The 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 but can also be limited by halibut PSC limits in that area. GOA CPs and CVs share seasonal halibut PSC apportionments, and GOA deepwater complex flatfish fisheries could be closed if effort and bycatch by GOA CVs targeting arrowtooth flounder are high. Finally, at least one A80 vessel is only endorsed to fish in the BS, meaning its response options are uniquely limited.

Figure 3-19. Amendment 80 monthly catch (metric tons) from 2010-2018. AKPL=Alaska Plaice, ATF=Arrowtooth Flounder, Atka=Atka Mackerel, FHS=Flathead Sole, NRS=Rock Sole, Pcod= Pacific cod, Plck=Pollock, POP=Pacific Ocean Perch, Sabl=Sablefish, YFS=Yellowfin Sole. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

3.3.2 Trawl Limited Access Sector (TLAS)

3.3.2.1 Background

The Trawl Limited Access Sector (TLAS) was established in 2008 with the implementation of Amendment 80. A80 formally divided the trawl apportionments of the primary trawl target fisheries between the A80 CPs and the remaining three harvest sectors of the trawl fishery (AFA CPs, AFA CVs, and non-AFA CVs). Allocations made to the Amendment 80 sector are not subject to harvest by participants in other fishery sectors, while the A80 sector is precluded from participating in these TLAS fisheries (NPFMC, 2007).

3.3.2.2 Fleet composition

The TLAS sector is made up of AFA CPs that catch and process limited access groundfish, and AFA and non-AFA CVs that deliver to both shoreside and at-sea (mothership) processors (Table 3-11). Since 2010 the fleet has consisted of 58-70 vessels (Figure 3-20). In 2018, four AFA CPs participated in the TLAS fishery while 46 TLAS vessels participated in AFA making shoreside deliveries and five with motherships. In 2018, 9 TLAS vessels also participated in the CDQ sector. Most TLAS vessels are owned in Seattle, WA.

Figure 3-20. Number of vessels in TLAS and cross-participation in CDQ fisheries 2010-2018. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

3.3.2.3 Catch/Revenue

The primary species for this sector (not including BS pollock) are Pacific cod and YFS (Figure 3-21). For the AFA CVs, aside from pollock harvested in the BS, Pacific cod is the second most important species in terms of volume for these vessels (Figure 3-21). While nearly all the groundfish harvested by the larger vessels is delivered to shoreside processors, many of the smaller vessels deliver their catch to motherships or catcher processors. The AFA trawl CVs have a sideboard limit of 86.09 percent of the seasonal allocations of BSAI Trawl CV Pacific cod. The Pacific cod harvest limits, like other groundfish and PSC bycatch limits for AFA CVs, are managed using directed fishing closures according to the procedures set out at §679.20(d)(1)(iv), §679.21(d)(8), and §679.21(e)(3)(v). There are nine AFA trawl CVs that are exempt from the AFA CV Pacific cod sideboard limits. Nineteen additional CVs have a mothership endorsement and are exempt from the sideboards after March 1. The harvest of BSAI Pacific cod for this sector is managed through an inter-cooperative agreement. Two or three AFA CPs have targeted Pacific cod, while several vessels target yellowfin sole. The Amendment 85 final rule removed the sideboard limit for BSAI Pacific cod for the AFA trawl C/Ps. The establishment of a separate BSAI Pacific cod allocation to this sector negates the need for the BSAI Pacific cod sideboard which protects the historic share of the non-AFA trawl C/P sector from being eroded by the AFA trawl C/P vessels.

The TLAS sector is allocated a proportion of the yellowfin sole initial allowable catch (ITAC) that varies based on the overall quantity of the yellowfin sole ITAC. As the ITAC for BSAI yellowfin sole increases, the proportion of the ITAC assigned to the BSAI TLAS also increases. The intent of increasing yellowfin sole allocations to the BSAI TLAS was to better accommodate major shifts in the yellowfin sole trawl fisheries during periods of high yellowfin sole ITAC. In addition, this approach was thought to provide increasing harvest opportunities for some non-Amendment 80 trawl sectors, while also maintaining some consistency in the historical catch in the Amendment 80 sector (NPFMC 2007). AFA vessels are subject to sideboard limits for yellowfin sole, but the Amendment 80 program relieves these when the yellowfin sole ITAC is equal to or greater than 125,000 metric tons (t). Below a 125,000 t ITAC, the yellowfin sole sideboard limits are based on the 1995 through 1997 aggregated retained catch of yellowfin sole for AFA CV sector and AFA CP sector relative to the total catch of yellowfin sole during the same period. Since 2008, the yellowfin sole ITAC has been higher than 125,000 t, so sideboard limits have not been in place for AFA vessels. Eight CVs (2 AFA-affiliated, 6 non-AFA) have endorsements on their LLPs to deliver YFS to motherships. There are other CVs that are endorsed to fish YFS but could only deliver to shoreside plants, and there's no shoreside market for YFS. Should such a market develop, that might increase use-demand for incidental catch of halibut and Pacific cod.

AFA vessels are subject to groundfish, crab, and prohibited species catch (PSC) sideboard limits. Vessels with less than 1,700 t of historic catch in the BSAI pollock fishery and that meet minimum landing requirements in either the BSAI and/or GOA are granted exemptions to the BSAI cod fishery sideboard and/or GOA groundfish and PSC sideboards. All catcher vessels in the Mothership cooperative become exempt to BSAI cod sideboard limits after March 1. Exemptions to BSAI cod sideboards only apply to the directed cod fishery; all AFA BSAI cod catcher vessels are subject to the PSC sideboard limits associated with the fishery. NMFS restricts the non-exempt AFA catcher vessel fishing by an aggregate sideboard cap for each groundfish species category, and an associated PSC bycatch limit. In turn, the AFA Catcher Vessel Inter-Cooperative Agreement manages the initial distribution, and re-distribution via inter-cooperative transfers, of the aggregate sideboard caps and associated PSC among the eight catcher vessel coops based on their members catch history. In some cases, the assigned caps are so small that, without the harvest management and monitoring provided by the Inter-Cooperative Agreement, NMFS would not open those fisheries to directed fishing by the AFA non-exempt catcher vessels. BSAI cod exempt vessels must meet PSC bycatch standards or face losing their exempt status (Gruver 2019).

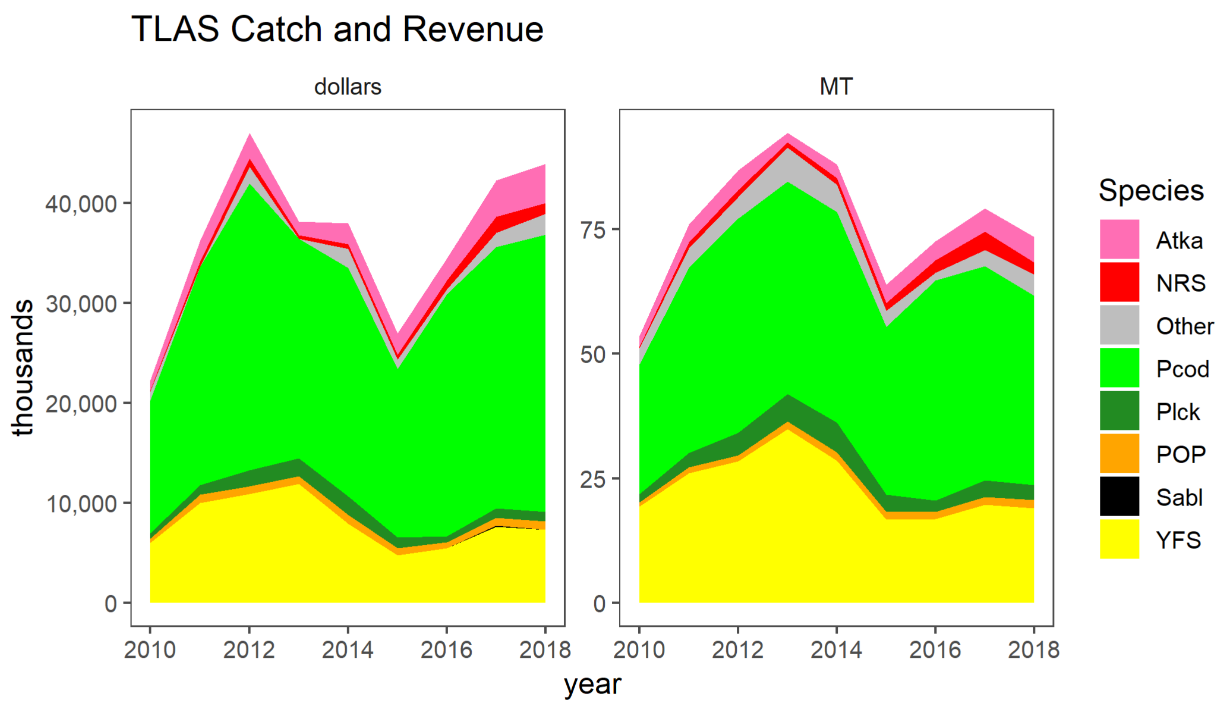


Figure 3-21. TLAS revenue (ex-vessel value, nominal dollars) and catch (metric tons) from 2010-2018. Atka=Atka Mackerel, NRS=Rock Sole, Pcod= Pacific cod, Plck=Pollock, POP=Pacific Ocean Perch, Sabl=Sablefish, YFS=Yellowfin Sole. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

3.3.2.4 Operations

Halibut PSC limits are apportioned annually to the TLAS sector with no seasonal limits (except that halibut for TLAS rockfish only becomes available on April 15).[18] Since the sector was established with the creation of A80, the AFA trawl CP/CV Pacific cod and TLAS YFS fisheries have not closed as a result of halibut PSC, though they have come close to the limit. These fisheries are primarily TAC-driven competitive fisheries. As such, the TLAS fishery is somewhat distinct among the five sectors covered here in that the direct effect of a potentially reduced halibut PSC limit could be conceptualized as a shortened fishery.

The non-pollock groundfish caught by AFA CPs accrue to allocations for TLAS while the groundfish caught by A80 CPs while acting as motherships for TLAS vessels accrues to their own A80 sector allocations. TLAS CVs break down generally into AFA and non-AFA subcategories, as defined by whether they are members of cooperatives with secure BS pollock allocations (and halibut PSC management responsibilities within those cooperatives). TLAS CVs also vary in their access to fisheries outside of the BSAI. Some CVs trawl in the GOA, others spend part of the year off the U.S. west coast (i.e. whiting fisheries), and others are dependent on BSAI non-pollock fishing. Those distinctions do not break down strictly on AFA/non-AFA lines. In general, CVs with access to cooperatively managed fisheries such as AFA pollock or the Central GOA Rockfish Program face a different set of decisions about when to fish and how to respond to the current constraint (cod TAC) or theoretical future constraints (a reduced PSC limit). Access to cooperative quota for other fisheries insulates some TLAS

[18] https://alaskafisheries.noaa.gov/sites/default/files/18_19bsaitable16.pdf

CVs from overall business risk if the Pacific cod or YFS fishery were to close prematurely relative to past expectations.

3.3.2.5 Annual Planning

Overall, the TLAS sector prosecute a majority of their fisheries from January through May, which is dominated by catch of Pacific cod (Figure 3-22). The fishery in which a TLAS CV begins the season depends on whether it is an AFA or non-AFA vessel. Some CVs have contracts with, or are owned by, companies that operate CPs as motherships, opening up opportunities for YFS and AI POP/Atka mackerel that other CVs do not have. When trawl gear opens on January 20, AFA CVs choose between BS pollock or trawl Pacific cod/YFS. Recently these vessels have begun the season in the cod fishery because of its increasingly competitive nature where the TAC may be taken relatively quickly and harvest opportunities are not secured by a catch share program (LAPP). Roughly 75% of the annual trawl CV Pacific cod TAC is allocated to the A season, January 20 to April 1. In 2018, roughly 10% of the TLAS cod TAC was allocated to the B season (April 1 to June 10), and 15% was allocated to the C season (June 10 to November 1). Catch rates and TAC utilization tend to be greater early in the calendar year, making the A season the focal point of the fishery and demanding competitive participation when it is open. The trawl CV cod fishery is both spatially and temporally confined. Within those confines, the cod fishery is experiencing pressures from participation; for example, AFA vessels without a cod sideboard exemption (lower historical cod dependency) are fishing at increasing levels.

AFA CVs that begin in cod might move into the pollock fishery when roe content is optimal. Non-AFA CVs begin with a choice between trawl CV Pacific cod and YFS; some vessels may fish in the YFS fishery until cod CPUE becomes established. CVs that have GOA trawl endorsements but also fish BS Pacific cod are typically making a choice between BSAI trawl CV cod or A/B season pollock and A season Pacific cod in the GOA. If the BSAI trawl CV Pacific cod season closes on TAC in February or early March, CVs could filter back to the YFS fishery go to the GOA for B season pollock. Some CVs that are not GOA-endorsed go to the AI for Atka mackerel and POP after the cod TAC is taken. For BSAI-focused CVs that are vertically integrated, the decision about where to fish outside of the early Pacific cod season is dictated by where their mothership market is fishing.

CVs that participate in the Pacific whiting fishery will typically be down on the west coast by May 15. Non-whiting CVs that remain in the BS would either return to pollock fishing for the B season on June 10 (AFA) or might get a mothership market for summer cod or YFS, if open. In recent years, the TLAS YFS fishery has dissipated by June or July due to either the TAC being taken, low CPUE in the summer, or low market demand during that time of year. Other opportunities for CVs during the summer months include tender contracts in salmon fisheries and research charters.

AFA CVs tend to wind down their season by finishing their pollock quota in September before Chinook salmon bycatch rates are expected to increase. Opportunities for non-AFA CVs in the late summer and fall are mostly limited to Pacific cod until November 1 and YFS. In recent years the TLAS YFS TAC has not been available that late in the year, having closed in June. Moreover, a pending rule will limit the number of CVs that could deliver YFS offshore (NPFMC 2018). That rule, implementing BSAI Amendment 116 was, in part, motivated by concern that increasing participation in the TLAS YFS fishery could drive up halibut PSC usage, thus closing the fishery and impacting CPs that depended on TLAS harvest and deliveries as a source of non-pollock revenue. Under the rule, CVs that cannot deliver to CPs will still be able to deliver YFS shoreside if the fishery is open and they possess the necessary refrigerated seawater system to make that delivery. Some TLAS CVs participate in the fall Pacific whiting fishery on the west coast. The timing of that fishery may depend on when AFA CPs finish their BS B-season and can move south to make an offshore whiting market.

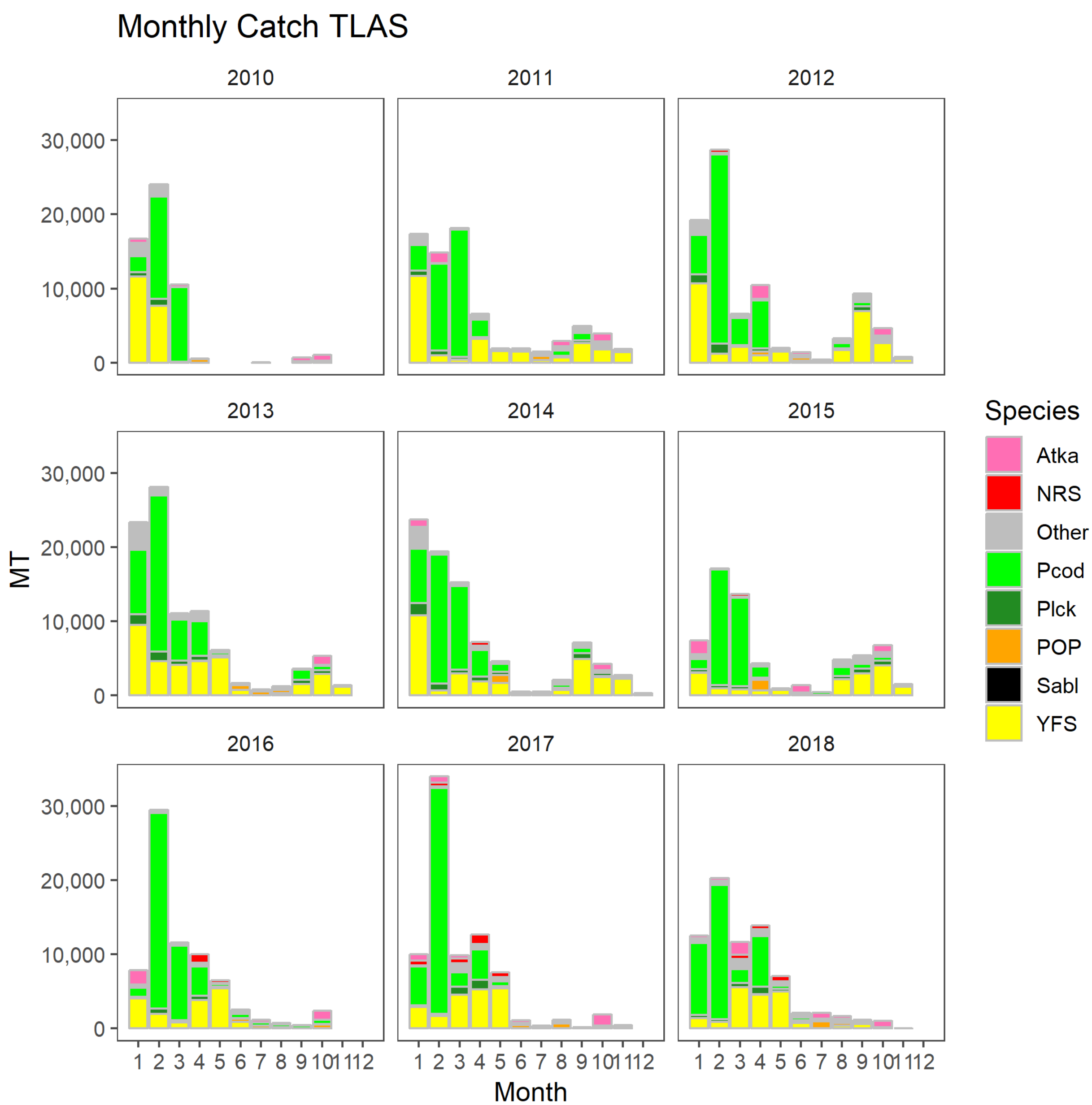


Figure 3-22. TLAS monthly catch (metric tons) from 2010-2018. Atka=Atka Mackerel, NRS=Rock Sole, Pcod= Pacific cod, Plck=Pollock, POP=Pacific Ocean Perch, Sabl=Sablefish, YFS=Yellowfin Sole. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

3.3.3 Hook-and-line catcher/processor (HALCP)

3.3.3.1 Background

The Hook and line CP HAL CP sector includes vessels operating as CPs using HAL gear. As of January 1, 2003, HAL C/Ps must have a 'Pacific cod HAL C/P' endorsement on their LLP license to target BSAI Pacific cod with HAL gear and process it onboard. These vessels, also known as freezer longliners, focus their effort on BSAI Pacific cod and are allocated 48.7% of the BSAI Pacific cod allocation (Amendment 85). Sablefish and Greenland turbot are secondary targets for some C/Ps.

Since 2006, most of the holders of LLP licenses endorsed as Pacific cod HAL C/Ps in the BSAI have been members of the voluntary Freezer Longline Conservation Cooperative (FLCC). In June 2010, the remaining LLP holders joined the cooperative, so that with the start of the 2010 B-season on August 15, all holders of LLP licenses authorizing the use of these C/Ps were members of the cooperative. Each year, the FLCC issues quota shares to members in proportion to historical fishing activity associated with each LLP of the BSAI HAL C/P sector allocation. FLCC members are free to exchange their quota shares among themselves, and to stack quota shares on individual HAL C/Ps. It is important to note that FLCC is not regulated by NMFS, with allocations being apportioned to the sector, and not the cooperative.

3.3.3.2 Fleet composition

From 2010 to 2018 the HALCP sector has declined from 38 vessels to 25 vessels (Figure 3-23). A number of these vessels have participated in the CDQ fishery through the years, most recently 11 in 2018. A majority of HALCP vessels are owned in Seattle (SIA table 2-4a).

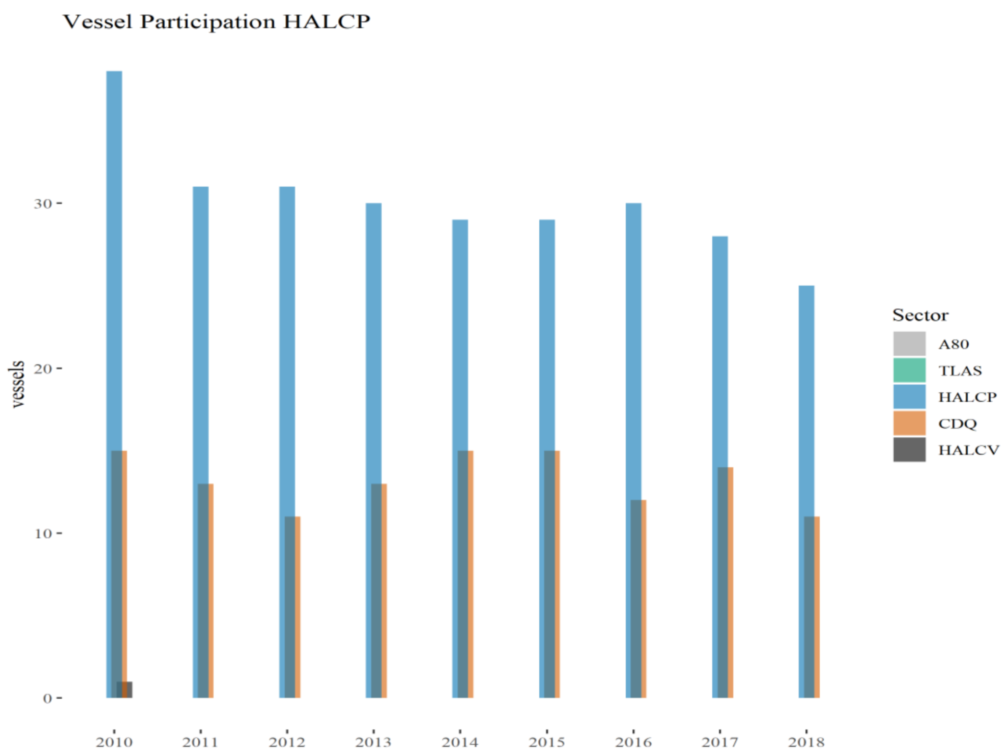


Figure 3-23. Number of vessels in HALCP sector and cross participation in CDQ fisheries 2010-2018. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

3.3.3.3 Catch/Revenue

The BSAI hook-and-line CP sector (HALCP) is primarily focused on the Pacific cod fishery. Landings increased from 2010-2012, and have stayed relatively stable since, with a slight drop off in 2018 (Figure 3-24). Overall, nominal wholesale revenue has increased from 2010 onward with slight dips in 2013, 2015 and 2018. Note that some HALCP vessels also derive revenue from IFQ sablefish however this is exempt from halibut PSC and is therefore not included in Figure 3-24.

The HALCP BSAI Pacific cod TAC is divided in to two seasons: A season runs from January 1 to June 10; B season runs from June 10 to December 31. The sector's annual cod quota is divided roughly evenly between the two seasons (51/49) and has been harvested at or near capacity in recent years.[19] The near even A/B season Pacific cod TAC split stands out from other gear sectors and underlines that this sector is a year-round operation for many vessels, although landings are slightly higher early in the year with a dip around May and June and a steady finish to the year (Figure 3-25). A-season is also 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 (NPFMC 2019).

While FLCC operations derive some value from secondary species such as Greenland turbot, IFQ sablefish, and GOA Pacific cod, the fact that the sector is essentially a single-species business limits options in a scenario where halibut PSC poses a constraint.

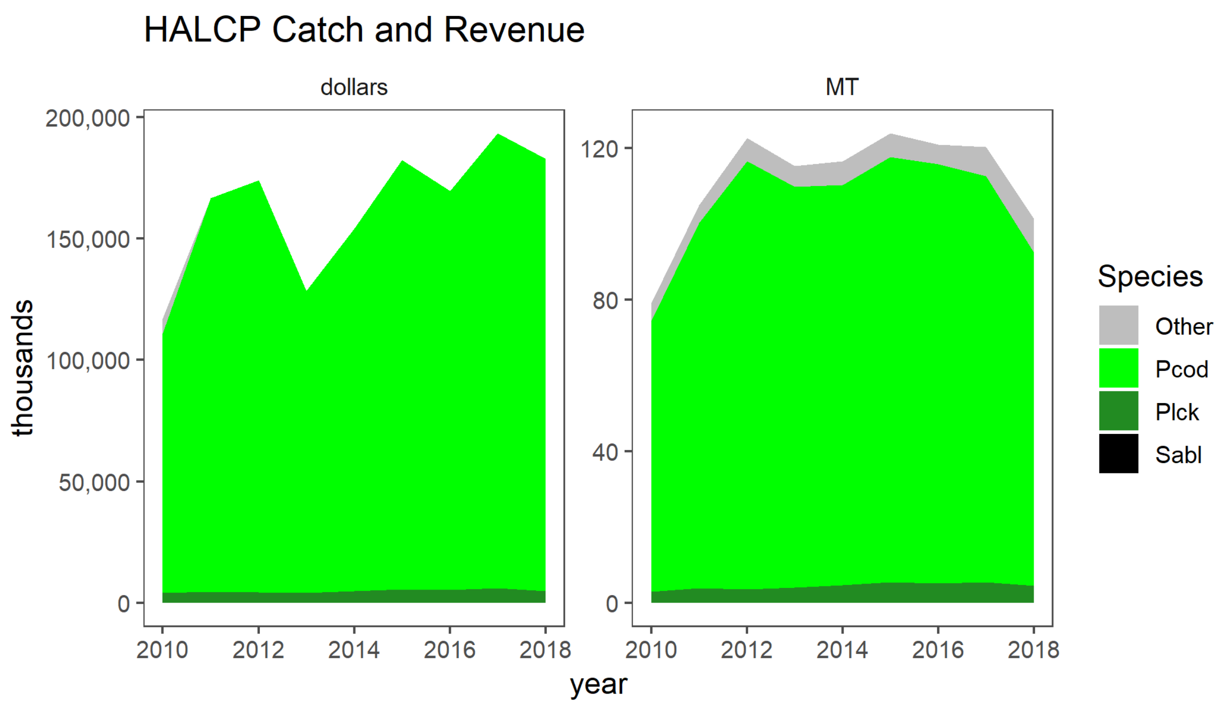


Figure 3-24. HALCP revenue (first wholesale value, nominal dollars) and catch (metric tons) in thousands from 2010-2018. Pcod= Pacific cod, Plck=Pollock, Sabl=Sablefish. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

[19] https://alaskafisheries.noaa.gov/fisheries-catch-landings

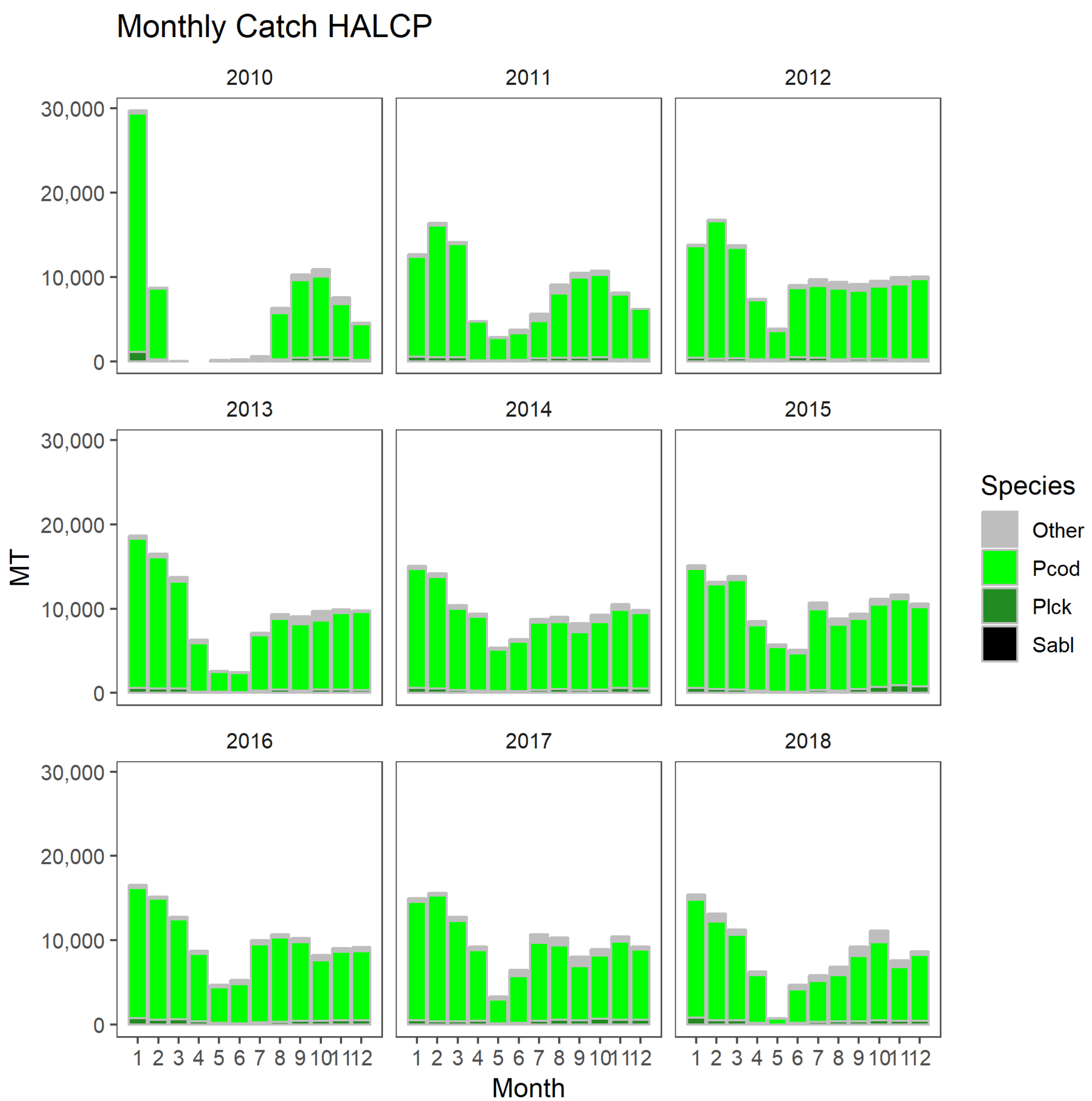


Figure 3-25. HALCP monthly catch (metric tons) from 2010-2018. Pcod= Pacific cod, Plck=Pollock, Sabl=Sablefish. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

3.3.3.4 Operations

Large-scale hook-and-line CP vessels are similar to one another in their mode of operation, which is distinct from that of a trawl vessel. Longline CPs deploy a large amount of baited groundline; fishery participants approximate that an active CP will occupy a 10-mile by 20-mile rectangle on the fishing grounds. Hauling, rebaiting, and moving that gear is more time- and fuel-intensive than a trawl vessel's move. If a longline CP wants to move in search of higher CPUE or lower PSC rates, its options are limited to what grounds are available. In other words, moving away from halibut can be a costly process and choices might still be limited. Longline CP operators also consider seabird bycatch rates when deciding whether to enter or remain in a fishing position. Companies that manage multiple vessels may choose to coordinate fishing in order to hold productive grounds. In addition to preempting one another, longline CPs must also share grounds with the trawl and pot sectors and with longline CVs. In some cases – for example, around the Pribilof Islands – CPs will coordinate to reserve areas for smaller-scale longline vessels that do not have the range to fish safely farther from port.

The degree to which grounds preemption or potential gear conflict affects the longline CP fleet's set of in-season fishing options may change from year to year depending on environmental factors or the ebbs and flows of effort in other fisheries. In some years, sea ice might concentrate the longline CP fleet spatially. From a fishery competition perspective, increased effort in the state-waters pot cod fishery could impact the amount of grounds and TAC available for Federal fixed-gear (and trawl) operators. Year-on-year changes in groundfish TACs (especially Pacific cod), and potentially halibut PSC limits under ABM, could affect the timing and location of trawl effort which in turn affects the extent to which that effort overlaps grounds that are preferred by longliners for their productivity and availability of profitable secondary species.

The crew composition on a HAL CP is typically around 20 persons, including a skipper, a mate, one or two engineers, a deck boss, a factory foreman, and around 15 individuals who fulfil both deck and processing duties.[20] While unique circumstances might occur on an individual vessel, typically it is understood that all crew positions are paid on a share basis; a percentage of share is determined by position and experience. Multiple crews are used throughout the extended, continuous fishing season. A changeover could be associated with local spending onshore by both vessel owners and crewpersons. Most inseason changeovers occur in Dutch Harbor/Unalaska. Crews might also change or depart/board the vessel in Seattle or Kodiak at the beginning or end of the season, or if the vessel leaves the BSAI for shipyard work. As anecdotally reported to the analysts, crewmembers in the HAL CP fleet largely hail form the Pacific Northwest and Alaska, but the companies that own these large vessels also recruit nationally and from foreign countries to meet labor demand. Vessels that are owned by CDQ groups prioritize hiring crew from the Alaska communities that they represent but hire from other locations as needed.

3.3.4 Community Development Quota (CDQ)

3.3.4.1 Background

The Community Development Quota (CDQ) Program was established by the Council and NMFS in 1992, and in 1996, authorization for the Program was incorporated into the Magnuson-Stevens Act. 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 CDQ groups representing different geographical regions in 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 six different non-profit managing organizations (CDQ groups).

The six CDQ groups represent the 65 eligible villages in Western Alaska:

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

[20] This, and the following generalizations about the BSAI HAL CP fleet, was provided through personal communication from the Freezer Longline Coalition (2019).

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.

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. In general economic terms, CDQ communities are remote, isolated settlements with few commercially valuable natural assets with which to develop and sustain a viable, diversified economic base.

3.3.4.2 Fleet Composition

Over the last ten years, vessels participating in the CDQ fishery have ranged from a low of 45 in 2010, peaking at 55 in 2013 and settling at 49 in 2018. In 2018 17 CDQ vessels also participated in the AFA pollock fishery (Table 3-11). CDQ vessels are a combination of those owned by CDQs or with which CDQ groups lease their fish. As such, many of the vessels in other sectors also participate in the CDQ fishery (Figure 3-26).

Figure 3-26. Number of vessels in CDQ sector and cross participation in other sectors 2010-2018. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

3.3.4.3 Catch/Revenue

Under the CDQ Program, a portion of the federal TAC for commercially important BSAI species — including pollock, crab, halibut, and various groundfish in the Bering Sea — 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). CDQ Program allocations vary by species. The pollock CDQ allocation was originally set at 7.5%, but was increased to 10% by Congress in 1998 as part of the AFA. 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).

Halibut PSC caught when directed fishing for CDQ pollock accrues to the CDQ halibut PSQ but because pollock catch is on a much larger scale than other CDQ groundfish catch it is not included in the figures below. Table 3-15 outlines the CDQ pollock catch and revenue for 2010-2018 for comparison purposes. 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 (Figure 3-27). In recent years this catch has generally peaked once early in the season (February and March) and again later in the season in late summer/early fall (Figure 3-28).

Table 3-15. CDQ pollock annual catch (metric tons) and revenue (millions nominal wholesale dollars) 2010-2018

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Catch (t)	82,441	118,556	123,879	129,796	131,842	136,727	139,547	140,006	142,233
Revenue	108.08	141.62	148.21	129.98	136.75	141.61	148.25	152.47	149.23

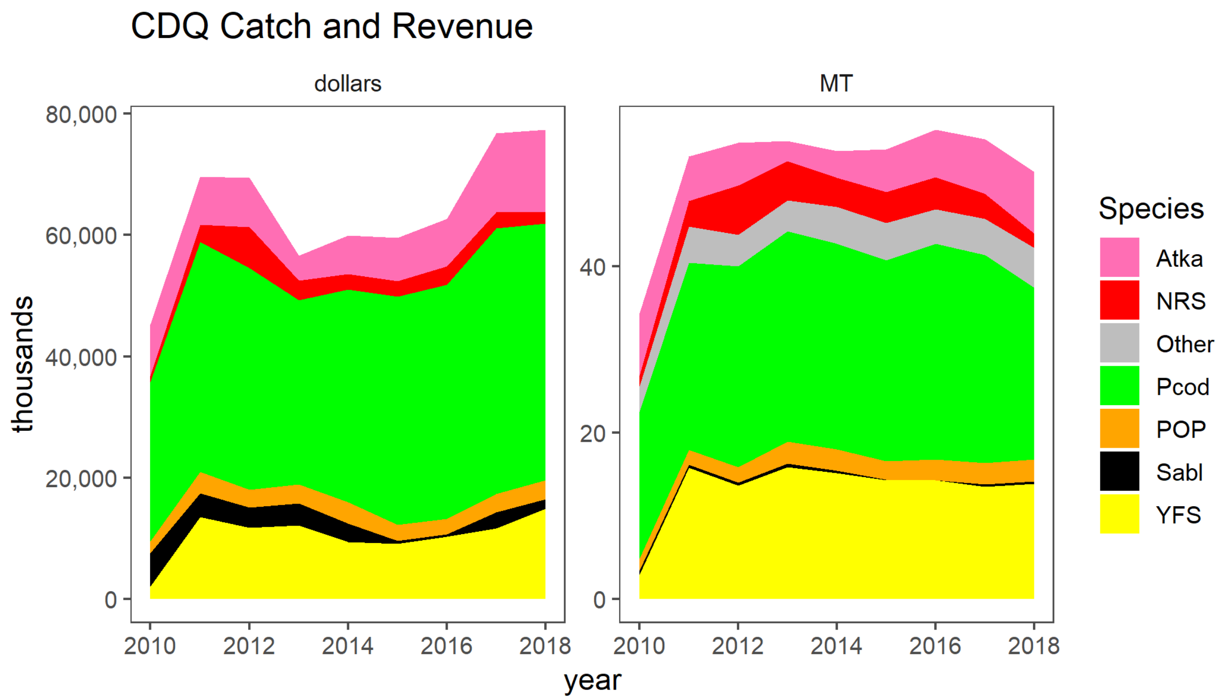


Figure 3-27. CDQ non-pollock revenue (nominal dollars, first wholesale value) and catch (metric tons) and in thousands from 2010-2018. Atka=Atka Mackerel, NRS=Rock Sole, Pcod= Pacific cod, POP=Pacific Ocean perch, Sabl=Sablefish, YFS=Yellowfin sole. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

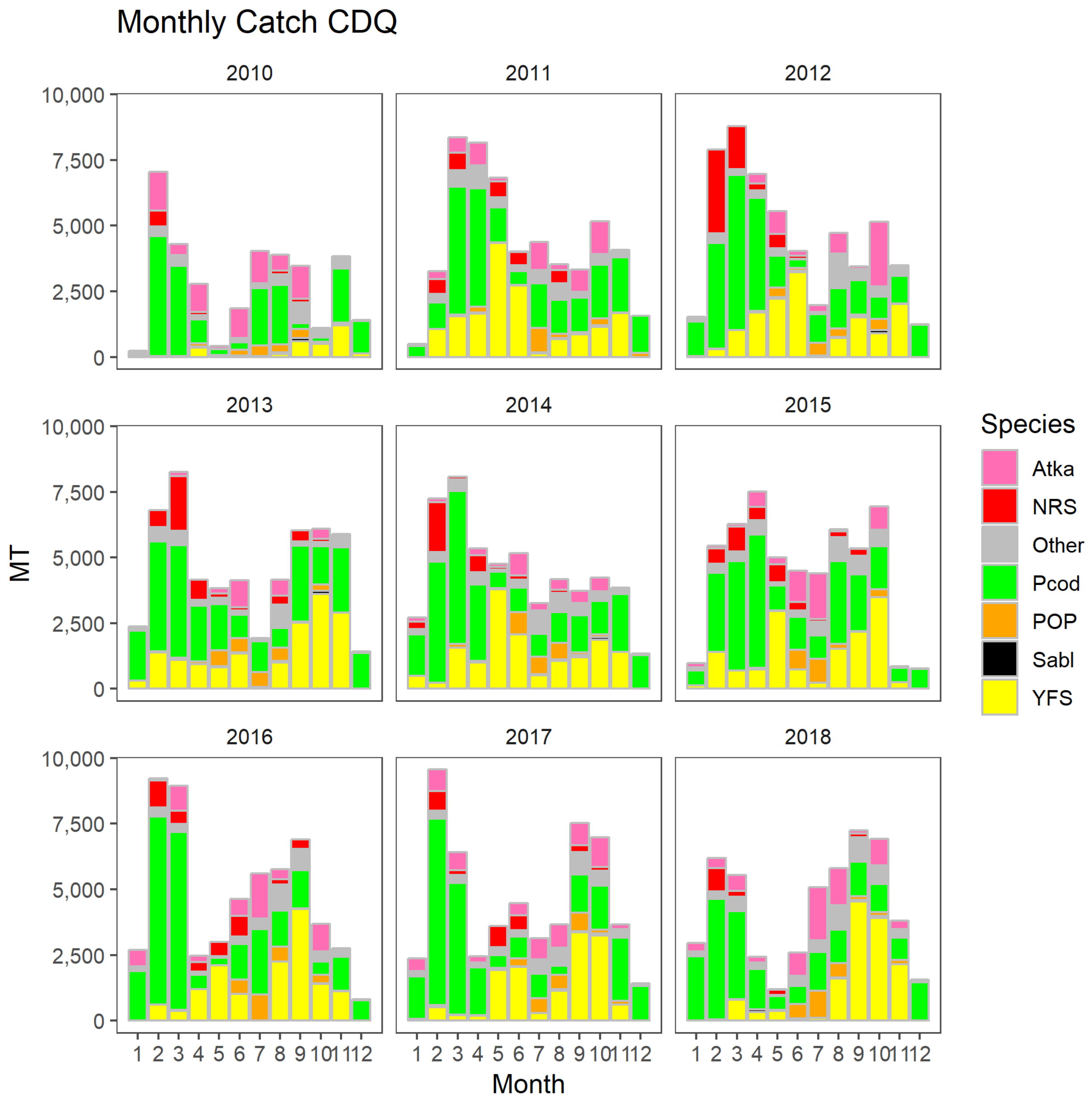


Figure 3-28. CDQ non-pollock monthly catch (metric tons) in thousands from 2010-2018. Atka=Atka Mackerel, NRS=Rock Sole, Pcod= Pacific cod, POP=Pacific Ocean perch, Sabl=Sablefish, YFS=Yellowfin sole. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

3.3.4.4 Operations

Harvesting constraints and operational decisions for the CDQ sector generally track those described in earlier sections based on the gear type and portfolio of fisheries targeted by the specific vessel. Trawl catcher processors that participate in CDQ and other sectors must record if the tow is a CDQ tow within two hours after completion of weighing all catch in the haul (§ 679.5(c)(4)(ii)(B)(2)). This may be an advantage for these vessels (compared to those participating in a single sector) as they can more flexibly manage to which sector tows are allocated based on different operational portfolios and allocations.

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. 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 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, providing the financing necessary for resident fishermen to purchase new boats and gear, and supporting market development for locally-harvested seafood products.

3.3.5 Hook-and-line Catcher Vessel (HALCV)

Hook and line CVs represent the smallest sector among the groundfish fishing sectors that are potentially affected by this action. Between 2010 and 2018 anywhere from 10 to one vessel participated in the non IFQ HALCV groundfish sector (Figure 3-29). Other than a few exceptions most HALCVs do not overlap in other sectors covered in this document. Most HALCVs are owned in communities in Alaska (SIA table 2-3a).

During 2016 and 2017 there were too few participating vessels to report catch or revenue information for the HALCV sector due to confidentiality rules. Aside from those years, catch has ranged from a low of 360 t in 2010, peaking at over 2,000 t in 2014 (Figure 3-30). A majority of HALCV catch is Pacific cod, most of which occurs early in the year.

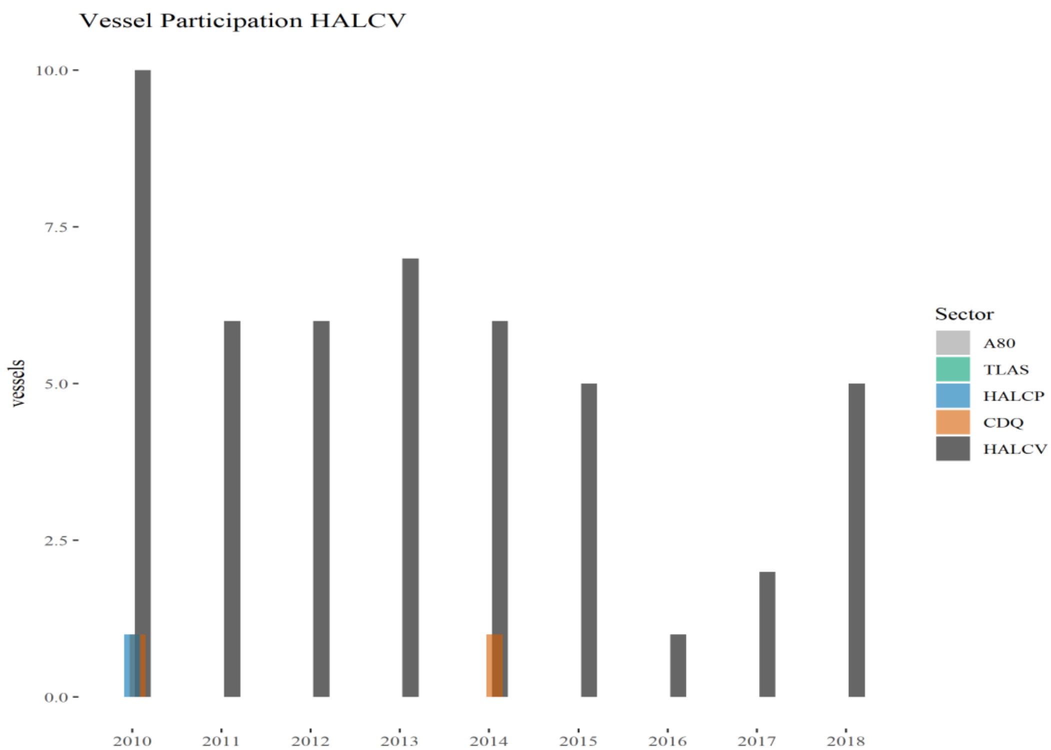


Figure 3-29. Vessels participating in the non IFQ hook and line CV sector 2010-2018. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

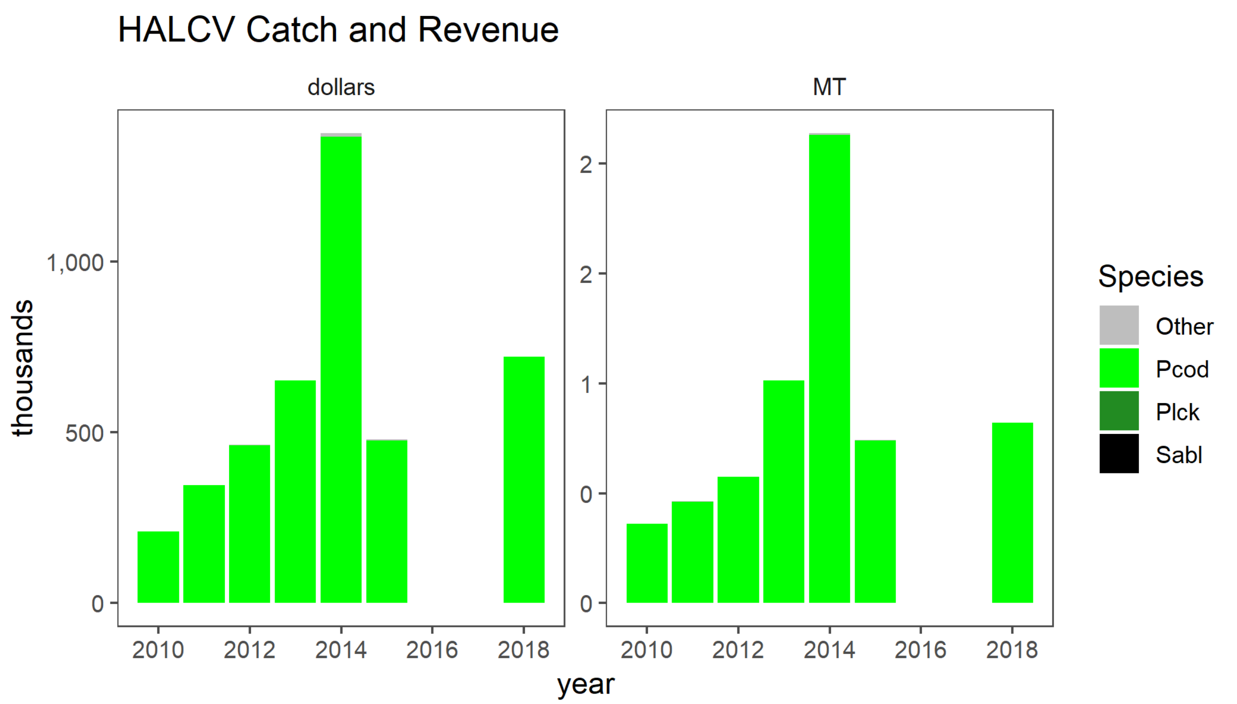


Figure 3-30. HALCV revenue (ex-vessel value, nominal dollars) and catch (metric tons) in thousands from 2010-2018. Pcod= Pacific cod, Plck=Pollock, Sabl=Sablefish. Note 2016 and 2017 not shown due to confidentiality. Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_BLEND_CA

3.3.6 Inshore processing

Inshore processors receive deliveries from CVs. The operations described in this section include both shore-based plants and floating processors that purchased non-pollock groundfish. Of the harvest sectors that are potentially affected by an ABM action – as defined in this analysis – the inshore processing sector interacts with TLAS (3.3.2), hook-and-line CVs (3.3.5), and CDQ groups (3.3.4). Inshore processors also receive deliveries from the directed halibut fishery, which is described in Chapter 4 of this document.

From 2010 through 2018, a total of 30 shore-based plants operations received BSAI groundfish deliveries. For this analysis, processing operation is defined by an "Intent to Operate (ITO) code," which could count the same physical facility multiple times during a set of years if ownership and registration changed. For example, during the 2010 through 2018 period, five ITO codes are listed for Adak, which is not known to have five processing facilities. In terms of ownership company registration, those operations represent 18 communities. (Community engagement in the ABM fisheries by the shore-based processing sector is further described in the Section 5.5 of the SIA (Appendix 1).) Ten shore-based processors received ABM sector groundfish deliveries in the most recent year for which data are available (2018). The number of operations that received non-pollock groundfish in a given year during this period ranged from 10 (four years) to 18 (one year).

The companies that operated these shore-based plants were registered in Alaska (Unalaska/Dutch Harbor, Akutan, Adak, Nome, King Cove, Sand Point, and Anchorage) and Seahurst, WA (part of the Seattle municipal area). The ten facilities active in 2018 were physically located in seven Alaska communities: Unalaska/Dutch Harbor (4), Akutan, Adak, St. Paul, King Cove, Sand Point, and Nome. Other plants that were active during this period but not during 2018 were located in Atka, Makoryuk, Toksook Bay, Togiak (Twin Hills), Chefornak, Kipnuk, Quinhagak, False Pass, Kodiak, and Seward. Seven localities received fewer than 100 t during the period and, among those, six were active in this species category in only one year, likely indicating that non-pollock groundfish deliveries were incidental to another fishery. Due to confidentiality, actual processing data can only be reported at the community level for Unalska/Dutch Harbor. That community accounted for 30% of non-pollock groundfish processing during this period.

Pacific cod accounted for 88% of non-pollock groundfish processed at these shore-based facilities from 2010 through 2018. The average annual volume of Pacific cod was around 67,000 t, though that amount was closer to 60,000 t in 2017 and 2018. Flatfish species accounted for 6% of non-pollock groundfish, while rockfish, sablefish, and Atka mackerel each accounted for 3% or less. In terms of ex-vessel value, Pacific cod accounted for 73% of total activity (average of $45.3 million per year in 2018$), and sablefish accounted for 25% (average of $15.5 million). The other species were each at 1% or less.

By comparison to other fisheries (pollock, crab, salmon, halibut, and herring), non-pollock groundfish accounted for 12% of the volume processed and 15% of ex-vessel value during the analyzed period ($561 million out of $3.68 billion in 2018$). For these facilities, pollock accounted for 81% of total volume processed and 44% of ex-vessel value ($1.60 billion). Salmon accounted for 3% of volume and 7% of ex-vessel value ($270 million). Commercially caught halibut accounted for only 0.5% of volume but 7% of ex-vessel value ($245 million). Crab species – primarily tanner crab and king crab – accounted for only 2% of volume but 27% of total ex-vessel value ($990 million).

Overall, 45% of shore-based processors' non-pollock groundfish volume came from the trawl sector while 50% came from the pot sector. HALCVs accounted for 4% of delivered volume and the jig sector accounted for 1%. For Pacific cod in particular, the trawl sector accounted for 40% of delivered volume while the pot sector accounted for 57%. On an annual basis, the portion of Pacific cod volume delivered to shoreside processors from the pot sector ranged from a minimum of 50% to a maximum of 63%. The portion of Pacific cod volume coming from trawl vessels ranged from 30% to 47%. In terms of value derived from non-pollock groundfish, shore-based processors produced 48% of ex-vessel value from pot deliveries ($244 million from Pacific cod and $27 million from sablefish), 30% of ex-vessel value from trawl deliveries ($150 million from Pacific cod, $12 million from rockfish and flatfish, and $4 million from sablefish), and 21% of ex-vessel value from hook-and-line gear ($8 million from Pacific cod and $109 million from sablefish). For Pacific cod, 60% of total ex-vessel value was generated from pot deliveries (annual range of 52% to 69%) and 37% was generated from trawl deliveries (annual range of 24% to 44%). On average, the hook-and-line sector accounted for 2% of Pacific cod ex-vessel value (range of less than 1% to 4%) and the jig sector accounted for 1% (range of less than 1% to 3%).

Five inshore floating processors received BSAI non-pollock groundfish deliveries during the 2010 through 2018 period. Each operation was associated by ownership with Seattle, WA. In any given year the number of active floating processors ranged from one to three. Only one inshore floating processor was active in every year. That platform accounted for over half of the total weight received by floating processors during the analyzed period, and roughly 80% of the non-pollock weight processed. Among all commercially delivered species – including non-pollock groundfish, pollock, crab, salmon, herring, and halibut – Pacific cod accounted for 66% of volume by weight and pollock accounted for 30%. Of the non-pollock groundfish species, Pacific cod accounted for 98.6% of volume. In this case, non-pollock groundfish is defined as Pacific cod, flatfish, Atka mackerel, rockfish (including POP), and sablefish. In terms of volume, the average annual weight of non-pollock groundfish processed by the floating processors from 2010 through 2018 was 14,108 t and the median was 11,971 t. In terms of gear type, 54% of the non-pollock groundfish delivered to floating processors came from trawl CVs and 46% came from pot CVs (which are not limited by halibut PSC limits). Fewer than 400 t were delivered by HAL CVs. Each of the five floating processors active during this period received deliveries from trawl CVs, though one operation took an amount of trawl-caught fish small enough that the analysts can presume that the processor has not recently relied on trawl deliveries as an important part of its business plan. By ex-vessel value, the set of floating processors purchased $86.7 million worth of non-pollock groundfish in inflation-adjusted 2018$ during the analyzed period. The annual average was $9.6 million. Over 99% of that value was accounted for by Pacific cod. Yearly data and information at the processor-level are not included due to confidentiality restrictions.

3.3.7 Taxes and cost recovery fees collected from BSAI groundfish and halibut fisheries

Taxes generated by the fishing industry are important revenue sources for communities, boroughs, and the state. This section summarizes the taxes levied on the both the groundfish sectors that would be affected by AMB and the halibut IFQ fishery (the halibut fishery is primarily described in Section 4 of this DEIS). This section also describes the NMFS cost recovery fees related to certain sectors affected directly or indirectly by this action. There are two main sources of fishery taxes in Alaska: shared taxes administered through the State of Alaska, and municipal fisheries taxes independently established and collected at select municipalities. There are two shared taxes that are derived from fishing: the fisheries business tax and the fisheries resource landing tax.

The state of Alaska levies several taxes on fish landings that apply to the operations of sectors that could be affected by ABM.

The shared Fishery Resource Landing Tax is levied on fish processed outside the 3-mile limit (but within the U.S. EEZ) and first landed in Alaska, based on the estimated unprocessed value of the resource. The unprocessed value is determined by multiplying a statewide average price per pound (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; see below). The levy is set at 3.0% for fisheries classified by ADF&G as "established," as would be the case for fisheries affected by this action. 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 municipalities where fishery resources are landed. If the offload or landing occurs at a community in the "un-organized borough" (as is the case for communities like Dutch Harbor and Adak), the fish taxes are shared primarily between that community and State, with a small portion going out to other communities in the un-organized borough. This tax was established in 1994.

Alaska also levies a shared Fisheries Business Tax (often referred to as the "raw fish tax") on businesses or persons who process or export fisheries resources from Alaska. The tax is based on the price paid to commercial fishermen (ex-vessel) or fair market value when there is not an arms-length transaction. Fisheries business tax is collected primarily from licensed processors and persons who export fish from Alaska. For fisheries classified by ADF&G as "established," the levy is set to be paid at 3.0% for shore-based processors and 5.0% for floating processors. Although the fisheries business tax is typically administered and collected by the individual boroughs, revenue from the tax is deposited in Alaska's General Fund. According to state statute, each year the state legislature appropriates 25%-50% of the revenue from the tax to the municipality or borough where processing occurs. The amount of money distributed depends on the taxes collected during the program base year, as defined in Alaska statute, and on other factors. These other factors include the organization of each borough in which processing or landings occur and number of incorporated cities in each borough. Processing that takes place outside of a city or borough can be shared back to that community through an allocation program administered by the Department of Commerce, Community and Economic Development (DCCED). The Fisheries Business Tax annually accounts for the greatest proportion of total fishery resource tax revenues collected by the state. Revenues from this tax were $39.9 million in 2016, while the nearest state fishery tax was the Fisheries Resource Landing Tax at $9.8 million that year.

Alaska 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 the 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.

In addition to these state taxes, some communities have developed local tax programs related to the fishing industry. These include taxes on raw fish transfers across public docks, fuel transfers, extraterritorial fish and marine fuel sales, and fees for bulk fuel transfer, boat hauls, harbor usage, port and dock usage, and storing gear on public land. There is no one source for data on these revenue streams; however, most communities self-report them in their annual municipal budgets collected by the Alaska Division of Community and Regional Affairs. The 2018 DCCED Alaska Taxable Supplement identifies 14 communities and four boroughs (Aleutians East, Bristol Bay, Kodiak Island, and Lake & Peninsula) with a raw fish tax; most are levied at 2.0%, with a range from 1.5% to 3.5%.[21] CPs do not pay taxes that are based on landings of raw fish.

Note that tax policies are subject to change. The existing set of fish taxes levied by the state of Alaska and fishing localities have been constant during recent years and the analysts have no reason to predict that taxation levels or revenue sharing policies will change in the near future. Nevertheless, the reader could consider that a community might choose to offset any reduction in revenue sharing from the state's Fisheries Business Tax by implementing or increasing local taxes.

In addition to state and municipal taxes, many of the harvesters that participate in sectors that could be affected by ABM are subject to cost recovery fees assessed on the ex-vessel value of landings. The MSA authorizes the collection of cost recovery fees for LAPPs, the CDQ program, and the halibut/sablefish IFQ program. 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 not exceed 3% of the annual ex-vessel value of fish harvested by a program subject to a cost recovery fee. NMFS's Cost Recovery and Fee Programs web page[22] links to the Federal Register notice announcing each subject fishery's standard prices and fee percentages by year through 2018, as well as to cost recovery annual reports by sector for 2016 through 2018. Fees are determined by dividing direct program costs by the value of the fishery's landings. Table 3-16 reports cost recovery fees for selected programs in 2017 and 2018.

Table 3-16 NMFS cost recovery fees for selected fisheries

Cost Recovery Program	Year Implemented	Rate in 2017	Rate in 2018
Amendment 80	2016	0.71%	0.75%
CDQ	2016	0.55%	0.66%
Halibut/Sablefish IFQ	2000	2.20%	2.80%
AFA mothership	2016	0.22%	0.34%

3.3.8 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

[21] The Alaska Taxable Supplement is available at https://www.commerce.alaska.gov/web/dcra/OfficeoftheStateAssessor/AlaskaTaxable-New.aspx. At that site the reader can refer to Table 1A ("Reported Tax Rates for Each Municipality") for local raw fish taxes rates and revenues in 2018.

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

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 that the ABM action. That exercise is limited to the BSAI groundfish sectors that are constrained by halibut PSC limits. Entities that are important in the consideration of the ABM action but are not directly regulated include shoreside processors and entities that fish for halibut either commercially under the IFQ program or for subsistence and sport uses. As the action alternatives are presently defined, the number and categories of small entities that would be directly regulated does not differ between alternatives. This document provides a "profile" of the directly regulated segments of the industry in the preceding subsections of Section 3.3.

Note that the preparation of a complete IRFA is not necessary for Council final action on this issue. NMFS Alaska Region prepares the IRFA for a proposed action in the Classification section of the proposed rule. Chapter 6 of this Draft EIS identifies the general nature of the potential economic impacts on directly regulated entities – small and non-small – and addresses whether the impacts may be adverse or beneficial.

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). The action alternatives would directly regulate vessels in the following sectors: Amendment 80 (Bering Sea non-pollock trawl catcher/processors), trawl limited access catcher vessels (TLAS), hook-and-line catcher/processors (HALCP), hook-and-line catcher vessels (HALCV), and vessels that are fishing for groundfish that were allocated to CDQ groups (CDQ). Note that vessels harvesting CDQ allocations are distinct from the non-profit CDQ groups, themselves. NMFS typically considers CDQ groups to be small entities due to their non-profit status. The CDQ groups that engage in fisheries that are potentially affected by the ABM action are not considered to be directly regulated but, nevertheless, are identified elsewhere in this document.

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 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.

The SBA counts the receipts or employees of the concern whose size is at issue and those of all its domestic and foreign affiliates, regardless of whether the affiliates are organized for profit, in determining the concern’s size. However, business concerns owned and controlled by Indian Tribes, Alaska Regional or Village Corporations organized pursuant to the Alaska Native Claims Settlement Act (43 U.S.C. 1601), Native Hawaiian Organizations, or Community Development Corporations authorized by 42 U.S.C. 9805 are not considered affiliates of such entities, or with other concerns owned by these entities solely because of their common ownership.

NMFS considers members of fishing cooperatives 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.

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. CDQ groups, themselves, are considered “small” entities for SBA purposes because they are non-profit entities, even though their annual gross revenues might place them above the SBA income thresholds. While CDQ groups, as distinct from the vessels with which they have ownership or partnership affiliation, might not be directly affected by this action, the analysts note that they could be considered in a future IRFA analysis at the analysts’ discretion. The relevant activity of the six CDQ groups established in western Alaska is described in Section 3.3.4.

An RFA analysis is narrower in scope than a Regulatory Impact Review (RIR) that would be dictated under E.O. 12866. In an RIR, the analysis would consider all potentially affected stakeholders. The RFA only requires consideration of *directly regulated* small entities. Moreover, NMFS guidance narrows the scope to directly regulated small entities that are adversely affected by the action under consideration. For this reason, the data provided below do not include inshore processors as they are not directly regulated by a change to the administration of halibut PSC limits. As a general note, the analysts are not well equipped to classify processing facilities or companies as small or non-small due to the lack of information available on ownership affiliation and employment across all affiliated facilities, worldwide. While inshore processors are not classified in this section, information about that sector is included in Section 3.3.6 (groundfish) and Section 4.4.2 (halibut) of this document.

In 2018, 133 vessels participated in the halibut PSC-limited sectors that this document has focused on as potentially directly impacted. Based on the SBA thresholds, AKFIN identifies 20 vessels as small entities. Thirteen of those vessels participated in TLAS, five were HAL CVs, and five were identified with the CDQ sector. Three of those small entity vessels represent an overlap between TLAS and CDQ.

3.4 Evaluation of Pacific halibut bycatch data

3.4.1 Halibut avoidance strategies

3.4.1.1 A80

Section 1.4.4 of the October 2017 ABM discussion paper summarized the A80 sector's tools and approaches to minimizing halibut PSC (NPFMC 2017). The sector developed its own set of 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. Intra-cooperative accountability measures for failure to meet the standards include monetary fines, increased monitoring, and possible reduction in vessel-level halibut PSC allocations the following year.

The foundations of halibut avoidance efforts are data sharing and communication on the fishing grounds about bycatch rates, the size of halibut measured onboard, and the effectiveness of halibut excluder devices. Participants noted that 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 existing cooperative has also invested in research on how to utilize halibut decksorting to reduce bycatch mortality, and how decksorting as a tool interacts with excluder use. Practitioners within the sector report that decksorting and excluder use do not necessarily provide additive benefits, so communication about which tool to use in a given circumstance is critical. The analysts recognize that recent vessel acquisitions within the sector may have resulted in platforms that were primarily focused on roundfish during prior years incorporating more flatfish targets. At present, the analysts understand that all A80 vessels are utilizing decksorting to some degree and that the learning curve for understanding when to decksort has largely been achieved, such that vessels generally utilize the measure when targeting flatfish.

Additional information on the impact that decksorting practices under an EFP, and eventually as a fully implemented rule, is addressed in Section 3.4.2 of this document.

3.4.1.2 TLAS

As noted in the October 2017 discussion paper (NPFMC 2017), the TLAS fishery is distinct in having a mix of participants with and without affiliations to other cooperatives that have formalized halibut avoidance protocols. AFA CV cooperatives apply a "halibut mortality allowance" to their TLAS activity. This allowance is established by cooperatives and is proportional to the cooperative's non-pollock groundfish sideboard percentage. After adjustments are made to account for sideboard exempt/non-exempt status and a "traditional time and area buffer," co-op vessels receive a halibut mortality allocation.

Cooperatives agree to manage their vessels such that PSC limits are not exceeded, and allow PSC that is not needed to harvest the co-op's sideboard allocations to be redistributed in a timely manner to other cooperatives at no cost.

AFA CVs have established Better Practices Protocols that vessels must adhere to when fishing with trawl gear for BS Pacific cod. Vessels must tow halibut excluders that meet agreed upon specifications. The protocols allow room to innovate new designs, as smaller or slower vessels might experience different levels of effectiveness using the same design towed by a larger vessel. Vessels are not allowed to fish for cod during night hours, when halibut encounters tend to be greater. The protocols also set a minimum codend mesh size to allow some escapement of undersized fish. In terms of monitoring, AFA CVs fishing in limited access may voluntarily carry 100% observer coverage for the expressed purpose of internally managing the cooperative's halibut mortality allowances. By virtue of their cooperative affiliations, many TLAS participants also share with each other near real-time catch, bycatch, and location data (including rates) through a third-party. Cooperatives impose internal accountability measures through vessel rankings of PSC rates and through monetary sanctions for vessels that are not complying with Better Practices Protocols. While unaffiliated vessels – mostly non-AFA CVs – are not subject to agreements that carry internal accountability measures, co-op managers communicate with those vessels to share avoidance measures and encourage them to adopt the same.

In recent years, TLAS vessels have been able to coordinate informally on avoidance plans that are responsive to Council objectives, even meeting voluntary mortality reduction targets. That coordination is largely facilitated through existing cooperative programs (i.e., AFA and A80). Entry by newer participants could make coordination more challenging because voluntary cooperatives often parcel out halibut mortality allowances (or the like) based on catch history in the TLAS fishery.

If a collective action problem were to arise it would likely appear in the TLAS Pacific cod fishery. That fishery is more spatially and temporally constrained and has more vessels to organize than the YFS fishery and is thus less well-suited for voluntary cooperation. It might be particularly difficult to engage independent vessels in a voluntary PSC stand down if those vessels are in a rush to complete the trawl CV cod A season before returning to another fishery, such as GOA B season pollock.

3.4.1.3 HALCP

As described in the October 2017 discussion paper (NPFMC 2017), FLCCs efforts to reduce halibut bycatch mortality are centered around avoidance, release viability, and vessel accountability. Avoidance measures are generally framed around near real-time communication on the fishing grounds, facilitated through a third party. FLCC members can access third-party catch monitoring with location data, including both target and bycatch as well as observed discard mortality rates (DMR). Members receive weekly accountability reports on fleet-wide PSC totals and rates. Those internal reports are vessel-specific ("clean/dirty list"), triggering social incentives to avoid activity that would result in lost fishing opportunities for the voluntary cooperative as a whole. Inseason reporting on observed DMRs reinforces the need to prioritize careful release practices to increase viability (fish handling) and can also inform choices about where to set gear.

FLCC members, through the Freezer Longline Coalition (FLC), promote communication and accountability on halibut bycatch in three ways: an annual FLC symposium for owners, officers, and crew; bycatch status updates for the fleet monthly and at board meetings; and an ad hoc FLC bycatch committee. The annual symposium aims to educate participants – from owners to crew members – on the resource and business imperative to minimize halibut mortality, and how measures like fish handling that can improve outcomes. The event also includes interaction with fishery managers from NMFS and third-party data managers. FLC formed a bycatch committee in 2014 to engage in the process of developing BSAI FMP Am. 111 (reduced halibut PSC limits) and to encourage halibut avoidance efforts. That committee has not met on a regular basis but could be recalled to aid in coordination or reporting.

3.4.2 Data selection and data changes

Throughout this document the analysts focus on fishery data for the years 2010 through 2018.[23] 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 nine-year sample through 2018.

Since 2010, there have been changes in the observer sampling protocols with respect to Pacific halibut – mainly related to measures taken to minimize discard mortality rates. Varying numbers of vessels have participated in an Exempted Fishing Permit (EFP) for halibut decksorting to evaluate the potential for reducing halibut DMRs by modifying the halibut handling procedures on Amendment 80 vessels. For the EFP, catch handling procedures were modified so that halibut were sorted out of the codend on deck and returned to the sea from the deck via a chute constructed for this purpose. Procedures for the EFP required full accounting of the number and length of each halibut via a census of halibut collected on deck and in the factory, as well as an assessment of viability for each halibut collected in the two locations. Participation in the EFP ranged from 9 vessels, accounting for 16% of A80 catch, to 17 vessels, accounting for 80% of A80 catch (Table 3-17). Draft data (subject to revision) provided by industry on sampling and catch prior to and during the development of the deck sorting EFP are shown in Table 3-17 and Table 3-18 below (J. Gauvin, Alaska Seafood Cooperative, pers. comm). The tables illustrate some of the issues noted in the changes to sampling in 2016 and 2017 and the differences between the number of lengths taken on deck and in the factory across years as well as what stage the EFP was in at that time and relative participation by vessels in the EFP. This highlights some of the data issues as described for 2016 and 2017. Currently, A80 vessels that participate in deck sorting also utilize the method when fishing in the GOA. Through August, eight A80 vessels had deck sorted halibut in the GOA during 2019.

The effects of the EFP has resulted in large increases in the number of fish measured for the bottom trawl fleet (Figure 3-31). Relative to the normal catch accounting system data, the measurements during the first years of the EFP suggests some bias towards larger Pacific halibut (Figure 3-32). Nonetheless these samples suggest significant changes in the survival rates of discarded halibut based on viability rates (Figure 3-33). For the longline fleet, the number of Pacific halibut measured has dropped in recent years while the mean length for different viability categories has been stable except for the “unknown” viability category which has varied considerably over time (Figure 3-34). The effect of the EFP has reduced the overall DMR for the trawl A80 sector (Figure 3-35).

[23] This statement does not apply to the data used to calibrate and run the halibut abundance operating model.

Table 3-17. Number of lengths collected on deck and in the factory for Amendment 80 sector. "DS EFP" refers to deck sorting experimental fishing permit

	Length measurements				
Year	Obs. Factory	EFP in Factory	EFP On deck	Total	DS EFP affected collection of length data?
2008	34,194	-	-	34,194	no DS EFP
2009	30,791	-	-	30,791	small scale DS EFP, data not entered into NMFS CAS
2010	29,683	-	-	29,683	no DS EFP
2011	20,229	-	-	20,229	no DS EFP
2012	17,683	-	-	17,683	small scale DS EFP, data not entered into NMFS CAS
2013	18,364	-	-	18,364	no DS EFP
2014	19,672	-	-	19,672	no DS EFP
2015	18,401	-	16,721	35,122	May EFP start; 9 EFP boats; EFP was 16% of A 80 BS catch, lengths not entered into CAS
2016	12,448	7,456	27,606	47,510	May start; 12 EFP boats; EFP was 29% of A80 BS catch; lengths not collected in factory during EFP
2017	2,703	1,861	64,240	68,804	Jan. start; 17 EFP vessels, EFP was 80% of A80 BS catch; lengths not collected in factory during EFP

Notes: Sea samplers collected EFP lengths on deck in 2015, number of lengths per year provided by Sea State, Sea State used the "R 16" code in the NMFS observer data to derive the # of lengths for deck sorting hauls

Table 3-18. Number of lengths collected on deck and in the factory for TLAS CPs participating in DS EFP.

	Length measurements				
Year	Obs. Factory	EFP in Factory	EFP On deck	Total	DS EFP affected collection of length data?
2008	1,235	-	1,235	no DS EFP	2008
2009	1,873	-	1,873	small scale DS EFP, omitted from NMFS CAS	2009
2010	455	-	455	no DS EFP	2010
2011	1,654	-	1,654	no DS EFP	2011
2012	2,157	-	2,157	small scale DS EFP, omitted from NMFS CAS	2012
2013	1,294	-	1,294	no DS EFP	2013
2014	1,275	-	1,275	no DS EFP	2014
2015	843	-	843	no TLAS CPs in 2015 DS EFP	2015
2016	818	4,683	5,501	May start; 2 TLAS CPs in EFP boats; obs did not collect lengths in factory during EFP	2016
2017	81	7,194	7,275	Jan EFP start; 2 TLAS CPs in EFP nearly all year, no lengths in factory during EFP	2017

Notes on data: Data for # of lengths per year and groundfish catch was provided by Sea State
Sea State used the "R 16" code in the NMFS observer data to derive the # of lengths for deck sorting hauls.

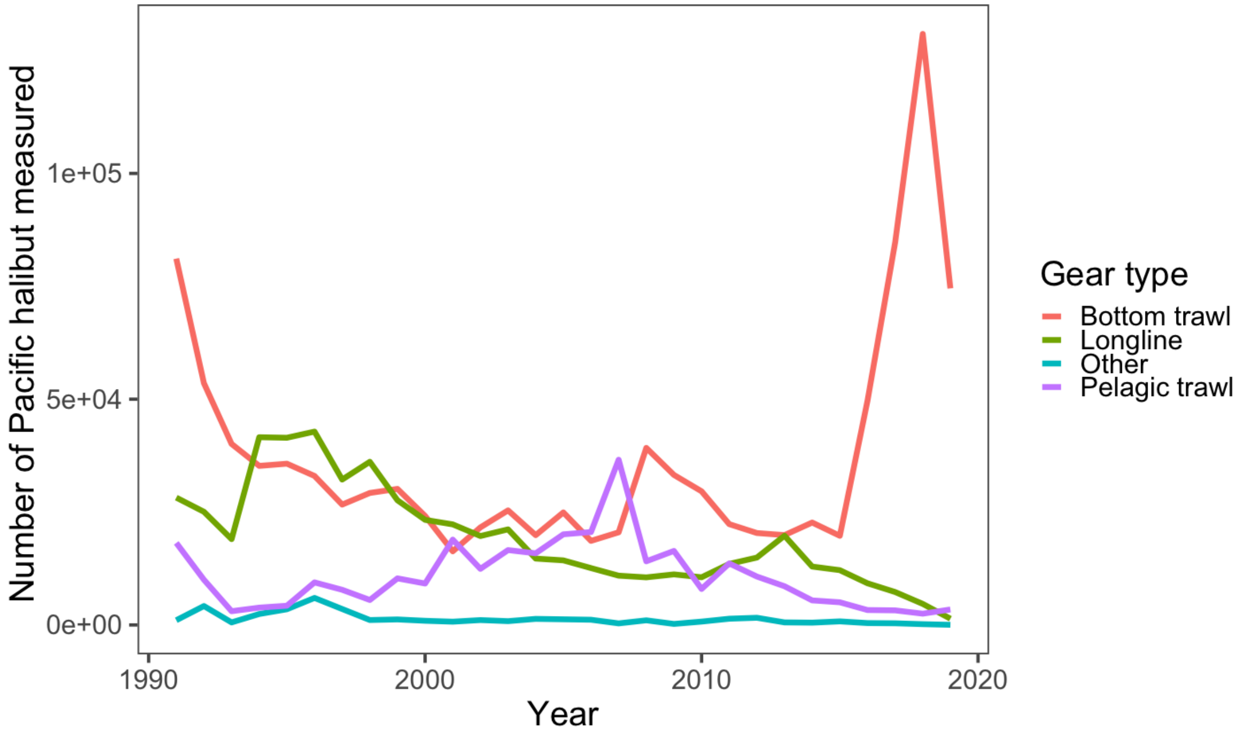


Figure 3-31. Numbers of Pacific halibut measured by gear based on NMFS observer data, 1991-2018.

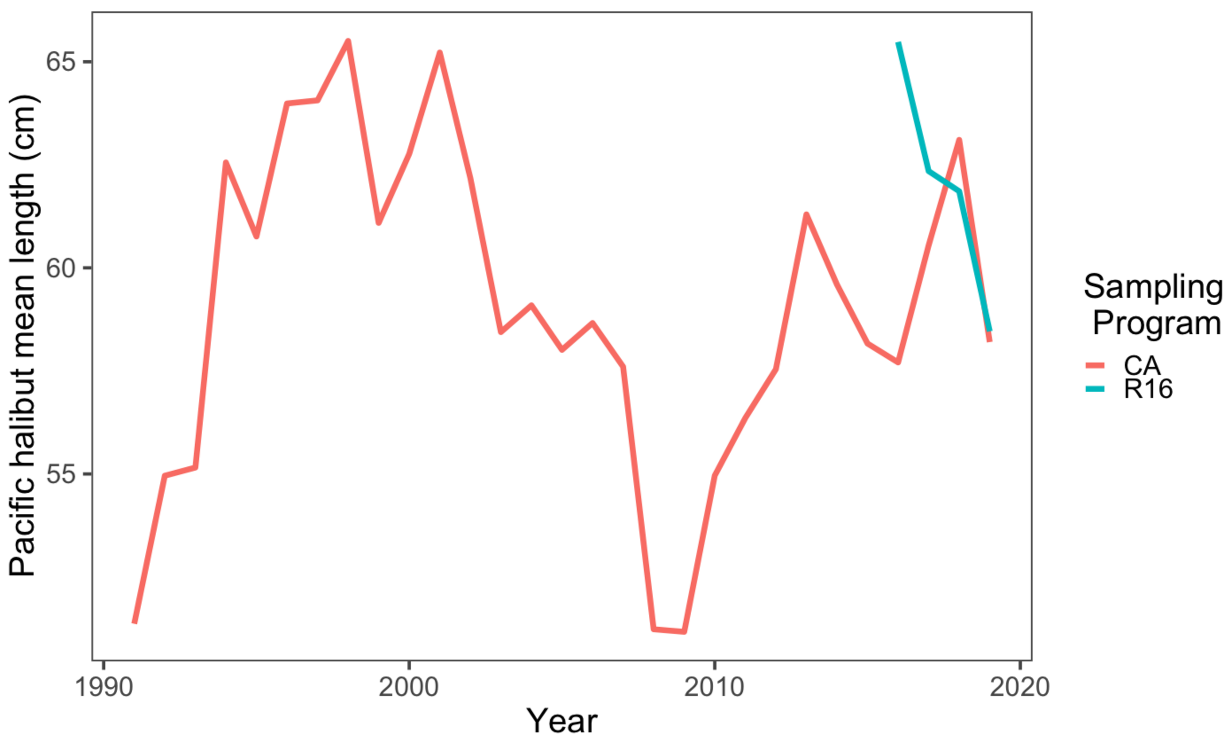


Figure 3-32. Pacific halibut mean length (cm) by sampling program: CA= catch accounting, "R16" = deck sorting EFP.

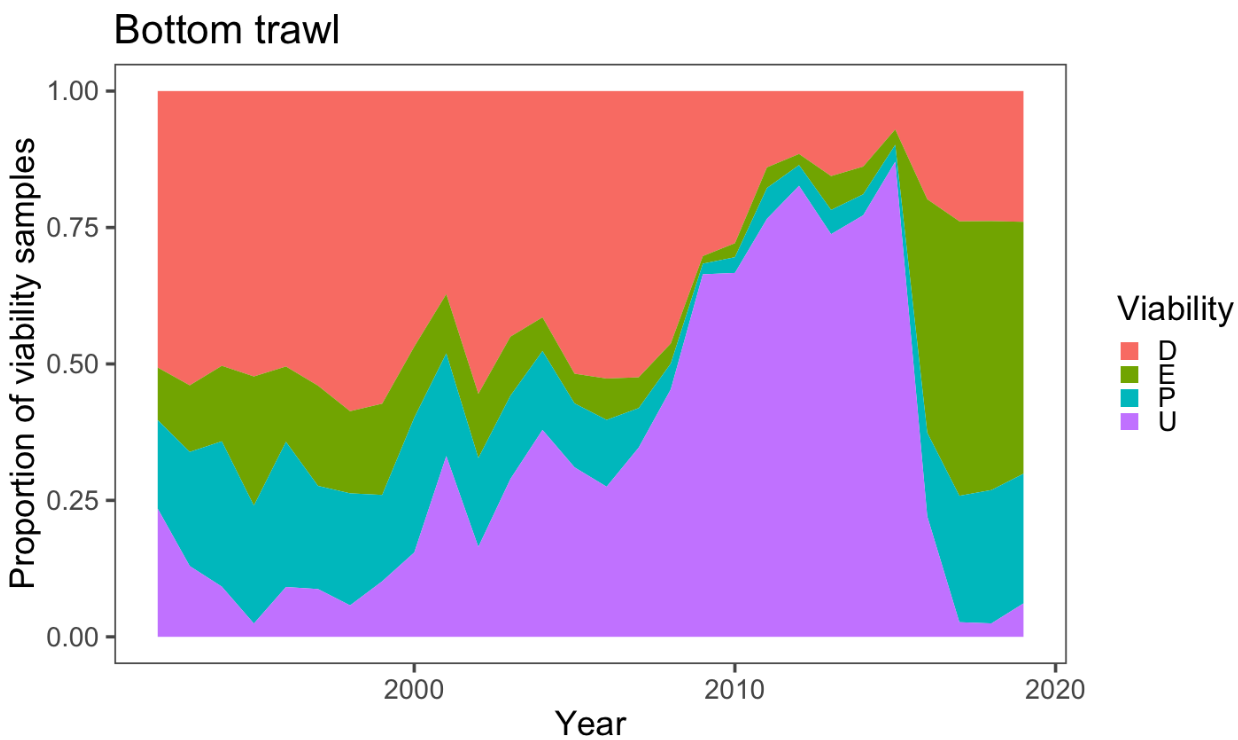


Figure 3-33. Observer estimates of Pacific halibut viability from the BSAI trawl fisheries. Viability codes (which affect DMR estimates) are: D=Dead, E=Excellent, P=Poor, U=Unknown.

