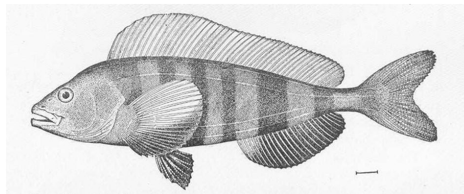
17. Assessment of the Atka mackerel stock in the Bering Sea and Aleutian Islands

Jane Sullivan, Sandra Lowe, and James Ianelli



This report may be cited as:

Sullivan, J., S. Lowe, and J. Ianelli. 2024. Assessment of the Atka mackerel stock in the Bering Sea and Aleutian Islands. North Pacific Fishery Management Council, Anchorage, AK. Available from https://www.npfmc.org/library/safe-reports/

Executive Summary

In 2023, Bering Sea and Aleutian Islands (BSAI) Atka mackerel changed from an annual to a biennial assessment frequency based on recent groundfish stock prioritization efforts. Under this new frequency, full assessments will be conducted in even years coinciding with the Aleutian Islands (AI) bottom trawl survey, and harvest projections (formerly called "partial" assessments) will be conducted in odd years. Additionally, new assessment definitions were introduced delineating "full" vs. "update" assessments. A full assessment updates all background and life history information, considers alternative model formulations for operational use, and responds to Plan Team and SSC comments as needed. In contrast, an update assessment uses the most recent approved assessment model, cites the most recent full assessment for background information, and responds to Plan Team and SSC comments when possible. In 2024, the BSAI Atka mackerel assessment is presented as an update. Relative to the last full assessment (Lowe and Ianelli, 2022), the following substantive changes have been made.

Summary of Changes in Assessment Inputs

Changes in the input data

1. Catches have been updated through 2023 and estimated total catch for 2024 was set equal to the TAC 72,987 t.
2. The 2024 AI bottom trawl survey biomass estimate was added.
3. The 2022 AI bottom trawl survey age composition data were added.
4. The 2022 and 2023 fishery age composition data were added.
5. The estimated average selectivity for 2019-2023 was used for projections.
6. Projected catches for 2025 and 2026 are 87,760 t and 78,507 t, respectively. We assume that approximately 85% of the BSAI-wide ABC is likely to be taken under the revised Steller Sea Lion Reasonable and Prudent Alternatives (SSL RPAs) implemented in 2015. This percentage was applied to the 2025 and 2026 maximum permissible ABCs, and those reduced amounts were assumed to be caught in order to estimate the 2025 and 2026 ABCs and OFL values.

Summary of Changes in the Assessment Methodology

There were no changes in the model configuration.

Summary of Results

1. The addition of the 2022 and 2023 fishery age composition data impacted the estimated magnitude of the 2017 and 2018 year classes, which decreased 31 and 36%, respectively, whereas the 2019 year class increased 64%. The 2019 year class is estimated to be 20% above average.
2. Projected 2025 female spawning biomass (119,853 t) is higher (8%) relative to last year's projection for 2025.
3. Projected 2025 female spawning biomass is above $B_{40\%}$ (105,894 t) at $B_{45\%}$, thereby placing BSAI Atka mackerel in Tier 3a for 2025. Last year, the projected 2025 female spawning biomass was below $B_{40\%}$ and Atka mackerel were in Tier 3b.
4. The projected 2025 acceptable biological catch (ABC) at $maxF_{ABC} = F_{40\%} = 0.53$ is 103,247 t, which is 22% higher relative to last year's estimate for 2025.
5. The projected 2025 overfishing level (OLF) at $F_{OFL} = F_{35\%} = 0.64$ is 122,622 t, which is 23% higher than last year's estimate for 2025.
6. The stock is not estimated to be overfished, overfishing, nor is it approaching an overfished condition.

Quantity	As estimated or *specified last* year for:		As estimated or *recommended this* year for:	
	2024	2025	2025*	2026*
M (natural mortality rate)	0.30	0.30	0.30	0.30
Tier	3a	3b	3a	3a
Projected total (age 1+) biomass (t)	625,578	631,261	627,115	605,644
Projected Female spawning biomass	116,618	110,694	119,853	106,274
$B_{100\%}$	280,456	280,456	264,734	264,734
$B_{40\%}$	112,182	112,182	105,894	105,894
$B_{35\%}$	98,160	98,160	92,657	92,657
F_{OFL}	0.76	0.75	0.64	0.64
$maxF_{ABC}$	0.61	0.60	0.53	0.53
F_{ABC}	0.61	0.60	0.53	0.53
OFL (t)	111,684	99,723	**122,622**	107,889
maxABC (t)	95,358	84,676	**103,247**	92,361
ABC (t)	95,358	84,676	**103,247**	92,361

Status	As determined *this* year for:		As determined *this* year for:	
	2022	2023	2024	2025
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

*Projections are based on estimated total catch of 87,760 t and 78,507 t in place of maximum permissible ABC for 2025 and 2026, respectively.

Area apportionment of ABC

The apportionments of the 2025 and 2026 recommended ABCs are based on the random effects model. In recent years, we recommended the 4-survey weighted average instead of the random effects model due to an anomalously low survey biomass estimate in the central AI (area 542) in 2018. Because survey biomass estimates have stabilized, we recommend the random effects method for apportionment but continue to present both alternatives for the Plan Team and SSC:

Apportionment Method	Area	Proportion	2025 ABC	2026 ABC
Random effects model (recommended)	541+SBS	0.452	**46,650**	**41,731**
	542	0.257	**26,511**	**23,716**
	543	0.291	**30,087**	**26,914**
	BSAI Total		**103,247**	**92,361**
Four-survey weighted average	541+SBS	0.477	49,253	44,060
	542	0.213	21,986	19,668
	543	0.310	32,008	28,633
	BSAI Total		103,247	92,361

Responses to SSC and Plan Team Comments Specific to the Atka Mackerel Assessment

This is an update assessment and transition year for the BSAI Atka mackerel assessment to a new lead author. Any outstanding comments not addressed here, will be addressed in the next full assessment.

From the December 2022 SSC report:

"*The SSC appreciates the author's work and recommends continued development of this assessment in the following areas:*
● *Testing the sensitivity and value of implementing a stock-recruitment relationship within this Tier 3 model.*

● *Exploration of why fishery ages have such a large effect on biomass estimates, given they should primarily affect fishery selectivity and the estimated recruitment history.*

● *Plot and calculate correlation of shared years of fishery ages and survey ages to evaluate if the high variability in fishery selectivity is reasonable, compared to survey selectivity.*

● *Explore whether this assessment would be a good candidate for biennial schedule given that new survey data are available on a biennial basis.*

> The BSAI Atka mackerel assessment has been moved to a biennial schedule on even years when the Aleutian Islands bottom trawl survey is conducted.

The SSC reiterates several previous SSC recommendations:
● *The BSAI GPT recommended, and the SSC supports, that the authors continue research into possible reasons for dome-shaped fishery and survey selectivity patterns, including senescence or differential distribution by age.*

● *The SSC highlighted the sensitivity of projections and F_{OFL} estimates to the assumed selectivity for future years in this assessment and reiterated its recommendation from December 2021 that BSAI Atka mackerel would be a good case study to examine when the GPTs develop guidance to assessment authors on what selectivity to use in projections for Tier 1-3 stocks with time-varying selectivity (see General Groundfish Stock Assessment Comments in the SSC December 2021 Report, p. 13).*"

> The current update assessment shows the current assessment's terminal year fishery selectivity estimate (2024) and the 5-year average selectivity used for projections (2019-2023) in Table 17.15 and Figure 17.4. This year the fishery selectivity shifted toward younger ages relative to the 2022 assessment. This year we added an analysis that shows the sensitivity of model results to sequentially adding new data to the model (Figures 17.9 and 17.10). Though we have not fully addressed this issue, we have improved the documentation of the topic in the results and assessment considerations sections of the risk table. Additionally, the AFSC is working towards consistent guidelines to address the issue of time-varying parameters and has an internal working group addressing the topic. We plan to explore this issue more fully in the next full assessment or in the 2026 CIE review.

From the December 2023 SSC report:

Harvest projection. There were no comments in the SSC report specific to Atka mackerel.

From the November 2022 BSAI Plan Team report:

The Team encouraged future research on apportionment and determining methods that may incorporate fishery performance, such as duration or number of tows as a standardizing factor, other data sources, or alternative methods.

> The current assessment provides two alternative apportionment schemes based on the 4-survey weighted average and the random effects (REMA) model. The REMA method is recommended and there is a discussion on the assessment authors' rationale for going back to the REMA method. Future assessments will continue investigation of alternative methods for apportionment, including the use of fishery dependent information.

From the September 2023 BSAI Plan Team report:

Harvest projection. No Plan Team comments specific to BSAI Atka mackerel.

From the November 2023 BSAI Plan Team report:

Harvest projection. No Plan Team comments specific to BSAI Atka mackerel.

Introduction

For this update assessment, we provide a brief summary of general biology and life history for Atka mackerel relevant to making management decisions. Please refer to the most recent full assessment for a detailed description of their distribution, life history, feeding and reproductive ecology, and evidence of stock structure (Lowe and Ianelli, 2022).

Atka mackerel (*Pleurogrammus monopterygius*) are widely distributed along the continental shelf across the North Pacific Ocean and Bering Sea from Asia to North America. In Alaskan waters, Atka mackerel are distributed throughout the Aleutian Islands (AI), where they are most abundant, north along the eastern Bering Sea (EBS) shelf, and through the Gulf of Alaska (GOA) to southeast Alaska. Nichol and Somerton (2002) found that Atka mackerel display strong diel behavior, with vertical movements away from the bottom occurring almost exclusively during daylight hours, presumably for feeding, and little to no movement at night (where they were closely associated with the bottom). Diel vertical behavior might affect availability to the bottom trawl survey or fisheries prosecuted during the day.

Atka mackerel exhibit a longitudinal gradient in size-at-age that is explained by food quality rather than food quantity or temperature. For example, Rand et al. (2010) found that Atka mackerel eating more energy rich euphausiids and forage fish in the eastern AI at Seguam pass were significantly larger at age than those eating copepod-rich diets in the central AI near Amchitka Island. These results might reflect local productivity in different areas.

Atka mackerel are a substrate-spawning fish with male parental care, a unique reproductive strategy that affects the seasonal distribution of the stock. Their reproductive cycle consists of three phases: 1) establishing territories, 2) spawning, and 3) brooding (Lauth et al. 2007a). In early June, a fraction of the adult males end schooling and diurnal behavior and begin aggregating and establishing territories on rocky substrate in nesting colonies (Lauth et al. 2007a). Many nesting sites in the AI are inside fishery trawl exclusion zones which may serve as *de facto* marine reserves for protecting Atka mackerel (Cooper et al. 2010). The spawning phase begins in late July, peaks in early September, and ends in mid-October (Lauth et al. 2007a). After spawning ends, territorial males with nests continue to brood egg masses until hatching, which can be as late as February (Lauth et al 2007a).

Management units

Amendment 28 to the Bering Sea/Aleutian Islands (BSAI) Fishery Management Plan became effective in mid-1993, and divided the Aleutian subarea into three districts at 177°W and 177°E for the purposes of spatially apportioning Total Allowable Catches (TAC). Since 1994, the BSAI Atka mackerel TAC has been allocated to the three regions (541 Eastern Aleutians, 542 Central Aleutians, and 543 Western Aleutians).

Fishery

Catch history

Atka mackerel became a reported species group in the BSAI Fishery Management Plan in 1978. Catches (including discards and community development quota [CDQ] catches), corresponding Acceptable Biological Catches (ABC), TAC, and Overfishing Levels (OFL) set by the North Pacific Fishery Management Council (NPFMC or Council) from 1978 to the present are given in Table 17.1 and Table 17.2. Non-commercial removals are presented in Appendix 17A. These supplemental catch data are estimates of total available removals that do not occur during directed groundfish fishing activities. These include removals incurred during research, subsistence, personal use, recreational, and exempted fishing permit activities.

From 1970-1979, Atka mackerel were landed off Alaska exclusively by the distant water fleets of the U.S.S.R., Japan and the Republic of Korea. U.S. joint venture fisheries began in 1980 and dominated the landings of Atka mackerel from 1982 through 1988. Total landings declined from 1980-1983 primarily due to changes in target species and allocations to various nations rather than changes in stock abundance. Catches increased quickly thereafter, and from 1985-1987 Atka mackerel catches averaged 34,000 t annually, dropping to a low of 18,000 t in 1989. The last joint venture allocation of Atka mackerel off Alaska was in 1989, and since 1990, all Atka mackerel landings have been made by U.S. fishermen. Beginning in 1992, TACs increased steadily in response to evidence of a large exploitable biomass, particularly in the central and western AI.

Description of the directed fishery

Fishery

Atka mackerel are caught almost exclusively by the Amendment 80 Fleet. The fishery for Atka mackerel has been a catch share fishery since 2008 when Amendment 80 to the BSAI Groundfish FMP was implemented, rationalizing the fleet of catcher/processor vessels in the Bering Sea and Aleutian Islands region targeting flatfish, Atka mackerel and Pacific ocean perch.

The patterns of the Atka mackerel fishery generally reflect the behavior of the species: (1) the fishery is highly localized and usually occurs in the same few locations each year; (2) the schooling semi-pelagic nature of the species makes it particularly susceptible to trawl gear fished on the bottom; and (3) trawling occurs almost exclusively at depths less than 200 m. In the early 1970s, most Atka mackerel catches were in the western AI (west of 180°W longitude). In the late 1970s and through the 1980s, fishing effort moved eastward, with the majority of landings occurring near Seguam and Amlia Islands. Areas fished by the Atka mackerel fishery from 1977 to 1992 are displayed in Fritz (1993). Areas of 2022 and 2023 fishery operations are shown in Figure 17.1.

Time series of nominal catch per unit effort (CPUE) in the fishery (defined as total catch per hour towed), effort (number of hours towed), and total catch by Aleutian Islands management subarea are shown in Figure 17.2. CPUE in subarea 542 and 543 have been relatively stable, though there have been some declines in 542 since 2015. Effort in those areas has also been relatively stable. Subarea 541 has shown the most variability in terms of CPUE and effort. The highest CPUE in that area was observed between 2003 and 2012, and has decreased markedly since that time. Effort peaked in area 541 in 2018, though catches have stabilized. CPUE patterns for Atka mackerel are often explained by management actions, and these time series should be interpreted within that context (see Management history section for more information).

Market

An economic performance report for 2024 for BSAI Atka mackerel is included in Appendix 17B (Dame, 2024). The U.S. (Alaska), Japan and Russia are the major producers of Atka mackerel.[1] Since 2019, approximately 98% of the Alaska caught Atka mackerel is processed as head-and-gut (H&G) products, while the remainder is mostly sold as whole fish (Table 17B-1 in Appendix 17B). The domestic market for Atka mackerel is minimal, and data indicate U.S. imports are approximately 0.1% of global production. Virtually all of Alaska's Atka mackerel production is exported, mostly to Asian markets in

[1] Japan and Russia catch the distinct species Okhotsk Atka mackerel (*Pleurogrammus azonus*) which are substitutes as the markets treat the two species identically.

Japan, South Korea, and northern China. In Asia it undergoes secondary processing into products like surimi, salted-and-split and other consumable product forms (Table 17B-2 in Appendix 17B). Based on U.S. export statistics, approximately 70% of Alaska's Atka mackerel is exported to Japanese markets where it is particularly popular in the northern Hokkaido region. Atka mackerel has a unique cultural significance and is a symbolic fish in the Hokkaido region (AFSC 2016).

COVID-19 had an unprecedented impact on fisheries in Alaska. One of the significant economic impacts experienced by the industry were the mitigation costs experienced by the fishing and processing industries to continue to supply national and global markets for seafood. Existing data collections do not adequately capture these costs, and as such, the economic performance report (Appendix 17B) focuses on catch, revenues and effort and changes occurring during the most recent year. Atka mackerel catch levels relative to TAC were within a typical range suggesting that COVID-19 did not have a significant impact on catch. In contrast to changes in landings, however, there was a notable decrease in prices for many of the products with significant exports to China for reprocessing and Japan, which ultimately go to food service sectors. This includes Atka mackerel, which has significant end markets in Japan, China, and South Korea in both food service and retail. The downward pressure on these prices during this time was likely the result of COVID-19 related logistical difficulties in international shipping and inspections, as well as foodservice closures, and compounded the downward pressure on prices from tariffs. The downward pressure on fish product prices in the first-wholesale market coupled with cost pressures from COVID-19 mitigation efforts likely resulted in negative impacts on net revenues between 2019 and 2022.

In 2023, however, the first wholesale value of Atka mackerel increased to $90.3 million, a 17% increase from 2022, due to increases in retained catch (65.9 thousand metric tons, up 13% from 2022) and a slight increase in wholesale prices ($1.06 per pound, a 5% increase from 2022). With the higher levels of retained catch, export volumes (15%) and value (13%) also increased from the 2014-2018 average, reaching the highest levels in the past five years (Table 17B-2 in Appendix 17B). Market and export data from 2023 suggest that the Atka mackerel market may have recovered to pre-COVID-19 levels. However, additional challenges, particularly from increased Russian seafood exports to China and Japan, may affect this industry in the near future. Preliminary export data between January and September indicates a decline in total export volume and value of Atka mackerel in 2024 (26.5 thousand t and $71 million) compared to the same time period in 2023 (35.7 thousand t and $81 million). However, export volume and value during this time period remains higher than the 2014-2018 average (23.7 thousand t and $66 million). The reduction in export volume is due to a decrease in Japanese exports, although other countries such as South Korea, have increased their imports of Atka mackerel in recent years.

Management history

Prior to 1992, ABCs were allocated to the entire Aleutian management district with no additional spatial management. However, because of increases in the ABC beginning in 1992, the Council recognized the need to disperse fishing effort throughout the range of the stock to minimize the likelihood of localized depletions. In 1993, Amendment 28 to the BSAI Fishery Management Plan became effective, dividing the Aleutian subarea into three districts at 177°W and 177°E for the purposes of spatially apportioning TACs. From 1994-2014, the BSAI Atka mackerel TAC was allocated to the three regions based on the weighted average distribution of biomass estimated from the AI bottom trawl surveys. Beginning in 2015, The ABC was apportioned by applying the random effects model to AI survey biomass estimates from 2015 to 2018. Beginning in 2019, ABC was apportioned by the weighted average distribution of biomass estimated by the AI trawl surveys. Table 17.2 gives the recent time series of BSAI Atka mackerel catches, corresponding ABC, OFL, and TAC by region.