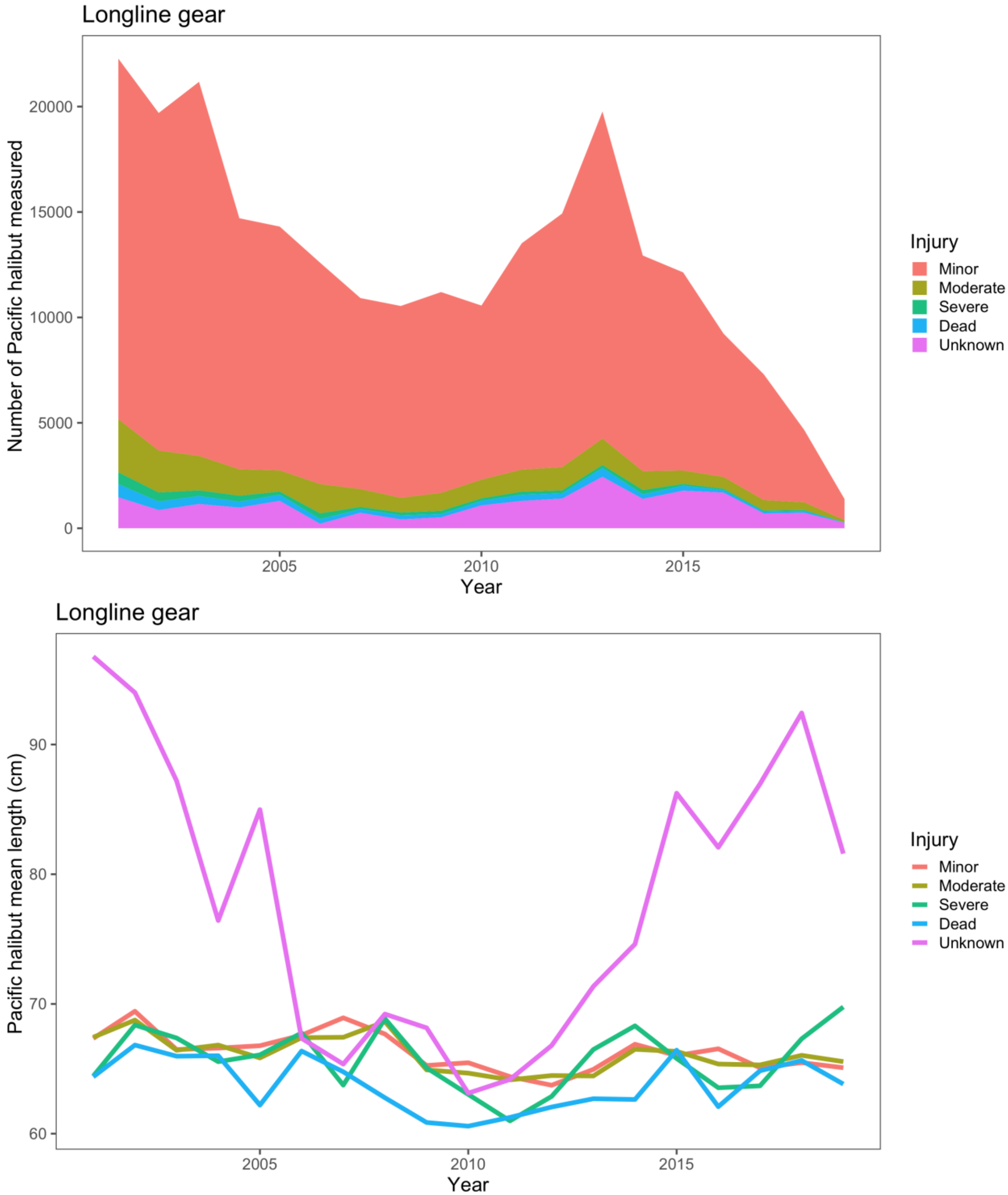


Figure 3-34. Pacific halibut number measured by viability (top) and mean length (cm) by viability (bottom) based on NMFS observer data on BSAI longline vessels, 2001-2018.

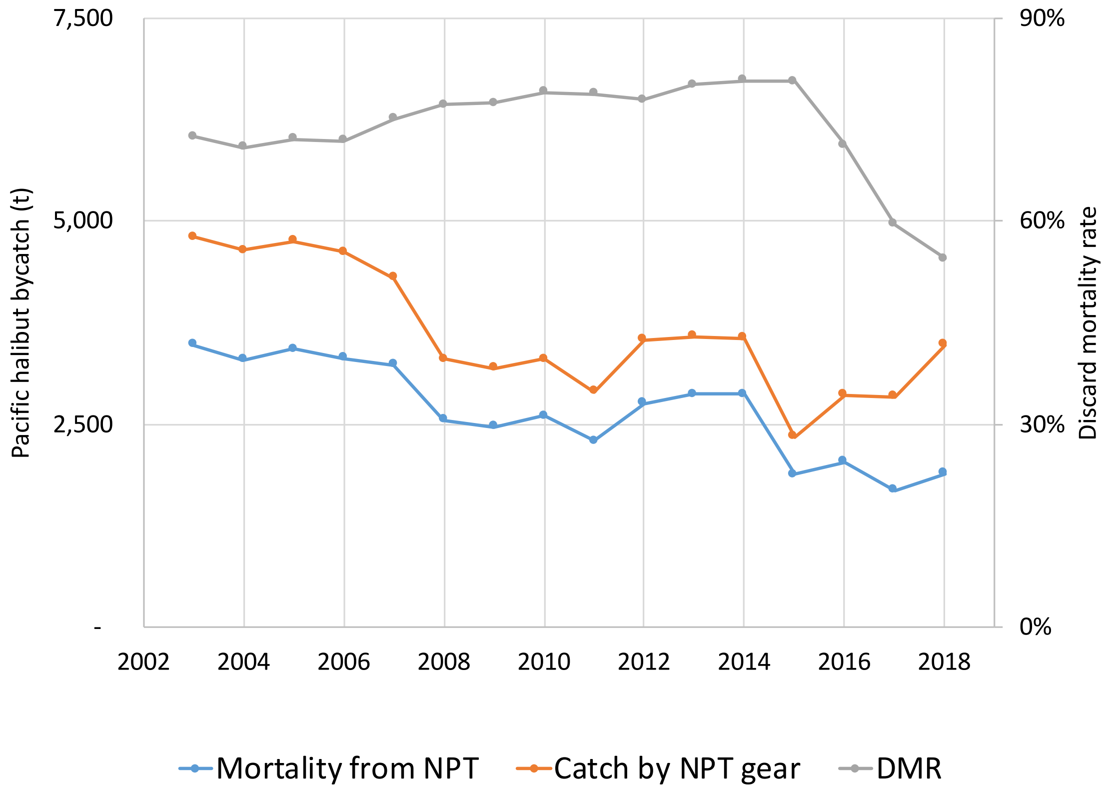


Figure 3-35. Bycatch of Pacific halibut (t) from 2003 through 2018 for the sectors fishing with non-pelagic trawl gear (NPT) expressed as estimated mortality, catch, and the ratio of the two (aggregate annual discard mortality). (top).

The catch and revenue data in Section 3.3 are compiled by AKFIN in Comprehensive_BLEND_CA from the NMFS Alaska Region Catch Accounting System. These data include open access, Amendment 80 and CDQ management program codes and were filtered to remove catch and revenue under the IFQ program management code as the halibut PSC from these fisheries does not accrue towards the limit. Although halibut PSC caught when directed fishing for CDQ pollock accrues to the CDQ halibut PSQ pollock catch and revenue was filtered out for the CDQ sector because pollock catch is on a much larger scale than other CDQ groundfish. Table 3-24 and Table 3-15 are provided for comparison of CDQ pollock catch, revenue and PSC.

Throughout the document, unless otherwise noted, revenue in the groundfish sectors is reported as ex vessel value for sectors dominated by catcher vessels (HALCV, TLAS) and first wholesale value for sectors dominated by catcher processors (A80, HALCP, CDQ). The analysts determined that while reporting consistent revenue metrics would facilitate comparison across sectors, it was preferable to report the most relevant revenue value for each sector.

Prohibited species catch data are from NMFS Alaska Region Catch Accounting System, compiled by AKFIN in Comprehensive_PSC. PSC is estimated based on the target species (as defined by the prominent groundfish species in the catch). Target species does not reflect the entirety of the species composition of the catch, therefore trips with the same target species could have different combinations of species composition. The overall revenue depends upon the relative values and proportions of the entirety of the catch (both the target and non-target species). Therefore, revenue associated with the same target fishery could be comprised of different proportions of target species and non-dominant species compositions.

3.4.3 Patterns in Pacific halibut bycatch by NMFS groundfish fishery sectors

For the data spanning 2010 through 2018, the sector-specific Pacific halibut mortality was highest for the A80 sector, followed by TLAS then HALCP (Table 3-19). Consideration of how Pacific halibut bycatch has changed over time and space was based on data aggregated by year and FMP area at the coarsest level, and down to week and ADFG statistical area at the finest resolution. Information on sector, species target, groundfish catch, and Pacific halibut catch were available at these resolutions. Throughout it is important to understand the difference between Pacific halibut catch and mortality since PSC are managed against the mortality. Since 2010, the mortality has consistently declined, especially for the sectors that had the highest bycatch (Table 3-20). For reference when viewing the 'mortality' rows in Table 3-20, the current PSC limits are shown in Table 2-1. The A80 limit is 1,745 t, the TLAS limit is 745 t, the CDQ limit is 315 t, and the non-trawl limit that covers both HALCP and HALCV is 710 t.

Table 3-19. Proportion of Pacific halibut mortality by BSAI groundfish sectors.

A80	TLAS	HALCP	CDQ	HALCV	*POT**	*AFA**
60.0%	15.0%	12.3%	6.9%	0.1%	*0.1%*	*5.6%*

* Note that the Pot and AFA fishery sectors Pacific halibut mortality does not accrue against annual PSC limits.

Table 3-20. Bycatch of Pacific halibut by year and sector including "Catch" estimates and "Mortality" in 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

It is important to understand when a vessel operates within specific management sectors. Of the 465 unique groundfish vessels identified as participants during the study period, 351 vessels recorded some Pacific halibut mortality. Of these, 73 vessels conducted CDQ operations, and 17 from that group participated in two other sectors along with CDQ (i.e., 17 boats identified with 3 different sectors during the study period). Two boats recorded participating in the CDQ sector and no other (their bycatch mortality was negligible). Ranking these 351 vessels by those having the highest Pacific halibut mortality shows that virtually all the mortality occurred from the first half of the identified fleet (180 boats). The highest bycatch occurred for about the first 11 vessels–each responsible for 4% of the Pacific halibut PSC mortality in the Bering Sea from 2010-2018 (Figure 3-36). This figure also identifies vessels that participated in different sectors and that the boats ranked greater than 20th tended to have similar contributions to Pacific halibut bycatch mortality.

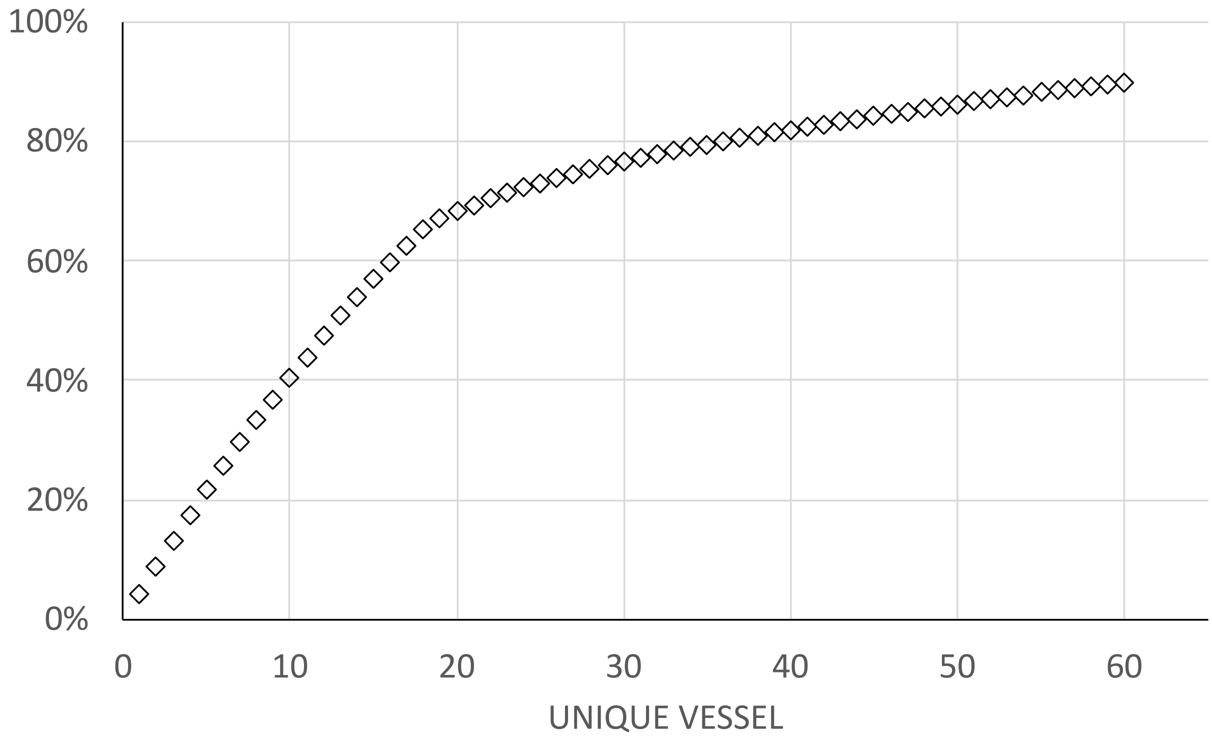


Figure 3-36. Cumulative proportions of Pacific halibut bycatch mortality by unique vessel. Vessels are ranked such that the boat with the most bycatch mortality during 2010-2018 is the furthest to the left on the horizontal axis. Most of these boats participated in CDQ operations at least once (37 out of 60). Only boats that added up to 90% of the total bycatch mortality are included for clarity; also, AFA and POT sectors are excluded and HALCV sector boats were outside the top 90% of bycatch vessels.

The time series of overall BSAI bycatch fisheries sectors has decreased in both catch and Pacific halibut mortality (Table 3-20; Figure 3-37). It is noteworthy that there is a large difference between the amount of halibut that are handled (caught) versus those estimated to have died before being returned to the sea. For example, the amount of Pacific halibut caught by the HALCP sector is highest but the mortality of Pacific halibut by this sector typically ranks third after the main trawl sectors (Figure 3-37). For a general within-year pattern over years from 2010 to 2018 shows that the highest Pacific halibut bycatch occurs in February while December, January, and July tend to have the lowest bycatch mortalities for this recent period (Figure 3-38).

Collapsing over all sectors the bycatch in “Target” fisheries shows the same overall annual trend, with most of the reductions coming from the yellowfin sole (YFS) directed fishery (Figure 3-39). When broken out by month it is clear that in February the bycatch is highest in the northern rock sole (NRS) and Pacific cod fisheries whereas bycatch from the YFS fishery is highest later in the year (except in December; Figure 3-40).

Detailed breakouts of target fishery bycatch patterns for each sector over time are shown in Figure 3-41 through Figure 3-45. These illustrate a number of features on bycatch patterns. First, within the A80 fleet the variability between months over years and among directed fisheries is high (Figure 3-41). The bycatch in the NRS fishery is generally highest during February to May but in some years (e.g., 2018) the highest bycatch was in June. Another example is the high Pacific halibut mortality observed in the arrowtooth flounder (ATF) fishery in 2012 in May and June (and relatively little bycatch from this fishery in most years). The bycatch in the flathead sole (FHS) is also relative minor in most months in most years but accounts for significant bycatch levels in a few months (e.g., June 2013).

The TLAS sector differs significantly from the A80 sector as their bycatch occurs mainly in the Pacific cod directed fishery and usually in the early part of the year (Figure 3-42). The HALCP sector also targets Pacific cod and the monthly pattern in bycatch attributed to this sector and fishery has high bycatch (relative to other months) in Jan 2010 but then is relatively consistent in bycatch levels by month (Figure 3-43). For the HALCV sector, the bycatch was low but varied between months (Figure 3-44). Finally, the CDQ sector bycatch varies among directed fisheries, in particular the NRS, YFS, and Pacific cod fisheries (Figure 3-45).

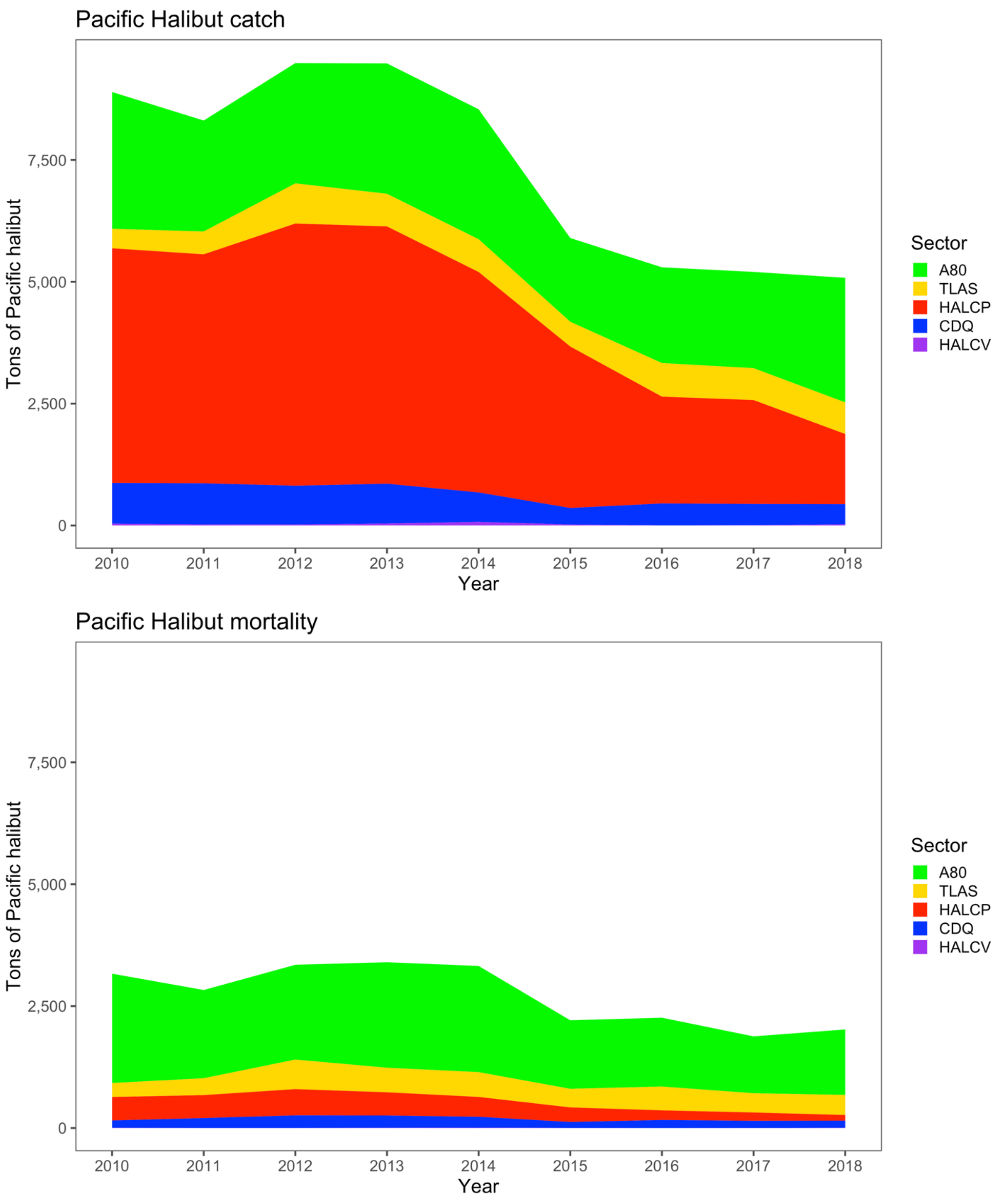
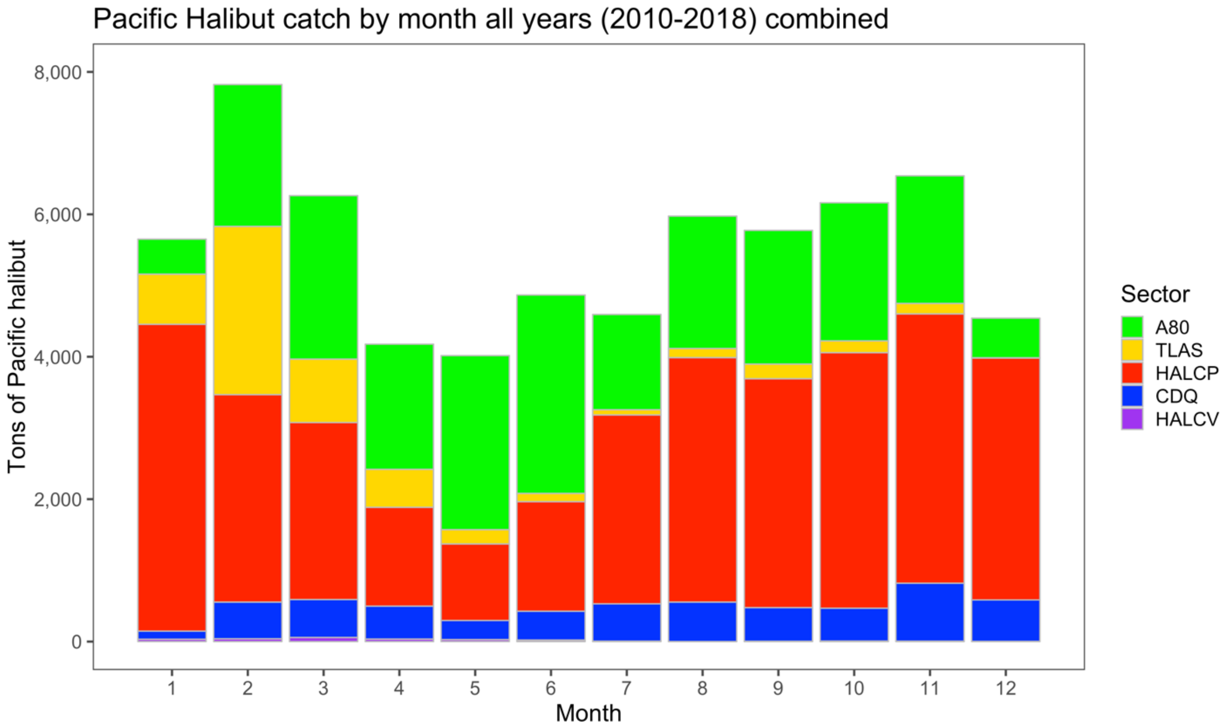


Figure 3-37. Bycatch of Pacific halibut (t) over time by sector (colors) for catch (top) and mortality (bottom).



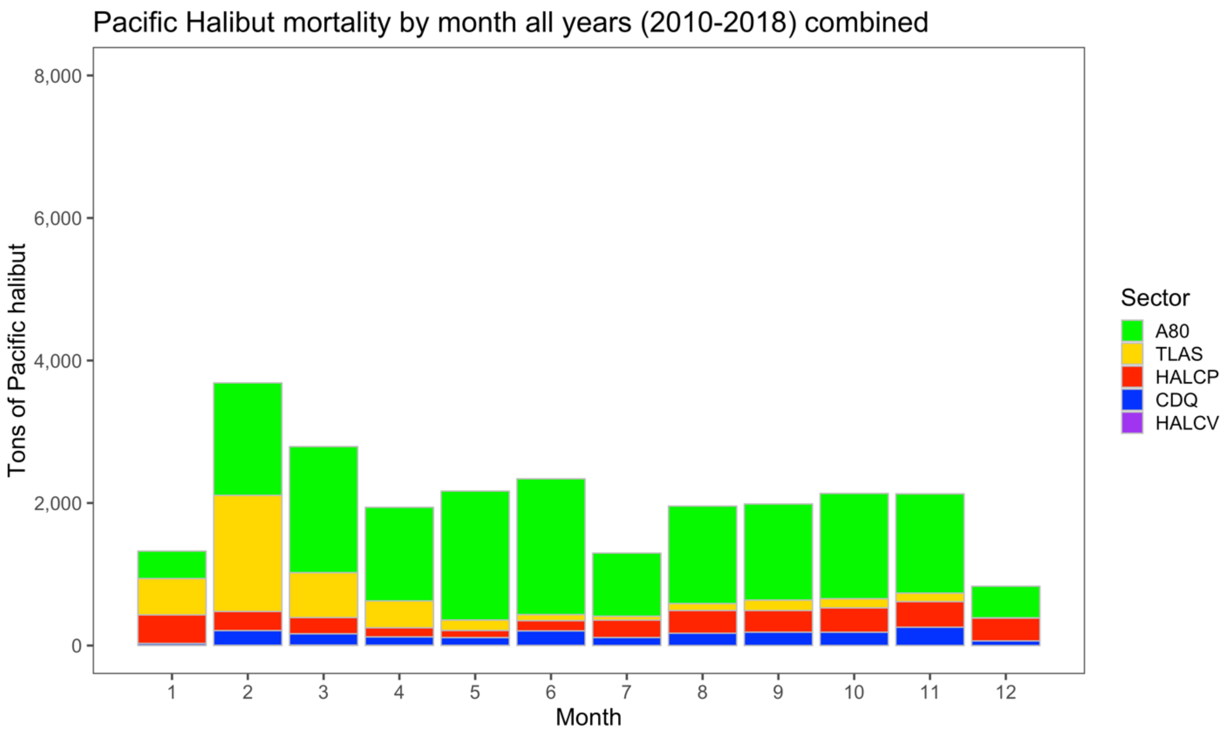


Figure 3-38. Bycatch of Pacific halibut (t) by month of year and sector (colors) over all years; values of bycatch are catch, (top) and mortality (bottom).

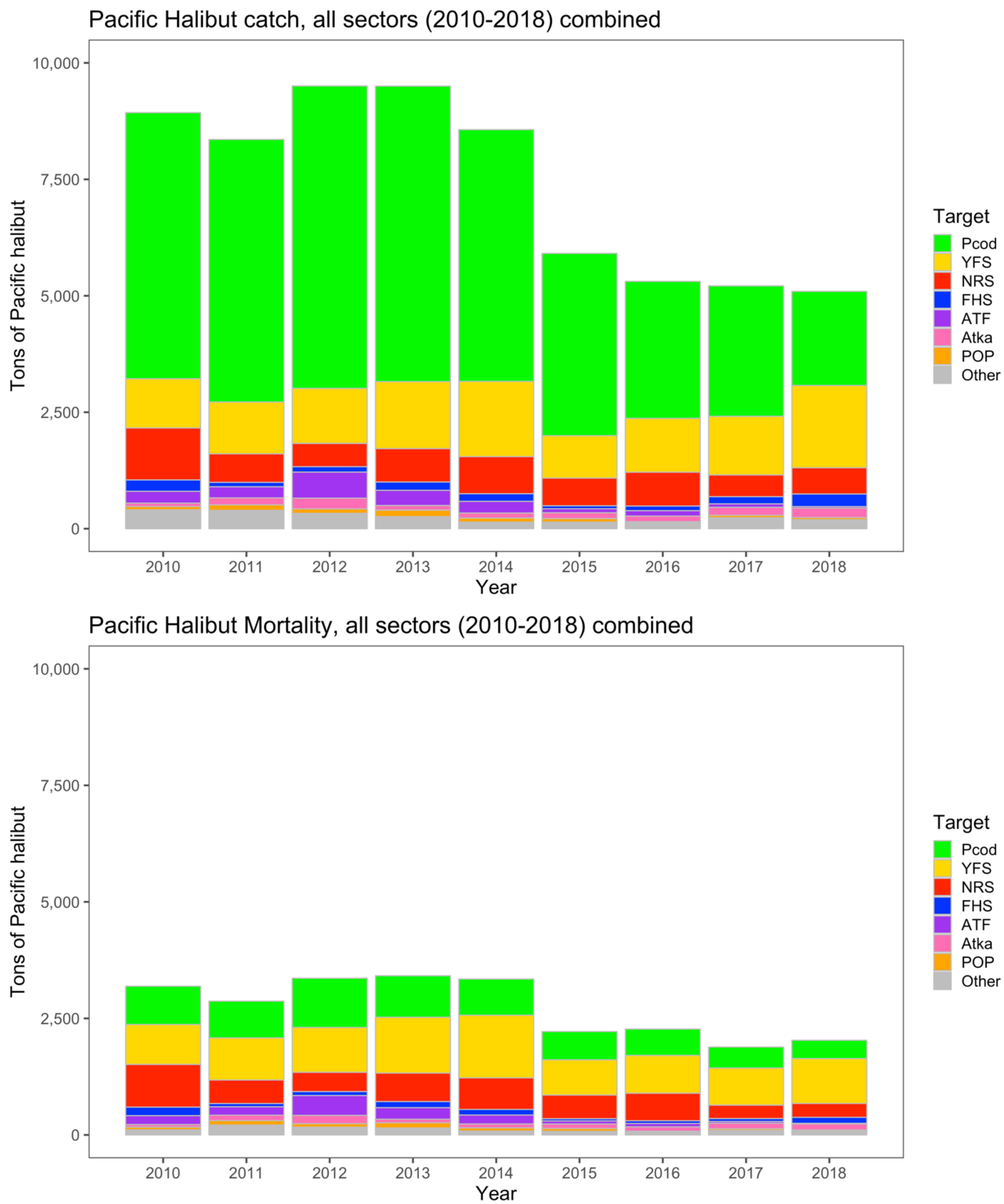


Figure 3-39. Bycatch of Pacific halibut (t) by year and target fishery (colors) over all sectors; values of bycatch are catch, (top) and mortality (bottom).

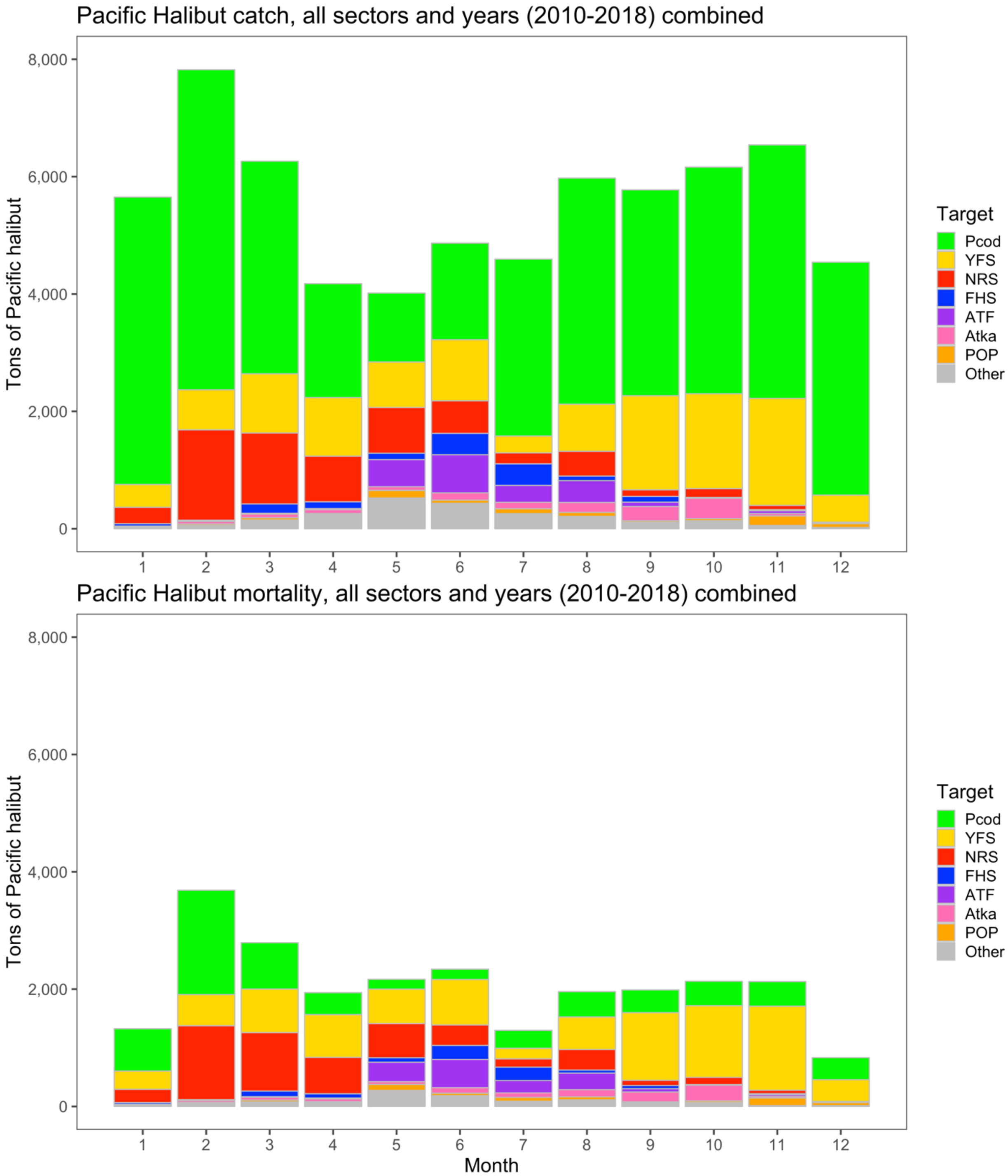


Figure 3-40. Bycatch of Pacific halibut (t) by month of year and target fishery (colors) over all years and sectors; values of bycatch are catch, (top) and mortality (bottom).

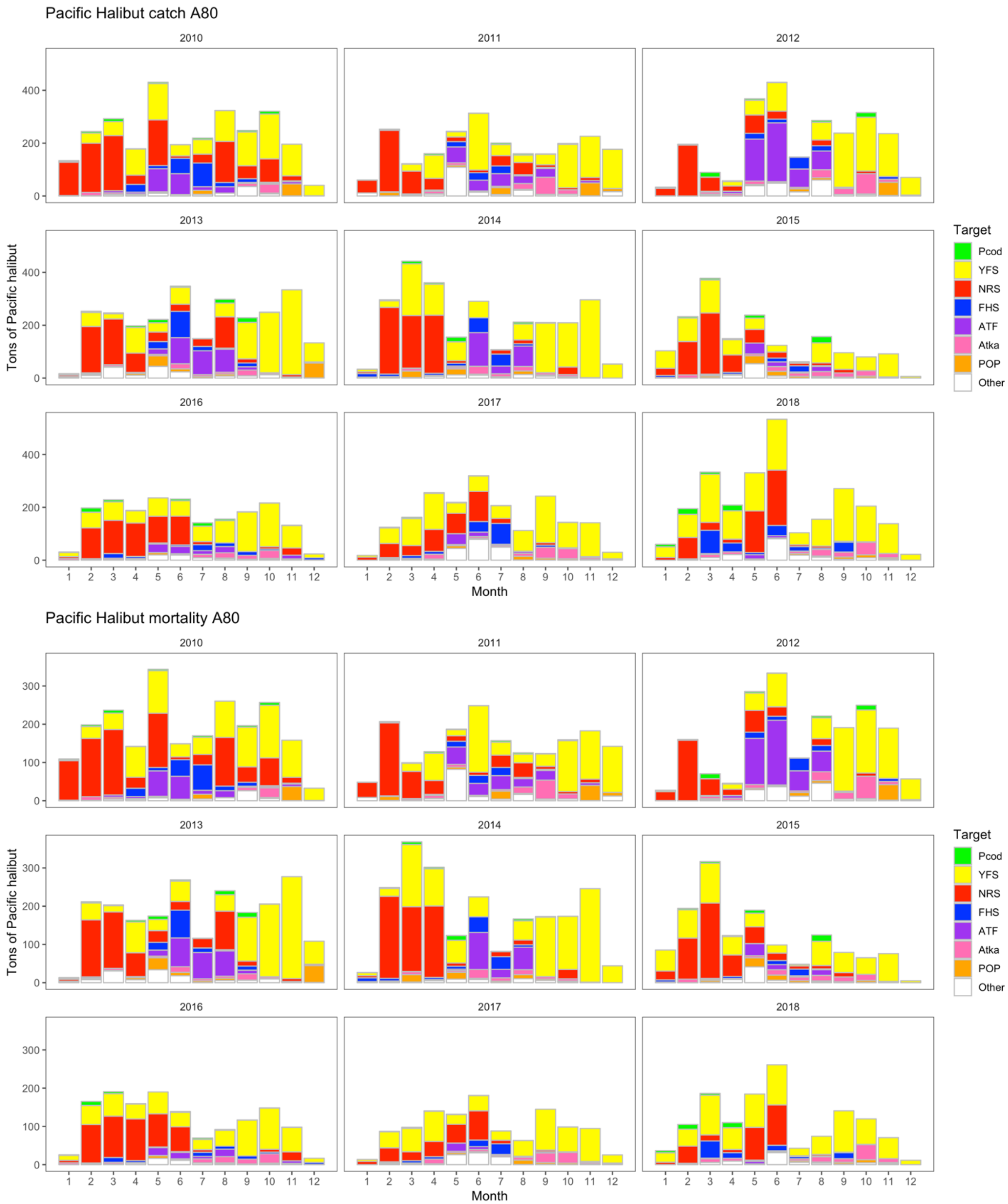


Figure 3-41. Bycatch of Pacific halibut (t) by month of year and target fishery (colors) with panels corresponding to years for the A80 sector; values of bycatch are catch, (top) and mortality (bottom).Note: vertical scales differ between top and bottom panels.

Figure 3-42. Bycatch of Pacific halibut (t) by month of year and target fishery (colors) with panels corresponding to years for the TLAS sector; values of bycatch are catch (top) and mortality (bottom). Note: vertical scales differ between top and bottom panels.

Figure 3-43. Bycatch of Pacific halibut (t) by month of year and target fishery (colors) with panels corresponding to years for the HALCP sector; values of bycatch are catch (top) and mortality (bottom).Note: vertical scales differ between top and bottom panels.

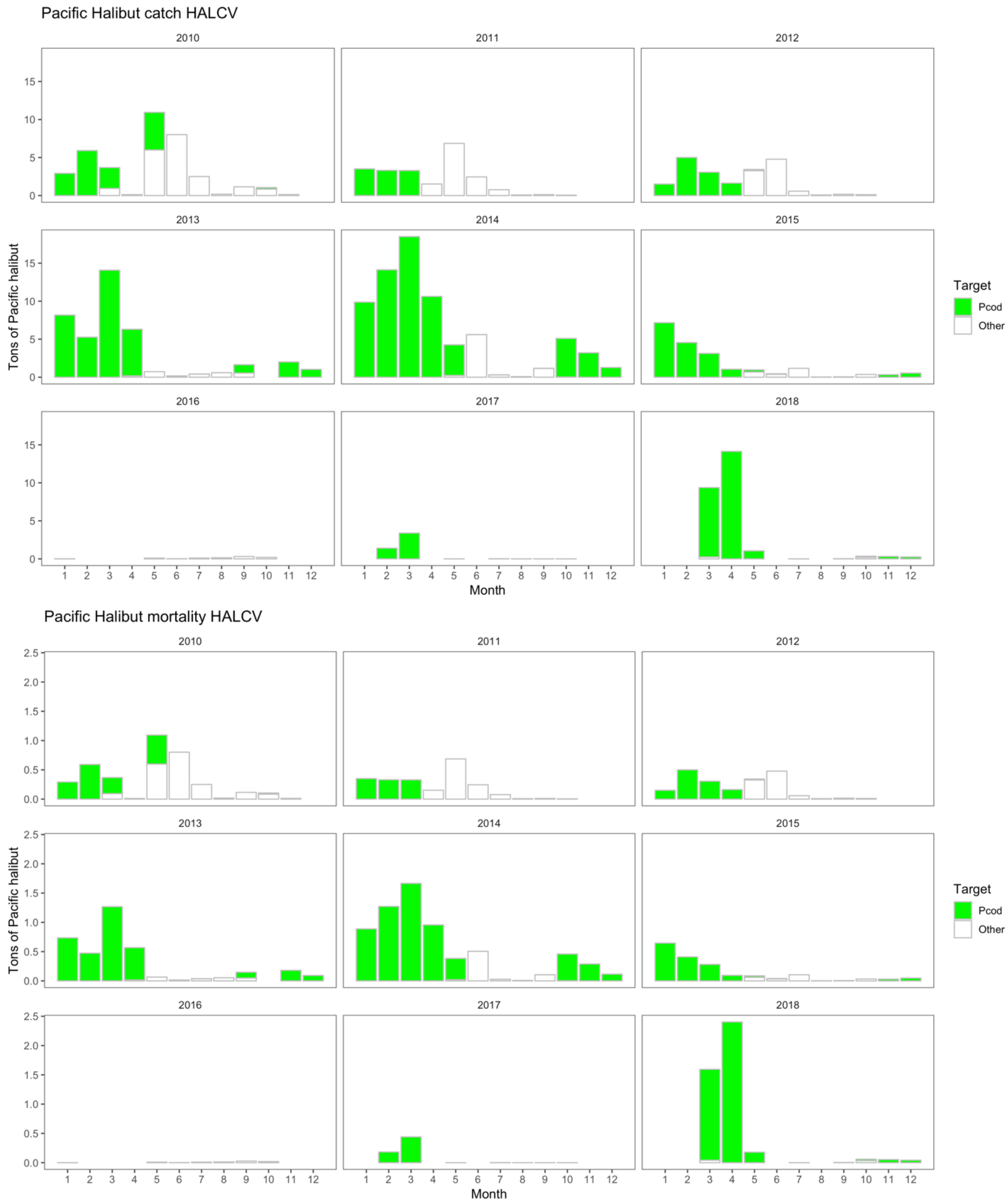


Figure 3-44. Bycatch of Pacific halibut (t) by month of year and target fishery (colors) with panels corresponding to years for the HALCV sector; values of bycatch are catch (top) and mortality (bottom).Note: vertical scales differ between top and bottom panels.

Figure 3-45. Bycatch of Pacific halibut (t) by month of year and target fishery (colors) with panels corresponding to years for the CDQ sector; values of bycatch are catch (top) and mortality (bottom). Note: vertical scales differ between top and bottom panels.

3.4.4 Pacific halibut encounter rates in NMFS groundfish fisheries

The general pattern of bycatch rates (expressed as kg of Pacific halibut per t of groundfish) show declines since 2008 (Figure 3-46). One way to evaluate patterns in bycatch is to examine the relationship with groundfish catch. As demonstrated above, there are considerable differences among sectors and this holds when comparing bycatch to groundfish catch (Figure 3-46 and Figure 3-47). For the three main sectors, Pacific halibut bycatch appears to be relatively unrelated to the groundfish catch in the Pacific cod fishery (bottom panel, Figure 3-49). For the A80 sector, the highest bycatch per t of groundfish was in the YFS fishery, followed by the NRS fishery (Figure 3-49, top panel). For the TLAS sector, the Pacific cod target fishery had the highest rate followed by YFS (Figure 3-49, middle panel).

For the main period used in this analysis (2010-2018) individual vessels operated it was possible to show how Pacific halibut bycatch mortality changed over time by sector (Table 3-21). Overall, the bycatch rate has dropped steadily for most sectors except for hook-and-line catcher vessels (HALCV) which represented a very small component of the overall bycatch (~0.1%).

Seasonal patterns (over all study years combined) shows reasonably steady encounter rates but with some increase in November and December even though 7% of the non-pollock groundfish annual catch occurs during these months it accounts for 11% of the halibut mortality (Table 3-22).

To evaluate seasonal time trends, it was noted that about 50% of halibut mortality occurred from January-May, with the other 50% from June-December. Aggregating these two "seasons" and examining over years shows that the encounter rates for the HALCP and A80 sectors declined (most dramatically for A80). The TLAS sector was relatively more variable over time (Table 3-23). One way to evaluate patterns in bycatch is to examine the relationship with groundfish catch. As demonstrated above, there are considerable differences among sectors and this holds when comparing bycatch to groundfish catch (Figure 3-47). When further broken down to include target species, analysis of within-sector bycatch rates shows that the YFS and NRS fishery are most important for the A80 fleet whereas the TLAS sector is a two-target fishery (Pacific cod and YFS), and HALCP is mainly focused on Pacific cod (Figure 3-48)

For the three main sectors, Pacific halibut bycatch appears to be relatively unrelated to the groundfish catch in the Pacific cod fishery (bottom panel, Figure 3-48). For the A80 sector, the highest bycatch per t of groundfish was in the YFS fishery, followed by the NRS fishery (Figure 3-48, top panel). For the TLAS sector, the Pacific cod target fishery had the highest rate followed by YFS (Figure 3-48, middle panel). A more detailed evaluation of the A80 sector's encounter rate relationship by target suggest that the relationship between tons of groundfish and Pacific halibut bycatch varies considerably among targets (Figure 3-49). Most striking among these is that the NRS target fishery bycatch appears to have been relatively unrelated to groundfish catch (top right panel of (Figure 3-49).

For the main period used in this analysis (2010-2018) individual vessels operated it was possible to show how Pacific halibut bycatch mortality changed over time by sector (Table 3-21). Overall, the bycatch rate has dropped steadily for most sectors except for hook-and-line catcher vessels (HALCV) which represented a very small component of the overall bycatch (~0.1%).

Seasonal patterns (over all study years combined) shows reasonably steady encounter rates but with some increase in November and December even though 7% of the non-pollock groundfish annual catch occurs during these months it accounts for 11% of the halibut mortality (Table 3-22).

To evaluate seasonal time trends, it was noted that about 50% of the Pacific halibut mortality occurred from January-May, with the other 50% from June-December. Aggregating these two "seasons" and examining over years shows that for the hook-and-line catcher-processors (HALCP) and A80 sectors, the encounter rates declined (most dramatically for A80). The TLAS sector was relatively more variable over time (Table 3-23).

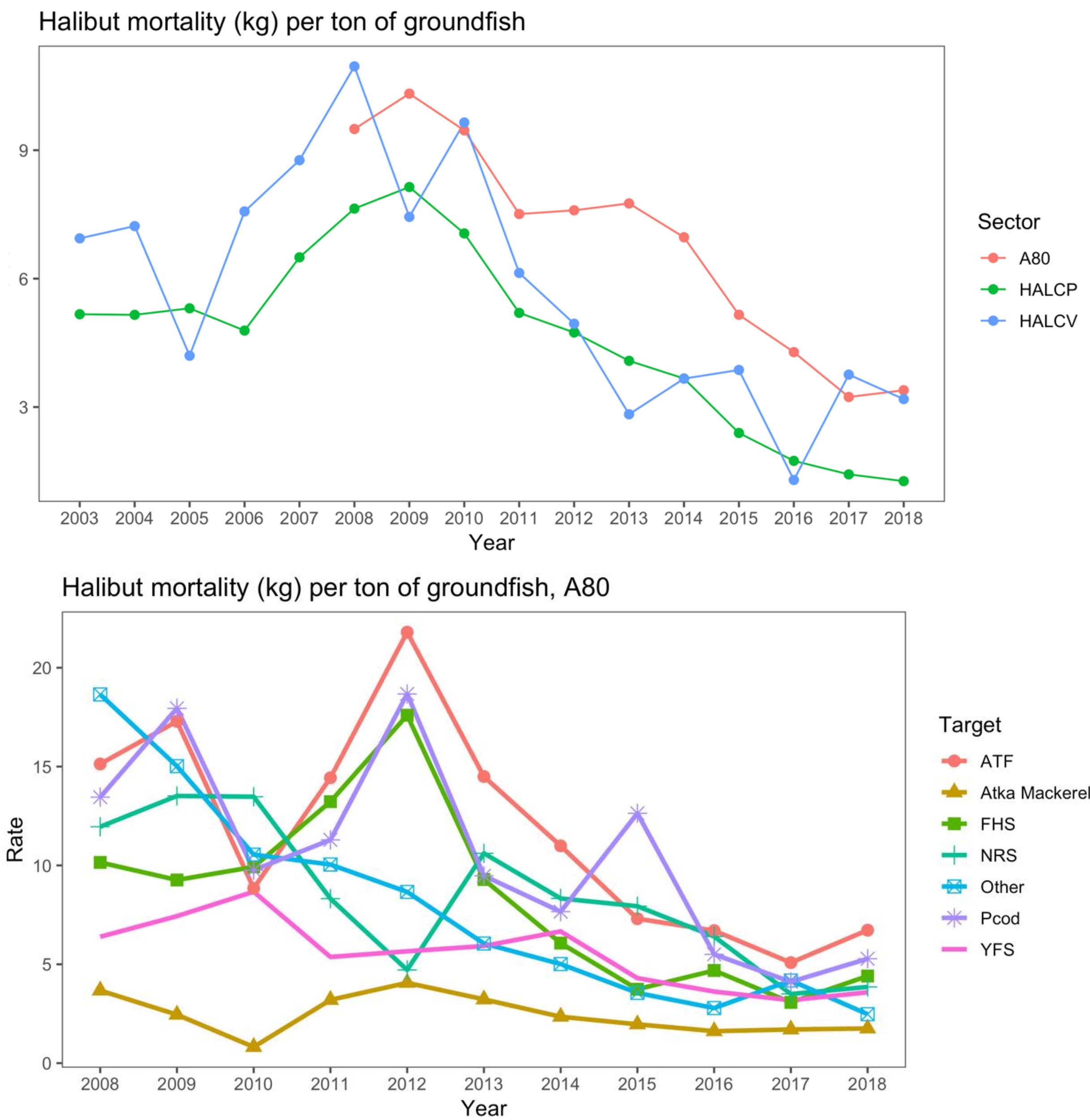


Figure 3-46. Bycatch of Pacific halibut (kg) per ton of groundfish by main fishery sectors (top) and by target within the A80 sector (bottom).

Table 3-21. Kilograms of Pacific halibut mortality per ton of groundfish catch by sector (included all sectors in aggregate) and year with darker column shading indicating higher values; the bottom row shows the relative bycatch contribution.

	A80	AFA	CDQ	HALCP	HALCV	POT	TLAS	Aggregate
2010	6.69	0.27	1.36	5.40	6.76	0.16	4.97	2.52
2011	5.57	0.26	1.38	4.00	3.98	0.22	4.20	1.75
2012	5.95	0.32	1.51	3.96	2.88	0.18	6.42	2.02
2013	6.48	0.18	1.41	3.52	3.09	0.11	5.00	1.90
2014	6.50	0.12	1.27	2.98	2.85	0.11	5.40	1.82
2015	4.59	0.09	0.66	2.04	2.21	0.11	5.68	1.22
2016	3.71	0.07	0.82	1.35	1.33	0.09	6.30	1.16
2017	2.62	0.06	0.68	1.19	6.06	0.06	3.41	0.91
2018	2.73	0.03	0.68	0.96	5.13	0.04	3.72	0.95
Mean	4.78	0.15	1.05	2.71	3.51	0.12	4.91	1.53
% Pacific halibut mortality	60.0%	5.6%	6.9%	12.3%	0.1%	0.1%	15.0%	

Table 3-22. Kilograms of Pacific halibut mortality per ton of groundfish catch by sector (included all sectors in aggregate) and month (summed over 2010-2018, 2010-2015, and 2016-2018) with darker column shading indicating higher values; the last three columns are monthly percentages.

2010-2018

Month	A80	AFA	CDQ	FLL	HALCV	POT	TLAS	All	All GF	Hal Mort.	GF w/o pollock
01	4.58	0.51	0.39	2.56	2.76	0.03	4.63	1.73	5%	6%	7%
02	5.07	0.32	0.66	1.83	2.63	0.03	6.46	1.62	15%	16%	14%
03	4.58	0.20	0.65	1.84	3.24	0.13	4.26	1.15	16%	12%	13%
04	3.88	0.08	2.12	1.69	4.09	0.75	3.66	2.10	5%	8%	8%
05	5.18	0.00	2.68	2.62	6.66	0.70	2.63	4.46	3%	8%	7%
06	5.57	0.04	0.99	2.92	19.07	1.65	4.70	1.49	9%	9%	9%
07	3.27	0.06	0.36	2.98	3.04	1.29	5.87	0.53	16%	5%	9%
08	4.44	0.07	0.90	3.36	0.80	0.33	5.19	0.86	14%	8%	9%
09	3.62	0.07	1.33	3.08	1.70	0.25	3.87	1.34	9%	8%	9%
10	4.46	0.31	2.20	3.25	3.03	0.22	3.70	2.84	5%	8%	8%
11	9.04	2.62	5.32	3.73	3.43	0.19	9.61	6.50	2%	8%	5%
12	14.26	-	4.07	3.29	3.41	0.18	7.08	5.22	1%	3%	2%
Mean	4.78	0.15	1.05	2.71	3.51	0.12	4.91	1.53	100%	100%	100%

2010-2015

Month	A80	AFA	CDQ	FLL	HALCV	POT	TLAS	All	All GF	Hal Mort.	GF w/o pollock
01	5.39	0.78	0.43	3.09	2.76	0.03	4.30	2.16	5%	6%	8%
02	6.02	0.43	0.84	2.13	2.54	0.02	6.98	1.89	15%	16%	15%
03	5.27	0.26	0.66	2.19	2.62	0.16	4.62	1.31	17%	12%	13%
04	4.62	0.08	2.21	2.38	3.09	4.46	4.82	2.52	5%	7%	7%
05	5.89	0.00	2.45	3.19	7.43	0.64	2.21	5.02	3%	8%	7%
06	7.37	0.05	0.96	3.85	19.25	1.85	2.72	1.57	10%	8%	9%
07	4.59	0.08	0.46	4.08	3.27	1.65	10.25	0.68	15%	6%	8%
08	6.16	0.10	1.07	4.27	0.76	0.23	6.17	1.15	14%	9%	9%
09	4.45	0.10	1.96	4.07	1.73	0.33	3.72	1.65	8%	8%	9%
10	5.60	0.35	2.49	4.20	3.69	0.29	3.54	3.20	5%	9%	8%
11	12.15	2.62	7.68	5.09	3.68	0.23	10.89	8.53	2%	9%	5%
12	16.56	-	5.43	4.72	3.82	0.32	7.08	7.25	1%	4%	2%
Mean	5.99	0.20	1.25	3.52	3.26	0.15	5.30	1.84	100%	100%	100%

2016-2018

Month	A80	AFA	CDQ	FLL	HALCV	POT	TLAS	All	All GF	Hal Mort.	GF w/o pollock
01	2.83	0.18	0.35	1.38	1.33	0.02	5.78	1.02	5%	5%	6%
02	3.29	0.11	0.39	1.26	7.98	0.04	5.63	1.15	15%	17%	14%
03	3.37	0.09	0.63	1.17	6.36	0.05	3.59	0.85	15%	13%	12%
04	2.87	0.06	1.84	0.77	5.52	0.08	2.83	1.57	6%	10%	9%
05	3.96	-	3.39	1.11	2.69	1.10	2.84	3.54	3%	10%	7%
06	3.57	0.00	1.11	1.15	1.33	0.48	6.39	1.35	8%	11%	8%
07	1.65	0.02	0.23	1.51	0.67	0.06	2.47	0.30	17%	5%	11%
08	1.86	0.02	0.60	1.61	1.19	0.64	1.94	0.38	14%	5%	8%
09	2.52	0.03	0.90	1.33	1.38	0.11	4.98	0.89	10%	9%	11%
10	2.76	0.01	1.82	1.15	1.25	0.09	4.40	2.06	4%	8%	8%
11	4.31	-	1.93	0.73	2.07	0.10	1.23	2.78	2%	5%	4%
12	7.10	-	1.53	0.75	2.07	0.08	-	1.56	1%	1%	2%
Mean	2.98	0.06	0.72	1.18	5.01	0.06	4.26	1.00	100%	100%	100%

Table 3-23. Kilograms of Pacific halibut mortality per ton of groundfish catch by the three sectors and year (summed by months) with darker column shading indicating higher values; the last three columns are monthly percentages for GF1 (all groundfish), HM (Pacific halibut mortality), and GF2 (all groundfish *except* for pollock).

	A80		HALCP		TLAS	
	Jan-May	Jun-Dec	Jan-May	Jun-Dec	Jan-May	Jun-Dec
2010	6.59	6.78	4.34	6.42	5.13	0.25
2011	4.44	6.56	2.39	5.46	4.12	4.49
2012	3.87	7.75	2.21	5.33	6.39	6.52
2013	5.27	7.40	2.50	4.53	5.05	4.77
2014	6.54	6.47	2.61	3.30	6.05	2.91
2015	5.87	3.28	1.76	2.26	5.38	6.34
2016	4.95	2.92	1.33	1.37	5.93	9.25
2017	2.56	2.67	1.19	1.19	3.53	1.71
2018	2.89	2.62	0.97	0.96	3.86	2.80

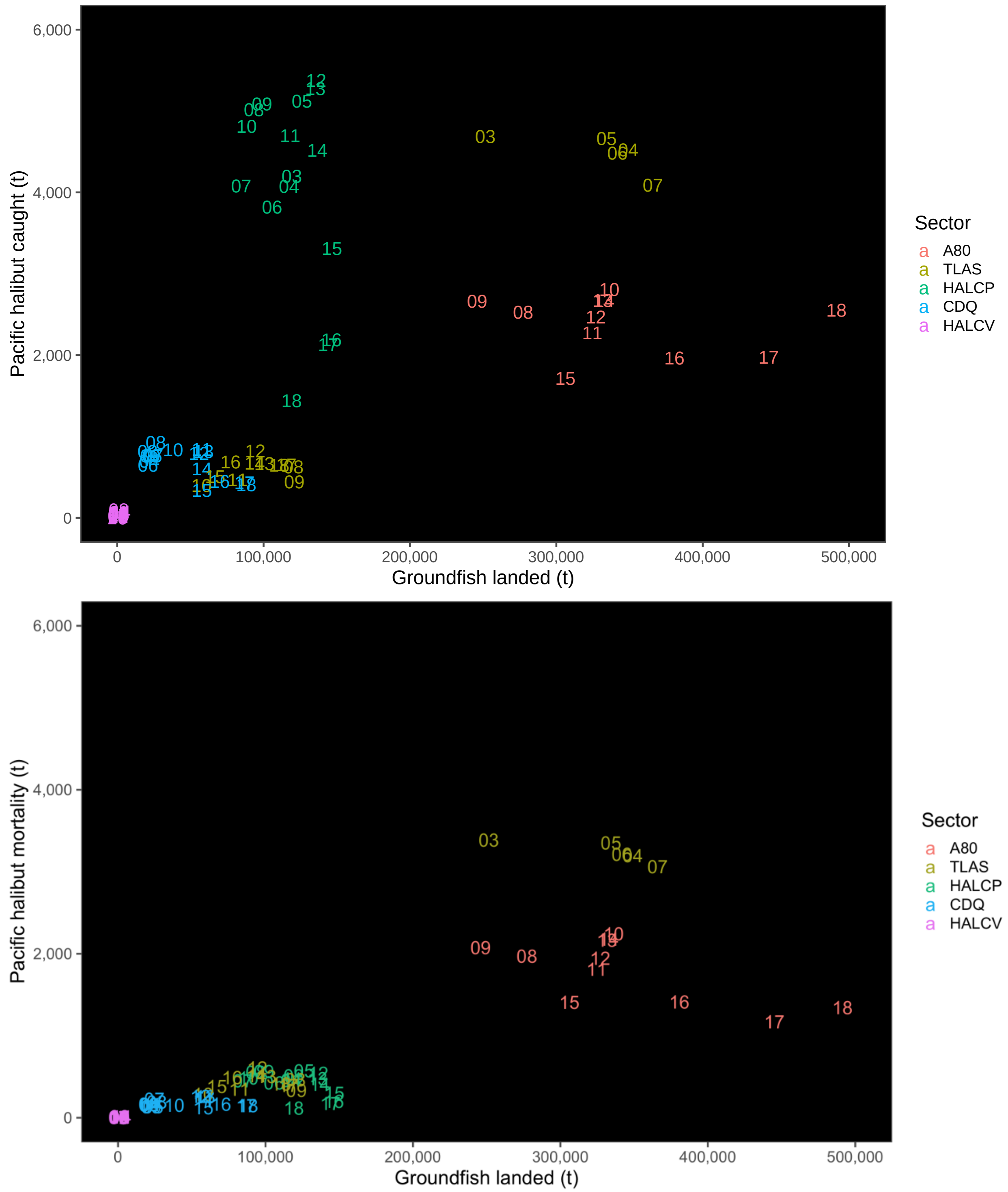


Figure 3-47. Bycatch of Pacific halibut (t) versus groundfish catch (horizontal axis) by sector (colors) and year (labels) for catch (top) and mortality (bottom). Note that data are from 2003-2018 (hence A80 pooled with TLAS prior to 2008).

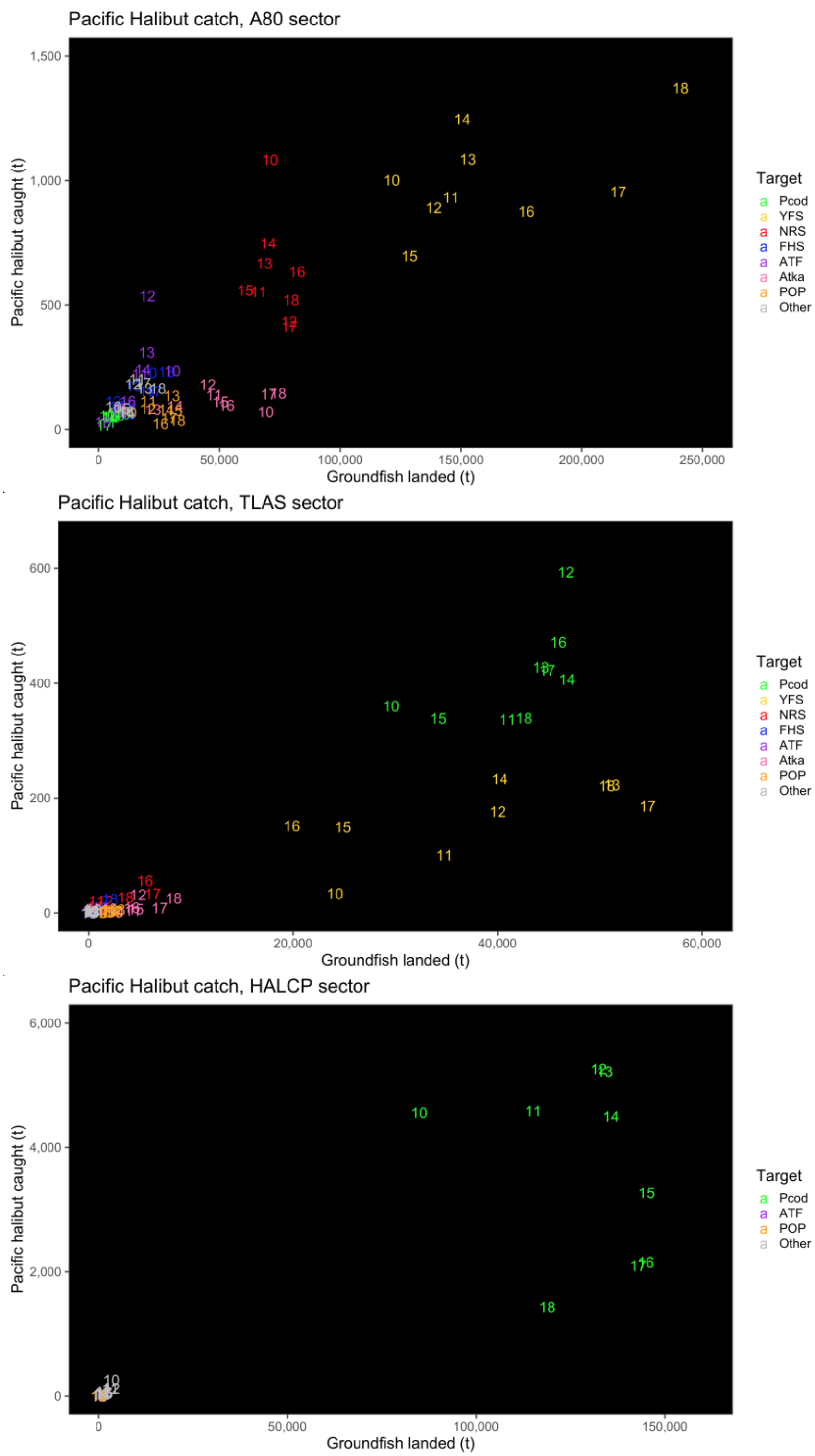


Figure 3-48. Bycatch of Pacific halibut (t) versus groundfish catch (horizontal axis) by target fisheries for A80 sector (top), TLAS, (middle) and HALCP (bottom). Note that vertical and horizontal scales change in the different panels.

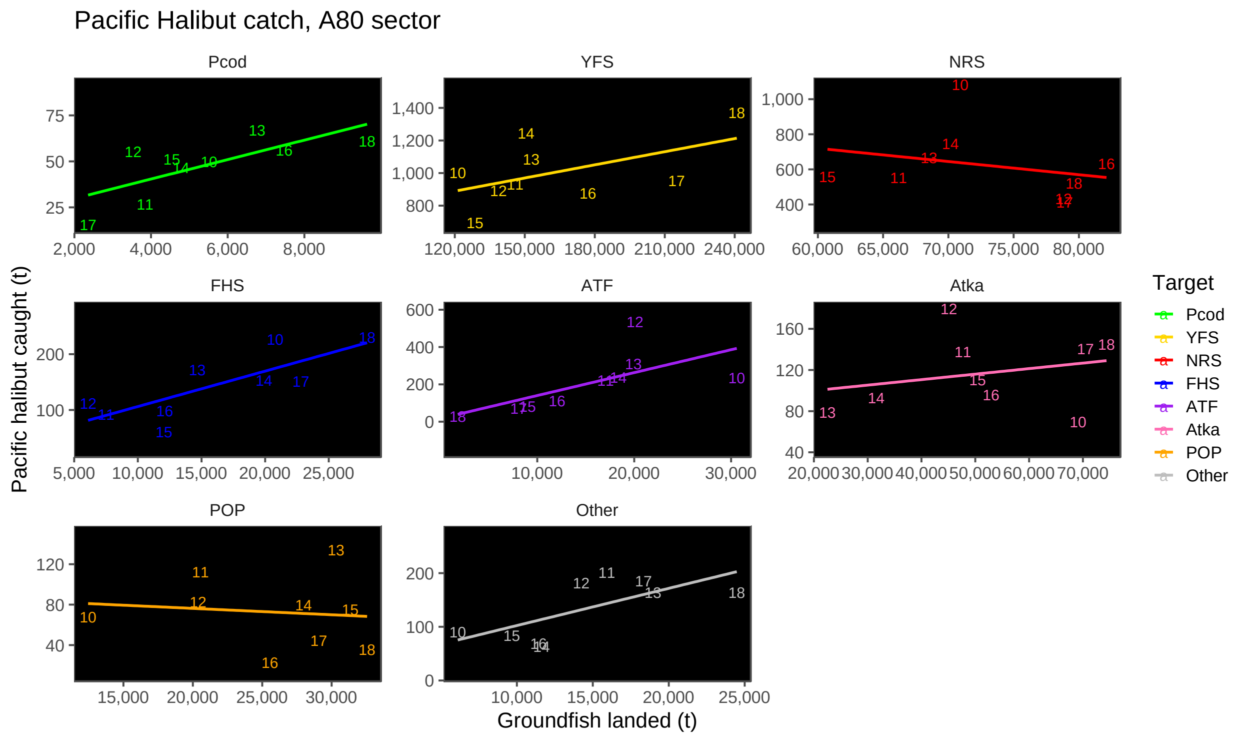


Figure 3-49. Bycatch of Pacific halibut (t) versus groundfish catch (horizontal axis) by target fisheries for A80 sector. Note that vertical and horizontal scales change in the different panels.

As an additional step in evaluating encounter rates, historical survey estimates of Pacific halibut biomass was related to groundfish abundance (specifically, YFS and NRS) and compared with the ratio of the two species occurring in the bycatch. While the fisheries operate at different times of year, including during the survey period (June-August), the relationship for YFS was modestly positive but for NRS, it was negative (Figure 3-50). This relative magnitude of the ratios was also much lower in the fishery than what is observed in the survey. This indicates that the fishery actively conducts operations to avoid halibut more than expected based on what can be considered their “natural” abundance based on survey data.

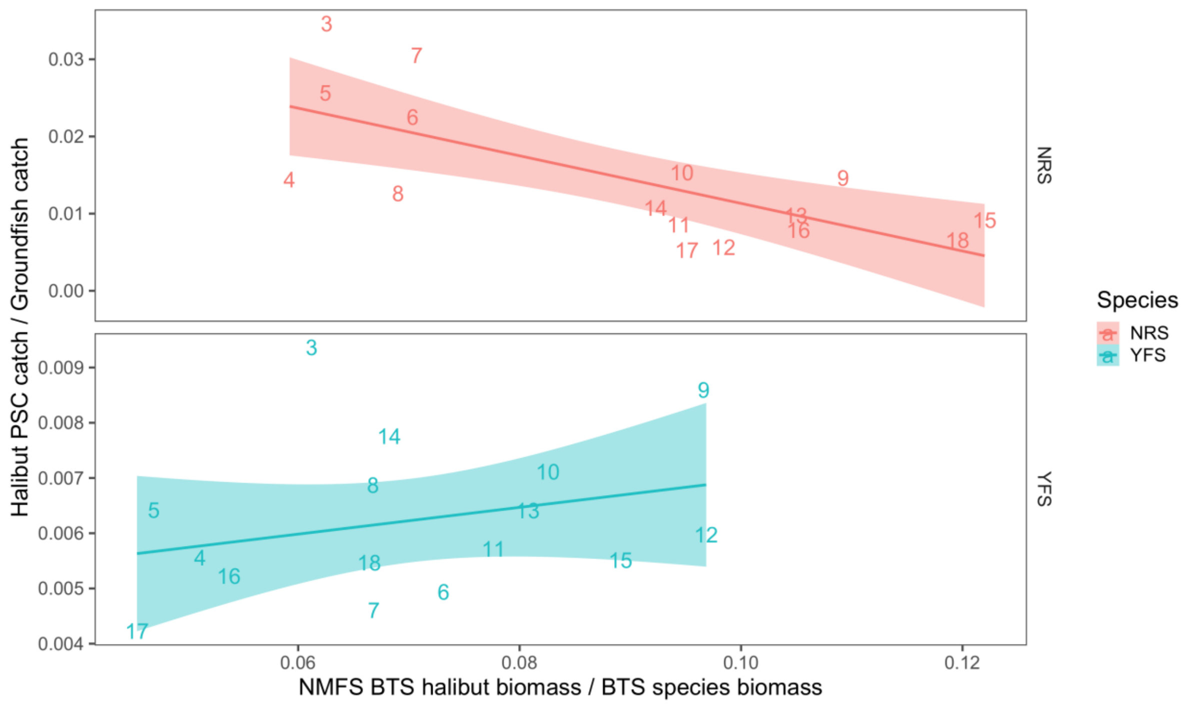


Figure 3-50. Trawl fishery bycatch (TLAS + A80 sectors) of Pacific halibut (t) divided groundfish catch (vertical axis) by target fishery (colors) compared to the biomass ratio of Pacific halibut over the species biomass estimate (horizontal axis) for years 2003-2018 (labels).

3.4.5 Size composition of bycatch

NMFS Observer data provide estimates of the length frequency of the bycatch in addition to estimates of total bycatch. By region, the number of Pacific halibut measured in the groundfish fisheries has varied but averaged 91,045 fish per year for the period 1991-2018 with the BSAI region making up an average 75,311 of that total. Conversely, the average Pacific halibut bycatch mortality for this period was 6,039 t with 60% occurring in the BSAI (compared to 83% of the lengths being measured from the BSAI). Over time, the mean length of Pacific halibut bycatch in the groundfish fisheries is highest for longline gear, followed by pelagic and bottom trawl with a modest increase in fish size observed in the bottom trawl fisheries (Figure 3-51). The relative frequency by gear type shows that most of the bycatch and trawl survey data are variable over time and mainly below the legal size (~80cm; Figure 3-52). A closer examination of longline gear shows that the IPHC setline survey length frequency is between the sizes taken as bycatch in the HAL fisheries and the directed Pacific halibut fishery (Figure 3-53).

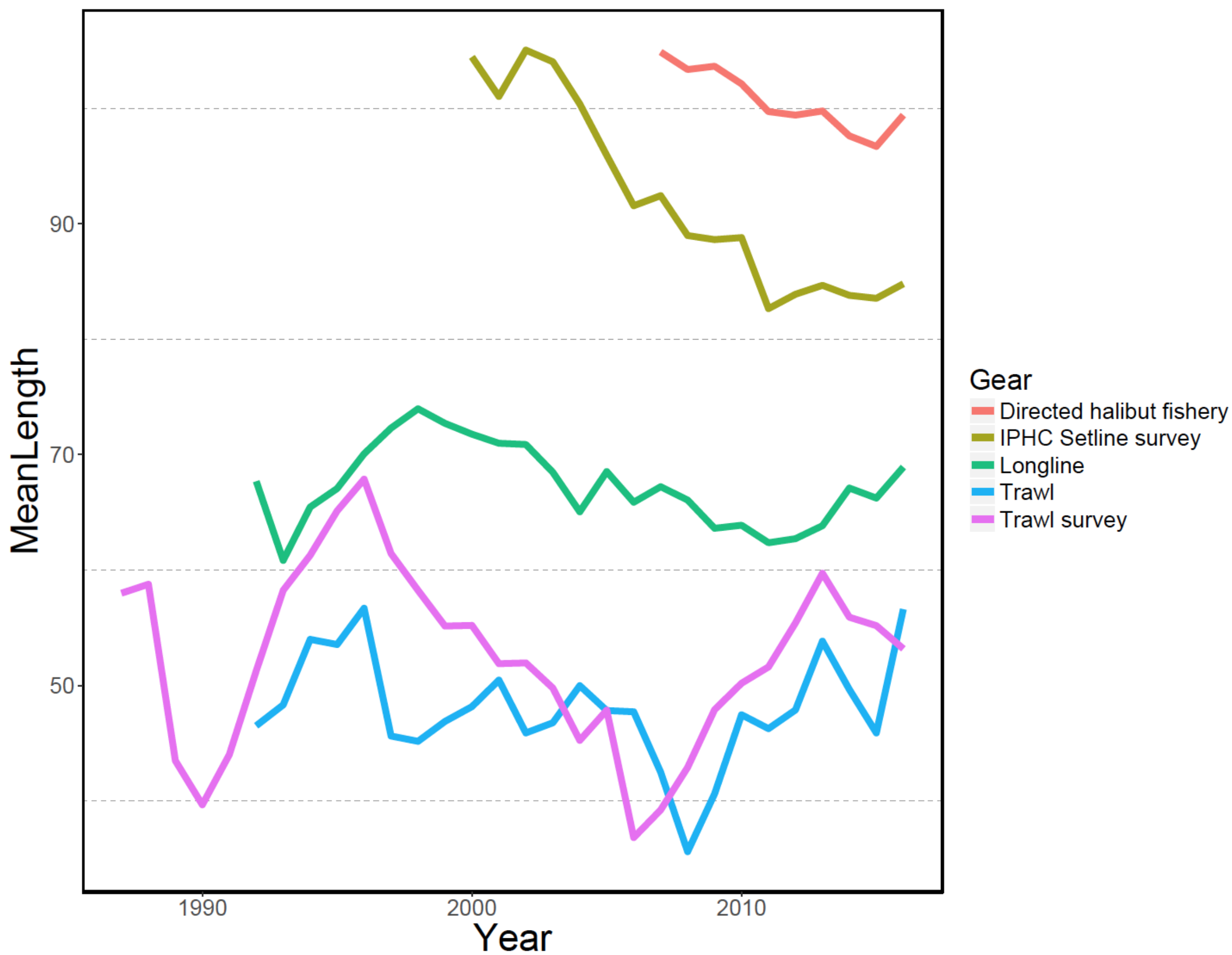


Figure 3-51. Pacific halibut mean length (cm) over time by data source for the EBS region..

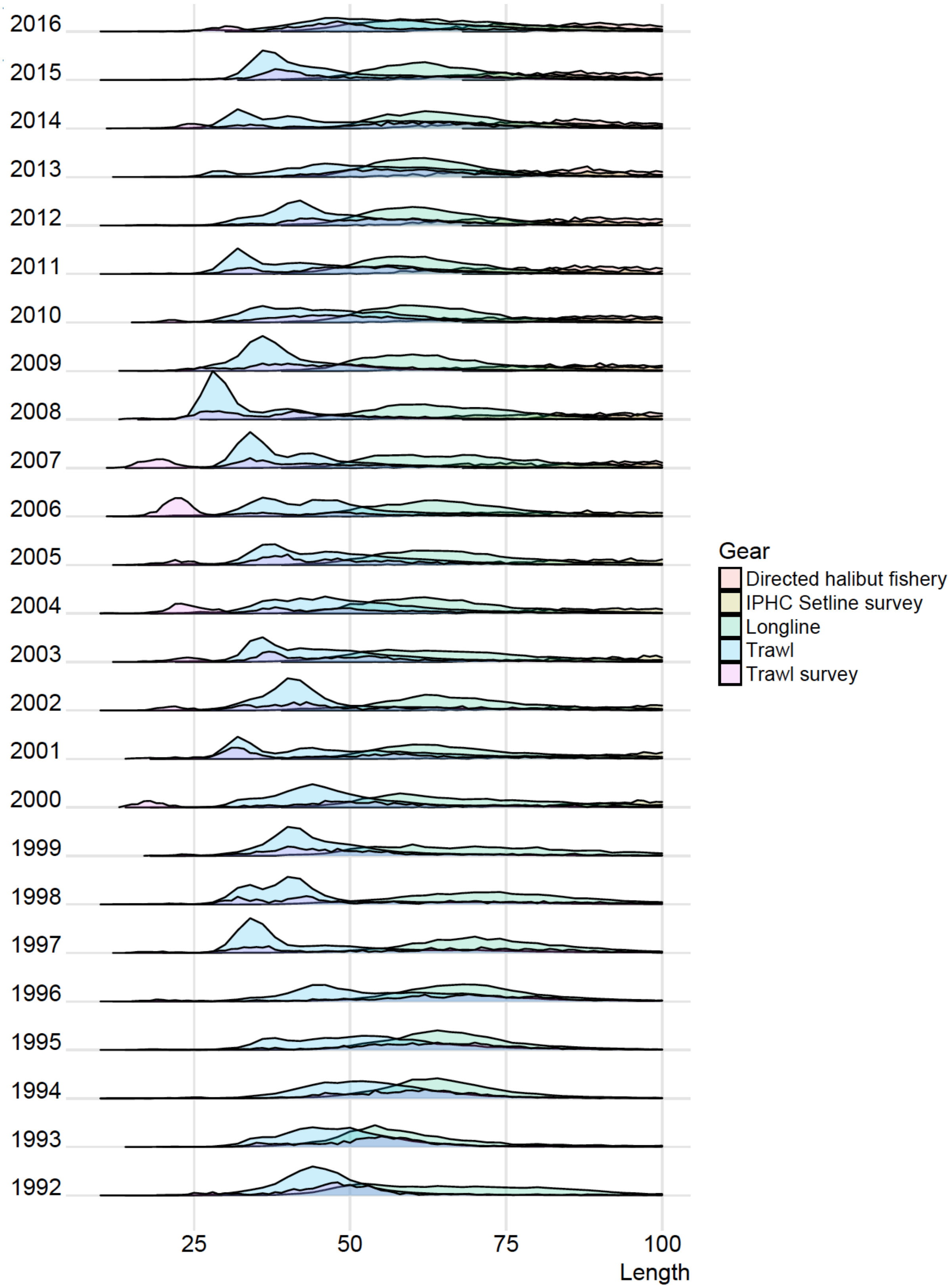


Figure 3-52. Pacific halibut length frequency (cm) by gear type / fishery over time.