In June 1998, the Council passed a fishery regulatory amendment that proposed a four-year timetable to temporally and spatially disperse and reduce the level of Atka mackerel fishing within Steller sea lion critical habitat (CH) in the BSAI Islands. Temporal dispersion was accomplished by dividing the BSAI

Atka mackerel TAC into two equal seasonal allowances, an A-season beginning January 1 and ending April 15, and a B-season from September 1 to November 1. The goal of spatial dispersion was to reduce the proportion of each seasonal allowance caught within CH to no more than 40% by the year 2002. No CH allowance was established in the Eastern subarea because of the year-round 20 nm trawl exclusion zone around the sea lion rookeries on Seguam and Agligadak Islands that minimized effort within CH. The regulations implementing this four-year phased-in change to Atka mackerel fishery management became effective on January 22, 1999 and lasted only 3 years (through 2001). In 2002, new regulations affecting the management of the Atka mackerel, pollock, and Pacific cod fisheries went into effect. Furthermore, all trawling was prohibited in CH from August 8, 2000 through November 30, 2000 by the Western District of the Federal Court because of violations of the Endangered Species Act (ESA).

As part of the plan to respond to the Court and comply with the ESA, NMFS and the NPFMC formulated new regulations for the management of Steller sea lion and groundfish fishery interactions that went into effect in 2002. The objectives of temporal and spatial fishery dispersion, cornerstones of the 1999 regulations, were retained. Season dates and allocations remained the same (A season: 50% of annual TAC from 20 January to 15 April; B season: 50% from 1 September to 1 November). However, the maximum seasonal catch percentage from CH was raised from the goal of 40% in the 1999 regulations to 60%. To compensate, effort within CH in the Central (542) and Western (543) Aleutian fisheries was limited by allowing access to each subarea to half the fleet at a time. Vessels fishing for Atka mackerel were randomly assigned to one of two teams, which started fishing in either area 542 or 543. Vessels were not permitted to switch areas until the other team had caught the CH allocation assigned to that area. In the 2002 regulations, trawling for Atka mackerel was prohibited within 10 nm of all rookeries in areas 542 and 543; this was extended to 15 nm around Buldir Island and 3 nm around all major sea lion haulouts. Steller sea lion CH east of 178° W in the Aleutian district, including all CH in subarea 541 and a 1° longitude-wide portion of subarea 542, was closed to directed Atka mackerel fishing.

The 2010 NMFS Biological Opinion found that the fisheries for Alaska groundfish in the Bering Sea and AI and GOA, and the cumulative effects of these fisheries, are likely to jeopardize the continued existence of the western distinct population segment of Steller sea lions, and also likely to adversely modify the designated critical habitat of the western Steller sea lions. Because this Biological Opinion found jeopardy and adverse modification of critical habitat, the agency was required to implement reasonable and prudent alternatives (RPAs) to the proposed actions (the fisheries). The 2010 Biological Opinion included RPAs, which required changes in groundfish fishery management in Management Sub-areas 543, 542, and 541 in the AI Management Area. NOAA Fisheries implemented the RPAs via an interim final rule before the start of the 2011 fishery in January.

The RPAs from the 2010 Biological Opinion and the 2014 Section 7 Consultation Biological Opinion specific to Atka mackerel are listed below.

RPAs from the 2010 Biological Opinion

<u>In Area 543:</u>

- Prohibit retention by all federally permitted vessels of Atka mackerel and Pacific cod.
- Establish a TAC for Atka mackerel sufficient to support the incidental discarded catch that may occur in other targeted groundfish fisheries (e.g., Pacific ocean perch).
- Eliminate the Atka mackerel platoon management system in the harvest limitation area.

<u>In Area 542:</u>

- Close waters from 0–3 nm around Kanaga Island/Ship Rock to directed fishing for groundfish by federally permitted vessels.
- Set TAC for Area 542 to no more than 47 percent of the Area 543 ABC.

- Between 177° E to 179° W longitude and 178° W to 177° W longitude, close critical habitat from 0–20 nm to directed fishing for Atka mackerel by federally permitted vessels year-round.
- Between 179° W to 178° W longitude, close critical habitat from 0-10 nm to directed fishing for Atka mackerel by federally permitted vessels year-round. Between 179° W and 178° W longitude, close critical habitat from 10-20 nm to directed fishing for Atka mackerel by federally permitted vessels not participating in a harvest cooperative or fishing a CDQ allocation.
- Add a 50:50 seasonal apportionment to the CDQ allocation to mirror seasonal apportionments for Atka mackerel harvest cooperatives.
- Limit the amount of Atka mackerel harvest allowed inside critical habitat to no more than 10 percent of the annual allocation for each harvest cooperative or CDQ group. Evenly divide the annual critical habitat harvest limit between the A and B seasons.
- Change the Atka mackerel seasons to January 20, 12:00 noon to June 10, 12:00 noon for the A season and June 10, 12:00 noon to November 1, 12:00 noon for the B season.
- Eliminate the Atka mackerel platoon management system in the harvest limitation area.

<u>In Area 541:</u>

- Change the Bering Sea Area 541 Atka mackerel seasons to January 20, 12:00 noon to June 10, 12:00 noon for the A season and June 10,12:00 noon to November 1, 12:00 noon for the B season.

<u>In Bering Sea subarea:</u>

- Close the Bering Sea subarea year-round to directed fishing for Atka mackerel.
- Prohibit trawling for Atka mackerel from 0 to 20 nm around all Steller sea lion rookeries and haulouts and in the Bogoslof Foraging Area.

Revised RPAs from the 2014 Biological Opinion

The season dates for the AI Atka mackerel trawl fishery are modified relative to the action analyzed in the 2010 Biological Opinion. The season dates from the action in the 2010 Biological Opinion, the interim final rule, and the 2014 Biological Opinion (BiOp) are shown in the table below.

	A Season		B Season	
	Start	End	Start	End
Action in 2010 BiOp	20-Jan	15-Apr	1-Sep	1-Nov
Interim Final Rule	20-Jan	10-Jun	10-Jun	1-Nov
Action in 2014 BiOp	20-Jan	10-Jun	10-Jun	31-Dec

<u>In Area 543:</u>

- Modify the closure around Buldir Island from a 0 to 15 nm closure to trawl fishing for Atka mackerel to a 0 to 10 nm closure.
- Limit the Area 543 Atka mackerel TAC to less than or equal to 65 percent of the ABC.

The action analyzed in the 2010 Biological Opinion did not include an Area 543-specific Atka mackerel harvest limit and prohibited directed fishing for Atka mackerel and Pacific cod.

In Area 542:

- Close Steller sea lion CH to Atka mackerel fishing between 178°E and 180° longitude.
- Increase 0 to 10 nm closures to 0 to 20 nm closures year-round at five rookeries (Ayugadak Point, Amchitka/Column Rocks, Amchitka Island/East Cape, Semisopochnoi/Petrel, and Semisopochnoi/Pochnoi)
- Increase 0 to 3 nm closures to 0 to 20 nm at six haulouts (Unalga and Dinkum Rocks, Amatignak Island/Nitrof Point, Amchitka Island/Cape Ivakin, Hawadax Island (formerly Rat Island), Little Sitkin Island, and Segula Island).

The action analyzed in the 2010 Biological Opinion included an Area 542-specific Atka mackerel harvest limit which set TAC for Area 542 to no more than 47 percent of the Area 542 ABC. The revised action does not include an Area 542-specific Atka mackerel harvest limit.

In Area 541:

- Open a portion of CH in Area 541 from 12 to 20 nm southeast of Seguam Island.
- Beyond the 50 percent seasonal apportionments there is no limit on the amount of the Atka mackerel TAC that could be harvested inside this open area of CH.

All of CH in Area 541 was closed to Atka mackerel fishing under the action analyzed in the 2010 Biological Opinion. Fishing for Atka mackerel has been prohibited in Steller sea lion CH in Area 541 since 2001.

In Bering Sea Subarea:

Management of the Atka mackerel TAC in the AI Area 541 is combined with the Bering Sea subarea. In general, the harvest of Atka mackerel in the Bering Sea is incidental to harvest of other groundfish target species, and occurs in relatively small quantities in critical habitat areas closed to directed fishing for Atka mackerel.

- Modify maximum retainable amount regulations for Amendment 80 vessels and Western Alaska Community Development Quota (CDQ) entities operating in the Bering Sea subarea to revise the method for calculating the MRA.

The effect of the modifications in the Bering Sea subarea would provide for more of the combined Bering Sea/541 Atka mackerel TAC to be harvested in the Bering Sea subarea rather than the AI.

Amendment 78 to the BSAI Groundfish FMP closed a large portion of the AI subarea to non-pelagic trawling. The Amendment 78 closures to nonpelagic trawling include the AI Habitat Conservation Area, the AI Coral Habitat Protection Areas, and the Bowers Ridge Habitat Conservation Zone, located in the northern portion of Area 542 and 543. These closures were implemented on July 28, 2006. These closures are in addition to the Steller sea lion protection measures and, in combination, substantially limit the locations available for nonpelagic trawling in the AI subarea. Amendment 80 to the BSAI Groundfish FMP was adopted by the Council in June 2006 and implemented for the 2008 fishing year. This action allocated several BSAI non-pollock trawl groundfish species (including Atka mackerel) among trawl fishery sectors, facilitated the formation of harvesting cooperatives in the non-American Fisheries Act (non-AFA) trawl catcher/processor sector, and established a limited access privilege program (also referred to as a catch share program). The Alaska Seafood Cooperative formerly the Best Use Cooperative was formed under Amendment 80 which includes most of the participants in the BSAI Atka mackerel fishery.

Bycatch and discards

The most commonly caught non-Atka mackerel groundfish species in trips defined by the Alaska Regional Office's Catch Accounting System as Atka mackerel targets are Pacific ocean perch (POP), northern rockfish, Pacific cod, and walleye pollock (Table 17.3). The POP and northern rockfish catches are likely attributable to mixed target trips where rockfish was the haul-specific target. The Other Rockfish species group, namely dusky and harlequin rockfish, are also commonly caught in the Atka mackerel fishery and can be constraining species for Atka mackerel fisheries (Table 17.3). The most common non-target or ecosystem species are grenadiers and miscellaneous fish, sponges, and red tree coral and other Bryozoans (Table 17.3). Additionally, seabirds are relatively common bycatch in the Atka mackerel fishery, including Northern Fulmar, Shearwaters, Auklets, and Storm Petrels. Bycatch estimates for prohibited species over the period 2015-2025 are given in Table 17.4. Red king crab, non-Chinook salmon, and golden (brown) king crab are the most common PSC species caught in the Atka mackerel fishery.

Atka mackerel are rarely caught as bycatch in other directed Aleutian Islands fisheries. The small amount of non-target bycatch of Atka mackerel (retained and discarded) comes from trawl Pacific cod and rockfish fisheries. The largest amount of discards of Atka mackerel, which are likely under-size fish, occur in the directed Atka mackerel trawl fishery (Table 17.5). However, the realized discard rates in the Atka mackerel fishery are very low (1-3% since 2009) and have been at similar levels in other target fisheries since 2015 (Table 17.6). This pattern is consistent across all areas in the Aleutian Islands. In contrast, discard rates have been consistently higher in the southern Bering Sea, likely due to incidental catch in other fisheries (Table 17.6). For more information about the interaction of past management history and the time series of discard rates of Atka mackerel, please refer to the last assessment (Lowe and Ianelli, 2022).

Data

The BSAI Atka mackerel assessment uses the following data in the assessment model:

Source	Data	Years
NMFS Aleutian Islands groundfish bottom trawl surveys	Survey biomass	1991, 1994, 1997, 2000, 2002 2004, 2006, 2010, 2012, 2014, 2016, 2018, 2022, 2024
	Age Composition	1991, 1994, 1997, 2000 2002, 2004, 2006, 2010, 2012, 2014, 2016, 2018, 2022
U.S. Atka mackerel trawl fisheries	Catch	1977-2024
	Age Composition	1977-2023 (except 1989)

Fishery data

Fishery data consist of total catch biomass from 1977 to 2024, as estimated by the Alaska Region (Table 17.1). Atka mackerel catch levels since 2015 have been 99% of the TAC almost every year. Thus, for projections we assume the 2024 end of year catch to be equal to the TAC (72,987 t). Appendix 17A contains Atka mackerel non-commercial catches from sources other than those that are included in the Alaska Region's official estimate of catch (e.g., removals due to scientific surveys, subsistence fishing, recreational fishing, and fisheries managed under other FMPs). The only significant non-commercial catches of Atka mackerel are from the AFSC summer bottom trawl surveys in the Aleutian Islands (Table 17A-1).

Fishery Length Frequencies

From 1977 to 1988, commercial catches were sampled for length and age structures by the NMFS foreign fisheries observer program. There was no joint venture allocation of Atka mackerel in 1989, when the fishery became fully domestic. Since the domestic observer program was not in full operation until 1990, there was little opportunity to collect age and length data in 1989. Also, the 1980 and 1981 foreign observer samples were small, so these data were supplemented with length samples taken by Republic of Korea fisheries personnel from their commercial landings. Data from the foreign fisheries are presented in Lowe and Fritz (1996). Sampling effort by the NMFS observer program since 1990 is shown in Table 17.7.

Atka mackerel fishery length distributions from 2000-2024 by management area are shown in Figure 17.3. There is evidence of a 2019 year class with small increases around 33 cm and 37 cm in the 2022 and 2023 length distributions, respectively. The available 2024 fishery data are presented and should be considered preliminary. These data show length distributions shifted toward smaller fish with a mode around 33 cm, which may be indicative of a strong 2021 or 2022 year class. These fish were primarily caught in the eastern and central Aleutians (Figure 17.3).

Fishery Age Data

Length measurements collected by observers and otoliths read by the AFSC Age and Growth Lab (Table 17.7) were used to create age-length keys to determine the age composition of the catch from 1977-2023 (Table 17.8). Catch-at-age in numbers was compiled using total annual BSAI catches and global (Aleutian-wide) year-specific age-length keys (Kimura, 1989). As described in the length frequency section, the commercial catches in 1980 and 1981 were not sampled for age structures, and there were too few age structures collected in 1989 to construct a reasonable age-length key. Kimura and Ronholt (1988) used the 1980 survey age-length key to estimate the 1980 commercial catch age distribution, and these data were further used to estimate the 1981 commercial catch age distribution with a mixture model (Kimura and Chikuni, 1987). However, this method did not provide satisfactory results for the 1989 catch data and that year has been excluded from stock assessment (Lowe et al. 2007).

The most notable features of the estimated catch-at-age data (Table 17.8) are the strong 1975, 1977, 1999, 2000, and 2001 year classes, and large numbers of the 2006 and 2012 year classes which showed up in the 2009-2012 and 2015-2019 fisheries, respectively. The new 2022 and 2023 age data provide evidence for an above average 2019 year class.

Survey data

Atka mackerel are a difficult species to survey because: (1) they do not have a swim bladder, making them poor targets for hydroacoustic surveys; (2) they prefer hard, rough and rocky bottom which makes sampling with bottom trawl survey gear difficult; (3) their diel schooling behavior and patchy distribution result in survey estimates associated with large variances; and 4) Atka mackerel are thought to be very responsive to tide cycles. During extremes in the tidal cycle, Atka mackerel may not be accessible which could affect their availability to the survey. Despite these caveats, the U.S.-Japan cooperative bottom trawl surveys conducted in 1980, 1983, 1986, and the 1991-2024 domestic trawl surveys, provide the only direct estimates of population biomass from throughout the Aleutian Islands region. Biomass estimates from the 1980s U.S-Japan cooperative surveys are not directly comparable with the biomass estimates obtained from the U.S. trawl surveys because of differences in the net, fishing power of the vessels, and sampling design (Barbeaux et al. 2004). Due to differences in area and depth coverage of the U.S-Japan cooperative surveys, these data are not fit in the assessment model and are presented in past assessments (Lowe and Ianelli, 2022).

Atka mackerel exhibit a very patchy distribution and biomass estimates are influenced by large isolated catches (Table 17.9, Figures 17.4 and 17.5). The 2024 survey effort was reduced by approximately 20 vessel days due to budget restrictions. This survey reduction was mitigated by strategically allocating effort to high variance strata; therefore, it did not appear to have disproportionate impacts to Atka mackerel biomass estimates (note the reductions in the number of hauls compared to the CVs in Table 17.9). It is unclear how survey reductions will impact the Aleutians trawl survey in future years. The 2024 survey estimate (574,769 t) is 11.4% below the long-term (1991-2024) mean and is a 14.5% decrease from the 2022 estimate (Table 17.9). Notably, the 2024 survey saw the second largest biomass estimate on record in the southern Bering Sea, which made up 25% of the total BSAI biomass.

Survey length frequencies

The bottom trawl surveys have consistently revealed a strong east-west gradient in Atka mackerel size similar to fishery data, with the smallest fish in the west and progressively larger fish to the east along the Aleutian Islands chain. The 2024 survey length frequency distributions also show a strong east-west gradient in Atka mackerel size, although the pattern is somewhat obscured in the Eastern Aleutians and southern Bering Sea, where smaller-sized fish were uncharacteristically abundant in 2024 (Figure 17.6).

Survey age data

The most recent survey age data is from the 2022 survey. Table 17.10 gives estimated survey numbers at age of Atka mackerel from the Bering Sea/Aleutian Islands trawl surveys and numbers of Atka mackerel otoliths aged. The 2022 survey age composition data are dominated by age-3 fish from the 2019 year class, followed by the 2016-2018 year classes (Table 17.10 and Figure 17.7).

Analytic Approach

For the 2024 update assessment, we continue to use Model 16.0b, which is implemented using the Assessment Model for Alaska (AMAK)[2] in AD Model Builder (Fournier and Archibald 1982, Fournier 1998). We provide an abbreviated description of the model structure and assumptions and refer the reader to the last full assessment for details (Lowe and Ianelli, 2022).

Model structure

The AMAK models catch-at-age with the standard Baranov catch equation. The population dynamics follows numbers-at-age over the period of catch history (here 1977-2024) with natural and age-specific fishing mortality occurring throughout the 11-age-groups that are modeled (1-11+). Age-1 recruitment in each year is estimated as deviations from a mean value expected from an underlying stock-recruitment curve. Deviations between the observations and the expected values are quantified with a specified error model and cast in terms of a penalized log-likelihood. The overall log-likelihood (L) is the sum of the log-likelihoods for each data component and prior specification (e.g., for affecting the extent selectivity is allowed to vary). Appendix 17C and Tables 17C-1 – 17C-3 in Lowe and Ianelli (2022) provide a description of the variables used, and the equations describing the population dynamics of Atka mackerel as they relate to the available data. The quasi[3] likelihood components and the distribution assumption of the error structure are given below:

[2] AMAK. 2015. A statistical catch at age model for Alaska, version 15.0. NOAA version available on request to authors.
[3] Quasi likelihood is used here because model penalties (not strictly relating to data) are included.

Data component	Years of data	Likelihood form	*CV* or sample size (*N*)
Catch biomass	1977-2024	Lognormal	*CV*=5% (all years)
Fishery catch age composition	1977-2023 (except 1989)	Multinomial	Year specific *N*=2-236, Ave.=100
Survey biomass	1991, 1994, 1997, 2000, 2002 2004, 2006, 2010, 2012, 2014, 2016, 2018, 2022, 2024	Lognormal	Year specific CV=14.4-35.4%, Ave=30.5%
Survey age composition	1991, 1994, 1997, 2000 2002, 2004, 2006, 2010, 2012, 2014, 2016, 2018, 2022	Multinomial	Year specific *N*=25-32, Ave.=30.5
Recruitment deviations		Lognormal	
Stock recruitment curve		Lognormal	
Selectivity smoothness (in age-coefficients, survey and fishery)		Lognormal	
Selectivity change over time (fishery and survey)		Lognormal	
Priors (where applicable)		Lognormal	

Parameters estimated outside the assessment model

The following parameters were estimated independently of other parameters outside of the assessment model: natural mortality (*M*), weight-at-age, maturity, and ageing error.

Natural mortality (M)

Natural mortality is fixed at 0.3 for all ages based on a meta-analysis of life history information by Lowe and Fritz (1997). A detailed description of past explorations of *M* is provided in Lowe and Ianelli (2022).

Weight-at-age

Year-specific weight-at-age estimates are used in the model to scale fishery and survey catch-at-age (and the modeled numbers-at-age) to total catch biomass and are intended to represent the average weight-at-age of the catch. Separate annual survey weights-at-age are compiled by expanding the numbers-at-age presented in Table 17.10 into age-selected survey biomass levels (Table 17.11). Survey estimates of length-at-age were obtained using year-specific age-length keys. Weights-at-age were obtained by multiplying the length distribution at age from the age-length key, by the mean weight-at-length from each year-specific data set (De Robertis and Williams 2008). In addition, a single vector of weight-at-age values based on the averages of the three most recent surveys with available age data (2016, 2018, and 2022) is used to derive population biomass from the modeled numbers-at-age (Table 17.11).

The updated fishery weight-at-age data presented in Table 17.12 for 2022-2024 was compiled using the age-length key estimation scheme described above in the Fishery Data section and the catch in numbers-at-age presented in Table 17.8. Previous values were carried forward from the prior stock assessment (Lowe and Ianelli, 2022).

Maturity

Female maturity at length and age were determined for Aleutian Islands Atka mackerel using histology (Table 17.13; McDermott and Lowe, 1997). The estimated female maturity at age is used in the assessment models. The age at 50% maturity is 3.6 years. Length at 50% maturity differs by area as the length-at-age differs by Aleutian Islands sub-areas:

	Length at 50% maturity (cm)
Eastern Aleutians (541)	35.91
Central Aleutians (542)	33.55
Western Aleutians (543)	33.64

Cooper et al. (2010) examined spatial and temporal variation in Atka mackerel female maturity at length and age. Maturity at length data varied significantly between different geographic areas and years, while maturity at age data failed to indicate differences and corroborated the age at 50% maturity determined by McDermott and Lowe (1997).

Ageing error

An ageing error conversion matrix is used in the assessment model to translate model population numbers-at-age to expected fishery catch-at-age. This matrix was not updated for the 2024 assessment. As described in Lowe and Ianelli (2022), the matrix was estimated using an ageing error model fit to the observed percent agreement at ages 2 through 10. The model was based on a linear increase in the standard deviation of ageing error and the assumption that ageing error is normally distributed. The model predicts percent agreement by taking into account the probability that both readers are correct, both readers are off by one year in the same direction, and both readers are off by two years in the same direction. Mean percent agreement is close to 100% at age 2 and declines to 54% at age 10. Annual estimates of percent agreement are variable, but show no obvious trend, hence a single conversion matrix for all years in the assessment model was adopted. The probability that both readers agree and were off by more than two years was considered negligible.

Effective sample size

For the fishery, the number of Atka mackerel lengths measured varied substantially as did the number of hauls from which hard-parts were sampled from fish for age-determinations. Stewart and Hamel (2014) found the maximum realized sample sizes for fishery biological data to be related both to the number of hauls and individual fish sampled from those hauls, and that a relative measure proportional to the number of hauls sampled might be a better indicator of sampling intensity. In Model 16.0b, the post-1989 fishery sample sizes were scaled to have the same mean as the 2015 assessment model (N=100) but varied relative to the number of hauls sampled; earlier years were set to constant values. Resultant effective sample sizes for Model 16.0b in 2024 are provided in Figure 17.8.

For the survey, input sample sizes were scaled to have a mean of approximately 50 and vary with the number of hauls where Atka mackerel were sampled (Lowe et al. 2017). Effective sample sizes for the survey age compositions were estimated following Francis (2011, equation TA1.8, Francis weights). Resultant effective sample sizes for Model 16.0b in 2024 tuned using Francis weights are provided in Figure 17.7.

Parameters estimated inside the assessment model

Deviations between the observations and the expected values are quantified with a specified error structure. Lognormal error is assumed for survey biomass estimates and fishery catch, and a multinomial error structure is assumed for survey and fishery age compositions. These error structures are used to estimate the following parameters conditionally within the model (fishing mortality, survey selectivity, survey catchability, age-1 recruitment). A description of these parameters and how they were estimated follows.

Fishing mortality and fishery selectivity

Fishing mortality is parameterized to be separable with a year component and an age (selectivity) component. The selectivity relationship is modeled with a smoothed nonparametric relationship that can take on any shape (with penalties controlling the degree of change over time, degree of declining selectivity at age (dome-shape, σ_d), and curvature as specified by the user). Selectivity is conditioned so that the mean value over all ages will be equal to one. To provide regularity in the age component, a moderate penalty was imposed on sharp shifts in selectivity between ages (curvature) using the sum of squared second differences (log-scale). In addition, the age component parameters are assumed constant for ages 10 and older. Maximum size (asymptotic growth) is reached at about age 9 to 10 years. Thus, it seemed reasonable to assume that selectivity of fish older than age 10 would be the same. We note that this assumption assumes there are no changes in behavior for the older fish. A moderate penalty was imposed to allow the model limited flexibility on the degree of declining selectivity at age. In the 2012 assessment we evaluated a range of alternative values for the prior penalty of the parameter determining the degree of dome-shape (σ_d) for fishery selectivity. Based on these results, a value of 0.3 for σ_d was chosen for the selected model (Lowe et al. 2012) and is carried forward unchanged in this assessment.

Since the 2016 assessment, we tuned the time-varying fishery selectivity variance (σ_{f_sel}) using the Francis weighting method (Francis 2011, equation TA1.8) on the fishery age composition data for Model 16.0b as described below. We consider that the mean input sample size for the fishery age composition is reasonable (mean=100) and that the lack of fit (or potential overfitting) could be adjusted by finding the appropriate level of inter-annual variability in selectivity. The procedure for tuning the degree of time-varying selectivity variability given input sample sizes was done iteratively by simply adjusting the variance term for selectivity variability (σ_{f_sel}) to achieve a “Francis weight” of 1.0 (or nearly). Typically, this was achieved in 3-4 iterations, and was done by manually editing the variance terms (which could differ by year, but for this case, were set to be the same for each year within a trial run). In 2024, as in the 2022 assessment, the σ_{f_sel} converged at 0.35. The original documentation for the smoothness (second differencing) penalty (L_2) was provided in Appendix Table 17D-3 of the 2017 (and previous) assessments as:

$$L_2 = \sum_l \lambda_2^l \sum_{j=1}^{A} \left(\eta_{j+2}^l + \eta_j^l - 2\eta_{j+1}^l\right)^2,$$

where λ is the weight for the prior on smoothness for selectivity. The index l is equal to s or f for survey or fishery selectivity respectively (in this case it is f). The index j denotes age with A being the maximum age modeled. The parameter η is the age effect for fishery selectivity.

The relationship between σ_{f_sel} and λ_2^l is:

$$\lambda_2^l = \frac{1}{2\sigma_{f\_sel}^2}.$$

Regarding selectivity variability adjustments relative to results, we suggest that tuning by adjusting the σ_{f_sel} term provides a robust statistical approach to setting the degree of selectivity variability (and thereby perhaps better track age-specific fishing mortality), assuming the effective sample size (to include overdispersion) is approximately correct. In contrast, other approaches, e.g., constant or blocked selectivity specifications, require downweighting the fishery age composition data, thereby implicitly accepting that the “model is correct” and the data are problematic. We consider the fishery age data to be the most robust of the data inputs. Model 16.0b, the current assessment model, uses Francis (2011) weights to tune the constraint governing the amount of time variability in fishery selectivity.

Survey selectivity and catchability

In Model 16.0b, the bottom trawl survey selectivity-at-age follows a parameterization similar to the fishery selectivity-at-age (except with no allowance for time-varying selectivity). Model 16.0b restricts survey catchability and selectivity-at-age to average 1.0 over ages 4-10 (i.e., as a combination of non-parametric selectivity-at-age and the scalar (q). This was done to avoid situations where the product of selectivity-at-age and q results in unreasonable values, and to standardize the ages over which selectivity most reasonably applies. Since the 2004 assessment (Lowe et al. 2004), we have used a moderate prior on q (mean = 1.0, $\sigma^2 = 0.2^2$).

Recruitment

Model 16.0b assumed the Beverton-Holt form of stock recruitment relationship based on Francis (1992). Values for the stock recruitment function parameters α and β are calculated from the values of R_0 (the number of 0-year-olds in the absence of exploitation and recruitment variability) and the "steepness" of the stock-recruit relationship (h). The "steepness" parameter is the fraction of R_0 to be expected (in the absence of recruitment variability) when the mature biomass is reduced to 20% of its pristine level (Francis 1992). Past assessments have assumed a fixed value of 0.8. A value of $h = 0.8$ implies that at 20% of the unfished spawning stock size, an expected value of 80% of the unfished recruitment level will result. Model runs exploring other values of h and the use of a prior on h were explored in previous assessments (Lowe et al. 2002), but were found to have little or no bearing on the stock assessment results and were not carried forward for further evaluation at the time. As in past years, we assumed $h = 0.8$ for all model runs since previous work showed that assessment results were insensitive to this assumption (and given the Tier 3 status does not affect future projections). Prior to the 2012 assessment, the recruitment variance was fixed at a value 0.6. Since 2012, we estimate this value.

Results

Model evaluation

This year we did not explore alternative model formulations. A summary of key results from the selected Model 16.0b is presented in Table 17.14. Results from the 2022 assessment are presented for comparison. Estimates of survey catchability increased from 1.6 in the 2022 assessment to 1.8 in the current assessment. Recruitment variability (Sigma$R$) increased slightly from 0.47 to 0.48. Overall, Model 16.0b performed very similarly between the 2022 and 2024 assessments with the addition of the new data sets. Briefly, the largest changes between assessments were in recent estimates of recruitment (downgrades in the 2017 and 2018 year classes and an increase in the estimate of the 2019 year class) and a shift in recent fishery selectivity toward younger ages, which reduced the scale of fishing mortality in the model. These changes are characteristic of Model 16.0b, which has a highly flexible fishery selectivity parameterization. These results are detailed below.

Impact of adding new data

An analysis was conducted to evaluate the impact of updating each dataset on model results. Figure 17.9 shows the changes in estimated spawning biomass, age-1 recruitment, and full-selection fishing mortality as the updated catches, catch-at-age, survey biomass, and survey age compositions were added sequentially. New data impacted both the trend and scale of the stock. In particular, the addition of new fishery ages (before Francis tuning) downgraded the scale of the spawning biomass, in turn increasing estimates of fishing mortality. The inclusion of the 2022 fishery ages increased the estimate of the 2019 year class, while downgrading the estimates of the 2017 and 2018 year classes. The presence of an above average 2019 year class was corroborated by the 2022 survey ages and 2023 fishery ages, though the relative magnitude of the 2019 year class estimate decreased with the inclusion of these new data sources.

The final Francis tuning step had negligible impact on the scale or trend of the spawning biomass or recruitment estimates.

Model 16.0b estimates of fishery selectivity and resultant fishing mortality rates are also sensitive to the inclusion of new data. Figure 17.10 shows the impact of sequentially updating each dataset on model estimates of fishery selectivity. The addition of the new fishery ages and 2024 survey biomass shifted fishery selectivity toward older ages, in turn increasing fishing mortality rates (Figure 17.9). However, once the new survey ages were added, the selectivity curve flattened, in part due to the high prevalence of age-3 fish in the 2022 survey data (Figure 17.7). The sensitivity of Model 16.0b fishery selectivity to new data has been documented in past assessments (Lowe and Ianelli, 2022).

Fits to the Data

The overall residual root-mean square error (RMSE) for the survey biomass data was estimated at 0.314, which is in line with estimates of sampling error *CV*s for the survey which range from 14.4-35.4% and average 30.5% over the time series1991-present (Table 17.9).

Figure 17.11 compares the observed and estimated survey biomass abundance values for the BSAI for Model 16.0b. The model performed very similarly to the 2022 assessment in terms of fits to the survey biomass. The decreases in biomass indicated by the 1994 and 1997 surveys followed by the large increases in biomass from the 2002 and 2004 surveys appear to be consistent with recruitment patterns. However, the large increase observed in the 2004 survey was not fit as well by the model compared to the 2000, 2002, and 2006 surveys. In the 2004 survey, an unusually high biomass (267,556 t) was estimated for the southern Bering Sea area (Table 17.7). This value represented 23% of the entire 2004 BSAI survey biomass estimate. The 2006 survey indicates a downward trend which is consistent with the population age composition at the time. The 2010 survey biomass estimate indicated an increase that was not predicted by the assessment model, likely due to the associated high *CV* and the lack of additional data corroborating the increase. The 2012 survey biomass estimate is the lowest value and associated with the lowest variance in the time series, but is not fitted by the model (Figure 17.11). The declining trend in biomass indicated by the 2014, 2016, and 2018 surveys is consistent with the population age composition. Population biomass would be expected to decline as fish from the strong 2006 year class aged and is past peak cohort biomass. The 2022 survey showed a large increase, primarily driven by a couple large catches in the eastern AI (Figure 17.4 and Table 17.9). There was a subsequent 14.5% decrease in survey biomass in 2024. Despite this decrease, the survey and fishery numbers-at-age provide evidence for above average recruitment in 2019, and currently the model is estimating a slight increase in biomass as that year class grows (Figures 17.7 and 17.8).

The fit of Model 16.0b to age composition data was evaluated using plots of observed and predicted age compositions, one-step-ahead (OSA) residual plots (Trijoulet et al., 2023), and aggregated fits to the composition data (Figures 17.7, 17.8, and 17.12). The model fits the fishery age composition data well particularly after 1997, and the survey age composition data much less so (Figures 17.7 and 17.8). This reflects the fact that the effective sample sizes for age composition data are higher for the fishery in most years than the survey, especially after 1999. The 2016-2021 fishery age data show the progression of the 2012 and 2013-year classes. The 2022 and 2023 fishery age data showed the first indication of a large 2019 year class. There are a relatively large number of Atka mackerel in the age-11+ plus group in the survey data since 2010, which are underpredicted by the model (Figure 17.7). Large numbers of fish in the plus group were not routinely observed in the earlier years of the survey. Because survey selectivity is constant, the model struggles to fit these two time periods. Therefore, while the aggregate survey age composition fits are acceptable, there are clear patterns in the OSA residuals bubble plot and QQ plots, suggesting a shift in selectivity or catchability in the survey that is not accounted for in the model (Figure 17.12). In contrast, the OSA residual diagnostics are acceptable for the fishery composition data, though there are some residual patterns in the youngest and oldest bins. The one outlier corresponds to the 2011 year class that is underpredicted by the model. This year class did not materialize in subsequent composition data to the same magnitude.

Time series results

Selectivity

For Atka mackerel, the estimated selectivity patterns are particularly important in describing their dynamics. The current assessment allows for flexibility over time (fishery only) and age (Figures 17.13, 17.14, and Table 17.15). The current assessment's terminal year fishery selectivity estimate (2024) and the 5-yr average selectivity used for projections (2019-2023) have shifted to the left, resulting in higher selectivity for ages 3-4, relative to the 2022 assessment (Figure 17.14). The current assessment's terminal year fishery selectivity pattern shows a peak for 9-year olds (2015 year class). Unlike fishery selectivity, the trawl survey selectivity is fairly consistent with the 2022 assessment.

The model estimates dome-shaped selectivity for both the fishery and survey. The dome-shaped patterns reflect the age compositions fairly well, but the mechanisms responsible for dome-shaped selectivity are uncertain and several factors likely contribute. The foreign and joint venture fisheries catches show a distinct lack of older fish in fishery catches. The decline in older age selectivity occurs after about 8 years old, which also corresponds with asymptotic growth and full maturity. Large, older fish may be less available to the fishery and survey. Alternatively, large, older fish may have higher natural mortality. Mature fish may be aggregated and unavailable to the summer surveys which can occur during the spawning season. Temperature may also affect recruitment of Atka mackerel and availability to the bottom trawl survey.