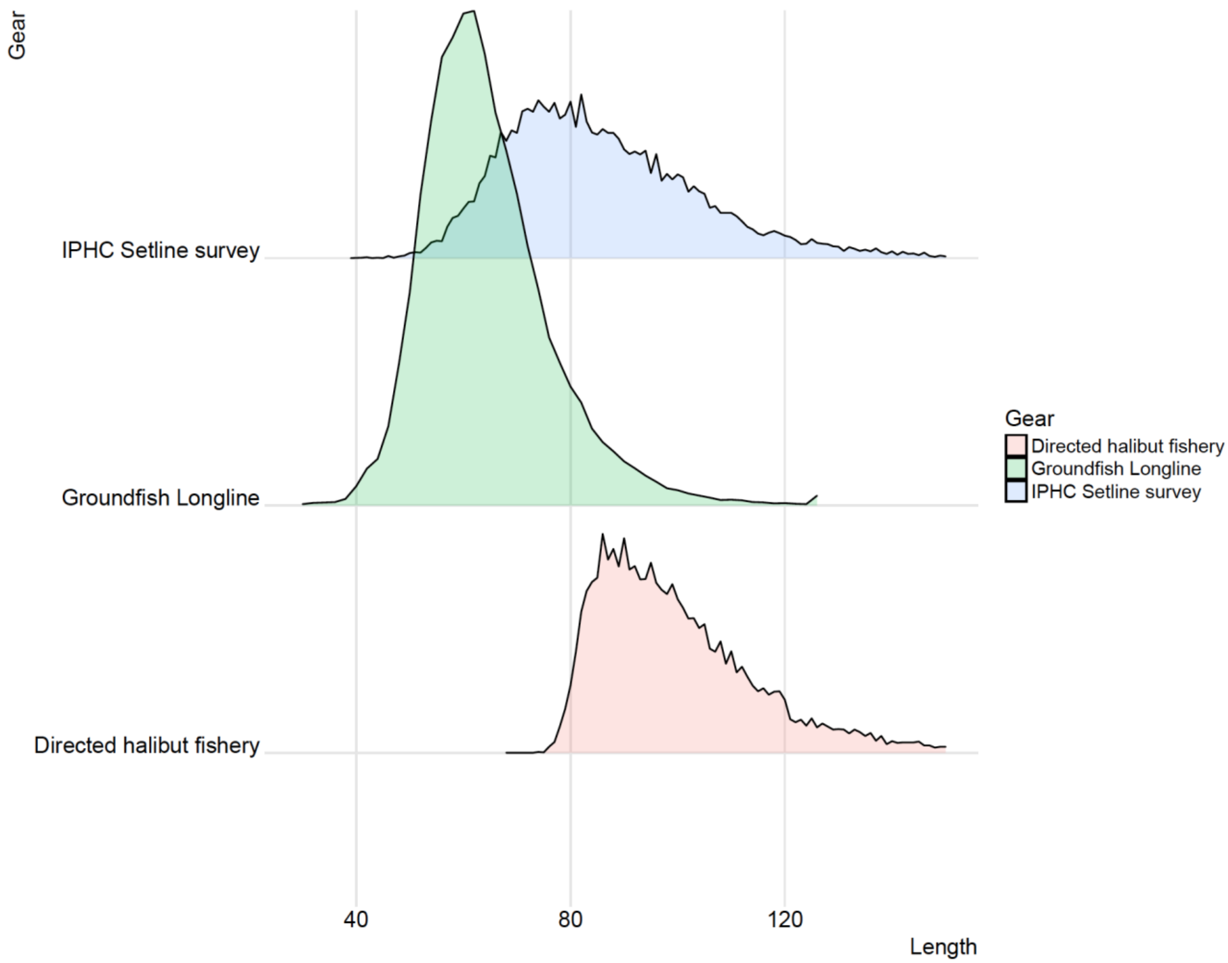


Figure 3-53. Pacific halibut length frequency by longline gear type / fishery.

3.4.6 Spatial/temporal analysis

To begin examining to evaluate spatial aspects by sector and target fishery we examined patterns over all years aggregated. This provides a general overview of where the Pacific halibut bycatch occurs (Figure 3-54 through Figure 3-56).

By year, some changes in Pacific halibut bycatch distribution can be discerned between target fishery specified for each sector (Figure 3-57 - Figure 3-61). Focusing on specific directed fisheries, a distinct pattern of change in the spatial distribution of Pacific halibut bycatch is clear. Specifically, for NRS fisheries the bycatch was highest in the southeastern part of the Bering sea close to Unimak Island until about 2015 when it appeared to be more northerly and diffuse in 2016-2018 (Figure 3-62 for A80 sector). Fot the other sectors targeting NRS, the pattern was similar but less pronounced (Figure 3-63 and Figure 3-64). Presumably these changes reflect different fishing concentrations for trips deemed as NRS (in all cases for groundfish trawling, fishing trips “target” multiple species). For the yellowfin sole fishery, the spatial pattern of bycatch was more consistent from year to year for the A80 sector, but still with some clear annual patterns (Figure 3-65) whereas for the TLAS sector was more variable (Figure 3-66) and the CDQ YFS fishery was more similar to the patterns in the A80 fleet (Figure 3-67).

For the Pacific cod target fishery by sector, most of the bycatch occurs in the CDQ fishery for the trawl gear sectors with A80 and TLAS having similar patterns of concentrated bycatch in the southeastern part close to Unimak island (Figure 3-68 - Figure 3-70). The Pacific halibut bycatch in the main hook-and-line sector (HALCP) shows that bycatch is broadly distributed throughout the middle and outer shelf region

(Figure 3-71). This figure also shows that in some years the bycatch occurs in concentrated areas (e.g., 2013) whereas in 2016-2018 the bycatch levels appeared more evenly distributed.

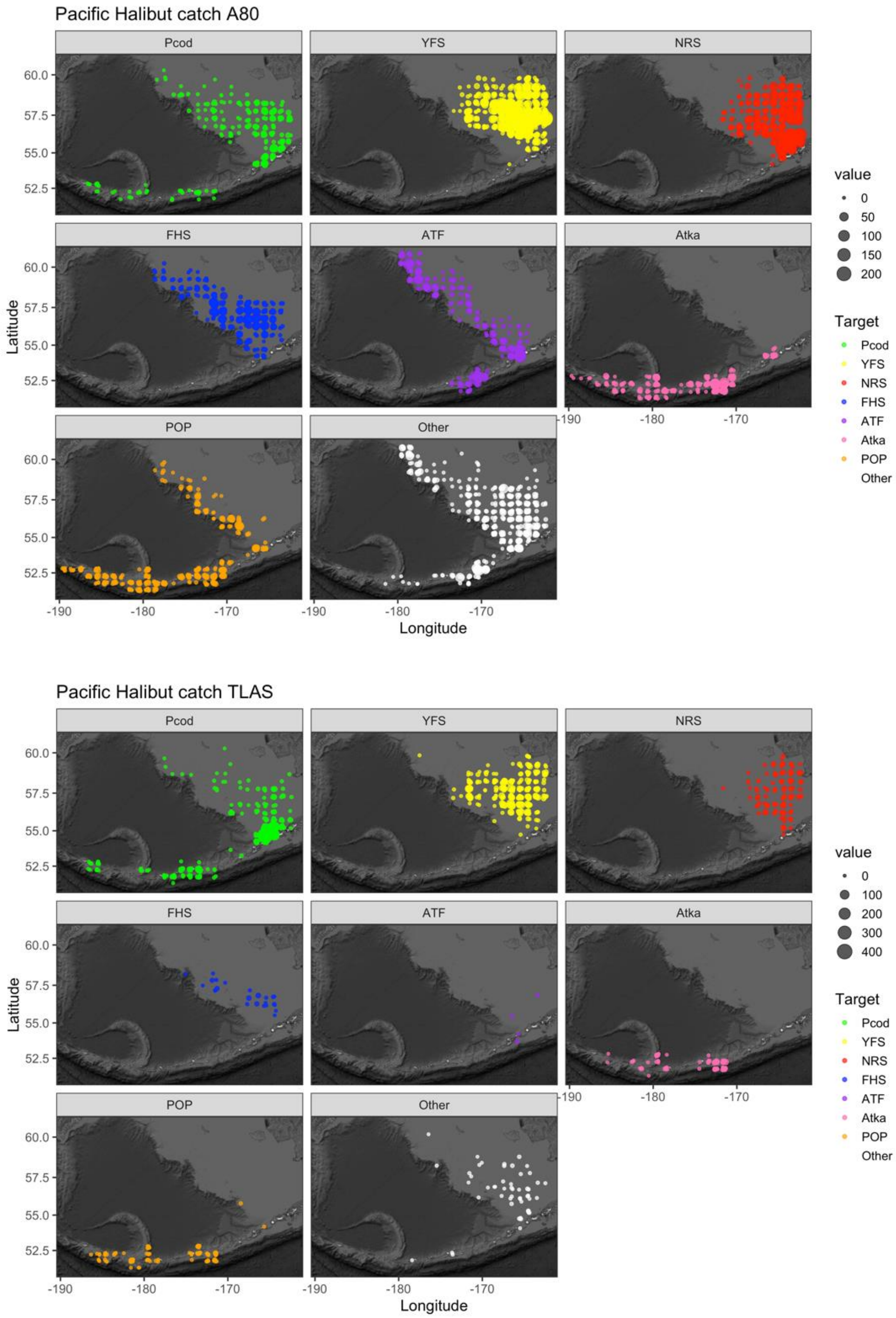


Figure 3-54. Bycatch of Pacific halibut in the A80 (top set) and TLAS (bottom set) sectors by “target”, 2010-2018 combined. The sizes of the circles are categorized proportionally as in legends where “value” is in metric tons.

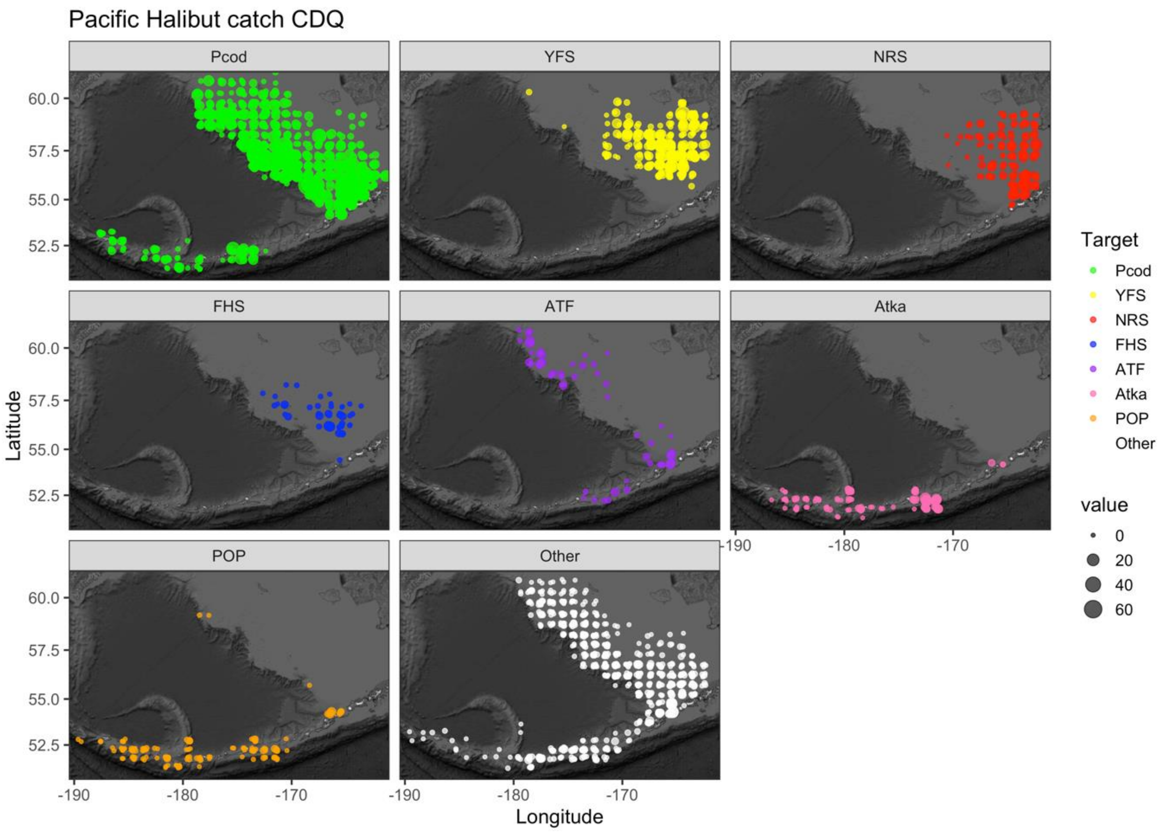


Figure 3-55. Bycatch of Pacific halibut in the CDQ sector by “target”, 2010-2018 combined. The sizes of the circles are categorized proportionally as in legends where “value” is in metric tons.

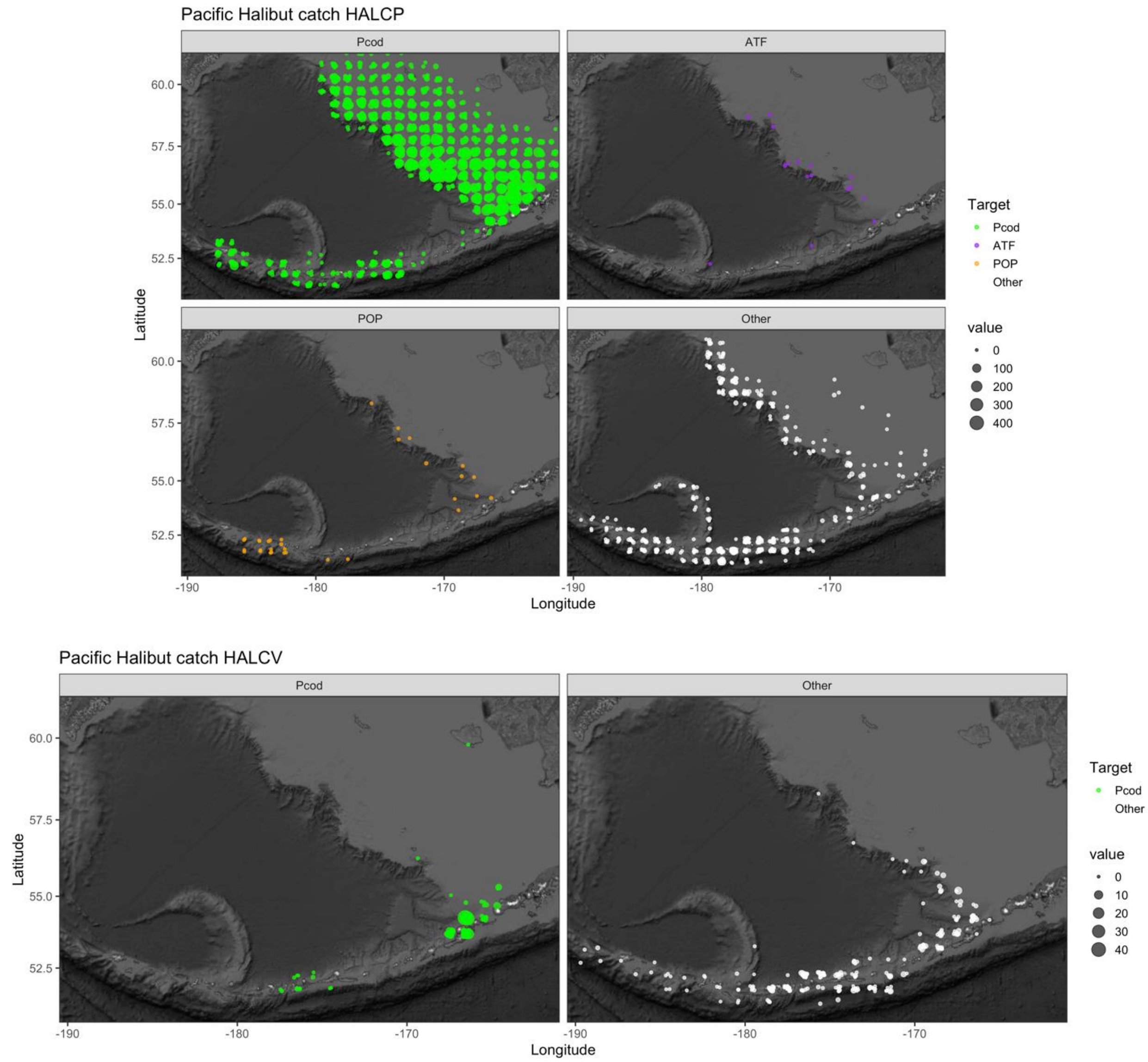


Figure 3-56. Bycatch of Pacific halibut in the HALCP (top set) and HALCV (bottom set) sectors by “target”, 2010-2018 combined. The sizes of the circles are categorized proportionally as in legends where “value” is in metric tons.

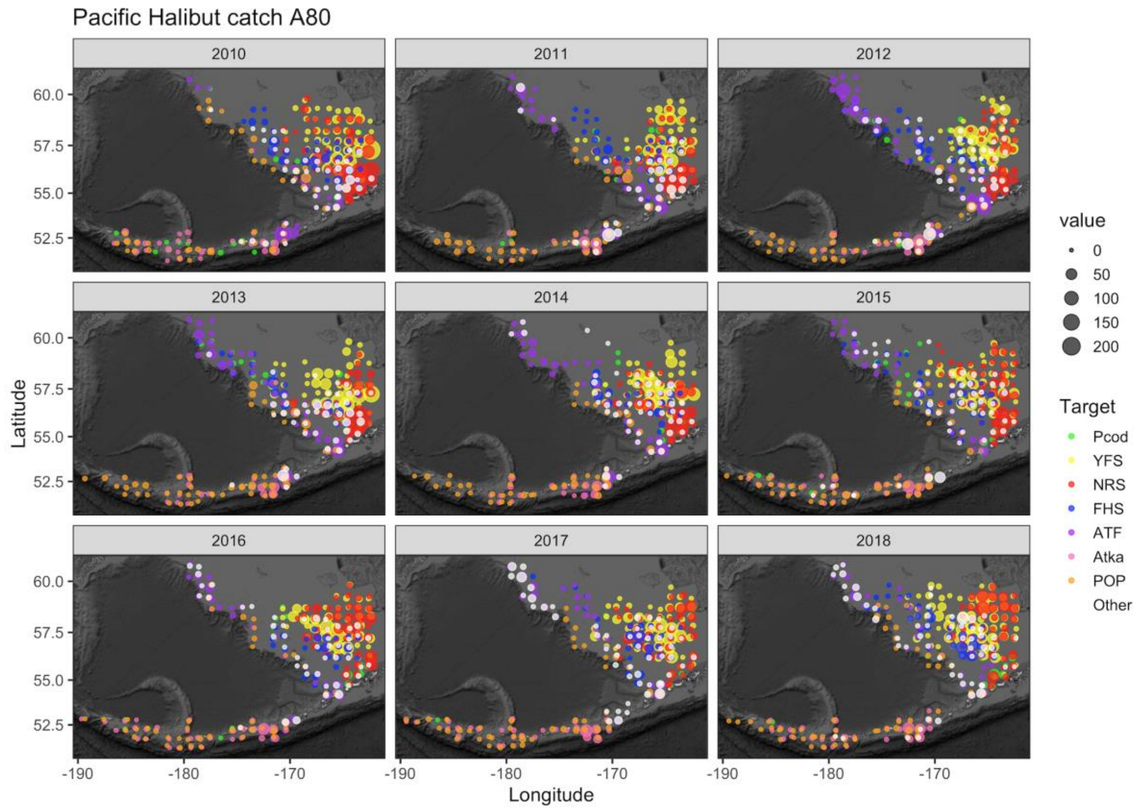


Figure 3-57. Bycatch of Pacific halibut in the A80 sector by "target" (colors), 2010-2018 (panels). Sizes of the circles are categorized proportionally as noted in legend where "value" is in metric tons.

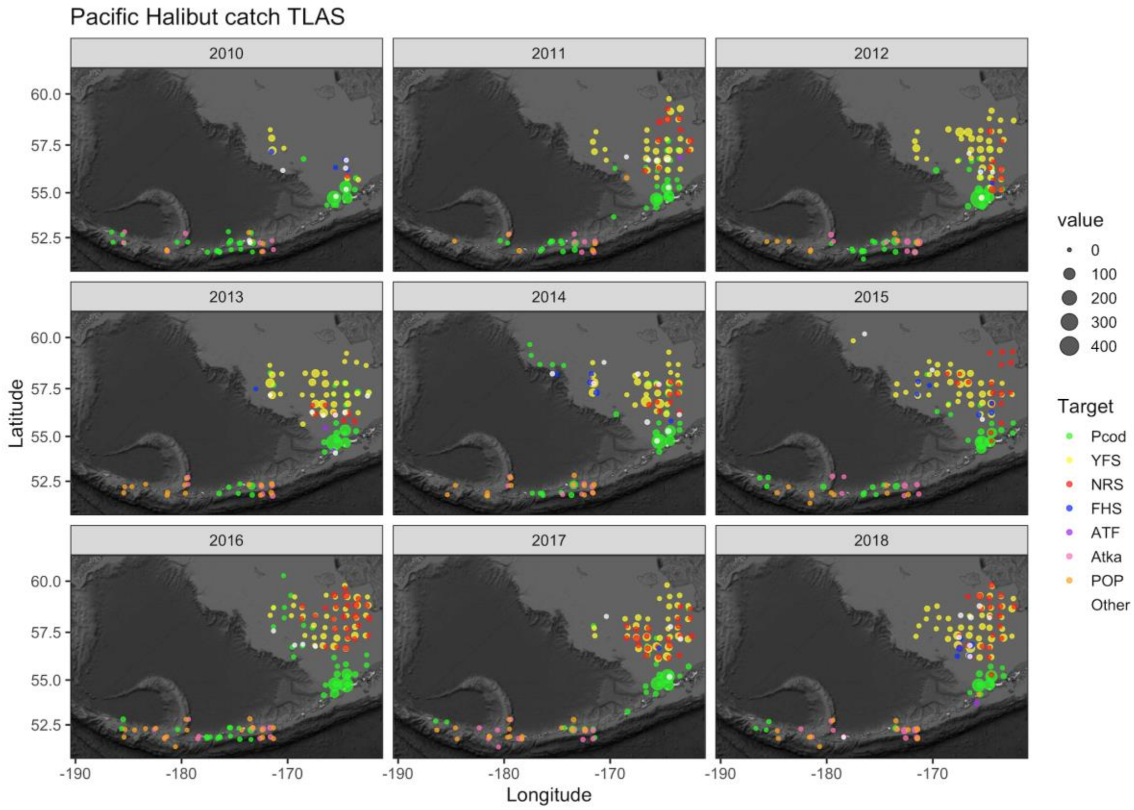


Figure 3-58. Bycatch of Pacific halibut in the TLAS sector by "target" (colors), 2010-2018 (panels). Sizes of the circles are categorized proportionally as noted in legend where "value" is in metric tons.

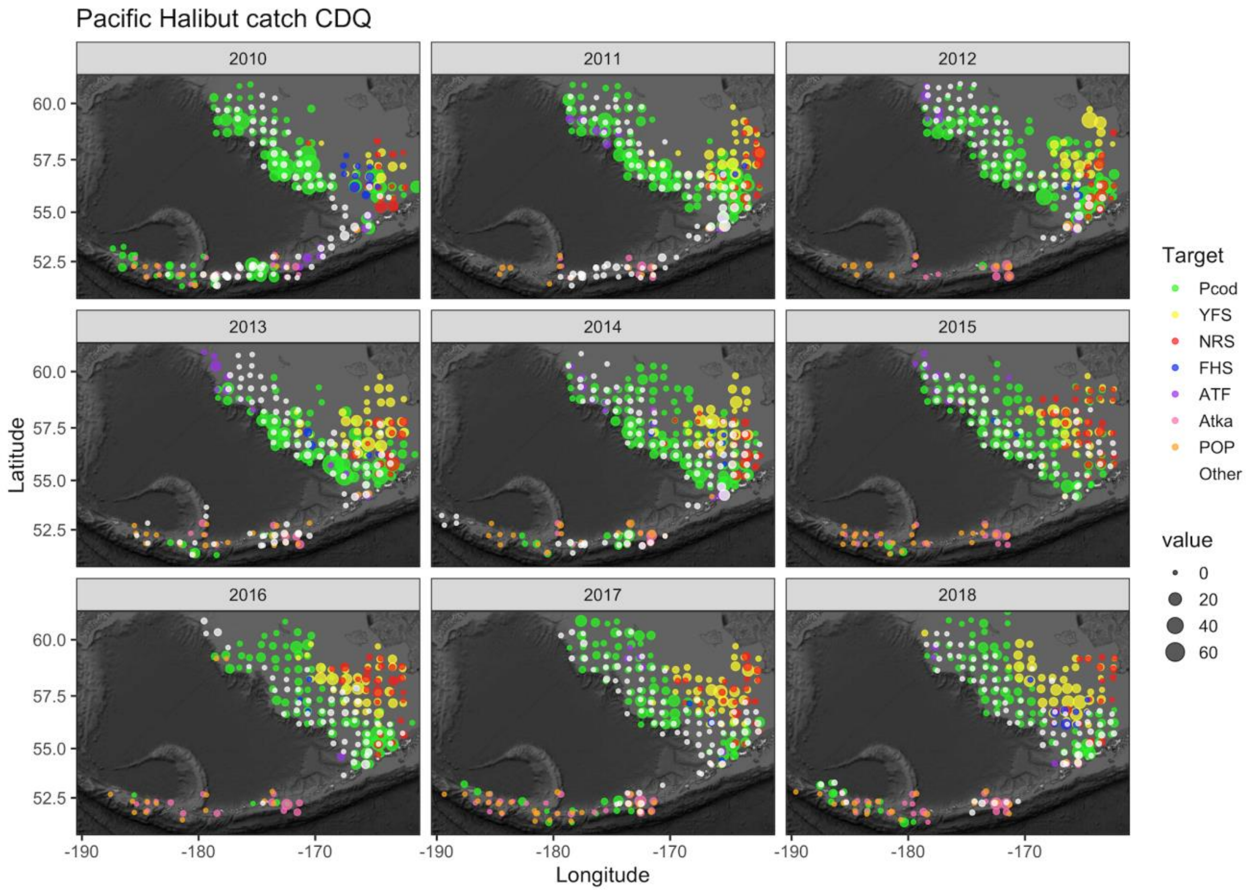


Figure 3-59. Bycatch of Pacific halibut in the CDQ sector by “target” (colors), 2010-2018 (panels). Sizes of the circles are categorized proportionally as noted in legend where “value” is in metric tons.

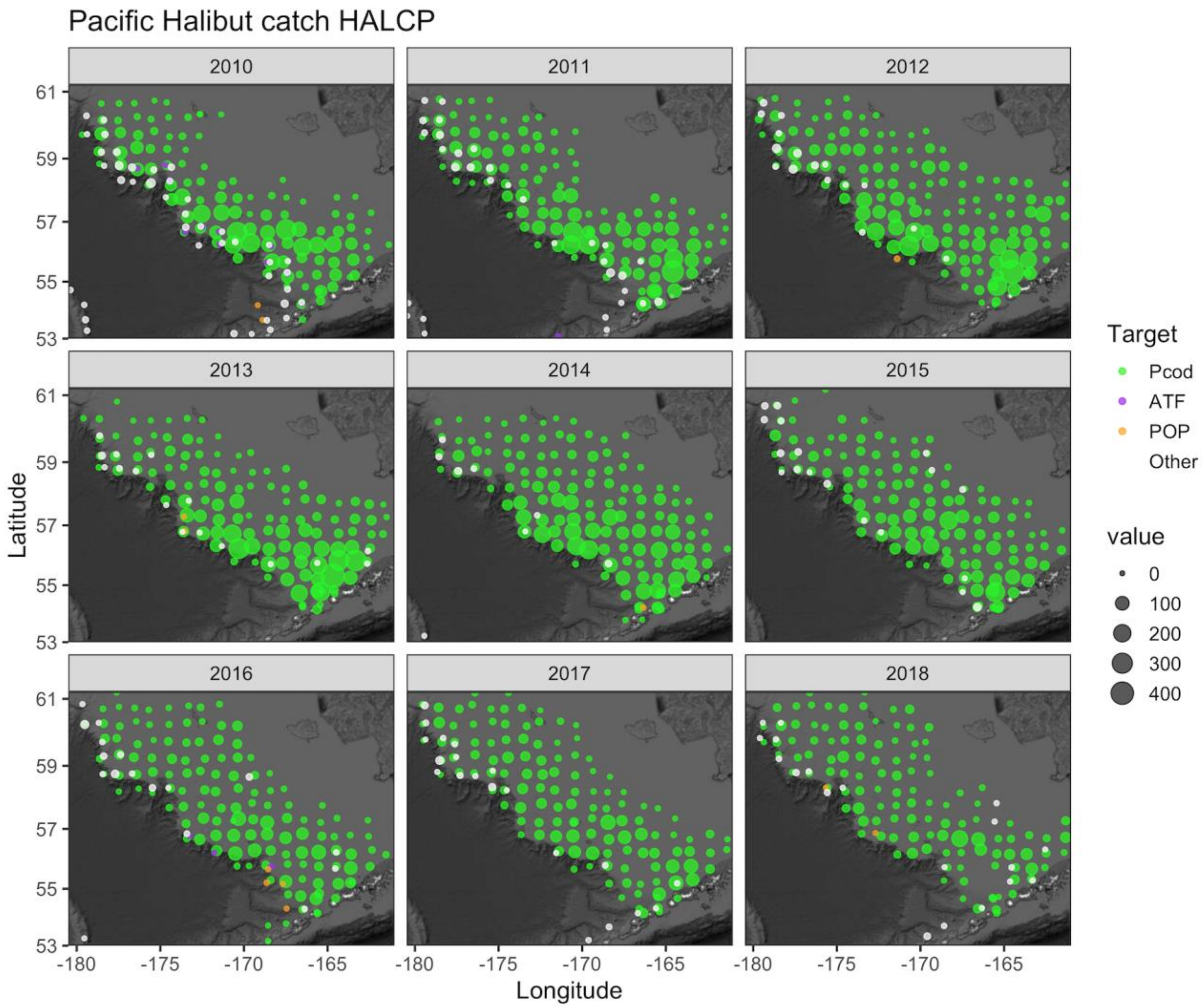


Figure 3-60. Bycatch of Pacific halibut in the HALCP sector by "target" (colors), 2010-2018 (panels). Sizes of the circles are categorized proportionally as noted in legend where "value" is in metric tons.

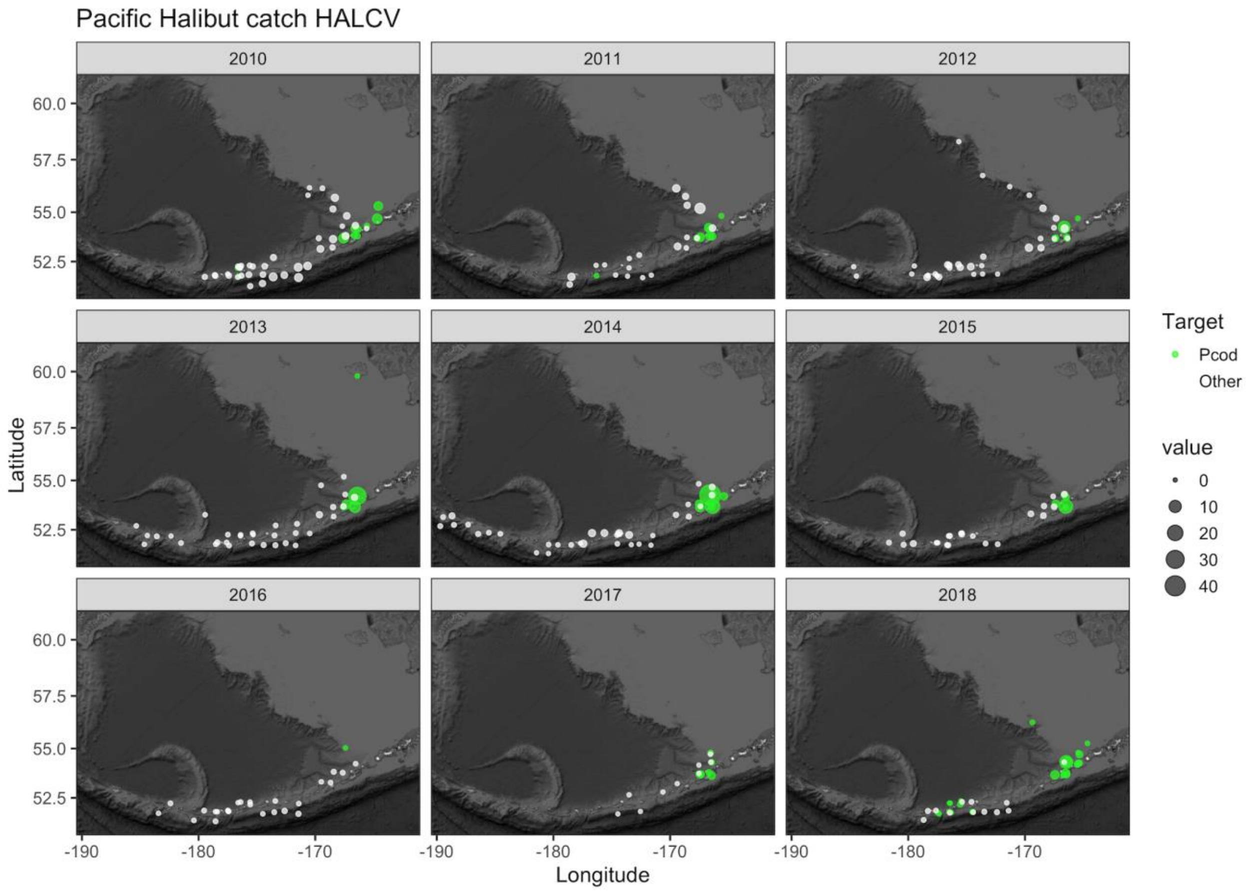


Figure 3-61. Bycatch of Pacific halibut in the HALCV sector by “target” (colors), 2010-2018 (panels). Sizes of the circles are categorized proportionally as noted in legend.

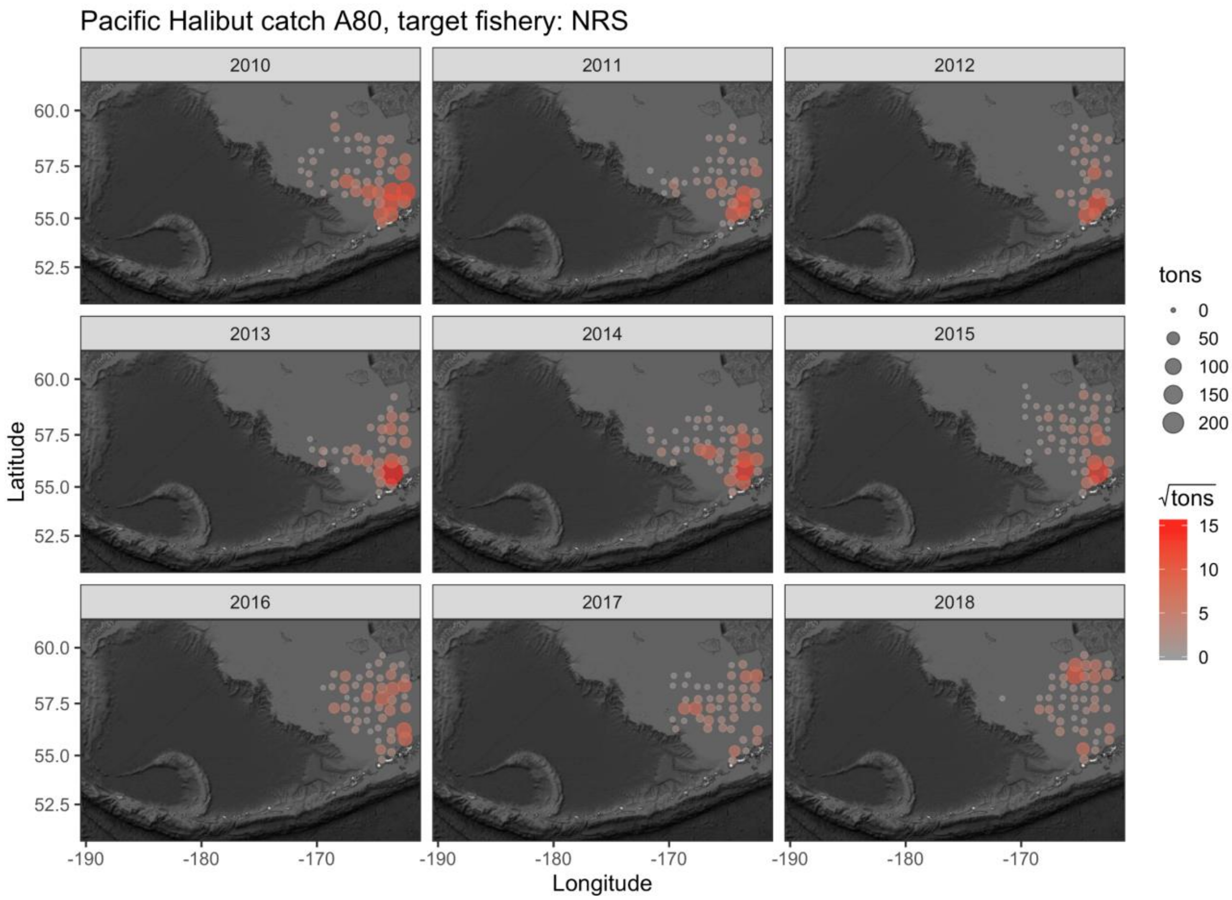


Figure 3-62. Bycatch of Pacific halibut in the A80 sector with "target" equal to northern rock sole (NRS), 2010-2018 (panels). Color gradient is scaled to the square root of tons whereas size of the circles are categorized proportionally as in legend.

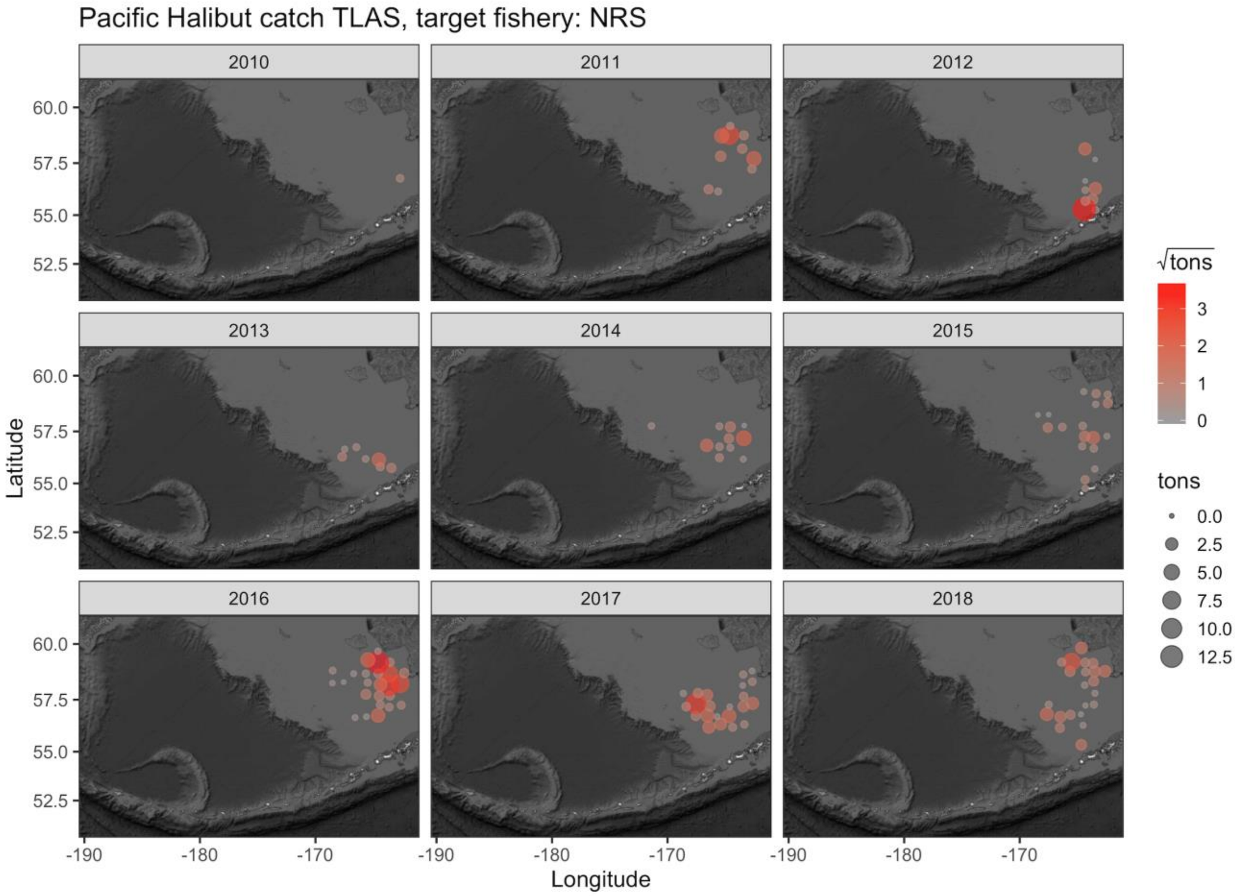


Figure 3-63. Bycatch of Pacific halibut in the TLAS sector with "target" equal to northern rock sole (NRS), 2010-2018 (panels). Color gradient is scaled to the square root of tons whereas size of the circles are categorized proportionally as in legend.

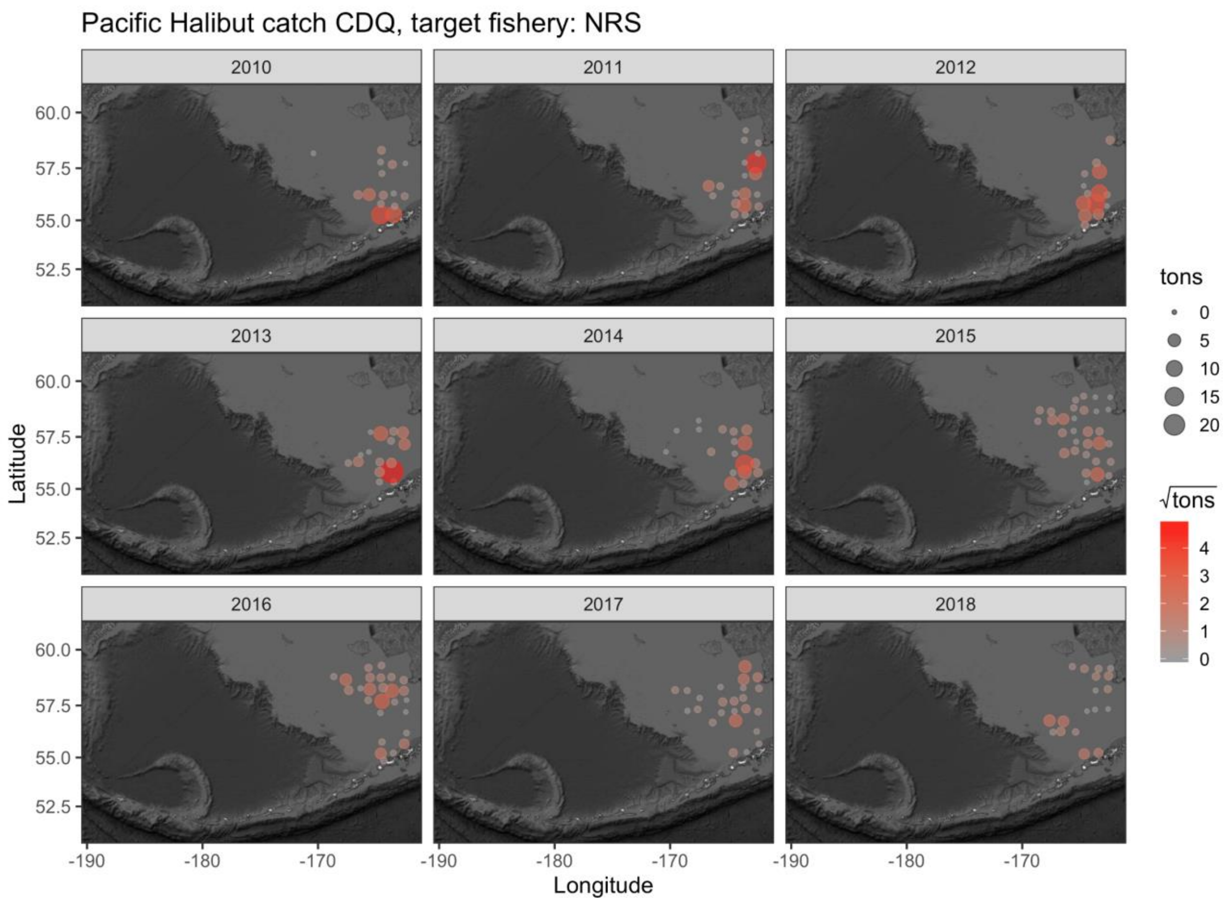


Figure 3-64. Bycatch of Pacific halibut in the CDQ sector with “target” equal to northern rock sole (NRS), 2010-2018 (panels). Color gradient is scaled to the square root of tons whereas size of the circles are categorized proportionally as in legend.

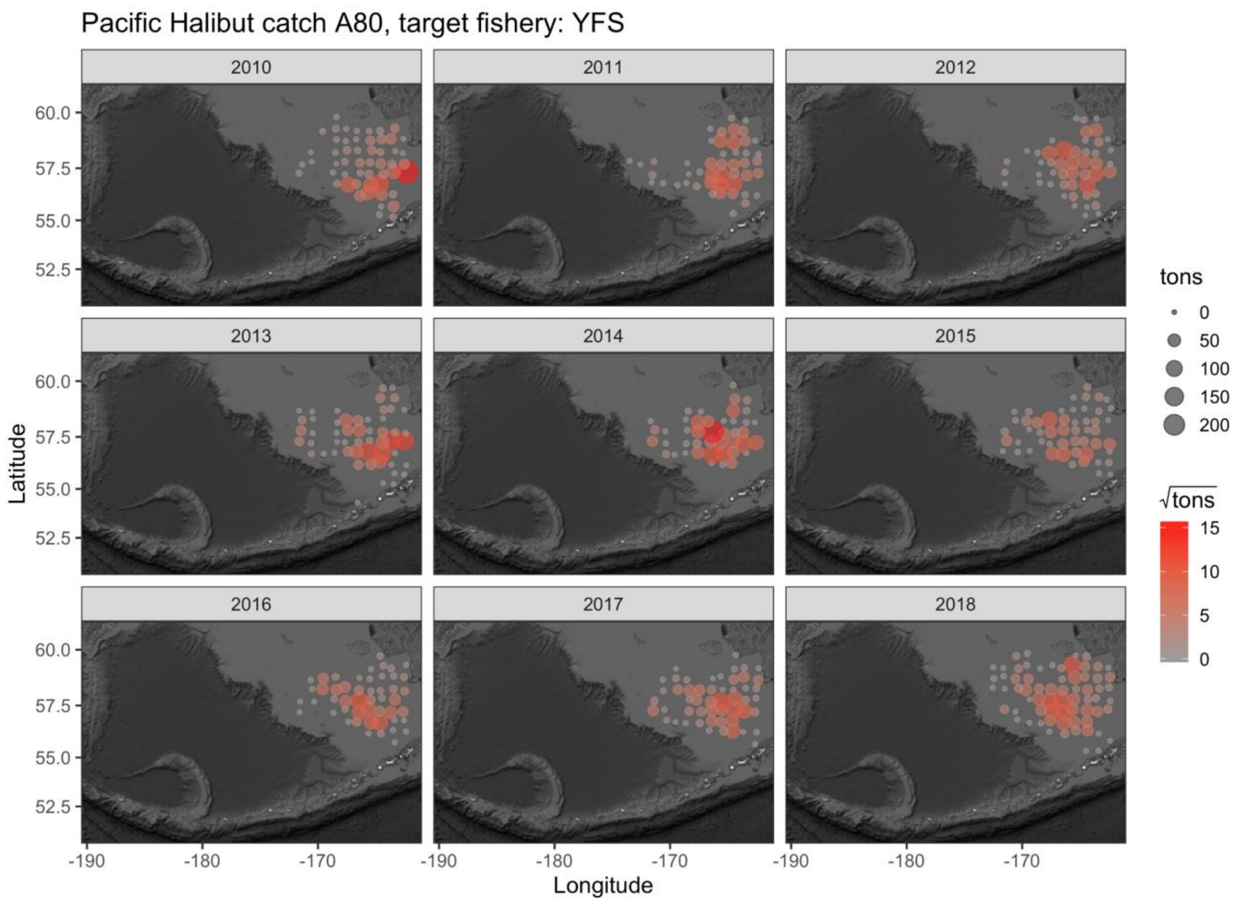


Figure 3-65. Bycatch of Pacific halibut in the TLAS sector with "target" equal to yellowfin sole (YFS), 2010-2018 (panels). Color gradient is scaled to the square root of tons whereas size of the circles are categorized proportionally as in legend.

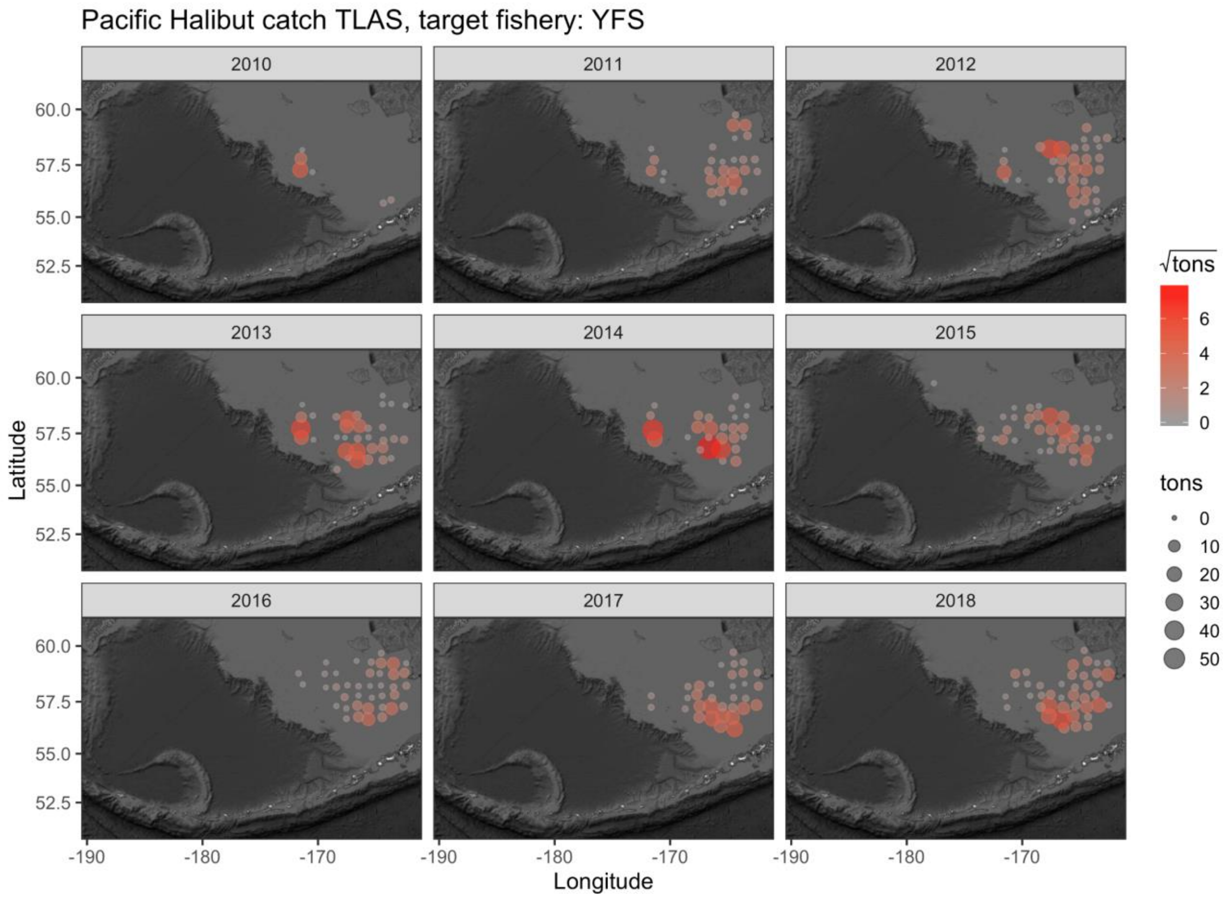


Figure 3-66. Bycatch of Pacific halibut in the TLAS sector with "target" equal to yellowfin sole (YFS), 2010-2018 (panels). Color gradient is scaled to the square root of tons whereas size of the circles are categorized proportionally as in legend.

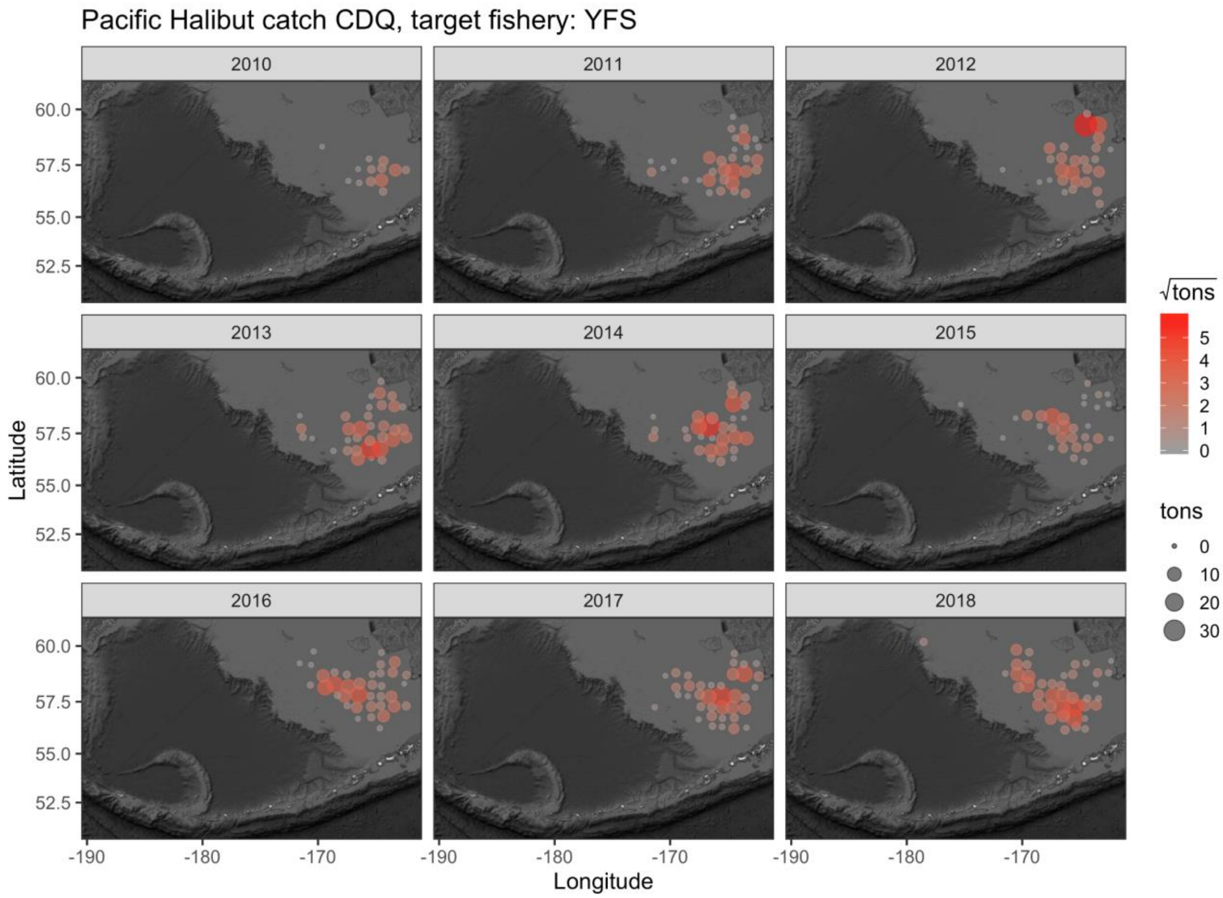


Figure 3-67. Bycatch of Pacific halibut in the CDQ sector with "target" equal to yellowfin sole (YFS), 2010-2018 (panels). Color gradient is scaled to the square root of tons whereas size of the circles are categorized proportionally as in legend.

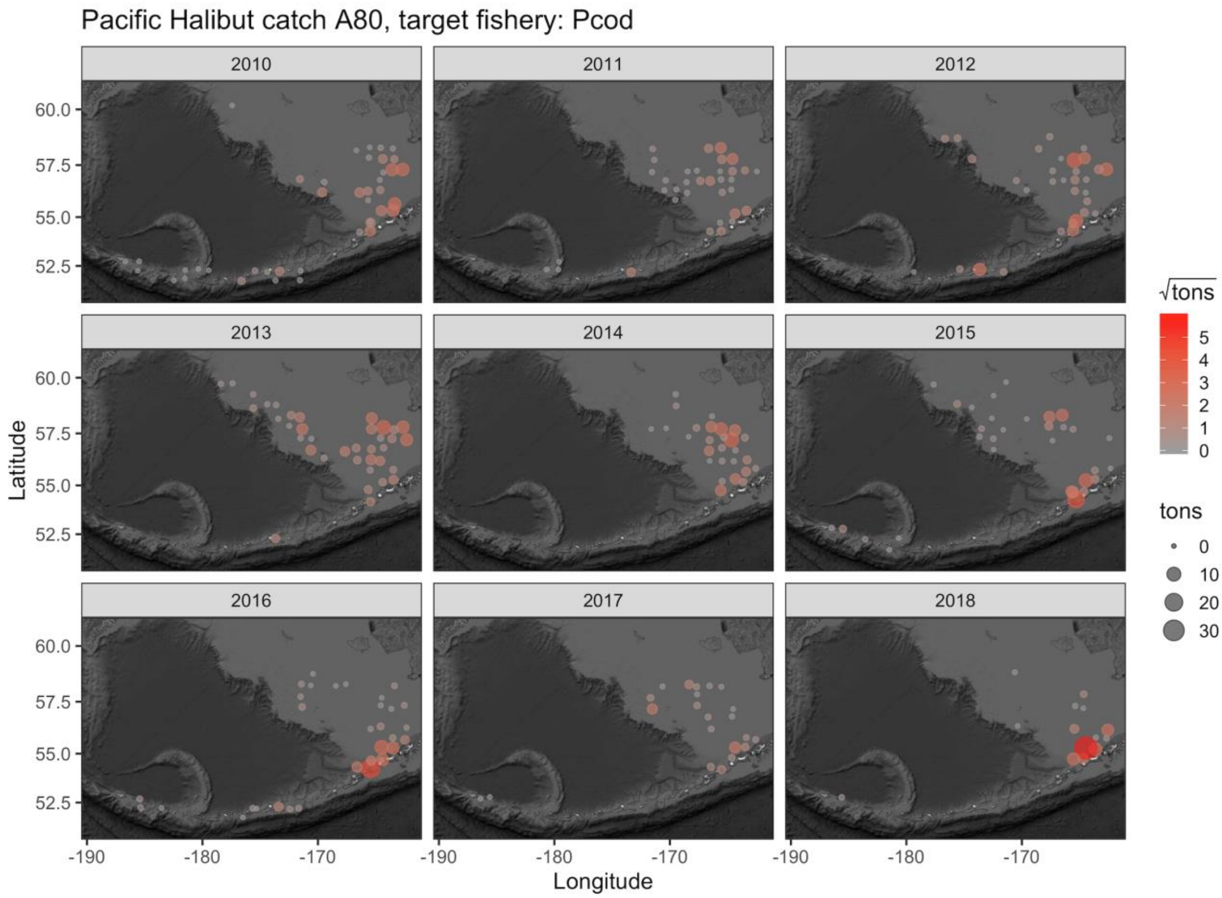


Figure 3-68. Bycatch of Pacific halibut in the A80 sector with “target” equal to Pacific cod, 2010-2018 (panels). Color gradient is scaled to the square root of tons whereas size of the circles are categorized proportionally as in legend.

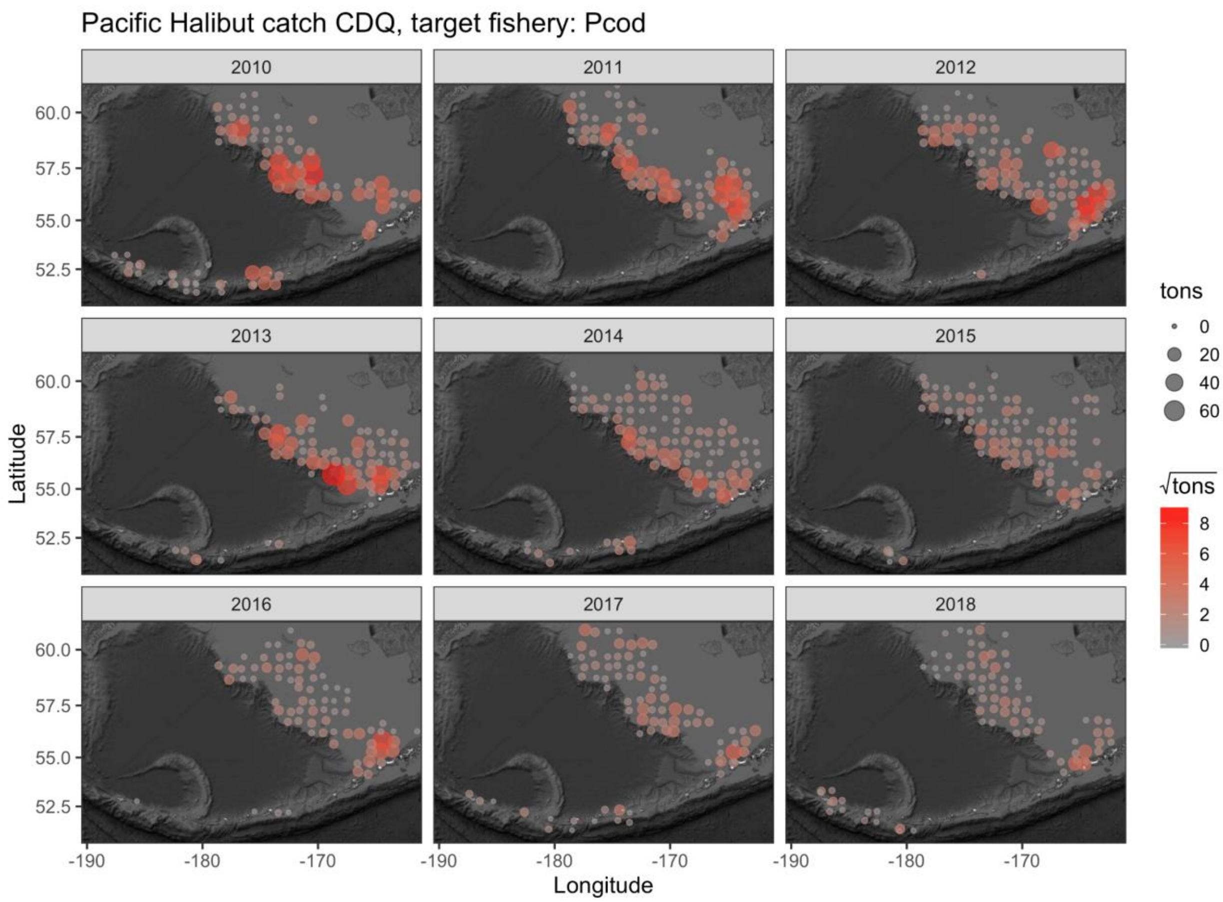


Figure 3-69. Bycatch of Pacific halibut in the CDQ sector with "target" equal to Pacific cod, 2010-2018 (panels). Color gradient is scaled to the square root of tons whereas size of the circles are categorized proportionally as in legend.

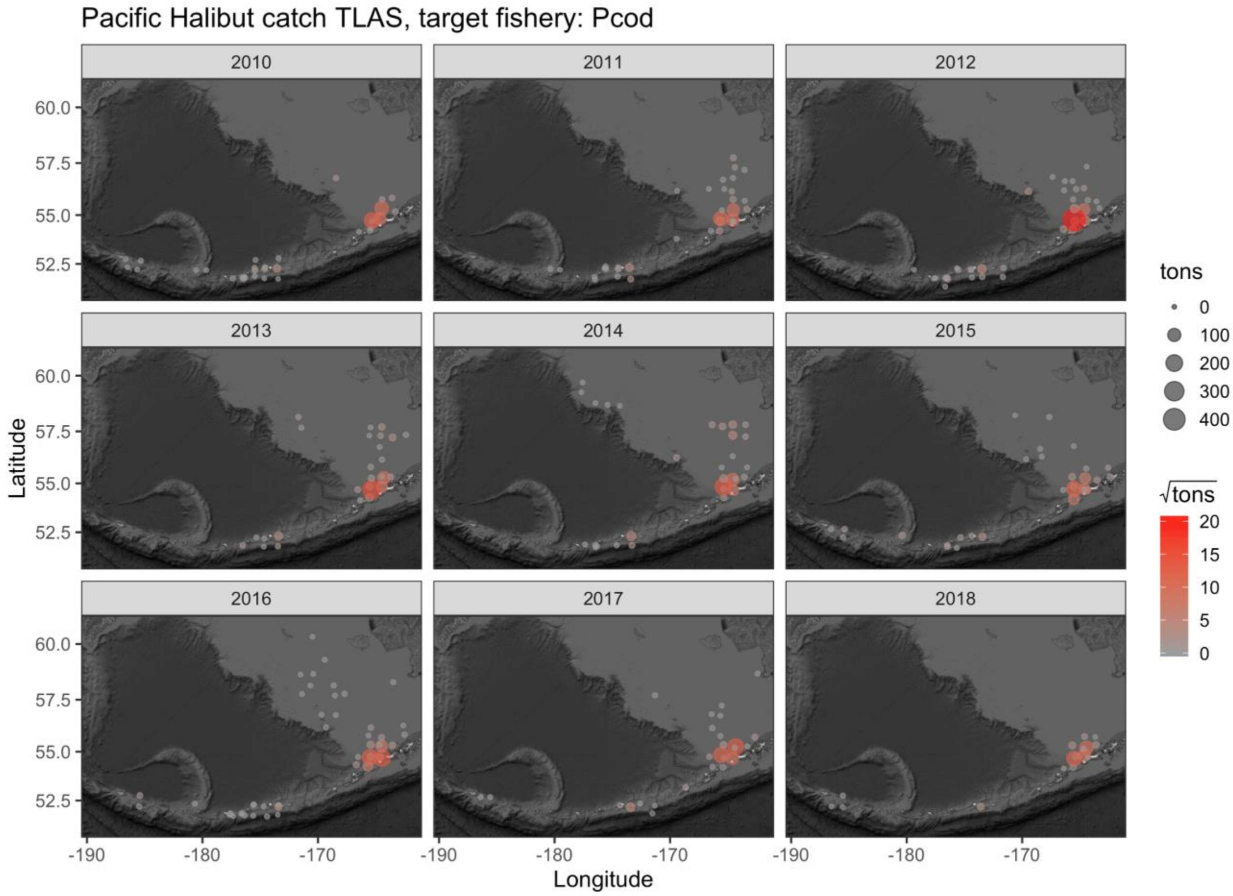


Figure 3-70. Bycatch of Pacific halibut in the TLAS sector with “target” equal to Pacific cod, 2010-2018 (panels). Color gradient is scaled to the square root of tons whereas size of the circles are categorized proportionally as in legend.

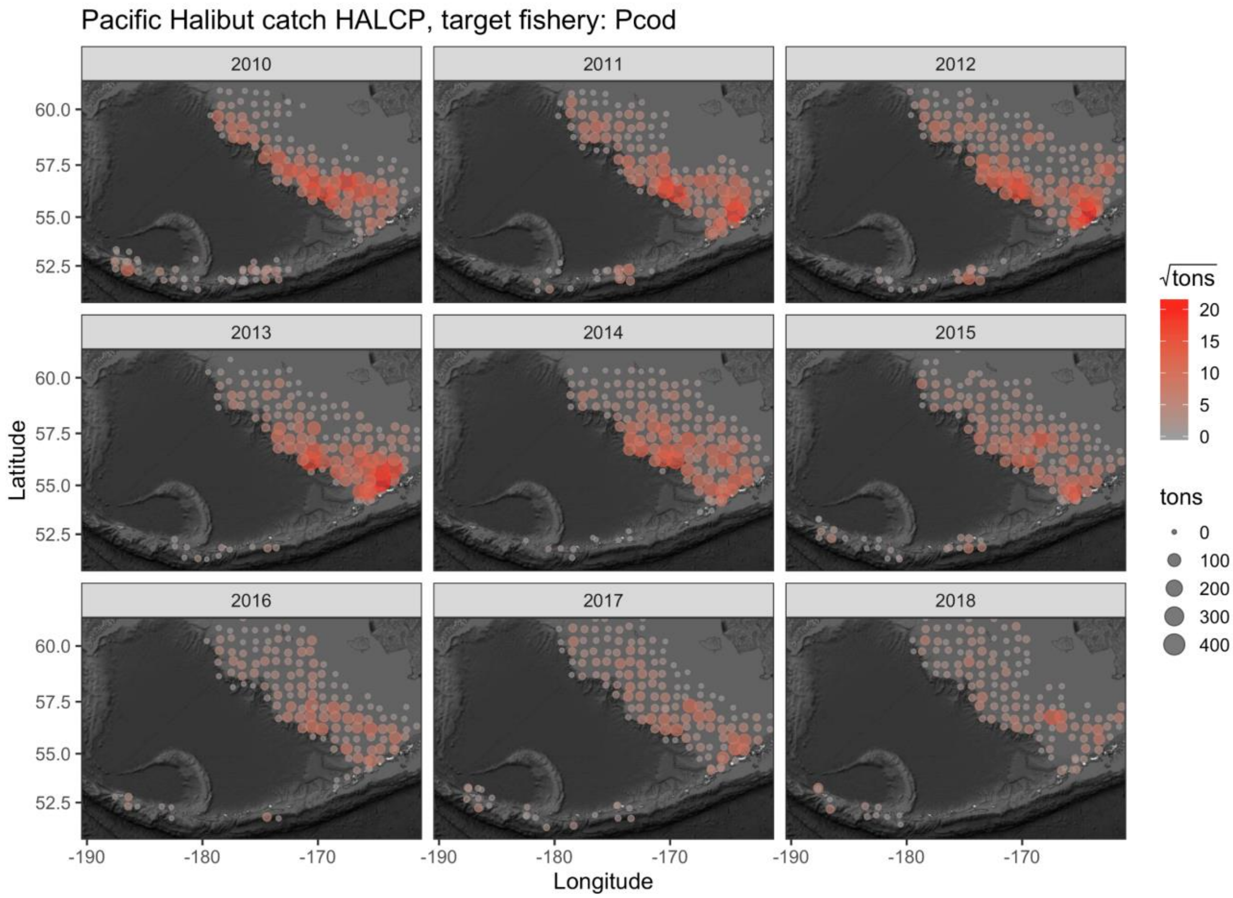


Figure 3-71. Bycatch of Pacific halibut in the HALCP sector with "target" equal to Pacific cod, 2010-2018 (panels). Color gradient is scaled to the square root of tons whereas size of the circles are categorized proportionally as in legend.

3.4.7 Pacific halibut mortality and groundfish revenue

Examining the relationship between halibut PSC mortality and groundfish revenue is helpful to understand how revenue from different sectors of the groundfish fishery may be impacted by changes in halibut PSC limits. Halibut PSC caught when directed fishing for CDQ pollock accrues to the CDQ halibut PSQ but because pollock catch is on a much larger scale than other CDQ groundfish catch it is not included in the figures below. Table 3-24 outlines the CDQ pollock catch and revenue for 2010-2018 for comparison purposes.

Figure 3-72 shows the relationship between metric tons of pacific halibut mortality (PSC use) and groundfish wholesale revenue, by sector for years 2010-2018. Overall, there is a generally positive relationship between groundfish revenue and PSC use, but there are many examples within sectors where this is not the case. For example, the A80 sector derived similar overall groundfish revenues in 2014 and 2016 with very different levels of PSC use (this may be due to deck sorting and DMR changes as well as changes in PSC limits after the implementation of A111 in 2015). Similar trends emerge for other sectors that derived comparable total revenues with differing levels of PSC use in different years (i.e. 2012 and 2015 in the HALCP sector). Numerous variables can affect the relationship between revenue and PSC including, but not limited to: species composition of catch, trends in wholesale values, distribution and co-occurrence of halibut and groundfish species, and discard mortality rates. It is also important to note that these are gross revenues that do not include cost data. It is possible a sector accrued additional costs (i.e. search costs, less efficient fishing, deck sorting) in order to gross an equivalent revenue with lower PSC use.

Table 3-24. Halibut mortality (metric tons) and Revenue per ton of PSC (nominal wholesale dollars) for CDQ sector targeting pollock.

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Halibut mortality	10.1	40.52	13.92	15.57	24.98	7.93	9.12	7.25	6.62
Revenue per ton PSC	1305	1192	1192	1000	1032	1035	1061	1087	1050

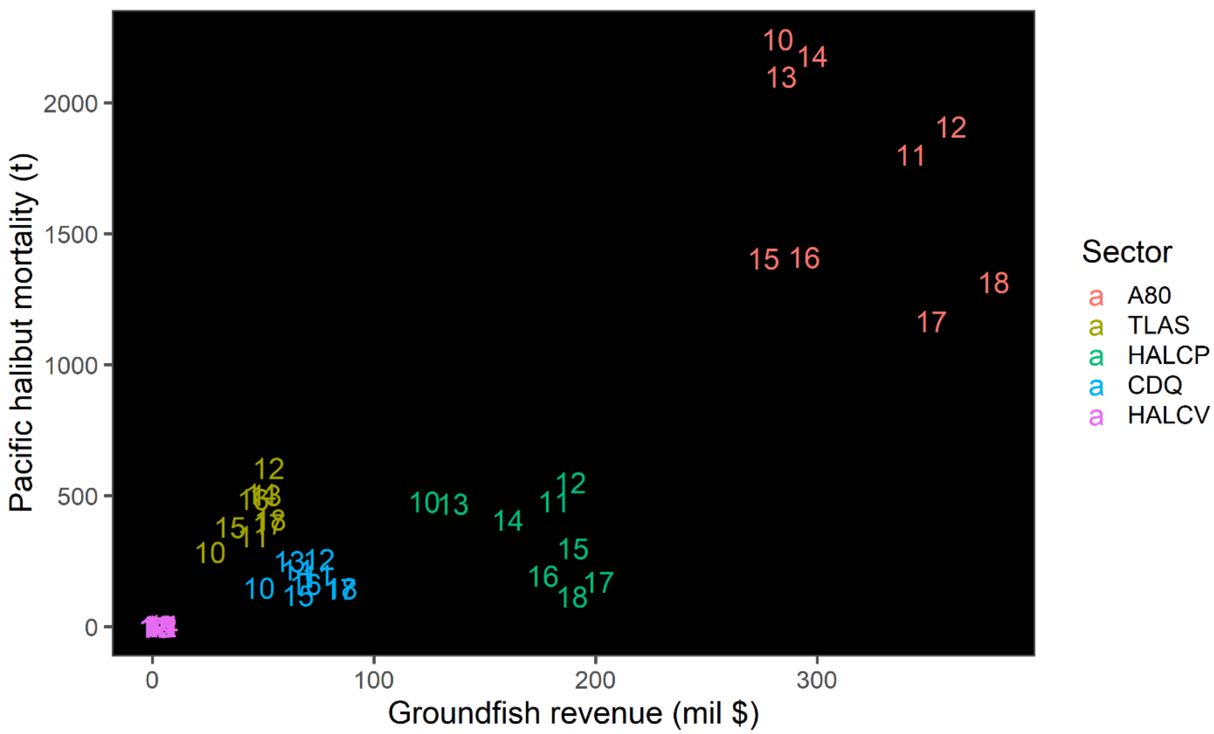


Figure 3-72. Mortality of Pacific halibut (t) versus groundfish revenue (millions nominal wholesale dollars) (horizontal axis) by sector (colors) and year (labels) 2010-2018.

Certain groundfish targets more commonly encounter Pacific halibut (Section 3.4.4). Similarly, the relationship between PSC and revenue varies by target. Figure 3-73 compares halibut mortality and groundfish revenue by target species for each sector. Revenue of some target species is highly correlated with halibut mortality (i.e. Yellowfin Sole in the TLAS sector) while others have very little relationship (i.e. Atka mackerel in the A80 sector).

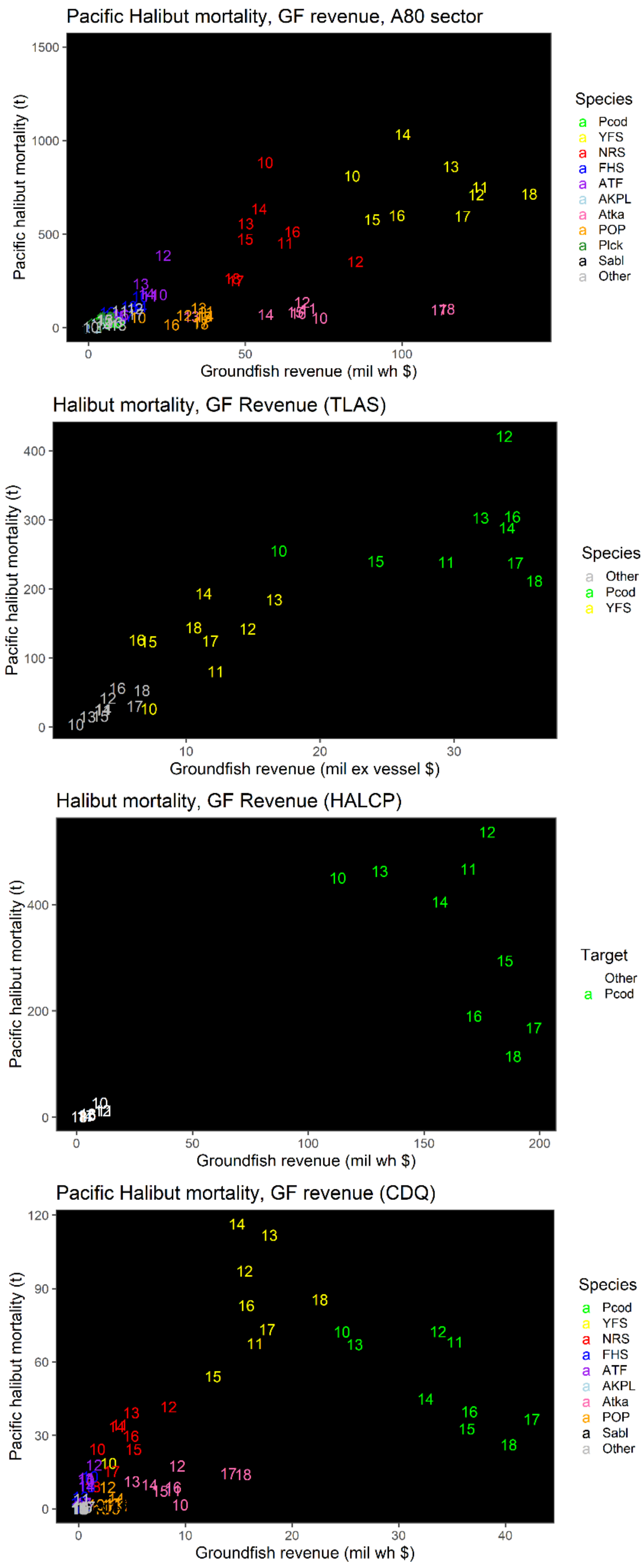


Figure 3-73. Mortality of Pacific halibut (t) versus groundfish (horizontal axis) by target fisheries for A80, TLAS, HALCP and CDQ. Revenue is reported in millions of nominal dollars of wholesale value for sectors A80, HALCP and CDQ and ex-vessel value for TLAS. Note that vertical and horizontal scales change in the different panels.

Another method to evaluate impacts of reductions in halibut PSC, is to examine the relative value of halibut PSC based on the wholesale revenues that are generated utilizing one metric ton of halibut PSC. The more wholesale revenue that can be generated per ton of halibut PSC, the more valuable that unit of halibut PSC becomes. This measurement represents the marginal wholesale revenue earned per metric ton of halibut PSC. 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 3-74 shows the annual value of a metric ton of halibut PSC for each groundfish sector from years 2010-2018. A80, HALCP and CDQ show increases in relative values of PSC with a notable increase in 2015.

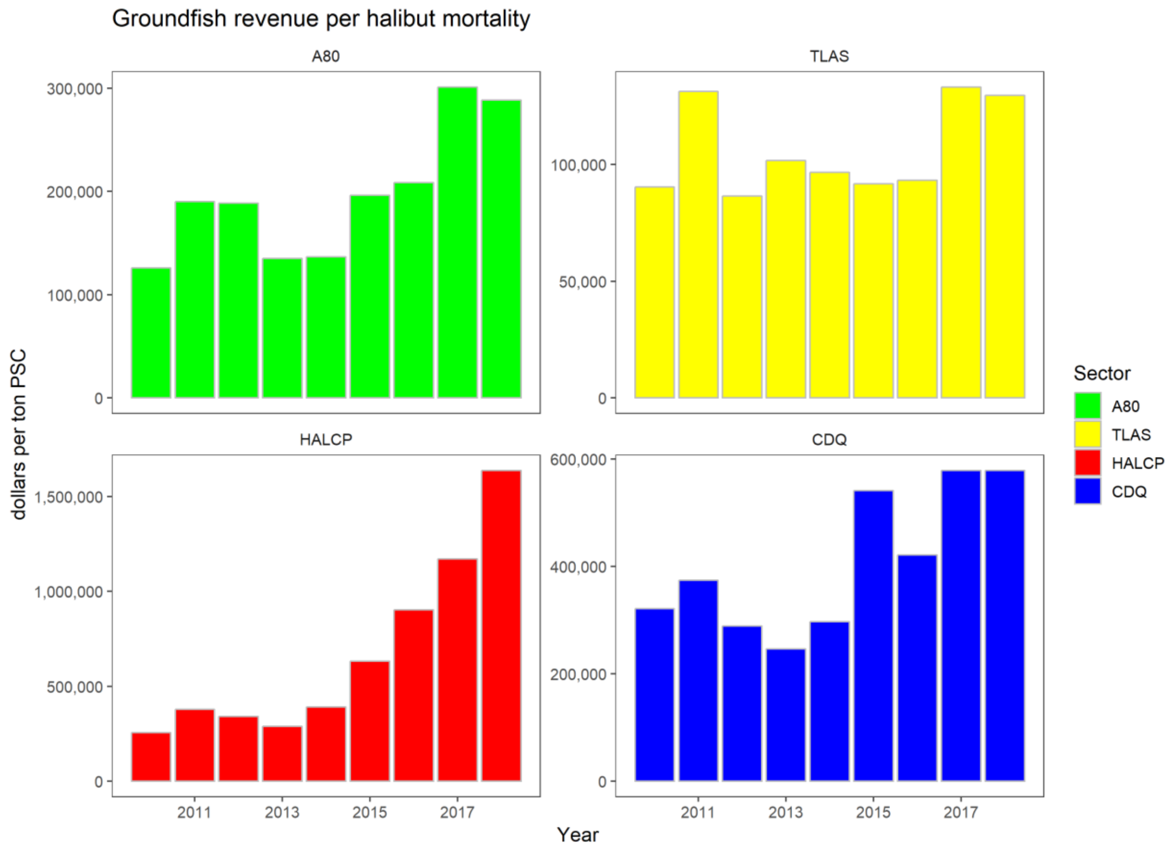


Figure 3-74. Annual groundfish revenue per metric ton of halibut PSC by sector 2010-2018. Revenue is reported in nominal dollars of wholesale value for sectors A80, HALCP and CDQ and ex-vessel value for TLAS. Note that vertical scales change in the different panels.