Abundance trend

The estimated time series of total numbers-at-age are given in Table 17.16. The estimated time series of total biomass (ages 1+) and female spawning biomass with approximate upper and lower 95% confidence limits are given in Table 17.17. A comparison of the age 3+ biomass and spawning biomass trends from the current and previous assessments (Table 17.18 and Figure 17.15 top panel) indicates consistent trends throughout the time series, i.e., biomass increased during the early 80s and again in the late 80s to early 90s. After the estimated peak spawning biomass in 1992, spawning biomass declined for nearly 10 years until 2001 (Figure 17.15 top panel). Thereafter, spawning biomass began a steep increase which continued to 2005. The abundance trend has been declining since the most recent peak in 2005 which represented a build-up of biomass from the exceptionally strong 1999-2001 year classes. Estimates from the current assessment (Model 16.0b) are similar up to 2020, after which there is slight divergence in trend due to revised estimates of recent year classes.

Recruitment trend

The estimated time series of age-1 recruits indicates the strong 1977 year class as the most notable in the current assessment, followed by the 1999, 1988, 2001, 2012, and 2000 year classes (Table 17.19, Figure 17.15 bottom panel). Relative to the most recent assessment in 2022, estimates of the 2017 and 2018 year classes decreased by 31 and 36%, respectively, but the estimate of the 2019 year class increased by 64%. These revised estimates in recent recruitment events explain the differences in total and spawning biomass estimates in the 2022 and 2024 assessments and the upward trajectory in the fit to the survey biomass (Figure 17.11 and 17.15, Table 17.18 and 17.19).

The Alaska Fisheries Science Center has recognized that an environmental "regime shift" affecting the long-term productive capacity of the groundfish stocks in the BSAI occurred during the period 1976-1977. Thus, the average recruitment value presented in the assessment is based on year classes spawned after 1976, and we leave a two-year lag on recruitment estimates. Therefore, projections of biomass for

2024 are based on estimated recruitments from the years 1978-2022 using a stochastic projection model described below. The mean recruitment over this period is 562 million fish.

Estimated age 1 recruits versus female spawning biomass with the Beverton-Holt stock recruitment curve plotted is shown in Figure 17.16. There are no estimates of female spawning biomass less than 108,000 t. The five largest year classes in the time series were all spawned from biomass levels ranging from 108,770-170,875 t. However, this range of female spawning biomass also spawned several years of low recruitment (Figure 17.16).

Trend in exploitation

The estimated time series of fishing mortalities on fully selected age groups and the catch-to-biomass (age 3+) ratios are given in Table 17.20 and shown in Figure 17.17. Estimates of catch-to-biomass are very similar between the 2022 and 2024 assessments.

Retrospective Analysis

Atka mackerel have a reasonable retrospective pattern for the last ~12 years of predicting spawning biomass, with periods that are lower and higher (Figure 17.18). The revised Mohn's rho statistic is low and slightly negative (-0.06). However, after data from 2012-2014 were dropped from the model, the retrospective pattern shows a consistent and fair significant positive bias. Lowe et al. (2017) determined that this pattern can be explained by the relative influence of the survey age compositions on survey selectivity estimates. The recent period of data has relatively large numbers of Atka mackerel in the survey age plus group; therefore, estimates of survey selectivity are approaching an asymptotic shape (Figure 17.14). However, for the retrospective peels which ignore those recent years of data, the survey selectivity becomes much more dome-shaped, hence the early period biomass estimates were estimated to be considerably higher.

Comparison of Historical Assessment Results

Figure 17.19 shows a comparison of female spawning biomass trajectories (t) from even year assessments between 2010 and 2024. The BSAI Atka mackerel assessment has shown a high level of consistency throughout time despite uncertainty in stock scale. Like the within model retrospective analysis, uncertainty in scale begins in the mid-2010s and is attributed to a change in the survey age composition and estimation of survey selectivity.

Projections and harvest recommendations

Results and recommendations in this section pertain to the authors' recommended Model 16.0b.

Amendment 56 Reference Points

Amendment 56 to the BSAI Groundfish Fishery Management Plan (FMP) defines "overfishing level" (OFL), the fishing mortality rate used to set OFL (F_{OFL}), the maximum permissible ABC, and the fishing mortality rate used to set the maximum permissible ABC (*max* F_{ABC}). The fishing mortality rate used to set ABC (F_{ABC}) may be less than this maximum permissible level, but not greater. The overfishing and maximum allowable ABC fishing mortality rates are given in terms of percentages of unfished female spawning biomass ($F_{SPR\%}$), on fully selected age groups. The associated long-term average female spawning biomass that would be expected under average estimated recruitment from 1978-2022 (559 million age-1 recruits) and F equal to $F_{40\%}$ and $F_{35\%}$ are denoted $B_{40\%}$ and $B_{35\%}$, respectively. The Tiers require reference point estimates for biomass level determinations. We present the following reference points for BSAI Atka mackerel for Tier 3 of Amendment 56. For our analyses, we computed the following values from Model 16.0b results based on recruitment from post-1976 spawning events:

$B_{100\%}$ = 264,734 t female spawning biomass
$B_{40\%}$ = 105,894 t female spawning biomass
$B_{35\%}$ = 92,657 t female spawning biomass

Specification of OFL and Maximum Permissible ABC

In the current assessment, Model 16.0b is configured with time-varying selectivity. We use a 5-year average (2019-2023) to reflect recent conditions for projections and computing ABC which gives:

Full selection *F*s	2024
F_{2024}	0.26
$F_{40\%}$	0.53
$F_{35\%}$	0.64

For specification purposes to project the 2025 ABC, we assumed a total 2024 year end catch of 72,987 t equal to the 2024 TAC. For projecting to 2026, an expected catch in 2025 is also required. Recognizing that the modified Steller sea lion RPAs implemented in 2015 require a TAC reduction in Area 543, we assume a stock-wide catch based on a reduced overall BSAI-wide Atka mackerel catch for 2025. Under the modified Steller sea lion RPAs, the Area 543 Atka mackerel TAC is set less than or equal to 65 percent of the Area 543 ABC. This percentage (65%) was applied to the Western Aleutian Islands maximum permissible 2025 ABC estimate, and that amount was summed with the maximum permissible ABC estimates for the Eastern and Central Aleutian areas for a total estimated 2025 catch. The total estimated 2025 catch was assumed to be caught in order to estimate the 2026 ABC and OFL values. We estimated that about 85% of the BSAI-wide 2025 ABC is likely to be taken.

It is important to note that for BSAI Atka mackerel, projected female spawning biomass calculations depend on the harvest strategy because spawning biomass is estimated at peak spawning (August). Thus, projections incorporate 7 months of the specified fishing mortality rate. The projected 2025 female spawning biomass (SSB_{2025}) is estimated to be 119,853 t given assumed 2024 catch and 7 months of the estimated 2025 catch reflecting the Steller sea lion RPA adjustment to the 2025 ABC.

The projected 2025 female spawning biomass estimate is above the $B_{40\%}$ value of 105,894 t, placing BSAI Atka mackerel in **Tier 3a**. The projected 2026 female spawning biomass estimate is above $B_{40\%}$, placing Atka mackerel in **Tier 3a**. The 2025 and 2026 maximum permissible ABC and OFL values under Tier 3a are:

Year	Catch* (t)	ABC (t)	F_{ABC}	OFL (t)	F_{OFL}	SSB (t)	Tier
2025	87,760	103,247	0.53	122,622	0.64	119,853	3a
2026	78,507	92,361	0.53	107,889	0.64	106,274	3a

* Catches in 2025 and 2026 are less than the recommended maximum permissible ABCs to reflect expected catch reductions under Steller sea lion RPAs.

Standard Harvest Scenarios and Projection Methodology

A standard set of projections is required for each stock managed under Tiers 1, 2, or 3, of Amendment 56. This set of projections encompasses seven harvest scenarios designed to satisfy the requirements of Amendment 56, the National Environmental Policy Act, and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA).

For each scenario, the projections begin with the vector of 2024 numbers-at-age estimated in the assessment. This vector is then projected forward to the beginning of 2038 using a fixed value of natural mortality of 0.3, the recent schedule of selectivity estimated in the assessment (in this case the average 2019-2023 selectivity), and the best available estimate of total (year-end) catch for 2024 (in this case assumed to be 72,987 t equal to TAC). As previously described, the 2025 and 2026 catches are reduced to accommodate Steller sea lion RPA TAC reductions for Scenarios 1 and 2. In each subsequent year, the fishing mortality rate is prescribed on the basis of the spawning biomass in that year and the respective harvest scenario. In each year, recruitment is drawn from an inverse Gaussian distribution whose parameters consist of maximum likelihood estimates determined from recruitments estimated in the assessment. Spawning biomass is computed each year based on the time of peak spawning (August) and the maturity and population weight schedules described in the assessment. Total catch is assumed to equal the catch associated with the respective harvest scenario in all years, except that in the first two years of the projection, a lower catch may be specified for stocks where catch is typically below ABC (as is the case for Atka mackerel). This projection scheme is run 1,000 times to obtain distributions of possible future stock sizes, fishing mortality rates, and catches.

Five of the seven standard scenarios are designed to provide a range of harvest alternatives that are likely to bracket the final TACs for 2025 and 2026, are as follows ("*max* F_{ABC}" refers to the maximum permissible value of F_{ABC} under Amendment 56):

Scenario 1: In all future years, F is set equal to *max* F_{ABC}. (Rationale: Historically, TAC has been constrained by ABC, so this scenario provides a likely upper limit on future TACs.).

Scenario 2: In all future years, F is set equal to a constant fraction of *max* F_{ABC}, where this fraction is equal to the ratio of the F_{ABC} value for 2025 recommended in the assessment to the *max* F_{ABC} for 2023, and where catches for 2025 and 2026 are estimated at their most likely values given the 2025 and 2026 maximum permissible ABCs under this scenario. (Rationale: When F_{ABC} is set at a value below *max* F_{ABC}, it is often set at the value recommended in the stock assessment).

Scenario 3: In all future years, F is set equal to the average of the five most recent years. (Rationale: For some stocks, TAC can be well below ABC, and recent average F may provide a better indicator of F_{TAC} than F_{ABC}.)

Scenario 4: In all future years, the upper bound on F_{ABC} is set equal to $F_{60\%}$. (Rationale: This scenario provides a likely lower bound on F_{ABC} that still allows future harvest rates to be adjusted downward when stocks fall below reference levels).

Scenario 5: In all future years, F is set equal to zero. (Rationale: In extreme cases, TAC may be set at a level close to zero.)

Two other scenarios are needed to satisfy the MSFCMA's requirement to determine whether a stock is currently in an overfished condition or is approaching an overfished condition. These two scenarios are as follows (for Tier 3 stocks, the MSY level is defined as $B_{35\%}$):

Scenario 6: In all future years, F is set equal to F_{OFL}. (Rationale: This scenario determines whether a stock is overfished. If the stock is expected to be 1) above its MSY level in 2024 or 2) above ½ of its MSY level in 2024 and above its MSY level in the 10th projection year (2034) under this scenario, then the stock is not overfished.)

Scenario 7: In 2025 and 2026, F is set equal to *max* F_{ABC}, and in all subsequent years, F is set equal to F_{OFL}. (Rationale: This scenario determines whether a stock is approaching an overfished condition. If the stock is 1) above its MSY level in 2024 or 2) above 1/2 of its MSY level in 2024 and expected to be above its MSY level in the 12th projection year (2036) under this scenario, then the stock is not approaching an overfished condition.).

The projections of female spawning biomass, fishing mortality rate, and catch corresponding to the seven standard harvest scenarios are shown in Table 17.21.

Status Determination

Under the MSFCMA, the Secretary of Commerce is required to report on the status of each U.S. fishery with respect to overfishing. This assessment reports the answer to three questions: 1) Is the stock being subjected to overfishing? 2) Is the stock currently overfished? 3) Is the stock approaching an overfished condition?

Harvest scenarios 6 and 7 are intended to permit determination of the status of a stock with respect to its minimum stock size threshold (MSST). Any stock that is below its MSST is defined to be *overfished*. Any stock that is expected to fall below its MSST in the next two years is defined to be *approaching* an overfished condition. Harvest scenarios 6 and 7 are used in these determinations as follows:

Is the stock overfished? This depends on the stock's estimated spawning biomass in 2024:

a) If spawning biomass for 2024 is estimated to be below ½ $B_{35\%}$, the stock is below its MSST.
b) If spawning biomass for 2024 is estimated to be above $B_{35\%}$, the stock is above its MSST.
c) If spawning biomass for 2024 is estimated to be above ½ $B_{35\%}$ but below $B_{35\%}$, the stock's status relative to MSST is determined by referring to harvest scenario #6 (Table 17.21). If the mean spawning biomass for 2034 is below $B_{35\%}$, the stock is below its MSST. Otherwise, the stock is above its MSST.

Is the stock approaching an overfished condition? This is determined by referring to harvest scenario #7 (Table 17.21):

a) If the mean spawning biomass for 2025 is below ½ $B_{35\%}$, the stock is approaching an overfished condition.
b) If the mean spawning biomass for 2025 is above $B_{35\%}$, the stock is not approaching an overfished condition.
c) If the mean spawning biomass for 2025 is above ½ $B_{35\%}$ but below $B_{35\%}$, the determination depends on the mean spawning biomass for 2036. If the mean spawning biomass for 2036 is below $B_{35\%}$, the stock is approaching an overfished condition. Otherwise, the stock is not approaching an overfished condition.

Based on the above criteria and Table 17.21, the BSAI Atka mackerel stock is not overfished and is not approaching an overfished condition. The fishing mortality that would have produced a catch in 2024 equal to the 2024 OFL is 0.567.

Risk Table and ABC Recommendation

Since 2020, the SSC has requested that full or update assessments fill out a risk table with assessment, population dynamics, environmental and ecosystem, and fishery performance considerations to inform potential reductions from maximum permissible ABC. The guidelines for risk table definitions are now available to reference in the Introduction to the BSAI SAFE.

<u>Assessment considerations</u>: (Level 1)

Model 16.0b has been used for the BSAI Atka mackerel assessment since the 2016 assessment. A comparison of spawning biomass from across assessments since 2010 shows that the assessment has provided relatively consistent results in terms of trend and for the most part scale of the populations, especially since 2015 (Figure 17.19). The model has a low retrospective bias for the recent time period

(Mohn's rho=-0.06; Figure 17.18), and the positive bias in peels before 2017 are easily explained by the relative influence of fish in the plus group of the survey age compositions on survey selectivity estimates (see Retrospective Analysis for more information). Additionally, the model fits the available survey biomass data well, despite the challenges of surveying Atka mackerel (e.g., their preference for untrawlable habitat, diel schooling behavior and patchy distribution, spawning aggregations during part of the survey season, and tidal influence).

This year we added OSA diagnostic plots for the composition data, which was useful in showing the good fit to the fishery ages and poor fit in the survey ages (Figures 17.7 and 17.8 show the survey and fishery annual composition fits, while Figure 17.12 shows the OSA diagnostics and the aggregate composition fits). The recent period of data has relatively large numbers of Atka mackerel in the survey age plus group; therefore, estimates of survey selectivity are approaching an asymptotic shape (Figure 17.14). Prior to 2010, the large numbers of fish in the plus group were not present in the survey ages. The aggregate fits show the constant survey selectivity trying to strike a balance between these two time periods and successfully failing to fit either of them (Figure 17.7 for annual fits, Figure 17.12 for aggregate fit). While the lack of fit to the survey ages should be explored in future iterations of the assessment, it did not warrant increased concern in the risk table at this time.

Finally, we showed the sensitivity of the model results (e.g., estimates of annual fishery selectivity, fishing mortality, recruitment, and spawning biomass) to adding new data sets (Figures 17.9 and 17.10). The selectivity parameterization in this assessment is quite flexible and exceeds 1, making the interpretation of fishing mortality and catchability coefficients challenging. We are currently transitioning lead authors and will be revisiting this topic in the next assessment cycle.

For 2024 we consider these unresolved issues in assessment to be typical of Model 16.0b and rate the assessment considerations a level 1.

<u>Population dynamics considerations</u>: (Level 1)

Model 16.0b shows a decline in female spawning biomass since peak biomass in 2005 and estimated female spawning biomass in near all-time lows. The peak biomass in 2005 is the result of 3 back-to-back very strong year classes (1999, 2000, 2001 year classes; Figure 17.16). Currently, the 2019 year class, which is dominant in the 2022 survey and fishery age data and the 2023 fishery age data is estimated to be above average (Table 17.19 and Figure 17.15).

The 2025 female spawning biomass is projected to be above $B_{40\%}$ and Atka mackerel are in Tier 3a. Under the Tier 3a $F_{40\%}$ harvest strategy and assuming SSL RPA catch reductions in 2025 and 2026, female spawning biomass is projected to remain above $B_{40\%}$ in 2026 through 2038 (Figure 17.20 and Table 17.21 Scenarios 1 and 2). If SSL RPA catch reductions are in place beyond 2026, expected female spawning biomass levels would be higher than projected after 2026. While the spawning biomass is currently low, stock trends are typical for the stock and expected given the stock dynamics. We rated the population dynamics-related concern as level 1.

<u>Environmental/Ecosystem considerations</u>: (Level 2)
Provided by Ivonne Ortiz

Environment: The average bottom temperature from the 2024 Aleutian Islands bottom trawl survey (165°W – 172°E, 30-500 m) was close to the 20-year mean (taken from surveys conducted between 1991 and 2012) for all subareas but still above the long term mean. This is in contrast with the four survey years prior, which were generally warmer than average for bottom temperatures. The bottom temperature means are similar across all four regions (Howard and Laman, 2024) and values close to the long-term mean are considered a positive indicator. Satellite surface temperatures show a step increase in 2014 with higher temperatures both in summer and winter (Xiao and Ren 2023). Sea surface temperatures were above the mean through winter across all subregions. Over the eastern Aleutian Islands, there were few days of marine heatwave (MHW) status relative to the mean over the last decade, which was also the case in 2021 and 2022. At times during late summer over 75% of the western Aleutians were in MHW status. While there were also warm anomalies and MHWs over 25% of the central and eastern Aleutians in summer, these were not sufficient to register in the spatial mean (Lemagie and Callahan, 2024).