To examine the variability of the relative value of a unit of PSC at a finer temporal scale, Figure 3-75 displays the monthly value of a metric ton of halibut PSC for each groundfish sector. Monthly patterns vary year to year. In recent years the A80 sector has had relatively low value PSC in spring and early summer months (May and June) bookended by relatively higher value PSC seasons, however this pattern does not hold for the entire time series. Monthly patterns vary annually for TLAS and CDQ sectors, while the HALCP sector shows some patterns of relatively higher values early and late in the year, with a dip in summer months (July and August).

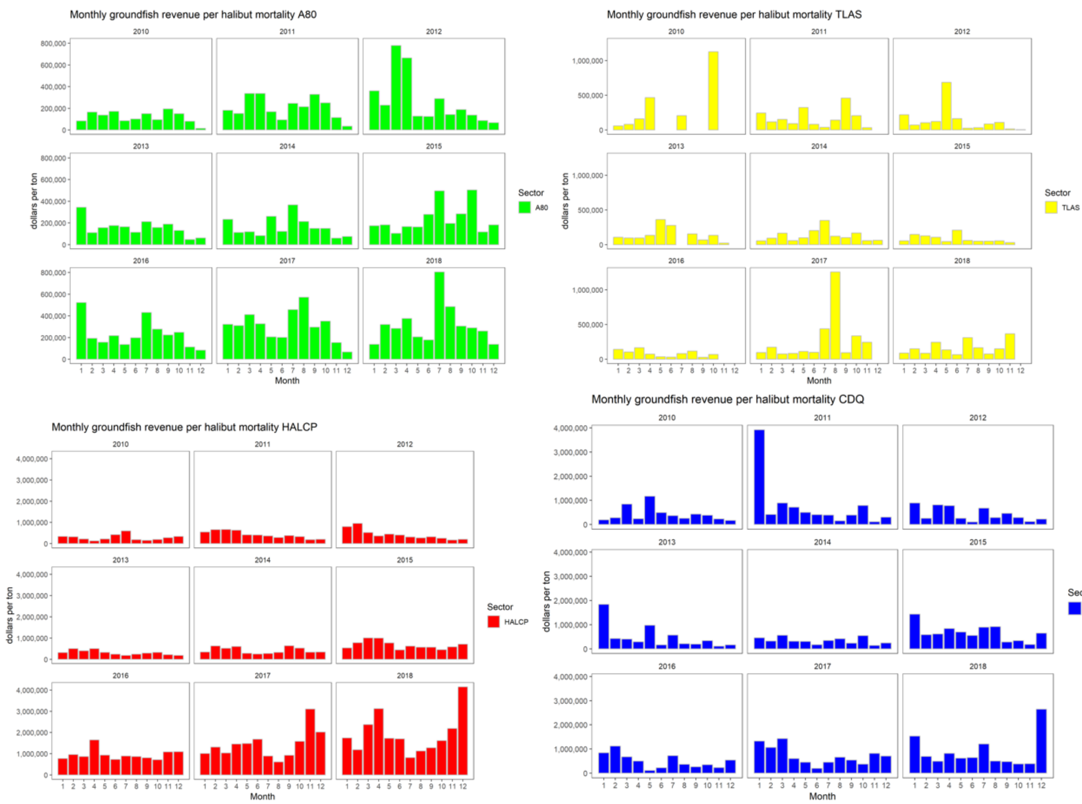


Figure 3-75. Monthly groundfish revenue per metric ton of halibut PSC by sector 2010-2018. Revenue is reported in nominal dollars of wholesale value for sectors A80, HALCP and CDQ and ex-vessel value for TLAS. Note that vertical scales change in the different panels.

The relative value of PSC changes by sector based on the target species (Figure 3-76). For the A80 and TLAS sectors, roundfish targets (Atka, POP) consistently show high relative values of PSC. Relative value of flatfish targets varies from year to year with yellowfin sole generally having the highest relative value in recent years. Note that “target” fishery does not reflect the entirety of the species composition of the catch. Target fishery is determined by the dominant species in the retained catch for each species. Therefore revenue associated with the same target fishery could be comprised of varying relative proportions of target species and varying non-dominant species compositions. Thus, the overall revenue will depend upon the relative values and proportions of both the target and non-target species.

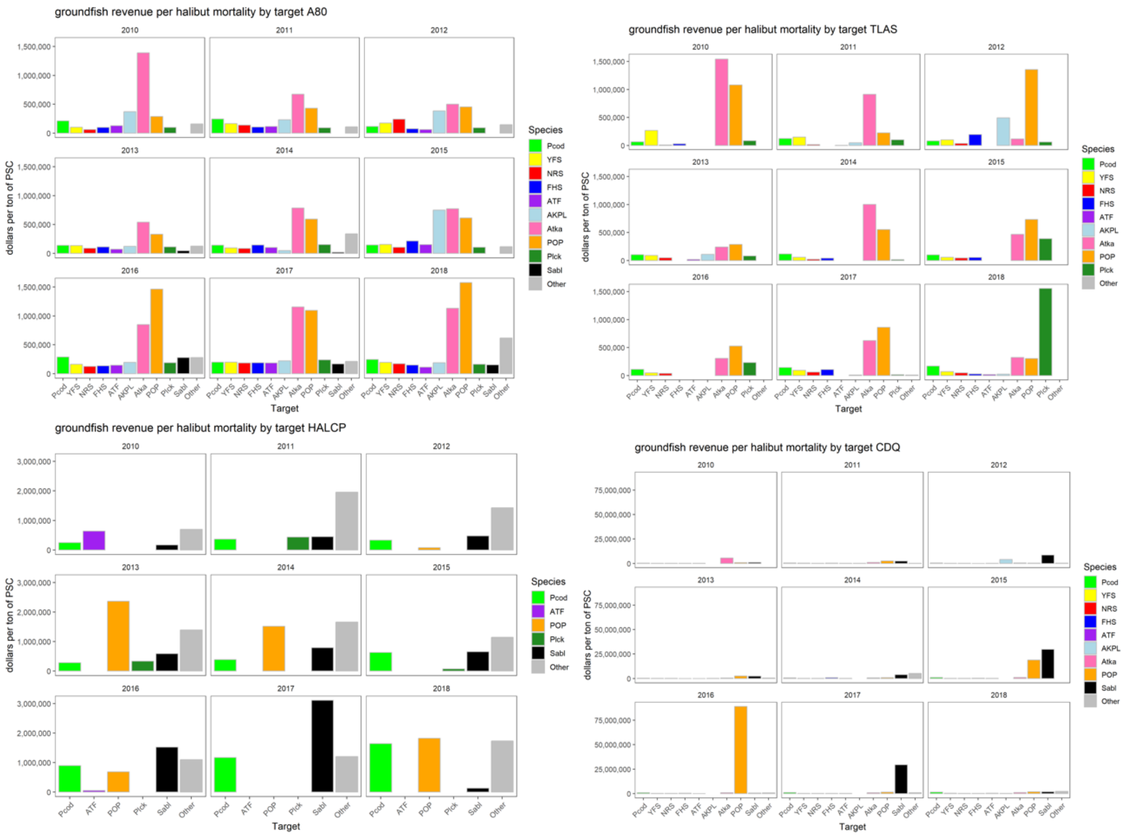
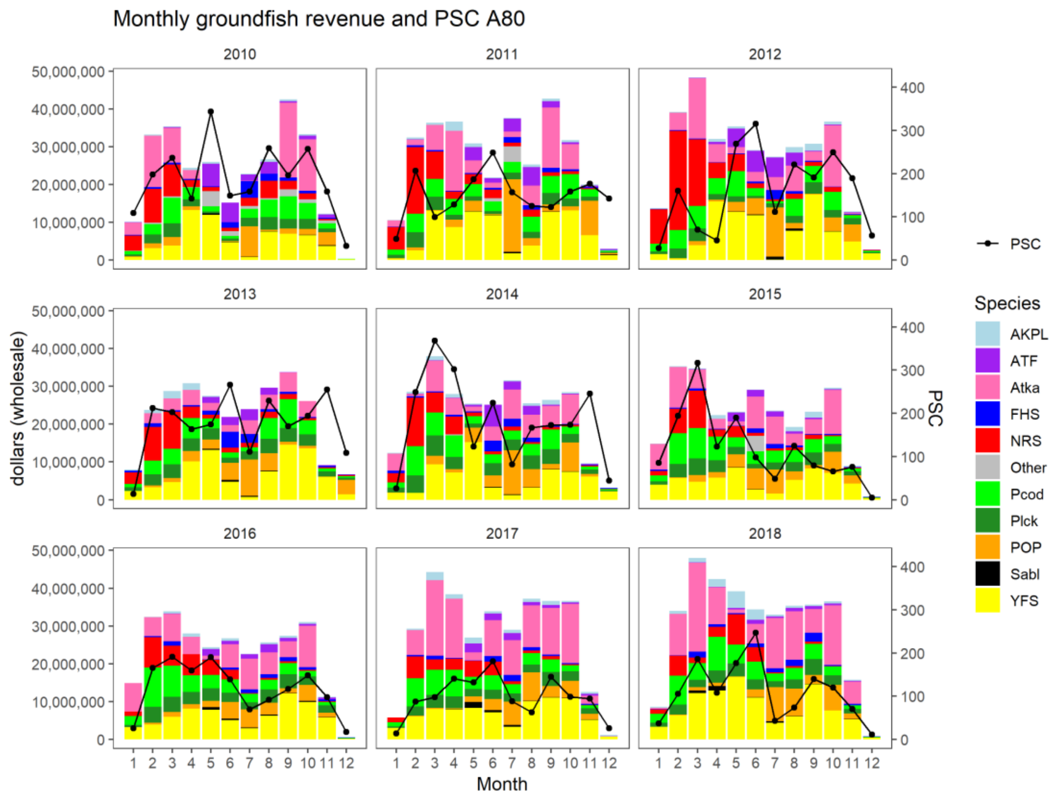
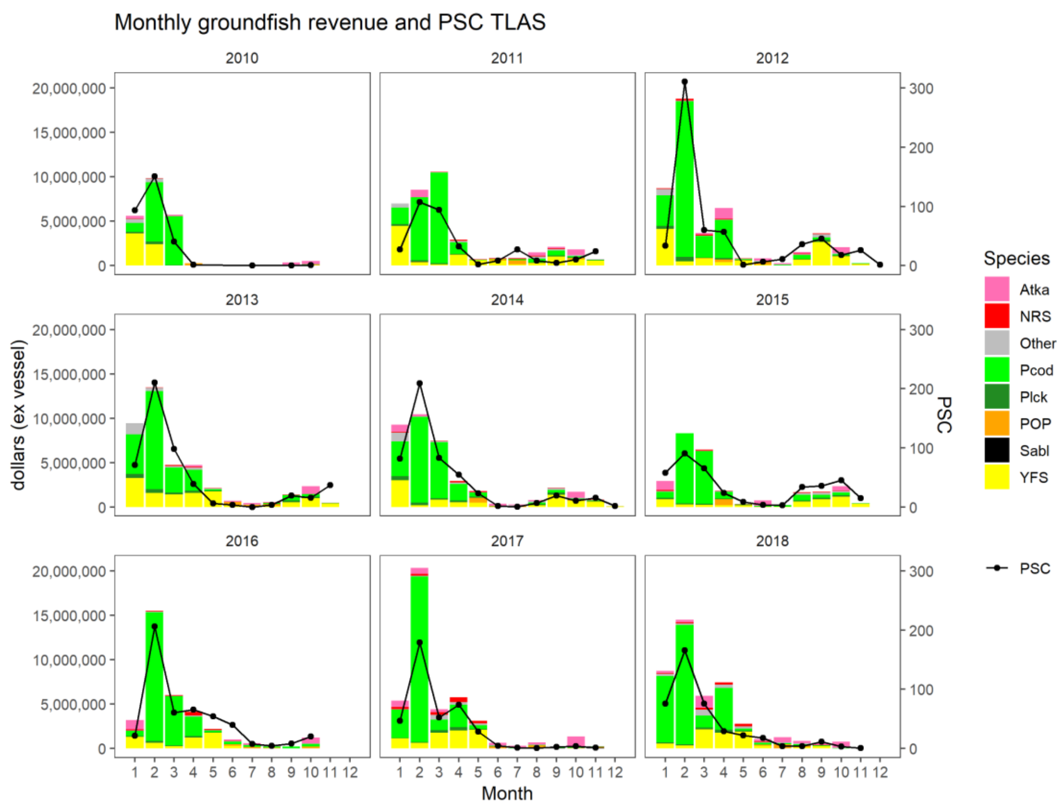


Figure 3-76. Annual groundfish revenue per metric ton of halibut PSC by target species by sector for 2010-2018. Revenue is reported nominal dollars of wholesale value for sectors A80, HALCP and CDQ and ex-vessel value for TLAS. Note that vertical scales change in the different panels.


Monthly groundfish revenue and PSC A80
2010
2011
2012
2013
2014
2015
2016
2017
2018
dollars (wholesale)
PSC
Month
PSC
Species
AKPL
ATF
Atka
FHS
NRS
Other
Pcod
Plck
POP
Sabl
YFS


Monthly groundfish revenue and PSC TLAS
2010
2011
2012
2013
2014
2015
2016
2017
2018
dollars (ex vessel)
PSC
Month
Species
Atka
NRS
Other
Pcod
Plck
POP
Sabl
YFS
PSC

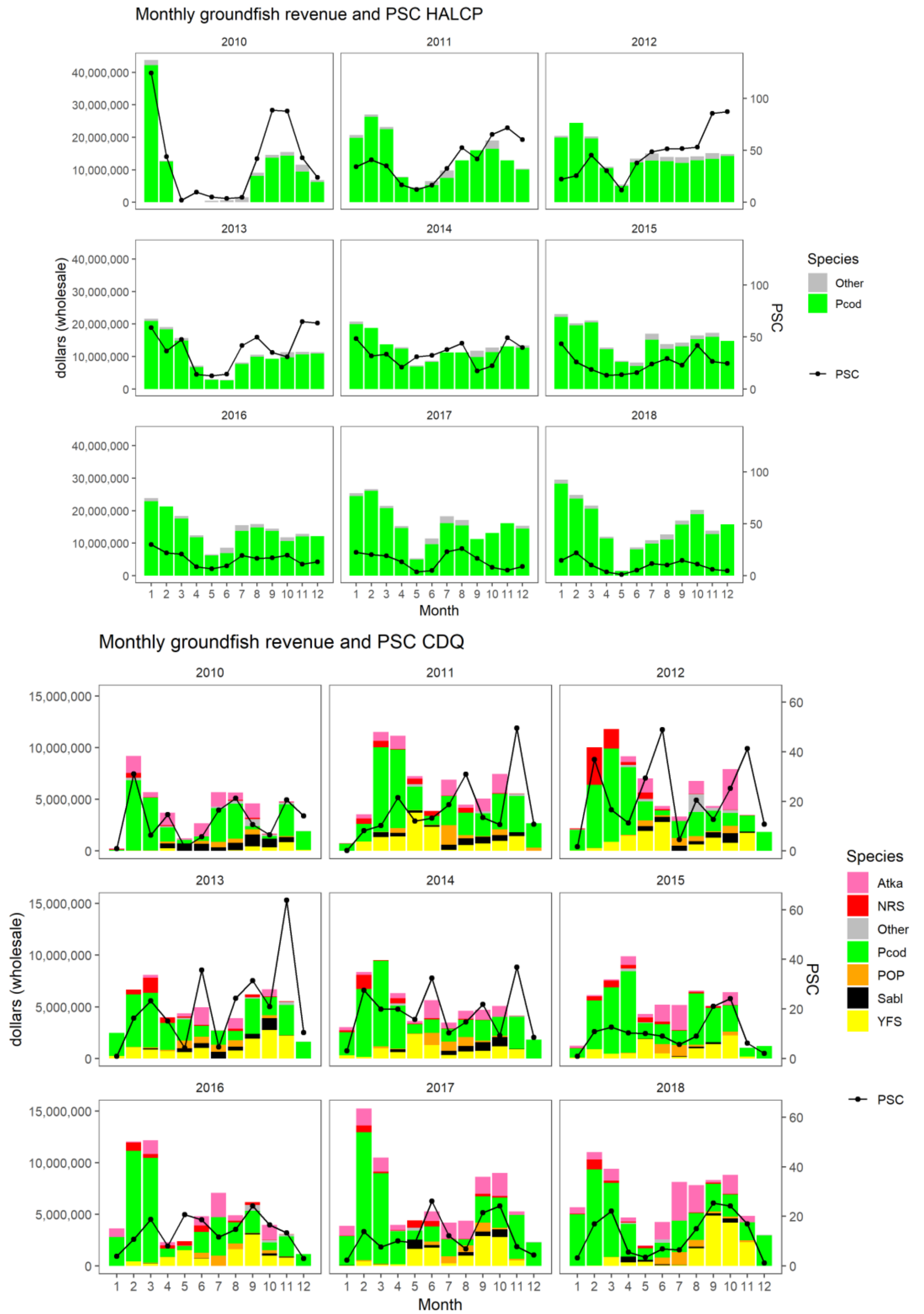


Figure 3-77. Monthly PSC use (black line) and monthly revenue by catch species for each sector for years 2010-2018. Note PSC (metric tons) is reported on the y-axis on the right side and revenue is reported on the y-axis on the left side of the figure. Revenue is reported in nominal dollars of wholesale value for sectors A80, HALCP and CDQ and ex-vessel value for TLAS. Note that vertical scales change in the different panels.

To parse out the seasonal relationship between catch composition and PSC, Figure 3-77 overlays monthly PSC use (black line) over monthly revenue by catch species for each sector for years 2010-2018. This figure displays the monthly variability in catch composition (or lack thereof for HALCP) as well as the different PSC use for different months. For some sectors this relationship is more complex than others and it is difficult to identify patterns. For the TLAS sector generally PSC use is higher early in the season, corresponding with larger Pacific cod catches and then trailing off later in the season. The HALCP sector is dominated by Pacific cod catch throughout the year, however PSC use generally seems to dip with a corresponding dip in catch in the late spring and early summer months. The CDQ sector is quite variable. In recent years there seems to be early year PSC use corresponding with relatively large Pacific cod catches and PSC use corresponding with relatively higher YFS catches latter part of the year. The A80 sector is highly variable in both PSC use patterns and catch composition. While PSC use seems to generally correspond with YFS catches, this pattern does not always hold.

3.5 Status quo issues

This section is included to acknowledge that the management, monitoring, and prosecution of the groundfish fisheries potentially affected by an ABM action are in a near-constant state of change. As a result, the analysts aim to identify recent, ongoing, or foreseeable changes to the landscape surrounding the fisheries and the data available to characterize them. In some cases, the issues identified in this section explain a change in data collection methods or fish handling procedures, and thus explain why a smaller, more recent set of years was relied upon to characterize the fishery. Other issues include the environment, cooperative affiliations, methods for estimating PSC mortality, and State or Federal-level regulatory changes that will (or could) affect the amount of available harvest and/or the modes in which a groundfish species will be harvested in the future. This section primarily points back to other sections of this DEIS document where issues are described in greater detail. The two exceptions are the following subsections on a recent Pacific cod management action by the State of Alaska and an ongoing early-stage review of a Council action that could change the way that some Federal Pacific cod fisheries are managed and prosecuted in the future.

At the most basic level, this document recognizes the fact that the natural environment plays an important role in how fisheries occur – from stock status to fish aggregation (and CPUE). Just 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. Observations of this recent sea temperature change are noted in Section 3.1.1.

Some regulations that could limit groundfish fishing opportunities under certain circumstances already exist. One such example is the Bristol Bay Red King Crab Savings Area. This area, illustrated in Figure 3-10 (Section 3.2.3), is closed to non-pelagic trawling year-round. However, there is a subarea along the southern edge of the Savings Area that is only closed in certain years depending on BBRKC stock status. This regulation is an example of a management tool that is exogenous to the non-pelagic trawl fishery, is somewhat unpredictable as to when a closure will be in effect, and yet is potentially impactful to the trawl fleet’s ability to find or follow aggregated flatfish with a low halibut bycatch rate. Whether clean fishing around the Savings Area is occurring in a given year and whether the subarea is closed is a two-part uncertainty that could have a bearing on realized halibut bycatch rates in important A80 targets like yellowfin sole.

The A80 sector itself has evolved since its inception in 2008. In recent years, a fishing company has exited the sector, vessels and quotas were sold to other A80 companies, and the number of cooperatives within the sector was reduced from two to one. One impact of intra-sector consolidation is that a single cooperative might be more successful in coordinating harvest and bycatch minimization strategies (the latter is discussed below). The recent transfer of vessels and the associated cooperative quotas of allocated groundfish and PSC had at least two effects on fishery outcomes. First, some vessels that changed ownership were temporarily less active in the BSAI fishery or completely sidelined while rebuilds or refurbishments were completed by the new owners (refer to Figure 3-16 in Section 3.3.1.2). This likely means that catch and bycatch data from the most recent years available represent an A80 fleet operating at less than full potential capacity. For that reason, groundfish catch and PSC mortality from the most recent years might underrepresent the expected level for future years, all else equal. Second, companies acquiring quotas via recent sales might elect to fish them differently within their particular species portfolio than the previous holders did. For example, an acquiring company might seek to utilize more of the quotas for species like flatfish that are typically associated with higher halibut PSC rates. In short, each of these developments provides a reason to think that fishery data in the future might be representing a different operational fishery landscape from the one that was operating in years prior.

Following the Council's BSAI halibut PSC reduction action in June 2015 (Amendment 111), the A80 sector formalized a halibut avoidance plan. The plan is described in Section 3.4.1.1 of this document. The development of the plan reflects an identifiable response to external and internal pressures to minimize halibut PSC, and PSC usage did decline relative to previous years following 2014 (see Table 3-20). The analysts recognize, however, that groundfish sectors' efforts to minimize PSC mortality are not – and cannot be expected to be – the sole driver of usage reductions; Section 3.4 provides evidence of the annual and monthly variability of PSC encounter rates within a sector or even within a target species. The external factors that influence PSC encounter rates are wide ranging and not all of them are observable in fishery data.

During the primary historical period for which fishery data is reported in this document (2010 through 2018), the A80 sector began the process of developing halibut deck sorting protocols through an EFP process in partnership with NMFS. Section 3.4.2 describes the purpose and progression of the deck sorting EFP in greater detail. The current EFP effort began in 2015, changing fish handling and sampling procedures for halibut caught on A80 trawl vessels. The number of vessels participating in the EFP and the number of halibut that were sampled has increased to the present where all A80 vessels are deck sorting halibut at some times, including when fishing outside of the BSAI (i.e., GOA). Analyses of data from the deck sorting EFP identified some data issues in 2016 and 2017. The amount of sampling from the bottom-trawl fleet increased by a large amount relative to other segments of the fishery (Figure 3-31), and measurements suggested some bias towards sampling of larger halibut. Because data from the more recent years of the EFP were entered into the Catch Accounting System, the effect of the deck sorting development on bycatch estimation should be noted for context when examining halibut mortality from 2016 through 2018. At the same time, the reader should also note that deck sorting has had the effect of reducing the DMR for discarded halibut in the A80 sector. Figure 3-35 illustrates a significant decline in the DMR that is applied to bottom trawl catch beginning in 2016, meaning that the same amount of halibut encounter results in less PSC mortality attributed to the sector's limit.

The approach used for establishing DMRs in the annual harvest specifications process has also changed in recent years (Section 3.2.2). Beginning in 2016, the fishery definitions for DMR estimates and application transitioned from species composition to vessel/gear operational characteristics that are causatively linked to halibut mortality. Also, while the previous approach used a 10-year reference period for DMR estimates, the new method uses a reduced reference period (2-3 years) to better incentivize improvement in halibut handling practices. Similar to how the effect that the deck sorting EFP had on halibut PSC mortality estimates, the change in DMR methodology occurred during the historical years highlighted in this document and had some effect on the PSC mortality that was estimated for earlier years.

The following two subsections provide greater detail on recent and ongoing issues related to Pacific cod management. Pacific cod is a species of great importance to the BSAI groundfish sectors that could be affected by the ABM action. The first action, taken by the Alaska Board of Fisheries, will affect how much Pacific cod is available to Federal groundfish fisheries in the BSAI. The second (potential) action would affect the management of CVs that target Pacific cod with trawl or pot gear, notably including the TLAS sector as defined in this document.

3.5.1 Recent Alaska Board of Fisheries actions to increase Pacific cod guideline harvest levels (GHL)

In October 2018 the Alaska Board of Fisheries (BOF) made changes to the BS and AI guideline harvest levels (GHL) 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 reduces available harvest for the trawl catcher vessels that are potentially affected by the ABM action. After deducting the GHL from ABC, 10.7% of the remaining TAC is allocated to CDQs. From that new remainder, 22.1% is allocated to the BS and AI trawl CV sector. Stated another way, under current regulation, each pound of Pacific cod that is allocated to the GHL fisheries reduces the allocation to the BSAI trawl CV sector by 0.197 pounds.

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. Starting in 2016, the AI GHL changed to 27% of the AI ABC, with annual step-up provisions 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 at 90% harvest. 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 federal 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).

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 before calculating the Federal BS TAC. Starting in 2016, the BOF changed the DHS GHL calculations 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. If the GHL is fully harvested (90% considered fully harvested), the limit is increased by 1% of the BS ABC each year until it reaches 15% in 2026. 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 the October 2018 BOF meeting it expanded the area to include waters between 162.30 degrees and 167.00 degrees west longitude. The 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 2018 season opened on January 30 and was closed on March 1 because the GHL was projected to be taken.) All of the catch is delivered to shoreside plants since it is harvested by pot vessels that are 58’ or less. A total of 32 pot gear vessels participated in the fishery in 2018. From 2014 through 2018, the DHS fishery was harvested at 98% 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. Because the DHS GHL fisheries are exclusive to pot and jig gear, an increase to the GHL directly reduces the amount of the ABC that is available to the BS trawl CV Pacific cod fishery prior to setting the federal TAC. When the DHS GHL for pot gear reaches 15% of the BS ABC, it will equate to a 134% increase in the previous GHL allocation, relative to 2018. In poundage terms, the 2018 GHL (6.4 percent) was 28.36 million lbs. (12,864 t).

Should the BOF action play out with no step-downs in the AI and a DHS GHL that reaches 15% in 2026, the projected federal BSAI non-CDQ trawl CV Pacific cod TAC would be reduced by 36.7% in 2026 relative to 2018 (25,543 t instead of 40,227 t). That projection is based on 2018 through 2020 ABCs, with the 2020 ABC projected forward through 2026. The percent effect of the BOF action will differ by 2026 depending on the status of the BSAI Pacific cod ABC over the 2020 through 2026 period, which is unknown at this time. The percent change in BSAI non-CDQ trawl CV Pacific cod TAC dropped by 11.4% from 2018 to 2019 and by 32.3% from 2018 to 2020 due to sequential cuts in BSAI Pacific cod ABC. From 2020 on, the reduction in trawl CV TAC due to the BOF action accounts for the difference between 32.3% and 36.7%, holding ABC constant at the projected 2020 level. The arithmetic behind these TAC allocation projections is provided in Table 2-10 (Section 2.6.7) of the April 2019 Public Review Draft on "Catcher/processor Mothership Restrictions in the Bering Sea and Aleutian Islands and the Gulf of Alaska when taking Directed Non-CDQ Pacific cod deliveries from Trawl Catcher Vessels."

3.5.1 Development of a limited access privilege program (LAPP) for BSAI Pacific cod

The Council is in the beginning stages of considering the development of Limited Access Privilege Programs (LAPPs) for all trawl CVs and/or pot CVs greater than or equal to 60' LOA that participate in the BSAI Pacific cod fishery. Whether LAPPs for the two aforementioned Pacific cod sectors would be developed separately or in conjunction has not yet been determined. At the October 2019 meeting, the Council will review a scoping paper that aids the development of alternatives and a purpose and need statement if such a program (or programs) is pursued. Information for this agenda item can be found under "D2 – BSAI Pcod trawl/pot CV management – Scoping Paper" at: https://meetings.npfmc.org/Meeting/Details/823.

The Council established a draft purpose and need statement for the Trawl CV rationalization proposal in February 2019. That statement highlights the combination of declining BSAI Pacific cod TAC and increasing participation in the non-CDQ trawl fishery, which has resulted in a shortened season and lesser ability to maximize the value of the fishery. The statement notes that the pace of the fishery might impair participants' willingness or ability to take actions that minimize bycatch and might also decrease safety at sea. When tasking the scoping paper, the Council also established a control date of February 7, 2019 that could preclude the consideration of catch history occurring after that date in any future allocations. The control date was included due to the potential for continued re-entry of latent LLP licenses that might exacerbate the challenges described above. Among the topics covered in the scoping paper are contextual information about historical participation by AFA (cod exempt) and non-AFA trawl CVs in the BSAI Pacific cod fishery, and the history of AFA CVs' cooperative-based cod harvest arrangements that have occurred since the implementation of AFA.

The scoping paper also addresses the Council's request to consider a cooperative-based rationalization structure for the Over-60' pot CV fishery more generally. The paper considers historical participation in the fishery, the existing GOA sideboard limitations for large BSAI pot cod vessels that have crab LLP endorsements (all), and any downstream effects that such a program might have on other sectors or fisheries.

Rationalizing portions of the BSAI Pacific cod fishery would affect groundfish sectors that fish under a halibut PSC limit and are thus impacted by the ABM action. Each of the halibut-limited BSAI groundfish sectors fish for Pacific cod; for some, cod is a primary species while for others cod is a valuable allocated species that can be limiting in terms of incidental catch. If the Council were to allocate Pacific cod to qualified trawl CVs via cooperatives, the LAPP might limit opportunities for TLAS vessels that choose not to join a cod cooperative or vessels that participate in the TLAS fishery but did not qualify for a Pacific cod trawl CV allocation. Trawl CVs that might fish for cod without a cooperative allocation could include new entrants or those that historically focused on yellowfin sole within the TLAS fishery. Regardless of how – and to which entities – Pacific cod quota might be allocated, a LAPP would need to consider how to account for cod catch that occurs in other groundfish fisheries. As noted in the scoping paper cited above, roughly 12% of the Pacific cod TAC allocated to the trawl CV sector is taken on trips that targeted groundfish other than cod. Whether or not TLAS vessels in the future are fishing for Pacific cod under a cooperative allocation system or a limited access system (or some combination thereof) would likely affect fishing patterns and the ability to manage a halibut PSC constraint. Allocating Pacific cod TAC could also affect whether and how in-season rollovers occur, as the trawl CV and the over-60' pot sectors are main sources of reallocated TAC. Under current management, unharvested TAC can be moved between sectors. Historically, one of the main recipients of roll-over Pacific cod TAC is the HAL/Pot CV (less than 60' LOA) sector. The HAL portion of that sector fishes under a halibut PSC limit and is thus directly managed by the ABM action.[24] Inseason cod rollovers typically occur in the fall, though reallocations from the jig sector to the HAL/Pot CV (less than 60' LOA) sector often happen in late April or early May. For more information on rollovers, refer to Section 6 of the October 2019 scoping paper (linked above). Finally, allocating Pacific cod might redirect the fishing entrants of vessels that receive little or no allocation. Among those entities might be vessels that are endorsed to fish for yellowfin sole but are only allowed to deliver shoreside, where no yellowfin sole market currently exists. Speculation as to whether a cod LAPP would spur interest in a shoreside flatfish market would be unfounded at this time.

Future iterations of the ABM analysis will monitor any progress towards rationalization in the BSAI Pacific cod fishery and direct or indirect effects on the groundfish sectors that are considered to be directly impacted by the ABM alternatives.

[24] Pot vessels fishing BSAI Pacific cod are exempt from halibut PSC limits due to traditionally low bycatch rates. This sector's halibut PSC is estimated by NMFS and reported to the IPHC to be considered in the annual harvest specification process.

4 Pacific Halibut

4.1 Life history, and distribution

Pacific halibut (*Hippoglossus stenolepsis*) is one of the largest species of fish 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, supplies 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 empirical weight-at-age estimates by year to convert numbers-at-age to biomass. This allows the model to account for the observed large changes in 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 the average recruitment treated as a function of environmental conditions where a regime (cool or warm) is determined from the Pacific Decadal Oscillation (PDO, Clark & Hare 2002).

The ensemble modeling provides a more robust assessment approach that acknowledges structural uncertainty and 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" 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. The fishing intensity is predicted to have been as much as 1.5 times the current interim harvest policy fishing intensity ($F_{SPR=46\%}$) with considerable uncertainty that overlaps $F_{SPR=46\%}$. However, Region 4 showed less departure in historical harvest rates compared to recent ones. Over this period, the estimated stock status was above 30% (i.e., higher than the threshold for concern and precautionary management action), weight-at-age was declining (even without fishing, a decline in spawning biomass and recommended catch levels are predicted over this period), 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.

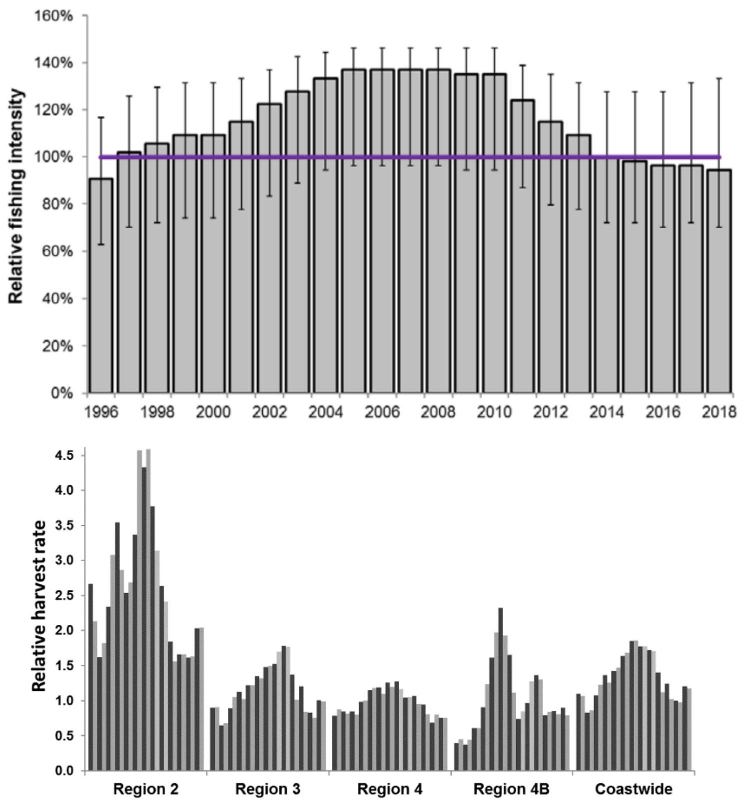


Figure 4-1. Top: Time-series of estimated fishing intensity coastwide (1996-2018; based on the Spawning Potential Ratio) relative to the IPHC current interim SPR = 46% reference level (horizontal line). Vertical lines indicate approximate credible intervals from the stock assessment ensemble. Bottom: Empirical harvest rates from 1993-2018. All rates relative to the coastwide average over the period 2014-2016, which is arbitrarily set to 1.0. From IPHC (IPHC-2019-AM095-08)

The estimated spawning stock biomass has been stable or slightly increasing in recent years, but that follows a considerable decline since the late 1990s (Figure 4-2). Weight-at-age is a contributing factor to this decline because the average weight-at-age of Pacific halibut has been declining over this same period.

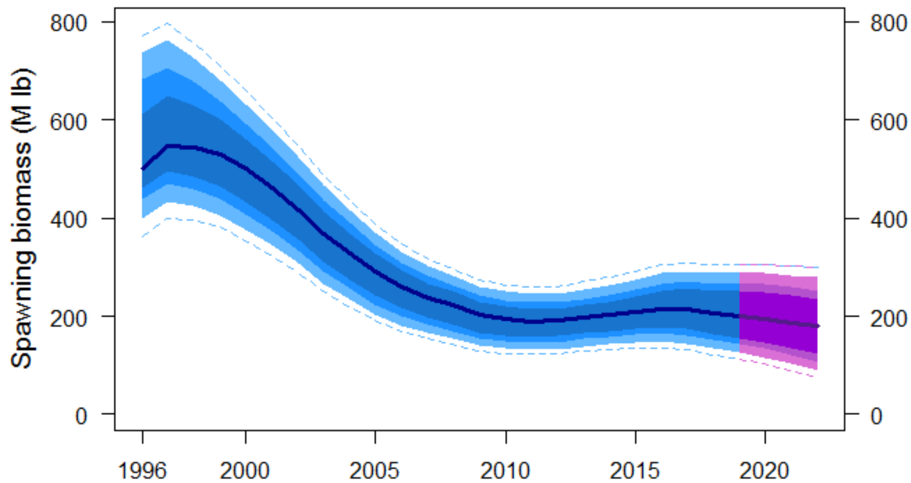


Figure 4-2. Estimated spawning biomass for the 2018 stock assessment ensemble (from Stewart & Hicks 2019) with a three-year projection (purple) based on a fishing intensity of $F_{SPR=48\%}$ (TCEY=37.2 million pounds, ~16,880 t; equivalent to the 2018 status quo).

4.3 Management of Pacific Halibut

4.3.1 IPHC and process for setting catch limits

In 2017, the previous harvest policy paradigm was replaced with a new interim SPR-based (Spawning Potential Ratio) harvest policy (Figure 4-3). This new paradigm sets a coastwide catch limit and then distributes the catch limits across Regulatory Areas (Figure 1, Hicks & Stewart 2017). Previously, the Regulatory Area catch limits were determined by multiplying the apportioned biomass (based on estimated biomass from survey catches) in each Area by an Area-specific harvest rate. This new paradigm now considers mortality from all sources and sizes when setting a coastwide catch limit, but still uses a similar method (using estimates of biomass from the survey) to distribute the catch limits across Regulatory Areas.

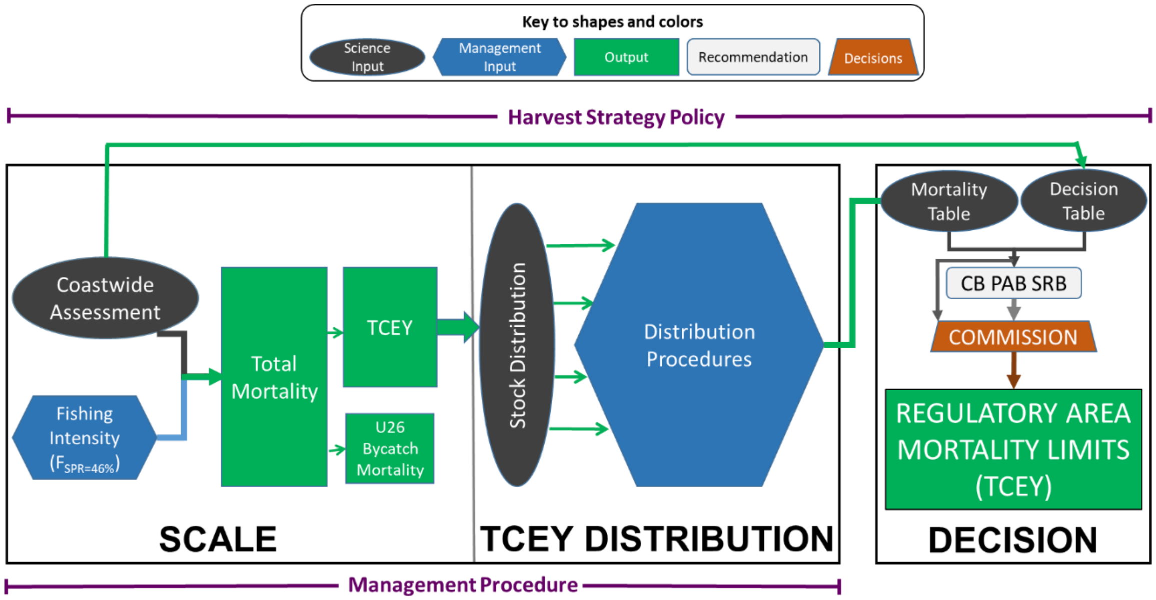


Figure 4-3. A pictorial description of the interim IPHC SPR-based harvest strategy policy showing the separation of scale and distribution of fishing mortality.

The default level of fishing intensity ($F_{SPR=46\%}$) for this interim harvest policy is based on an average of fishing intensities over the years 2014, 2015, and 2016, which are years where the stock is estimated to have been stable or slightly increasing. 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 stock status has never been estimated less than 30% since it was a part of the harvest policy. It 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 critically low levels.

The Total Mortality determined from F_{SPR} is split into two components: under 26" (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 Regulatory Areas based on estimates of biomass from the setline survey 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 and 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 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.

Currently, investigations are being done at IPHC in a management strategy evaluation (MSE) framework to determine a level of fishing intensity that meets the long-term objectives of the directed fishery and managers. These include biological sustainability, optimizing yield, and stability in yield. Recently, investigations of management procedures to distribute the TCEY have begun in concert with fishing intensity, but bycatch mortality 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.

An SPR-based harvest policy makes it easier to determine impacts on the spawning capital, but SPR is affected by changes in selectivity. The stock assessment estimates selectivity for the different fleets using available data, but there may be up to an eight-year lag before the management advice is completely informed by the data because halibut are not commonly selected by the directed fishery or IPHC fishery-independent survey until approximately eight years old. The MSE incorporates variability in the selectivity patterns for each fleet, and the best performing management procedure (including an SPR rate) should be robust to reasonable changes in selectivity. The control rule protects the stock when the stock status gets low, and monitoring of changes in selectivity will maintain sustainable total mortality levels. Meeting conservation objectives is the top priority in the MSE.

The distribution of the TCEY (currently using the setline survey and different harvest rates in the western and eastern Areas) is currently being investigated using the MSE framework, and includes discussions with industry to define Area-specific goals & objectives, further development of multi-area operating models, and the development of distribution procedures. A change in the distribution procedure may affect the treatment of bycatch in a specific 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 distribution would change greatly among Areas, but even a small change could be significant for some 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 & Hicks 2018 for a recent investigation). A change in this size limit could increase efficiency of the commercial fleet but would result in a change in selectivity. As noted above, a change in selectivity will result in a change to the target SPR that meets the defined goals and objectives, although in the likely range of selectivity, this change in SPR would be slight.

Another possible consideration is how the TCEY is distributed to the various sectors. Currently, a TCEY is determined for each Regulatory Area, and within an Area, bycatch is subtracted first and the remainder is allocated to the directed fisheries (see Figure 4-4 for distribution specific to BSAI Area 4). An alternative could be to first subtract a minimum amount for directed fisheries, and then take off the allocation for the non-directed fisheries with the remainder adding to the directed fisheries allocation. This is purely a management decision that would require agreements between various agencies. It may affect bycatch limits in some Areas but may have no effect in others.

The recent changes to the IPHC harvest strategy policy will benefit the management of the coastwide stock of Pacific halibut and provide opportunity to measure impacts from different fisheries, but it does not solve the difficult issues of allocation between fisheries. We can understand the components of the harvest policy and measure impacts of each fleet, but ultimately it comes down to understanding and balancing the trade-offs between goals and objectives of each fishery.

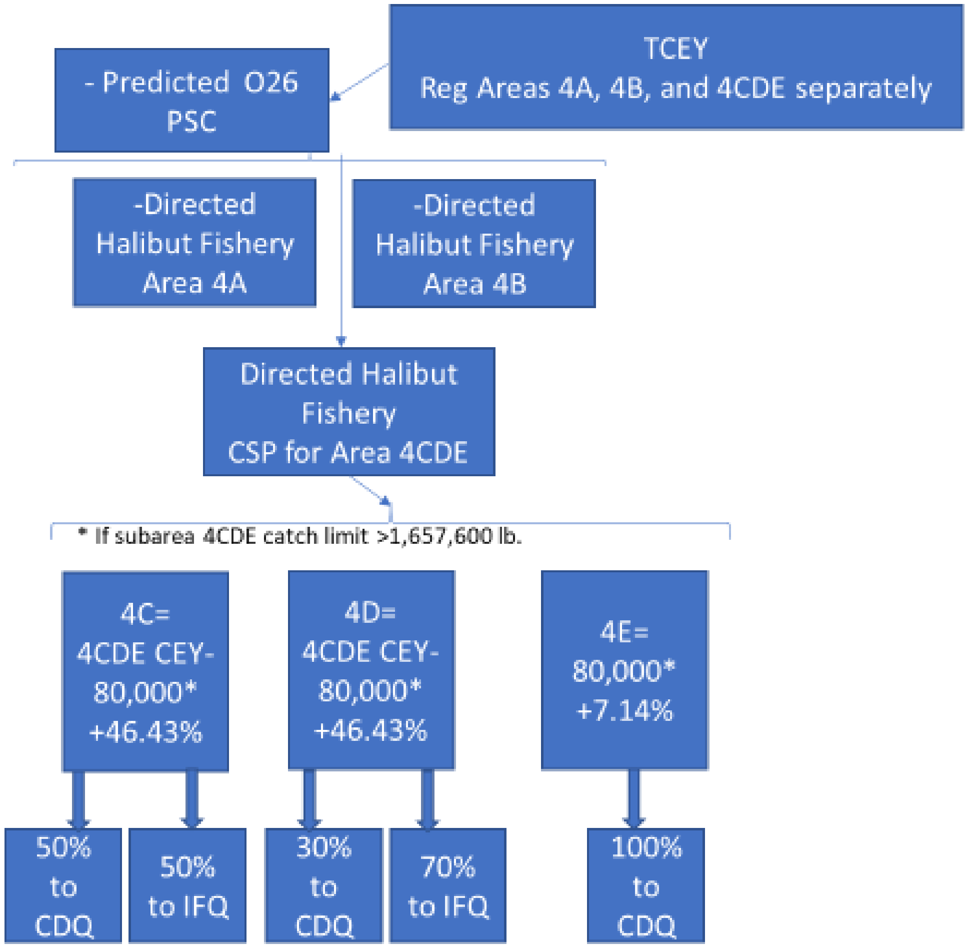


Figure 4-4. Distribution of TCEY to directed fishery users in Area 4

4.3.2 NPFMC Area 4 Catch Sharing Plan

The BSAI management area equates approximately to the IPHC's Area 4 regulatory areas. Area 4CDE and the Closed Area are considered to be a single unit in all IPHC apportionment and harvest policy analyses. Halibut allocations of the IPHC catch limits to sectors within each of the Area 4 regulatory areas (Area 4A, 4B, and 4CDE) are under the jurisdiction of the Council and NMFS, rather than the IPHC.

The 4C, 4D, and 4E subareas were created to serve the needs of the Council's Area 4CDE Catch Sharing Plan (CSP). Annually, the IPHC adopts the Council's CSP to determine the specific catch limits for these subareas. The percentage share to these areas, as determined by the Council, are: Areas 4C and 4D each receive 46.43 percent of the IPHC's adopted catch limit for Area 4CDE, and Area 4E receives 7.14 percent. If the total catch limit for Area 4CDE exceeds 1,657,600 pounds, Area 4E receives 80,000 pounds off the top of the total 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 percent, Area 4D 30 percent and Area 4E 100 percent. 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 Mlb 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

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[25]) and through resources accessible on the NMFS Alaska Region website.[26] 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 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.

[25] https://www.npfmc.org/wp-content/PDFdocuments/halibut/IFQProgramReview_417.pdf

[26] https://www.fisheries.noaa.gov/alaska/sustainable-fisheries/pacific-halibut-and-sablefish-individual-fishing-quota-ifq-program

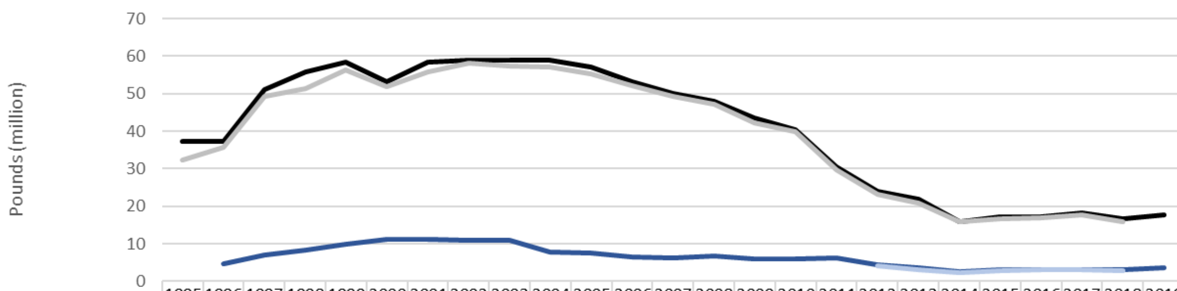
4) Maintain the diversity in the fleet with respect to vessel categories.
5) Maintain the existing business relationships among vessel owners, crews, and processors.
6) Assure that those directly involved in the fishery benefit from the IFQ Program by assuring that these two fisheries are dominated by 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. The longer fishing seasons have allowed for better handling of fish, a change in product form from frozen to fresh halibut[27], the removal of unused fishing gear from grounds, and likely fewer IFQ gear conflicts.

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 4-5 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 4.4.1.1. Decreasing TACs may change how QS holders and hired masters participate in the IFQ fisheries. For example, since decreasing TACs result 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 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.

[27] With the focus of this document on Area 4, the analysts note that 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.



	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
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
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	
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
Area 4 Catch																		4.1	3.1	2.4	2.9	3.0	3.0	2.8	

Figure 4-5 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 2019 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. 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 Area 4 QS is distributed among vessel classes. The table shows that 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 areas, 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 Area 4 halibut quota share distribution by vessel class

	4A	4B	4C	4D	4E
Class A	4%	6%	0%	8%	All CDQ
Class B	59%	77%	40%	83%	
Class C	30%	15%	22%	9%	
Class D	7%	3%	38%	0%	

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 2018. Values are shown in tons to better put commercial harvest in the context of PSC limits for the groundfish fisheries. During that period, Area 4 accounted for 21% of statewide catch on average, ranging from 18% in 2010 to 24% in 2011. Table 4-3 shows total ex-vessel value by area in inflation-adjusted 2018 dollars (millions). Overall, Area 4 accounted for 19% 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.

Table 4-2 Alaska commercial IFQ and CDQ halibut catch (t) by IPHC area, 2010 through 2018

IPHC Area	2010	2011	2012	2013	2014	2015	2016	2017	2018
2C	2,627	1,427	1,597	1,780	2,017	2,223	2,364	2,412	2,046
3	18,432	13,255	10,287	9,137	6,357	6,411	6,197	6,406	5,789
4	4,534	4,721	3,415	2,568	1,984	2,210	2,398	2,379	2,216
Total (t)	25,593	19,403	15,298	13,485	10,358	10,844	10,958	11,197	10,051
Total (M lbs.)	56.4	42.8	33.7	29.7	22.8	23.9	24.2	24.7	22.2

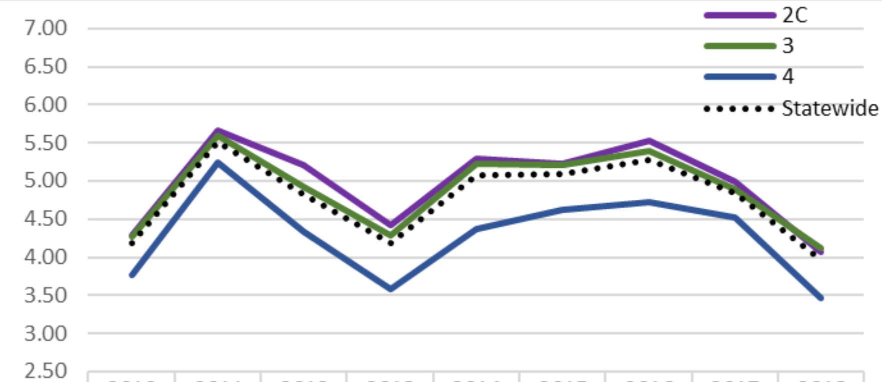
Source: CFEC Fish Ticket data provided by AKFIN
Note: Conversion to millions of lbs. (M lbs.) provided for comparison to Figure 4-5.

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

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

Source: CFEC Fish Ticket data provided by AKFIN

Figure 4-6 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 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 Figure 4-7 and Figure 4-8. The purpose of Figure 4-6 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 like 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. This regional dynamic is discussed further in Section 4.4.1.2 of this document.



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

Figure 4-6 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 4-7 and Figure 4-8 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 (CV) 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 4-8 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 4-8 highlights that average values are lower in Area 4, and particularly so in Area 4E where inshore processing availability has declined in recent years.

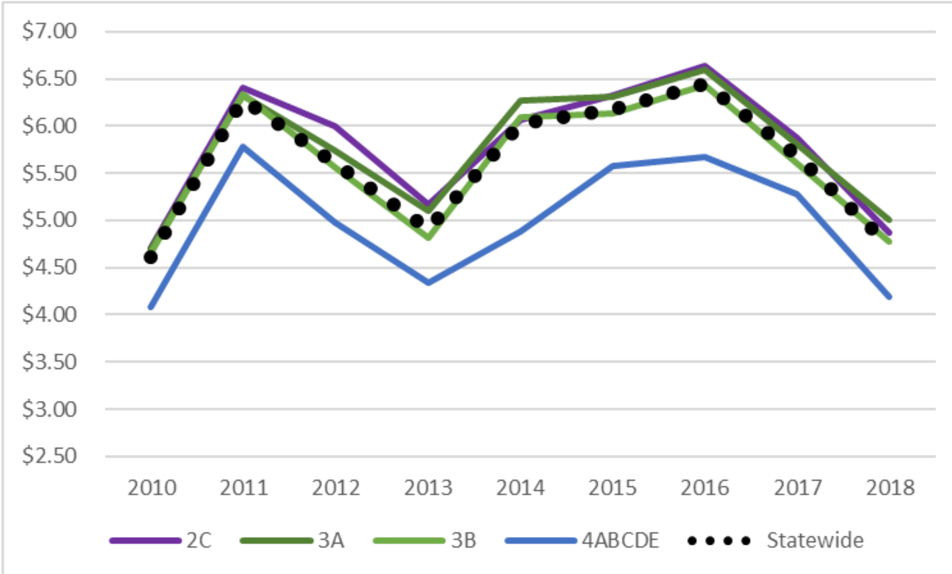


Figure 4-7 Commercial halibut ex-vessel value/lb. (nominal dollars) by IPHC area, 2010 through 2018
Source: NMFS – See "Annual ex-vessel and volume prices – Halibut" at https://www.fisheries.noaa.gov/alaska/sustainable-fisheries/alaska-fisheries-management-reports.
Note: Area 4ABCDE estimates for 2014 and 2015 omit Area 4C due to confidential data.

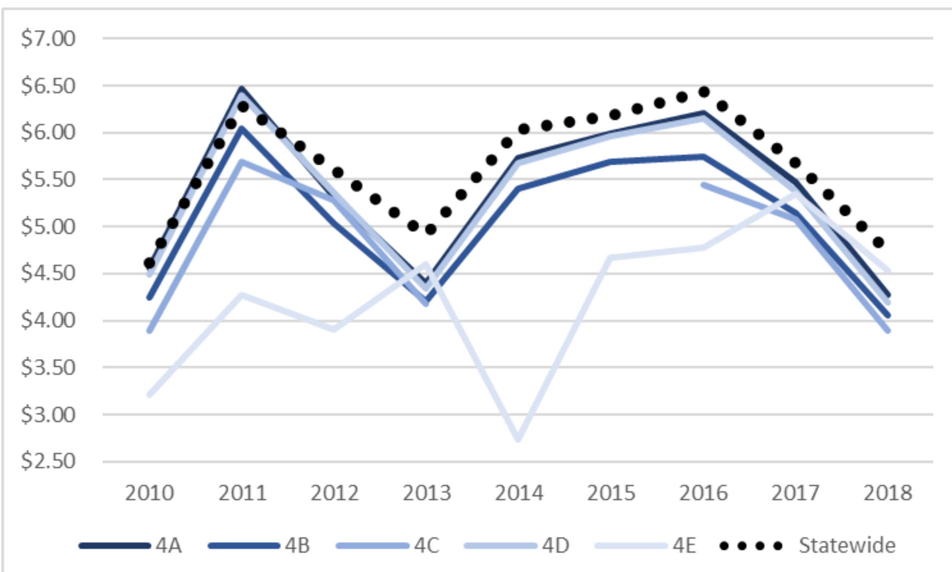


Figure 4-8 Area 4 subarea commercial halibut ex-vessel value compared to statewide value (nominal dollars), 2010 through 2018
Source: NMFS – see "Annual ex-vessel and volume prices – Halibut" at https://www.fisheries.noaa.gov/alaska/sustainable-fisheries/alaska-fisheries-management-reports
Note: Area 4C data in 2014 and 2015 is redacted as confidential.

From 2010 through 2018, the number of CVs participating in Area 4 averaged 209 per year, ranging from 337 CVs in 2011 to 123 CVs in 2018 (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 2014, 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 five. 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.

Table 4-4 Number of vessels in the Area 4 halibut fishery by vessel class, 2010 through 2018

	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
Average	**130**	**55**	**25**	**209**	**5**
Median	**81**	**53**	**22**	**150**	**4**

Section 5.7 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 2018. On average, the Area 4 fishery generated 6.47 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 4-5.

Table 4-3 reported gross halibut ex-vessel revenue from the Area 4 fishery for 2010 through 2018 (2018$). Table 4-6 reports inflation-adjusted ex-vessel revenues (2018$) by Area 4 subarea to the extent allowed under confidentiality restrictions. The annual average value was around $28 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.

Section 5.7 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 2018

	4A	4B	4C	4D	4ABCD Subtotal	4E	4ABCDE Total
2010	3,204,111	2,483,204	1,013,835	2,748,241	9,449,391	546,103	**9,995,494**
2011	3,070,785	2,749,754	1,055,179	2,923,669	9,799,387	609,221	**10,408,608**
2012	2,110,355	2,308,241	759,494	1,906,104	7,084,194	443,665	**7,527,859**
2013	1,628,942	1,661,653	678,671	1,319,916	5,289,182	372,694	**5,661,876**
2014	1,199,972	1,486,726	541,423	943,318	4,171,439	202,313	**4,373,752**
2015	1,794,649	1,454,879	549,573	954,325	4,753,426	C	*
2016	1,823,229	1,487,320	552,786	1,262,552	5,125,887	159,704	**5,285,591**
2017	1,742,815	1,397,215	678,302	1,207,444	5,025,776	C	*
2018	1,621,429	1,382,072	660,849	1,094,895	4,759,245	C	*
Average	**2,021,810**	**1,823,452**	**721,124**	**1,595,607**	**6,161,992**	**310,666**	**6,472,658**

C = confidential; * denotes data not shown in order to maintain confidentiality. Areas 4ABDC are subtotaled to give the reader a sense of total Area 4 catch without being able to show catch in 4E.
Source: CFEC Fish Tickets provided by AKFIN

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

	4A	4B	4C	4D	4ABCD Subtotal	4E	4ABCDE Total
2010	12,618,162	9,060,223	3,695,186	10,675,677	36,049,247	1,577,994	**37,627,241**
2011	16,843,193	14,018,154	5,455,909	15,818,404	52,135,659	2,418,054	**54,553,713**
2012	9,318,335	9,616,865	3,635,347	8,490,837	31,061,384	1,576,836	**32,638,219**
2013	5,883,198	5,694,140	2,540,515	4,680,621	18,798,474	1,520,714	**20,319,188**
2014	5,517,242	6,402,611	2,404,359	4,293,766	18,617,977	476,385	**19,094,363**
2015	8,544,002	6,530,837	2,503,616	4,497,403	22,075,858	C	*
2016	8,908,289	6,714,815	2,603,684	6,085,685	24,312,473	627,583	**24,940,057**
2017	8,119,576	6,122,683	2,938,104	5,522,621	22,702,984	C	*
2018	5,775,440	4,681,520	2,150,300	3,839,246	16,446,505	C	*
Average	**9,058,604**	**7,649,094**	**3,103,002**	**7,100,473**	**26,911,173**	**1,122,873**	**28,034,046**

C = confidential; * denotes data not shown in order to maintain confidentiality. Areas 4ABDC are subtotaled to give the reader a sense of total Area 4 catch without being able to show catch in 4E. 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 2018

Area	Vessel Class	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total	Average
4A	B	250,874	267,875	157,398	143,409	94,398	117,728	210,629	161,540	143,483	1,547,334	171,926
	C	1,890,376	1,947,014	1,397,768	1,037,906	781,315	1,208,128	1,163,687	1,226,283	1,139,628	11,792,105	1,310,234
	D	991,508	816,417	525,231	430,171	269,619	435,416	384,331	327,217	320,561	4,500,471	500,052
4A Total		**3,132,758**	**3,031,306**	**2,080,397**	**1,611,486**	**1,145,332**	**1,761,272**	**1,758,647**	**1,715,040**	**1,603,672**	**17,839,910**	**1,982,212**
4B	B	23,246	17,731	42,175	60,179	40,178	52,962	48,817	7,823	0	293,111	32,568
	C	1,339,774	1,404,528	1,478,062	965,649	965,348	947,827	1,024,598	962,853	952,369	10,041,008	1,115,668
	D	1,013,114	1,252,522	788,004	635,509	481,200	454,090	413,905	425,127	429,703	5,893,174	654,797
4B Total		**2,376,134**	**2,674,781**	**2,308,241**	**1,661,337**	**1,486,726**	**1,454,879**	**1,487,320**	**1,395,803**	**1,382,072**	**16,227,293**	**1,803,033**
4C	B	752,767	697,594	36,729	55,610	62,025	53,318	37,128	68,402	443,470	2,207,043	245,227
	C	252,519	324,621	54,062	10,733	23,989	25,945	16,728	50,216	203,317	962,130	106,903
	D	C	C	C	C	C	C	C	C	C	103,392	11,488
4C Total		*	*	*	*	*	*	*	*	*	**3,272,565**	**363,618**
4D	B	73,801	40,769	70,696	48,263	50,635	13,966	30,299	32,371	48,182	408,982	45,442
	C	1,590,306	1,501,540	948,842	692,631	480,105	568,280	633,887	639,464	585,446	7,640,501	848,945
	D	932,821	1,268,083	707,466	517,342	380,902	338,046	534,928	493,641	425,619	5,598,848	622,094
4D Total		**2,596,928**	**2,810,392**	**1,727,004**	**1,258,236**	**911,642**	**920,292**	**1,199,114**	**1,165,476**	**1,059,247**	**13,648,331**	**1,516,481**
4E	B	499,916	553,919	411,157	344,075	181,869	67,904	85,244	94,464	58,533	2,297,081	255,231
	C	C	C	C	C	C	C	C	C	42,684	*	44,909
	D	C	0	0	0	0	0	C	0	0	C	C
4E Total		**544,541**	*	*	*	*	*	**131,753**	*	**101,217**	**2,702,043**	**300,227**

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 2018

Area	Vessel Class	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total	Average
4A	B	977,995	1,462,095	703,842	502,860	429,209	544,593	1,013,436	723,415	492,140	6,849,586	761,065
	C	7,418,891	10,664,680	6,133,369	3,688,536	3,572,667	5,748,559	5,668,718	5,732,330	3,993,178	52,620,929	5,846,770
	D	3,948,269	4,503,281	2,346,532	1,630,759	1,269,413	2,096,484	1,922,136	1,542,938	1,228,945	20,488,756	2,276,528
4A Total		**12,345,155**	**16,630,056**	**9,183,744**	**5,822,156**	**5,271,288**	**8,389,635**	**8,604,290**	**7,998,683**	**5,714,263**	**79,959,271**	**8,884,363**
4B	B	65,045	66,038	146,502	189,463	157,336	224,107	196,252	28,774	0	1,073,517	119,280
	C	4,655,280	6,883,715	6,024,397	3,217,374	4,040,728	4,175,074	4,520,382	4,162,187	3,225,129	40,904,265	4,544,918
	D	3,965,258	6,664,069	3,445,966	2,286,270	2,204,547	2,131,655	1,998,181	1,925,643	1,456,391	26,077,980	2,897,553
4B Total		**8,685,583**	**13,613,822**	**9,616,865**	**5,693,107**	**6,402,611**	**6,530,837**	**6,714,815**	**6,116,603**	**4,681,520**	**68,055,762**	**7,561,751**
4C	B	2,715,937	3,552,121	170,138	209,019	275,208	240,425	173,594	292,160	1,439,292	9,067,894	1,007,544
	C	946,477	1,722,552	237,736	38,548	108,911	119,835	86,921	228,865	664,943	4,154,788	461,643
	D	C	C	C	C	C	C	C	C	C	473,092	52,566
4C Total		**3,695,186**	**5,353,914**	**440,139**	**271,768**	**426,279**	**473,005**	**336,312**	**584,290**	**2,114,883**	**13,695,774**	**1,521,753**
4D	B	227,333	169,138	345,149	151,466	211,198	53,072	131,700	145,629	204,152	1,638,837	182,093
	C	6,200,154	8,118,717	4,215,705	2,469,363	2,196,591	2,702,893	3,066,277	2,915,013	2,029,891	33,914,604	3,768,289
	D	3,663,785	6,920,055	3,130,578	1,837,485	1,741,229	1,582,694	2,582,680	2,278,595	1,482,009	25,219,110	2,802,123
4D Total		**10,091,272**	**15,207,909**	**7,691,432**	**4,458,314**	**4,149,017**	**4,338,659**	**5,780,657**	**5,339,237**	**3,716,052**	**60,772,551**	**6,752,506**
4E	B	1,424,443	2,158,818	1,417,217	1,430,423	395,476	230,132	300,940	440,787	183,635	7,981,871	886,875
	C	C	C	C	C	C	C	C	C	187,627	*	186,334
	D	C	0	0	0	0	0	C	0	0	C	279
4E Total		**1,576,469**	*	*	*	*	*	**496,893**	*	**371,262**	**9,661,387**	**1,073,487**

C = confidential; * denotes data not shown in order to maintain confidentiality.
Source: CFEC Fish Tickets provided by AKFIN

Treatment of Area 4A data

Note that the participation, catch, and revenue data presented in Section 4 incorporate all halibut IFQ catch that occurred in IPHC Area 4. These data include some activity that occurs in the portion of Area 4A that coincides with the GOA FMP area (Area 610) rather than the BSAI FMP area. However, the data that underly the Operating Model and associated analysis include only BSAI fishing. For this reason, the analysts thought it appropriate to identify how much harvest occurs on the GOA side of Area 4A as compared to the BSAI side. From 2010 through 2018, roughly 65% of Area 4A catch and ex-vessel value was generated in the area that overlaps the BSAI. Average annual catch by volume (IFQ pounds) in Area 4A was 1.98 million pounds, with 1.28 million in the BSAI portion and 700,000 pounds in the GOA. Median annual catch for all of Area 4A was 1.75 million pounds (1.04 million in the BSAI and 704,000 in the GOA). The percentage of annual catch that occurred on the GOA side ranged from around 29% from 2010 through 2012 to around 47% in 2016 and 2017. Measured by ex-vessel revenue, catch on the BSAI side of Area 4A was worth an average of $5.26 million annually and catch from the GOA side was worth an average of $2.94 million annually (2018$).

Table 4-9 identifies vessels whose Area 4 halibut participation occurred exclusively on the GOA side of Area 4A from 2010 through 2018. Twenty-two distinct vessels fished Area 4 halibut only on the GOA side of 4A during the studied period. The vessels fishing in Area 4A/GOA were diverse in terms of ownership residency, including Alaska (15), Washington (6), and Oregon (1). Many vessels displayed this effort pattern in only one year, while several did so in as many as five years. The greatest number of vessels with this fishing pattern in a given year was nine (2016), and the fewest was zero (2018); the annual average for the period was 5.3 vessels. Excluding 2018, the average combined gross ex-vessel revenue from this halibut fishing was roughly $518,000. The highest annual revenue was $1.05 million in 2016; and a lowest non-zero annual revenue occurred in 2017 but is confidential due to the number of vessels. This level of effort is small relative to the total Area 4 and Area 4A figures reported in Table 4-2 and Table 4-5, and thus their inclusion does not cause the Area 4 summary statistics to differ in a substantial way from the fishery catch data that was input into the modeling exercise.

Table 4-9. Vessel count and ex-vessel revenue ($2018) for vessels whose Area 4 halibut IFQ fishing occurred exclusively in the GOA side of Area 4A, 2010 through 2018

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*
Vessels	8	4	6	6	8	5	9	2	0
Ex-Vessel Rev. ($)	626,918	538,646	499,341	262,459	522,270	*	1,051,801	conf.	0

* Redacted to maintain confidentiality

4.4.1.1 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 4-9 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 equates to roughly 540 t of halibut. For comparison, the total allocation of BSAI groundfish species to CDQ groups is 195,297 t.[28] The total allocated of crab species to the CDQ program in 2018 was roughly 4 million lbs. (1,814 t).

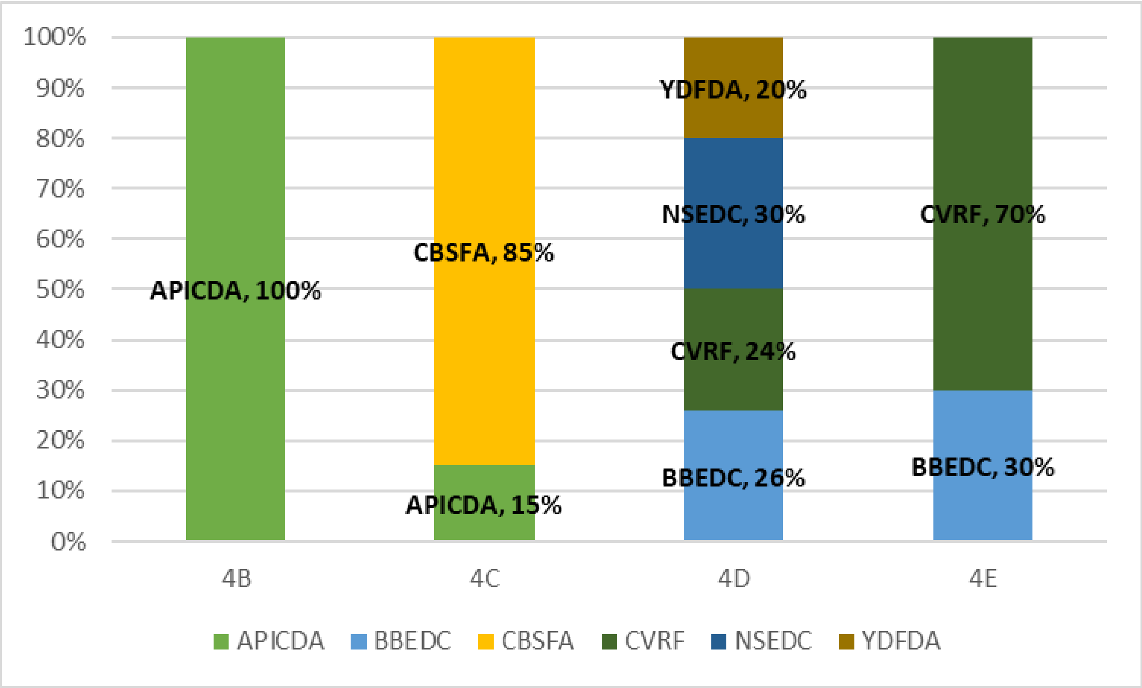


Figure 4-9 Allocation of CDQ reserve halibut by CDQ group in Areas 4BCDE

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

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

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.[29] 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[30]). 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.[31] 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 4-10 summarizes CDQ allocations, harvest, and the number of vessel landing events (i.e. trips) in Areas 4BCDE from 2013 through 2018.[32] 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

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

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

[31] MSA Section 305(i)(1)(E)(iii)

[32] 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

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 2018 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 around 1.0 million lbs. in the three most recent years. CDQ harvest was at its highest point in 2013 (1.1 million lbs.), representing an 86% harvest rate of available quota across the four subareas. Harvest rates in the other years have ranged from 85% in 2016 to 98% in 2014. It is apparent from the annual subtotals that include all of 4BCDE that the subareas where data are confidential actually account for the majority of total CDQ harvest as well as individual landing events. The pounds harvested could include both direct catch by vessels from CDQ communities and catch of quotas that was contracted to other vessels fishing in these areas and generated royalties for the CDQ group.

Table 4-10 CDQ halibut allocation, harvest, and landing events, 2013 through 2018 (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	*	*	**2016**	4B	*	228,000	*	*
	4C	*	429,500	*	*		4C	*	366,800	*	*
	4D	165	309,240	160,877	52%		4D	122	220,080	180,790	82%
	4E	876	212,000	279,910	132%		4E	122	192,800	119,821	62%
	Subtotal	**1,462**	**1,240,740**	**1,066,864**	**86%**		**Subtotal**	**558**	**1,007,680**	**851,869**	**85%**
2014	4B	*	228,000	*	*	**2017**	4B	*	228,000	*	*
	4C	*	298,300	*	*		4C	*	376,000	*	*
	4D	176	178,980	120,075	67%		4D	106	225,600	224,116	99%
	4E	240	91,800	152,118	166%		4E	*	196,000	*	*
	Subtotal	**730**	**797,080**	**784,726**	**98%**		**Subtotal**	**544**	**1,025,600**	**966,914**	**94%**
2015	4B	*	228,000	*	*	**2018**	4B	*	210,000	*	*
	4C	*	298,300	*	*		4C	*	366,751	*	*
	4D	98	178,980	116,847	65%		4D	94	220,050	157,636	72%
	4E	*	91,800	*	*		4E	*	113,000	*	*
	Subtotal	**420**	**797,080**	**721,310**	**90%**		**Subtotal**	**493**	**909,801**	**828,334**	**91%**

* denotes confidential data

4.4.1.2 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. The cost recovery fee for halibut IFQ was 2.8%, up from 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. 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 2018, the CDQ cost recovery fee percentage was 0.66%, which was up from 0.55% in 2017 and 0.29% in 2016. The total ex-vessel value of CDQ fisheries –

which, again, are comprised mostly of non-halibut species – was $86.1 million in 2018; this was an increase from $81.7 million in 2017 and $69.0 million in 2016.[33]

Section 3.3.7 of this document describes the state and municipal taxes that can also apply to commercial halibut landings. These include the Fisheries Business Tax ("raw fish tax") that the State of Alaska collects from shore-based and floating processors (3% and 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%.[34] 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 1.25% of ex-vessel value that goes toward the administration of the North Pacific Observer Program's partial coverage category (including electronic monitoring). The Council is currently considering an action that could increase the fee percentage to a level *up to* 2.0%, though no decision has been made. The Council is considering differential fee percentages based on gear type, meaning that fixed-gear halibut IFQ vessels may or may not face the same percentage increase – if any – as other gear types like trawl.

4.4.1.3 Halibut discard mortality in the commercial halibut fishery

The commercial IFQ fishery, itself, incurs halibut bycatch mortality. 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.[35] 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 fisheries-independent setline survey (FISS) 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 4-11 shows commercial halibut discards in all Alaska IPHC areas from 2009 through 2018. Area 4 accounted for 14% of the commercial discards that occurred from 2009 through 2018 across all Alaska areas. For comparison, commercial IFQ halibut bycatch mortality equated to 5.6% of the commercial catch by volume from 2009 through 2018 (1.46 million lbs. compared to 25.18 million lbs.). For those years, that relationship was highest in 2010 (6.9%) and lowest in 2018 (4.0%).

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

[34] The Alaska Taxable Supplement is available at https://www.commerce.alaska.gov/web/dcra/OfficeoftheStateAssessor/AlaskaTaxable-New.aspx. At that site the reader can refer to Table 1A ("Reported Tax Rates for Each Municipality") for local raw fish taxes rates and revenues in 2018.

[35] IPHC fishery statistics (2018) published for the January 2019 IPHC Annual Meeting; available at https://iphc.int/uploads/pdf/am/2019am/iphc-2019-am095-05.pdf

Table 4-11 Halibut discard mortality (net weight tons) in the commercial IFQ fishery, 2009 through 2018 (Source: IPHC)

Area	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Average
2C	138	118	38	43	50	54	55	56	39	27	62
3A	533	658	422	269	235	201	236	171	157	129	301
3B	361	410	349	239	183	148	98	105	106	94	209
4A	71	63	65	43	32	16	36	24	30	31	41
4B	8	17	20	17	16	25	16	27	14	9	17
4CDE	41	43	87	34	25	24	24	29	13	12	33
Total	**1,152**	**1,308**	**980**	**645**	**542**	**468**	**464**	**414**	**360**	**302**	**664**

4.4.2 Processing component

Shore-based processors accounted for over 99% of the processing of the Area 4 halibut catch from 2010 through 2018 (57.1 M lbs.). 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 2010-2018 catch of 310,000 lbs. with a combined estimated ex-vessel value of $1.3 million in inflations adjusted 2018$). 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 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 5.8 of the SIA Appendix, Area 4 halibut was processed every year in 13 Alaska communities. Within the BSAI area, those communities included Adak, Akutan, Unalaska/Dutch Harbor, St. Paul, Nome/Savoonga; Twin Hills (Togiak area). Communities elsewhere included Anchorage, Homer, King Cove, Kodiak, Sand Point, and Seward. Processors in Atka and False Pass processed Area 4 halibut in eight of the nine analyzed years. Six of the seven 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 community with inconsistent processing participation was Togiak (BBEDC CDQ region), where halibut processing occurred in all covered years since 2016.

The average number of Alaska shore-based processing facilities the received Area 4 halibut in a given year from 2010 through 2018 was 26.8, ranging from a high of 32 (2011 through 2013) to just 20 in 2018. 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 12.8 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 82%, NSEDC and BBEDC together accounted for 3%, CVRF accounted for 2%, while facilities in GOA communities accounted for 14% (see Table 35 in Section 5.8 of the SIA Appendix). Processed volume and value cannot be further disaggregated to the community level due to confidentiality restrictions. According to Fish Ticket data provided by AKFIN, the average annual gross ex-vessel revenue of the Area 4 halibut processed at Alaska shore-based facilities from 2010 through 2018 was $24.8 million (2018$). In inflation-adjusted 2018 dollars, that value ranged from a high of $54.6 million in 2011 to $16.9 million in 2018. 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 $608 million, meaning that Area 4 halibut accounted for roughly just 4% of 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 (1.1% 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 22% of ex-vessel value from Area 4 halibut. Facilities in the NSEDC/BBEDC regions (combined) generated roughly 8.5% of ex-vessel value from Area 4 halibut.

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 4-5).

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) estimates 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 can range from over 60' LOA to the size of a skiff. While this vessel-based crew estimate is small relative to groundfish CPs, it is similar to the Fish Ticket-based average annual median crew estimates for TLAS and HALCV platforms of four persons. As noted in Section 3, crew sizes for the CP sectors that are affected by the ABM action range from approximately 20 to 30 persons. A likely range for the number of individuals who work as crew each year in the Area 4 halibut CV fishery is between 440 to

800. 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 2018 period (220; refer to Section 4.4.1 and/or to Table 30 within SIA Section 5.7). 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 would suppose 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. As such, the analysts cannot estimate crew shares as a percentage of ex-vessel revenues or average crew earnings. As a result, the 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 6.3 of this DEIS. Within the SIA Appendix, subsistence use is described in SIA Section 5.9, 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 5.10.

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 Methods

This Chapter describes the simulation model used in the analysis for Pacific halibut as well as calculations for the PSC limits under all of the alternatives, and any additional analytical assumptions employed in this analysis. The methodology for the SIA is addressed in Appendix 1.

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 2018).

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 The closed-loop simulation model for Pacific halibut

We use a closed-loop simulation framework to compare the Pacific halibut stock trends and PSC limits across the set of alternatives. 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 (Appendix 3) and values estimated in Webster et al. (2013). Weight-at-age is assumed to be constant and equal to 2018 values used in the 2018 IPHC assessment models (Stewart and Hicks 2019). Although the model validation exercise used historical time-varying values of weight-at-age from Stewart and Hicks (2019), and established that matching the historical patterns of halibut dynamics required incorporating changes in weight-at-age over time (Appendix 3), weight-at-age is thought to change slowly over time and was held constant in this initial analysis of short-medium term allocation dynamics. The model included five fishing fleets: the halibut fishery in the BSAI, the halibut fishery in the other area, the BSAI trawl PSC fishery, the BSAI non-trawl PSC fishery, and the bycatch fishery in the other area. Many values for halibut population dynamics were fixed based on results from the most recent (2018) IPHC coastwide long assessment model (Stewart and Hicks 2019).

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 (Chapter 2).

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 assessment model, and applying assessment error, along with a parameter describing the influence of the previous year's assessment on the current year's assessment results to recognize that estimates from sequential assessments may be related. The coastwide catch limits were then calculated by way of a simple relationship between historical IPHC estimates of spawning biomass and total mortality of halibut in the year that followed, and subtracting the previous year's PSC mortality for over-26-inch (O26) fish as a proxy for expected O26 PSC in coming year. This approach assumes that the process of decision-making at the IPHC in the future will resemble that of the past. The model allocated a fixed percentage of the coastwide catch limit (TCEY) to the BSAI in each year, according to the historical distribution of total mortality by area. As is the case in the current management system, the PSC (and O26 PSC) in the BSAI may exceed the TCEY allocated to the BSAI in any given year. Bycatch in the other area is fixed to its 2018 value throughout the simulation.

The simulations were conducted for 20 future years and 500 simulations, each with a unique set of random deviations defining the process and observation errors modeled. We summarized the simulations using a set of performance metrics corresponding to each of the Council's defined objectives. In addition, we calculated the median and 90% intervals (the values of the quantity of interest were within this interval for 90% of the simulations) in each simulated year of spawning biomass, recruitment, recruitment allocation, PSC limits, PSC usage, and TCEY.

The model was first run for 25 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 (which is not used in this initial analysis), and the chosen mean recruitment allocation and 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.

5.2.1 Operating Model Details

5.2.1.1 Recruitment

Pacific halibut age-2 recruitment for area l, and year y is represented as a Beverton-Holt stock-recruitment relationship occurring coastwide, and then allocated among the two areas and by sex.