Nests of Atka mackerel have been observed between depths of 22-144 m, and at temperatures of 3.9 to 10.7°C (Lauth et al., 2007b). In laboratory conditions, incubation varied from 44 days at 9.85°C to 100 days at 3.89°C (Lauth et al., 2007a). Mean surface temperatures of 10.5°C and 10.1°C were observed in August and September 2024 compared to the 1985-2014 mean of ~ 9.7°C in those months, when Atka mackerel spawns around Amchitka Island. Spawning has been observed to be later in September and October towards the eastern Aleutians (Lauth et al. 2007) in Seguam Pass where sea surface temperatures were cooler, 9.5°C and 8°C, respectively (close to the 1985-2014 mean of 9.5°C for September and 7.8°C for October). While there were also warm anomalies and MHWs over 25% of the central and eastern Aleutians in summer, these were not sufficient to register in the spatial mean (Lemagie and Callahan, 2024). The high sea surface temperatures during August-September could pose a potential risk of increased temperatures to nests at the shallowest depths, with potentially shorter incubation periods and eggs hatching earlier in the season that typically extends from October to January with a peak in November. Hatching too early or too late in the season may cause a mismatch with the availability of prey suitable for larvae and juveniles, decreasing the chance of survival.

Prey: With temperatures being close to the 1991-2012 mean, bioenergetic costs for Atka mackerel would not be expected to increase. Despite this cooling, the fish condition of Atka mackerel (defined as mean weight-length residuals) was 1 std. dev below the long term mean. Although there was a slight overall improvement from 2018 to 2022 to average condition, fish condition in 2024 is the lowest since 2006; the low fish condition was observed across the entire chain (Howard et al. 2024). This indicates prey was less available, with areas showing insufficient food to promote optimal growth during that time.

The biennial cycle and cascading effects of east Kamchatka pink salmon predation on copepods has been documented before by Springer and van Vliet (2014) and Batten et al. (2018). Based on the Kamchatka pink-salmon – copepods relationship, we assume that copepod prey availability to Atka mackerel in 2024 would be higher than in odd years when pink salmon abundance is high (Ruggerone, 2024) and predation of copepods by salmon would be higher. Estimated catch in numbers of age-2 Atka mackerel shows a biennial pattern from ~2011 onwards, with higher catches shown in odd years when pink abundances are high. This pattern is suggestive of some interaction between pink salmon and Atka mackerel, particularly in the absence of alternative hypotheses for the pattern in catches. The biennial pattern is not seen in other ages. The decrease in the number of fish in catch-at-age estimates of age-2 Atka mackerel from 2010 onwards coincides with the steep increase of eastern Kamchatka pink salmon from 2009 onwards when the high abundance in odd years doubled. A study by Matta et al. (2020) showed annual variation in otolith growth followed a biennial pattern, with increased growth during even (low pink abundance) years. While both the catch-at-age and otolith growth may show that there is some effect, the biennial pattern is not observed in subsequent age classes in the catch-at-age estimates, nor in the stock assessment or in the survey samples.

Other inferences we can make about zooplankton prey availability are from seabird reproductive success. Planktivorous auklets that nest in the western Aleutians at Buldir Island had below average reproductive success in general in 2024, suggesting that zooplankton were not sufficiently abundant to support successful production of chicks. At Aiktak, diving plankton feeders (ancient murrelets) and surface plankton feeders (Leach's and fork-tailed storm-petrels) had average or above average reproductive success, suggesting there was a gradient in foraging conditions from east to west, with more favorable conditions towards the eastern Aleutians (Rojek et al. 2024). Data for 2023 from the Continuous Plankton Recorders (CPR) that sample near the Aleutian chain show anomalously small copepod taxa since

2014 (apart from 2019 and in 2021), which suggests a real increase in the relative abundance of smaller species, potentially because of warmer than normal conditions. The meso-zooplankton biomass, also from the 2023 CPR data, was positive (for the first time since 2017) (Ostle and Batten, 2024).

Competitors and predators: The fish pelagic foragers, once dominated by Atka mackerel and walleye pollock biomass, are now dominated by rockfish – Pacific ocean perch and northern rockfish which were heavily fished by the foreign fishery in the 1960s and 1970s and have subsequently been increasing since the 1980s to peak biomass (age-3+) in 2011-2012. Since then rockfish have decreased but remain at a high biomass that have potentially displaced Atka mackerel and compete for prey and space. This might be supported by the increased bycatch of Atka mackerel in the Pacific ocean perch fishery. Atka mackerel are a key prey for Steller sea lions, harbor seals, Pacific cod, arrowtooth flounder, and Pacific halibut (AFSC Groundfish Food Habits database). Recent data suggest that SSL populations have continued to decline in the western Aleutians (Sweeney and Gelatt 2024), suggesting that their predatory impact on Atka has not increased. Likewise, harbor seals are decreasing in the Aleutians (London et al., 2021). Pacific cod had a slight increase based on survey biomass estimates. Since 2016, Atka mackerel has contributed a small and decreasing proportion (by weight) to diets of Pacific cod in NMFS area 541; in 2022 Atka contributed less than 5%. The contribution of Atka mackerel to Pacific cod diets was equally small in the western Aleutians, but increased significantly in the central Aleutians where it comprised almost 40% of their diet. Arrowtooth flounder biomass peaked in 2006 and has been decreasing since, as has Pacific halibut since 1997 based on AI survey biomass estimates (Ortiz, 2024). Together there are no clear signs of changes in predation pressure that would be negatively influencing Atka mackerel.

In summary, the i) sustained combined increased abundance of competitors: Pacific ocean perch, northern rockfish, and pink salmon in odd years since 2009, along with the increase of pollock, the ii) below average condition despite the near average temperatures, and iii) the potentially unfavorable foraging condition in the western Aleutians, indicate plausible negative cumulative ecosystem impacts on Atka mackerel.

The above factors, in addition to the decrease in survey biomass estimates for Atka mackerel despite the potential decreased predation mortality, lower temperatures, and potentially suitable foraging conditions in the eastern Aleutians, support environmental/ecosystem considerations rated as level 2 (Multiple indicators showing consistent adverse signals a) across the same trophic level, and/or b) up or down trophic levels (i.e., predators and prey of stock)).

<u>Fishery performance considerations</u>: (Level 1)

Catches since 2015 have been relatively consistent and ranged from 53,000-70,000 t (Table 17.1 and 17.2). Fishery catches of BSAI Atka mackerel have not shown any unusual trends in location, timing and catch levels (Figure 17.1). This year we presented fishery CPUE by area and showed a long-term trend of CPUE declines in area 541 coupled with increasing effort, though this looks to be reversing in the last several years (Figure 17.2). As described in the Management history section, there is intensive spatial management in the Aleutian Islands, which strictly limits the Amendment 80 footprint in that region when fishing for Atka mackerel. A CPUE standardization exercise would be useful in understanding trends in fishery CPUE by area relative to these management actions.

The assessment authors have been in touch with industry about *Kudoa*, a parasite that degrades fish quality and has impacted Atka mackerel fishery performance in past years and areas in the Aleutians. *Kudoa* was not an issue in 2023 or 2024, but we will continue monitoring in future years. Additionally, we heard reports from industry this year about skinny fish in the spring. Atka mackerel growth conditions improved throughout the year; however, this highlights the importance of monitoring and communication with industry about the fishery and how conditions are impacting fleet behavior and resource-use. For this assessment we rated the fishery performance-related concern as Level 1.

These results are summarized in the table below:

Assessment-related considerations	*Population dynamics considerations*	*Environmental/ ecosystem considerations*	*Fishery Performance considerations*
Level 1: Typical to moderately increased uncertainty/minor unresolved issues in assessment.	Level 1: Stock trends are typical for the stock; recent recruitment is within normal range.	Level 2: Multiple indicators showing consistent adverse signals a) across the same trophic level as the stock, and/or b) up or down trophic levels (i.e., predators and prey of the stock)	Level 1: No apparent fishery/resource-use performance and/or behavior concerns

The scores for Environmental/ecosystem considerations are increased to a Level 2 for this assessment. We increased the score for Environmental/ecosystem considerations from Level 1 to Level 2 due to several persistent indicators that might have adverse effects on Atka mackerel, particularly with respect to competition, prey availability, and marine heat waves. A Level 2 score indicates some adverse signals, but the patterns are consistent across all indicators. The Level 2 score for Environmental/ecosystem considerations indicates that continued monitoring of indicators is crucially important, and continued process research and the development of an Ecosystem and Socioeconomic Profile (ESP) for Atka mackerel would help contextualize these indicators. **Overall, the risk table scores and supporting information do not support setting the ABC below the maximum permissible.**

ABC Recommendation

The recommended model (Model 16.0b) provides reasonable fits to the available data and previously has been selected as appropriate for providing advice on BSAI Atka mackerel catch levels. The assessment model estimates a declining trend in spawning biomass that will fall slightly below $B_{40\%}$ in 2027, and then an increase to above $B_{40\%}$ in 2028. The maximum permissible Tier 3a F_{ABC} is appropriately precautionary (for Atka mackerel). Recent fishing mortality rates have been below F_{ABC}. For perspective, a "management path" plot of the relative harvest rate ($F_t/F_{35\%}$) versus relative female spawning biomass ($B_t/B_{35\%}$) is shown in Figure 17.21. For all of the time series the current assessment estimates that relative harvest rates have been below 1.0, and the relative spawning biomass rates have been greater than 1.0.

The 2025 recommended ABC based on the Tier 3a F_{ABC} of 0.53 is 103,247 t. The 2025 OFL is 122,622 t. The recommended 2025 ABC this year is 8% higher than the 2024 ABC specified last year.

The 2026 recommended ABC associated with the Tier 3b F_{ABC} is 92,361 t and the 2026 OFL is 107,889 t. Note that these calculations assume 2025 catches were equal to 85% of the 2025 ABC.

Area Allocation of Harvests

Amendment 28 of the BSAI Fishery Management Plan divided the Aleutian subarea into 3 districts at 177° E and 177° W longitude, providing the mechanism to apportion the Aleutian Atka mackerel ABCs and TACs. Prior to 2016, the Council used a 4-survey weighted average to apportion the BSAI Atka mackerel ABC. The rationale for the weighting scheme was described in Lowe et al. (2001).

The SSC requested that the Atka mackerel assessment use the random effects (RE) model for setting subarea ABC allocations (Dec. 2015 SSC minutes). This method was applied from 2016-2017. The apportionments from the 2018 RE model reflected the large unexplained drop in the 2018 Central area survey biomass estimate relative to the 2016 Central area survey biomass estimate. The 4-survey weighted average was used in the last full assessment (Lowe and Ianelli, 2022).

For 2025 and 2026, we recommend moving away from the 4-survey weighted average and instead apportion ABCs based on the REMA model following past assessments (Figure 17.22). The REMA model is standard practice for apportionment within the NPFMC process and transitioning back to REMA will allow the authors to more easily explore new approaches in the future like incorporating fishery-dependent indices. Survey estimates have stabilized and the anomalously low survey biomass estimate in the central AI (area 542) in 2018 is no longer a concern (Table 17.9 and Figure 17.22). We continue to present both alternatives for Plan Team and SSC consideration:

Apportionment Method	Area	Proportion	2025 ABC	2026 ABC
Random effects model (recommended)	541+SBS	0.452	**46,650**	**41,731**
	542	0.257	**26,511**	**23,716**
	543	0.291	**30,087**	**26,914**
	BSAI Total		**103,247**	**92,361**
Four-survey weighted average	541+SBS	0.477	49,253	44,060
	542	0.213	21,986	19,668
	543	0.310	32,008	28,633
	BSAI Total		103,247	92,361

Ecosystem Considerations

The Aleutian Islands experienced sustained above average temperatures between 2019-2023, followed by cooling in 2024. Direct and indirect impacts of these environmental conditions on BSAI Atka mackerel are described in the Environmental and ecosystem conditions considerations section of the risk table (section titled "Should the ABC be reduced from maximum permissible?").

Ecosystem effects on BSAI Atka mackerel

Prey availability/abundance trends

Adult Atka mackerel in the Aleutians consume a variety of prey, but are primarily zooplanktivores, consuming mainly euphausiids and calanoid copepods (Yang 1996, Yang 2003). Other zooplankton prey include larvaceans, gastropods, jellyfish, pteropods, amphipods, isopods, and shrimp (Yang and Nelson 2000, Yang 2003, Yang et al. 2006). Atka mackerel also consume fish, such as sculpins, juvenile Pacific halibut, eulachon, Pacific sand lance, juvenile Kamchatka flounder, juvenile pollock, and eelpouts, in small proportions relative to zooplankton (Yang and Nelson 2000, Yang et al. 2006, Aydin et al. 2007). The proportions of these various prey groups consumed by Atka mackerel vary with year and location (Yang and Nelson 2000). Atka mackerel diet data also shows a longitudinal gradient, with euphausiids dominating diets in the east and copepods and other zooplankton dominating in the west. Greater piscivory, especially on myctophids, occurs in the island passes (Ortiz, 2007). Rand et al. (2010) found that Atka mackerel near Amchitka Island (area 542) were eating more copepods and less euphausiids, whereas fish at Seguam pass (area 541) were eating more energy rich euphausiids and forage fish.

An update of current ecosystem prey availability and foraging conditions is provided in the Environmental and ecosystem conditions considerations section of the risk table (section titled "Should the ABC be reduced from maximum permissible?").

Predator population trends

Atka mackerel are consumed by a variety of piscivores, including groundfish (e.g., Pacific cod, Pacific halibut, and arrowtooth flounder, Livingston et al. unpubl. manuscr.), marine mammals (e.g., northern fur seals and Steller sea lions, Kajimura 1984, NMFS 1995, Sinclair and Zeppelin 2002, Sinclair et al. 2013), skates, and seabirds (e.g., thick-billed murres, tufted puffins, and short-tailed shearwaters, Springer et al. 1999). For detailed information on the role of Atka mackerel in the Aleutian Island ecosystem and a comparison of how predation mortality compares to fishing mortality, please refer to the last full assessment (Lowe and Ianelli, 2022).

Changes in habitat quality

<u>Atka mackerel habitat associations</u>

From camera tow data, Atka mackerel in the Central and Eastern Aleutian Islands were found to be associated almost exclusively with coarse-grained and rocky substrates. At Seguam and Petrel, greater than 60% of substrate identified was rock (largely bedrock and boulders), while the remainder was largely gravel and cobble. At Tanaga, gravel and cobble composed 75% of all substrate. At Seguam, nearly all substrate had between 26%-75% biocover (sponges and corals). Biocover at Tanaga and Petrel ranged from nearly bare to almost 100% (McDermott et al. 2014). Impacts to these habitats could potentially affect Atka mackerel, but at this time only associations to these habitat types have been established.

<u>Climate</u>

Interestingly, strong year classes of AI Atka mackerel have occurred in years of hypothesized climate regime shifts 1977, 1988, and 1999, as indicated by indices such as the Pacific Decadal Oscillation (Francis and Hare 1994, Hare and Mantua 2000, Boldt 2005). Bailey et al. (1995) noted that some fish species show strong recruitment at the beginning of climate regime shifts and suggested that it was due to a disruption of the community structure providing a temporary release from predation and competition. It is unclear if this is the mechanism that influences Atka mackerel year class strength in the Aleutian Islands. El Niño Southern Oscillation (ENSO) events are another source of climate forcing that influences the North Pacific. Hollowed et al. (2001) found that gadids in the GOA have a higher proportion of strong year classes in ENSO years. There was, however, no relationship between strong year classes of BSAI Atka mackerel and ENSO events (Hollowed et al. 2001). The state of the North Pacific atmosphere-ocean system during 2015-2016 featured the continuance of warm sea surface temperature anomalies that became prominent late in 2013. A strong El Niño developed during winter 2015-2016 (Zador and Yasumiishi 2016). The North Pacific atmospheric-ocean climate system during fall 2017 to summer 2018 was similar to that during 2016-2017. A weak La Nina developed during winter 2017-2018 along with a weaker than normal Aleutian Low, similar to the previous year (Bond 2018).

Eddies in the Alaskan Stream south of the Aleutian Islands have been shown to influence flow into the Bering Sea through the Aleutian Passes (Okkonen, 1996). By influencing flow through the passes, eddies could impact flow in the Aleutian North Slope Current and Bering Slope Current as well as influencing the transports of heat, salt and nutrients (Mordy et al., 2005; Stabeno et al., 2005) into the Bering Sea. Particularly strong eddies were observed south of Amukta Pass in 1997, 1999, 2004, 2006/2007, 2009/2010, and summer 2012 (Ladd 2016). The 1999-2001 and the 2006 Atka mackerel year classes were strong, the 2012 year class is slightly above average. Eddy energy in the region has been low from the fall

2012 through 2018 (Ladd 2018). In early 2016, a small eddy was present in the region, resulting in slightly above average EKE (Ladd 2016). These trends indicate that higher than average volume, heat, salt, and nutrient fluxes to the Bering Sea through Amukta Pass may have occurred in 1997/1998, 1999, 2004, 2006/2007, 2009/2010, and summer 2012. These fluxes were likely smaller during the period from fall 2012 until early 2015 and may have been slightly enhanced in early 2016 (Ladd 2016). In early 2022, another strong eddy was observed in the eastern AI, but we have no information yet on how that might affect recruitment. The role of eddies in determining year class strength may be the transport of larva which hatch in the fall, and or the increase in nutrients and favorable environment conditions. Further research is needed to determine the effects of climate on growth and year class strength, and the temporal and spatial scales over which these effects occur.

Bottom temperature

The distribution of Atka mackerel spawning and nesting sites are thought to be limited by water temperature (Gorbunova 1962). Temperatures below 3 °C and above 15 °C are lethal to eggs or unfavorable for embryonic development depending on the exposure time (Gorbunova 1962). Temperatures recorded at Alaskan nesting sites, 3.9 – 10.7 ºC, do not appear to be limiting, as they were within this range (Lauth et al. 2007b). The 2000 and 2012 Aleutian Islands summer bottom temperatures indicated that these were the coldest years followed by summer bottom temperatures from the 2002 survey, which indicated the second coldest year (Figure 17.5). The 2004 AI summer bottom temperatures indicated that 2004 was an average year, while the 2006 and 2010 bottom temperatures were slightly below average. The average bottom temperatures measured in the 2014 survey were the third highest of the Aleutian surveys, significantly higher than the 2000 and 2012 surveys and very similar to the 1991 and 1997 surveys. The 2016 survey bottom temperatures were the highest in the Aleutian survey time series.

The temperature anomaly profiles from the 2016 AI survey data appear to be some of the warmest on record (Figure 17.5). These warm anomalies were also some of the most pervasive (vertically and longitudinally) recorded to date. The profiles from 2016 are similar to those of 2014 and share the characteristics of widely distributed warm surface waters along with greater thermal stratification although the 2016 anomalies are more broadly dispersed and penetrate deeper (Laman 2016). By contrast, the 2000 AI survey remains one of the coldest years in the record. The last three survey years in the AI have generally been warmer than previous years with the exception of 1997 which was comparable with the thermal anomalies observed in 2014 and 2016 (Laman 2018). The 2018 AI profile suggests a return to slightly cooler conditions relative to 2016, but is still amongst the warmer years from the records with warm anomalies penetrating deeper and distributed more extensively across the Aleutian archipelago than in 2014 (Laman 2018). These differences among survey years illustrate the highly variable and dynamic oceanographic environment found in the Aleutian archipelago. Recent phenomena of the resilient ridge of atmospheric high pressure that helped to establish the warm water "Blob" in the Northeast Pacific influenced water temperatures in the Aleutian Islands. The formation and intensification of the warm blob in 2014 and 2015 followed by the ENSO in 2015-16 almost certainly influenced the temperatures observed during the 2016 AI bottom trawl survey (Laman 2016). Phenomena like this influence both Aleutian Islands and Bering Sea ecosystems and fish populations.

Thermal regime and mixed-layer-depth differences are known to influence regional biological processes and impact fish populations. In the AI, the magnitude of primary production depends on mixed-layer-depth (Mordy et al., 2005) while ontogenesis of Atka mackerel eggs and larvae is temperature dependent (Lauth et al., 2007a). Recent studies of habitat-based definitions of essential fish habitat (EFH) in the Aleutian Islands demonstrate that water temperature can be an important determinant of EFH for many groundfish species (Laman et al. 2017). The effect of temperature on survey catchability and fish behavior is unknown, but could affect the vertical or broad scale distribution of Atka mackerel to make them less available to the trawl during cold years. It is unclear what effect the recent warm temperatures may have on Atka mackerel nesting sites that are within this depth range, or on adult fish distributions in response to water temperatures, though speculations are made in the environmental and ecosystems considerations section.

Atka mackerel fishery effects on the ecosystem

Atka mackerel fishery contribution to bycatch

The levels of bycatch in the Atka mackerel fishery of prohibited species, forage fish, Habitat Areas of Particular Concern (HAPC) biota, marine mammals, birds, and other sensitive non-target species is relatively low except for the species which are noted in Table 17.3 and discussed below.

The Atka mackerel fishery has very low bycatch levels of some species of HAPC biota, e.g. sea pens and whips. The bycatch of sponges and coral (e.g. red tree coral and other Bryozoans) in the Atka mackerel fishery is highly variable (Table 17.3). During 2023, the directed Atka mackerel fishery took 94.36 t of sponge and about 16.62 t of corals. Sponge bycatch has decreased in recent years (Table 17.3). It is unknown if the absolute levels of sponge and coral bycatch in the Atka mackerel fishery are of concern.

Fishing gear effects on spawning and nesting habitat

Bottom contact fisheries could have direct negative impacts on Atka mackerel by destroying egg nests and/or removing the males that are guarding nests (Lauth et al. 2007b); however, this has not been examined quantitatively. It was previously thought that all Atka mackerel migrated to shallow, nearshore areas for spawning and nesting sites. When nearshore bottom trawl exclusion zones near Steller sea lion rookeries were implemented this was hypothesized to eliminate much of the overlap between bottom trawl fisheries and Atka mackerel nesting areas (Fritz and Lowe 1998). Lauth et al. (2007b), however found that nesting sites in Alaska were "…widespread across the continental shelf and found over a much broader depth range…". The use of bottom contact fishing gear, such as bottom trawls, pot gear, and longline gear, utilized in July to January could, therefore, still potentially affect Atka mackerel nesting areas, despite trawl closures in nearshore areas around Steller sea lion rookeries.

Management measures for the Atka mackerel fishery have an impact on the fishery interactions with Steller sea lions and on Atka mackerel habitat. Substantial parts of the Aleutian Islands were closed to trawling for Atka mackerel and Pacific cod (the predominant target species) as well as longlining for Pacific cod in early 2011 as part of mitigation measures for Steller sea lions. Management area 543 and large sections of 542 were included in this closure. The western and central Aleutian Islands were subsequently reopened to trawling in 2015.

Observed fishing effort is used as an indicator of total fishing effort (Olson 2015), and can be used as an indicator of potential habitat disturbance. For the period 2005-2014 there were 23,499 observed bottom trawl tows in the Aleutian Islands (Olson 2015). During 2014, the amount of observed bottom trawl effort was 1,789 tows, which is almost 24 percent below average for the 10-year period. It represents a decrease over 2013. Patterns of high and low fishing effort are dispersed throughout the Aleutian Islands. The primary catches in these areas are Pacific cod, Pacific ocean perch, and Atka mackerel. In 2014, areas of anomalous fishing effort were minimal but scattered throughout the region, with higher than average observed effort east of Agattu Island and on Petrel Bank. Some areas that were closed in 2011 due to Steller sea lion management measures were reopened to varying degrees in 2015. In 2006, the Aleutian Islands Habitat Conservation Area (AIHCA) closed approximately 279,114 nm^2 to bottom trawl fishing in the three AI management areas (Olson 2015). Changes in management regulations and the amount of Atka mackerel fishing effort is likely to have ecosystem impacts.

NMFS has conducted ongoing tagging studies to determine the efficacy of trawl exclusion zones as a fishery-Steller sea lion management tool and to determine the local movement rates and abundance of Atka mackerel. A comprehensive report funded through the North Pacific Fishery Research Board

(NPRB) that examined local scale fishery interactions of Atka mackerel and Steller sea lions in areas 541 and 543, will be forthcoming in 2018.

Indirect effects of bottom contact fishing gear, such as effects on fish habitat, may also have implications for Atka mackerel. Living substrate that is susceptible to fishing gear includes sponges, sea pens, sea anemones, ascidians, and bryozoans (Malecha et al. 2005). Of these, Atka mackerel sampled in the NMFS bottom trawl survey are primarily associated with emergent epifauna such as sponges and corals (Malecha et al. 2005, Stone 2006). Effects of fishing gear on these living substrates could, in turn, affect fish species that are associated with them. Bycatch of coral, sponge, and other nontarget species are detailed in Table 17.3.

Concentration of Atka mackerel catches in time and space

Analyses of historic fishery CPUE revealed that the fishery may create temporary localized depletions of Atka mackerel, and historic fishery harvest rates in localized areas may have been high enough to affect prey availability of Steller sea lions (Section 12.2.2 of Lowe and Fritz 1997). The localized pattern of fishing for Atka mackerel could have created temporary reductions in the size and density of localized Atka mackerel populations which may have affected Steller sea lion foraging success during the time the fishery was operating and for a period of unknown duration after the fishery closed. As a precautionary measure, the NPFMC passed regulations in 1998 and 2001 (described above) to disperse fishing effort temporally and spatially as well as reduce effort within Steller sea lion critical habitat.

Steller sea lion protection measures have spread out Atka mackerel harvests in time and space through the implementation of seasonal and area-specific TACs and harvest limits within sea lion critical habitat. Most recently, RPAs from the 2010 Biological Opinion closed the entire Western Aleutians (Area 543) to directed fishing for Atka mackerel, and several closures were implemented in critical habitat in the Central Aleutians (Area 542) and the TAC for Area 542 was reduced to no more than 47 percent of the Area 543 ABC. These measures were in place from 2011 to 2014. Revised RPAs were implemented in 2015. For the 2015 fishery, the Area 543 Atka mackerel TAC was set to less than or equal to 65 percent of the Area 543 ABC. In Area 542, there are expanded area closures and no requirement for a TAC reduction. Concentration of catches in time and space is still an issue of possible concern and research efforts continue to monitor and assess the availability of Atka mackerel biomass in areas of concern. Also, in some cases the sea lion protection measures have forced the fishery to concentrate in areas outside of critical habitat that had previously experienced lower levels of exploitation. The impact of the fishery in these areas outside of critical habitat is unknown.

Atka mackerel fishery effects on amount of large size Atka mackerel

The numbers of large size Atka mackerel are largely impacted by highly variable year class strength rather than by the directed fishery. Year to year differences are attributed to natural fluctuations.

Atka mackerel fishery effects on Atka mackerel age-at-maturity and fecundity

The effects of the fishery on the age-at-maturity and fecundity of Atka mackerel are unknown. Studies were conducted to determine age-at-maturity (McDermott and Lowe 1997, Cooper et al. 2010) and fecundity (McDermott 2003, McDermott et al. 2007) of Atka mackerel. These are recent studies and there are no earlier studies for comparison on fish from an unexploited population. Further studies would be needed to determine if there have been changes over time and whether changes could be attributed to the fishery.

Atka mackerel fishery contribution to discards and offal production

There is no time series of the offal production from the Atka mackerel fishery. Most of the Atka mackerel fishery discards in the Atka mackerel fishery are small fish. Discards of Atka mackerel in the Atka mackerel fishery are detailed in Tables 17.5 and 17.6.

Data Gaps and Research Priorities

The Atka mackerel assessment is currently transitioning lead authors. There will likely be a CIE review in 2026. In preparation for this CIE, we will likely be focusing on the fits to the survey age composition data (potentially through a time block on survey selectivity) and improving our understanding of how adding new data changes estimates of fishery selectivity and fishing mortality. Near term priorities also include continuing to update the reproducibility of the code and project workflow for the stock assessment, updating the input sample sizes using AFSC standard practices (afscISS and sampler R libraries), development of an Environmental and Ecosystem Profile (ESP) for Atka mackerel, and migration of the current assessment to Template Model Builder (TMB) or RTMB.

Acknowledgements

The new lead author would like to acknowledge and thank Sandra Lowe for her many years as the Atka mackerel stock assessment lead and mentorship during this authorship transition. Sandra has a wealth of knowledge and shares it generously.

Thank you to Ivonne Ortiz (AFSC) for her help in developing the risk table and providing environmental/ecosystem considerations for the assessment. Thank you to Steve Barbeaux (AFSC) for providing Figure 17.1 of the fishery catch maps, and Margaret Siple (AFSC) for providing Figure 17.4 of the survey CPUE maps. Thank you to GAP scientists, especially Zack Oyafuso and Emily Markowitz, for their work in 2023 and 2024 improving the database structures and assisting stock assessment authors with the transition.

The authors thank the AFSC Groundfish Assessment Program (GAP) survey scientists for the collection of data and providing the biomass estimates. We are especially grateful to all the fishery observers working with the Fishery Monitoring and Analysis (FMA) Division who collect vital data for the stock assessments. We also thank the staff of the AFSC Age and Growth Unit for the ageing of otoliths used to determine the age compositions in the assessment.

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Tables

Table 17.1. Time series of Bering Sea/Aleutian Islands Atka mackerel catches (including discards and CDQ catches), corresponding Acceptable Biological Catches (ABC), Total Allowable Catches (TAC), and Overfishing Levels (OFL) set by the North Pacific Fishery Management Council from 1978 to the present. Catches, ABCs, TACs, and OFLs are in metric tons.

Year	Catch	ABC	TAC	OFL
1977	21,763	a	a	
1978	24,249	24,800	24,800	
1979	23,264	24,800	24,800	
1980	20,488	24,800	24,800	
1981	19,688	24,800	24,800	
1982	19,874	24,800	24,800	
1983	11,726	25,500	24,800	
1984	36,055	25,500	35,000	
1985	37,860	37,700	37,700	
1986	31,990	30,800	30,800	
1987	30,061	30,800	30,800	
1988	22,084	21,000	21,000	
1989	17,994	24,000	20,285	
1990	22,206	24,000	21,000	
1991	26,626	24,000	24,000	
1992	48,532	43,000	43,000	435,000
1993	66,006	117,100	32,000	771,100
1994	65,360	122,500	68,000	484,000
1995	81,554	125,000	80,000	335,000
1996	103,942	116,000	106,157	164,000
1997	65,842	66,700	66,700	81,600
1998	57,097	64,300	64,300	134,000
1999	56,237	73,300	66,400	148,000

a) Atka mackerel was not a reported species group until 1978.

b) 2024 catch updated through October 5, 2024. Projected total year catch is assumed equal to the 2024 TAC of 72,987 t.

Sources: compiled from NMFS Regional Office web site and various NPFMC reports.

Table 17.1.cont. Time series of Bering Sea/Aleutian Islands Atka mackerel catches (including discards and CDQ catches), corresponding Acceptable Biological Catches (ABC), Total Allowable Catches (TAC), and Overfishing Levels (OFL) set by the North Pacific Fishery Management Council from 1978 to the present. Catches, ABCs, TACs, and OFLs are in metric tons.

Year	Catch	ABC	TAC	OFL
2000	47,230	70,800	70,800	119,000
2001	61,563	69,300	69,300	138,000
2002	45,288	49,000	49,000	82,300
2003	58,060	63,000	60,000	99,700
2004	60,563	66,700	63,000	78,500
2005	62,014	124,000	63,000	147,000
2006	61,883	110,000	63,000	130,000
2007	58,747	74,000	63,000	86,900
2008	58,082	60,700	60,700	71,400
2009	72,807	83,800	76,400	99,400
2010	68,647	74,000	74,000	88,200
2011	51,822	85,300	53,080	101,000
2012	47,829	81,400	50,763	96,500
2013	23,181	50,000	25,920	57,700
2014	30,951	64,131	32,322	74,492
2015	53,277	106,000	54,500	125,297
2016	54,485	90,340	55,000	104,749
2017	64,446	87,200	65,000	107,200
2018	70,387	92,000	71,000	108,600
2019	57,471	68,500	57,951	79,200
2020	58,884	70,100	59,305	81,200
2021	61,354	73,590	62,257	85,580
2022	58,107	78,510	66,481	98,870
2023	66,613	98,588	69,282	118,787
2024[b]	64,439	95,358	72,987	111,684

a) Atka mackerel was not a reported species group until 1978.
b) 2024 catch updated through October 5, 2024. Projected total year catch is assumed equal to the 2024 TAC of 72,987 t.

Sources: compiled from NMFS Regional Office web site and various NPFMC reports.

Table 17.2. Time series of Bering Sea/Aleutian Islands Atka mackerel catches (including discards and CDQ catches) by region, corresponding Acceptable Biological Catches (ABC), and Total Allowable Catches (TAC) set by the North Pacific Fishery Management Council from 1995 to the present. Apportioned catches prior to 2015 are available in Lowe *et al*. 2018. Catches, ABCs, and TACs are in metric tons.

Year	Name	BS/EAI	CAI	WAI	Total
2015	ABC	38,492	33,108	34,400	106,000
	TAC	27,000	17,000	10,500	54,500
	Catch	26,351	16,672	10,253	53,277
2016	ABC	30,832	27,216	32,292	90,340
	TAC	28,500	16,000	10,500	55,000
	Catch	28,360	15,795	10,330	54,485
2017	ABC	34,890	30,330	21,980	87,200
	TAC	34,500	18,000	12,500	65,000
	Catch	34,264	17,748	12,433	64,446
2018	ABC	36,820	32,000	23,180	92,000
	TAC	36,500	21,000	13,500	71,000
	Catch	36,079	20,889	13,419	70,387
2019	ABC	23,970	14,390	30,140	68,500
	TAC	23,970	14,390	19,591	57,951
	Catch	23,709	14,320	19,441	57,471
2020	ABC	24,535	14,721	30,844	70,100
	TAC	24,535	14,721	20,049	59,305
	Catch	24,291	14,596	19,997	58,884
2021	ABC	25,760	15,450	32,380	73,590
	TAC	25,760	15,450	21,047	62,257
	Catch	25,183	15,308	20,863	61,354
2022	ABC	27,260	16,880	34,370	78,510
	TAC	27,260	16,880	22,341	66,481
	Catch	19,138	16,761	22,208	58,107
2023	ABC	43,281	17,351	37,956	98,588
	TAC	27,260	17,351	24,671	69,282
	Catch	24,862	17,210	24,541	66,613
2024[a]	ABC	41,723	16,754	36,882	95,358
	TAC	32,260	16,754	23,973	72,987
	Catch	28,250	14,917	21,272	64,439

a) 2024 catch updated through October 5, 2024. Projected total year catch is assumed equal to the 2024 TAC of 72,987 t.

Sources: compiled from NMFS Regional Office web site and various NPFMC reports.

Table 17.3. Incidental catch of FMP species (upper table) and non-target species (bottom table) in the directed Atka mackerel fishery, 2015-2023. All catch is in metric tons except seabirds, which are counts. Species are listed in descending order based on cumulative catch during the period. Seabird catches, which have been aggregated due to confidentiality reasons, include Northern Fulmars, Shearwaters, Auklets, and Storm Petrels.