(1) $$R_{l,y} = \delta_{l,y} \frac{SSB_y 4hR_{0,y}}{SSB_{0,y}(1-h)+SSB_y(5h-1)} e^{\varepsilon_y - \frac{\sigma_r^2}{2}}$$

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 (see Table 5-4 for values and description of μ_x, σ_x and ρ):

(2) $\delta_{l,y} = \exp(x_y)/(1 + \exp(x_y))$, 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 (Stewart and Hicks 2019) 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~B(1,p), where $p = (1 - yInt)/(1 + exp(-k(run - midPt))) + yInt.$

Recruitment parameters were taken from the 2018 IPHC coastwide long assessment model (Stewart & Hicks 2019).

5.2.1.2 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. Five fleets are modeled: (i) the directed fishery for halibut ("the halibut fishery") in the BSAI and (ii) the halibut fishery in the other area (which is assumed to have the same selectivity-at-age in each area), (iii) the trawl PSC fishery in the BSAI, (iv) the non-trawl PSC fishery in the BSAI, and (v) 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.

The selectivity-at-age for all fleets is given in Table 5-5 and Figure 5-1-Figure 5-2. The selectivity-at-age for the halibut fishery, both in the BSAI and in the other area was that estimated from the IPHC's 2018 coastwide long assessment model in the year 2018. Selectivity-at-age in the 2018 coastwide long assessment model was allowed to vary through time, but estimates are similar for the most recent 25 years, despite changes in weight-at-age, and therefore halibut fishery selectivity-at-age was not time-varying in the OM. The BSAI trawl PSC fishery selectivity was set equal to the bottom trawl survey selectivity specified in the 2018 coastwide long assessment model. The BSAI non-trawl PSC selectivity was specified as the average of the 4ABCDE setline survey and the EBS trawl survey selectivities in 2018, as defined in the 2018 IPHC coastwide long stock assessment. The rationale behind the approach for non-trawl PSC selectivity is that the percent of over 32-inch (O32) fish in the non-trawl PSC is much lower than for the Fishery Independent Setline Survey (FISS), but higher than for the trawl PSC because the hooks for Pacific cod are smaller than for the FISS. The bycatch selectivity in the other area was fixed to the asymptotic selectivity specified for coastwide-multi-gear bycatch in the IPHC's 2018 coastwide long assessment model.

5.2.1.3 Numbers-at-age

Halibut numbers at age are updated based upon annual recruitment and age-specific survival. Recruitment is calculated at age 0, and fish under the age of 2 are not subject to fishing mortality, and the allocation of recruitment between the BSAI and the other area is specified to apply to age 2 individuals. Therefore, numbers at $a = 2$ calculated as:

(5) $$N_{l,s,y,a=2} = 0.5 R_{l,y-1} e^{-2M_s}$$

Numbers at age for all ages $2 < a < A$ 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) $$N_{l,s,y,a=A} = N_{l,s,y-1,a=A} e^{-Z_{l,s,y-1,a=A}} + N_{l,s,y-1,a-1} e^{-Z_{l,s,y-1,a-1}}$$

5.2.1.4 Spawning biomass, total biomass weight-at-age, and maturity-at-age

Spawning stock biomass in each area l is a product of female numbers-at-age, weight-at-age, and maturity at age, summed across age and sex:

(8) $$SSB_{l,y} = \sum_a \sum_s N_{l,1,y,a} w_{1,a} m_{1,a},$$

where $N_{l,1,y,a}$is the number of females in year *y* at age a in area l, $w_{1,a}$ and $m_{1,a}$ are the weight and maturity for females at each age a., and total biomass in each area, $B_{l,y}$, is:

(9) $$B_{l,y} = \sum_a \sum_s N_{l,s,y,a} w_{s,a}$$

Weight-at-age in forward simulations was fixed at the 2018 values input into in the IPHC's assessment models (which were calculated outside of the models). Likewise, maturity-at-age is set equal to values used in the 2018 IPHC assessment (Stewart and Hicks 2019; Figure 5-3).

5.2.1.5 Catch

Catch-at-age in numbers by area, sex, year, and gear is calculated as:

(10) $$C_{l,s,y,a,g} = \left(\frac{v_{g,s,a} F_{l,g,y}}{Z_{l,s,y,a}}\right) N_{l,s,y,a} \left(1 - e^{-(M_s + v_{g,s,a} F_{l,g,y})}\right)$$

Catch in units of biomass by area, year, and gear is the product of catch-at-age and weight-at-age, summed across sexes and ages:

(11) $$H_{l,y,g} = \sum_s \sum_a C_{l,s,y,a,g} w_{s,a}$$

5.2.1.6 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. We let Φ be an array of annual probabilities of movement where the *i*,*k*,*a*th element of the matrix Φ_a ($\phi_{i,k,a}$) is the annual probability of movement from area *i* to area *k* at age a. The numbers-at-age by area and sex are updated by matrix multiplying:

(122) $$N_{,s,y,a} = N_{s,y,a} \Phi_a$$

5.2.1.7 Initial Conditions

The forward simulation model is initiated with the IPHC's 2018 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 5-4).

(13) $$N_{l,s,1,a} = p_a N_{s,1,a}$$

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).

5.2.2 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 2018 coastwide long assessment model. The BTS survey selectivity was fixed within the assessment using prior information. The survey biomass was simulated as

(14) $$B_{l,y,f}^{surv} = q_f \sum_s \sum_a N_{l,s,y,a} v_{s,a,f} w_{s,a}\, exp\, (\gamma_f - \sigma_{\gamma_f}^2/2),$$

where $v_{s,a,f}$ 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 add survey observation error.

5.2.3 Calculating the measures of stock status (assessment)

The assessment process is simulated within the modeling framework, producing an estimate of spawning biomass each year, summed over areas (SSB_y) for use in defining halibut 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:

$$\tilde{B}_y = \tilde{B}_{y-1} + \theta\left[\left(\sum_l SSB_{l,y}\, exp\,(\varphi - \frac{\sigma_\varphi^2}{2})\right) - \tilde{B}_{y-1}\right], \quad (15)$$

where $\tilde{B}_y$ is the assessment-estimated spawning biomass in year y, and $\varphi \sim N(0, \sigma_\varphi^2)$.

5.2.4 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 PSC 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.

5.2.4.1 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. It is unclear what this relationship should be, especially at PSC limits and halibut biomass levels that have not be observed in recent history. As an initial assumption to understand the alternatives without the complexity of a non-linear relationship between PSC limits and use, we assumed that PSC use is the PSC limit multiplied by average the fleet-specific ratio of PSC use: PSC limit from the most recent three years (2016-2018); 0.69 for trawl PSC and 0.26 for non-trawl PSC.

A second usage scenario that was originally considered assumed that the usage percentage became higher as the PSC limit approached the floor and became more constraining. In this case, we used a linear ramp from the starting point to the floor, where at the starting point the usage was at the current three-year average ratio of PSC use:PSC limit and at the floor usage was equal to the limit. This scenario was omitted from these initial results because of odd behavior in the non-trawl sector, where the current three-year average ratio of PSC use:PSC limit is 0.26, leading to sometimes large increases in PSC use (in absolute terms) as PSC limits reached the floor of the control rule.

5.2.4.2 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-AM95). 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 halibut fishery gear). After a catch limit (TCEY) is decided upon for each regulatory area, the halibut 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 halibut fishery sector. Bycatch in the BSAI is referred to as PSC. Typically, the expected O26 inch bycatch is set equal to the O26 inch realized 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 halibut fishery catch limit is included in the model, and the model is able to approximate the magnitude of catches expected in the halibut fishery each year reasonably well. The general steps used in the model to mimic the halibut 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, (ii) distribute the expected total mortality among the two areas, (iii) subtract the expected bycatch in each area from the expected total mortality to arrive at expected catch for the halibut fishery in each area, noting that expected catch by area will equal 0 if the expected bycatch in that area is greater than the expected total mortality in the area. Next, we describe these three steps in greater detail.

5.2.4.2.1 Developing a function that relates assessed spawning biomass to expected total mortality

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 5-4). We used the total mortality in year y as a proxy for TCEY. The regression equation 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 using this variable, 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 call this a TCEY proxy. Caution should be used when interpreting the halibut fishery catches in model results – rather than evaluating the directed catches in absolute biomass, we compare the relative magnitude of halibut catches over time between management alternatives.

5.2.4.2.2 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.

(17) $$TCEY_{l,y}^{proxy} = TCEY_y^{proxy} \, B_{1,y,FISS}^{surv} / B_{2,y,FISS}^{surv}$$

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. Even though the proportion of the TCEY since 2013 in the BSAI area is slightly less than the proportion of the FISS biomass in the BSAI area, in part due to a lower relative harvest rate in the BSAI than in eastern areas, the distribution of modeled FISS biomass seems a reasonable proxy for this task because it ensures that the catch limits set in each area are responsive to major changes in the distribution of older fish between the two areas. The historical distribution of the IPHC's FISS 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. Approximately 20% of the FISS biomass has occurred in the BSAI over the last 25 years, see Appendix 3 for more information on the historical distribution of FISS biomass between the two areas.

5.2.4.2.3 Accounting for expected PSC (BSAI) and bycatch mortality (other area) to arrive at directed fishery catch limits by area

The halibut 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 2018 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 (in biomass) 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 halibut fishery is set equal to 0. Additionally, the model assumes that the halibut fishery catch by area is equal to the halibut fishery catch limit by area, and is known without error. Therefore, we define only directed fishery catches:

(18) $$C_{\text{Directed, BSAI, y}} = \max(0, TCEY^{proxy}_{BSAI,y} - PSC_{\text{Trawl, y-1,7+}} - PSC_{\text{Non-Trawl, y-1,7+}}),$$

(19) $$C_{\text{Directed, Other, y}} = \max(0, TCEY^{proxy}_{Other,y} - \text{Bycatch}_{\text{y-1,7+}}),$$

where $C_{\text{Directed,BSAI,y}}$ and $C_{\text{Directed, Other,y}}$ are the halibut fishery catches in the BSAI and other area in biomass, respectively for year *y*, $PSC_{\text{Trawl,y-1,7+}}$, $PSC_{\text{HAL,y-1,7+}}$ are the trawl and non-trawl PSC of age 7+ (O26) fish in the BSAI (only) for year *y-1*, and $\text{Bycatch}_{\text{y-1,7+}}$ is the bycatch of age 7+ (O26) fish in the other area in year *y-1*, all in biomass.

5.3 Forward Simulation

For each management alternative, the model dynamics were simulated over 20 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. The same set of random deviates were used for model runs across management alternatives to ensure that results were directly comparable across alternatives.

5.4 Performance Metrics

A small set of performance metrics were calculated, each corresponding to one of the five management objectives defined by the NPFMC. All performance metrics were calculated, averaged or calculated over the entire 20-year simulation period, averaged or calculated over the last 10 years of the simulation period.

(1) Correlation between PSC limits and total biomass (shown in plots)
(2) Ratio of PSC limit to trawl-selected biomass and ratio of PSC limit to non-trawl, non-directed-selected biomass (relates to Council Objective “Flexibility provided to avoid unnecessarily constraining the groundfish fishery particularly when halibut abundance is high”)
(3) Average annual variability (AAV; relates to Council Objective “Provide for some stability in PSC limits on an inter-annual basis”). The equation used for AAV was: $AAV = \frac{\sum_t |C_{t+1} - C_t|}{\sum_t |C_t|}$
(4) Proportion of time the percent change in the PSC limit is greater than or equal to 10% (10% is less than the 15% constraint on many of the alternatives, so provides contrast among the alternatives more so than 15% would; relates to Council Objective “Provide for some stability in PSC limits on an inter-annual basis”)
(5) Probability of the halibut fishery catch limit falling below <75% of the 2018 halibut halibut fishery catch limit (relates to Council Objective “Provide for directed halibut fishing operations in the Bering Sea”)

(6) Average annual variability (AAV) for halibut fishery catch (relates to Council Objective "Provide for directed halibut fishing operations in the Bering Sea"). The equation used for AAV was: $AAV = \frac{\sum_t |C_{t+1} - C_t|}{\sum_t |C_t|}$

(7) Proportion of time the percent change in the directed halibut fishery catch limit is greater than or equal to 15% (relates to Council Objective "Provide for directed halibut fishing operations in the Bering Sea").

A performance metric related to the Council Objective "Halibut spawning stock biomass should be protected especially at lower levels of abundance" was not calculated, as spawning biomass did not differ substantially among alternatives, but is examined through several types of plots.

5.5 Model Tables

Table 5-1 Indexing symbols used in the modeling description

Symbol	Description
$\boldsymbol{l}$	Area or location (Bering Sea and Aleutian Islands and remaining West Coast halibut range)
$\boldsymbol{y}$	Year
$\boldsymbol{s}$	Sex
$\boldsymbol{a}$	Age
$\boldsymbol{g}$	Gear type or fishing sector
$\boldsymbol{i}$	Area migrating **from**
$\boldsymbol{j}$	Area migrating **to**

Table 5-2 Quantities used in the model description

Parameter	Description
$\boldsymbol{R_{l,y}}$	Recruitment
$\boldsymbol{SSB_y}$	Spawning stock biomass
$\boldsymbol{N_{l,s,y,a}}$	Numbers at age
$\boldsymbol{B_{l,s,y,a}}$	Biomass at age
$\boldsymbol{Z_{l,s,y,a}}$	Total mortality
$\boldsymbol{F_{l,g,y}}$	Fishing mortality rate
$\boldsymbol{f_{l,s,y,a}}$	Age and sex-specific fishing mortality rate
$\boldsymbol{C_{l,s,y,a}}$	Total catch in numbers
$\boldsymbol{c_{l,s,y,a,g}}$	Catch in numbers by gear type
$\boldsymbol{H_{l,y,g}}$	Harvest in biomass by gear type

Table 5-3 Parameters in the model description

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 5-4 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	0.6	Standard deviation of recruitment process error	2018 IPHC Coastwide Long Assessment Model
h	0.75	Steepness (proportion of R0 that occurs when spawning biomass is 0.2 of its unfished value)	2018 IPHC Coastwide Long Assessment Model
$ln(R_{0,y})$ (non PDO, PDO)	10.9337, 11.294368	Unfished recruitment at age 0 in a non-PDO year and in a PDO year (PDO is Pacific Decadal Oscillation)	2018 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	0.21 (f), 0.17 (m)	Natural mortality for females and males	2018 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	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

Table 5-5 Selectivity-at-age by fleet and sex used in the operating model.

	Selectivity											
Age	Trawl PSC BSAI		Non-trawl PSC BSAI		Bycatch Other Area		Halibut Fishery BSAI & Other Area		Bottom Trawl Survey		Fishery Independent Setline Survey	
	F	M	F	M	F	M	F	M	F	M	F	M
2	0.44	0.44	0.22	0.22	0.06	0.06	0.00	0.00	0.44	0.44	0.00	0.00
3	0.79	0.79	0.39	0.39	0.35	0.35	0.00	0.00	0.79	0.79	0.00	0.00
4	1.00	1.00	0.50	0.50	0.87	0.87	0.00	0.00	1.00	1.00	0.01	0.00
5	1.00	1.00	0.51	0.51	1.00	1.00	0.00	0.00	1.00	1.00	0.03	0.01
6	0.99	0.99	0.53	0.51	1.00	1.00	0.00	0.00	0.99	0.99	0.07	0.03
7	0.90	0.90	0.54	0.48	1.00	1.00	0.01	0.02	0.90	0.90	0.18	0.06
8	0.74	0.74	0.55	0.43	1.00	1.00	0.02	0.06	0.74	0.74	0.37	0.13
9	0.56	0.56	0.59	0.40	1.00	1.00	0.06	0.16	0.56	0.56	0.62	0.24
10	0.42	0.42	0.64	0.39	1.00	1.00	0.14	0.31	0.42	0.42	0.86	0.37
11	0.32	0.32	0.66	0.41	1.00	1.00	0.29	0.42	0.32	0.32	0.99	0.50
12	0.27	0.27	0.63	0.43	1.00	1.00	0.51	0.43	0.27	0.27	1.00	0.58
13	0.24	0.24	0.62	0.42	1.00	1.00	0.76	0.43	0.24	0.24	1.00	0.60
14	0.23	0.23	0.62	0.42	1.00	1.00	0.95	0.43	0.23	0.23	1.00	0.60
15	0.23	0.23	0.62	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
16	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
17	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
18	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
19	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
20	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
21	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
22	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
23	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
24	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
25	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
26	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
27	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
28	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
29	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60
30	0.23	0.23	0.61	0.42	1.00	1.00	1.00	0.43	0.23	0.23	1.00	0.60

5.6 Model Figures

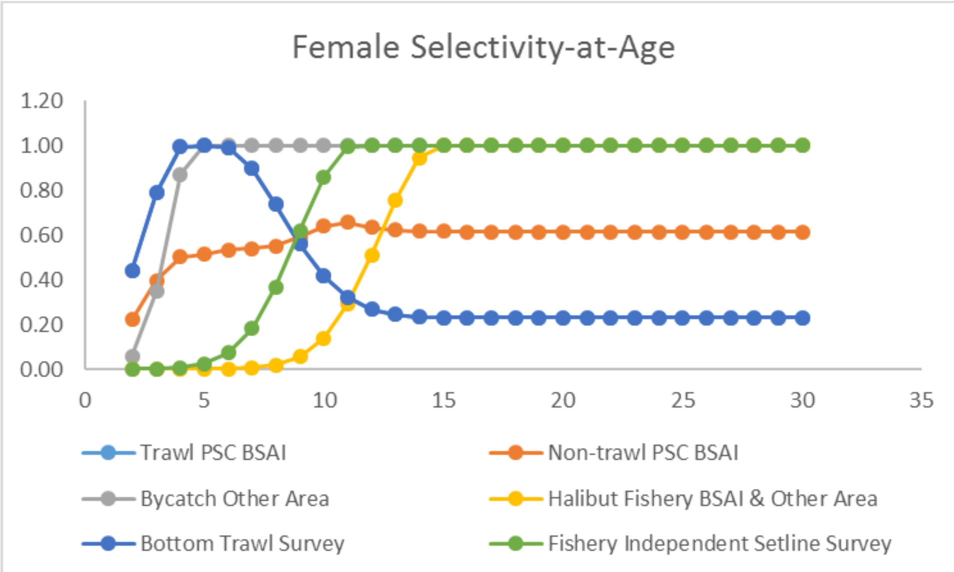


Figure 5-1. Female selectivity-at-age by fleet used in the operating model. Selectivity curves for trawl PSC in the BSAI and the Bottom Trawl Survey were assumed to be the same.

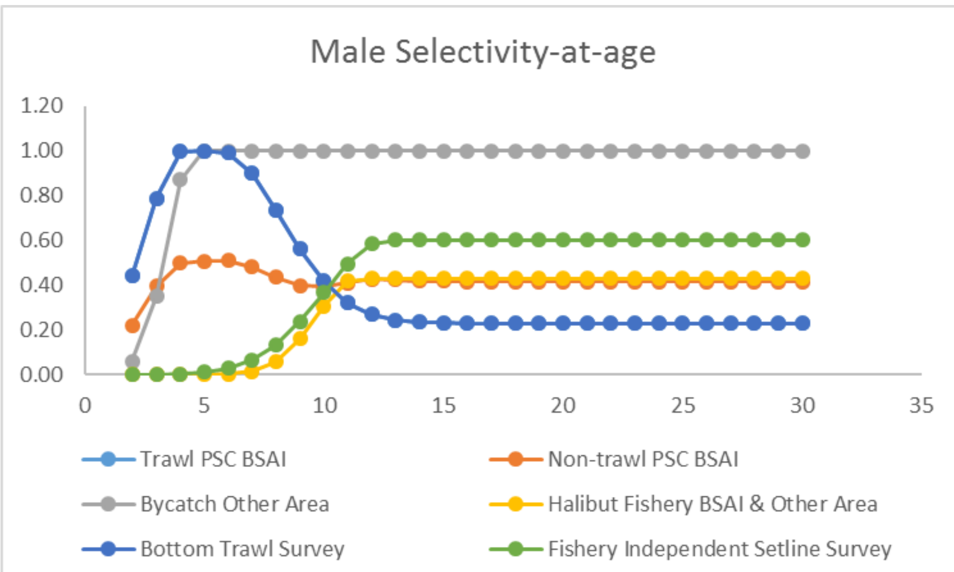


Figure 5-2. Male selectivity-at-age by fleet used in the operating model. Selectivity curves for trawl PSC in the BSAI and the Bottom Trawl Survey were assumed to be the same.

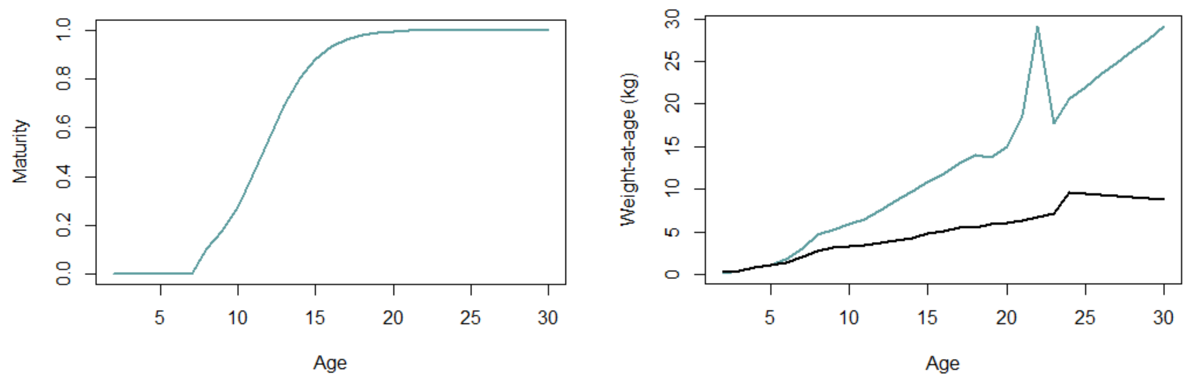


Figure 5-3. Maturity-at-age (left panel) and weight-at-age (right panel) used in the operating model for forward simulations. Females (blue), males (black), both relationships were used in the 2018 IPHC stock assessment (Stewart and Hicks 2019).

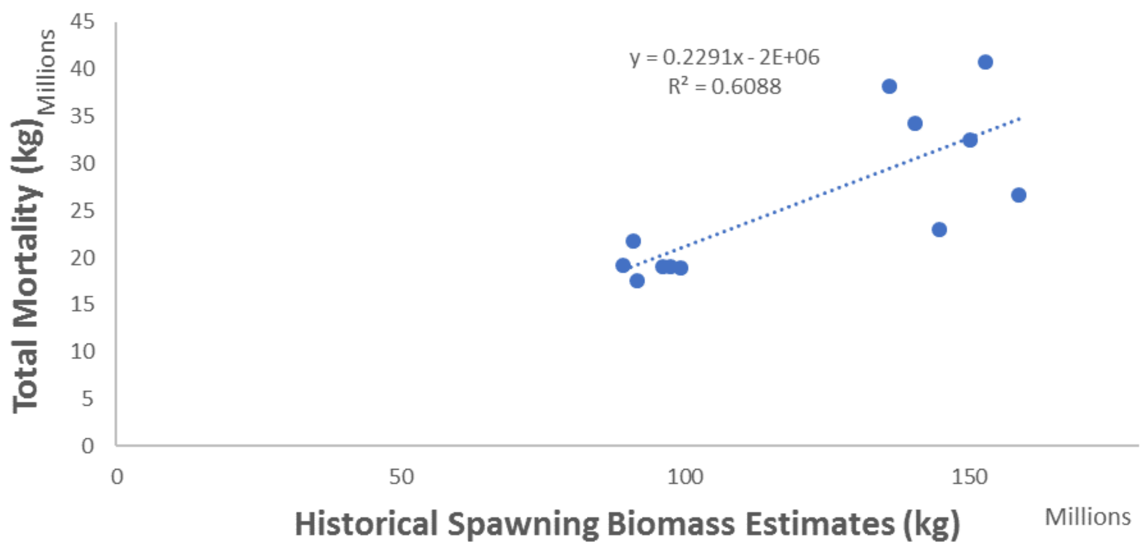


Figure 5-4. Relationship between recent historical IPHC spawning biomass estimates (in kg) and the total mortality in the year that followed, from 2007-2018.

5.7 Sector allocation

The Council motion in February indicated that "Sector-specific scenarios should be expanded to the gear level (trawl or non-trawl) and sector-level apportionments should be proportional to the status quo" and that "The analysis should clearly demonstrate the effects of the alternatives on the resulting allocations to the Amendment 80, BSAI trawl limited access, non-trawl, and CDQ sectors. Allow the CDQ PSC cap to vary with abundance in the same manner as the trawl sector." (February 2019 Council motion[36]). For

[36] February 2019 Council motion on Halibut ABM

purposes of this analysis to comply with the Council's request the following analytical decisions were made.

1. As the Elements and Options are all framed in total mortality (e.g., Elements 1, 2 and 3) and not specific by gear type a ratio was applied 20:80 for non-trawl and trawl gear respectfully. This is directly applicable to the current cap ratio between non-trawl and trawl which is 20.2% non-trawl and 79.8% trawl (these numbers were rounded for simplicity). All simulations of Alternatives 2 and 3 use this ratio to parse Elements 1-3 out by gear type.
2. The CDQ allocation varies with the trawl portion of Alternatives 2 and 3
3. In order to allocate to the sector level the following proportions were used which are equivalent to the status quo proportions of the current PSC limits when the CDQ proportion is estimated within the aggregate of the Amendment 80, TLAS and CDQ PSC limits (resulting in 2,805 t trawl and 710 t non-trawl). This results in the following: Amendment 80 62.2%, TLAS 26.6% CDQ 11.1%
4. Apportionments to target fisheries below the aggregate gear cap are assumed to be equivalent to the proportions in the 2019 harvest specifications. For non-trawl PSC limit this is equivalent to cod 93.1% and other targets 6.9%.

Implications of sector allocations are discussed qualitatively in the analysis by alternative.

6 Impacts Analysis for Groundfish and Halibut stocks and fisheries (including direct, indirect and cumulative)

6.1 Comparison of alternatives

6.1.1 Status quo and other static limits

Appendix 4 shows detailed model results for Alternative 1 (status quo), and a suite of other static limits (zero PSC for Alternative 1c and a 10,000 t PSC limit for trawl and non-trawl for Alternative 1d) for PSC use scenario 1 (using the 3-year average PSC use:limit ratio to calculate PSC usage from the limit). Results for Alternative 1 show that the PSC usage for the non-trawl fleet would increase slightly from its 2018 value because PSC usage in 2018 was lower than the 3-year average of usage relative to the limit. Alternative 1 also shows that the SSB declined in initial simulation years in both areas and then stabilized, which we see across all alternatives. Alternative 1c (zero PSC) shows the same pattern in spawning biomass over time, and similar age-2 recruitment, as well as similar values for survey indices in the BSAI to the status quo (Alternative 1) results. The directed fishery catch in Alternative 1c is larger throughout the simulation, with average values between 2,000 and 3,000 t over time (as compared to average values under Alternative 1, status quo, between 1,000 and 2,000 t over time, indicating that lower PSC limits (even PSC limits of 0) fail to lead to increases in spawning biomass and recruitment, but do lead to increases in directed fishery catches.

Alternative 1d was conducted as a demonstration of model dynamics if PSC limits were unrealistically large, given the size of the halibut stock by setting PSC limits for trawl and non-trawl each to 10,000 t. Here, the average spawning biomass in the BSAI declined over all simulation years, and was close to zero by the end of the 20 years simulation period. The average spawning biomass in the other area was lower on average than in Alternative 1 (status quo), with an average in the last year of the simulation of a little below 40,000 t (as compared to the Alternative 1 average in the last year close to 50,000 t), but was stable, indicating a relatively minor effect on spawning biomass of a huge PSC limit in the BSAI. As expected in Alternative 1d, if the PSC limits are huge, the directed fishery catch limits are equal to 0. Interestingly, when PSC limits are huge, the bottom trawl survey (BTS) index is still relatively stable, due to incoming recruitment. This occurs because (based on the model validation exercise described in Appendix 3) around 50% of the coastwide recruitment, on average, is specified to settle in the BSAI, so spawning biomass may be very low in the BSAI, but as long as the spawning biomass in the other area is being maintained, new recruits will settle there, and the BTS survey will reflect that.

6.1.2 Evaluating trends over time

Comparing all alternatives based on the simulation model results shows 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) and directed halibut fishery catches (Table 6-1). This table indicates that using an abundance-based management alternative in place of the status quo static PSC limits would have little impact on halibut spawning biomass. In contrast, the alternatives impose some large percentage changes in PSC usage and limits relative to status quo limits and simulated PSC limits are negatively correlated with Pacific halibut fishery catches (Table 6-1).

Table 6-1. Projected relative median values of PSC usage, Pacific halibut spawning biomass, and Pacific halibut directed fishery catch, and PSC limit as estimated from the simulation model. Values are expressed relative to status quo (Alternative 1 in row 1). Red shading indicates a lower relative value within each measure. Note that PSC Limit is identical (in relative terms) to PSC usage because it is in relative terms.

PSC Limit

Alternative	2020	2023	2026	2029
1	0	0	0	0
1a	-33	-33	-33	-33
1b	-44	-44	-44	-44
2.1	0	6	14	14
2.1a	1	8	15	15
2.1b	-28	-37	-32	-32
2.2	-3	-7	-7	-3
2.3	0	6	14	14
2.4	-28	-40	-38	-37
3.1	-1	3	10	13
3.1a	0	5	13	14
3.1b	-1	5	12	15
3.1c	-3	2	8	11
3.1d	-28	-39	-34	-32
3.2a	-28	-30	-26	-23
3.2b	-28	-50	-44	-35
3.3a	-36	-60	-56	-51
3.3b	-36	-38	-31	-29

PSC Usage

Alternative	2020	2023	2026	2029
1	0	0	0	0
1a	-33	-33	-33	-33
1b	-44	-44	-44	-44
2.1	3	11	19	19
2.1a	4	14	21	20
2.1b	-28	-35	-29	-29
2.2	-2	-3	-3	-2
2.3	3	11	19	19
2.4	-28	-38	-35	-35
3.1	1	7	15	17
3.1a	3	10	18	18
3.1b	2	9	17	19
3.1c	-1	7	13	15
3.1d	-28	-37	-31	-30
3.2a	-28	-30	-26	-23
3.2b	-28	-50	-44	-35
3.3a	-36	-60	-56	-51
3.3b	-36	-38	-31	-29

BSAI SSB

Alternative	2020	2023	2026	2029
1	0	0	0	0
1a	1	-1	0	2
1b	1	-2	0	2
2.1	0	0	0	0
2.1a	0	0	0	0
2.1b	0	-1	-1	1
2.2	0	0	0	1
2.3	0	0	0	0
2.4	0	-1	-1	1
3.1	0	0	0	0
3.1a	0	0	0	0
3.1b	0	0	0	0
3.1c	0	0	0	0
3.1d	0	-1	-1	1
3.2a	0	-1	0	1
3.2b	0	-1	-1	2
3.3a	0	-1	-1	2
3.3b	0	-1	-1	2

Halibut fishery catch

Alternative	2020	2023	2026	2029
1	0	0	0	0
1a	24	27	31	31
1b	32	36	43	41
2.1	0	-2	-4	-7
2.1a	0	-2	-4	-8
2.1b	11	29	29	26
2.2	4	4	3	-1
2.3	0	-2	-5	-7
2.4	11	32	34	33
3.1	1	-1	0	-6
3.1a	0	-1	0	-6
3.1b	0	-2	-2	-6
3.1c	3	2	3	-2
3.1d	11	30	30	26
3.2a	11	27	28	22
3.2b	11	35	37	30
3.3a	14	46	53	46
3.3b	14	32	32	28

Year

Percent change v SQ: 30, 0, -30, -60

Figure 6-1-Figure 6-4 show the distribution of changes in four metrics (SSB, PSC usage, PSC limit, and halibut fishery catch) over all simulations at two snapshots in time (2025 and 2035), relative to values in 2018 for each alternative. It is important to note that the difference between the presentation of results shown in Table 6-1 and that of Figure 6-1-Figure 6-4 is that the table shows values relative to Alternative 1 whereas the Figures are relative to 2018 values. The width of each colored region at each value indicates the number of simulations for which the metric was at that value. For instance, in many of the 500 simulations (over all alternatives, including status quo – Alternative 1) the SSB was approximately 40% smaller in 2025 than in 2018, and in only a few simulations the SSB was 15-30% smaller in 2025 than in 2018 (Figure 6-1). The distribution of SSB in 2025 is similar over simulations and alternatives (showing little variation among simulations relative to SSB in 2035) because the model is initiated with numbers-at-age in 2018 as estimated by the 2019 IPHC assessment, and these numbers-at-age are assumed to be known in 2018 in the model without uncertainty. This was a simplifying assumption of the model, as, in reality, uncertainty exists about the numbers-at-age and stock status in 2018. The trajectories of SSB vary over time as a function of the random values chosen for recruitment and recruitment allocation, as well as observation error modeled in the surveys and estimation error in the assessment process, such that a much greater amount of variation exists in modeled SSB in 2035 than in 2025 (Figure 6-1).

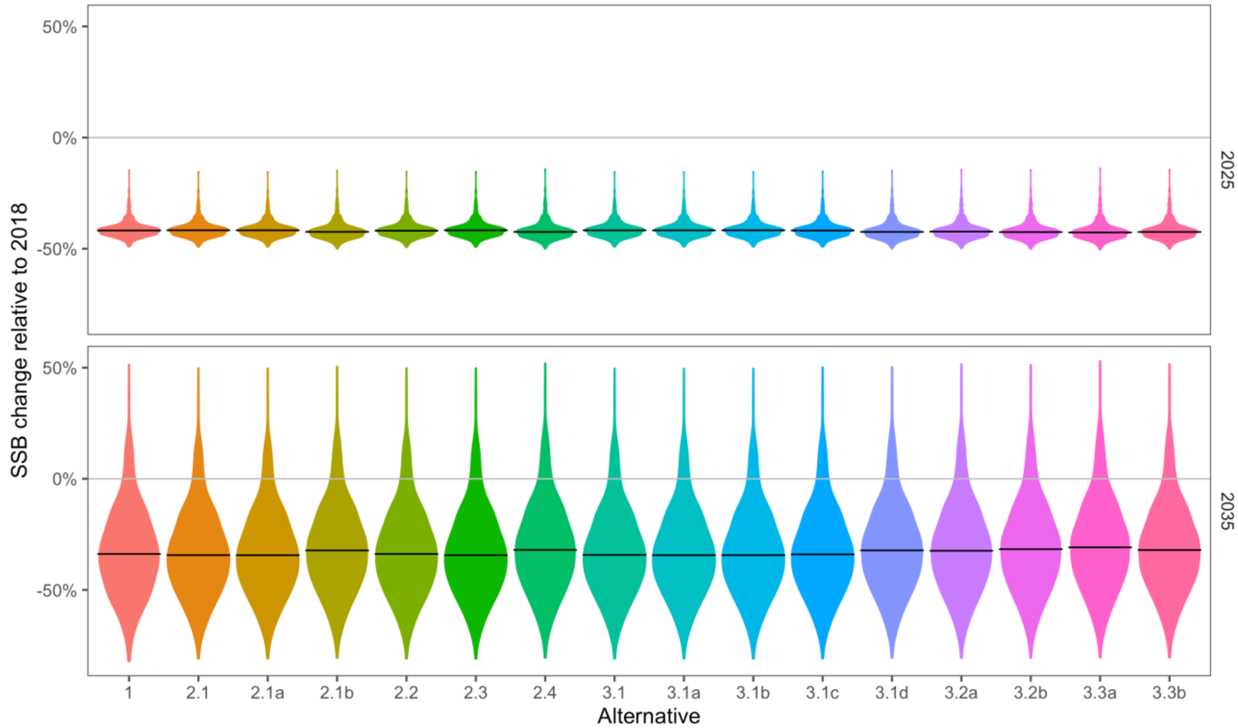


Figure 6-1. Comparison of changes in **Pacific halibut BSAI SSB** relative to the 2018 value by alternative (colors and x-axis within panels) and years (2025, top row and 2035, bottom row). Horizontal bars are median values from the simulations, the width of each region at each SSB value indicates the number of simulations for which SSB was estimated to be at that value.

Similarly, results show a broad range in the characteristic distributions of changes in PSC usage relative to usage in 2018 (Figure 6-2) for each alternative and in changes in Pacific halibut PSC limits relative to PSC limits in 2018 (Figure 6-15).

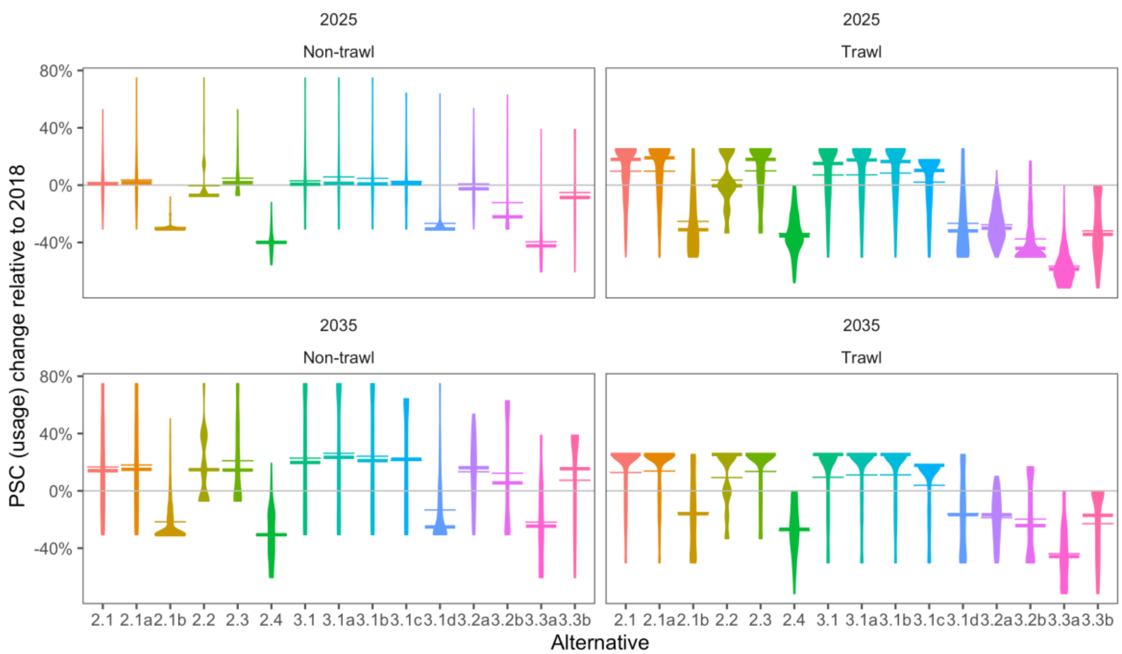


Figure 6-2. Comparison of changes in **Pacific halibut PSC usage** relative to the 2018 value by alternative (colors and x-axis within panels) by groundfish gear (columns) and years (2025, top row and 2035, bottom row). Thick and thin horizontal bars are median and mean values from the simulations, respectively.

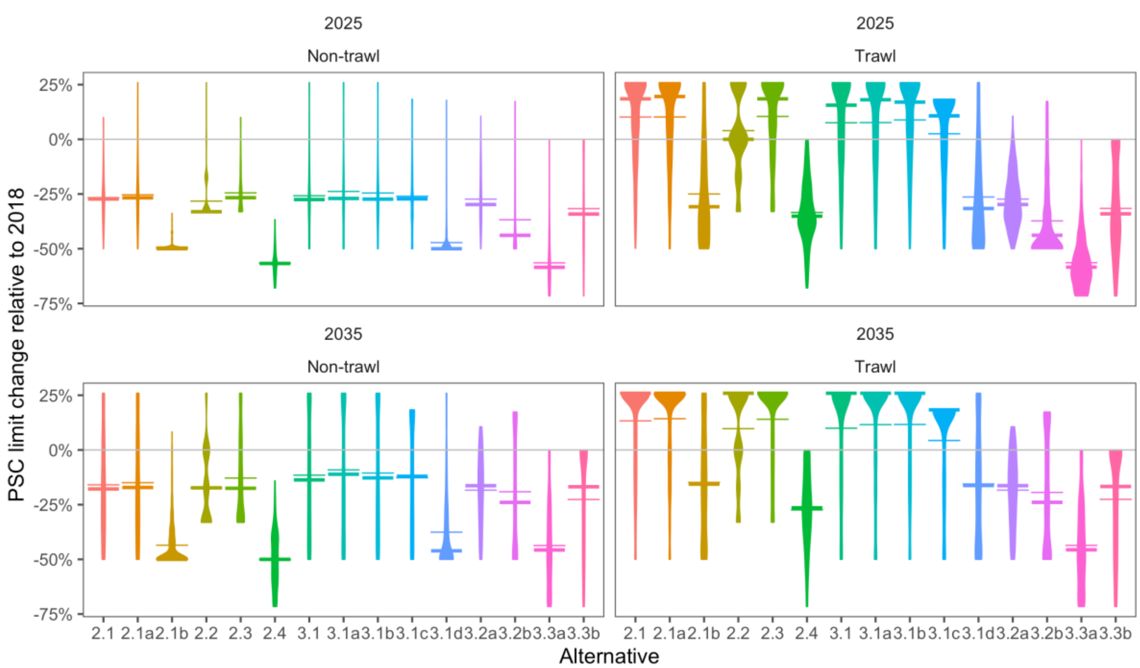


Figure 6-3. Comparison of changes in **Pacific halibut PSC limit** relative to the 2018 value by alternative (colors and x-axis within panels) by groundfish gear (columns) and years (2025, top row and 2035, bottom row). Thick and thin horizontal bars are median and mean values from the simulations, respectively. Note that the vertical scales differ from the previous figure

The impact of the alternatives on the directed Pacific halibut fishery catch varies only slightly among alternatives (relative to the 2018 catch) and each also has similar within-alternative variability which increases by 2035 (Figure 6-4). It is important to note that the difference between the presentation of results shown in Table 6-1 and that of Figure 6-1-Figure 6-4 is that the table shows values relative to Alternative 1 whereas the Figures are relative to 2018 values.

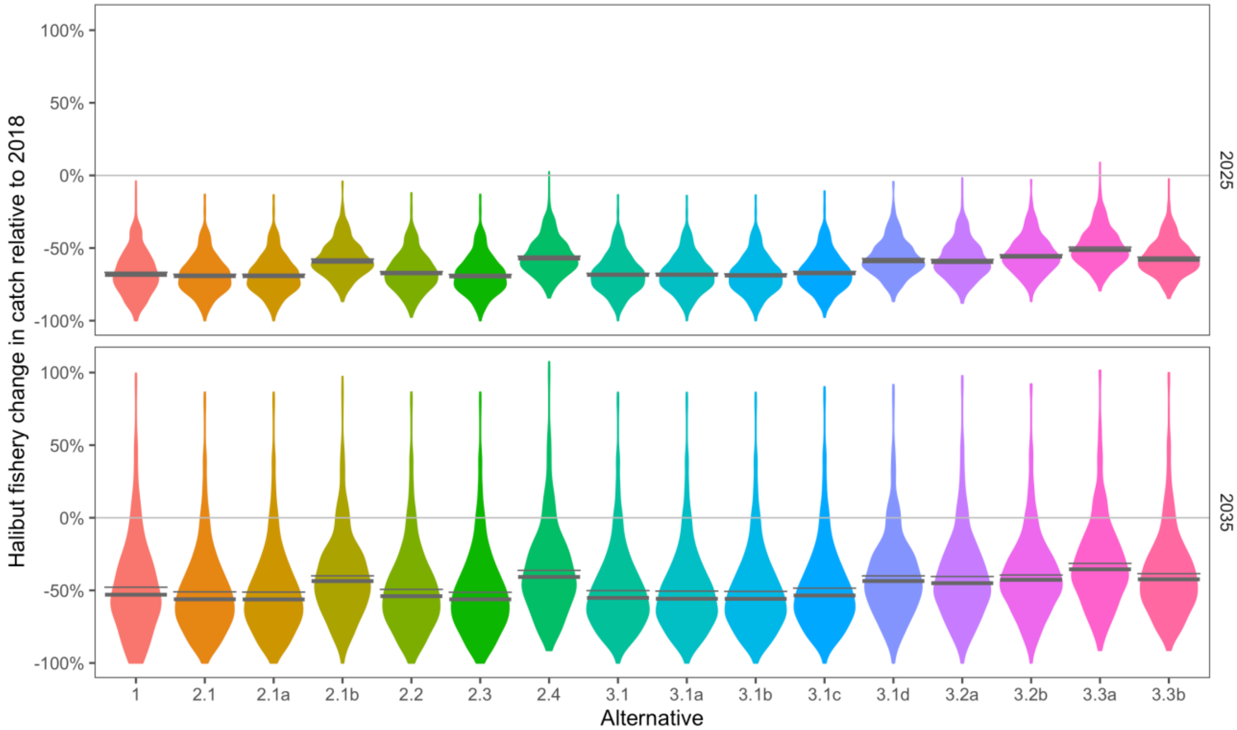


Figure 6-4. Comparison of changes in BSAI **Pacific halibut fishery catch** relative to the 2018 value by alternative (colors and x-axis within panels) by groundfish gear (columns) and years (2025, top row and 2035, bottom row). Thick and thin horizontal bars are median and mean values from the simulations.

6.1.3 Characteristics of the alternatives

The following subsections present some attributes for the alternatives conditioned on the simulation model as specified. Results may vary under biological different scenarios/simulation model specifications.

6.1.3.1 Tradeoffs between PSC limits and Pacific halibut fishery catch

Table 6-1 shows that Alternatives 2.1b, 2.4, and 3.1d-3.3b lead to lower PSC and PSC limits and larger directed halibut fishery catches than for the status quo (Alternative 1). In contrast, Alternatives 2.1, 2.1a, 2.3, and 3.1-3.1c lead to higher PSC and PSC limits and lower directed halibut fishery catches than for the status quo. Alternative 2.2 leads to PSC limits and usage that are very similar to status quo (Alternative 1; Table 6-1, Figure 6-5). These results highlight the consistent tradeoff between PSC limits and directed fishery catches for each alternative, which is expected because only the O26 portion of the expected PSC (which is the previous year's realized O26 PSC) is subtracted from the TCEY to calculated directed halibut fishery catches (and directed halibut fishery catches are equal to the directed halibut fishery catch limits in the model).

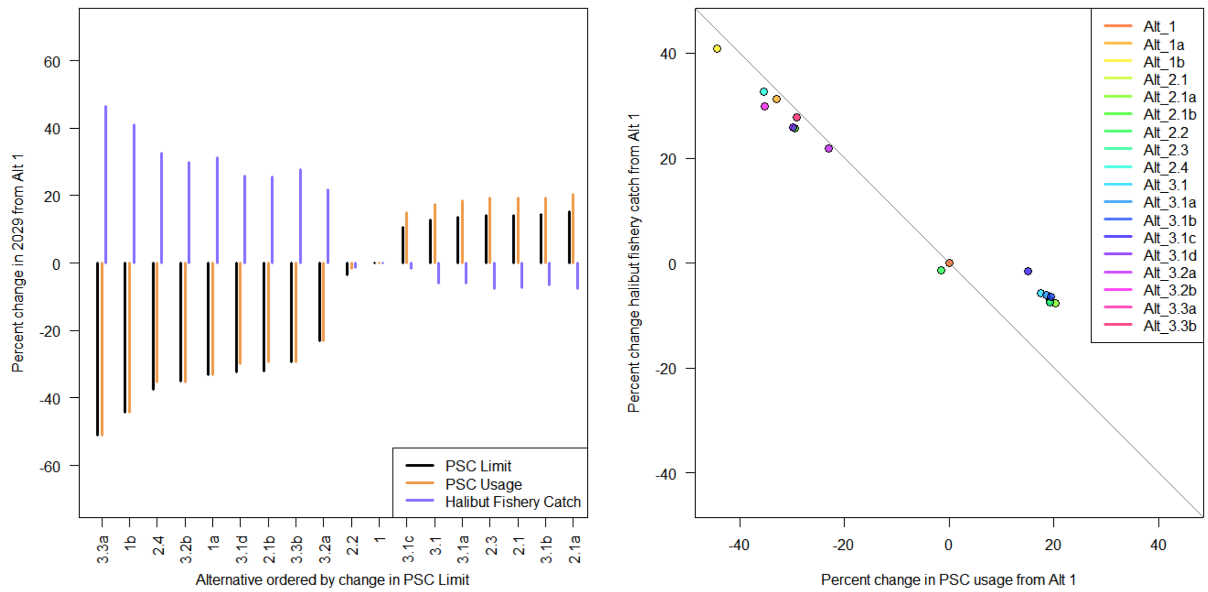


Figure 6-5. Percent change in 2029 for the median PSC limit, PSC usage, and halibut fishery catch compared to Alternative 1 ordered by the alternative with the largest reduction in the median PSC limit to the that with the largest increase in the median PSC limit (left plot). The percent change in the median 2029 halibut fishery catch is plotted against the percent change in the median PSC usage in 2029 (both compared to Alternative 1) with an inverse 1:1 line drawn to show where the trade-offs would be exactly opposite (right plot).

6.1.3.2 PSC limit changes from status quo are larger than changes in average Pacific halibut fishery catch limits

In addition, median relative decreases in PSC usage and PSC limits compared to Alternative 1 are slightly greater in absolute value than median relative increases in halibut fishery catch and limits (Table 6-1 and Figure 6-5). For instance, a median 35% decrease in PSC in Alternative 2.4 in 2029 led to a median 33% increase in the halibut fishery catch. Conversely, an increase in the median relative PSC usage led to a smaller median relative decrease in the halibut fishery catch limits. For example, a median relative increase in the PSC usage of 19% in 2029 for Alternative 2.3 resulted in a median relative decrease of 7% in 2029 for the halibut fishery catch. This occurs because only the O26 expected PSC usage (which is the previous year's realized O26 PSC usage) is taken into account in the calculation of the halibut fishery catch limit from the TCEY and the majority of the PSC is taken in the trawl fishery, which encounters U26 halibut. Therefore, an increase in 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 halibut fishery catch limit. Furthermore, for alternatives using the BTS index to calculate changes in PSC limits in the trawl fishery, 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 that is used to calculate halibut fishery catches and limits each year may change in the opposite direction until the cohort responsible for the recruitment pulse becomes part of the O26 and spawning components.

6.1.3.3 PSC and Pacific halibut fishery catches are sensitive to the starting point

There is a direct correlation between the starting point of the alternative and the resulting decreases or increases in PSC limits and directed halibut fishery catches shown in Table 6-1. The starting point is the most critical factor in determining immediate and long-term PSC limits. Figure 6-6 and Figure 6-7 show the average of the final 5 years of the simulated PSC limits for trawl and non-trawl fisheries compared to their respective starting points. The relationships are strong for both gear types, but strongest for the trawl PSC limits. The non-trawl PSC limit relationship is slightly less strong, primarily because of 3.1b which is due to its “slow-down, fast-up” control rule.

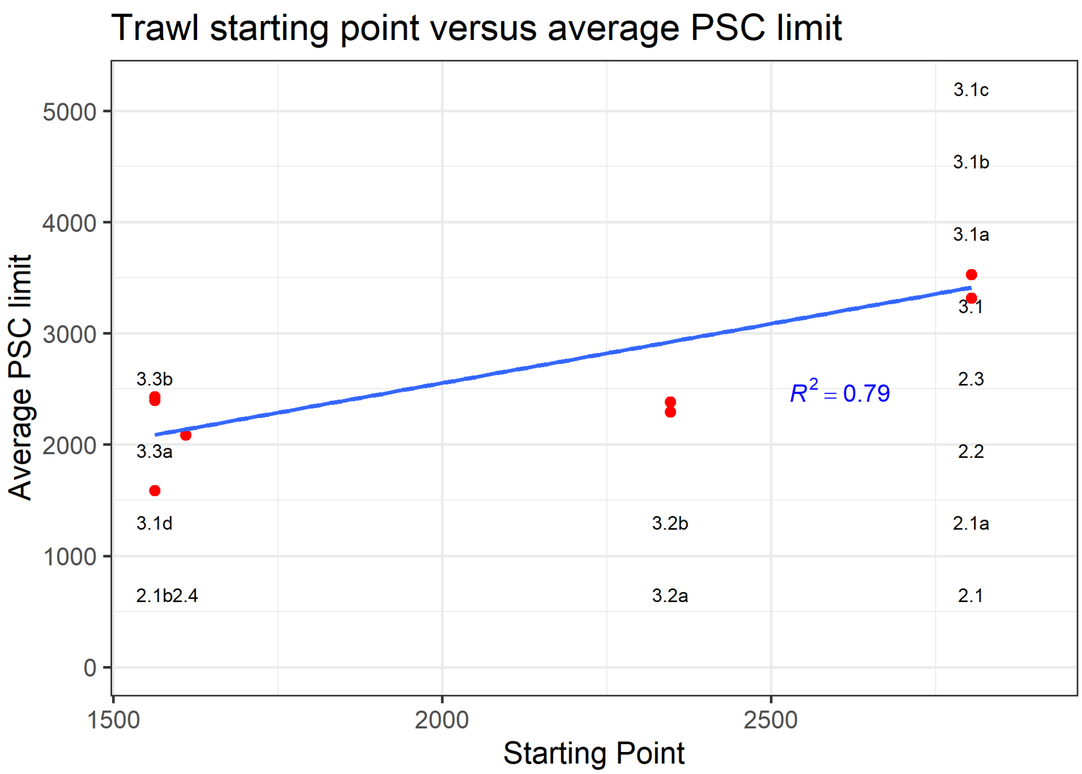


Figure 6-6. Relationship of trawl starting point versus average of the last 5 years’ simulated PSC limits. Because points overlap, labels are jittered to show which alternatives fall under the cluster of points.

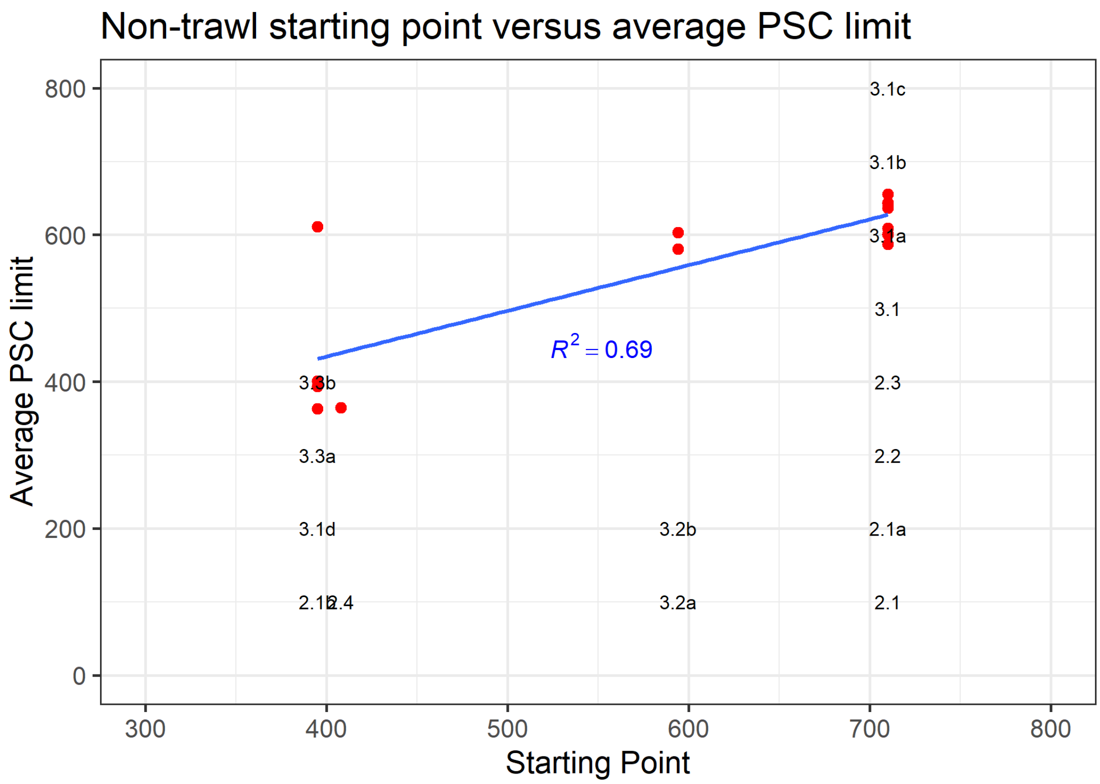


Figure 6-7. Relationship of non-trawl starting point versus average of the last 5 years' simulated PSC limits. Because points overlap, labels are jittered to show which alternatives fall under the cluster of points.

6.1.3.4 PSC limits are mostly related to halibut biomass in the BSAI

The majority of both the trawl and non-trawl PSC limits are highly correlated with the indices that were used as the primary index for those limits (Figure 6-8). The greatest exceptions were 3.3a for the trawl PSC limit and 2.1b for the non-trawl PSC limit. Alternative 3.3a is uncorrelated with the trawl index primarily because of its relatively low starting point, and the effect of the secondary index starting low and rapidly dropping in the beginning of the time series. For Alternative 2.1b, the lack of correlation is similarly due to the low starting point and the primary index rapidly decreasing while the PSC limit is constrained to only move 15% per year.

As expected, the trawl PSC limits are not well correlated with BSAI halibut spawning biomass (Figure 6-9), but the non-trawl PSC limit is highly related to BSAI spawning biomass. On the other hand, PSC limits for both gears are reasonably well correlated with BSAI total biomass (Figure 6-10). The exceptions to this only occur in the non-trawl PSC relationship with total biomass, specifically 2.1b, 2.4, and 3.1c. All three of these are generally uncorrelated because of their low starting points and constraints that do not allow them to drop immediately to the starting point and fluctuate with these decreases and the later increases in total biomass.

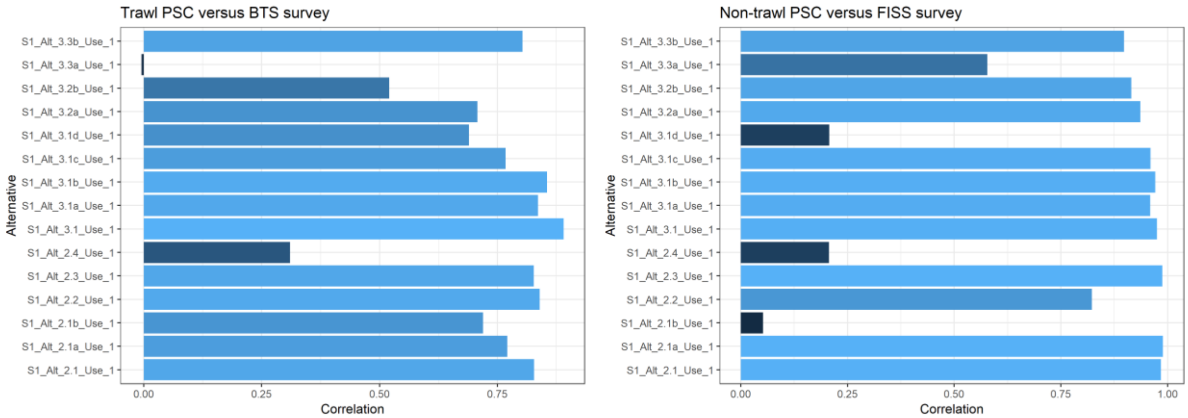


Figure 6-8. Correlations of PSC limits with their respective gear type indices across alternatives for the trawl fishery (left) and the non-trawl fishery (right).

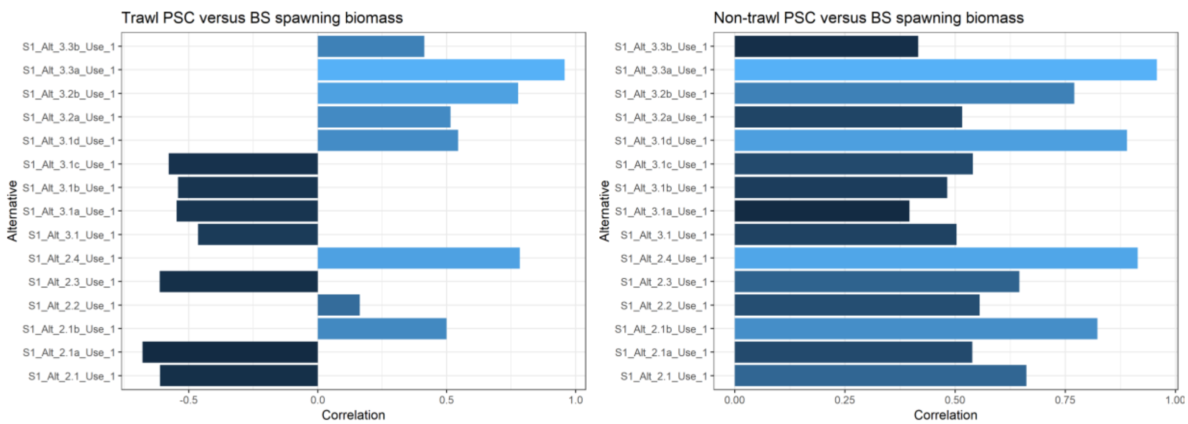


Figure 6-9. Correlations of PSC limits with halibut spawning biomass across alternatives for the trawl fishery (left) and the non-trawl fishery (right).

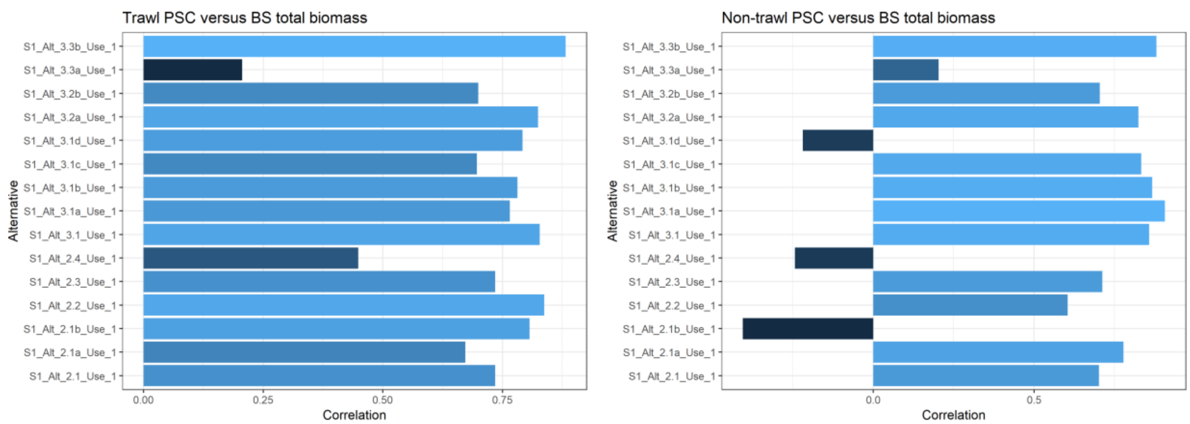


Figure 6-10. Correlations of PSC limits with halibut total biomass across alternatives for the trawl fishery (left) and the non-trawl fishery (right).

6.1.3.5 BSAI spawning biomass is insensitive to the PSC limits specified in the alternatives

As noted above, Pacific halibut relative spawning biomass (SSB) is largely insensitive to the alternatives under consideration. For example, Alternative 2.4 suggests a median relative decline of 35% in PSC limit/usage and a median relative increase of 33% in halibut fishery catch in 2029 compared to Alternative 1, but the average change to the spawning biomass in the BSAI is 1% larger in 2029 than in 2018. Any potential increases in SSB due to decreases in PSC limits are largely negated by increases (relative to status quo) in the Pacific halibut directed fishery catch (and limits).

6.1.3.6 Frequency of use of floors and ceilings across alternatives

Each of the 16 sub-alternatives that were analyzed – e.g., Alt. 1, Alt. 2-1, 2-1a, 2-1b, …, 3.1, 3.1a, …, 3.3b – included elements that define a PSC limit floor and ceiling. If a groundfish sector's PSC limit has reached the floor then any further reduction in the halibut abundance index (or indices) represents a reduction to directed halibut fishery catch but no change for the groundfish sector(s) because the limit has reached a new static level. Conversely, if the PSC limit has reached the ceiling then further increases in abundance benefit the halibut fishery but do not provide additional PSC to the groundfish sector(s) beyond that point. Figure 6-11 and Figure 6-12 show the years in which the median projected PSC limit would have been confined by the floor or ceiling for a particular sub-alternative.

Figure 6-11 shows the incidents of the trawl PSC limit reaching the ceiling. Median projections for Alternatives 2-1, 2-1a, 2-2, 2-3, 3-1, 3-1a, and 3-1b start to reach the trawl PSC limit ceiling around 2032. Within the Alternative 2 sub-alternatives, the difference between the ones that did not reach the ceiling and those that did was a lower starting point. The same is true when distinguishing between Alternative 3 sub-alternatives that did or did not reach the ceiling, except for Alternative 3-1c which had the same starting point as 3-1, 3-1a, and 3-1b but had a discrete control rule (look-up table) rather than a continuous one. The only sub-alternative under which trawl PSC limits reached the floor was 3-2b. Alternative 3-2b has a lower starting point than 3-1 and 3-1a/b/c, but not as low as the starting point for Alternatives 3-1d and 3-3a/b.

Figure 6-12 shows that median PSC limit projections for the non-trawl sectors are not likely to reach any of the defined ceilings during the modeled period, but certain sub-alternatives are more likely than not to reach the floor. (It is worth noting that historical PSC use in the non-trawl sectors is far below the level of the status quo PSC limits – see section 6.2.1). The sub-alternative that are projected to reach the floor are

2-1b, 2-2, 3-1d, and 3-2b. Alternatives 2-1b and 3-1d have relatively low starting points for the non-trawl PSC limit. Alternative 2-2 is distinguished by having a relatively higher floor. Alternative 3-2b is distinguished from other Alternative 3 sub-alternatives in that it has a non-continuous control rule (look-up table) that is not constrained in the amount that one look-up cell can differ from its nearest neighbor (i.e. the constraint is not interpolated to have an equal change between each cell).

Greater detail on model projections for these alternatives are provided in Appendix 4. The panels for abundance index values within those plots generally show the BTS increasing over time while the FISS decreases and then recovers during years that are farther into the future. As such, the trawl PSC limits tend to increase over time, reaching ceilings in the 2030s while the increase in the PSC limits for the non-trawl sector are lagged but trending upwards (i.e., off the “floor”) during the most distant years covered by model simulations.

	Alternative															
	1	2.1	2.1a	2.1b	2.2	2.3	2.4	3.1	3.1a	3.1b	3.1c	3.1d	3.2a	3.2b	3.3a	3.3b
2019																
2020																
2021																
2022																
2023														F		
2024														F		
2025																
2026																
2027																
2028			C													
2029																
2030																
2031																
2032			C						C							
2033		C	C			C			C	C						
2034		C	C		C	C		C	C	C						
2035		C	C		C	C		C	C	C						
2036		C	C		C	C		C	C	C						
2037		C	C		C	C		C	C	C						
2038		C	C		C	C		C	C	C						

Figure 6-11. Occurrence of median trawl PSC limits reaching a floor (F, pink) or a ceiling (C, blue) for each alternative and year in the simulation.

	Alternative															
	1	2.1	2.1a	2.1b	2.2	2.3	2.4	3.1	3.1a	3.1b	3.1c	3.1d	3.2a	3.2b	3.3a	3.3b
2019																
2020																
2021					F											
2022					F											
2023				F	F							F		F		
2024				F	F							F		F		
2025				F	F							F				
2026				F	F							F				
2027				F	F							F				
2028				F	F							F				
2029				F								F				
2030				F								F				
2031				F								F				
2032				F												
2033				F												
2034				F												
2035				F												
2036																
2037																
2038																

Figure 6-12. Occurrence of median non-trawl PSC limits reaching a floor (F, pink) or a ceiling (C, blue) for each alternative and year in the simulation.

6.1.3.7 Consideration of interactions with IPHC Pacific halibut management

Current IPHC harvest policy guidance is based on a fishing intensity that meets a specific Spawning Potential Ratio (SPR) to account for mortality of all sizes of Pacific halibut from all sources, and a 30:20 control rule where the fishing intensity is recommended to be reduced when the coastwide spawning biomass is estimated to be less than 30% of SSB_0, and halted when the coastwide spawning biomass is estimated to be less than 20% of SSB_0 (Section 4.3). The simulation model assumes that the TCEY is a function of spawning biomass (Section 5.2.4.2.1), estimated from management decisions that have been made since 2007. The control rule is not considered in this assumption because the 30:20 control rule was never invoked in the period examined, since the historical estimates of coastwide spawning biomass were greater than 30% of unfished spawning biomass (SSB_0). In addition, the IPHC harvest policy is used as guidance to decision-makers, and decision-makers may decide on catch limits coastwide and for each regulatory area that are above or below this guidance. Therefore, a relationship between historical spawning biomass estimates to the total mortality that resulted from these estimates was thought to be the best representation of the decision-making process. However, a number of considerations should be made when interpreting these results.

First, without modelling the 30:20 control rule, the TCEY is not reduced accordingly when the coastwide spawning biomass reaches low levels, and simulations of SSB may show declines greater than would occur if this control rule were followed. The recent IPHC stock assessment (Stewart & Hicks 2019) estimates the current stock status at 43% of unfished levels with a 95% credible range equal to 27–63%, and a probability of 11% that the stock is less than 30% of SSB_0. Due to recent poor recruitment, the spawning biomass is projected to decline under the IPHC current interim reference SPR of 46% (Figure 6-13). The projections from the simulation model used here also predict a decline in spawning biomass, which is likely to be below 30% of SSB_0 in the projected years (Appendix 4). The halibut fishery catch is simply the TCEY minus the expected O26 PSC usage (equal to the previous year's O26 PSC usage), and with the PSC limit not specifically linked to spawning biomass, the declines in spawning biomass lead to declines in the halibut fishery catch limits, but do not necessarily lead to declines in the PSC limit. With a control rule modelled, the decline in halibut fishery catch may be greater in the initial years of the projection, causing the spawning biomass to increase sooner, and leading to higher halibut fishery catches in later years of the simulations.

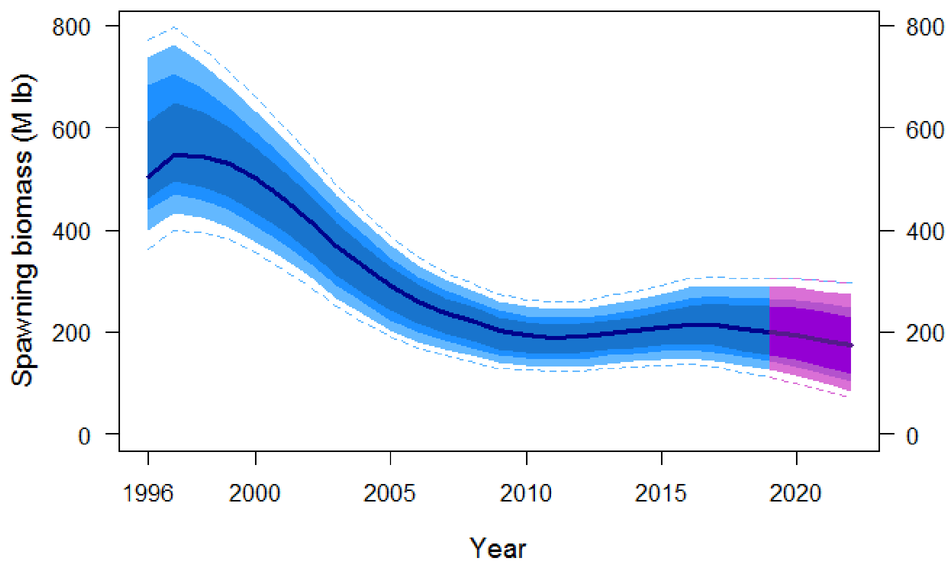


Figure 6-13. Three-year projections of stock trend under mortality related to the IPHC reference SPR=46% (40.0 million pounds, ~18,100 t). Reproduced from IPHC-2019-AM095-09, Figure 19.

Secondly, the current IPHC SPR-based guidance (currently with a target) is assumed to be reasonably approximated by the historical relationship between SSB and actual catch. As such, data (and dynamics) on the size (as mapped to age) composition of the bycatch are ignored in the current approach; including them would allow estimates that would specifically account for the lifetime impact of the removals on subsequent SSB (per recruit). Therefore, coastwide O26 and U26 abundance and mortality in each modeled year would be accounted for in the determination of that year's TCEY. While the proxy approach used here largely ignores early dynamics related to age and size of fish in the modeled population, it also avoids complications with dealing with the range of variability in the relative proportions at age observed in the bycatch (which could be influenced by factors such as selectivity and recruitment allocation varying over time). The results show that in a particular year, the halibut fishery catch is less responsive to increases in the PSC limit because some of the PSC usage is composed of U26 mortality and therefore there is a lag when extending to the impact on SSB. Long-term simulation results may show a more consistent trade-off between PSC usage and halibut fishery catch. However, tracking an SPR-basis and computing a TCEY would provide an alternative evaluation of impacts.

As mentioned in Section 5.2.4.2.1 caution should be used when interpreting the directed fishery catches, and comparisons should be made across alternatives and should not be interpreted as absolute levels of catch. Additionally, a TCEY determined from the current IPHC harvest policy would likely be more responsive to low coastwide spawning biomass levels.

6.1.4 Performance metrics describing the ability of alternatives to meet Council-defined objectives for ABM relative to groundfish and halibut

Table 6-2 through Table 6-4 show performance metrics associated with each of the Council-defined objectives for ABM, all calculated over the full 20 years of the simulation, and Figure 6-15 shows the distribution of changes in PSC limits from the previous year over the full 20 years of simulation. These metrics were developed to assess how well each alternative (or sub-alternative) met a subset of the Council objectives. The 20-year period of the simulation used in these metrics includes the initial years of the simulation where spawning biomass is simulated starting with the IPHC assessment estimates of 2018 numbers-at-age, which, as described above, led to a decline in spawning biomass over all alternatives in the initial years of simulation. In addition, some effects of transitioning between static status quo PSC limits and abundance-based PSC limits is evident in simulations where the starting point was very different from the status quo, and in cases where the starting point was different from status quo and a constraint on changes in PSC limits was imposed, creating a multi-year downward trend in PSC limits at the start of the simulation. The last 10 years of the simulations, in contrast, was a relatively stable period for SSB for all of the alternatives. Therefore, we show Table 6-5 through Table 6-7 to demonstrate the ability of each alternative to meet objectives in the last 10 years of simulation when these transition effects are generally resolved and SSB is in a more stable state.

In general, there is little contrast over simulations in the ratio of PSC limits to gear-selected biomass and in average annual variability (AAV) for trawl and non-trawl PSC limits. In Table 6-2 the ratio of trawl PSC limits to trawl-selected biomass, averaged over 20 years, is between 0.03 and 0.05 for all non-status-quo alternatives. In

Table 6-3 the ratio of non-trawl PSC limits to non-trawl-selected biomass is 0.01 for all alternatives. The average annual variability (AAV) is similar among alternatives for trawl and non-trawl PSC limits as well, with a maximum AAV in both tables of 0.12.

Some differences exist among alternatives in the proportion of time that the percent change in PSC limit from the previous year is greater than or equal to 10%, and Alternative 2.2 produces the lowest value for this metric for both trawl and non-trawl PSC limits at 0.2, or 20% of the time, for trawl PSC limits and 25% of the time for non-trawl PSC limits for 20-year performance metrics. Trawl PSC alternatives for which the percent change in PSC limit from the previous year was greater than 10% more than 40% of the time over a 20-year period were Alternatives 2.1b, 3.1d, 3.2b, 3.3a, and 3.3b – all of the alternatives in this list had a starting point below status quo. Alternative 2.4 also had a starting point below status quo and a relatively high value for this metric (39%). Many of the alternatives in this list included a 15% maximum constraint on changes in PSC limits.

Many of the non-trawl PSC alternatives led to percent changes in PSC limits from the previous year that were greater than 10% more than 40% of the time; exceptions were Alternatives 2.1b, 2.2, 2.3, and 3.2a. Of these alternatives, 2.1b still had a relatively high value for this metric (35%), consistent with its low starting point, Alternatives 2.2 and 2.3 has starting points equal to the status quo, and Alternative 3.2a had a starting point slightly lower than status quo (2,941 t aggregated across gears), but also was a discrete alternative with lower responsiveness for the primary index than 1:1.

Table 6-5-Table 6-7 show the same performance metrics calculated over the last 10 years of the simulation (rather than over the entire 20 year period), such that the transition from 2018 PSC limits to new starting points and changes in spawning biomass at the start of the simulation have already taken place. These tables show that the average ratio of PSC limit to trawl-selected biomass over the last 10 years is higher than over the 20-year period, and AAV and the proportion of time that the percent change in PSC limit from the previous year is greater than or equal to 10% are lower than for the 20-year time period. This makes sense, as it is reflective of a stable period of spawning biomass. In addition, Alternative 2.2 still achieves the best values for each of these performance metrics, indicating that, of the non-status-quo alternatives) it best meets the Council objectives related to flexibility to avoid unnecessarily constraining the groundfish fishery and providing for some stability in PSC limits.

Three directed halibut fishery performance metrics, calculated over a 20 year period starting in the first projected year, are shown in Table 6-4 and Table 6-7 to address the Council objective “provide for directed halibut fishing operations in the Bering Sea.” The probability that the halibut fishery catch limit is less than 75% of the 2018 catch limit in the BSAI is above 0.80 for all alternatives except Alt_3.3a (a probability of 0.79). The average annual variability (AAV), a measure of the average proportional change in the halibut fishery catch over the 20 year period, ranges from 0.27 to 0.39, with Alt_3.3a having the lowest AAV. The third performance metric, proportion of time the halibut fishery catch limit changes by more than 15%, also provides insight into inter-annual variability of the halibut fishery catch limit and ranges from 0.67 to 0.77 with Alt_3.3a having the lowest value. The alternatives with the lowest probability that the halibut fishery catch limit is less than 75% of the 2018 catch limit also tended to have the lowest inter-annual variability. All three performance metrics for alternatives 2.1b, 2.4, and 3.1d-3.3b were less than the performance metrics for the status quo static PSC limit alternative (Alt_1). All seven of these alternatives had a lower starting point than the status quo, supporting the conclusion that the starting point is a major driver of performance.

The performance metrics calculated over the last ten years of the simulations (Table 6-7) showed slight differences to the 20-year performance metrics but the same conclusions. The probability that the halibut fishery catch limit was less than 75% of the 2018 catch limit was lower than the performance metrics calculated over a 20-year period and Alt_3.3a was the lowest. The variability performance metrics were nearly identical for the 10-year and 20-year periods. Overall, alternative 3.3a was the best performing alternative tested in these simulations for the halibut fishery catch limit, and was one of seven alternatives that showed an improvement over the status quo alternative, all of which had a lower starting point than the status quo.

Here, Alternative 3.3a best achieves the three metrics, with the lowest probability of halibut catches falling below 75% of the 2018 catches, the lowest AAV in halibut catch and lowest proportion of the time that that the change in halibut catch limits is greater than 10%. Alternative 3.3a is unique in that it uses the FISS index to calculate both trawl and non-trawl PSC, uses a low starting point value as well as a low floor and ceiling, and uses the BTS as a secondary index with relatively low responsiveness (0.35:1). Changes in PSC limits are constrained to 20% in this alternative. As is evident from Figure 6-6 and Figure 6-7, the starting point is related to the PSC limits, and a lower PSC limit will lead to higher halibut fishery catch limits (Figure 6-5).

Comparing all the simulations by alternatives show that the relationship between coastwide SSB and PSC usage is weak (Figure 6-14). This is most likely due to the lagged impact of lower PSC limits (and subsequent usage) and SSB. This plot is included to address whether the objective “Halibut spawning stock biomass should be protected especially at lower levels of abundance” is being met. However, the SSB is never at very low levels in these simulations. A different scenario, modeling lower levels of SSB would be needed to fully assess whether the alternatives would be responsive to low levels of abundance.

Section 6.1.3.2 and Figure 6-8-Figure 6-9 address the Council objective “Halibut PSC limits should be indexed to halibut abundance.”

Table 6-2. Trawl PSC performance metrics calculated over all 20 years of simulation for each alternative. The best value across alternatives/sub-alternatives for each performance metric is highlighted in bold (defined as the value that is closest to the optimal value listed in the first row of the table)

Performance Metric	Average ratio of PSC limit to trawl-selected biomass over 20 years	AAV over 20 years	Proportion of time that the percent change in PSC limit from the previous year is greater than or equal to 10% over 20 years
Council Objective	Flexibility…to avoid unnecessarily constraining the groundfish fishery…	Provide for some stability in PSC limits…	Provide for some stability in PSC limits…
	Higher is better	*Lower is better*	*Lower is better*
Alt_1	0.04	0.00	0.00
Alt_2.1	**0.05**	0.05	0.26
Alt_2.1a	**0.05**	0.05	0.24
Alt_2.1b	0.03	0.09	0.48
Alt_2.2	0.04	**0.04**	**0.20**
Alt_2.3	**0.05**	0.05	0.25
Alt_2.4	0.03	0.08	0.39
Alt_3.1	0.04	0.05	0.30
Alt_3.1a	**0.05**	0.06	0.28
Alt_3.1b	**0.05**	0.05	0.28
Alt_3.1c	0.04	0.05	0.28
Alt_3.1d	0.03	0.08	0.48
Alt_3.2a	0.03	0.07	0.31
Alt_3.2b	0.03	0.08	0.52
Alt_3.3a	0.02	0.12	0.59
Alt_3.3b	0.03	0.09	0.48

Table 6-3. Non-trawl PSC performance metrics, calculated over all 20 years of simulation for each alternative. The best value across alternatives/sub-alternatives for each performance metric is highlighted in bold (defined as the value that is closest to the optimal value listed in the first row of the table)

Performance Metric	Average ratio of PSC limit to trawl-selected biomass over 20 years	AAV over 20 years	Proportion of time that the percent change in PSC limit from the previous year is greater than or equal to 10% over 20 years
Council Objective	Flexibility…to avoid unnecessarily constraining the groundfish fishery…	Provide for some stability in PSC limits…	Provide for some stability in PSC limits…
	Higher is better	*Lower is better*	*Lower is better*
Alt_1	0.015	0.00	0.00
Alt_2.1	**0.012**	0.09	0.49
Alt_2.1a	**0.012**	0.11	0.48
Alt_2.1b	0.008	0.07	0.35
Alt_2.2	**0.012**	**0.05**	**0.26**
Alt_2.3	**0.012**	0.07	0.39
Alt_2.4	0.008	0.11	0.59
Alt_3.1	**0.012**	0.09	0.49
Alt_3.1a	**0.012**	0.11	0.46
Alt_3.1b	**0.012**	0.09	0.49
Alt_3.1c	**0.012**	0.08	0.50
Alt_3.1d	0.008	0.07	0.40
Alt_3.2a	0.011	0.07	0.31
Alt_3.2b	0.010	0.08	0.52
Alt_3.3a	0.007	0.12	0.59
Alt_3.3b	0.010	0.09	0.48

Table 6-4. Directed halibut fishery PSC performance metrics, calculated over all 20 years of simulation for each alternative. The best value across alternatives/sub-alternatives for each performance metric is highlighted in bold (defined as the value that is closest to the optimal value listed in the first row of the table). All three performance metrics were developed to address the Council Objective "Provide for directed halibut fishing operations in the Bering Sea."