Management species/species group	2015	2016	2017	2018	2019	2020	2021	2022	2023
Pacific Ocean Perch	5,112	7,763	6,945	9,140	6,871	6,977	7,816	8,519	7,866
Northern Rockfish	4,118	2,941	3,071	3,865	4,361	4,682	3,858	4,502	5,002
Pacific Cod	2,277	2,512	3,940	3,361	2,226	2,202	1,965	2,486	2,350
Pollock	165	451	506	910	589	521	457	1,453	1,793
BSAI Skate	495	662	719	863	491	487	400	383	354
Other Rockfish	240	313	385	598	320	357	394	439	352
BSAI Kamchatka Flounder	280	400	389	442	429	188	251	228	124
Sculpin	380	304	477	386	341	308	0	0	0
Arrowtooth Flounder	110	223	132	353	98	181	225	229	218
Sablefish	3	13	56	101	42	56	241	221	209
Rougheye Rockfish	33	35	38	79	76	98	144	133	167
Rock Sole	52	57	72	105	77	67	65	101	75
Greenland Turbot	25	46	45	28	49	19	57	24	3
BSAI Shortraker Rockfish	9	13	14	25	18	38	28	33	29
BSAI Other Flatfish	11	9	11	11	10	13	39	23	19
Flathead Sole	5	8	5	4	6	5	7	9	8
Squid	13	16	12	6	0	0	0	0	0
Shark	conf.	2	2	3	1	conf.	5	6	3
Octopus	1	1	0	1	0	0	1	2	2
Yellowfin Sole	conf.	0	1	0	conf.	conf.	0	1	5

Nontarget Species Group	2015	2016	2017	2018	2019	2020	2021	2022	2023
Grenadiers	44.51	96.96	59.70	64.86	106.78	68.56	88.22	37.24	45.36
Misc fish	117.67	123.06	185.86	177.53	115.32	119.24	118.09	111.17	122.02
Sponge	116.75	75.59	150.25	153.48	173.00	110.54	81.71	80.80	94.36
Red Tree Coral & Other Bryozoans	14.54	6.88	9.61	15.47	13.46	7.99	6.36	8.69	16.62
Urchins/Dollars/Cucumbers/Sea Stars	14.01	10.44	18.29	29.25	30.61	14.35	11.22	17.76	17.95
Other Misc fish	1.59	1.98	2.55	3.99	2.16	4.32	4.53	8.79	6.65
Anemones	1.49	1.44	2.02	1.47	1.53	0.91	1.84	2.10	0.52
Snails	0.70	0.34	0.47	0.84	1.12	1.32	1.03	1.08	4.77
Scypho jellies	0.59	1.28	0.42	15.28	9.48	3.88	3.28	3.84	5.66
Misc invertebrates	conf.	6.91	0.09	0.72	4.70	4.46	38.42	0.88	10.45
Pandalid shrimp	0.11	0.22	0.22	0.21	0.16	0.14	0.26	0.18	0.21
Misc crabs	2.60	0.16	0.24	0.40	0.29	0.43	0.50	0.34	0.40
Tunicate	0.42	0.20	0.57	3.71	1.86	4.15	0.34	2.67	1.71
Bivalves	0.14	0.11	0.11	0.07	0.15	0.08	0.13	0.11	0.06
Hermit crabs	0.12	0.04	0.03	0.03	0.02	0.05	0.02	0.14	0.03
Misc crustaceans	0.09	0.23	0.12	0.27	0.03	0.05	0.04	0.27	0.19
Sea pens whips	0.01	0.02	0.00	conf.	0.06	0.06	0.04	0.01	0.02
Squid	0.00	0.00	0.00	0.00	8.78	8.45	15.83	17.09	14.02
Sculpins	0.00	0.00	0.00	0.00	0.00	0.00	328.70	376.18	555.13
Seabirds	conf.	conf.	conf.	553	891	conf.	1,000	323	602

Table 17.4. Prohibited species catch in the Atka mackerel fishery, 2015-2023. Estimates are reported in metric tons for halibut and herring, and counts of fish for crab and salmon.

Species group name	2015	2016	2017	2018	2019	2020	2021	2022	2023
Bairdi Tanner Crab	254	0	44	0	0	0	0	0	7
Blue King Crab	0	0	0	0	0	0	0	0	0
Chinook Salmon	136	535	1,109	652	532	680	354	1,192	699
Golden (Brown) King Crab	1,321	2,898	1,409	7,074	14,236	2,107	4,012	1,727	3,660
Halibut	126	121	171	203	111	69	86	144	128
Herring	0	0	0	0	0	0	0	0	0
Non-Chinook Salmon	1,687	1,162	1,611	1,507	3,640	1,194	1,512	1,255	2,860
Opilio Tanner (Snow) Crab	38	0	0	0	40	9	0	0	0
Red King Crab	4,956	348	239	239	149	131	0	0	0
Total Halibut and Herring (t)	126	121	171	203	111	69	86	144	128
Total Numbers of Crab and Salmon	8,391	4,943	4,412	9,472	18,598	4,121	5,877	4,174	7,225

Table 17.5. Estimated discarded, retained, and total catch of Atka mackerel with associated discard rates in the directed Atka mackerel fishery and all other target fisheries.

Year	Target Fishery	Discarded	Retained	Total Catch	Discard Rate
2003	Atka Mackerel	9,126	42,519	51,646	18%
2003	Other	3,934	2,481	6,414	61%
2004	Atka Mackerel	6,994	46,471	53,466	13%
2004	Other	4,880	2,218	7,098	69%
2005	Atka Mackerel	2,617	56,451	59,068	4%
2005	Other	1,394	1,551	2,945	47%
2006	Atka Mackerel	1,793	57,815	59,608	3%
2006	Other	1,240	1,035	2,275	55%
2007	Atka Mackerel	1,730	55,563	57,293	3%
2007	Other	324	1,130	1,454	22%
2008	Atka Mackerel	1,091	54,023	55,114	2%
2008	Other	158	2,810	2,969	5%
2009	Atka Mackerel	2,620	67,271	69,891	4%
2009	Other	326	2,590	2,916	11%
2010	Atka Mackerel	3,880	63,191	67,071	6%
2010	Other	101	1,475	1,576	6%
2011	Atka Mackerel	1,191	47,529	48,721	2%
2011	Other	581	2,521	3,102	19%
2012	Atka Mackerel	929	44,100	45,030	2%
2012	Other	410	2,389	2,799	15%
2013	Atka Mackerel	448	19,387	19,835	2%
2013	Other	245	3,101	3,346	7%
2014	Atka Mackerel	113	28,053	28,166	0%
2014	Other	274	2,511	2,785	10%
2015	Atka Mackerel	555	46,979	47,533	1%
2015	Other	245	5,499	5,743	4%
2016	Atka Mackerel	285	48,082	48,367	1%
2016	Other	142	5,976	6,118	2%
2017	Atka Mackerel	309	58,390	58,699	1%
2017	Other	82	5,665	5,747	1%
2018	Atka Mackerel	497	63,573	64,070	1%
2018	Other	188	6,129	6,317	3%
2019	Atka Mackerel	417	47,833	48,250	1%
2019	Other	190	9,030	9,220	2%
2020	Atka Mackerel	425	49,235	49,660	1%
2020	Other	277	8,947	9,224	3%
2021	Atka Mackerel	452	53,288	53,740	1%
2021	Other	254	7,359	7,613	3%
2022	Atka Mackerel	511	50,964	51,475	1%
2022	Other	177	6,455	6,632	3%
2023	Atka Mackerel	825	56,222	57,047	1%
2023	Other	206	9,360	9,566	2%

Table 17.6. Estimated discarded and total catch of Atka mackerel with associated discard rates in all BSAI fisheries by management area (541=eastern Aleutians, 542=central Aleutians, 543=western Aleutians, and SBS=Southern Bering Sea).

Year	Variable	541	542	543	SBS
2003	Discarded catch	703	4,839	4,099	3,419
	Total catch	6,336	27,564	19,088	5,072
	Discard rate	11%	18%	21%	67%
2004	Discarded catch	520	3,615	3,021	4,717
	Total catch	3,681	30,176	19,547	7,159
	Discard rate	14%	12%	15%	66%
2005	Discarded catch	305	1,496	867	1,344
	Total catch	3,661	35,516	19,297	3,540
	Discard rate	8%	4%	4%	38%
2006	Discarded catch	232	1,391	261	1,149
	Total catch	4,246	39,921	14,553	3,164
	Discard rate	5%	3%	2%	36%
2007	Discarded catch	169	1,260	238	386
	Total catch	19,922	26,941	8,880	3,005
	Discard rate	1%	5%	3%	13%
2008	Discarded catch	18	746	395	89
	Total catch	18,719	22,926	16,045	392
	Discard rate	0%	3%	2%	23%
2009	Discarded catch	439	1,722	740	45
	Total catch	26,173	30,137	16,253	244
	Discard rate	2%	6%	5%	18%
2010	Discarded catch	384	2,354	1,195	48
	Total catch	23,458	26,389	18,650	151
	Discard rate	2%	9%	6%	32%
2011	Discarded catch	467	886	205	214
	Total catch	39,681	10,714	205	1,222
	Discard rate	1%	8%	100%	18%
2012	Discarded catch	308	723	195	113
	Total catch	36,345	10,323	195	966
	Discard rate	1%	7%	100%	12%
2013	Discarded catch	149	416	119	9
	Total catch	15,630	7,284	120	147
	Discard rate	1%	6%	99%	6%
2014	Discarded catch	43	86	240	18
	Total catch	21,054	9,520	242	136
	Discard rate	0%	1%	99%	14%
2015	Discarded catch	182	391	98	128
	Total catch	26,078	16,672	10,253	273
	Discard rate	1%	2%	1%	47%
2016	Discarded catch	115	143	65	103
	Total catch	28,000	15,795	10,330	359
	Discard rate	0%	1%	1%	29%
2017	Discarded catch	129	130	109	23
	Total catch	33,946	17,748	12,433	318
	Discard rate	0%	1%	1%	7%
2018	Discarded catch	294	146	132	114
	Total catch	34,940	20,889	13,419	1,139
	Discard rate	1%	1%	1%	10%
2019	Discarded catch	134	139	236	99
	Total catch	22,534	14,320	19,441	1,175

Year	Variable	541	542	543	SBS
	Discard rate	1%	1%	1%	8%
2020	Discarded catch	214	115	185	188
	Total catch	23,227	14,596	19,997	1,064
	Discard rate	1%	1%	1%	18%
2021	Discarded catch	222	109	249	127
	Total catch	23,940	15,308	20,863	1,242
	Discard rate	1%	1%	1%	10%
2022	Discarded catch	155	164	273	96
	Total catch	16,469	16,761	22,208	2,669
	Discard rate	1%	1%	1%	4%
2023	Discarded catch	210	366	333	122
	Total catch	22,581	17,210	24,541	2,281
	Discard rate	1%	2%	1%	5%

Table 17.7. Numbers of Atka mackerel length-weight data, length frequency, and aged samples based on NMFS observer data 1990-2023.

Year	Number of length-weight samples	Length frequency records	Number of aged samples
1990	731	8,618	718
1991	356	7,423	349
1992	90	13,532	86
1993	58	12,476	58
1994	913	13,384	837
1995	1,054	19,653	972
1996	1,039	24,758	680
1997	126	13,412	123
1998	733	15,060	705
1999	1,633	12,349	1,444
2000	2,697	9,207	1,659
2001	3,332	11,600	935
2002	3,135	12,418	820
2003	4,083	13,740	1,008
2004	4,205	14,239	870
2005	4,494	13,142	1,024
2006	4,194	13,598	980
2007	2,100	11,841	884
2008	1,882	19,831	922
2009	2,374	15,207	971
2010	2,462	16,347	879
2011	1,976	11,814	720
2012	1,495	13,794	1,012
2013	1,178	13,327	642
2014	1,301	14,210	1,061
2015	2,493	15,959	1,687
2016	2,819	29,095	1,868
2017	4,921	26,472	1,318
2018	3,745	63,084	1,581
2019	2,699	47,745	1,510
2020	2,797	51,285	2,111
2021	1,205	54,961	1,204
2022	2,598	50,001	1,026
2023	2,556	52,396	997

Table 17.8. Estimated catch-in-numbers at age (in millions) of Atka mackerel from the BSAI region, 1977-2023. These data were used in fitting the age-structured model.

Age	2	3	4	5	6	7	8	9	10	11+
1977	6.83	31.52	20.06	15.11	1.22	0.39	0.2	---	---	---
1978	2.7	60.16	15.57	9.22	3.75	0.59	0.34	0.11	---	---
1979	0.01	4.48	26.78	13	2.2	1.11	---	---	---	---
1980	---	12.68	5.92	7.22	1.67	0.59	0.24	0.13	---	---
1981	---	5.39	17.11	0	1.61	8.1	---	---	---	---
1982	---	0.19	2.63	25.83	3.86	0.68	---	---	---	---
1983	---	1.9	1.43	2.54	10.6	1.59	---	---	---	---
1984	0.09	0.98	7.3	7.07	10.79	21.78	2.21	0.96	---	---
1985	0.63	15.97	8.79	9.43	6.01	5.45	11.69	1.26	0.27	---
1986	0.37	11.45	6.46	4.42	5.34	4.53	5.84	9.91	1.04	0.85
1987	0.56	10.44	7.6	4.58	1.89	2.37	2.19	1.71	6.78	0.75
1988	0.4	9.97	22.49	6.15	1.8	1.54	0.63	0.96	0.2	0.48
1989[a]										
1990	1.74	7.62	13.15	4.78	1.77	0.81	0.11	0.09	0.03	0.17
1991	0	4.15	6.49	7.78	5.71	3.94	1.04	0.18	0.35	0.22
1992	0	0.93	20.82	2.97	1.4	0.62	0	0	0	0
1993	0	13.55	18.33	38.88	12.16	6.76	4.17	0.61	0.59	0
1994	0.05	9.16	6.83	23.13	36	4.64	8.21	5.27	3.04	0.61
1995	0.13	20.65	33.67	9.81	18.78	33.09	4.01	5.84	7.9	2.98
1996	0.02	3.65	63.55	21.94	14.14	19.44	31.59	2.85	3.37	2.53
1997	0	17.11	4.66	66.28	3.72	1.56	0.67	3.56	0.36	0
1998	0	11.15	15.73	15.24	25.07	11.21	4.02	3.55	5.28	1.85
1999	1.17	1.08	38.31	8.85	7.09	9.93	5.24	1.8	1.49	1.79
2000	0.54	8.91	6.4	26.59	7.53	4.33	8.33	1.93	0.78	1.01
2001	1.87	20.59	13.57	8.68	27.2	8.16	4.6	3.86	0.78	0.5
2002	1.94	22.68	25.37	7.88	3.89	16.2	3.23	1.56	1.67	0.53
2003	0.78	19.96	49.54	20.63	5.95	3.27	7.02	0.78	0.49	0.85
2004	0.09	20.44	31.49	44.2	12.32	2.4	1.56	2.21	0	0.39
2005	1.43	3.96	35.31	27.23	28.97	9.68	1.54	0.25	0.85	0
2006	3.56	16.74	5.66	33.56	20.27	22.62	4.12	0.56	0.36	0.26
2007	2.25	19.63	11.63	5.39	19.94	15.9	12.46	2.69	0.77	0.08
2008	5.49	13.29	16.9	7.61	6.29	20.04	10.53	11.63	1.64	0.54
2009	4.69	31.92	15.73	20	8.81	8.56	16.59	8.24	8.71	1.79
2010	1.67	19	47.22	13.06	13.59	6.46	3.82	7.9	4.66	1.75
2011	1.05	3.02	17.61	22.41	6.68	4.89	1.16	2.73	4.44	4.82
2012	0.18	7.41	3.54	21.16	20.78	5.69	3.21	2.69	2.36	9.96
2013	1.56	7.42	19.99	4.59	14.75	11.71	2.52	1.32	0.85	3.44
2014	0.48	23.5	2.71	8.1	2.87	4.02	2.86	0.44	0.59	1.27
2015	0.58	16.21	13.06	10.55	13.24	6.86	14.11	7.73	1.98	1.42
2016	0.12	8.3	28.76	10.13	8.66	9.81	4.69	8.43	3.59	0.74
2017	1.01	2.05	21.83	29.96	11.81	10.18	5.27	3.45	3.45	3.69
2018	0.67	10.84	3.81	28.18	31.16	8.74	6.4	4.2	1.78	2.3
2019	1.3	3.42	13.9	6.6	19.32	20.23	6.08	3.03	1.89	1.2
2020	0.72	13.5	10.08	13.43	6.41	14.5	15.14	4.09	2	1.28
2021	0.61	6.73	24	11.65	10.99	4.96	10.53	9.64	2.21	1.15
2022	0.73	22.62	11.57	13.56	7.33	6.52	2.94	5.82	3.27	1.37
2023	5.55	14.97	37.2	10.71	12.05	4.55	4.34	2.17	3.45	1.83

[a] Too few fish were sampled for age structures in 1989 to construct an age-length key.

Table 17.9 Aleutian Islands Atka mackerel design-based estimates of survey biomass with coefficients of variation (*CV*) and number of hauls by area.

Year	Quantity	WAI	CAI	EAI	SBS	Total
1991	*Biomass (t)*	343,426	287,593	77,218	61	708,299
1994		327,242	83,784	208,379	66,603	686,007
1997		134,367	186,813	45,137	95,680	461,997
2000		179,680	330,255	919	2,044	512,897
2002		253,671	331,824	190,817	59,883	836,195
2004		376,414	269,071	244,043	267,556	1,157,084
2006		101,098	278,036	350,206	12,308	741,648
2010		255,419	198,874	372,429	103,529	930,251
2012		133,588	109,130	33,149	1,009	276,876
2014		215,235	204,868	302,383	1,443	723,928
2016		156,433	133,022	158,525	186	448,166
2018		134,766	26,615	168,188	25,645	355,213
2022		212,694	107,714	351,139	716	672,263
2024		151,374	163,575	113,577	146,244	574,769
1991	*CV*	18%	17%	83%	37%	14%
1994		57%	48%	44%	99%	32%
1997		56%	36%	68%	99%	31%
2000		51%	34%	74%	88%	28%
2002		32%	24%	58%	99%	20%
2004		24%	35%	33%	43%	17%
2006		35%	24%	55%	44%	28%
2010		58%	28%	74%	86%	35%
2012		28%	27%	46%	77%	18%
2014		29%	50%	43%	73%	24%
2016		56%	54%	50%	39%	31%
2018		34%	29%	57%	70%	30%
2022		31%	50%	59%	55%	33%
2024		30%	24%	43%	81%	25%
1991	*Number of hauls*	56	91	129	55	331
1994		69	114	133	64	380
1997		92	116	136	52	396
2000		113	110	138	58	419
2002		107	114	132	61	414
2004		124	130	112	53	419
2006		112	110	91	44	357
2010		118	128	121	51	418
2012		120	113	132	55	420
2014		134	110	122	44	410
2016		135	114	127	43	419
2018		129	120	126	45	420
2022		108	112	131	47	398
2024		88	80	104	35	307

Table 17.10. Estimated survey numbers-at-age (in millions) of Atka mackerel from the Aleutian Islands trawl surveys and numbers of Atka mackerel otoliths aged (*n*).