	Probability that the directed halibut catch limit in the BSAI is less than 75% of the 2018 limit over 20 years	Average Annual Variability (AAV) over 20 years	Proportion of time that the percent change in directed halibut catch limit in the BSAI from the previous year is greater than or equal to 15% over 20 years
	Lower is better	*Lower is better*	*Lower is better*
Alt_1	0.88	0.38	0.76
Alt_2.1	0.91	0.39	0.77
Alt_2.1a	0.91	0.39	0.77
Alt_2.1b	0.85	0.31	0.71
Alt_2.2	0.90	0.37	0.76
Alt_2.3	0.91	0.39	0.77
Alt_2.4	0.83	0.29	0.70
Alt_3.1	0.91	0.38	0.76
Alt_3.1a	0.91	0.39	0.77
Alt_3.1b	0.91	0.39	0.76
Alt_3.1c	0.90	0.37	0.75
Alt_3.1d	0.86	0.31	0.71
Alt_3.2a	0.86	0.31	0.71
Alt_3.2b	0.85	0.30	0.70
Alt_3.3a	**0.79**	**0.27**	**0.67**
Alt_3.3b	0.85	0.30	0.70

Table 6-5. Trawl PSC performance metrics, calculated over all the last 10 years of simulation for each alternative. The best value across alternatives/sub-alternatives for each performance metric is highlighted in bold (defined as the value that is closest to the optimal value listed in the first row of the table)

Performance Metrics	Average ratio of PSC limit to trawl-selected biomass over last 10 years	Average AAV over last 10 years	Proportion of time that the percent change in PSC limit from the previous year is greater than or equal to 10% over last 10 years
Council Objective	Flexibility…to avoid unnecessarily constraining the groundfish fishery…	Provide for some stability in PSC limits…	Provide for some stability in PSC limits…
	Higher is better	*Lower is better*	*Lower is better*
Alt_1	0.037	0.00	0.00
Alt_2.1	0.044	**0.04**	0.24
Alt_2.1a	**0.045**	0.05	0.20
Alt_2.1b	0.029	0.08	0.41
Alt_2.2	0.041	**0.04**	**0.19**
Alt_2.3	**0.045**	**0.04**	0.21
Alt_2.4	0.025	0.07	0.31
Alt_3.1	0.042	0.05	0.26
Alt_3.1a	0.042	0.05	0.23
Alt_3.1b	0.043	0.04	0.25
Alt_3.1c	0.039	0.04	0.25
Alt_3.1d	0.029	0.07	0.40
Alt_3.2a	0.029	0.06	0.22
Alt_3.2b	0.027	0.07	0.42
Alt_3.3a	0.019	0.10	0.47
Alt_3.3b	0.027	0.08	0.39

Table 6-6. Non-trawl PSC performance metrics, calculated over the last 10 years of simulation for each alternative. The best value across alternatives/sub-alternatives for each performance metric is highlighted in bold (defined as the value that is closest to the optimal value listed in the first row of the table)

Performance Metrics	Average ratio of PSC limit to non-trawl-selected biomass over last 10 years	Average annual variability (AAV) over last 10 years	Proportion of time that the percent change in PSC limit from the previous year is greater than or equal to 10% over last 10 years
Council Objective	Flexibility…to avoid unnecessarily constraining the groundfish fishery…	Provide for some stability in PSC limits…	Provide for some stability in PSC limits…
	Higher is better	*Lower is better*	*Lower is better*
Alt_1	0.013	0.00	0.00
Alt_2.1	0.011	0.08	0.45
Alt_2.1a	0.011	0.10	0.44
Alt_2.1b	0.007	0.05	0.24
Alt_2.2	0.011	**0.04**	**0.21**
Alt_2.3	**0.012**	0.07	0.35
Alt_2.4	0.006	0.08	0.44
Alt_3.1	**0.012**	0.07	0.43
Alt_3.1a	**0.012**	0.09	0.40
Alt_3.1b	**0.012**	0.08	0.44
Alt_3.1c	0.011	0.07	0.43
Alt_3.1d	0.008	0.06	0.31
Alt_3.2a	0.011	0.06	0.22
Alt_3.2b	0.010	0.07	0.42
Alt_3.3a	0.007	0.10	0.47
Alt_3.3b	0.010	0.08	0.39

Table 6-7. Directed halibut fishery PSC performance metrics, calculated over the last 10 years of simulation for each alternative. The best value across alternatives/sub-alternatives for each performance metric is highlighted in bold (defined as the value that is closest to the optimal value listed in the first row of the table). All three performance metrics were developed to address the Council Objective "Provide for directed halibut fishing operations in the Bering Sea."

Performance Metrics	Probability that the directed halibut catch limit in the BSAI is less than 75% of the 2018 limit over last 10 years	Average Annual Variability (AAV) over last 10 years	Proportion of time that the percent change in directed halibut catch limit in the BSAI from the previous year is greater than or equal to 15% over last 10 years
	Lower is better	*Lower is better*	*Lower is better*
Alt_1	0.80	0.40	0.74
Alt_2.1	0.85	0.38	0.75
Alt_2.1a	0.85	0.39	0.76
Alt_2.1b	0.76	0.30	0.69
Alt_2.2	0.84	0.38	0.75
Alt_2.3	0.85	0.39	0.75
Alt_2.4	0.72	0.29	0.68
Alt_3.1	0.85	0.37	0.74
Alt_3.1a	0.85	0.38	0.75
Alt_3.1b	0.85	0.38	0.74
Alt_3.1c	0.84	0.36	0.73
Alt_3.1d	0.76	0.31	0.69
Alt_3.2a	0.76	0.31	0.70
Alt_3.2b	0.76	0.30	0.69
Alt_3.3a	**0.66**	**0.27**	**0.66**
Alt_3.3b	0.75	0.29	0.68

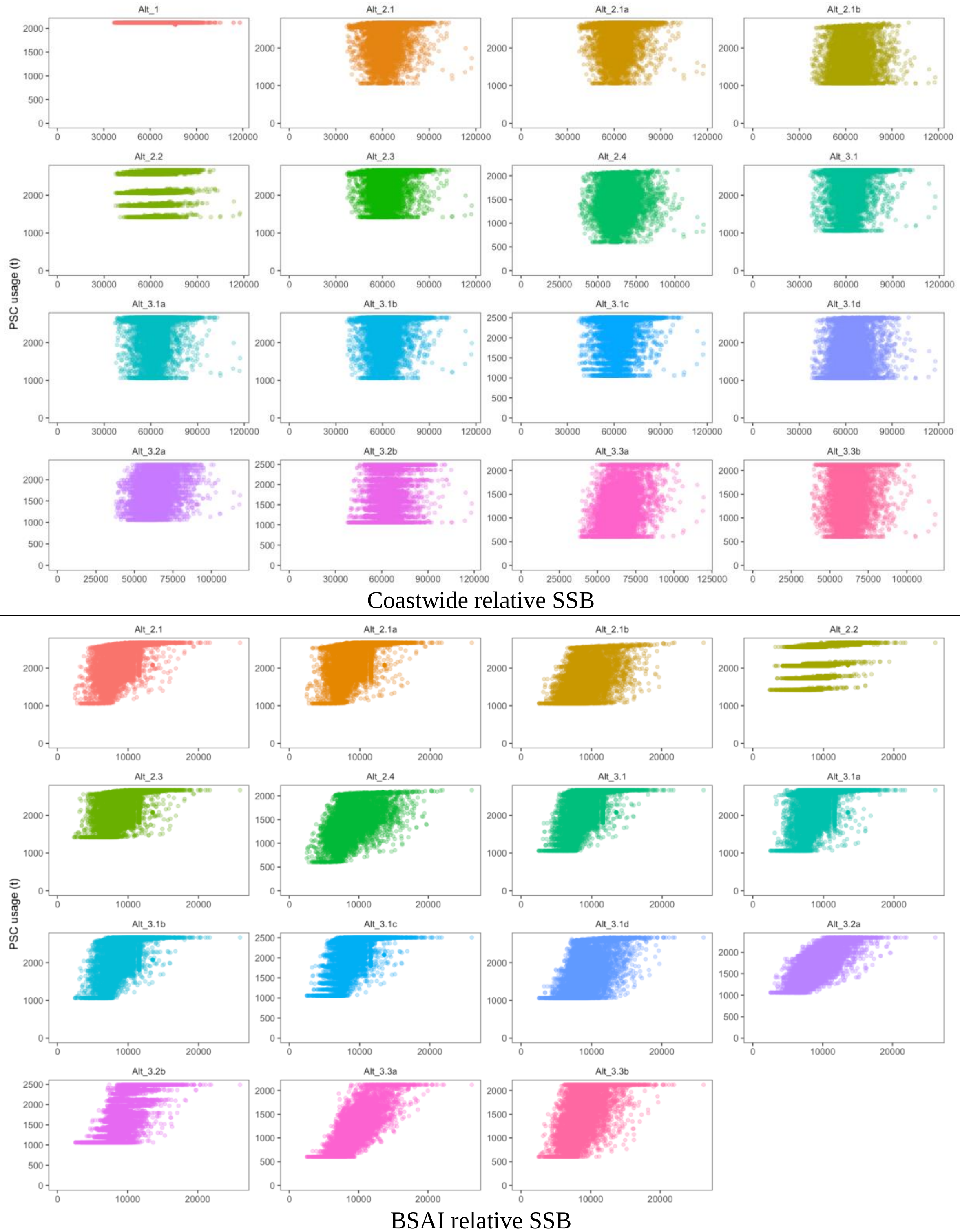


Figure 6-14. Simulation patterns for total project PSC usage (t) from 2019-2038 by alternative (colors and panels) relative to SSB (x-axis). The top set is for coast-wide SSB, bottom is for BSAI only.

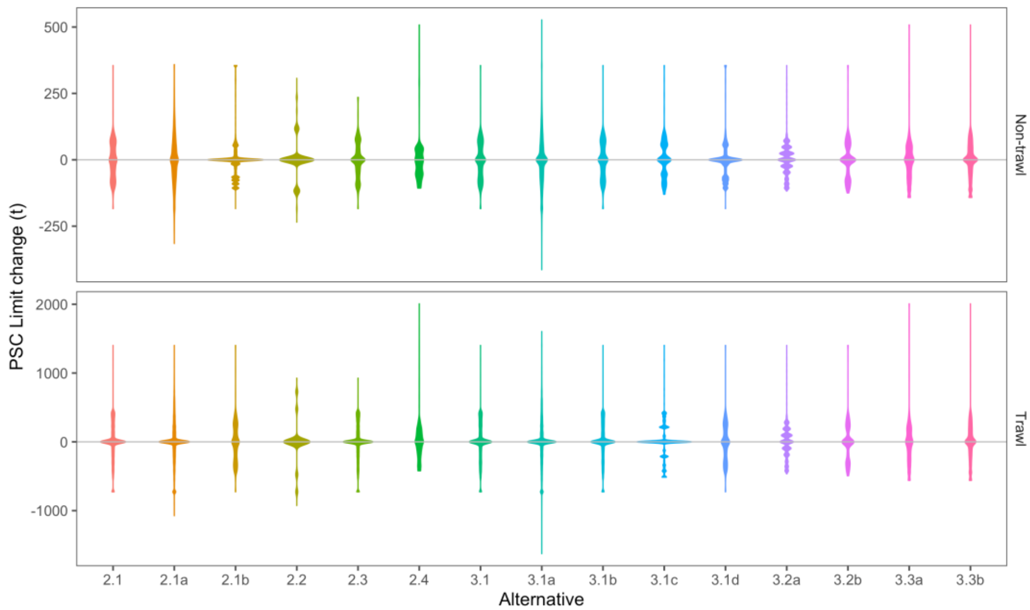


Figure 6-15. Distributions of changes in **Pacific halibut PSC limit** tons from 2018-2038 by alternative (colors and x-axis within panels) and groundfish gear (panels). The width of the shapes shows that relative frequency of changes (with zero meaning "no change"—the most common across years and simulations).

6.1.5 Examples demonstrating effects of interacting Elements and Options

Figure 6-16 compares Alternative 2.2 (the only alternative to use a stair-step approach and to use a two-year moving average of the index in the PSC control rule) to Alternative 2.1 (a continuous control rule with a 15% maximum constraint on changes in PSC limits), and to Alternative 1 (status quo). Alternative 2.2 uses the same starting points and ceilings as for 2-1, making for an interesting comparison. Spawning biomass and halibut fishery catch limits are almost exactly the same among these three alternatives, indicating a lack of benefit to the halibut fishery and stock of implementing abundance-based management under Alternatives 2.1 and 2.2. However, aside from Alternative 1 (status quo), Alternative 2.2 has the best performing values for performance metrics related to the Council objective to "Provide for some stability in PSC limits on an inter-annual basis," with average annual variability (AAV) of 0.04 for trawl PSC and 0.05 for non-trawl PSC, and 0.20 and 0.26 as the proportion of time that the percent change in PSC limit from the previous year is greater than or equal to 10% for trawl and non-trawl PSC, respectively (Table 6-2-Table 6-3, Figure 6-15).

In addition, there are some differences in PSC limits and usage. Median PSC limits and usage for the trawl sector remain at status quo in Alternative 2.2 for most years of the simulation until 2034 when a jump occurs in the median PSC limit to the ceiling (3,532 t; Figure 6-16). In contrast, in 2.1, the median trawl PSC limit slowly increases over seven years (which may be influenced by the 15% maximum constraint on changes in PSC limits); it reaches the same ceiling (3,532 t) in 2026 (eight years earlier than for Alternative 2.2), and the median PSC limit remains at or near the ceiling thereafter. The median non-trawl PSC limits respond to the FISS index very similarly, with changes to the median PSC limit in Alternative 2.1 that are smaller and more incremental than for Alternative 2.2.

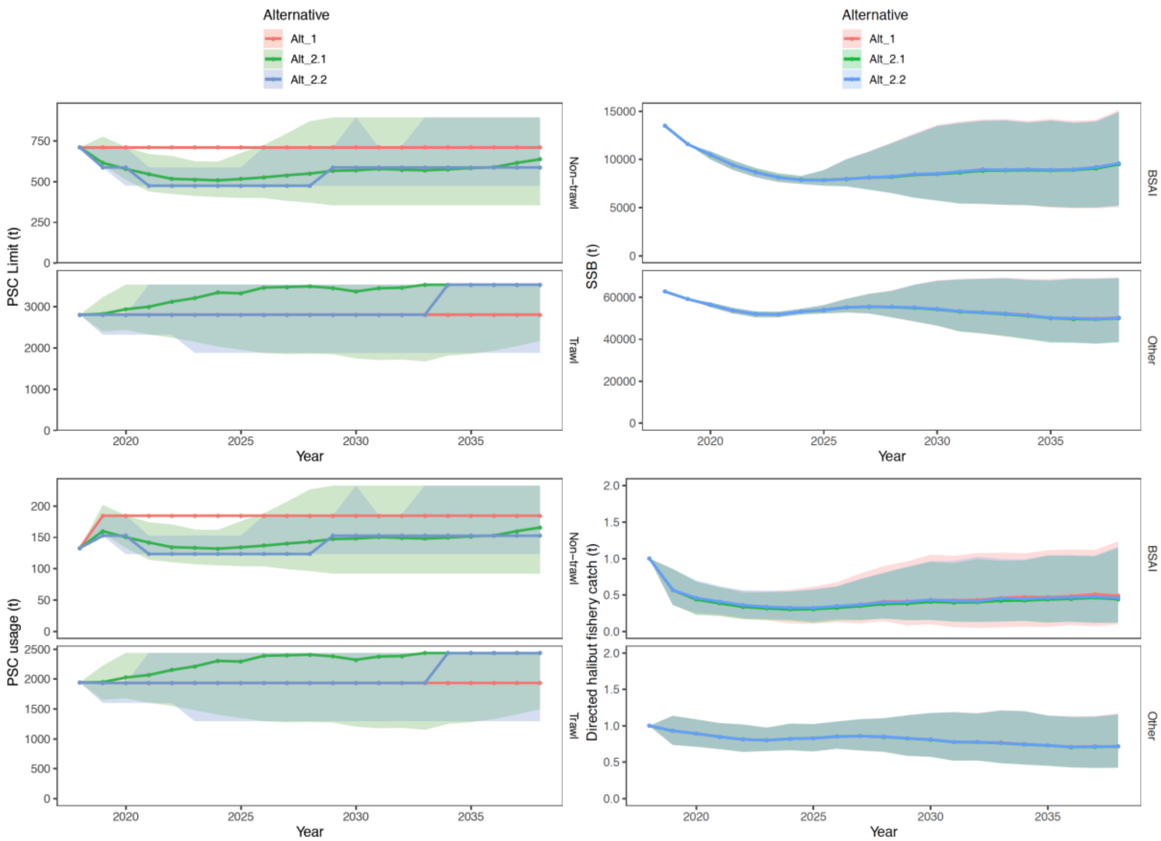


Figure 6-16. A comparison of projected PSC limits, usage, spawning biomass (SSB), and halibut fishery catch for the status quo (Alternative 1), Alternative 2.1, and Alternative 2.1 is continuous with a maximum 15% constraint on the change in PSC limit from the previous year, while Alternative 2.2 uses a stair-step approach to changes in PSC limits, but does not apply a maximum 15% constraint on changes from the previous year.

One way to compare the use of a single index with an alternative that is similar but also includes a secondary index can be examined using Alternatives 2.1 and 3.1. While only one case using one set of model assumptions for biology and trajectory of stock status, use of the secondary index in 3.1 resulted in slightly more variability in the PSC usage and limits but very little impact on spawning biomass and the halibut fishery catches (Figure 6-17).

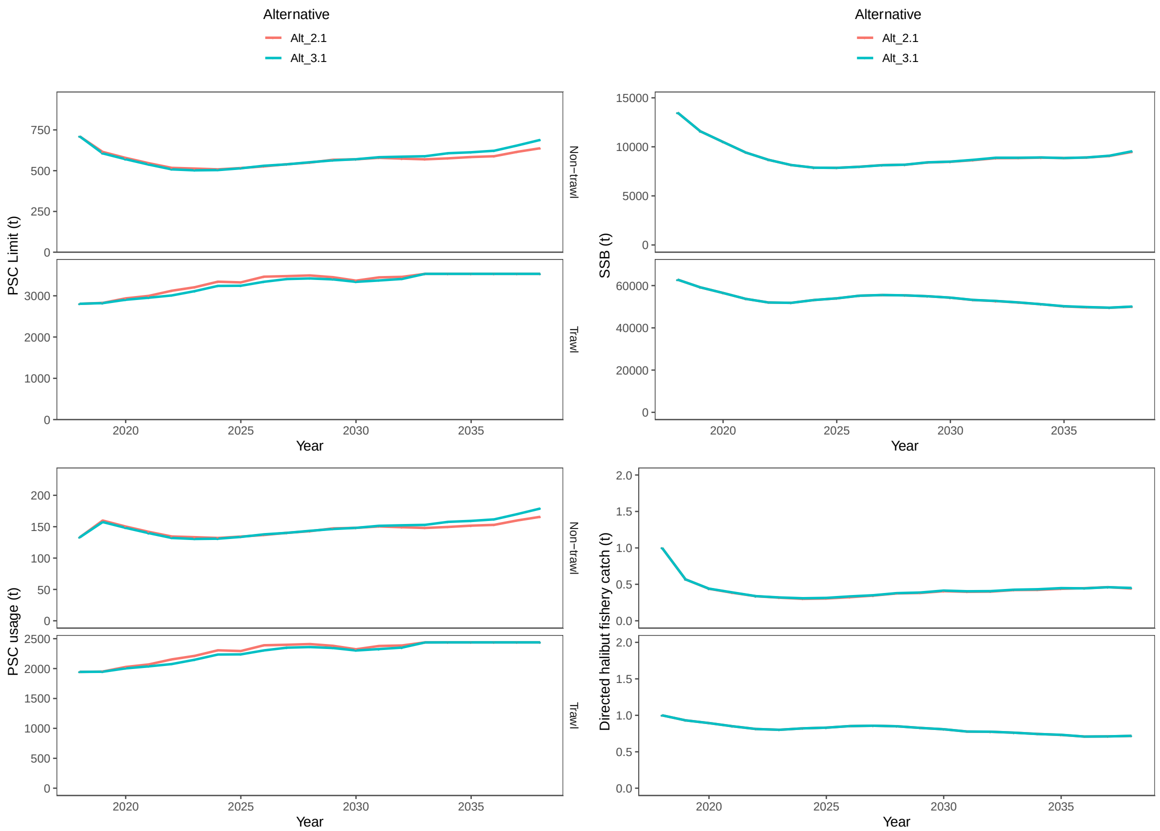


Figure 6-17. A comparison of projected PSC limits, usage, spawning biomass (SSB), and directed halibut fishery catch for Alternative 2.1 and Alternative 3.1.

Alternatives 3.2a and 3.2b are shown in Figure 6-18. In these two alternatives, which have identical starting points, floors, and ceilings, and a 15% constraint on changes in PSC limits, the index is scaled to the 1998-2018 mean index value, rather than the 2018 value. Responsiveness is interpolated in 3.2a between the floor, starting point, and ceiling, leading to responsiveness that is lower than 1:1. 3.2b has a responsiveness of 1:1 for the primary index. SSB and halibut fishery catch are nearly identical for these two options. Both show a decline in PSC limits and usage in initial years because the starting point is lower than for 2018, and this occurs over several years due to the 15% constraint on changes in PSC limits. After these initial years, the index is still low, and 3.2a stabilizes due to lower responsiveness, while 3.2b continues to decline to the floor. Thereafter, the index increases and 3.2b increases at a faster rate than 3.2a, again because of the difference in responsiveness. Non-trawl PSC usage in 2019 increases relative to 2018 because the assumption that the PSC usage:PSC limit ratio is equal to the average recent historical ratio, but non-trawl PSC usage in 2018 (defined by data, rather than the model) was lower than this average.

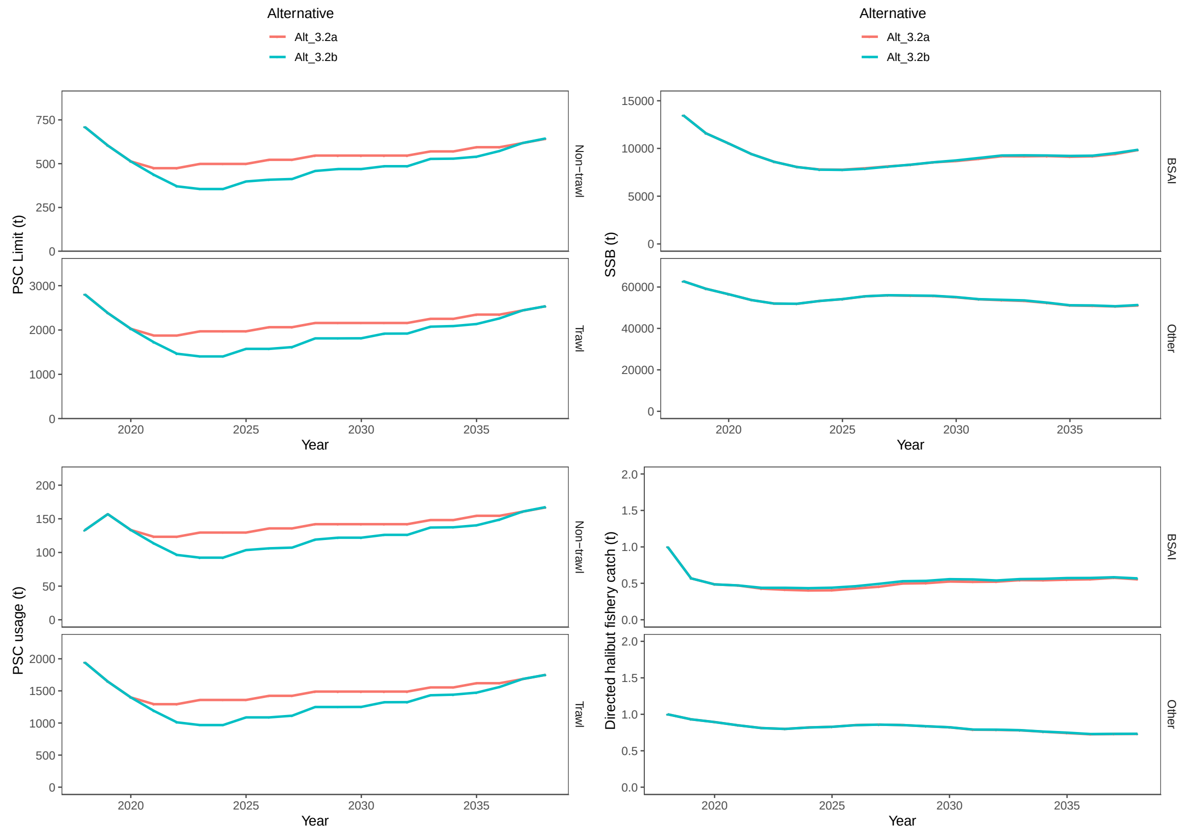


Figure 6-18. A comparison of projected PSC limits, usage, spawning biomass (SSB), and directed halibut fishery catch for Alternatives 3.2a and 3.2b.

Finally, to compare alternatives relying on one survey (FISS in 3.3a and BTS in 3.3b), Figure 6-19 shows that using the FISS index alone resulted in greater reductions in PSCs (limits and usages) for both gear types than using the BTS index alone.

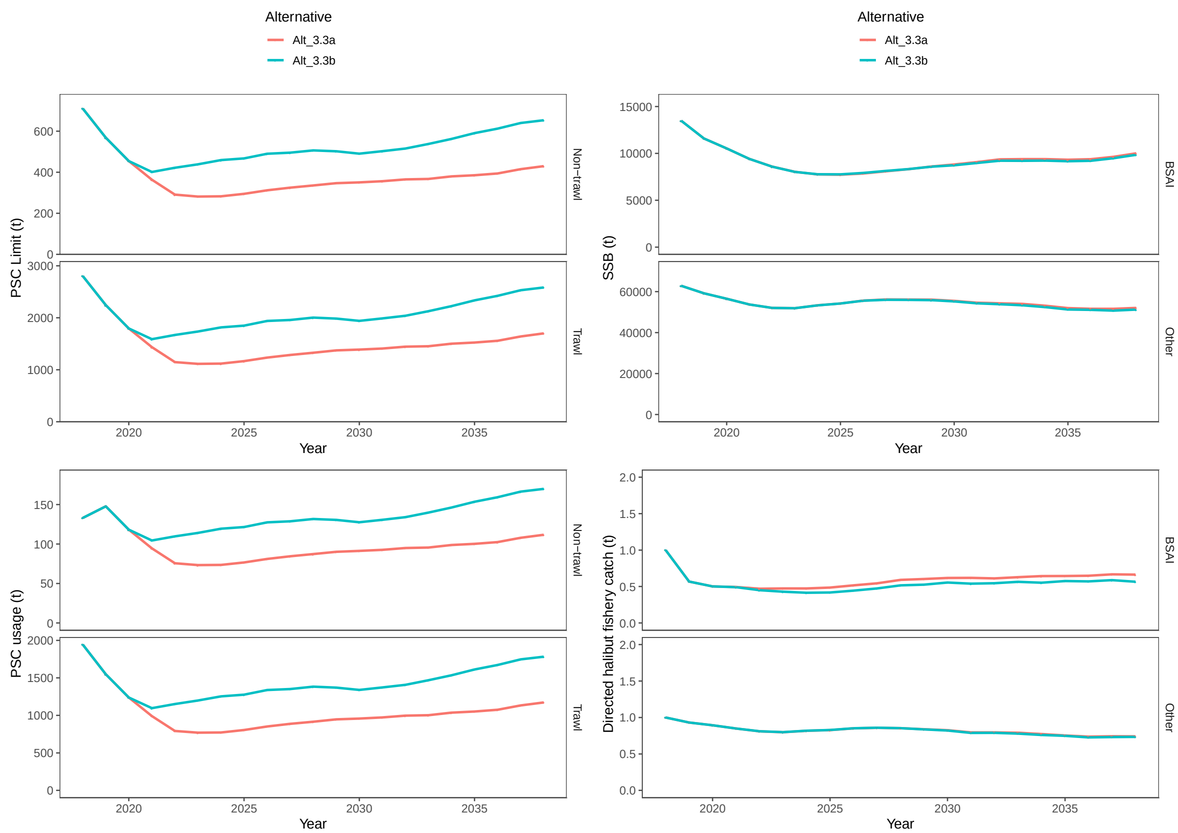


Figure 6-19. A comparison of projected PSC limits, usage, spawning biomass (SSB), and directed halibut fishery catch for Alternatives 3.3a and 3.3b.

6.1.6 Groundfish stocks

The extent that changes in PSC limits and subsequent usage will affect groundfish stocks are anticipated to be minor and similar across all of the alternatives. This is because the groundfish surveys and assessments carried out each year, along with the fisheries being 100% covered by scientific observers, monitor the groundfish stocks closely and modify 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 considerable variability in recent 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, suggesting that the directed groundfish fisheries will operate in similar areas and have access to similar species groups and groundfish size compositions. That is, changes in the general groundfish conservation status and management seem unlikely to be caused by changes in the determination of Pacific halibut PSC limits.

6.2 Economic

6.2.1 Model interpretation

Results of the closed-loop simulation model comparing Pacific halibut stock trends and PSC limits across the set of alternatives suggest that the implementation of abundance-based management of halibut PSC is an allocation decision rather than a conservation decision. PSC limits under the considered alternatives have very little impact on Pacific halibut spawning biomass and recruitment. Rather than impacting SSB, reductions in PSC lead to increases in halibut fishery catch and increases in PSC lead to reductions in halibut catch (as projected by the model relative to Alternative 1, Table 6-1). These tradeoffs between PSC limits and halibut fishery catches are not associated with changes in the SSB; rather, they occur because O26 PSC is subtracted from the TCEY to calculate directed halibut fishery catches. Therefore, as the PSC mortality decreases, a smaller amount is subtracted to calculate directed halibut catch, and the catch increases. This increase in catch limits largely offsets any potential increase in SSB due to decreased PSC limits. Thus, the direct effect of reduced PSC limits is increased catch limits for directed halibut fishing.

The tradeoffs between PSC limits and halibut fishery catches are consistently in opposite directions but not in equal amounts. Under each alternative, relative changes in PSC and PSC limits from the status quo are larger than relative changes in directed fishery catch limits (Table 6-1). This is because only the O26 PSC is subtracted from the TCEY to calculate the directed fishery catch limit. As the PSC limit changes, the catch limit changes in an opposite direction but only by the portion of PSC that is O26. The larger change in PSC limits relative to directed fishery catch limits also occur because the trawl fishery accounts for a majority of the PSC and alternatives that use the BTS index may change the PSC limit based on changes in recruitment that are larger than the changes in O26 PSC.

Not only do the alternatives illustrate tradeoffs between PSC limits and halibut catch limits, they also present tradeoffs between sectors of the groundfish fishery. Table 6-8 shows the projected median PSC limits by sector and sub-alternative in 2024 and 2030. Projected median values of PSC limits in 2024 and 2030 represent reductions from current limits for the non-trawl fishery in every alternative, while the trawl fishery receives reductions under only seven of the 15 action alternatives (Table 6-8). The lower 2024 non-trawl PSC limits occur because the model was initiated with 2018 numbers-at-age, estimated from the 2019 IPHC stock assessment (AM95), and this drives a downward trend in the spawning biomass in the first few years of the simulation under every alternative (see spawning biomass plotted over time by alternative in Appendix 4). The non-trawl PSC limits are set by the FISS (with the exception of Alternative 3.3b), which is highly correlated to the spawning biomass because FISS survey gear catches larger, older fish that are more likely to be mature. In contrast, the trawl PSC limits are related to the BTS, which tends to catch smaller, younger fish that are less likely to be mature. In addition, the biomass of smaller fish is a function of incoming recruitment. Recruitment in the BSAI in the model is a function of spawning biomass, but is also highly variable. Additionally, the proportion of recruitment between the BSAI and the other area is variable, and doesn't show the consistent downward trend in spawning biomass at the start of the simulation. The 2030 non-trawl PSC limits are generally larger than those in 2024, consistent with the fact that spawning biomass (and thus the FISS trend) stabilize in the BSAI and show a very slight increase between 2025 and 2030.

Table 6-8 Comparison of sector allocation of Pacific halibut PSC limits (t) by alternative for median values of the projection simulations to 2024 (top section) and 2030 (bottom section)

	Trawl				Non-trawl (NT)		
PSC allocation %	A80 62.3%	TLAS 26.6%	CDQ 11.1%	Trawl Total 100%	Cod 93.1%	Other 6.9%	NT Total 100%
Status quo limit	1,745	745	315	2,805	661	49	710
Avg. usage (2016-18)	1,307	431	153	1,892		163*	
2024	**A80**	**TLAS**	**CDQ**	**Trawl limit**	**Cod**	**Other**	**NT limit**
Alternative 1	1,745	745	315	2,805	661	49	710
Alternative 2.1	2,080	890	371	3,341	473	35	508
Alternative 2.1a	2,116	905	378	3,398	474	35	509
Alternative 2.1b	1,207	516	215	1,938	331	24	355
Alternative 2.2	1,746	747	312	2,805	442	33	475
Alternative 2.3	2,080	890	371	3,341	476	35	511
Alternative 2.4	1,334	485	202	1,822	279	21	300
Alternative 3.1	2,016	862	360	3,239	469	35	504
Alternative 3.1a	2,041	873	364	3,279	471	35	506
Alternative 3.1b	2,042	873	364	3,280	476	35	511
Alternative 3.1c	1,934	827	345	3,106	481	36	517
Alternative 3.1d	1,180	505	211	1,896	331	24	355
Alternative 3.2a	1,226	524	219	1,969	464	34	498
Alternative 3.2b	874	374	156	1,403	331	24	355
Alternative 3.3a	696	298	124	1,119	263	20	283
Alternative 3.3b	1,131	484	202	1,816	427	32	459
2030	**A80**	**TLAS**	**CDQ**	**Trawl limit**	**Cod**	**Other**	**NT limit**
Alternative 1	1,745	745	315	2,805	661	49	710
Alternative 2.1	2,097	897	374	3,367	530	39	570
Alternative 2.1a	2,160	924	385	3,469	537	40	577
Alternative 2.1b	1,251	535	223	2,009	331	24	355
Alternative 2.2	1,746	747	312	2,805	547	41	587
Alternative 2.3	2,096	897	374	3,367	530	39	570
Alternative 2.4	1,153	493	206	1,852	323	24	347
Alternative 3.1	2,078	888	371	3,337	531	39	570
Alternative 3.1a	2,135	913	381	3,430	541	40	581
Alternative 3.1b	2,096	896	374	3,366	538	40	578
Alternative 3.1c	2,067	884	369	3,319	531	39	571
Alternative 3.1d	1,235	528	220	1,984	331	24	355
Alternative 3.2a	1,344	575	240	2,158	509	38	546
Alternative 3.2b	1,128	483	201	1,812	437	32	469
Alternative 3.3a	864	370	154	1,388	327	24	351
Alternative 3.3b	1,209	517	216	1,942	457	34	491

* The 2016-2018 average usage for non-trawl includes both the HALCP and HALCV sectors. Figure 2-1 illustrates that halibut PSC for the non-trawl category is divided by target species (Pacific cod and 'all other targets'). Though not shown in this table, the non-trawl Pacific cod fishery PSC limit (status quo = 661 t) is further divided through harvest specifications between non-trawl CPs (status quo = 648 t) and non-trawl CVs (status quo = 13 t).

While projected median PSC limits represent reductions from current limits for the non-trawl fishery in every alternative, this trend changes when comparing projected median PSC limits to previous years' average PSC use. None of the alternatives represent a PSC limit that is at a level below the previous 3-year average of PSC use for the non-trawl fleet (2016-2018), whereas for the trawl fleet four of the alternatives represent a reduction relative to recent use in 2024 and three do so in 2030. These differences illustrate an important distinction between PSC use and PSC limits, a key uncertainty in the model.

In recent history, PSC use has been less than the PSC limit, but the relative differences between PSC limit and use has varied by year and by groundfish sector (Figure 6-20). The simulation model assumes that PSC use is the PSC limit multiplied by the average of the fleet-specific ratio of PSC use to PSC limit from the most recent three years (2016-2018); 0.69 for trawl PSC and 0.26 for non-trawl PSC. In reality, the relationship between PSC limit and PSC use is not constant and is impacted by numerous variables, some of which can be affected by fishing behavior, others of which cannot. It is unclear how this relationship will evolve with the potential changes in PSC under different sub-alternatives.

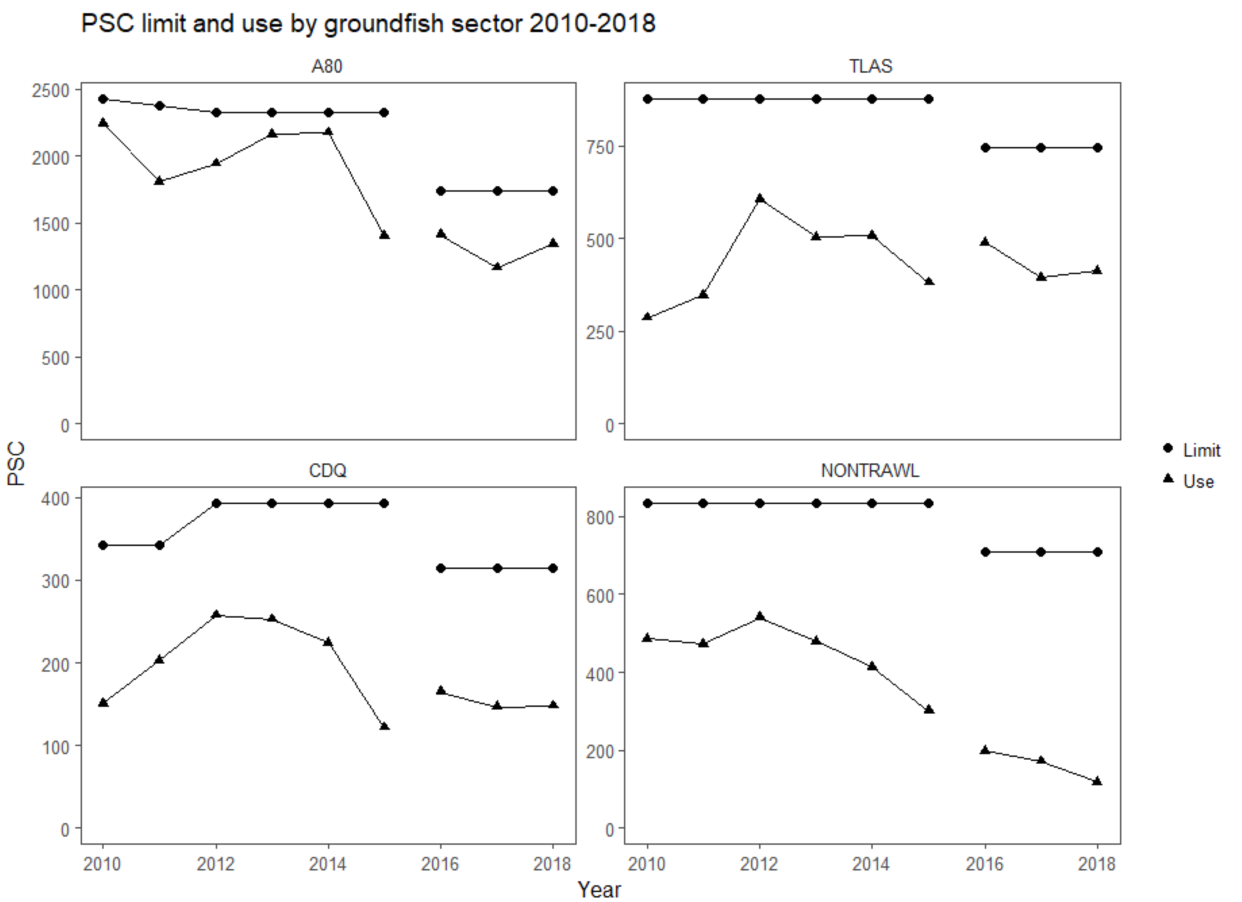


Figure 6-20. PSC limits and PSC use by groundfish sector 2010-2018. Gap in x-axis represents implementation of Amendment 111 and related PSC limit reductions. Note y-axis differs in each panel.

The groundfish fleet has implemented numerous halibut avoidance strategies (3.4.1) as PSC limits have declined in recent years. These strategies have succeeded in reducing PSC use. Fleetwide PSC use decreased substantially after 2012 (Figure 6-20). Yet it is uncertain if the marginal benefit of these strategies would persist if PSC limits were to continue to decline. For example, if A80 vessels are already implementing deck sorting on a majority of tows (3.4.2), it may not be possible to achieve additional benefits in PSC reduction through deck sorting. If this is the case, it is possible that as PSC limits decrease, the relative rate of PSC use increases. Alternatively, it is unclear how PSC use would respond to a higher PSC limit. If the limit were high enough that it were perceived to be non-constraining, would

PSC use increase at a significantly higher rate, a consistent rate as the limit, or a slower rate relative to the limit? Halibut avoidance strategies impose a cost on groundfish vessels and if these strategies are deemed no longer necessary in order to meet PSC limits, would they continue to be employed? There are other social and political pressures that may impact fishing behavior such that halibut avoidance strategies would continue regardless of change in PSC limit. For example, the A80 fleet practices deck sorting in the GOA where PSC limits are not tightly constraining. However, it is unclear how widespread these strategies would be and how effective they would be in a high halibut abundance environment.

Given the PSC use assumption in the model, specific elements of the sub-alternatives are more or less influential on the projected PSC limits and halibut catch. PSC limits and directed fishery catches were most sensitive to the starting point of the alternative (6.1.3.3). Additionally, in certain sub-alternatives the floors and ceilings impose a PSC limit that is artificially low (ceilings) or high (floors) given the abundance index. This occurs most frequently in the form of ceilings in later years of the model runs for the trawl sector (Figure 6-11) and as floors in varying years for the non-trawl sector (Figure 6-12). The defining characteristic for a majority of the trawl sub-alternatives that reach the ceiling is a higher starting point, while the defining characteristic for the non-trawl sub-alternatives that reach the floor is a lower starting point. Thus, starting point is a primary driver for PSC limits even in certain sub-alternatives that reach the ceiling or floor.

Generally, model simulations demonstrate that reductions in PSC under the considered alternatives have relatively minor impact on spawning biomass and on the Pacific halibut fishery while some alternatives appear to have considerable contrast in the PSC constraints that would impact the groundfish fisheries. For these alternatives, abundance-based PSC limits can impose a cost on the groundfish fishery without a reciprocal benefit to another user group or to the resource.

6.2.2 Approach to economic impacts analysis

Numerous variables influence the impacts of PSC limit reduction on groundfish sectors. Analysts group these variables into three categories: 1) Environmental variables such as the spatial distribution and co-occurrence of halibut with target groundfish species; 2) Regulatory variables such as changes in TACs of other species or the portfolio of species allocated to a particular vessel or sector; and 3) Behavioral variables such as deck sorting, target switching or other halibut avoidance strategies. Harvesters cannot directly impact environmental or regulatory variables. They can impact behavioral variables but this influence has a cost.

The cost associated with influencing these behavioral variables, or avoidance costs, is one of the costs associated with PSC reduction. Avoidance costs include any change in fishing strategy implemented to reduce halibut PSC. This includes search time looking for grounds with lower halibut bycatch, fishing less efficient areas where there are fewer halibut, changing catch handling techniques such as deck sorting, or any other change from standard fishing operations imposed to reduce halibut PSC. These costs are incurred regardless of whether or not the PSC limit becomes a constraint. Avoidance costs impact net revenues, but analysts do not have data to quantify these costs.

Other costs associated with PSC reduction are costs in terms of forgone groundfish revenues if halibut becomes constraining. These costs impact gross revenues, although determining the cause of gross revenue reductions is not straightforward. A constraining halibut PSC limit - or the mere presence of a limit that could become constraining over the course of an unpredictable year - is just one management factor that can lead to underutilized groundfish TACs. Therefore quantifying the cost of forgone groundfish revenue resulting from PSC reductions would be speculative and highly uncertain.

Analysts used the recent reduction in PSC limits (Amendment 111, implemented in 2016) to illustrate that the relationship between PSC limits, use, and groundfish revenue varies. Table 6-9 shows the PSC limits before and after A111 as well as average annual PSC use, groundfish dollars per ton of PSC use, non-pollock groundfish revenue (wholesale, real 2018 dollars), and the difference in these values before and after A111. To further explore the variability in the relative groundfish value of PSC, analysts calculated hypothetical groundfish revenue estimates for the period after A111 assuming a constant groundfish dollars-per-ton value of halibut PSC. Hypothetical revenue estimates were calculated by multiplying the average groundfish dollars per ton of PSC pre A111 (2012-2015) by the actual change in the PSC limit (t) or by the average PSC use (t) post A111. In other words, assuming that the relationship between groundfish dollars and PSC tons is a constant one - which it is not - Table 6-10 shows how the expected groundfish revenue after A111 would have been projected if only considering the change in PSC limit and use and compares that calculation to the actual groundfish revenues that were realized in the years since A111 (2016-2018). Under the false assumption of constant PSC values, average annual gross revenues from 2016 through 2018 for the A80, TLAS, CDQ, and non-trawl groundfish sectors would be estimated to be $25 million to $90 million lower than actual realized revenues. The specific value of estimated revenue in Table 6-10 is unimportant; rather, the importance of this hypothetical is to demonstrate that PSC value is not constant and that overly simplistic estimates of revenue change based on a static “PSC value” are not valid and do not capture other changes in the fishery that affect the value of halibut PSC as expressed in terms of groundfish harvest.

This exercise illustrates important lessons that frame the analysts’ approach to the economic impacts analysis of the groundfish fisheries. The first lesson is that changes in PSC limits are not directly correlated with changes in groundfish revenue. As seen in the bottom panel of Table 6-9, PSC limits and PSC use have decreased since 2016 while groundfish revenue has increased. The reader should note that Table 6-9 is a simplified example that does not incorporate other factors that impact gross groundfish revenues such as TAC level, price trends, catch composition, etc. Nevertheless, this example helps illustrate the second lesson, which is that the relative value of a ton of PSC is not static. In general, wholesale revenue per ton of 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 would appear to remain the same. If the rates differ, the relative value of a ton of PSC could change drastically. Wholesale revenues can be influenced by additional covariates that are also not static, such as vessel, processor, target species, area, and season. Also, halibut PSC encounter may be somewhat mitigated by numerous avoidance strategies. Therefore, the third lesson is that a simplified quantitative approach to estimating specific revenue loss at different PSC scenarios offers false precision at best and, at worst, is inaccurate and ignores the realities of behavioral response.

Because the relationship between PSC and groundfish revenue fluctuates and is impacted by numerous variables, analysts use a qualitative approach to the economic impacts analysis. Analysts describe the range of impacts in the context of the different types of operations within the groundfish sectors, how they vary and how this affects their vulnerability to PSC reductions. Results from the simulation model are used to demonstrate the likelihood of impacts under each sub-alternative.

Table 6-9. PSC limits, annual averages of PSC use, groundfish revenue per ton of PSC use and gross non-pollock groundfish revenue before and after A111 and the differences between these periods.

	Sector	PSC Limit	Average annual… PSC Use	PSC Use:Limit	Groundfish $/ t PSC use	Non-pollock groundfish revenue
Pre A111 (2012-2015)	A80	2,325	1,923	0.83	155,398	298,869,286
	TLAS	875	500	0.57	195,375	97,590,011
	CDQ	393	214	0.55	324,076	69,433,362
	NON TRAWL	833	434	0.52	403,020	174,809,718
Post A111 (2016-2018)	A80	1,745	1,307	0.75	244,624	319,805,750
	TLAS	745	431	0.58	252,708	109,001,276
	CDQ	315	153	0.49	506,379	77,644,765
	NON TRAWL	710	163	0.23	1,151,011	187,614,773
Difference (post - pre)	A80	-580	-616	-0.08	89,226	20,936,464
	TLAS	-130	-68	0.01	57,332	11,411,265
	CDQ	-78	-61	-0.06	182,303	8,211,403
	NON TRAWL	-123	-271	-0.29	747,991	12,805,055

Table 6-10. Realized annual average gross revenue and hypothetical estimated revenue post Amendment 111, using actual changes in PSC limit and use, holding gf$/t PSC use constant to pre A111 rates.

Sector	Realized revenue	Estimated revenue given reduction in: PSC limit	Average PSC use
A80	319,805,750	229,674,885	133,962,641
TLAS	109,001,276	83,602,474	70,284,385
CDQ	77,644,765	52,366,808	32,625,156
NON TRAWL	187,614,773	138,043,372	28,925,836

At this stage, the economic analysis in this DEIS is framed around a qualitative description of impacts. Future versions of this analysis could incorporate additional quantitative approaches to estimate a range of impacts to each groundfish sector once the Council and stakeholders have had an opportunity to understand and affirm the model-based approach and, potentially, to narrow the range of alternatives. Two possible avenues for future quantitative analysis are described below.

1. More rigorous modeling of “PSC value”

The hypothetical revenue estimation exercise described earlier in this section illustrates the pitfalls of a simplistic, static assumption of the value of PSC in terms of groundfish revenue. However, more rigorous modelling of PSC value controlling for other variables that impact groundfish revenue might better demonstrate the relationship between PSC value and PSC limits or use. Results could be validated using the natural experiment of the A111 PSC reduction. Within the analysis of the A80 sector, it may be possible to account for certain behavioral changes such as deck sorting by utilizing pre-deck-sorting DMRs to determine a comparable PSC rate to compare PSC data that include catch that occurred with and without deck sorting.

2. Relationship between catch per unit effort and PSC use

As described earlier in Section 6.2.2 , halibut avoidance imposes a cost on groundfish sectors. Those costs can be monetary (e.g., equipment) but are more likely to manifest in terms of additional time spent in search of “clean” fishing or moving out of productive groundfish areas if halibut encounter rates are too high. Due to the constant accrual of variable costs when operating a groundfish vessel and the decreased productivity of labor and capital if harvest targets take longer to achieve, it is clear that bycatch minimization and avoidance impact net revenues. Analysts do not have data to quantify these costs. Given that data gap, analysts could model catch-per-unit-of-effort (CPUE) as a metric of the relative efficiency of fishing operations and compare this to PSC use. It is not likely that the analysts could assign a value to the variable costs associated with minimizing PSC due to the numerous factors that affect catch or catch value and would thus have to be controlled for (e.g., year effects, TACs of high- or low-PSC targets, or company quota portfolios). The "effort" in CPUE can be defined in a number of ways; the analysts would test multiple effort definitions, likely beginning with a measure of time but noting that time at sea and trip definitions are considered differently for CPs and CVs. If a measure of CPUE is positively correlated with PSC use, one might be able to identify when vessels are incurring costs to minimize PSC. This approach could inform the relative efficiencies of different sectors throughout the year and how this relates to their PSC use.

6.2.3 Impacts on groundfish fishery planning and operation

One of the principal model outputs is a quantitative, comparative assessment of how an abundance-based approach is likely to alter the halibut PSC limit under which BSAI groundfish fisheries are prosecuted (Table 6-8). This section temporarily sets aside any effects of bycatch on halibut abundance and also sets aside the cumulative effects of bycatch, abundance, and management on the amount of halibut available for commercial harvest. Instead, this section focuses on how the BSAI groundfish sectors' fishing operations could be affected – directly or indirectly – by PSC limits that differ from the status quo. This section identifies the determinants of groundfish catch and halibut PSC outcomes, and considers which are internal – i.e., somewhat within the control of a fishery participant – and which are external. In broad terms, this section discusses how vessel operators, fishing companies, or sectors interact with the current PSC limit as one of multiple operational constraints that influence fishing decisions made throughout the year.

As noted in the previous section, the amount of halibut PSC that accrues to a given groundfish sector is predictable within a range but can vary annually. Moreover, the groundfish revenue that is generated from a metric ton of PSC is also variable and is not necessarily driven by the PSC limit (see Section 6.2.2). While the level of bycatch in a given year is difficult to predict, the presence of PSC as a factor in fishery operational planning is a constant for certain of the BSAI groundfish sectors. Figure 3-47 through Figure 3-49 (Section 3.4.4) illustrate the variability in annual PSC by sector and by target species. Figure 3-47 shows that the smallest scale sector (HALCV) and the sector that operates in the most annually consistent time and space (TLAS, with regard to the general focus on early-year Pacific cod openings) are somewhat predictable in terms of groundfish catch and PSC; neither sector tends to approach their annual PSC limit (Table 6-8). However, Figure 3-47 plots the HALCP and A80 sectors as having more interannual variability, but each sector's variability occurs along a different dimension. The amount of groundfish harvested each year in the HALCP sector remains fairly constant as it is controlled by Pacific cod TAC, and the sector is not constrained by the halibut PSC limit. The amount of halibut encountered by the HALCP sector varies from fewer than 2,000 t to more than 5,000 t (note that encounter is not equivalent to PSC mortality), but PSC mortality is consistently low relative to the limit due to the small DMR applied to HALCP catch. The variability in halibut encounter reflects the fact that halibut avoidance is a consideration for HALCP vessels, but the presence of halibut in the catch might not drive a behavioral response in the same way that it would for a more tightly PSC-constrained sector like A80. By contrast, the amount of halibut encounter and PSC shown in the figure for A80 is more consistent because it is influenced by a PSC limit that has been *relatively* more constraining.[37] The annual variability for that

[37] Also see Figure 6-16. Of the four main ABM groundfish sectors, A80 has been the most likely to fish close to the PSC limit, though the sector's PSC use relative to the pre- and post-Am111 limit decreased substantially beginning in 2015.

sector is the amount of groundfish harvested within the PSC constraint (and other constraints mentioned below).

The various ways in which BSAI groundfish sectors plan their fishing year are described more thoroughly in Section 3.3.[38] Annual planning accounts for factors that can be controlled and those that are anticipated but are ultimately external forces. Internally controllable factors include target species, the timing and location of fishing, halibut avoidance, and efforts to minimize mortality rates for the halibut that are encountered. Sectors vary in the amount of choice they have to select targets. For example, Figure 3-48 contrasts the number of target species that are prosecuted in the A80 sector compared to the TLAS and HALCP sectors. A80 is comprised of several key target species (e.g., yellowfin sole, rock sole, Atka mackerel, and Pacific ocean perch) and other commercially valuable species that are caught incidentally and can, themselves, function as a constraint on the ability to catch other A80 species (e.g., Pacific cod).[39] Compared to the HALCP or TLAS sectors – which are basically confined to Pacific cod and cod/yellowfin sole, respectively – the A80 sector would seem to have more options to target different species or move locations to avoid high halibut encounter rates.[40] However, fishing companies within A80 differ in their portfolios of allocated groundfish species; some companies are more reliant on flatfish species that have higher expected PSC rates while others have greater access to lower-bycatch targets like Atka mackerel.[41]

Another controllable factor in dealing with potential PSC constraints is measures that are taken to avoid halibut PSC or to minimize mortality, thus reducing the halibut catch:PSC ratio. The A80 sector in particular has modified its operations to incorporate halibut deck sorting which has resulted in lower DMRs applied to their catch (see Sections 3.4.2 on deck sorting and 3.2.2 on DMRs). Section 3.4.2 notes that the use of deck sorting within the A80 cooperative has increased over the course of EFP development. Deck sorting imposes costs on the fleet in terms of the pace of fishing operations (hauls/day) and deck sorting might not be employed on every haul if halibut encounter rates are low. If ABM alternatives and low abundance levels were to substantially reduce the sector's PSC limit, the fleet might respond by deck sorting an even greater percentage of hauls and, thus, accruing more opportunity costs. The Council might also consider how the deck sorting fleet would react to PSC limits that increase under future ABM scenarios. Given the cost of deck sorting, it is conceivable that fewer hauls would be deck sorted when abundance and PSC limits are high. While the analysts can only speculate, it seems likely that in a higher-abundance scenario the rate of change in halibut PSC use would increase less quickly than the PSC limit itself. This assumption is based on the fleet's internal incentive to conserve PSC at all times due to uncertainty about unpredictable high-PSC events that could occur mid-year, and also the social and political incentives to minimize PSC to the extent practicable at all times.

There are numerous factors that directly or indirectly influence halibut encounter and PSC which are – to varying extents – outside of the control of groundfish operators. Given the presumption that halibut encounter is positively correlated with fishing effort (i.e., trawl nets in the water, or number of hooks set), regulatory and environmental factors that depress CPUE could also affect expected halibut catch. Aside from natural variation in catchability, CPUE might also be influenced by macro-level changes in the BSAI marine environment that cause groundfish species to be less aggregated or less predictably located. For example, the recent weakening of the "cold pool" phenomenon in the Bering Sea might cause target species to be more spatially dispersed and require more effort to achieve the same level of catch.

In some cases, environmental and market factors combine to constrain the BSAI groundfish fleet's ability to respond to a change in PSC limits. For example, Pacific cod is an important species for each of the

[38] Refer to subsections for each sector titled 'Operations' and 'Annual Planning'.
[39] Further detail on the dynamics within the A80 sector is provided in Section 6.2.4.1.
[40] Figure 3-54 in Section 3.4.6 maps the different "footprints" of the A80 target fisheries, showing that a change in target sometimes also involves a change in fishing location.
[41] Catch by species at the company level cannot be reported due to confidentiality restrictions.

sectors that are potentially affected by ABM. Trawl vessels that target cod as a primary species (e.g., TLAS vessels) cannot choose to fish for that species in a different time or location outside of the well-understood spawning aggregation that occurs early in the year. Various groundfish sectors target species like cod and rock sole for the value of their roe content. Similar to a spawning aggregation, roe value is an external factor that influences the value of the fishery and could only be modified in response to a PSC constraint by choosing not to fish at that time, essentially reducing the value of the fishery.

Regulatory inputs that affect CPUE or halibut encounter rates might include closed areas and harvest specifications. Closed areas (e.g., crab conservation areas) might prevent groundfish vessels from entering an area that, in a given year, could have high catch rates and low bycatch rates. The fact that the overall BSAI groundfish fishery is capped at a 2 million metric ton TAC requires an annual policy decision about the relative amount of catch that is made available for pollock and non-pollock species (e.g., Pacific cod and flatfish). Should the ABC for BSAI pollock decrease, it is possible that a larger proportion of the 2 million ton cap would be comprised of relatively higher halibut-encounter species such as flatfish. This would mean that an external decrease in pollock abundance increases the overall expected halibut encounter rate for the BSAI.

Table 3-20 and Figure 6-16 reflect the extent to which PSC use for each sector is annually variable, but typically remains within an expected range due to the intrinsic nature of each sector’s operations and the bycatch avoidance efforts that are taken. In a statistical sense, that variation within the predictable range – or “year effect” – is an independent source of uncertainty. Year effects would capture the influence of annual variability in target catch composition, CPUE, and halibut encounter rates. For that reason, it is difficult to forecast the marginal change in behavior or catch and revenue outcomes in a future year that would result from one ABM alternative versus another, even when assuming a common abundance trajectory. As the Council continues to narrow its range of possible preferred alternatives, it could consider whether the groundfish stakeholders would benefit more from stability in the PSC limit or by an alternative that could result in a less restrictive cap when abundance is high. The latter would include the risk of tighter constraints when abundance is low but could provide insulation against the unpredictable effects of external factors when abundance is high. The relative difference between “high” and “low” abundance will be determined largely by how the “starting point” element is defined.

6.2.4 Groundfish sector-specific impacts

6.2.4.1 Amendment 80 (A80)

Of the BSAI groundfish sectors potentially affected by this action, A80 is the sector with the most non-pollock groundfish wholesale revenue. The sector’s gross first wholesale revenue from 2010 through 2018 ranged between $275 and $380 million (nominal dollars) (Table 3-11). In 2018 there were 19 active A80 vessels - all CPs operating under a single cooperative. Eight A80 vessels also harvested CDQ fish. Participating in the CDQ fishery provides those vessels with additional flexibility regarding halibut PSC as they are able to specify whether a haul is an A80 or CDQ haul up to two hours after weighing all catch in the haul. Depending on the catch composition, hauls can be attributed to whichever sector is more advantageous for the management of vessel and sector-level PSC limits. The A80 sector has high halibut encounter rates relative to other sectors, accounting for 1,307 t of the 1,892 t total average annual PSC use for the trawl sectors over the past three years (2016-2018). The A80 sector has consistently decreased its annual PSC use since the implementation of Amendment 111 in 2016 (Table 3-21). Sector representatives attribute lower PSC, in part, to efforts put toward increased data sharing and communication to avoid or mitigate halibut encounters and increased use of deck sorting to reduce discard mortality rates. The sector also implemented a cooperative halibut avoidance plan that established accountability measures for lower-performing vessels (Section 3.4.1.1). Vessels with high bycatch rates could face reduced harvest opportunities or financial penalties (paid into cooperative bycatch avoidance initiatives).

The potential impacts of abundance-based PSC limits for the A80 sector are complex due to the multi-species composition of the sector's catch and allocation. While many groundfish sectors operate in an environment with only one, or a few constraining species, A80 vessels are potentially constrained by PSC or any of their allocated species. For example, although Pacific cod is an allocated species, it is often managed by the fleet as a bycatch species necessary to access other catch. A80 vessels must manage both their total annual catch of Pacific cod and also the time-distribution of that catch, as cod quota might be necessary to access the flatfish species fished later in the year. For example, (Figure 3-19) shows monthly A80 catch by target species, and yellowfin sole remains a predominant target species with cod bycatch late in the year. Additionally, A80 operations are attempting to maximize profit across numerous species. Different species have varying seasons or distinct values associated with different parts of the year (i.e. when roe content is high). Vessel operation decisions are more complex when trying to balance a diverse portfolio of target fisheries for a year-round operation. While in some instances this diversity of operations may provide additional flexibility, dependent on a company or vessel's portfolio of species allocations, A80 vessels may have opportunities to switch targets relative to other sectors. However, relying on a mix of species might also reduce flexibility if other stocks approach constraining levels or if CPUE for a certain A80 species is low in a given year or month. Many flatfish targets overlap spatially which may also reduce the ability of vessels to respond to halibut encounters through target switching (Figure 3-57).

Halibut encounter rates vary by target species; Arrowtooth flounder, Pacific cod, Flathead sole, rock sole, and yellowfin sole having relatively high encounter rates (Figure 3-46). Vessels or companies that have higher allocations of those species or are more reliant on those species might have more difficulty adapting to changes in PSC limits. The relationship between revenue and halibut PSC varies by target fisheries as well (Figure 3-73). Target fisheries for roundfish such as Atka mackerel and POP are consistently associated with lower PSC. The figure shows that even under widely varying annual revenues there is little variation in PSC for these targets. Therefore, impacts of reduced PSC may be less significant for vessels or companies with relatively larger Atka mackerel allocations as high revenue years are not dependent upon high PSC use.[42] Alternatively, target fisheries for yellowfin sole and rock sole are consistently associated with higher PSC use; however, the amount of the PSC use can vary substantially from year to year (Figure 3-73).

Table 6-5 shows that six of the 15 sub-alternatives within Alternatives 2 and 3 result in projected median PSC limits that are below the sector's recent average PSC use (2016-2018) within the next five years (2.1.b, 3.1.d, 3.2.a/b and 3.3.a/b). Seven sub-alternatives would reduce PSC below the current limit. Eleven years into the future, six sub-alternatives would still result in a reduced PSC limits; the sub-alternatives that reduce PSC on that timeline are slightly different from the ones identified above (2.1.b, 3.1.d, 2.4, 3.2.b and 3.3.a/b).

6.2.4.2 Trawl Limited Access (TLAS)

In 2018 the TLAS sector was comprised of 70 vessels including 55 AFA CVs and CPs (Table 3-12). Between 2010 and 2018 TLAS annual gross groundfish ex-vessel revenue ranged from $22 to $47 million (nominal dollars). TLAS vessels primarily target Pacific cod and YFS and a majority of the catch occurs early in the year, between January and May (Figure 3-22). These fisheries are primarily TAC-driven competitive fisheries therefore the impact of potential reductions in PSC limits could include a shortened fishery.

From 2010-2018, the TLAS sector accounted for 15% of Pacific halibut mortality of BSAI groundfish sectors (Table 3-19). Unlike other groundfish sectors, TLAS PSC mortality has not shown as consistent declines in recent years (Table 3-20). Halibut avoidance methods vary in the TLAS fishery based on the

[42] company-level catch - a proxy for intra-cooperative allocation - cannot be reported due to confidentiality

participants affiliation with other cooperatives. AFA CV cooperatives apply a “halibut mortality allowance” to their TLAS activity and have established Better Practices Protocols that vessels must adhere to when fishing with trawl gear for BS Pacific cod, including mandated use of halibut excluders and prohibition of fishing at night. Unaffiliated vessels do not have agreed upon accountability measures but communicate with co-op managers and are encouraged to adopt similar avoidance strategies.

In general, PSC is positively correlated with revenue for the TLAS sector (Figure 3-77), however these specific relationships vary by species. TLAS revenue derived from Yellowfin sole is positively correlated with halibut mortality, where years with high mortality correspond to high revenue years (Figure 3-73). Pacific cod is generally associated with high halibut mortality at varying ranges of revenue (Figure 3-73).

Impacts of potential halibut PSC reduction for participants in the TLAS sector will largely depend upon individual vessel’s participation in other fisheries such as AFA pollock or Central GOA Rockfish. Those vessels with access to cooperative quota from other fisheries may be better positioned to adapt to PSC constraints or shortened seasons if the Pacific cod or YFS fishery were to close prematurely relative to previous seasons. The likelihood of this varies by sub-alternative with only alternatives 3.2.b and 3.2.a result in modeled median PSC limits in 2024 that represent decreases from recent PSC use (Table 6-5).

6.2.4.3 Hook-and-line Catcher Processors

The HALCP, or freezer longline, sector currently consists of around 25 vessels that target BSAI Pacific cod with hook-and-line gear. In 2018, 11 HALCPs also fished CDQ quotas. The annual value of the sector’s gross first wholesale production from 2010 through 2018 ranged from $117 million in 2010 to $201 million in 2017 (nominal dollars). HALCP vessels typically operate throughout the length of the calendar year. The monthly distribution of catch is shown in Figure 3-25, illustrating more intense harvest from January to March (spawning aggregation) followed by a mid-season drop-off before the B season begins in mid-June and monthly catch is relatively evenly distributed throughout the remainder of the season.

The HALCP sector accounted for 12.3% of total BSAI halibut PSC mortality from 2010 through 2018. The sector is managed under the total non-trawl PSC limit of 710 t that is apportioned in harvest specifications by target species (cod/other) and includes both non-trawl CPs and CVs. Figure 2-1 shows that in 2019 the PSC limit for HALCPs fishing Pacific cod was 648 t and the combined CP/CV limit for non-trawl vessels fishing non-cod species was 49 t. During the 2010 through 2018 period, total halibut PSC mortality for HALCPs ranged from 538 t in 2012 to 115 t in 2018. The general trend in annual halibut PSC has been downward since 2012 (Table 3-20). While halibut PSC mortality is low due to the lower DMR applied to the sector’s halibut catch, HALCPs encounter the most halibut of any BSAI groundfish sector (Table 3-20). This underlines the importance of fish-handling as part of the sector’s approach to minimizing PSC to the extent practicable. Figure 3-47 illustrates the annual variability in halibut catch per ton of Pacific cod. The fact that halibut encounter has ranged from less than 2,000 t to over 5,000 t while groundfish catch hovered consistently around 100,000 t suggests that some natural variability in encounter rates exists (i.e., and external factor in bycatch outcomes).

While the sector’s voluntary cooperative promotes best practices for halibut avoidance (described in Section 3.4.1.3), the need to significantly alter fishing practices to stay within the status quo PSC limit is not obvious. Table 6-8 shows that the median model projection for non-trawl PSC limits across all Alternative 2 and 3 sub-alternatives is not less than 283 t in 2024 (Alt. 3-3a) with a maximum of 517 t (Alt. 3-1c), and not less than 347 t in 2030 (Alt. 2-4) with a maximum of 587 t (Alt. 2-2). For comparison, the average PSC for all non-trawl vessels (both HALCP and HALCV) from 2016 through 2018 was only 163 t. Given those projections, it is likely that the HALCP sector would be able to continue prosecuting the BSAI Pacific cod fishery in its current manner under any of the analyzed ABM alternatives. If halibut PSC limits reach the lowest levels projected, HALCP vessels might spend more time and accrue additional costs moving out of areas with higher encounter rates because the sector does not have the option of switching targets and it would be financially and operationally challenging to have large-scale CPs stand down from fishing (see Section 3.3.4.4). Moreover, one might presume that if BSAI halibut abundance falls to an index level where the PSC limit is at the projected minimum then encounter rates would also go down. The footprint of the fishery is quite expansive, as illustrated in Figure 3-56. The large geographic range of the fishery further suggests that the most likely response to a reduced halibut PSC limit would be greater movement between longline sets and, as a result, lower CPUE and lower value of capital and labor.

6.2.4.4 Hook-and-line Catcher Vessels

The HALCV sector operates on the smallest scale of the BSAI groundfish sectors that are constrained by halibut PSC limits and thus potentially affected by an ABM action. The sector included five vessels in 2018. From 2010 through 2018, the sector grossed between $200,000 and $1.38 million (nominal$) in ex-vessel value, all of which was delivered to the inshore processing sector. The HALCV sector essentially targets one species (Pacific cod) and operates from January through May with the bulk of activity occurring during spawning aggregation. Figure 3-56 shows that catch (and bycatch) intensity is concentrated spatially near Unalaska/Dutch Harbor. Because the vessels in this sector operate in a temporally and spatially constrained fishery and compete for a TAC outside of a cooperative structure, there are no coordinated halibut avoidance measures in place. That said, the scale of halibut PSC is small compared to other BSAI groundfish sectors. The BSAI non-trawl CV PSC limit in 2019 is 13 t (Figure 2-1). During the analyzed period, PSC mortality ranged from less than 1 t to 7 t (~0.1% of total BSAI halibut PSC). Total annual halibut catch (before a DMR is applied) ranged from 1 t to 74 t, with an average of 27 t.

Given the historical level of PSC relative to the non-trawl CV limit, it is unlikely that halibut bycatch has been a determinant factor in how the fishery is prosecuted. It is also unlikely that any of the ABM alternatives would reduce the non-trawl CV PSC limit to the point that HALCV fishing plans would be altered.

6.2.4.5 Community development quota (CDQ)

The six CDQ groups receive annual apportionments of TAC for the BSAI groundfish, crab, and halibut fisheries. The number vessels fishing CDQ quota for BSAI groundfish from 2010 through 2018 ranged from 45 in 2010 to 55 in 2013; in 2018 the number of "CDQ vessels" was 49. Figure 3-26 illustrates the overlap of vessels that fish CDQ quota and also fish in the other BSAI sectors that are limited by halibut PSC. Vessels from the HALCP, TLAS, and A80 sectors fished CDQ quota in all years; one HALCV fished CDQ in 2010 and 2014. CDQ catch and revenue are illustrated annually in Figure 3-27. Monthly catch by year is shown in Figure 3-28. The total first wholesale revenue (nominal $) for non-pollock CDQ species has generally increased over the 2010 through 2018 period, ranging from around $45 million in 2010 to $75 million in 2018. The bulk of the volume and value during the period was derived from Pacific cod, which is shown to be decreasing in volume beginning in 2016. The other key species in terms of revenue are yellowfin sole and Atka mackerel, fished on A80 vessels. On a monthly basis, patterns of CDQ catch largely reflect a combination of HALCP catch (Pacific cod) and A80 species composition (yellowfin sole and Atka mackerel throughout the year, with a focus on rock sole during the roe season in February and March).

The operational impact of ABM alternatives on the ability to fish CDQ quota would be largely the same as those described above for the harvest sectors that are fishing the quota. CDQ entities, however, do have some advantage in how they might respond to a constraining halibut PSC limit. CDQ groups could choose to lease groundfish quota to the pot gear sector, which does not have a halibut PSC limit, or to an unconstrained trawl/HAL sector if one or the other is more limited under an ABM scenario. Shifting the harvest of CDQ quota from PSC-limited gear types to pot gear could insulate revenues from species that can be prosecuted with pots (e.g., Pacific cod), but would not likely mitigate any constrained catch for species like yellowfin sole or rock sole that are only economically harvested with trawl gear.

CDQ groups – as distinct from CDQ stakeholders which might include non-CDQ vessels fishing CDQ quota – are unique in that they derive socioeconomic benefits from both the PSC-constrained groundfish fisheries and the Area 4 directed halibut fishery. The analytical conclusions reached in Sections 6.1 and 6.3.1 suggest that, all else equal, some ABM alternatives could result in lower PSC limits for groundfish and additional catch available to the directed halibut fishery. While CDQ groups generally derive more revenue from groundfish fishing or leasing, maintaining an active local halibut fishery is also an objective for certain CDQ groups that is not necessarily prioritized on the basis of revenue generated.

6.2.5 Impacts on Area 4 commercial halibut fishery

As stated in Section 6.1.2 and shown in Appendix 4, Pacific halibut SSB is largely insensitive to PSC levels given the alternatives under consideration. However, the analysts do conclude that the projected level of PSC limits and usage in BSAI groundfish fisheries is negatively correlated with the amount of catch that is available to the Area 4 directed halibut fishery. In other words, an alternative that is projected to reduce PSC limits in a future year results in more catch available to the halibut fishery relative to the static limit that would have existed under Alternative 1. Figure 6-4 indicates that the median projection for both 2025 and 2035 across all alternatives (including Alternative 1) is a decline in available catch relative to 2018. The 2035 projection relative to 2018 is higher than the 2025 projection relative to 2018, reflecting a modeled expectation that BSAI halibut SSB will decline in the near future but then trending upwards beginning around 2028 to 2030 (see "SSB" panels in Appendix 4).

When comparing the median projected halibut fishery catches in Figure 6-4 across alternatives (rather than comparing to 2018), one sees that a subset of alternatives is projected to result in lower PSC limits and higher future halibut fishery catch than the status quo alternative: Alternatives 2-1b, 2-4, 3-1d, 3-2a, 3-2b, 3-3a, and 3.3b. In general, though, the magnitude of the difference between alternatives in median expected halibut catch is not large in percentage terms. (The general lack of contrast between sub-alternatives in the extent to which they meet the Council objective of "providing for directed fishing operations in the BSAI" was previously highlighted in section 6.1.3.7. The other sub-alternatives led to higher PSC limits and lower directed halibut fishery catches than would be expected under the status quo alternative. Together, these results highlight the consistent tradeoff between PSC limits and directed fishery catches. This conclusion is not unexpected since available catch for the halibut fishery is determined after subtracting O26 PSC from the TCEY (for further detail on how expected PSC is accounted for in calculating Area 4 directed fishery catch limits, refer back to Section 5.2.4.2.3). The correspondence (inverse relationship) between PSC usage and directed fishery catch appears to strengthen with time, perhaps because years modeled further into the future are capturing how the simulated halibut population takes time to equilibrate to the dynamics that drive the modeled SSB and age-2 recruits. In other words, it is possible that the effect of decreasing or increasing PSC limits on directed catch is somewhat muted in the near term but would be more obvious and impactful in the medium- to long-term.

The most common feature among the sub-alternatives that results in higher projected halibut fishery catch is lower starting points, though some differ in whether they constrain year-on-year variation in PSC limits. Section 6.1.5 shows plots comparing model outputs for Alternative 1, Alternative 2-1, and Alternative 2-2. Those alternatives have the same starting points and same ceilings (slightly different floors). Alternative 2-2 has stairstep breakpoints and a different constraint on the maximum year-on-year percentage change in PSC that is allowed. Despite being so different in terms of elements, the projected SSB and directed halibut fishery catch limits are almost exactly the same among these three alternatives. The similarity in model outcomes suggests that in many cases the ABM action alternatives are not expected to substantially increase halibut fishery catch relative to Alternative 1.

Section 6.1.5 analyzes the difference in halibut fishery outcomes between Alternatives 2 and 3 (one index versus two "primary/secondary" indices). A comparison of Alternative 2-1 to 3-1 shows that including a secondary index (Alt 3) results in slightly more variability in median projected PSC limits, but virtually no difference in median projected SSB and directed fishery catch (Figure 6-17).

Within the Alternative 3 sub-alternatives, 3-3a and 3-3b differ in which index (BTS or FISS) is defined as primary and which is secondary. The comparison plots of these two sub-alternatives show that reversing the primary/secondary order of the indices used to determine ABM PSC do not affect SSB or directed fishery catch differently (Figure 6-19). This is true even though the projected PSC limits for trawl and non-trawl begin to diverge around 2021, reaching a point around 2023 where the difference between the two sub-alternatives is stable. Using the set-line survey as the primary index (3-3a) leads to relatively lower PSC limits for both the trawl and non-trawl sectors.

Section 6.1.3.6 identifies the frequency with which each alternative might cause the trawl or non-trawl PSC limit to reach the floor or ceiling that is defined for each sub-alternative. In theoretical terms, it would be of interest to know whether a groundfish sector is likely to reach a floor or ceiling and, if so, how soon after implementation that is likely to occur. Reaching a floor or ceiling could affect both incentives for groundfish harvesters in the years after the floor/ceiling is reached and the distribution of halibut savings or loss that accrue after the floor/ceiling is reached. For example, if halibut abundance is increasing to the point where PSC limits are capped by the ceiling then any further abundance increases generate catch opportunities for directed fishery users but do not provide additional PSC flexibility to the groundfish sectors. Conversely, if halibut abundance is decreasing and PSC limits fall to the floor then any further abundance decreases result in reduced harvest opportunities for halibut fishermen but they do not continue to tighten the PSC constraint for the groundfish sectors. Figure 6-11 shows that the trawl limit is not likely to reach the PSC floor, but might reach a ceiling on a 15-20 year time horizon. Figure 6-12 shows that under certain sub-alternatives the non-trawl PSC limit could reach the floor for a period of years beginning as soon as three to five years after ABM implementation, but that a lagged rebound in SSB is likely to lift the limit off the floor by the 15-year mark at the latest. In summary, the floor and ceiling elements are not expected to be the most impactful of elements in terms of shaping groundfish sector outcomes under ABM, nor are they expected to change the amount of halibut that is available to the directed fishery compared to what would occur if those elements were omitted from ABM. This statement relies, in part, on the previously stated conclusion that halibut bycatch in the groundfish fishery is not a strong determinant of SSB status or of directed fishery catch limits for Area 4. As the Council continues to consider ABM elements it will need to weigh whether floors and ceilings are meant to influence behavior, to distribute the benefit (or burden) of increasing (or decreasing) abundance, or to simply reflect the range of what is a reasonable amount of PSC that is needed to prosecute the BSAI groundfish fisheries in accordance with the MSA National Standards.

Having considered the broad conclusions from the model and compared particular ABM elements that highlight the extent to which ABM might (or might not) affect the amount of halibut available to the directed fishery, the conclusion of this section characterizes the stakeholders that would be affected by changes in catch limits as a result of ABM, if any do occur.

The Area 4 halibut fishery is distinct from other Alaska IPHC areas in its scale by volume, gross ex-vessel value, and value per pound. Figure 4-5 shows that the Area 4 TAC typically accounts for 20% or less of the statewide halibut TAC (21% in 2019). Table 4-3 shows that the ex-vessel value generated in Area 4 is recently comparable to that of Area 2C, though its value had exceeded that of Area 2C consistently until roughly 2012. The bulk of the ex-vessel value generated in Alaska's commercial halibut fishery has come from Area 3. Figure 4-6 through Figure 4-8 reflect that the unit value of Area 4 halibut (ex-vessel $/lb.) lags the statewide average due to several factors mentioned in Section 4, including the geographic location of BSAI processors relative to end-markets and the disposition of the large-scale processing facilities towards focusing on high-volume groundfish and crab fisheries.

The shore-based processors that receive Area 4 halibut deliveries are diverse in scale and dependence on the resource, but the facilities that account for the majority of fishery activity generate less than 25% of total gross revenue (by ex-vessel value) from halibut. Several processing operations that are the sole market in the more rural BSAI areas (outside of Unalaska/Dutch Harbor), and thus critical to facilitating local fisheries, generate less than 10% of their total gross revenue from halibut. While most BSAI processors have relatively lower reliance on the halibut fishery, engagement remains high with between 20 and 30 facilities processing Area 4 halibut each year from 2010 through 2018. In some cases, halibut serves as a side-line that keeps workers engaged; this can be especially important where workers are housed at the facility and cannot easily be released and brought back when high-volume fisheries pick up. In other cases, particularly in CDQ communities, processors are an essential partner in allowing a small boat fishery to operate. While facility- or community-level data cannot be shown due to confidentiality restrictions, the recent average annual ex-vessel value of halibut processed at BSAI shoreside facilities gives a sense of the revenue at risk if the halibut resource were to decline further. The 2010 through 2018 average value at the dock was $24.8 million (2018$). The value in 2018 was $16.9 million, down from a recent peak of $54.6 million in 2011. Figure 4-6 shows that the real unit value of the resource (real ex-vessel $/lb., using 2018$) is flat or decreasing, indicating that the gross economic benefits from the fishery are contingent on maintaining or increasing the amount of available catch. Area 4, in particular, is not a strong candidate for generating additional direct economic benefits through value-added production.

CDQ fishing and CDQ quota management are important elements of the economic and social benefits derived from the Area 4 fishery. Section 4.4.1.1 describes the distribution of CDQ reserve halibut quota across Area 4 subareas. CDQ groups receive zero percent of the Area 4A quota share pool but, aside from that, CDQ accounts for between 20% of quota in 4B to 100% in 4E. CDQ groups that receive part of the quota share reserve may use that quota to directly facilitate a local fishery – contingent on the ability to secure or provide a processing market – or lease the quota for royalties that generate funds which can be deployed to meet community development objectives. The impact of ABM on the amount of available commercial harvest (IFQ+CDQ) – if there is any impact – might differ across regions depending on whether the CDQ entity has adopted a ‘fish’ or ‘lease’ posture. The potential impact of an ABM scenario would not differ significantly between IFQ stakeholders and CDQ participants in a region where the CDQ entity leases annual fishing quota for royalties. By contrast, individuals who rely on their CDQ group to provide an opportunity for active participation could be impacted if abundance levels and available catch decline to a point where a CDQ group will not support the overhead cost of providing a local market. It should be noted that CDQ groups make such determinations by their own criteria, which may or may not place positive net income over small boat harvest opportunity; as a result, the analysts do not attempt to quantify an Area 4 catch limit level at which small scale local operations are less likely to be supported. In any event, the preceding analysis of ABM alternatives suggests that low abundance levels and the resulting lower PSC rates have only a moderate impact on TCEY for all of Area 4. ABM might mitigate the decline in available catch during a low-abundance scenario, but once a PSC limit floor is reached the sub-alternatives under consideration would not provide additional harvest to the directed fishery in the most extreme abundance scenarios.

In addition to the well understood economic benefits of halibut fishing for quota holders, vessel operators, processors, and crew, the fishery also generates downstream impacts in the communities where fish are landed and where active participants reside. The most obvious of these positive impacts are the state and local tax revenues that support public programs and infrastructure, including necessary fishing infrastructure (Section 4.4.1.2). Revenues from the Area 4 halibut fishery can be particularly important in remote communities that do not general significant amounts of revenues from processing the higher-volume groundfish species.[43] Other downstream benefits that are generated from the spending of wages

[43] The analysts note, however, that the communities that were almost entirely reliant on halibut for processing revenue are the ones in the CVRF CDQ region that have not processed halibut since 2014 (see Section 4.4.2).

by harvesting and processing crew; the geographic distribution of these impacts are further discussed in the SIA (Appendix 1). Of note, Section 5.9 of the SIA addresses subsistence fishing and highlights the importance of cash inflows from commercial halibut work that support not only basic household consumption but also purchase the inputs that are now commonly needed to participate in subsistence harvest of both marine and terrestrial wild resources.

6.3 Social and Environmental Justice

Appendix 1, the Social Impact Assessment (SIA) evaluates community and regional participation patterns in the BSAI groundfish and halibut fisheries as well as potential community level impacts from the various action alternatives and the no-action alternative. Potential impacts to subsistence and sport halibut fisheries are also evaluated. This section summaries those SIA evaluations.

6.3.1 BSAI groundfish fishery dependency and vulnerability to community-level impacts of the proposed action alternatives among Alaska communities

The initial 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 one or more of the following indicators in the primary dataset used for analysis: an annual average of one or more active BSAI groundfish TLAS catcher vessel(s), hook-and-line catcher vessel(s), Amendment 80 sector groundfish trawl catcher/processor(s), and/or groundfish hook-and-line catcher/processor(s) with a local ownership address that participated in the BSAI groundfish fisheries 2010-2018 inclusive; and/or an annual average of 0.5 or more locally operating shore-based processor(s) that processed BSAI groundfish from catcher vessels in the TLAS and/or hook-and-line sectors and/or deliveries of CDQ groundfish harvested by catcher vessels from any sector (not just the TLAS and hook-and-line sectors) over the years 2010-2018 inclusive.

Using these initial screening criteria, 12 Alaska communities were selected for analysis as potentially substantially engaged in, and/or potentially substantially dependent on, the BSAI groundfish fishery sectors most likely to be directly affected by one or more of the proposed action alternatives. These Alaska communities are shown in Table 6-11. Also shown in this table for reference is the level of engagement of these same 12 communities in the BSAI/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 BSAI groundfish shore-based processing and BSAI/Area 4 halibut shore-based processing); Newport (Oregon), also not shown, has the second-highest level of engagement in the BSAI groundfish TLAS catcher vessel sector.

Table 6-11 Graphic Representation of Potentially Affected Alaska BSAI Groundfish Communities Relative Annual Average Engagement in BSAI Groundfish and Halibut Fisheries, 2010-2018 (table legend is provided in the lower panel)

Alaska Community	Relative Community Size	BSAI Groundfish Engagement					BSAI Halibut Engagement	
		Local Ownership Address Catcher Vessels		Local Ownership Address Catcher/Processors		Shore-Based Processing Location	Local Ownership Address CVs	Shore-Based Processing Location
		TLAS	Hook & Line*	Amendment 80	Hook & Line			
Adak								
Akutan								
Anchorage								
Atka								
Homer								
King Cove								
Kodiak								
Nome								
Petersburg								
Sand Point								
Sitka								
Unalaska/Dutch Harbor								

* Note: The only Alaska community not included in this table that has BSAI groundfish values in the ranges shown in table key is Wasilla, with hook-and-line catcher vessel participation in the 0.5-0.9 annual average range.

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 Groudfish Catcher Vessel Participation	2010-2018 annual avg = 0.5 -- 0.9 CVs	2010-2018 annual avg = 1.0 -- 2.9 CVs	2010-2018 annual avg = 3.0 or more CVs
BSAI Groudfish Catcher/Processor Participation	2010-2018 annual avg = 0.5 -- 0.9 CPs	2010-2018 annual avg = 1.0 -- 2.9 CPs	2010-2018 annual avg = 3.0 or more CPs
BSAI Groundfish Shore-Based Processor Participation	2010-2018 annual avg = 0.5 -- 0.9 SBPRs	2010-2018 annual avg = 1.0 -- 1.9 SBPRs	2010-2018 annual avg = 2.0 or more SBPRs
BSAI/Area 4 Halibut Catcher Vessel Participation	2010-2018 annual avg = 1.0 -- 4.9 CVs	2010-2018 annual avg = 5.0 -- 9.9 CVs	2010-2018 annual avg = 10.0 or more CVs
BSAI/Area 4 Halibut Shore-Based Processor Participation	2010-2018 annual avg = 0.5 -- 0.9 SBPRs	2010-2018 annual avg = 1.0 -- 1.9 SBPRs	2010-2018 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 fisheries and the economic resiliency and diversity of the community. Dependency is influenced by the relative importance of the relevant BSAI groundfish fisheries to vessels participating directly in the fisheries in comparison to all area, species, and gear fisheries in which those same vessels participate (community sector vessel diversity); the relative importance of the relevant BSAI groundfish fisheries to all community resident-owned commercial fishing vessels participating in all area, species, and gear fisheries combined (community fleet diversity); the relative importance of the relevant BSAI groundfish processing to all locally operating processors participating in all area, species, and gear fisheries combined (community processor 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 fishery sectors and alternative employment, income, business, and public revenue opportunities available within the community as a result of the location, scale, and relative economic diversity of the community. At their most extreme, potential adverse impacts associated with a proposed action could present a risk to fishing community sustained participation in the BSAI groundfish fisheries.

The relative importance of the BSAI 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 2010-2018 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.

6.3.1.1 BSAI region communities

6.3.1.1.1 Unalaska and Akutan

Unalaska and Akutan direct engagement in the relevant BSAI groundfish fisheries in the catcher vessel sector was limited to hook-and-line catcher vessels with Unalaska ownership addresses and in the shore-based processing sector to large, multi-species, multi-fishery BSAI groundfish shore-based processors operating in both communities. Unalaska and Akutan also derive substantial public revenues from BSAI groundfish landings by catcher vessels and related activities. Unalaska, unique among Alaska communities, also derives substantial public revenues from BSAI groundfish catcher/processors offloading/transferring processed product in the port (and from related economic activities).

Unalaska has a small resident-owned commercial fishing fleet. It is also not a CDQ community and as a result, the local fleet does not have direct access to CDQ quota to use as a stable underpinning or a hedge against their vulnerability to potential adverse impacts of proposed management alternatives in either the Pacific cod or halibut fisheries. For shore-based processors accepting relevant BSAI groundfish deliveries in Unalaska and Akutan combined, the ex-vessel value of these landings accounted for 82.8 percent of the ex-vessel value of relevant BSAI groundfish landings at all shore-based processors in Alaska combined. These landings accounted 6.8 percent of all ex-vessel value of landings at all processors operating in these two communities.

Unalaska, 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 TLAS and/or hook-and-line catcher vessel fleets and/or Amendment 80 and/or hook-and-line catcher/processor fleets if port calls were to decline as a result of the proposed action.

6.3.1.1.1.1 **Potential environmental justice concerns**

In Unalaska and Akutan processing workforces include a high proportion of minority employees. Impacts to processing workers could occur, depending on how specific plants and, importantly, their delivering fleets, adapt to changing conditions. While the dependency of these plants on the relevant BSAI groundfish deliveries is not high, it is not insignificant and economic dependency as measured by ex-vessel value of landings does not capture the importance a particular fishery may have in the overall annual cycle of the plant or the labor hour effort that may be needed for that fishery, as how labor-intensive processing a particular species or a given product form may be varies widely. It is not likely, however, that any of the proposed alternatives would result in any high and adverse impacts to processing workers in the form of substantial processor workforce reductions, given the relatively modest level of dependency of the plants in these communities on relevant BSAI groundfish deliveries, although a reduction in processing worker earnings through the loss of labor hours, including overtime hours, may occur.

6.3.1.1.2 Adak and Atka

Adak and Atka direct engagement in the relevant BSAI groundfish fisheries was limited a single shore-based processor operating in each community that accepted relevant BSAI groundfish deliveries. In both communities, deliveries took place in seven out of the nine years 2010-2018. While all revenue data associated with these processors are confidential, in the case of Atka, the Council's recent Amendment 113 analysis indicated that Aleutian Islands Pacific cod deliveries to the Atka plant were limited to incidental catch from a different target fishery as the plant otherwise focused on halibut and sablefish. Further, the Atka plant did not operate in 2018 and its future is uncertain. As a result, it is not likely that any of the proposed alternatives would directly and adversely affect the community of Atka.

The plant in Adak, in contrast, has historically been substantially dependent on Pacific cod based on delivery figures for 2002-2008 made public in previous Council documents through a waiver of confidentiality. While the Adak plant has been through many changes since 2008, it is generally understood that dependence on Pacific cod has remained very high. Adak has also been the continuing focus of a concerted effort to grow the fishery support service sector of the local economy, and BSAI groundfish vessel port calls constitute an important economic driver for this sector. Adak shore-based processing has faced, from the local perspective, a number of 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. Given the historic fragility/inconsistency of local shore-based processing operations, Adak is particularly vulnerable to adverse impacts related to the proposed action alternatives. The level of adverse impact will depend on the nature and success of behavioral adaptions of BSAI groundfish vessels and the local plant in response to the ultimately implemented proposed alternative. Whether adverse impacts related to any specific alternative would represent a significant threshold or tipping point for larger impacts of a cumulative nature in Adak is unknown at this time.

6.3.1.1.2.1 Potential environmental justice concerns

Direct adverse impacts to Adak as a result of the proposed action alternatives, if any, would be focused on the shore-based processing sector. As in Unalaska and Akutan, processing workers in Adak have included a high proportion of minority employees. Additionally, as of 2017, 40.0 percent of Adak's residents were considered low-income, compared to 10.2 percent of Alaska's general population. To the extent that the proposed action alternatives would adversely impact local processing operations and result in a loss of employment and income opportunities, environmental justice would potentially be an issue of concern for the community of Adak.

6.3.1.1.3 Nome

Nome's direct engagement in the relevant BSAI groundfish fisheries in 2010-2018 was limited a single shore-based processor operating in the community that accepted relevant BSAI groundfish deliveries each of the nine years during this period. However, these deliveries included tomcod, which was used for bait, as well as Pacific cod. Engagement in the Pacific cod fishery in Nome, according to NSEDC management staff, is still in its infancy. Community level impacts from any of the proposed action alternatives on existing levels of fishery engagement are unlikely, but the potential impact of the proposed alternatives with respect to either facilitating or impeding the growth of Pacific cod fishery engagement is unknown.

6.3.1.1.4 Other CDQ communities

CDQ entities and their constituent communities could be impacted by potential changes to the BSAI groundfish 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 fisheries and (2) through CDQ group investments in direct participation in the potentially affected industrial-scale groundfish fisheries, including catcher vessel, catcher/processor, and shore-based processor ownership interests.

It is also important to note that efforts directed toward exploration or development of a greater degree of direct engagement in the BSAI Pacific cod fishery through local small vessel fleets is underway in some CDQ communities, including Nome, Savoonga, and St. Paul, and has recently been contemplated in False Pass and Atka. It is also likely that the BSAI groundfish shore-based processing will occur in False Pass in the future, given recent increases to shore-based processing capacity in the community. At present the potential impact of the proposed action alternatives on these efforts, if any, are unclear.

6.3.1.2 GOA region communities

6.3.1.2.1 Anchorage and Kodiak

Anchorage is shown in the dataset as the community of ownership address for BSAI groundfish hook-and-line catcher/processors and the location of shore-based processors that accepted relevant deliveries of BSAI groundfish 2010-2018. Kodiak is shown in the data as the community of ownership address for BSAI groundfish TLAS catcher vessels and BSAI groundfish hook-and-line catcher vessels, as well as the location of shore-based processors that accepted relevant deliveries of BSAI groundfish during this time.

All first wholesale gross revenue data associated with Anchorage’s engagement in the relevant sectors are confidential. However, a general knowledge of the industry, a review of the available data, and past Council analyses would suggest that at least some of the activity attributed to Anchorage is the result of inaccurate assignment of operating locations of processing plants and, in the case of catcher/processors, at least some of the ownership attributed to Anchorage is likely due to some CDQ entities basing their offices and fishery business support operations in Anchorage rather than in the CDQ regions themselves. The relatively modest level of engagement in the BSAI groundfish fishery combined with the size of Anchorage and the size and relative diversity of the local economy makes adverse community-level impacts from any of the proposed action alternatives unlikely.

Relevant BSAI groundfish ex-vessel gross revenues for the annual average of 4.3 active Kodiak TLAS vessels (10 unique vessels) accounted for approximately 0.46 percent of the average annual total ex-vessel gross revenues for all catcher vessels (for all areas, gears, and fisheries) with Kodiak ownership addresses over this same time period. It is important to note, however, that impacts to Kodiak ownership address BSAI groundfish TLAS vessels in particular could be substantial at the operational level, depending on the specific proposed action alternative selected for implementation.

While multiple Kodiak ownership address BSAI groundfish hook-and-line catcher vessels participated in the BSAI groundfish fishery over the course of three years 2010-2018, none did so in the five most recent years covered by the dataset. An annual average of 0.7 Kodiak shore-based processors accepted relevant BSAI groundfish deliveries 2010-2018, but none participated in five of the nine years during this time. Revenue data for the Kodiak BSAI groundfish hook-and-line catcher vessels and the BSAI groundfish shore-based processors are confidential, but given the intermittent nature of engagement in these two sectors and a general knowledge of the local fishing industry, it is assumed that their revenue contribution to local commercial fishing fleet and the local shore-based processing sector is minimal.

Kodiak has a robust fishery support service sector and while it is possible that some of these businesses could be adversely affected by implementation of one or more of the proposed action alternatives, this type of potential impact cannot be quantified with existing information. For Kodiak, the relatively modest level of engagement in the BSAI groundfish fishery combined with the size of the community (approximately 6,100 residents in 2010), the size and relative diversity of the local economy in general, and the fishery-based component of the local economy in particular, makes adverse community-level impacts from any of the proposed action alternatives unlikely.

6.3.1.2.2 King Cove and Sand Point

King Cove and Sand Point were engaged in the BSAI groundfish fisheries most directly potentially affected by one or more of the proposed action alternatives exclusively through shore-based processing sector. King Cove and Sand Point have relatively small populations (938 and 976 residents, respectively, in 2010). Both have relatively large residential commercial fishing fleets and are the operating location of a single, relatively large multi-species shore-based processing plant participating in both BSAI and GOA fisheries.

The King Cove shore-based processor accepted landings of BSAI TLAS and/or hook-and-line caught groundfish each year during this period. While revenue data associated with King Cove's engagement in this sector are confidential, given a general knowledge of King Cove shore-based processing operations, it is assumed that the King Cove shore-based processor has little dependency on relevant BSAI groundfish landings relative to landings of all area, gear, and species fisheries combined. The Sand Point shore-based processor actively participated in the relevant BSAI groundfish fisheries in five of the nine years 2010-2018. Revenue data associated with Sand Point's engagement in this sector are confidential but given a general knowledge of Sand Point shore-based processing operations, it is assumed that the Sand Point shore-based processor has little dependency on the BSAI groundfish landings relevant to this analysis relative to landings the plant accepts from all area, gear, and species fisheries combined. For both communities, adverse community level impacts resulting from the implementation any one of the proposed action alternatives is considered unlikely.

6.3.1.2.3 Homer, Sitka, and Petersburg

Homer, Sitka, and Petersburg were engaged in the BSAI groundfish fisheries most directly potentially affected by one or more of the proposed action alternatives exclusively through having catcher vessels (Homer and Sitka) or catcher/processors (Petersburg) with local ownership addresses active in a relevant sector of the fishery.

Homer had an annual average of 5.3 BSAI groundfish hook-and-line catcher vessels with local ownership addresses for the period 2010-2018 (a total of 15 unique vessels). That was more than any other community in any state and these vessels accounted for roughly half of all the ex-vessel gross revenues for BSAI groundfish hook-and-line vessels with Alaska ownership addresses during this time period. However, associated revenues account for only 0.67 percent of the total ex-vessel gross revenues for all commercial fishing vessels with Homer ownership addresses participating in all area, gear, and species fisheries (i.e., the Homer "community fleet"). The relatively modest level of engagement in the BSAI groundfish fishery combined with the size of the community (approximately 5,000 residents in 2010), size and relative diversity of the local economy in general, and the fishery-based component of the local economy in particular, makes adverse community-level impacts from any of the proposed action alternatives unlikely. It is important to note, however, that impacts to Homer ownership address BSAI groundfish hook-and-line vessels in particular could be substantial at the operational level, depending on the specific proposed action alternative selected for implementation.

Sitka had annual average of approximately 1.2 BSAI groundfish hook-and-line catcher vessels with local ownership addresses over this period (a total of seven unique vessels), but none were active in the fishery in the most recent four years covered by the data (2015-2018). Ex-vessel gross revenue from the BSAI groundfish hook-and-line fishery accounted for 0.13 percent of the total ex-vessel gross revenues for all commercial fishing vessels with Sitka ownership addresses participating in all area, gear, and species fisheries (i.e., the Sitka "community fleet"). Given the limited dependency of the overall Sitka catcher vessel fleet on the relevant BSAI groundfish fisheries, and the relative size and economic diversity of the City and Borough of Sitka in general (population approximately 8,900 in 2010) and its commercial fisheries in particular, it is unlikely that Sitka would experience adverse community-level impacts under any of the proposed action alternatives.

Petersburg had an annual average of 4.5 hook-and-line catcher/processors with local ownership addresses engaged in BSAI groundfish fishery over this period. However, none participated in the fishery in the three most recent years covered by the data. Petersburg also appears in the data as having one BSAI groundfish TLAS catcher vessel with a community ownership address active in the fishery in 2010, but there is no similar activity in the most recent eight years covered by the dataset. All revenues associated with these vessels are confidential. Given the lack of participation in relevant BSAI groundfish fisheries sectors in recent years, and the relative size and economic diversity of Petersburg in general (population approximately 2,950 in 2010) and its commercial fisheries in particular, it is unlikely that Petersburg would experience adverse community-level impacts under any of the proposed action alternatives.

6.3.2 BSAI groundfish fishery dependency and vulnerability to community-level impacts of the proposed action alternatives among Pacific Northwest communities

Given the degree of centralization of ownership of the directly engaged BSAI groundfish fishery sectors in the Seattle MSA and the centralization of the support services provided by Seattle-based firms, potential adverse economic impacts associated with proposed action alternatives described Section 6.2.2 would largely accrue to the Seattle MSA in particular and the Pacific Northwest in general.

As noted in Section 6.2.2, numerous variables influence the impacts of PSC limit reduction on groundfish sectors, including environmental, regulatory, and behavioral variables. While harvesters cannot directly impact environmental or regulatory variables, they can impact behavioral variables through halibut avoidance strategies, all of which come with avoidance costs. These avoidance strategies include search time looking for grounds with lower halibut bycatch, fishing less efficient areas where there are fewer halibut, and changing catch handling techniques such as deck sorting, among others. These costs, which impact net revenues, are incurred regardless of whether or not 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 would be speculative and highly uncertain (see Section 6.2.2 for additional details).

6.3.2.1 Potential environmental justice concerns

In terms of absolute numbers (based on existing participation/engagement patterns), whatever adverse impacts related to BSAI groundfish TLAS catcher vessel, BSAI groundfish Amendment 80 catcher/processor, and hook-and-line catcher/processor direct employment and income that would occur as the result of implementation of the proposed action alternative ultimately selected for implementation would largely accrue to the Seattle MSA. No systematically collected demographic data for vessel crew are available. However, 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 in the BSAI groundfish fisheries. The demographic data supplied by those firms indicate that two-thirds of all employees working on the 10 catcher/processors represented in these data are minority employees. Minority representation is substantially higher for two of the job categories and in all but two job categories (captains and engineers) minority employees represented greater than 50 percent of all employees in that category. In contrast, minority representation in the general Seattle MSA 2010 population was 32 percent (1,099,535 minority residents out of a total population of 3,439,809 residents).

Given the demographic characteristics summarized here, if disproportionate high and adverse impacts were to accrue to the Seattle MSA ownership address BSAI groundfish Amendment 80 catcher/processor workforce due to implementation of a proposed action alternative, environmental justice would potentially be an issue of concern.

Of specific concern would be loss of income opportunities for crew related to increased expenses in operations with additional halibut avoidance measures, and/or more time away from home with time-consuming and/or labor-intensive avoidance 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 employees who have worked their way up from entry level positions.

6.3.3 Community engagement, dependence, vulnerability, resilience, and risks to fishing community sustained participation in the relevant BSAI/Area 4 halibut fisheries

The initial screening criteria for the selection of Alaska communities for inclusion in this portion of the SIA 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 2010-2018, inclusive.

Using these initial screening criteria, 21 Alaska communities 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. A total of 17 of these Alaska communities were considered to be halibut-dependent and are shown graphically in Table 6-12. Not shown in this table is the level of engagement of Alaska communities outside of the BSAI region or Pacific Northwest communities.

Table 6-12 Graphic Representation of Potentially Affected Alaska BSAI Halibut-Dependent Communities Annual Average Engagement in BSAI Halibut Fisheries (table legend is provided in the 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	Halibut Ex-Vessel Gross Revenues as Percentage of Total Ex-Vessel: Halibut CVs Only	Halibut Ex-Vessel Gross Revenues as Percentage of Total Ex-Vessel: All Local CVs
Adak	(none)								
Atka	APICDA								
Akutan	APICDA								
St. George	APICDA								
Unalaska/Dutch Harbor	(none)								
St. Paul	CBSFA								
Hooper Bay	CVRF								confidential
Kipnuk	CVRF								
Mekoryuk	CVRF								
Toksook Bay	CVRF								
Chefornak	CVRF								
Newtok	CVRF								
Nightmute	CVRF								
Quinhagak	CVRF								
Tununak	CVRF								
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

Type/Level of Engagement			
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	2013-2017 Population = less than 15%	2013-2017 Population = 15.0-24.9%	2013-2017 Population = 25.0% or more
BSAI/Area 4 Halibut Catcher Vessel Participation	2010-2018 annual avg = 1.0 -- 4.9 CVs	2010-2018 annual avg = 5.0 -- 9.9 CVs	2010-2018 annual avg = 10.0 or more CVs
BSAI/Area 4 Halibut Shore-Based Processor Participation	2010-2018 annual avg = 0.5 -- 0.9 SBPRs	2010-2018 annual avg = 1.0 -- 1.9 SBPRs	2010-2018 annual avg = 2.0 or more SBPRs
BSAI/Area 4 Halibut Shore-Based Processor Participation	2010-2018 annual avg = less than 25%	2010-2018 annual avg = 25.0 - 49.5%	2010-2018 annual avg = 50.0% or more

The problematic nature of the no action alternative for directed halibut fishery participants is inherently recognized in the Council's purpose and need statement. The potential for BSAI 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 BSAI halibut fisheries. Similar to what was described for relevant BSAI groundfish fisheries, dependency on the BSAI halibut fishery is influenced by the relative importance of BSAI 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 BSAI halibut fisheries and alternative employment, income, business, and public revenue opportunities available within the community as a result of the location, scale, and relative economic diversity of the community.

It is assumed that directed BSAI halibut fisheries, including the commercial, subsistence, and sport halibut fisheries, would potentially benefit from the various proposed alternatives relative to the degree that the BSAI halibut stock itself (halibut spawning stock biomass) would potentially benefit from these proposed actions, particularly in low abundance conditions, and, especially in the case of the commercial directed halibut fishery, the effective redistribution of overall allocations between sectors that would occur to greater or lesser degrees under the various alternatives. While to the extent that they would be felt, impacts to communities engaged in the BSAI groundfish fisheries would be immediate and adverse; potential impacts to communities engaged in the BSAI halibut fisheries, to the extent that they would be felt, would not (except for a de-facto reallocation of halibut between fisheries) be immediately apparent and the full extent of their beneficial impact would not be realized for several years.

6.3.3.1 Potential Differential Distribution of Impacts to Communities Engaged in the Commercial Halibut Fishery

6.3.3.1.1 Alaska communities

Dependence of the total resident-owned catcher vessel fleet (all resident-owned commercial fishing vessels, not just resident-owned vessels that participated in the halibut fishery) 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 the highest 2010-2018 annual average catcher vessel Area 4 halibut ex-vessel gross revenues (at approximately $2.5 million, over 40 percent higher than Unalaska, the next closest community in the BSAI region), was also the community with the second-highest percentage of community fleet dependency on BSAI halibut ex-vessel gross revenues (99.8 percent). The only community with a higher local fleet dependency on BSAI halibut ex-vessel gross revenues was Savoonga (at 100 percent), which features a smaller scale community fleet.

Among the communities or small groups of communities for which revenue totals can be disclosed, three other communities (Adak/Atka, St. George, and Mekoryuk) have local ownership address catcher vessels fleets that were 80 percent or more dependent on BSAI halibut ex-vessel gross revenues on an annual average basis for the years 2010-2018, while four others were 25 percent or more dependent (Akutan, Unalaska, 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 basis, nine have dependencies of 90 percent or greater and one is more than 80 percent dependent.

In most cases, potentially substantially engaged or substantially dependent BSAI halibut communities located in the BSAI region itself are member communities of CDQ entities that receive substantial benefit from direct investment in commercial fishing operations. Many of these operations are directly involved in the harvesting and/or processing of BSAI groundfish and would be subject to decreases in BSAI halibut PSC limits during low abundance conditions under the proposed alternatives being considered. Ultimately, the level of direct impact to an individual CDQ entity and level of indirect impact to its member communities would depend on the individual levels of investment, range of investments with regard to fishery and geography, and overall financial management of other investments outside of commercial fishing.

While each CDQ entity manages their investments differently, 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. Some CDQ regions are coincident with Area 4E, which has a 100 percent CDQ reserve, essentially meaning that engagement of small, locally owned vessels in a commercial halibut fishery would necessarily be mediated by the CDQ group; in other CDQ regions with different levels of CDQ reserve, individuals, assuming they own or otherwise have the means to acquire or access IFQ quota, have the option of engaging in the fishery directly without exclusively going through the local CDQ entity.

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 tipping point whereby in-region halibut fisheries would be considered sustainable by the relevant CDQ group(s) even in low abundance conditions. For this reason, it is difficult to predict whether implementation of any one of the proposed alternatives would result in a different pattern of in-region CDQ community commercial small boat direct halibut fishery engagement than is seen at present.

6.3.3.1.1.1 **Potential environmental justice concerns**

The potentially substantially engaged or substantially dependent BSAI halibut communities as determined by use of initial screening criteria that would potentially experience high and adverse impacts under the no-action alternative, and that would potentially benefit the most from the action alternative, include communities with high proportions of minority populations and high proportions of low-income populations. In terms of minority populations, of the 17 halibut dependent communities in the BSAI region, 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. In terms of Alaska Native populations specifically, of the 17 communities identified as halibut dependent communities in the BSAI region, 15 are members of CDQ groups. Of these 15 communities, Alaska Native residents make up over 90 percent of the total population in 11 of the communities, over 80 percent of the total population in two communities, and over 50 percent in one community.

In terms of low-income populations, of the 17 halibut dependent communities in the BSAI region, in 2017 three had between 40 and less than 50 percent of their residents living below the poverty threshold, five had between 30 and less than 40 percent of their residents living below the poverty threshold, one had between 20 and less than 30 percent of their residents living below the poverty threshold, and five had between 10 and less than 20 percent of their residents living below the poverty threshold (compared to 10.2 percent of Alaska's general population living below the poverty threshold).

Given these demographics, if these communities were to experience disproportionate high and adverse impacts under the no-action alternative, 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.

6.3.3.1.2 Pacific Northwest communities

The Seattle MSA is also substantially engaged in the BSAI/Area 4 halibut 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 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.

6.3.3.2 Potential Impacts to BSAI Communities Engaged in the Subsistence Halibut Fishery

Subsistence harvest of halibut would not be directly affected by the proposed action alternatives. Unlike the commercial halibut fishery, the subsistence halibut fishery would not benefit from potential reallocations between the BSAI groundfish and the BSAI/Area 4 directed halibut fisheries under the proposed alternatives. As noted in Section 4.3.1, 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. Each year, the IPHC estimates subsistence harvest by using the actual harvest level from the previous year as a base, and then adjusts the estimate by considering how accurate the previous year's harvest estimate was compared to actual harvest for that 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. In Areas 4A and 4B, encompassing the communities of Akutan, Unalaska, Nikolski, Atka, and Adak, under a Subsistence Halibut Registration Certificate permit there is a harvest limit of 20 halibut per person per day and no possession limit and a limit of 30 hooks per person onboard up to 90 hooks per vessel; in Areas 4C, 4D, and 4E, which encompass all of the other BSAI area communities, there are no daily or possession limits and there are no hook limits.

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 spawning mass, an overall improvement in availability of halibut for subsistence harvest, and/or an accompanying decrease in effort and expense in harvesting halibut for subsistence use. Beyond direct use of halibut as a subsistence resource, the proposed action alternatives could have impacts on other subsistence pursuits. These types of impacts fall into two main categories: impacts to other subsistence pursuits as a result of loss of income 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 as a result 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 under the no-action alternative.

6.3.3.3 Potential Impacts to BSAI Communities Engaged in the Sport Halibut Fishery

Similar to the subsistence harvest of halibut, the sport harvest of halibut would not be directly affected by the proposed action alternatives as, unlike the commercial halibut fishery, the sport halibut fishery would not benefit from potential reallocations between the BSAI groundfish fishery and the BSAI commercial halibut fisheries if BSAI halibut PSC limits were reduced under low abundance conditions. 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.

6.3.3.4 Potential Cumulative Small/Rural Community and Cultural Context Issues

The SIA largely focuses on community impacts associated with the implementation of proposed BSAI halibut PSC limit revisions through the use of quantitative fishery information and through characterizations of a number of 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 groups throughout Alaska. In addition to being a primary subsistence resource for many coastal groups, 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.

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 underlines 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 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 in particular would be more secure.

6.4 Management and Enforcement considerations

6.4.1 Cost recovery

Halibut PSC management actions recommended by the Council, and implemented by NMFS, could affect the total amount harvested by the AFA catcher vessel, Amendment 80, and CDQ Programs. Under section 304(d) of the MSA, these programs are subject to cost recovery fees (80 FR 935, January 7, 2015).[44] NMFS is required to recover the actual costs directly related to the management, data collection, and enforcement of any Limited Access Privilege (LAP) program and the CDQ program. To calculate the cost recovery fee percentage for each fishing year, NMFS divides the direct program costs of an eligible fishery program by the total ex-vessel fishery value, then multiplies by 100 to calculate the fee percentage levied on landings. This action could change halibut PSC limits which could impact the value of fisheries subject to cost recovery by changing the total amount of fish or the amount of each species harvested. Changes to direct program costs, fishery value, or both, could alter the fee percentage due. The potential impact of this action on the fee percentages due is uncertain. It is not possible to quantitatively estimate the potential impact of this action on cost recovery fee percentages given the wide variety of factors that affect the direct program costs incurred by NMFS, and the value of a fishery. These factors can include, among others, TACs, ex-vessel prices, and specific fleet responses to this action which are all variable and can change simultaneously.

Section 304(d) limits total cost recovery fees to 3 percent of the ex-vessel value for a fishery. In 2018, cost recovery fee percentages ranged from 0.24 percent to 0.75 percent of ex-vessel value for the AFA, Amendment 80, and CDQ Programs. The potential impact of this action on cost recovery fees will vary based on changes to fishery value and direct program costs, but cannot exceed 3 percent of fishery value. A detailed description of the costs and potential fees associated with the AFA, Amendment 80, and CDQ Programs is available in the proposed rule and the analysis to implement cost recovery fees and is incorporated by reference[45].

6.4.2 Vessel safety

None of the proposed alternatives or options would change safety requirements for fishing vessels. The proposed action to change halibut PSC limits is not likely to affect safety for vessels that operate in the CV hook-and-line Pacific cod fishery and CV/CP hook-and-line other targets fishery because none of the analyzed options would immediately constrain groundfish harvest in these fisheries to a point where increased vessel safety concerns would be expected. The proposed alternatives and subsequent options provide for a gradual increase, decrease or maintenance of PSC limits, with buffers against dramatic annual variation. In this way, if continual reductions in PSC limits became apparent, there would be time to address new vessel safety concerns before they became significant.

The proposed action also is not likely to affect safety for vessels that operate in a rationalized fishery (Amendment 80, hook-and-line CP Pacific cod, and CDQ fisheries). These vessels have the ability to coordinate within the sector to respond to variable PSC limits by reducing groundfish harvests or by using other methods to reduce halibut PSC use.

If the proposed action results in a reduction of halibut PSC limits this may increase competition for PSC among vessels that operate in a non-rationalized fishery (BSAI TLAS). These vessels do not coordinate operations across the entire sector, and PSC limit reductions may result in a race for harvesting groundfish TACs that are limited by PSC. To the extent that vessel operators take more risks, e.g., fishing in marginal weather, increasing competition for halibut PSC may marginally impact the safety of human

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[44] See proposed rule published on January 7, 2015, at https://www.federalregister.gov/documents/2015/01/07/2014-30841/fisheries-of-the-exclusive-economic-zone-off-alaska-bering-sea-and-aleutian-islands-management-area#p-1.

[45] See analysis at http://www.regulations.gov/#!documentDetail;D=NOAA-NMFS-2014-0031-0002.

life at sea. However, it is unlikely that any of the alternatives would result in substantial increases in competition for PSC in the BSAI TLAS fisheries.

If the proposed action results in an increase of halibut PSC limits this may relax competition for PSC among vessels that operate in a non-rationalized fishery (BSAI TLAS) and may deter vessel operators from taking unnecessary risks, e.g. fishing in marginal weather.

6.4.3 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 will may decrease the incentive to bias an observer's data and reduce reports of harassment, intimidation, and hostile work environments directed at observers.

6.4.4 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. 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.

6.5 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:

- Deck sorting of halibut on Amendment 80 trawl catcher processors. New regulations are being enacted to make procedures required for sorting halibut on deck in the flatfish fisheries, so that the halibut can be returned to the sea more expeditiously, and hopefully improve the mortality rate of halibut intercepted in the fishery. The implementation of deck sorting procedures should benefit the halibut stock by reducing the mortality of halibut resulting from groundfish fishery interactions. The final rule is scheduled to publish in the fall of 2019 with regulations to be implemented for the start of the 2020 fishing season.
- 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.

7 Other Resource Categories

7.1 Marine Mammals

7.1.1 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, the Endangered Species Act, and the Fur Seal Act are the relevant statutes for managing marine mammal interactions with human activities, including commercial fishing operations. The Marine Mammal Protection Act (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 Endangered Species Act (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 7-1. 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 7-1 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 Me
	Northern fur seal *(Callorhinus ursinus)*	Eastern Pacific	Depleted, Strategic	Met
	Harbor seal *(Phoca vitulina)*	Pribilof Islands	None	Unknown**
		Bristol Bay	None	Unknown**
	Ribbon seal *(Phoca fasciata)*	Alaska	None	Met
	Bearded seal *(Erignathus barbatus nauticus)*	Alaska	Threatened, depleted, strategic	Unknown*
	Spotted seal *(Phoca largha)*	Alaska	None#	Met
	Ringed seal *(Phoca hispida)*	Alaska	None¥	Unknown*
	Pacific Walrus *(Odobenus rosmarus divergens)*	Alaska	Strategic§	Met
Cetacea	Killer whale *(Orcinus orca)*	Eastern North Pacific Alaska Resident	None	Met
		Eastern North Pacific GOA, AI, and Bering Sea transient	None	Met
		Offshore***	None	Unknown*
	Pacific White-sided dolphin (*Lagenorhynchus obliquidens*)	North Pacific	None	Unknown*
	Harbor porpoise *(Phocoena phoecena)*	Bering Sea	Strategic	Unknown*
	Dall's porpoise (*Phocoenoides dalli*)	Alaska	None	Unknown*
	Beluga whale *(Delphinapterus leucas)*	Beaufort Sea	None	Met
		Eastern Chukchi Sea	None	Met
		Eastern Bering Sea	None	Unknown*
		Bristol Bay		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‡	Endangered, Depleted, Strategic	Not Met
		Central North Pacific ‡‡	Threatened, Depleted, Strategic‡‡	Not Met
	Fin whale *(Balaenoptera physalus)*	Northeast Pacific	Endangered, Depleted, Strategic	Unknown*
	Minke whale *(Balaenoptera acutorostrata)*	Alaska	None	Unknown*
	North Pacific right whale *(Eubalaena japonica)*	Eastern North Pacific	Endangered, Depleted, Strategic	Met****
	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	Met
Ursoidea	Polar Bear *(Ursus maritimus)*	Chukchi/Bering Sea	Threatened, Depleted, Strategic	Met

Sources: Muto et al 2015; List of Fisheries for 2017 (January 12, 2017 82 FR 3655)
* 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, 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.
‡ Corresponds to the new Asia/ 2nd WDPS (endangered).
‡‡ Includes the new Mexico (threatened) and Hawaii DPSs (not protected under the ESA).

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.
© 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 listed as threatened under the ESA in December 2012. In July 2014 the U.S. District Court vacated the listing.In October 2016 the US Court of Apeals for the 9th Circuit reversed the July 2014 decision returning the Beringia DPS to a threatened status under the ESA.
¥ 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.
§ 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.

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 7-1- Table 7-4).

Table 7-2 Status of Pinnipedia and Carnivora stocks potentially affected by the action.

Pinnipedia and Carnivora species and stock	Status under the ESA	Status under the MMPA	Population trends	Distribution in action area
Steller sea lion –Western (W) and Eastern (E) Distinct Population Segment (DPS)	Endangered (W)	Depleted & a strategic stock	For the WDPS, regional increases in counts in trend sites of some areas have been offset by decreased counts in other areas so that the overall population of the WDPS appears to have stabilized (NMFS 2010a). The EDPS is steadily increasing and is delisted.	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 & a strategic stock	Recent pup counts show a continuing decline in the number of pups surviving in the Pribilof Islands. NMFS researchers found an approximately 9% decrease in the number of pups born between 2004 and 2006. The pup estimate decreased most sharply on St. Paul Island.	Fur seals occur throughout Alaska waters, but their main rookeries are located in the Bering Sea on Bogoslof Island and the Pribilof Islands. Approximately 55% of the worldwide abundance of fur seals is found on the Pribilof Islands (NMFS 2007b). 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 – Gulf of Alaska	None	None	A moderate to large population decline has occurred in the GOA stock.	GOA stock found primarily in the coastal waters and may cross over into the Bering Sea coastal waters between islands.
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. Occasional movement into the GOA (Boveng et al. 2008)
Northern sea otters – SW Alaska	Threatened**	Depleted & a strategic stock	The overall population trend for the southwest Alaska stock is believed to be declining, particularly in the Aleutian Islands.	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: Allen and Angliss 2014; List of Fisheries for 2017 (January 12, 2017 82 FR 3655). Northern fur seal pup data available from http://www.alaskafisheries.noaa.gov/newsreleases/2007/fursealpups020207.htm.

*NMFS determined that ribbon seals were not to be listed on September 23, 2008. The Center for Biological Diversity and Greenpeace filed suit against NMFS regarding this decision on September 3, 2009.

**Northern sea otter information from http://www.nmfs.noaa.gov/pr/pdfs/sars/seaotter2008_ak_sw.pdf and 74 FR 51988, October 8, 2009.

Table 7-3 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 – AT1 Transient, E N Pacific transient, W Coast transient, AK resident, Southern resident	Southern resident endangered; remaining stocks none	AT1 depleted and a strategic stock, Southern Resident depleted. The rest of the stocks: None	Southern residents have declined by more than half since 1960s and 1970s. Unknown abundance for the Alaska resident; and Eastern North Pacific GOA, Aleutian Islands, and Bering Sea transient stocks. The minimum abundance estimate for the Eastern North Pacific Alaska Resident stock is likely underestimated because researchers continue to encounter new whales in the Alaskan waters.	Southern resident do not occur in GOA. Transient-type killer whales from the GOA, Aleutian Islands, and Bering Sea are considered to be part of a single population.
Dall's porpoise Alaska	None	None	Reliable data on population trends are unavailable.	Found in the offshore waters from coastal Western Alaska throughout the GOA.
Pacific white-sided dolphin	None	None	Reliable data on population trends are unavailable.	Found throughout the GOA.
Harbor porpoise GOA	None	Strategic	Reliable data on population trends are unavailable.	Primarily in coastal waters in the GOA, usually less than 100 m.
Humpback whale – Western and Central North Pacific	Endangered and under status review	Depleted & a strategic stock	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 (Calambokidis et al. 2008).	W. Pacific and C. North Pacific stocks occur in GOA waters and may mingle in the North Pacific feeding area.
North Pacific right whale Eastern North Pacific	Endangered	Depleted & a strategic stock	This stock is considered to represent only a small fraction of its precommercial 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 (Braham and Rice 1984). 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 (Brownell et al. 2001). Critical habitat near Kodiak Island in the GOA
Fin whale Northeast Pacific	Endangered	Depleted & a strategic stock	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- Cook Inlet	Endangered	Depleted & a strategic stock	2008 abundance estimate of 375 whales is unchanged from 2007. Trend from 1999 to 2008 is not significantly different from zero.	Occurrence only in Cook Inlet.
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 and in the inshore waters of the GOA. Not common in the Aleutian Islands.
Sperm whale North Pacific	Endangered	Depleted & a strategic stock	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. Found year-round In GOA.
Baird's, Cuvier's, and Stejneger's beaked whale	None	None	Reliable data on population trends are unavailable.	Occur throughout the GOA.

Sources: Allen and Angliss 2014; List of Fisheries for 2014 (79 FR 49053, August 19, 2014); http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spermwhale.htm. North Pacific right whale included based on NMFS (2006a) and Salveson (2008). AT1 Killer Whales information based on 69 FR 31321, June 3, 2004. North Pacific Right Whale critical habitat information: 73 FR 19000, April 8, 2008. For beluga whales: 73 FR 62919, October 27, 2008.

7.1.2 Effects on Marine Mammals

7.1.2.1 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 2017 (82 FR 3655, January 12, 2017), describes known incidental takes of marine mammals in the groundfish fisheries. 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.

Some options under Alternatives 2 and 3 may result in no change to the status quo. Some options under Alternative 2 and 3 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 and 3 could result in increased PSC limits. This could result in a response of increased fishing effort, as industry is less constraint by halibut PSC limits. However, TAC and other restrictive harvest measures for a given fishery will not be changed as a result of this action.

A formal analysis to assess or predict how the proposed alternatives would impact the incidental take of marine mammals was not attempted given the lack of available information at the time of this preliminary DEIS.

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 options under Alternative 2 and 3 are expected to result in significant increases in total fishing effort in the BSAI. Therefore, the incidental takes under Alternatives 2 and 3 would not have a significant effect on marine mammals.

7.1.2.2 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 7-4 shows the BSAI marine mammal species and their prey species that may be impacted by BSAI groundfish fisheries.

Table 7-4 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 7-5 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 7-5). 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.

Table 7-5 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 and 3 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 and 3 could result in increased PSC limits. This could result in a response of increased fishing effort, as industry is less constraint 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 or 3 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.

A formal analysis to assess or predict how the proposed alternatives would impact the prey availability of marine mammals was not attempted given the lack of available information at the time of this preliminary DEIS.

7.1.2.3 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 and Alternative 3 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 or Alternative 3 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 and 3 are not likely to result in population level effects.

A formal analysis to assess or predict how the proposed alternatives would impact disturbance of marine mammals was not attempted given the lack of available information at the time of this preliminary DEIS.

7.1.3 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.

7.2 Seabirds

7.2.1 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 7-6; 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 7-6; 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 7-6 Seabird species in Alaska

Type	Common name	Status	Type	Common name	Status
Albatrosses	Black-footed		Guillemots	Black	
	Short-tailed	Endangered		Pigeon	
	Laysan		Eiders	Common	
Fulmars	Northern fulmar			King	
Shearwaters	Short-tailed			Spectacled	Threatened
	Sooty			Steller's	Threatened
Storm petrels	Leach's		Murrelets	Marbled	
	Fork-tailed			Kittlitz's	
	Pelagic			Ancient	
	Red-faced		Kittiwakes	Black-legged	
	Double-crested			Red-legged	
Gulls	Glaucous-winged		Auklets	Cassin's	
	Glaucous			Parakeet	
	Herring			Least	
	Mew			Whiskered	
	Bonaparte's			Crested	
	Slaty-backed		Terns	Arctic	
Murres	Common		Puffins	Horned	
	Thick-billed			Tufted	
Jaegers	Long-tailed				
	Parasitic				
	Pomarine				

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 2017 through 2018 (Krieger et al. 2019). Document available at: https://www.fisheries.noaa.gov/national/bycatch/seabirds

7.2.2 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 short-tailed albatross which are listed as endangered under the ESA. The USFWS consulted with NOAA Fisheries Alaska Region under section 7 of the ESA on the effects of the groundfish fisheries on the endangered short-tailed albatross. In its 2015 biological opinion, the USFWS determined the groundfish fisheries off Alaska are likely to adversely affect short-tailed albatross, but they are not likely to jeopardize its continued existence (USFWS 2015). This 2015 biological opinion included an incidental take limit of six short-tailed albatross every two years in the groundfish fisheries off Alaska, either by hook-and-line gear or trawl gear.

7.2.3 Impact Analysis

7.2.3.1 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 645 birds per year from 2010 through 2018 (Krieger et al. 2019). 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 2018. The estimated takes of gulls, fulmars, and shearwaters in the entire groundfish fishery are very small percentages of these species' populations (Krieger et al. 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). To date, striking of trawl vessels or gear by the short-tailed albatross has not been reported by observers. The probability of short-tailed albatross 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 short-tailed albatross collisions are very rare, but the possibility of such collisions cannot be completely discounted. USFWS' Biological Opinion included an Incidental Take Statement of six short-tailed albatross for the trawl and hook-and-line groundfish fisheries off Alaska combined (USFWS 2015).

7.2.3.2 Incidental Take of Seabirds in Hook-and-Line Fisheries

Incidental takes of seabirds can occur when they are attracted to baited hooks as they are being set, and become entangled in the gear, or caught on the hooks. Hook-and-line gear accounts for the majority of seabird take in the North Pacific groundfish fisheries. Annual BSAI hook-and-line bycatch of seabirds has been substantially reduced over that time, however, to the current numbers of about 4,800 birds annually (average for 2010 through 2018). This reduction has largely been due to the use of seabird avoidance techniques such as paired streamer lines in the hook-and-line fisheries. Recent studies have also highlight the utility of other seabird bycatch mitigation measures for the hook-and-line fisheries such as night setting (Melvin et al. 2019), and longlines without attached floats (Gladics et al. 2017). The species composition for seabird bycatch in the combined BSAI hook-and-line fisheries is primarily northern fulmars, shearwaters, and gulls, with a small proportion of seabirds unidentified (Krieger et al. 2019). There are also annual albatross takes and small numbers of kittiwake and murre takes.

Two short-tailed albatross were observed taken in the BSAI hook-and-line Pacific cod fishery in August and September of 2010, leading to an estimated take of 15 birds in the CAS. Another single take was reported in October, 2011, leading to an estimate of 5 short-tailed albatross. Again in 2014, two short-tailed albatross were observed taken, leading to an estimate of 11 short-tailed albatross. The Biological Opinion for short-tailed albatross included an Incidental Take Statement of six short-tailed albatross for the trawl and hook-and-line groundfish fisheries off Alaska combined (USFWS 2015). Note that this take is based on numbers of birds observed rather than the estimate of total take in the CAS derived from the observed take. The takes recorded in 2010 were the first ones observed since 1998. No takes of short-tailed albatross in federal fisheries off Alaska have been observed since 2014.

7.2.3.3 Impacts under the alternatives

Estimated takes in the BSAI trawl groundfish fisheries average 645 birds per year, and in the hook-and-line fishery, 4,800 birds per year; in both, they primarily consist of northern fulmars (Krieger et al. 2019). 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 jog gear because NOAA Fisheries does not have independent observer data from these fisheries.

Options under Alternatives 2 and 3 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 of 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. 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 incidental take, compared to the status quo, if this increased fishing activity overlaps temporally and geographically with areas used by seabirds. In contrast, some options under Alternatives 2 and 3 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 or Alternative 3. 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 fishery. 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 short-tailed albatross, but the take of this species in BSAI groundfish fisheries are already closely monitored with respect to the incidental take statement in the Biological Opinion.

7.2.3.4 Prey Availability Disturbance of Benthic Habitat

As noted in Table 7-7, 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 7-7 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).

7.2.4 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.

7.3 Habitat

7.3.1 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

7.3.2 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 and 3 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 and 3 could result in increased PSC limits. This could result in a response of increased fishing effort, as industry is less constraint by halibut PSC limits.

Shifts in the location or timing of fishing may occur as a result of Alternatives 2 and 3. 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 and 3 change effort in the BSAI groundfish fishery, those alternatives would change impacts on habitat relative to the status quo.

7.4 Ecosystem

7.4.1 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 Ecosystem Status Report (Zador 2018). These considerations are summarized according to the ecosystem effects on the groundfish fisheries, as well as the potential fishery effects on the ecosystem.

7.4.2 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. Exempted fishing permits currently support investigation of new management approaches for the control of halibut removals through halibut excluder devices http://alaskafisheries.noaa.gov/ram/efp.htm.

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. Options under Alternatives 2 and 3 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 and 3 could result in increased PSC limits. This could result in a response of increased fishing effort, as industry is less constraint by halibut PSC limits.

Shifts in the location or timing of fishing may occur as a result of Alternatives 2 and 3. 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 and 3 change effort in the BSAI groundfish fishery, 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 (Zador 2018).

8 Magnuson-Stevens Act and Pacific Halibut Act Considerations

8.1 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.

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 prior to finalization.

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 would modify halibut PSC limits in the BSAI groundfish fisheries. 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 FMP establishes optimum yield for the BSAI groundfish fishery as a whole. This action is not expected to interfere with the achievement of optimum yield on a continuing basis.

Additionally, the "optimum yield" from the fishery reflects ecological, social, and economic considerations.

Additional information will be provided on relative impacts to groundfish fleets and ability to mitigate these in the next iteration of this analysis.

Additional information will be provided on relative impacts to groundfish fleets and ability to mitigate these in the next iteration of this analysis.

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 (Section 1.X). 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 major sectors affected by the proposed action, including both groundfish and halibut fisheries. A description of participants in each fishery and sector, including residency information for the groundfish fishery sectors, and for halibut. Community engagement in the groundfish and halibut fisheries is analyzed in Appendix 1. While the Council does not have direct authority over setting halibut catch limits, the proposed action may increase opportunities for directed halibut fishing, if the IPHC increases the commercial catch limit for the directed halibut fishery in response to this action.

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.

National Standard 7 — Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

The proposed action is consistent with this standard.

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.

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. A summary of the level of fishery engagement in communities and dependency analysis is provided in Appendix 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 groundfish fisheries to the extent practicable.

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 the non-trawl, Amendment 80, or CDQ fisheries. To the extent that the proposed action increases competition for PSC among vessels in the BSAI trawl limited access fisheries, and vessel operators take more risks, there may be some marginal impact on safety.

8.2 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 6 and appendix 1). The effects of the proposed action on safety of human life at sea are evaluated in Section 3. 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 groundfish fisheries 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.

8.3 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 8.1. 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 a 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;

(B) historical fishing practices in, and dependence on, the fishery;

(C) the economics of the fishery;

(D) the capability of fishing vessels used in the fishery to engage in other fisheries;

(E) the cultural and social framework relevant to the fishery and any affected fishing communities;

(F) the fair and equitable distribution of access privileges in the fishery; and

(G) any other relevant consider actions.

- Sections XX through XX for the groundfish fishery sectors provide a description of participants in each fishery and sector, including residency information, as well as the historical fishing practices of participants in these fisheries, the economics of the fisheries, and the vessels' diversification into other fisheries. Similar information is provided in Section XX for halibut.
- The engagement, social and cultural framework, and dependency of communities on the groundfish and halibut fisheries are analyzed in Appendix 1.

Sections XX through XX evaluate the impacts from the Alternative 2 and 3 options with respect to these considerations.

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[46] Contribuing does not imply endorsement by the contributor's associated agency

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11 Appendices

Appendix 1: Social Impact Assessment

[Appended separately}

Appendix 2: Additional Indices considered and correlation analyses previously Considered in development of ABM

Table 1. Description of Pacific halibut indices developed for consideration in creating alternative ABM control rule frameworks. Note that the naming convention follows roughly the size:area:gear:units format for Pacific halibut. Also noted are which indices are included in each ABM option from the April 2017 discussion paper

Pacific halibut Index Name	Description	Applies to what part of the halibut population
O26/O32.4CDE.Setline.Bio	Biomass of halibut over 32 inches from the IPHC setline survey in the BS/AI	Representative of mostly female mature fish, and fish targeted by the directed fishery in the EBS (Area 4CDE)
O26/O32.CW.Setline.Bio	Biomass of halibut over 32 inches from the IPHC setline survey in all areas	Representative of mostly female mature fish and as a proxy to coast wide stock status
SB.Assessment.Bio	Current estimate of spawning biomass from the stock assessment model	Stock assessment estimate of coastwide female spawning biomass, similar to stock status, also representative of large fish
Status.Assessment.Bio	Current level of spawning biomass relative to unfished from the stock assessment	Stock assessment estimate of coastwide stock status, representative of the relative amount of female spawners
Tot.EBSShelf.Trawl.Bio	Biomass of all sizes on the EBS Shelf trawl survey 2016	Representative of the trawl-vulnerable biomass in the EBS and what the groundfish bycatch fishery encounters.
Tot.AI.Trawl.Num	Biomass of all sizes on the AI Shelf trawl survey	Representative of younger population in the AI, possibly of fish successfully leaving the EBS shelf.
Tot.EBSShelf.Trawl.Num	Numbers of all sizes on the EBS Shelf trawl survey 2016	Representative of younger population in the EBS, for tracking recent higher recruitment to the EBS shelf.
Tot.GOA.Trawl.Num	Numbers of all sizes on the GOA trawl survey 2016	Representative of younger population in the GOA, possibly of fish successfully leaving the EBS shelf or coastwide recruitment success.
U12.AI.Trawl.Num	Numbers under 12 inches on the AI trawl survey	Representative of recruitment in the last two years in the AI, possibly indicative of coastwide recruitment success.
U12.AK.Trawl.Num	Combined numbers under 12 inches on the GOA/AI/EBS trawl surveys	Representative of recruitment in the last two years in the overall Alaska stock, probably indicative of coastwide recruitment success.
U12.EBSShelf.Trawl.Num	Numbers under 12 inches on the EBS Shelf trawl survey	Representative of recruitment in the last two years in the EBS, possibly indicative of coastwide recruitment success and fish to be encountered soon as bycatch in the EBS.
U12.GOA.Trawl.Num	Numbers under 12 inches on the GOA trawl survey	Representative of recruitment in the last two years in the GOA, possibly indicative of coastwide recruitment success.
O12.EBSShelf.Trawl.Num	Numbers over 12 inches on the EBS Shelf trawl survey	Fish older than 2 in the EBS that could be encountered by both groundfish and directed fisheries
U26.AI.Trawl.Num	Numbers under 26 inches on the AI trawl survey	Representative of younger sub-legal fish in the AI and indicative of recent recruitment.
U26.EBSShelf.Trawl.Num	Numbers under 26 inches on the EBS Shelf trawl survey 2016	Representative of younger sub-legal fish on the EBS shelf vulnerable to the groundfish fishery and indicative of recent recruitment.
U26.GOA.Trawl.Num	Numbers under 26 inches on the GOA trawl survey	Representative of younger sub-legal fish in the GOA and indicative of recent recruitment or movement from the EBS.
U26.AK.Trawl.Num	Combined numbers under 26 inches on the GOA/AI/EBS trawl surveys	Representative of younger sub-legal fish in in Alaska waters, and indicative of recent coastwide recruitment success.

Table 2. Characteristics of indices developed for consideration in creating alternative ABM control rule frameworks. Column labeled “2016 value” represents the “multiplier” or value from the standardized index defined as the index value divided by the index mean from 1998-2016. Index variability is the measure of interannual variance, which contains elements of process and measurement error.

Pacific halibut Index Name	Units	2016 Value	Index CV	Range	Frequency
O26/O32.4CDE.Setline.Bio	Biomass	0.95	25%	1998-2016	Annual
O26/O32.CW.Setline.Bio	Biomass	0.69	36%	1998-2016	Annual
SB.Assessment.Bio	Biomass	0.73	40%	1998-2017	Annual
Status.Assessment.Bio	Biomass	0.72	40%	1998-2017	Annual
Tot.EBSShelf.Trawl.Bio	Biomass	1.00	17%	1982-2016	Annual
Tot.AI.Trawl.Num	Numbers	0.72	17%	1980-2016	Biennial
Tot.EBSShelf.Trawl.Num	Numbers	0.88	38%	1982-2016	Annual
Tot.GOA.Trawl.Num	Numbers	0.96	27%	1984-2015	Biennial
U12.AI.Trawl.Num	Numbers	0.94	62%	1980-2016	Biennial
U12.AK.Trawl.Num	Numbers	0.57	75%	1984-2016	Annual*
U12.EBSShelf.Trawl.Num	Numbers	0.43	133%	1982-2016	Annual
U12.GOA.Trawl.Num	Numbers	0.72	53%	1984-2015	Biennial
O12.EBSShelf.Trawl.Num	Numbers	0.98	32%	1982-2016	Annual
U26.AI.Trawl.Num	Numbers	0.68	15%	1980-2016	Biennial
U26.EBSShelf.Trawl.Num	Numbers	0.84	47%	1982-2016	Annual
U26.GOA.Trawl.Num	Numbers	0.83	31%	1984-2015	Biennial
U26.AK.Trawl.Num	Numbers	0.83	33%	1984-2016	Annual*

*Alaska-wide trawl indices use the previous year’s estimate for areas that are in an off year of their biennial cycle (i.e., Aleutians in odd years and Gulf of Alaska in even years).

Table 3. A subset of all the pairwise correlations between halibut indices. Strong positive and negative between indices (>0.8), and the weakest correlations (<0.1). 53.3% the 135 pairs of correlations were positive

Index 1	**Index 2**	***r***	**Type**
O12.EBSShelf.Trawl.Num	O32.4CDE.Setline.Bio	-0.812	**Strong Negative**
Tot.EBSShelf.Trawl.Bio	U12.AI.Trawl.Num	-0.803	
Tot.EBSShelf.Trawl.Num	U12.GOA.Trawl.Num	-0.098	**Uncorrelated**
U12.EBSShelf.Trawl.Num	O32.CW.Setline.Bio	-0.093	
O32.CW.Setline.Bio	U12.EBSShelf.Trawl.Num	-0.093	
Status.Assessment.Bio	U12.AK.Trawl.Num	-0.053	
SB.Assessment.Bio	U12.AK.Trawl.Num	-0.052	
U12.AI.Trawl.Num	U12.EBSShelf.Trawl.Num	-0.05	
U12.GOA.Trawl.Num	U26.EBSShelf.Trawl.Num	-0.042	
Tot.AI.Trawl.Num	Tot.GOA.Trawl.Num	-0.022	
Tot.EBSShelf.Trawl.Bio	Tot.GOA.Trawl.Num	-0.006	
U12.AI.Trawl.Num	U26.GOA.Trawl.Num	-0.003	
Tot.AI.Trawl.Num	U12.EBSShelf.Trawl.Num	-0.002	
Tot.AI.Trawl.Num	U12.AK.Trawl.Num	0.008	
Tot.AI.Trawl.Num	U12.GOA.Trawl.Num	0.027	
O32.CW.Setline.Bio	U12.AK.Trawl.Num	0.054	
Tot.AI.Trawl.Num	U12.AI.Trawl.Num	0.064	
U12.EBSShelf.Trawl.Num	U12.GOA.Trawl.Num	0.066	
O12.EBSShelf.Trawl.Num	U12.AK.Trawl.Num	0.089	
O12.EBSShelf.Trawl.Num	Tot.EBSShelf.Trawl.Num	0.81	**Strong Positive**
Tot.GOA.Trawl.Num	U26.Tot.Trawl.Num	0.84	
Tot.EBSShelf.Trawl.Num	U26.Tot.Trawl.Num	0.871	
U26.EBSShelf.Trawl.Num	U26.Tot.Trawl.Num	0.891	
O32.4CDE.Setline.Bio	O32.CW.Setline.Bio	0.922	
U26.GOA.Trawl.Num	U26.Tot.Trawl.Num	0.924	
U12.AK.Trawl.Num	U12.EBSShelf.Trawl.Num	0.94	
Tot.GOA.Trawl.Num	U26.GOA.Trawl.Num	0.958	
Status.Assessment.Bio	O32.4CDE.Setline.Bio	0.961	
O32.4CDE.Setline.Bio	Status.Assessment.Bio	0.961	
O32.CW.Setline.Bio	Status.Assessment.Bio	0.986	
O32.CW.Setline.Bio	SB.Assessment.Bio	0.987	
Tot.EBSShelf.Trawl.Num	U26.EBSShelf.Trawl.Num	0.995	

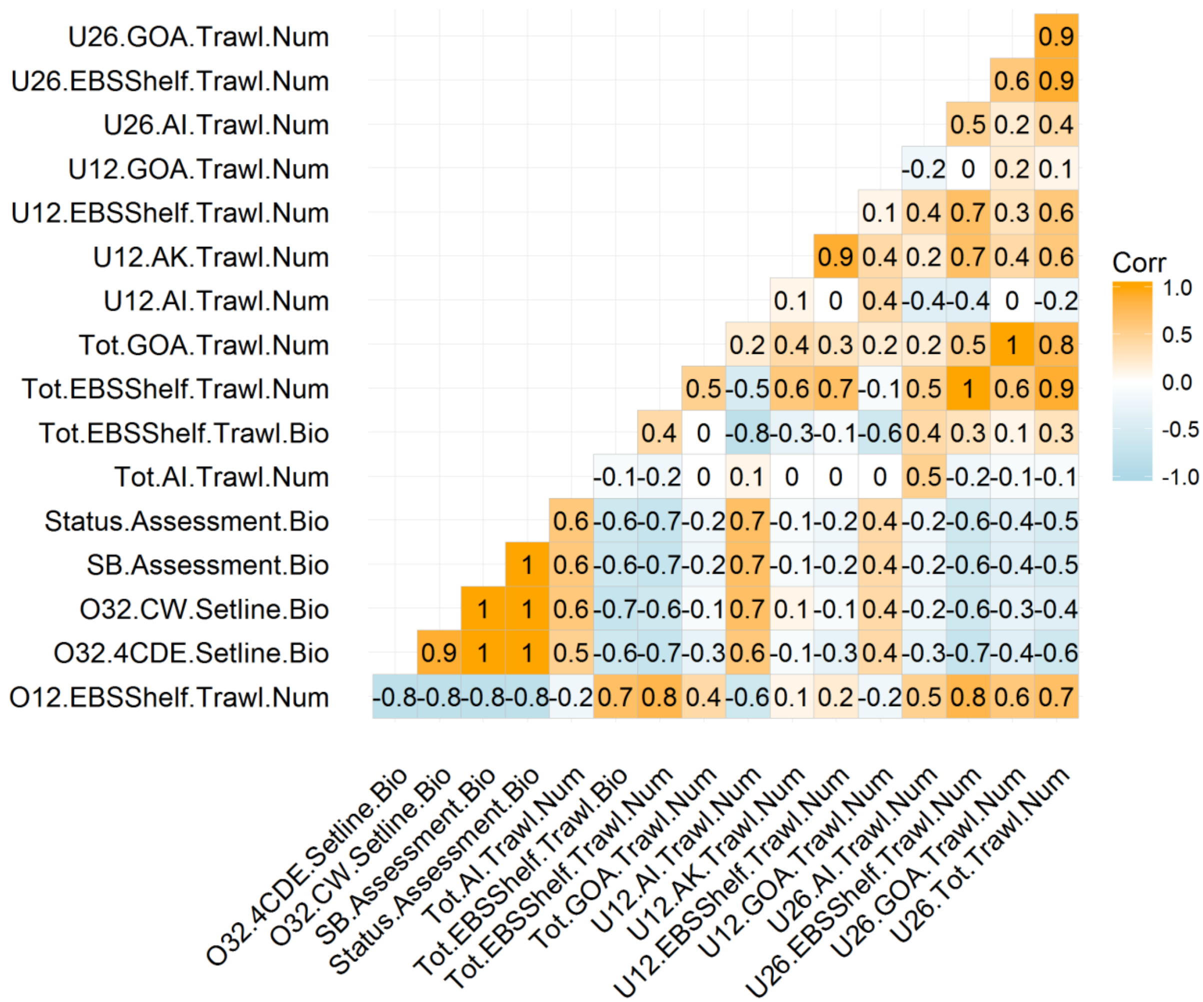

Figure 1. Complete pairwise correlations among indices. Orange is positive and blue is negative.

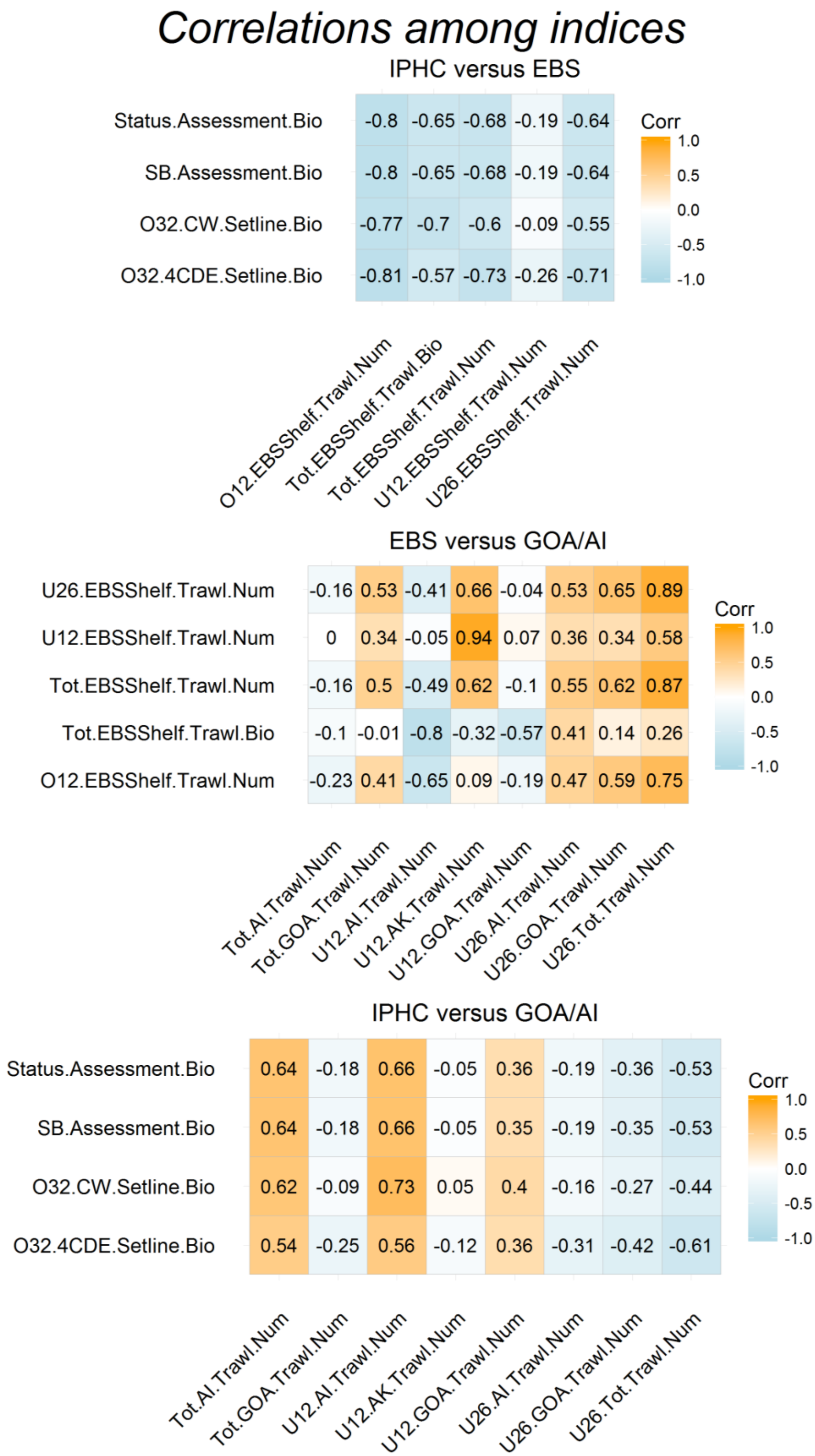

Figure 2. Correlations between groups of indices (IPHC longline, inside the EBS, and outside the EBS).

Appendix 3: Model Validation

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 2018 IPHC assessment (Stewart and Hicks 2019). 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 25 years of historical catch data, grouped by modeled fleet and area, and initiated the model with 1994 numbers-at-age from the 2018 IPHC stock assessment (Stewart and Hicks 2019). 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 2018 IPHC coastwide long assessment model (Stewart and Webster 2019), 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 2018 IPHC assessment, indicating that these two time-varying features were necessary inclusions in the OM. The selectivity-at-age from the IPHC 2018 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 2018 value for all future years.

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 A3-1). 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 A3-1, 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 A3-1 (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”). 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 A3-2-Figure A3-4). 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 A3-4).

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 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 of 0.79 for the BTS and 0.96 for the FISS, while preserving reasonably matched coastwide population dynamics (Figure A3-5).

Additionally, we conducted an approximate relative comparison between ages of the proportion of fish in the BSAI between the sub-model and the 2018 IPHC 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 A3-5 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 2018 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 2019). 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). 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 2008-2017 (the most recent 10-year period; Figure A3-7).

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 A3-7). 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.

The initial forward simulation runs were done for a period of 20 years and were conducted using the 2018 weight-at-age despite the large changes in weight-at-age seen in the past that were necessary to validate the OM. This was a simplification to obtain results in a timely manner and to be able to isolate the role of fluctuating weight-at-age when conducting future sensitivity analyses including this feature. Weight-at-age is thought to change slowly over time and longer simulations (e.g. 50 or 100 years) would especially need to incorporate time-variation.

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 25 years

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Webster, R.A., Clark, W.G., Leaman, B.M., and Forsberg, J.E. 2013. Pacific halibut on the move: a renewed understanding of adult migration from a coastwide tagging study. Can. J. Fish. Aquat. Sci. 70(4): 642-653.

Figures

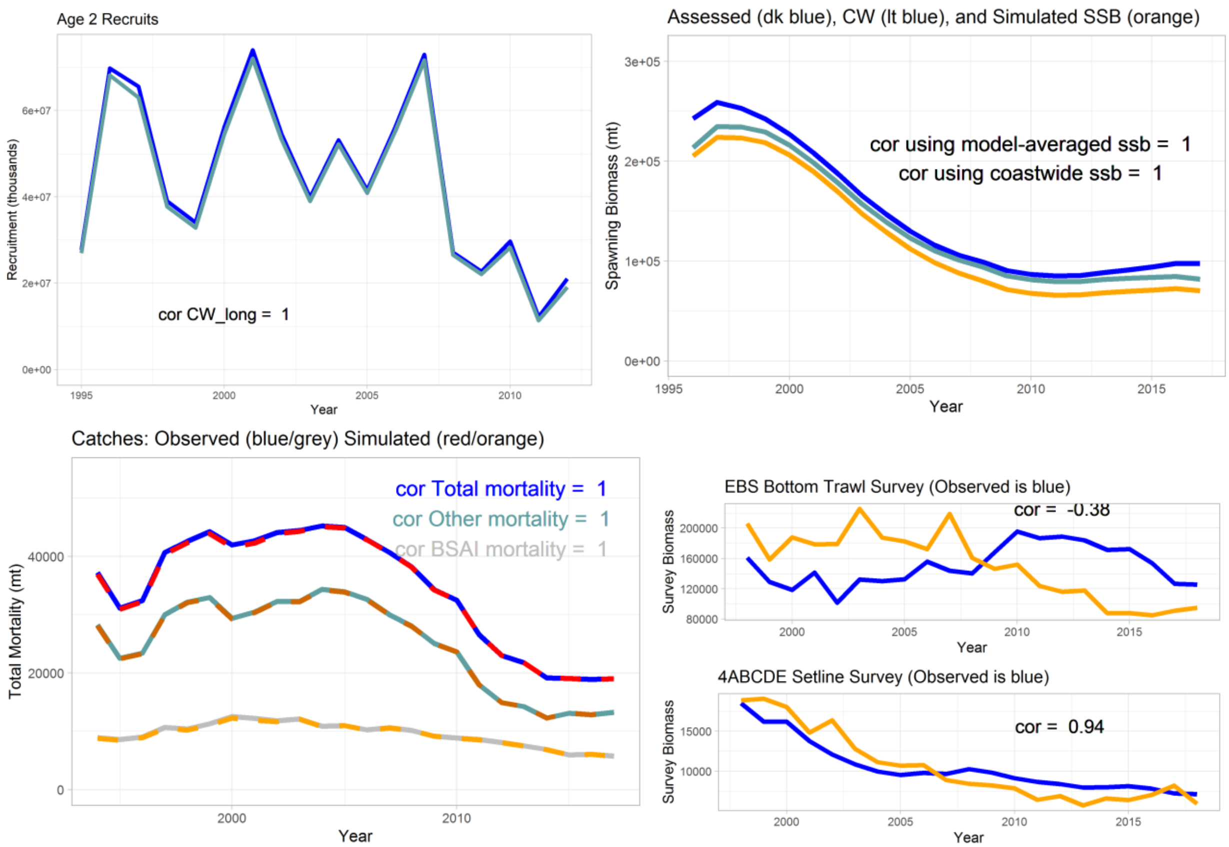


Figure A3-1. A comparison of Pacific halibut population dynamics observed or estimated by the 2018 IPHC coastwide long assessment model to dynamics from the closed loop simulation model run for 25 historical years with historical catch data and historical estimates of recruitment deviations, weight-at-age, 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).

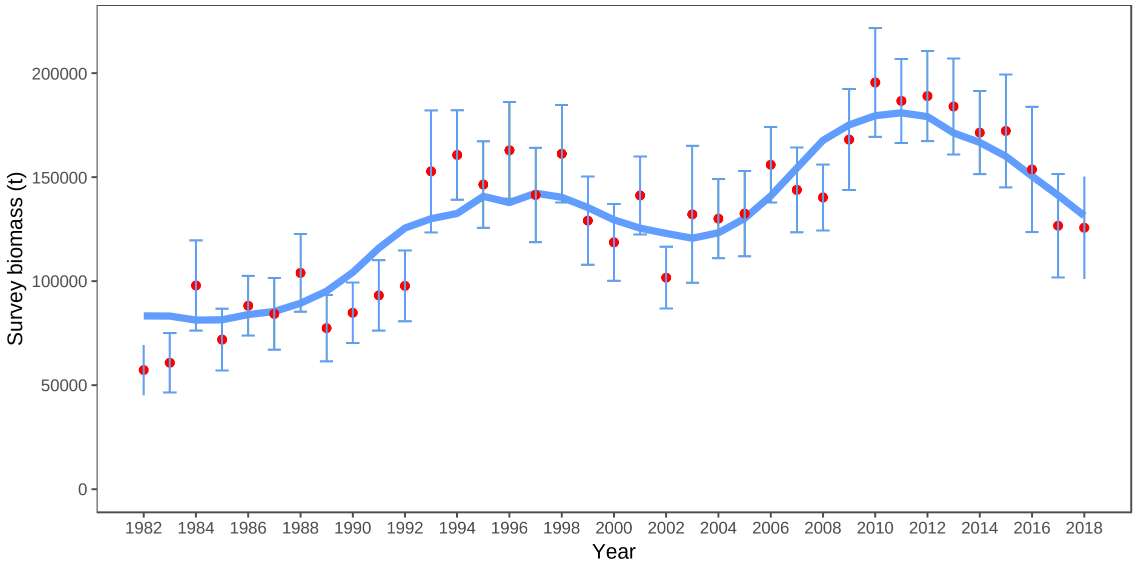


Figure A3-2. The BSAI sub-model (thick blue line) conditioned to fit to the observed BTS biomass index (red dots). Vertical lines show 95% asymptotic intervals about the observed BTS biomass index point estimates.

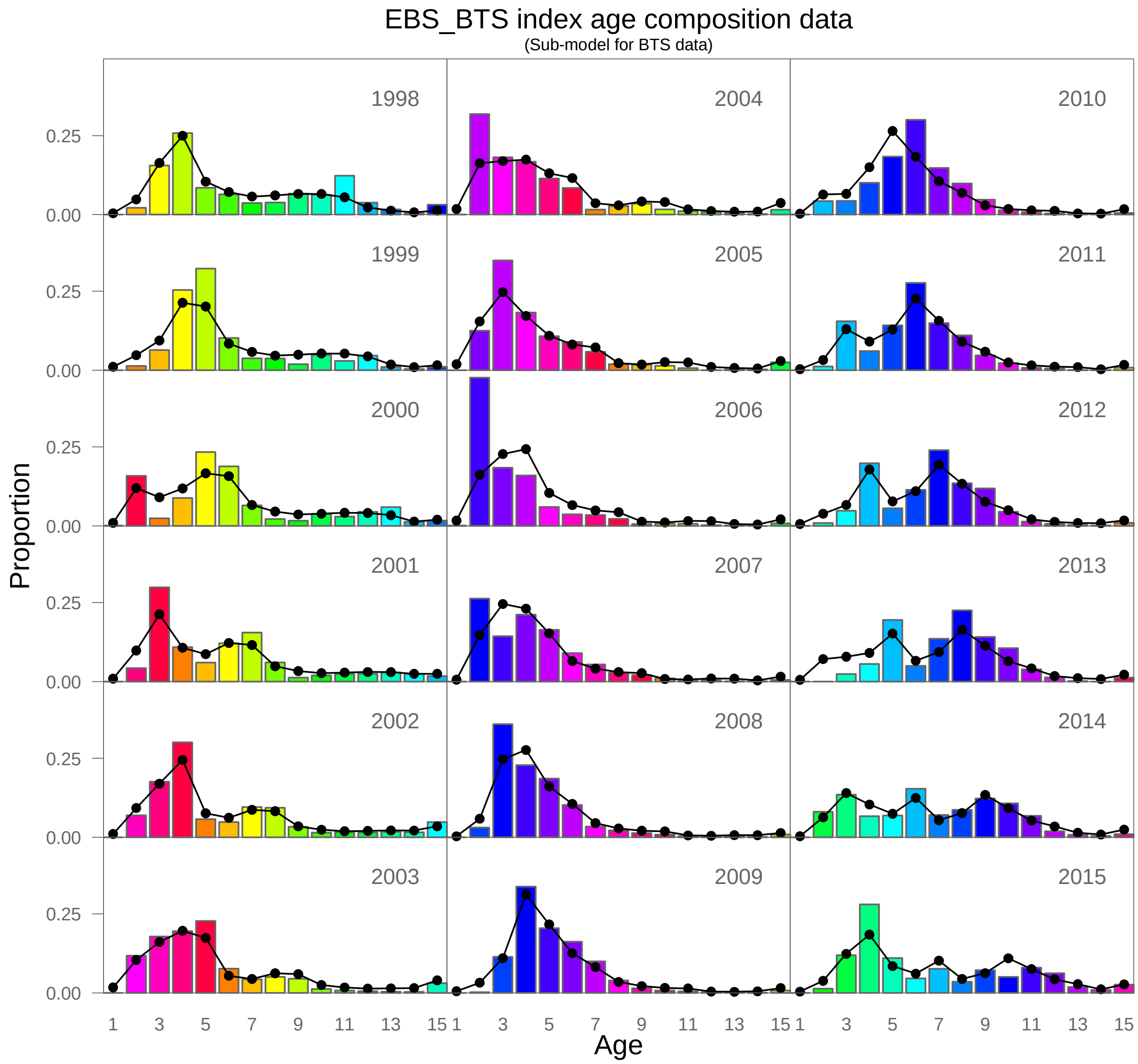


Figure A3-3. The BSAI sub-model conditioned to fit the available yearly BTS age composition data (data are shown as the multi-color frequency histogram, model fits to data are indicated by black dots and line).

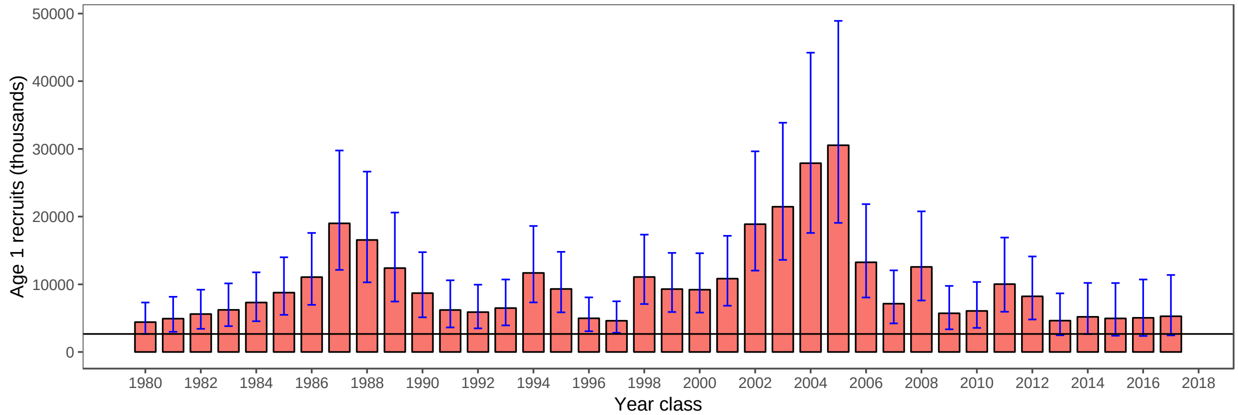


Figure A3-4. Age-1 Recruitment estimates from the BSAI sub-model. These relative values were used to evaluate the process error component of the BTS in OM projections relative to the OM conditioned to mimic the 2018 coastwide long assessment by the IPHC.

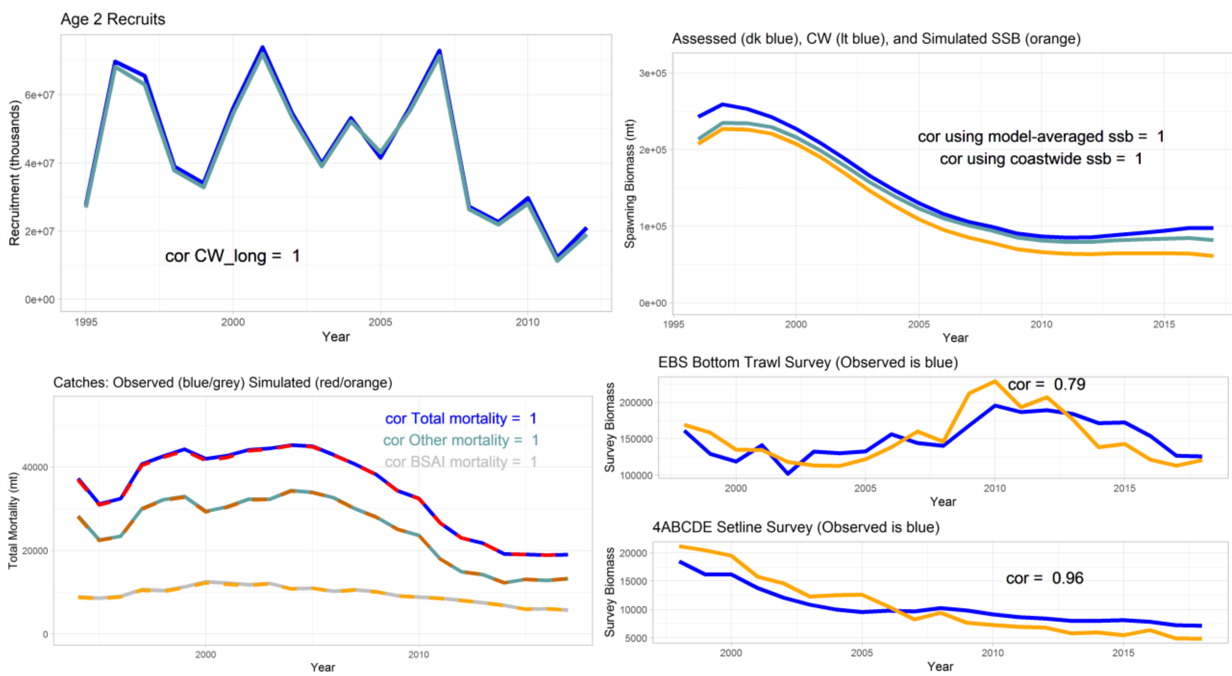


Figure A3-5. As for Figure A3-1, but with an OM using recruitment trends from the BSAI sub-model to represent relative recruitment in the BSAI, with remaining coastwide recruitment assigned to the other area. Top left: estimated numbers-at-age 2 from the coastwide long assessment model and calculated 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).

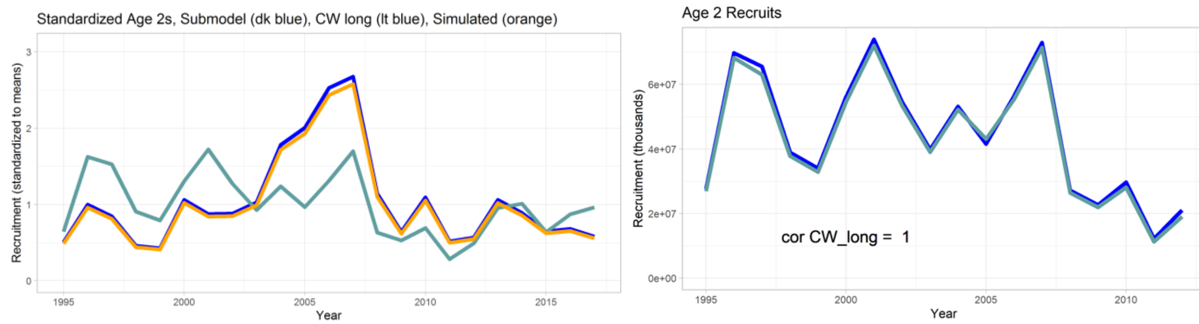


Figure A3-6. Left panel: Relative age-2 recruitment to the BSAI from the sub-model (dark blue), the relative recruitment to the BSAI modeled by the OM, where it is standardized as a proportion of mean coastwide recruitment to the BSAI (0.5) within the model, then made relative to its mean for visualization (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 2018 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.

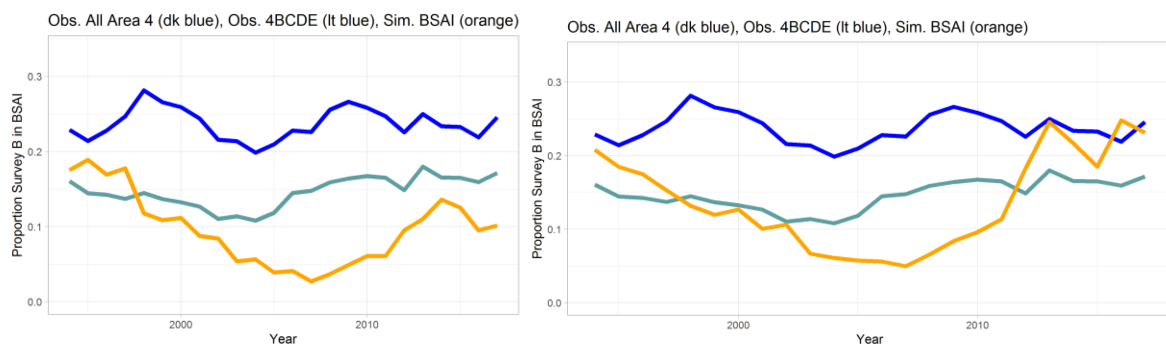
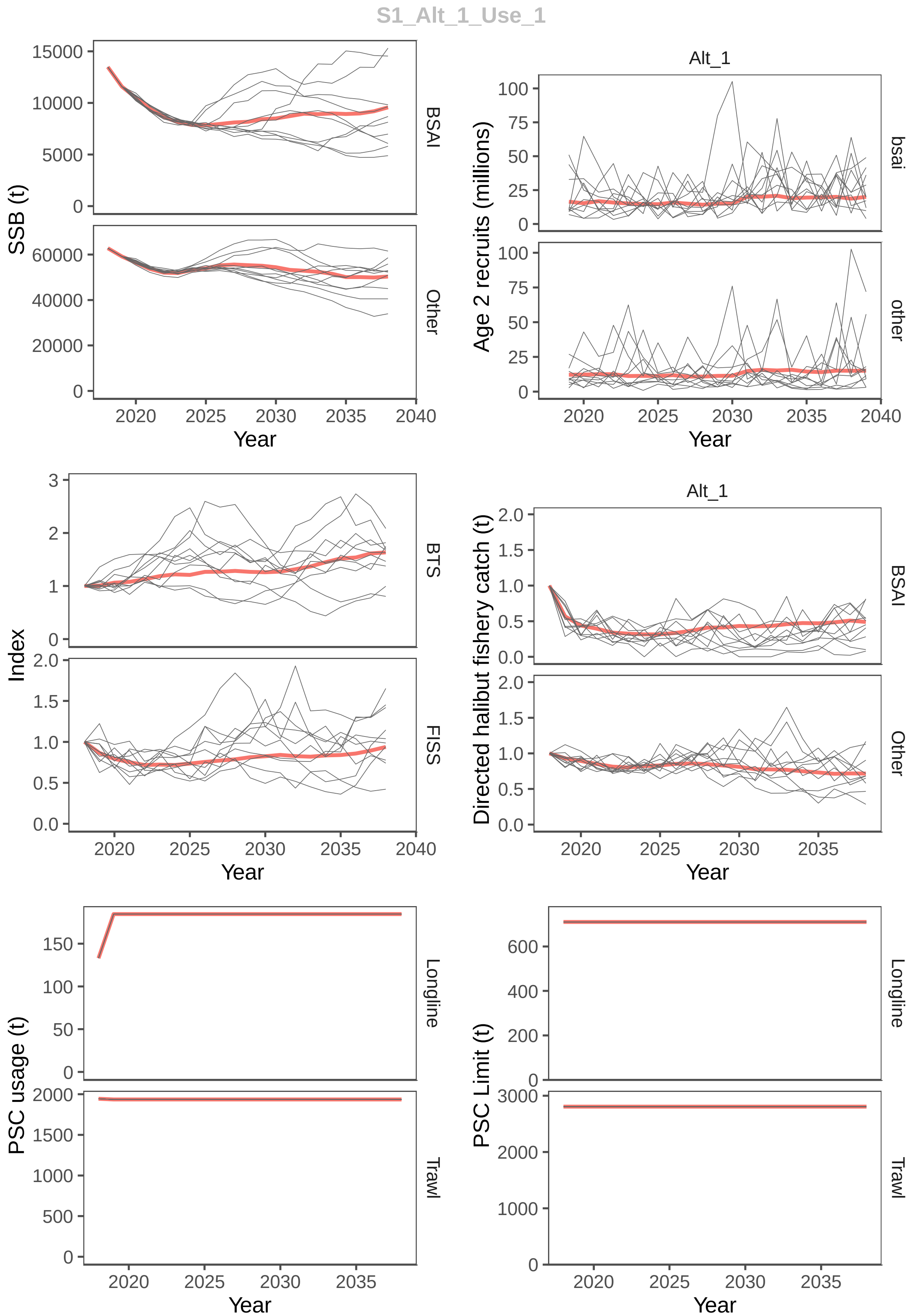


Figure A3-7. Observed and simulated proportion of FISS biomass in the BSAI for two model validation runs. Left panel: a run using the age-specific adult movement estimates from Webster et al. (2013). Right panel: a run using the age-specific adult movement estimates from Webster et al. (2013), with a 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.

Appendix 4: Detailed model results by Alternative

The following figures show main model outputs by each alternative on separate pages.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Longline
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PSC Limit (t)

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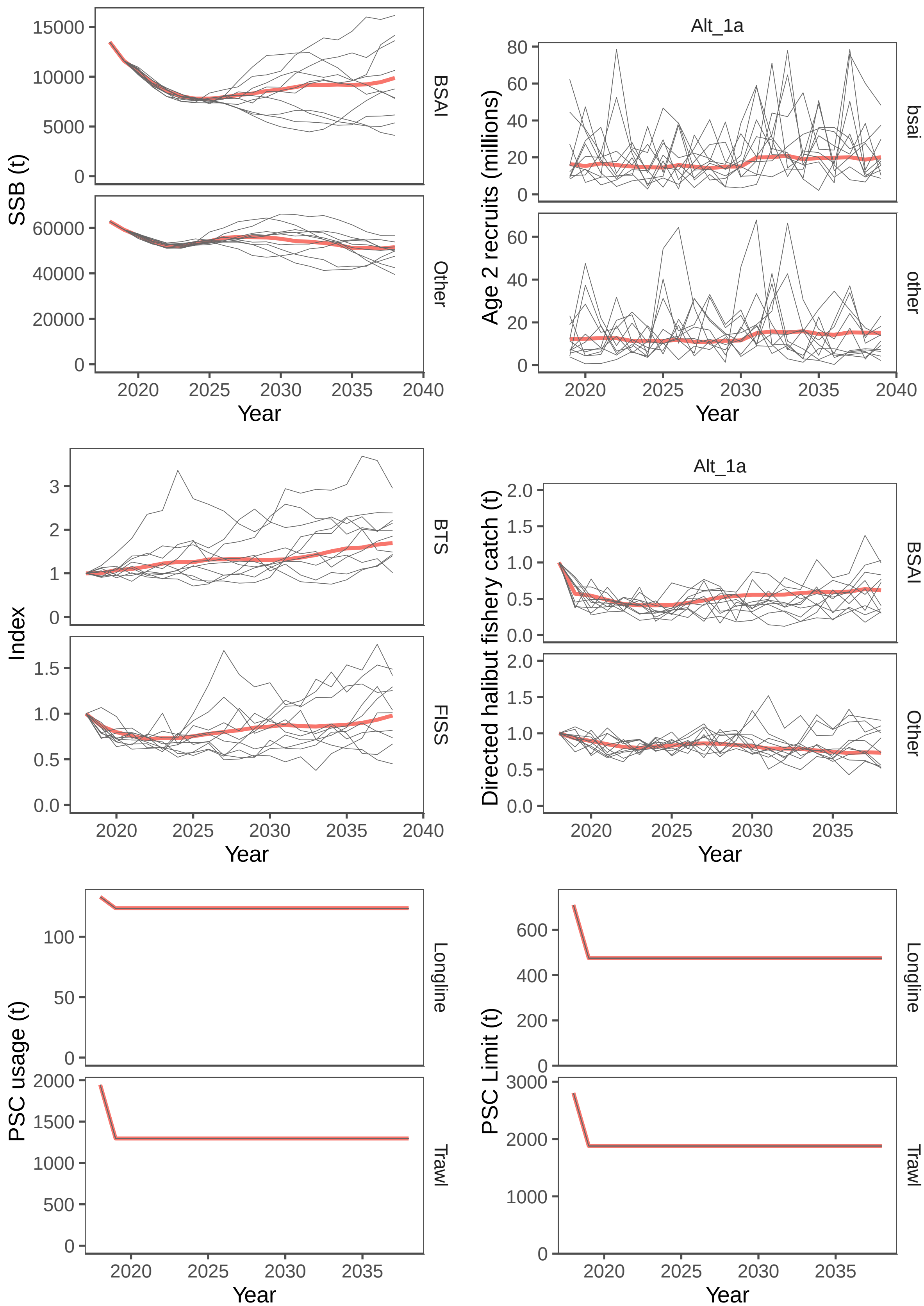

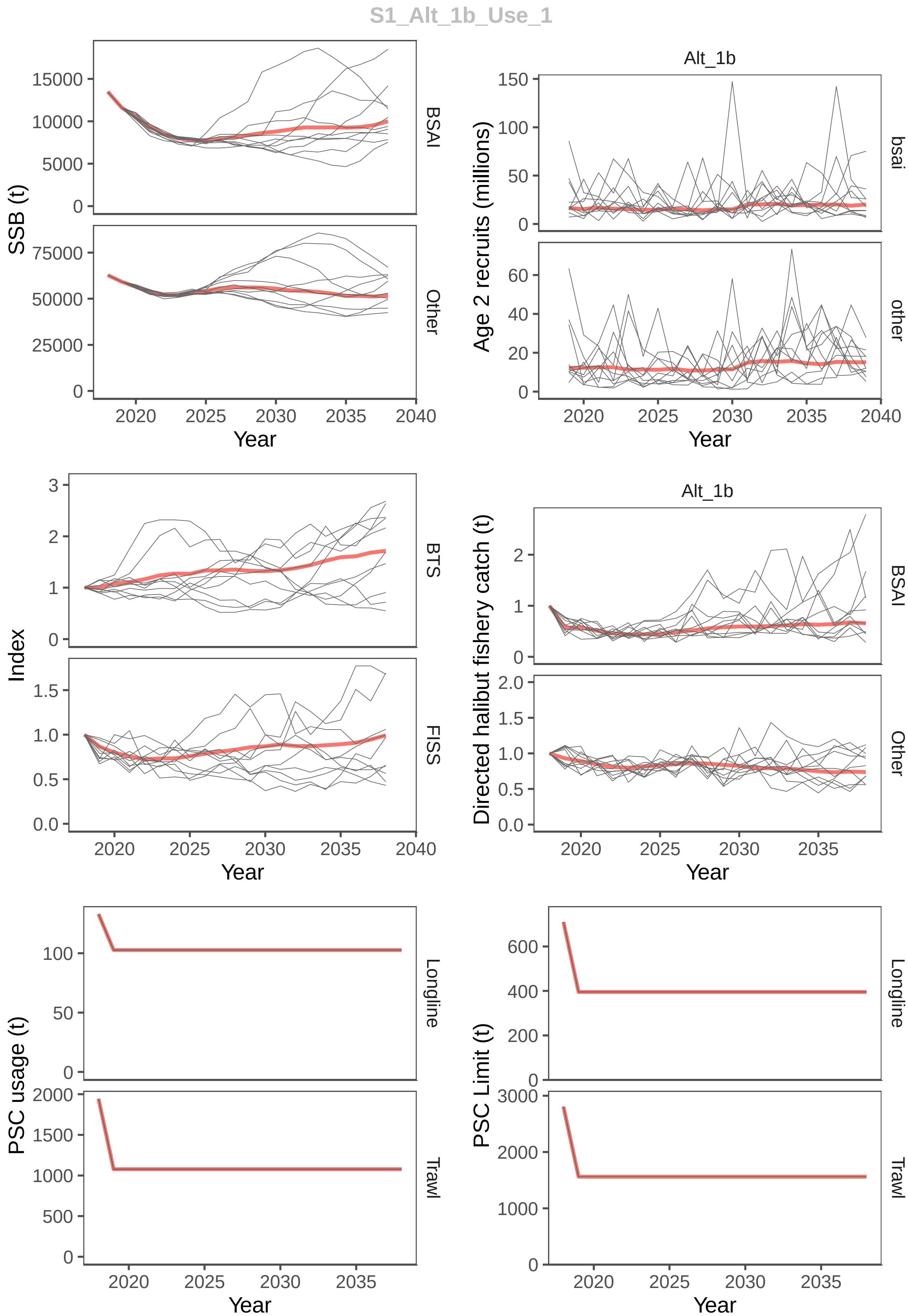
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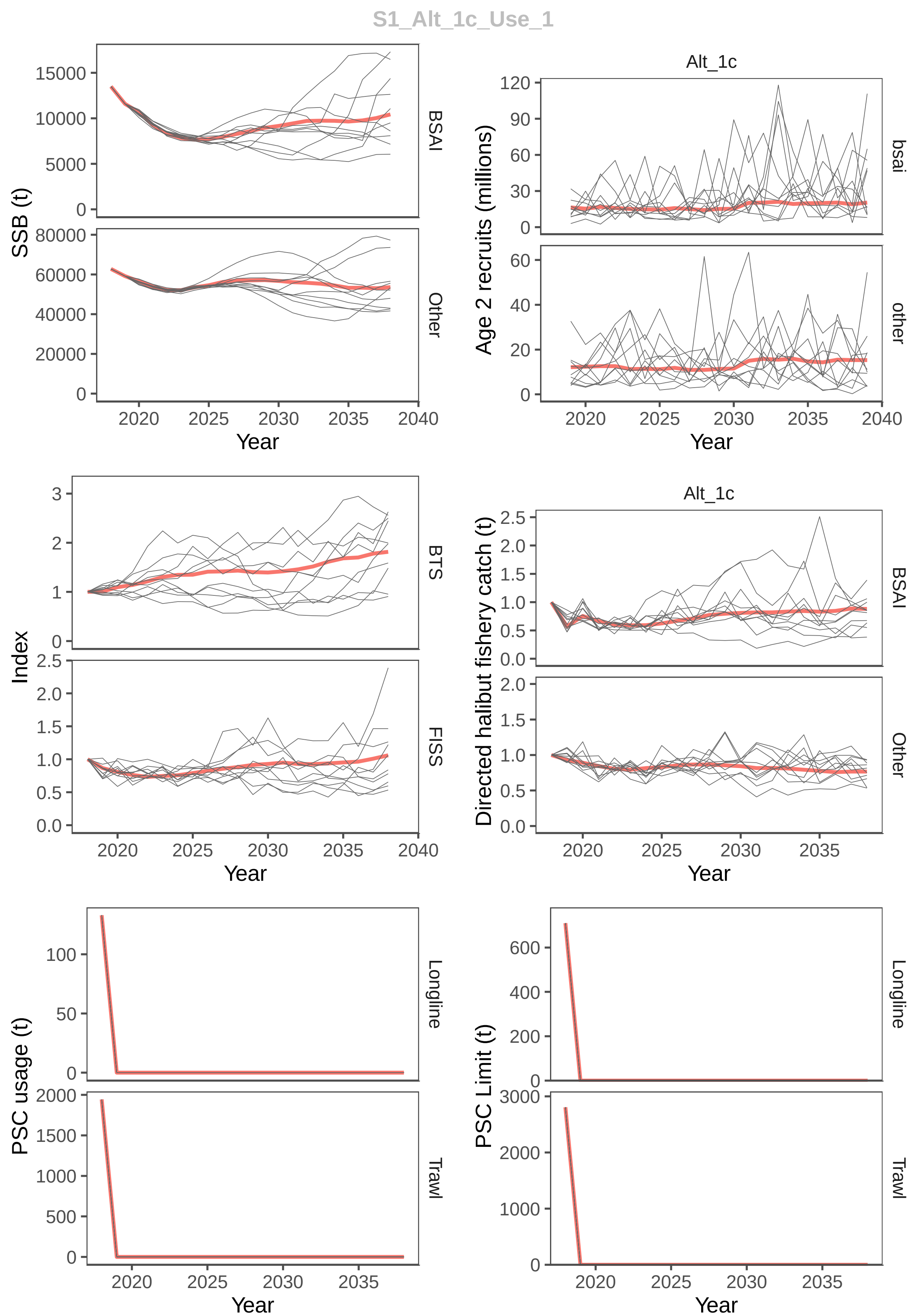
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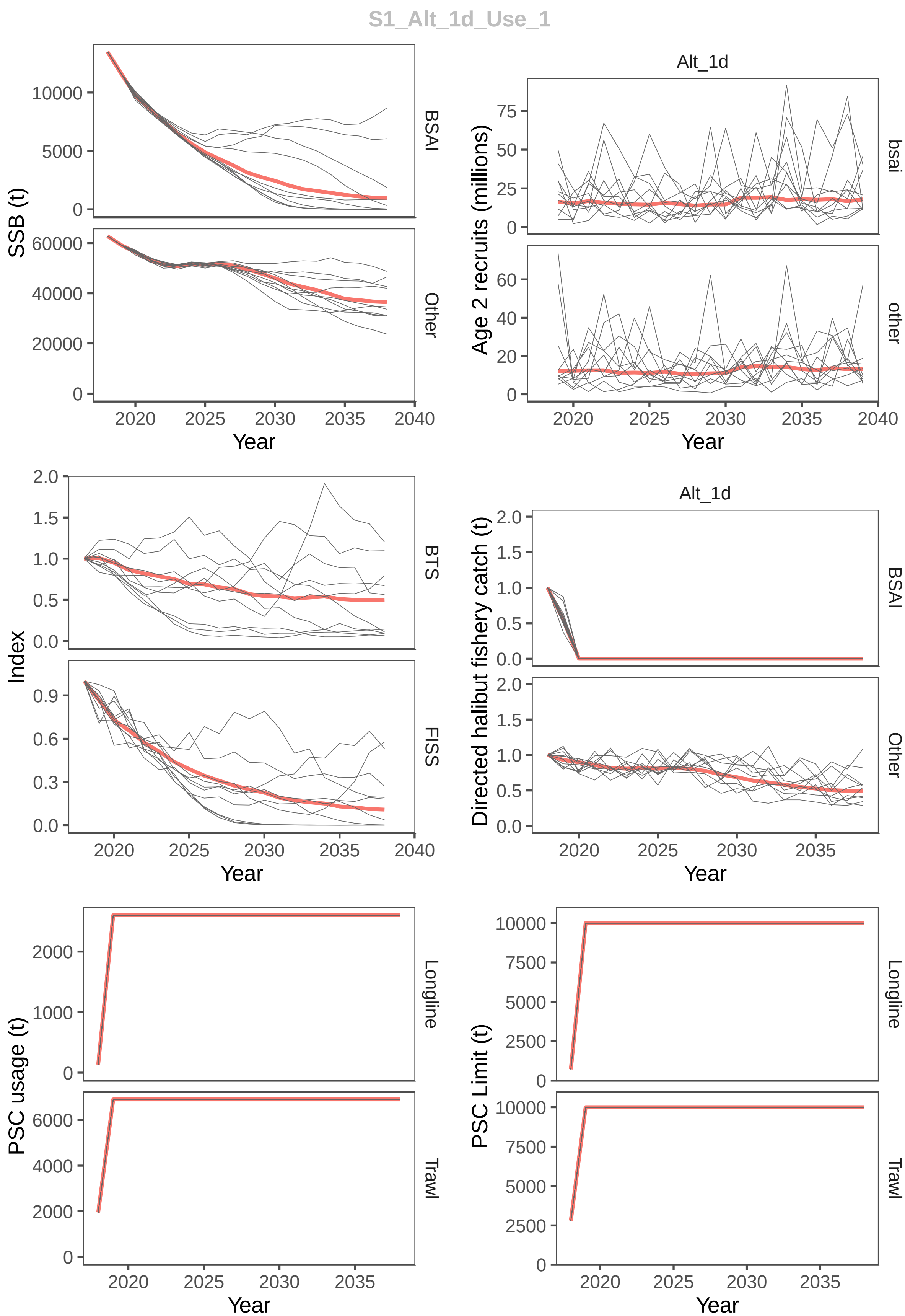
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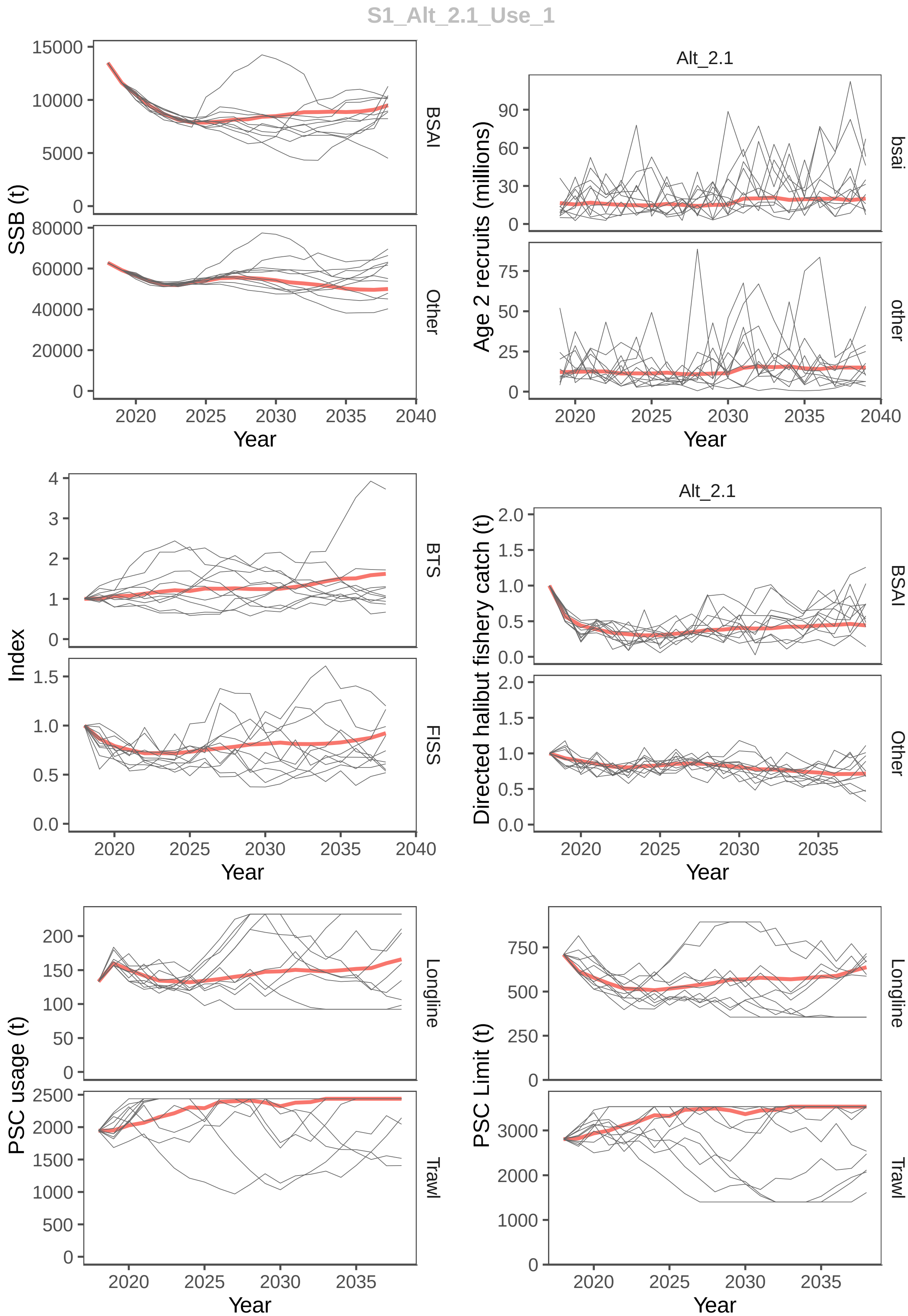
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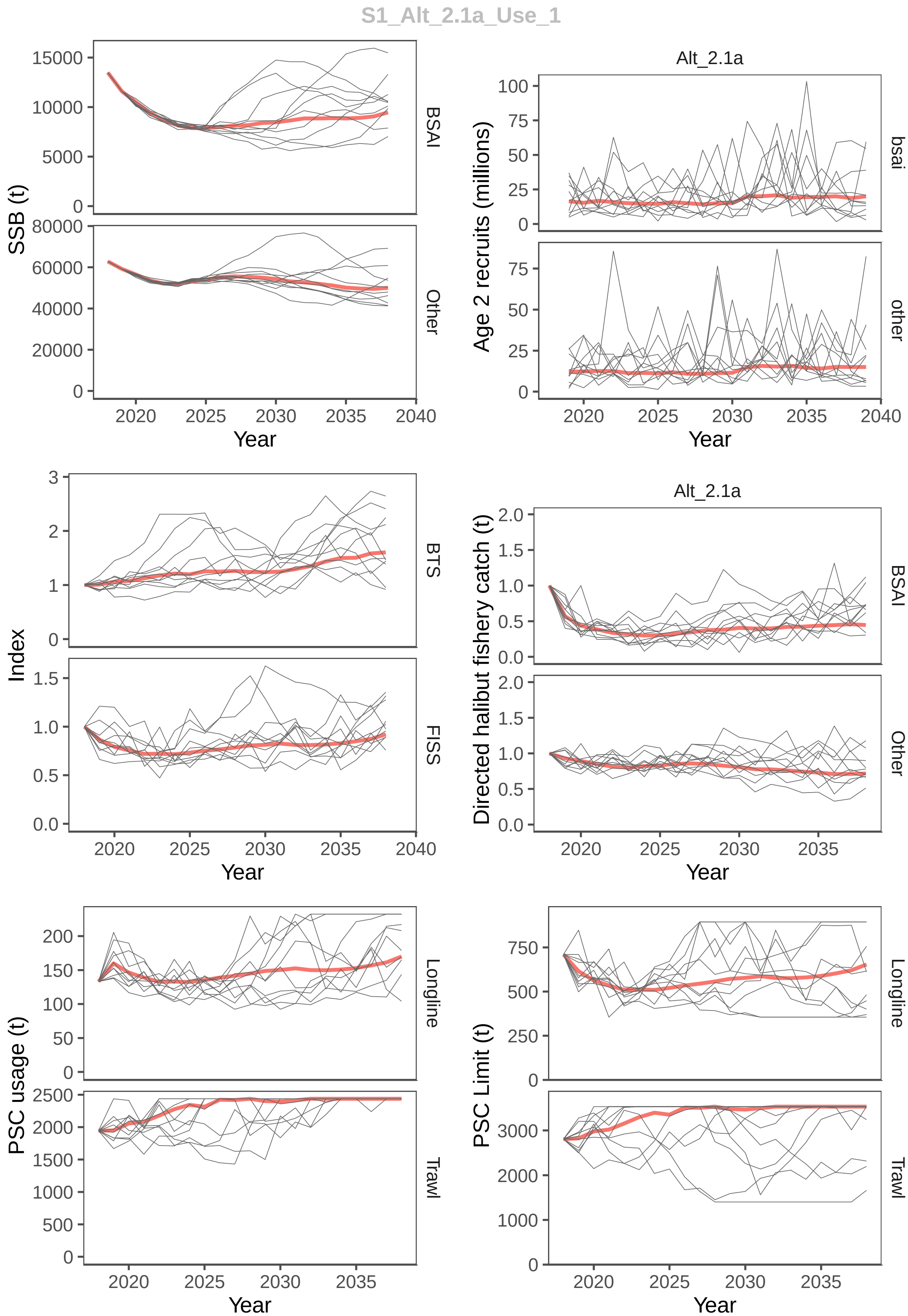
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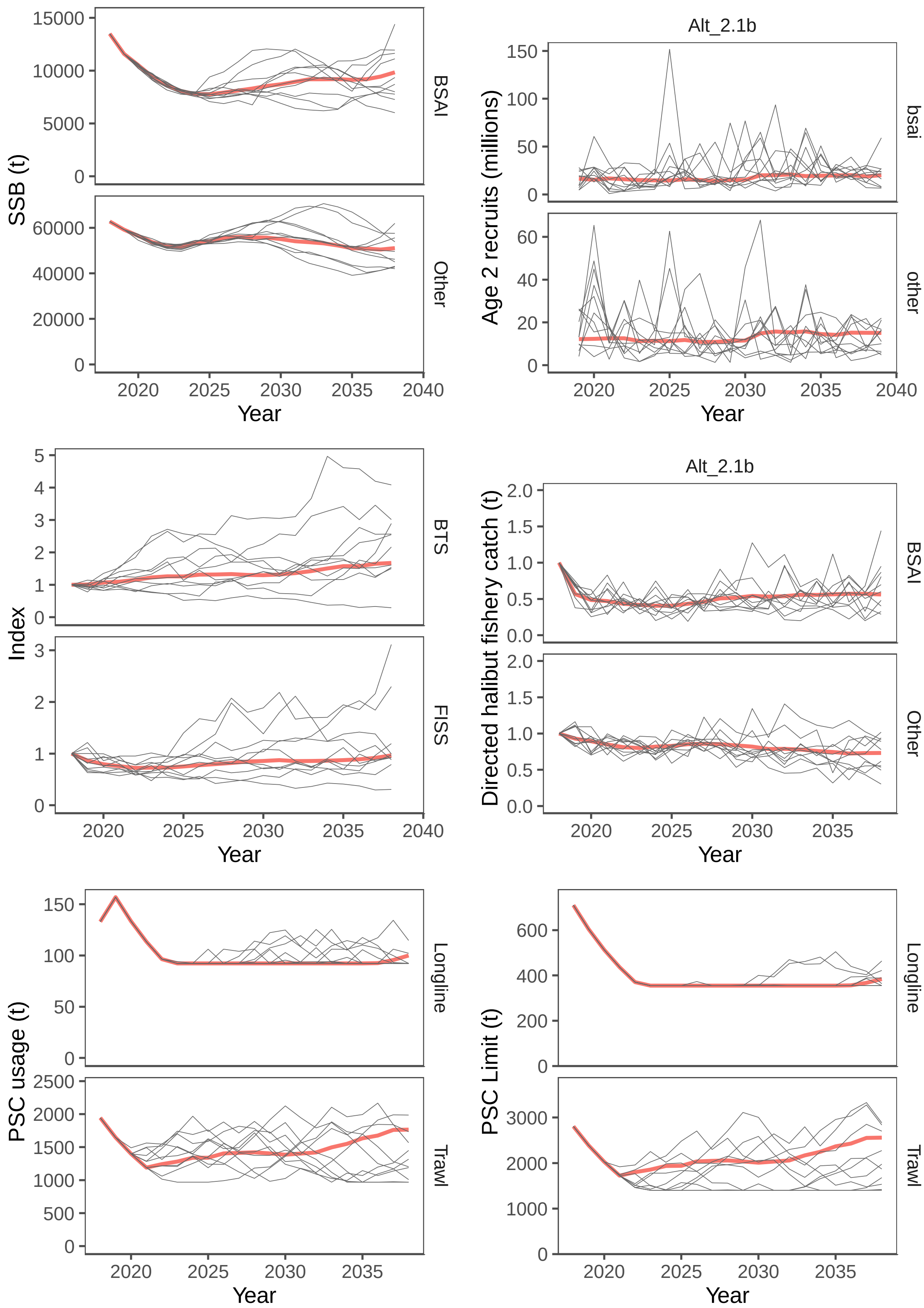

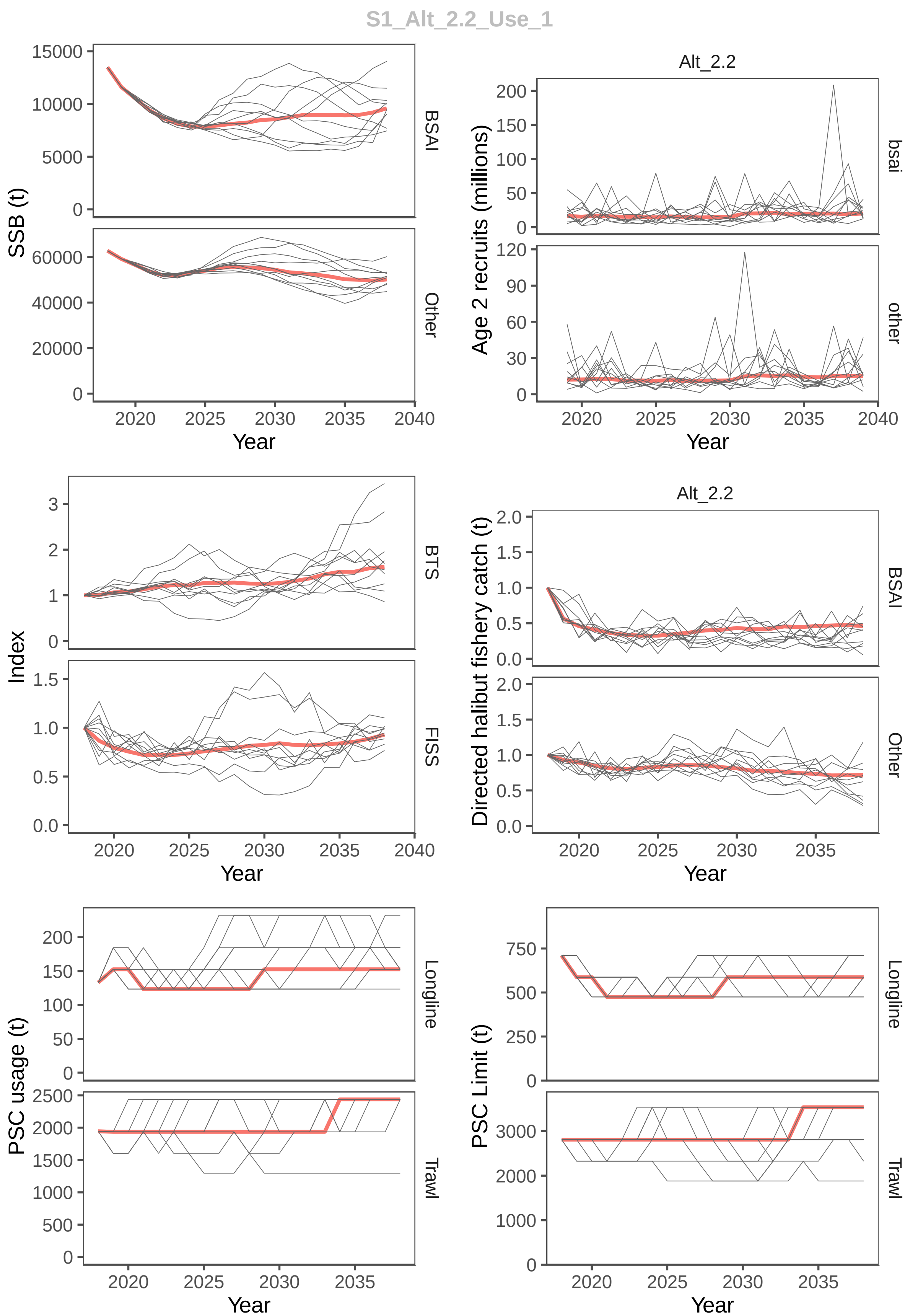
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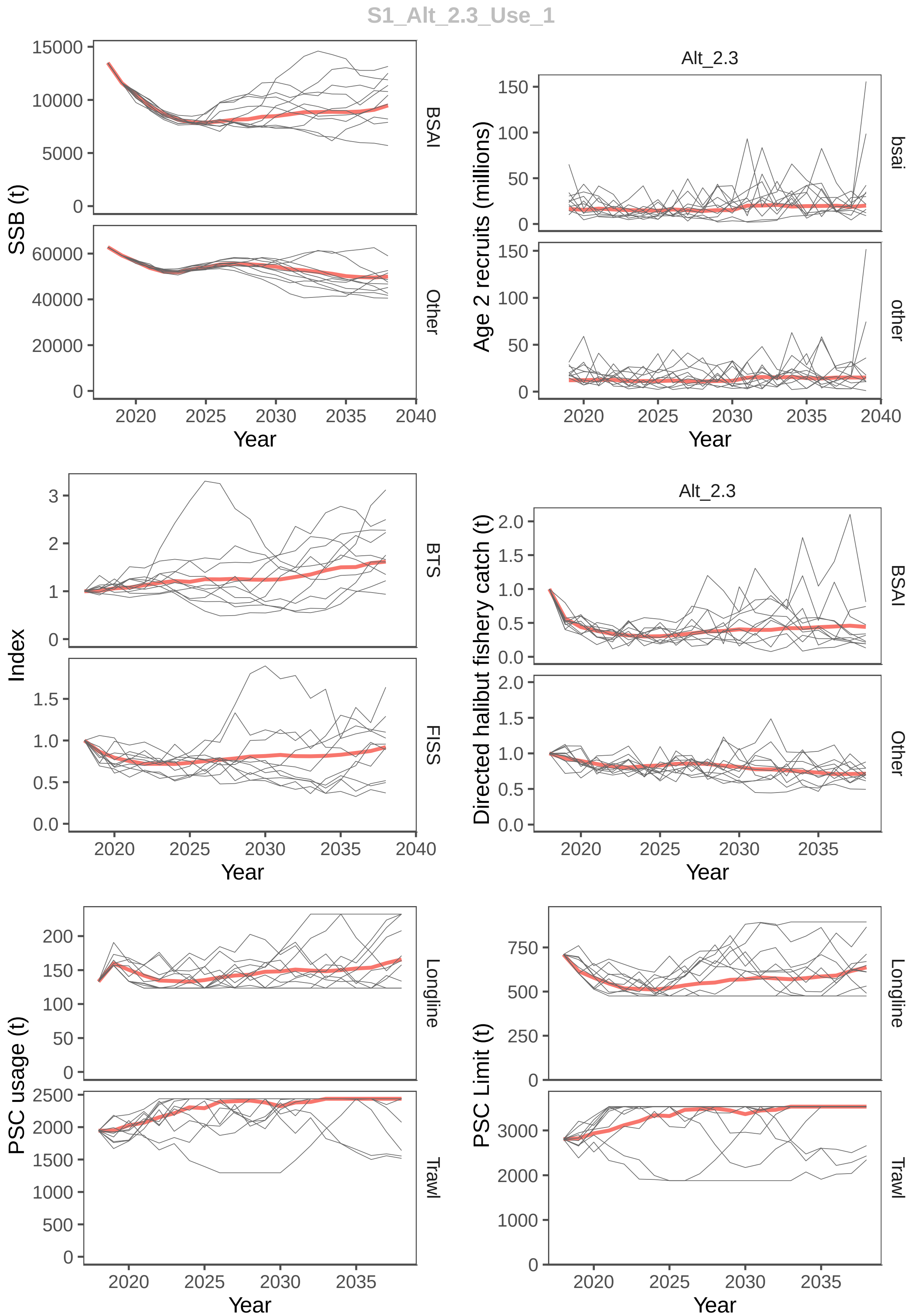
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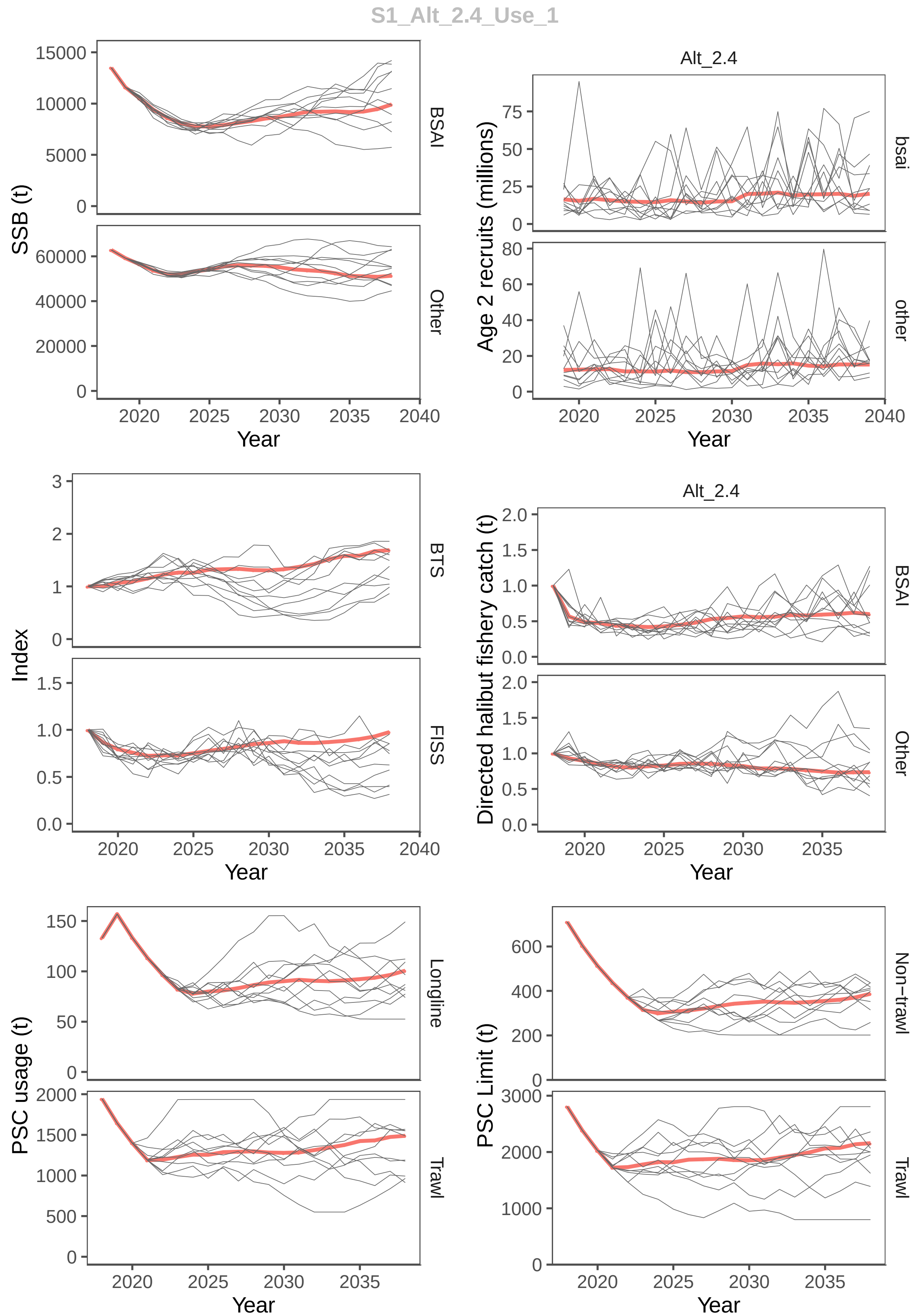
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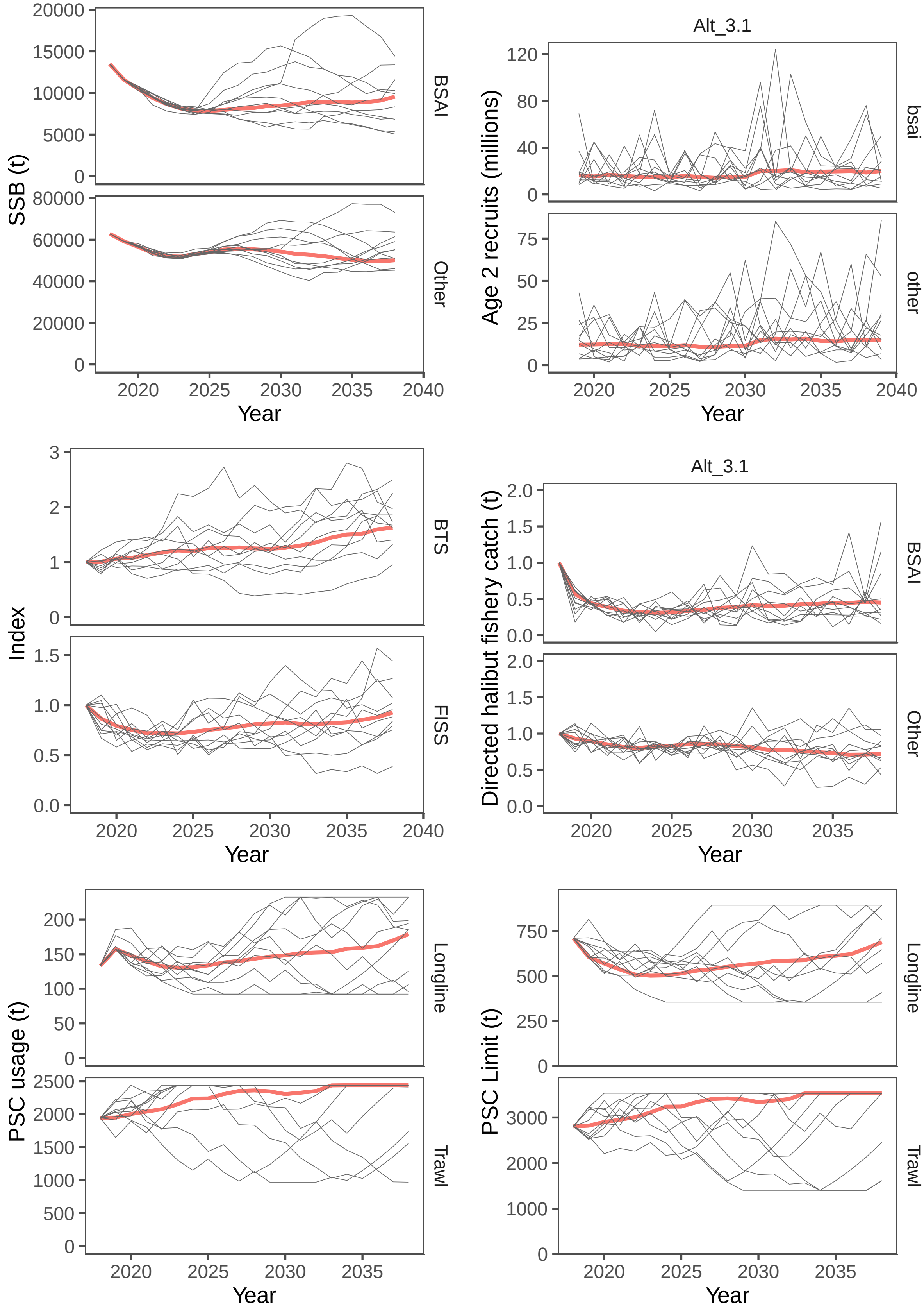

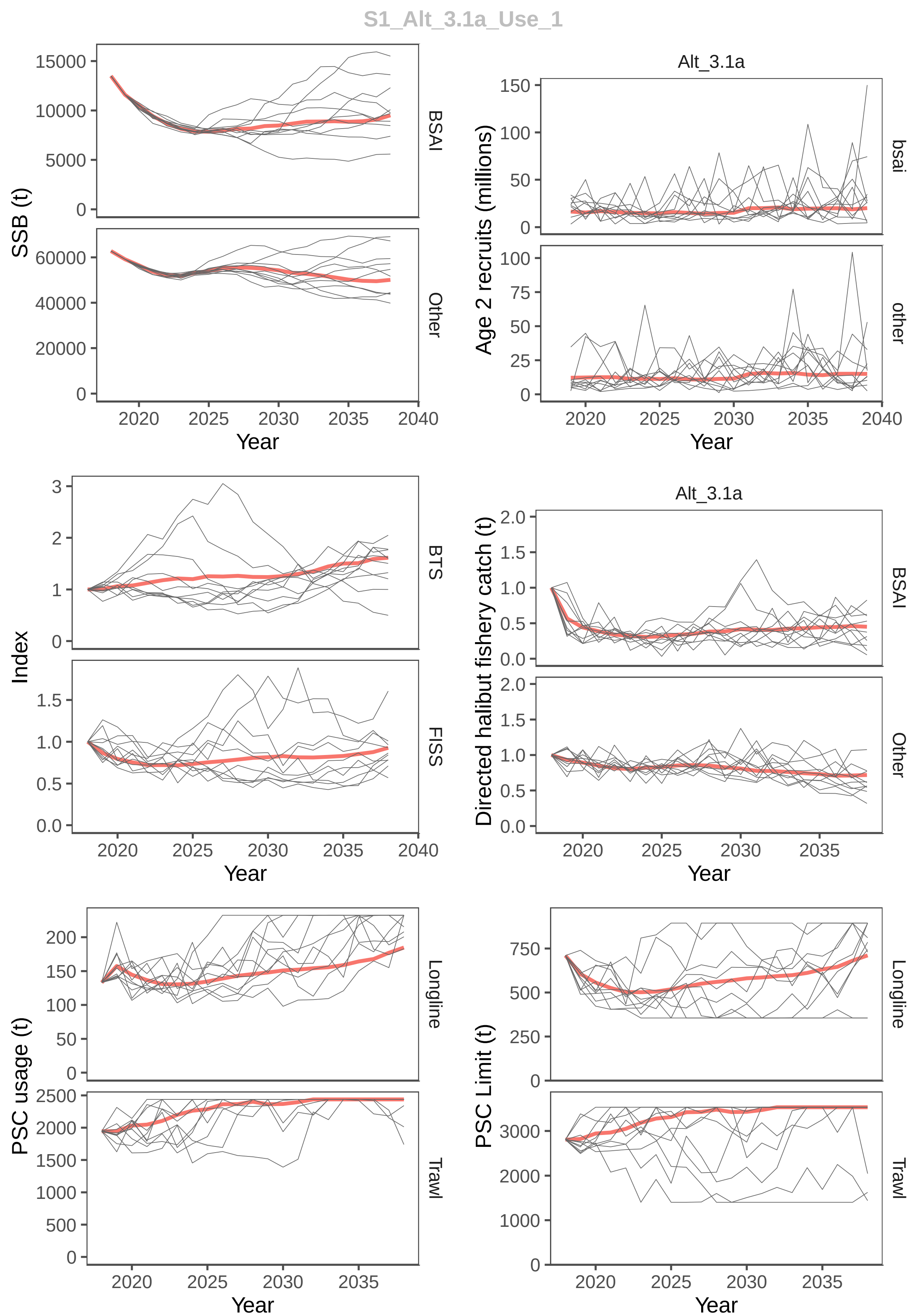
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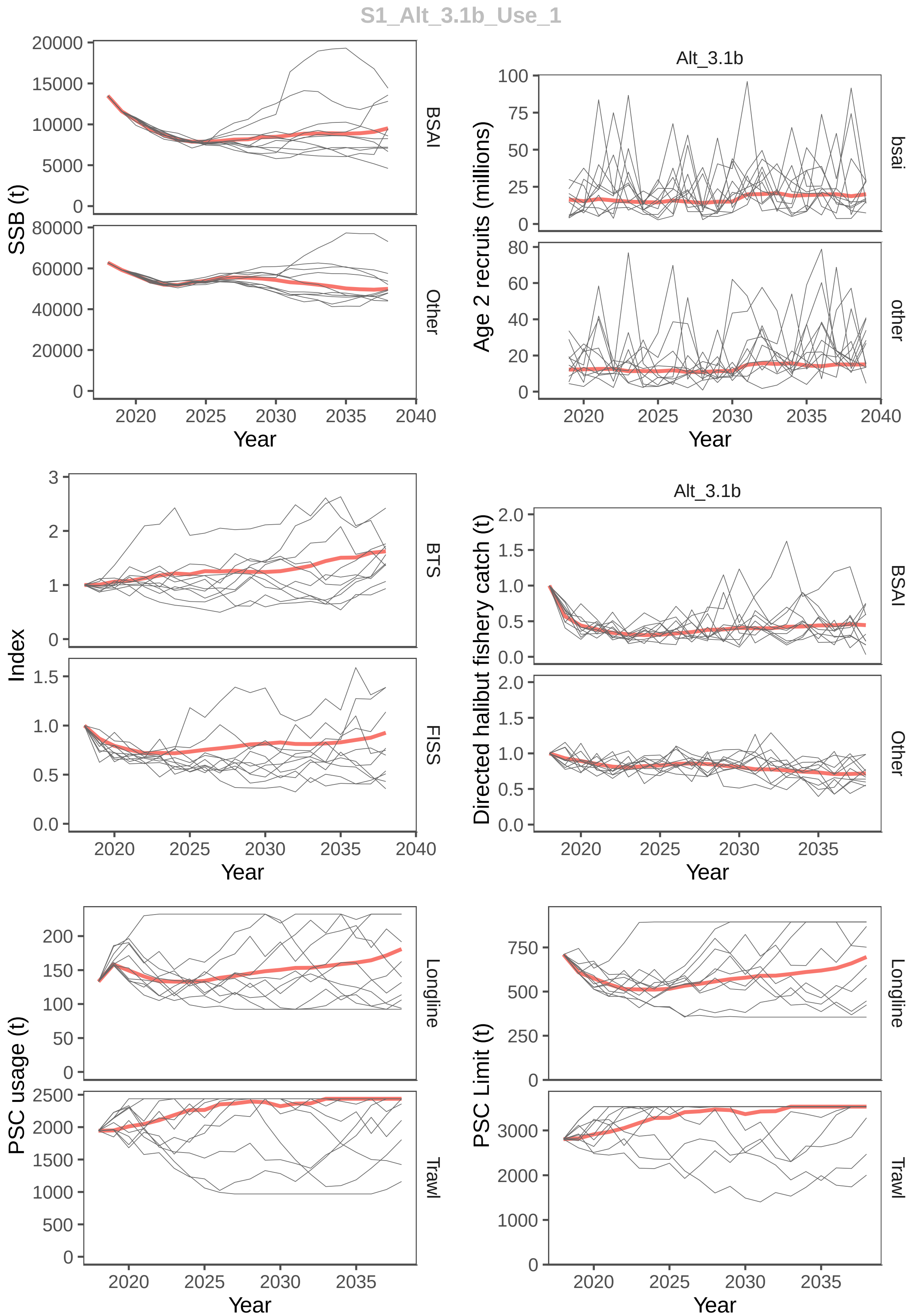
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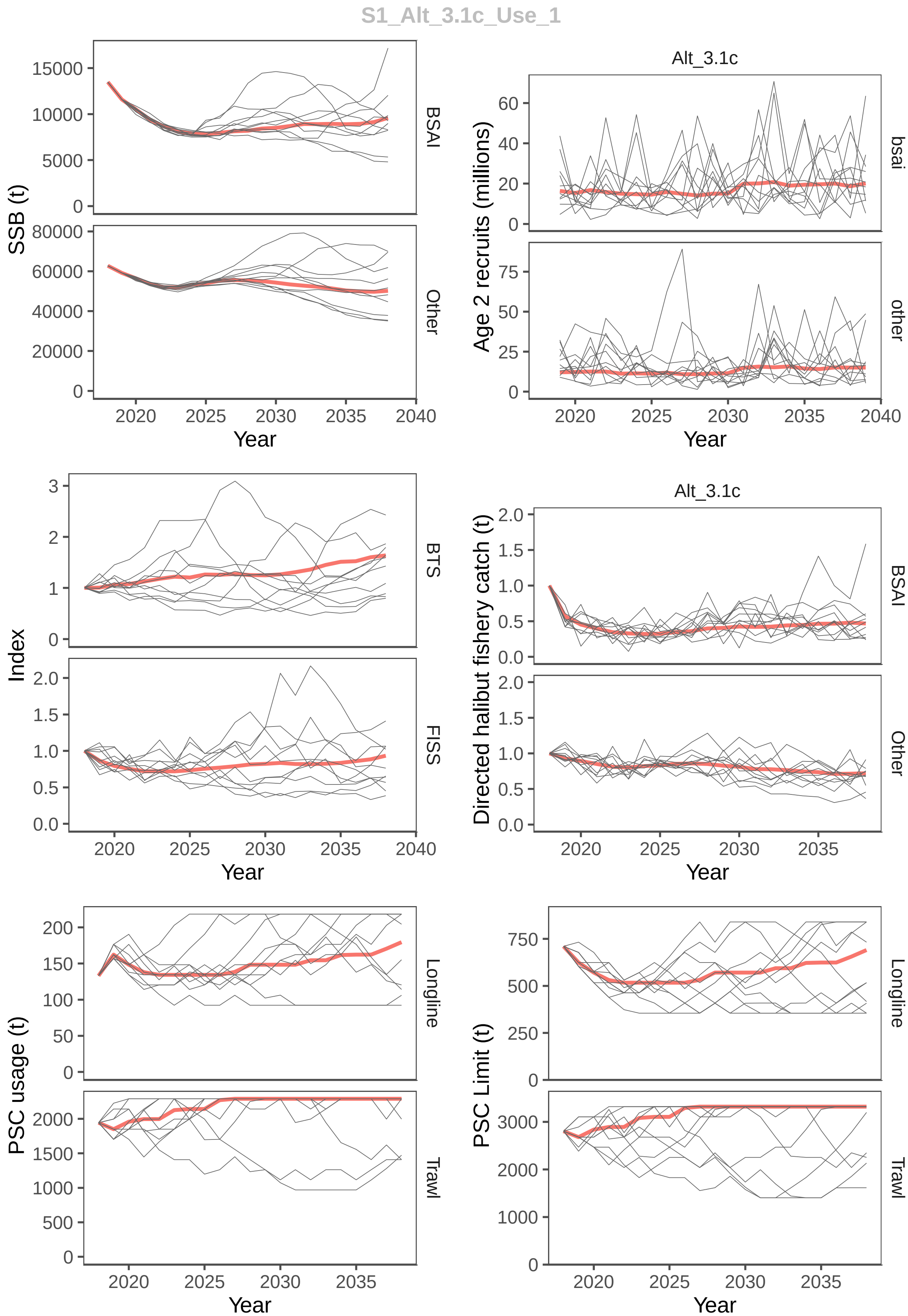
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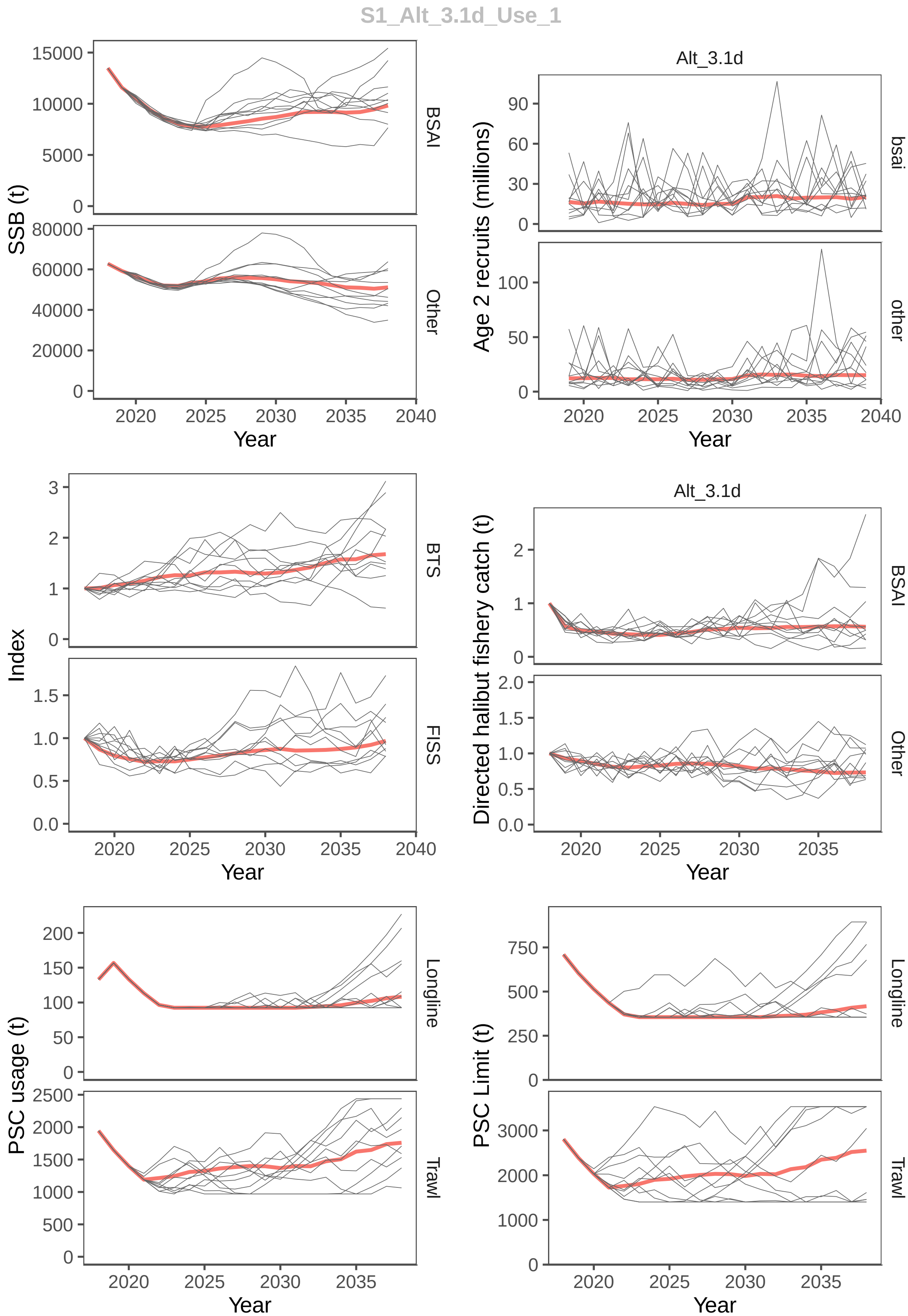
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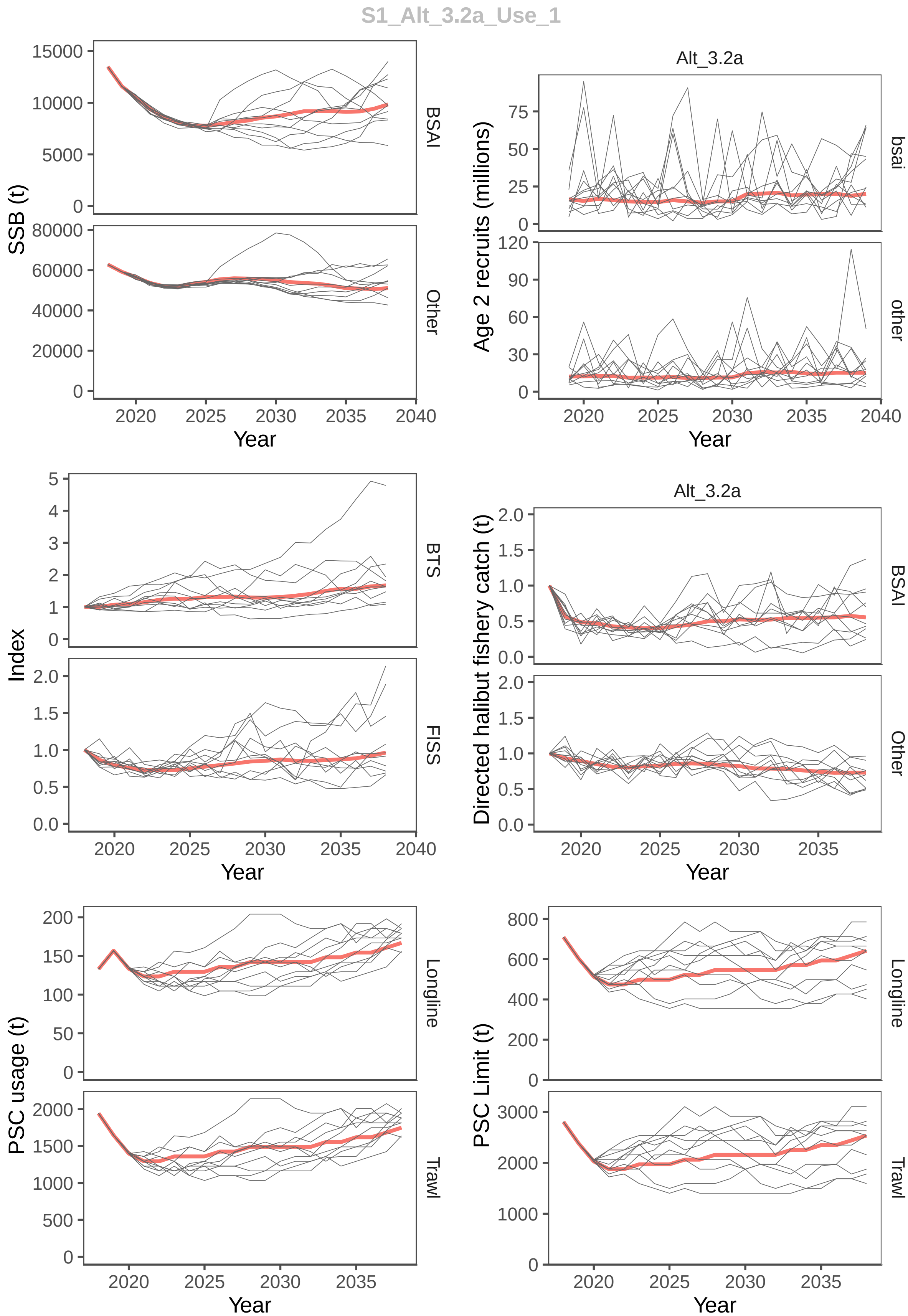
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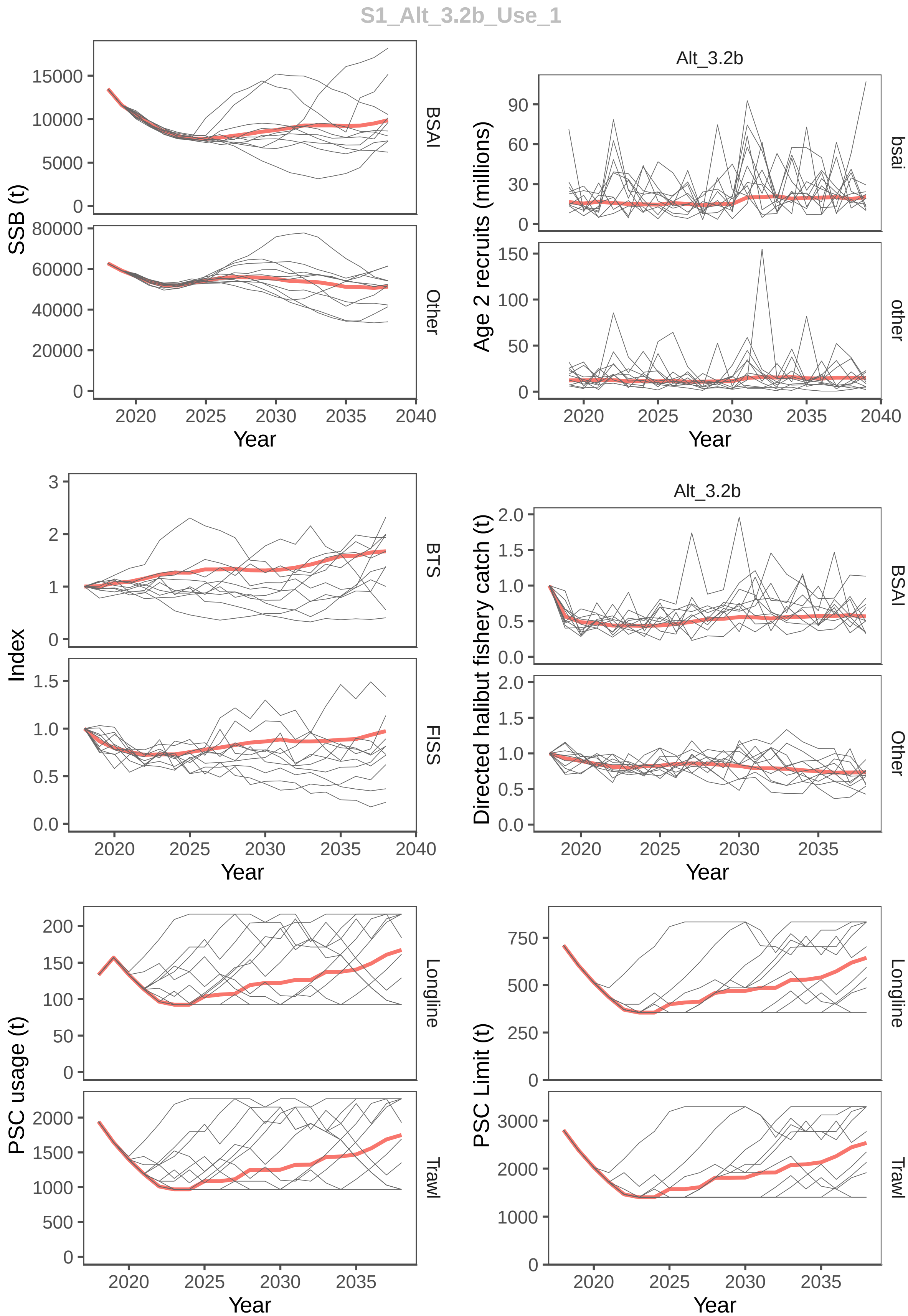
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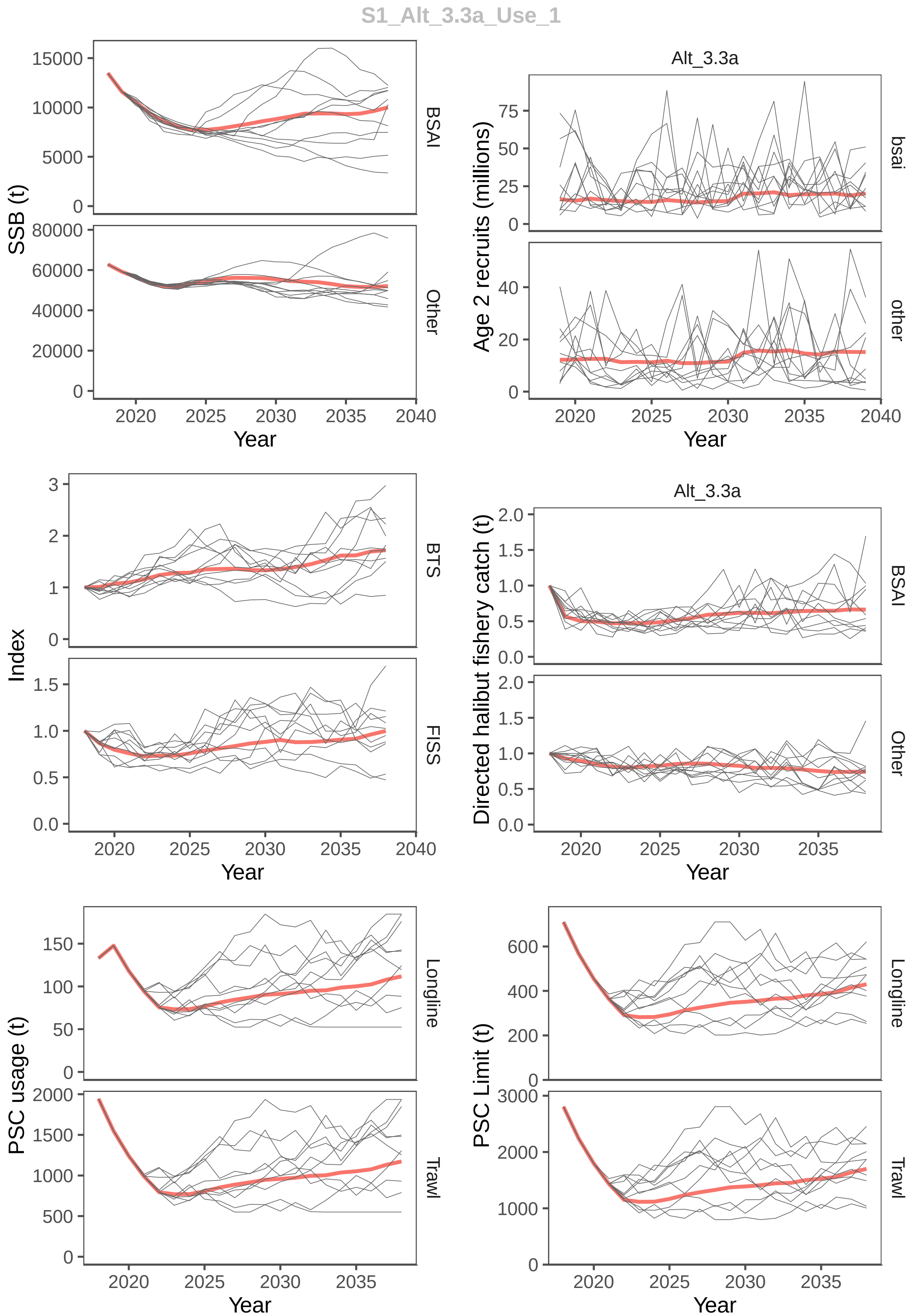
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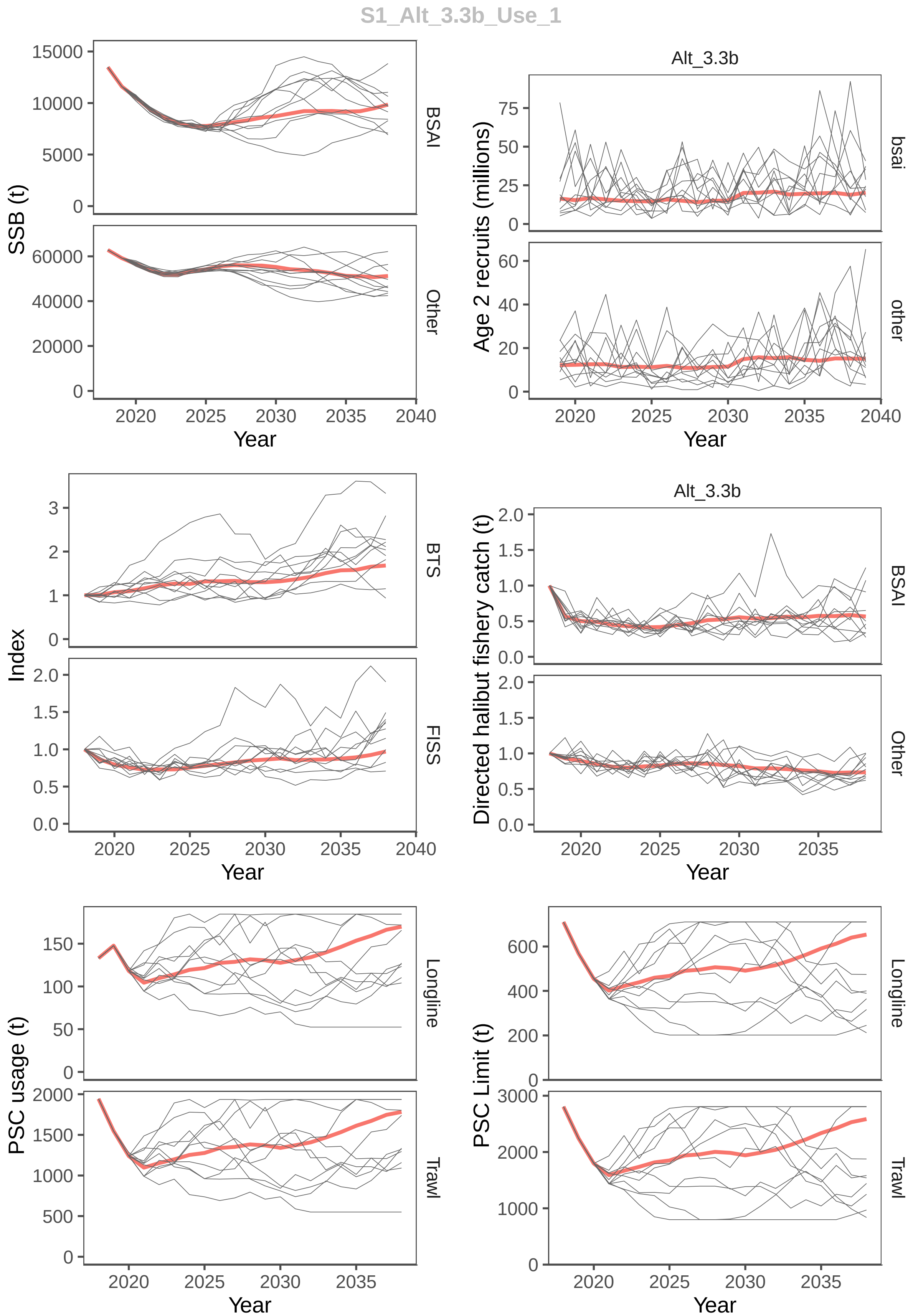
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Appendix 5: Sensitivity runs on Operating Model

This Appendix to be posted separately as soon as it becomes available.