Year	*n*	1	2	3	4	5	6	7	8	9	10	11+
1991	270	0.00	60.37	859.18	100.70	244.80	87.15	109.84	22.13	10.06	0.03	0.00
1994	665	0.00	15.96	180.96	112.99	190.97	198.28	53.07	66.34	22.64	30.61	4.70
1997	384	0.00	20.72	199.82	112.30	115.49	49.27	21.27	29.37	40.27	3.50	15.50
2000	827	0.00	178.97	69.30	25.01	223.78	65.57	72.02	119.05	39.88	16.81	26.17
2002	724	0.01	77.54	953.54	521.14	89.56	23.47	82.29	35.93	12.46	13.99	1.75
2004	596	0.00	59.67	655.12	520.74	582.38	146.87	42.76	64.47	40.89	13.68	21.01
2006	524	0.00	52.12	128.21	65.20	221.31	250.42	325.00	121.51	18.58	0.00	14.87
2010	560	0.00	45.46	394.91	398.12	79.62	84.08	35.29	39.77	93.11	74.30	122.40
2012	415	0.00	43.57	127.73	52.77	130.85	76.67	15.74	13.63	8.64	5.22	23.83
2014	478	0.02	110.17	153.12	152.92	131.76	86.10	171.37	147.91	36.42	22.97	70.13
2016	300	0.00	33.90	233.00	247.39	67.16	51.87	52.34	18.47	37.92	52.14	22.50
2018	1,052	0.00	22.10	74.90	16.39	82.95	108.50	54.91	29.67	44.69	11.26	31.43
2022	1,061	0.02	4.23	211.86	87.95	100.88	94.47	93.05	52.12	91.64	75.29	33.79

Table 17.11. Year-specific survey and the population weight-at-age (kg) values used to obtain expected survey catch biomass and population biomass. The population weight-at-age values are equal to the average of the most recent three surveys with age data (2016, 2018, and 2022).

Year	1	2	3	4	5	6	7	8	9	10	11+
1991	0.045	0.185	0.449	0.637	0.652	0.751	0.811	0.693	1.053	1.764	1.011
1994	0.045	0.177	0.450	0.653	0.738	0.846	0.941	0.988	0.906	0.907	0.885
1997	0.045	0.191	0.486	0.686	0.753	0.805	0.887	0.970	0.919	1.375	0.988
2000	0.045	0.130	0.387	0.623	0.699	0.730	0.789	0.810	0.792	0.864	1.031
2002	0.045	0.139	0.342	0.615	0.720	0.837	0.877	0.773	0.897	0.955	1.126
2004	0.045	0.138	0.333	0.497	0.609	0.739	0.816	0.956	0.928	0.745	0.968
2006	0.045	0.158	0.332	0.523	0.516	0.675	0.764	0.719	0.855	1.653	0.991
2010	0.045	0.161	0.369	0.633	0.667	0.744	0.974	1.075	0.981	1.041	1.244
2012	0.045	0.161	0.360	0.517	0.627	0.705	0.762	0.820	0.863	0.809	0.949
2014	0.045	0.162	0.465	0.524	0.662	0.709	0.856	0.951	0.920	0.808	1.017
2016	0.045	0.189	0.370	0.480	0.696	0.744	0.759	0.892	0.910	0.917	0.887
2018	0.069	0.161	0.481	0.593	0.751	0.771	0.891	0.896	0.971	0.973	0.981
2022	0.053	0.157	0.455	0.635	0.718	0.673	0.727	0.783	0.830	0.845	0.722
2024	0.053	0.157	0.455	0.635	0.718	0.673	0.727	0.783	0.830	0.845	0.722
Population WAA	0.058	0.158	0.464	0.621	0.729	0.706	0.781	0.821	0.877	0.888	0.809

Table 17.12. Year-specific fishery weight-at-age (kg) values used to obtain expected fishery catch biomass. The 2024 fishery weight-at-age and projection period weight-at-age for the fishery is assumed to be the average of the last three years with available age data (2021-2023). The break between 1998 and 1999 denotes the shift from the foreign to domestic fishery.

Year	1	2	3	4	5	6	7	8	9	10	11+
1977	0.069	0.132	0.225	0.306	0.400	0.470	0.507	0.379	0.780	0.976	1.072
1978	0.069	0.072	0.225	0.300	0.348	0.388	0.397	0.371	0.423	0.976	1.072
1979	0.069	0.496	0.319	0.457	0.476	0.475	0.468	0.546	0.780	0.976	1.072
1980	0.069	0.365	0.317	0.450	0.520	0.585	0.630	0.546	0.780	0.976	1.072
1981	0.069	0.365	0.317	0.450	0.520	0.585	0.630	0.546	0.780	0.976	1.072
1982	0.069	0.365	0.273	0.443	0.564	0.695	0.795	0.546	0.780	0.976	1.072
1983	0.069	0.365	0.359	0.499	0.601	0.686	0.810	0.546	0.780	0.976	1.072
1984	0.069	0.297	0.410	0.617	0.707	0.777	0.802	0.890	0.910	0.976	1.072
1985	0.069	0.302	0.452	0.552	0.682	0.737	0.775	0.807	1.007	1.011	1.072
1986	0.069	0.146	0.334	0.528	0.546	0.786	0.753	0.829	0.858	0.954	1.052
1987	0.069	0.265	0.435	0.729	0.908	0.859	0.964	1.023	1.054	1.088	1.098
1988	0.069	0.196	0.351	0.470	0.564	0.624	0.694	0.783	0.818	0.850	1.064
1989	0.069	0.295	0.440	0.577	0.739	0.838	0.664	0.817	0.906	1.010	1.065
1990	0.069	0.362	0.511	0.728	0.877	0.885	0.985	1.386	1.039	1.445	1.442
1991	0.069	0.230	0.207	0.540	0.729	0.685	0.655	0.755	1.014	0.743	1.021
1992	0.069	0.230	0.390	0.607	0.715	0.895	0.973	0.839	0.865	0.916	1.010
1993	0.069	0.230	0.572	0.626	0.682	0.773	0.826	0.782	1.041	0.812	1.010
1994	0.069	0.150	0.363	0.568	0.649	0.697	0.777	0.749	0.744	0.736	0.922
1995	0.069	0.092	0.228	0.520	0.667	0.687	0.691	0.707	0.721	0.641	0.909
1996	0.069	0.188	0.294	0.474	0.633	0.728	0.743	0.770	0.799	0.846	0.973
1997	0.069	0.230	0.397	0.664	0.686	0.862	0.904	0.971	0.884	0.951	1.108
1998	0.069	0.230	0.296	0.494	0.580	0.644	0.682	0.775	0.707	0.798	0.858
1999	0.069	0.240	0.406	0.568	0.707	0.755	0.839	0.979	1.170	1.141	0.961
2000	0.069	0.215	0.497	0.594	0.689	0.734	0.778	0.854	0.813	0.904	0.988
2001	0.069	0.224	0.418	0.563	0.719	0.765	0.841	0.826	0.946	0.912	1.109
2002	0.069	0.253	0.293	0.459	0.600	0.601	0.723	0.722	0.791	0.851	0.940
2003	0.069	0.208	0.304	0.420	0.539	0.667	0.747	0.731	0.669	0.824	0.996
2004	0.069	0.176	0.316	0.444	0.567	0.624	0.679	0.810	0.728	0.916	1.015
2005	0.069	0.247	0.406	0.480	0.536	0.558	0.657	0.966	1.184	0.942	1.010
2006	0.069	0.265	0.393	0.503	0.551	0.613	0.647	0.714	0.848	0.856	0.984
2007	0.069	0.247	0.437	0.547	0.715	0.697	0.768	0.778	0.776	1.272	1.033
2008	0.069	0.265	0.388	0.540	0.615	0.727	0.719	0.700	0.798	0.786	0.998
2009	0.069	0.215	0.395	0.494	0.605	0.667	0.734	0.745	0.770	0.816	0.813
2010	0.069	0.204	0.362	0.565	0.583	0.673	0.684	0.758	0.723	0.762	0.803
2011	0.069	0.220	0.445	0.640	0.807	0.753	0.770	0.798	0.931	0.913	0.899
2012	0.069	0.230	0.374	0.509	0.612	0.658	0.713	0.772	0.822	0.894	0.949
2013	0.069	0.266	0.280	0.606	0.677	0.740	0.867	0.822	0.803	0.822	1.093
2014	0.069	0.316	0.569	0.634	0.709	0.735	0.840	0.838	0.791	0.942	0.923
2015	0.069	0.178	0.375	0.604	0.620	0.679	0.702	0.736	0.770	0.763	0.864
2016	0.069	0.249	0.455	0.552	0.680	0.679	0.706	0.720	0.767	0.764	0.754
2017	0.069	0.257	0.458	0.627	0.646	0.756	0.783	0.796	0.838	0.809	0.857
2018	0.069	0.292	0.511	0.695	0.744	0.708	0.783	0.819	0.839	0.852	0.835
2019	0.069	0.426	0.595	0.665	0.769	0.783	0.746	0.847	0.811	0.818	0.862
2020	0.069	0.391	0.555	0.599	0.730	0.793	0.824	0.810	0.833	0.815	0.880
2021	0.069	0.412	0.547	0.699	0.728	0.797	0.842	0.880	0.842	0.919	0.876
2022	0.069	0.412	0.547	0.699	0.728	0.797	0.842	0.880	0.842	0.919	0.876
2023	0.069	0.289	0.557	0.725	0.800	0.823	0.886	0.906	0.910	0.903	0.981
2024	0.069	0.348	0.531	0.676	0.750	0.802	0.849	0.889	0.878	0.938	0.939

Table 17.13. Schedules of age and length specific maturity of Atka mackerel from McDermott and Lowe (1997) by Aleutian Islands subareas. Eastern - 541, Central - 542, and Western - 543. The proportion mature at age vector is used in the stock assessments, whereas the proportion mature at length by area is provided as reference.

	INPFC Area				
Length (cm)	541	542	543	Age	Proportion mature
25	0	0	0	1	0
26	0	0	0	2	0.04
27	0	0.01	0.01	3	0.22
28	0	0.02	0.02	4	0.69
29	0.01	0.04	0.04	5	0.94
30	0.01	0.07	0.07	6	0.99
31	0.03	0.14	0.13	7	1
32	0.06	0.25	0.24	8	1
33	0.11	0.4	0.39	9	1
34	0.2	0.58	0.56	10	1
35	0.34	0.73	0.72		
36	0.51	0.85	0.84		
37	0.68	0.92	0.92		
38	0.81	0.96	0.96		
39	0.9	0.98	0.98		
40	0.95	0.99	0.99		
41	0.97	0.99	0.99		
42	0.99	1	1		
43	0.99	1	1		
44	1	1	1		
45	1	1	1		
46	1	1	1		
47	1	1	1		
48	1	1	1		
49	1	1	1		
50	1	1	1		

Table 17.14. Estimates of key results from AMAK for Bering Sea/Aleutian Islands Atka mackerel from Model 16.0b. Results from the 2022 assessment (Model 16.0b) and the 2024 assessment (Model 16.0b) are given. Coefficients of variation (*CV*) for some key reference values are given, appearing directly below.

Assessment Model	**2022 (Model 16.0b)**	**2024 (Model 16.0b)**
Scaling parameters		
Survey catchability (Estimated)	1.6	1.8
Steepness (Fixed)	0.8	0.8
SigmaR (Estimated)	0.47	0.48
Natural mortality (Fixed)	0.3	0.3
Fishery Average Effective *N*	215	225
Survey Average Effective *N*	102	103
RMSE Survey	0.301	0.314
Number of Parameters	577	601
-log Likelihoods		
Survey index	11.27	12.47
Catch biomass	0.05	0.06
Fishery age comp	141.35	147.56
Survey age comp	24.52	29.60
Sub total	177.19	189.70
-log Penalties		
Recruitment	-2.11	-1.44
Selectivity constraint	98.95	105.81
Prior	2.50	3.95
Sub Total	99.34	108.32
Total	276.53	298.02
Fishing mortalities (full selection)		
F_{2022}	0.450	0.284
$F_{40\%}$	0.61	0.53
Stock abundance		
Initial Biomass (t, 1977)	715,150	683,113
CV	18%	16%
Assessment year total biomass (t)	561,130	584,610
CV	21%	18%
2006 year class (millions at age-1)	850	821
CV	14%	11%
2017 year class (millions at age-1)	775	536
CV	23%	18%

Table 17.15. Estimates of Atka mackerel annual (1977-2023) fishery and survey selectivity-at-age (scaled to have a maximum of 1.0). The 2024 fishery selectivity is set equal to 2023. The average of the most recent 5 years' estimates of fishery selectivity (2019-2023) are used for projections and computation of ABC. Trawl survey selectivity is estimated but assumed constant over time.

	1	2	3	4	5	6	7	8	9	10	11+
Fishery 1977	0.007	0.076	0.543	1.000	0.936	0.555	0.334	0.199	0.120	0.086	0.086
Fishery 1978	0.007	0.074	0.633	0.945	1.000	0.659	0.401	0.230	0.135	0.094	0.094
Fishery 1979	0.007	0.052	0.385	1.000	0.947	0.649	0.428	0.235	0.131	0.090	0.090
Fishery 1980	0.007	0.053	0.336	0.895	1.000	0.758	0.587	0.288	0.148	0.099	0.099
Fishery 1981	0.008	0.058	0.361	0.737	0.955	0.973	1.000	0.366	0.176	0.118	0.118
Fishery 1982	0.006	0.043	0.216	0.513	1.000	0.906	0.586	0.278	0.147	0.100	0.100
Fishery 1983	0.006	0.043	0.243	0.544	0.841	1.000	0.648	0.301	0.165	0.112	0.112
Fishery 1984	0.006	0.047	0.272	0.647	0.894	1.000	0.769	0.392	0.218	0.140	0.140
Fishery 1985	0.007	0.057	0.468	0.864	0.997	1.000	0.817	0.537	0.325	0.197	0.197
Fishery 1986	0.007	0.057	0.469	0.851	1.000	0.987	0.911	0.719	0.480	0.265	0.265
Fishery 1987	0.006	0.054	0.422	0.937	1.000	0.906	0.850	0.708	0.490	0.330	0.330
Fishery 1988	0.005	0.044	0.356	1.000	0.876	0.692	0.642	0.527	0.384	0.259	0.259
Fishery 1989	0.006	0.049	0.360	0.992	1.000	0.794	0.696	0.572	0.423	0.309	0.309
Fishery 1990	0.005	0.047	0.376	1.000	0.967	0.765	0.692	0.573	0.438	0.329	0.329
Fishery 1991	0.006	0.043	0.265	0.799	1.000	0.910	0.791	0.643	0.495	0.393	0.393
Fishery 1992	0.006	0.040	0.223	0.693	1.000	0.995	0.880	0.732	0.578	0.471	0.471
Fishery 1993	0.005	0.034	0.184	0.547	0.881	1.000	0.905	0.779	0.626	0.514	0.514
Fishery 1994	0.005	0.030	0.163	0.487	0.844	1.000	0.950	0.883	0.719	0.576	0.576
Fishery 1995	0.005	0.028	0.147	0.480	0.759	0.937	1.000	0.940	0.779	0.634	0.634
Fishery 1996	0.004	0.025	0.130	0.432	0.700	0.887	1.000	0.992	0.786	0.642	0.642
Fishery 1997	0.004	0.024	0.133	0.438	0.756	0.878	0.996	1.000	0.832	0.681	0.681
Fishery 1998	0.003	0.022	0.124	0.463	0.726	0.832	0.962	1.000	0.835	0.669	0.669
Fishery 1999	0.003	0.020	0.130	0.503	0.643	0.764	0.875	1.000	0.791	0.600	0.600
Fishery 2000	0.002	0.017	0.164	0.453	0.630	0.741	0.872	1.000	0.728	0.527	0.527
Fishery 2001	0.002	0.018	0.165	0.486	0.702	0.834	1.000	0.985	0.721	0.514	0.514
Fishery 2002	0.002	0.018	0.137	0.454	0.659	0.791	1.000	0.882	0.626	0.456	0.456
Fishery 2003	0.003	0.021	0.185	0.486	0.738	0.872	1.000	0.943	0.633	0.464	0.464
Fishery 2004	0.003	0.030	0.235	0.602	0.836	0.925	1.000	0.919	0.667	0.482	0.482
Fishery 2005	0.003	0.040	0.283	0.635	0.825	0.903	1.000	0.830	0.623	0.466	0.466
Fishery 2006	0.004	0.055	0.482	0.652	0.817	0.883	1.000	0.837	0.661	0.497	0.497
Fishery 2007	0.003	0.055	0.495	0.716	0.709	0.793	1.000	0.871	0.694	0.499	0.499
Fishery 2008	0.003	0.047	0.389	0.655	0.703	0.841	1.000	0.933	0.834	0.526	0.526
Fishery 2009	0.003	0.034	0.248	0.568	0.766	0.841	1.000	0.916	0.769	0.559	0.559
Fishery 2010	0.003	0.029	0.180	0.555	0.775	0.962	1.000	0.913	0.816	0.599	0.599
Fishery 2011	0.003	0.024	0.151	0.390	0.693	0.955	1.000	0.910	0.943	0.858	0.858
Fishery 2012	0.002	0.020	0.133	0.302	0.507	0.772	0.884	0.858	0.919	1.000	1.000
Fishery 2013	0.002	0.022	0.222	0.475	0.526	0.706	0.860	0.904	0.977	1.000	1.000
Fishery 2014	0.002	0.020	0.499	0.352	0.539	0.673	0.670	0.833	1.000	0.919	0.919
Fishery 2015	0.001	0.013	0.121	0.277	0.421	0.592	0.754	1.000	0.959	0.664	0.664
Fishery 2016	0.001	0.011	0.077	0.250	0.323	0.503	0.713	0.881	1.000	0.585	0.585
Fishery 2017	0.001	0.014	0.089	0.260	0.410	0.573	0.843	0.895	1.000	0.748	0.748
Fishery 2018	0.002	0.015	0.124	0.262	0.498	0.665	0.766	1.000	0.996	0.737	0.737
Fishery 2019	0.002	0.017	0.121	0.358	0.545	0.703	0.894	1.000	0.990	0.726	0.726
Fishery 2020	0.002	0.017	0.160	0.363	0.499	0.657	0.772	1.000	0.924	0.660	0.660
Fishery 2021	0.002	0.017	0.171	0.462	0.555	0.617	0.742	0.929	1.000	0.644	0.644
Fishery 2022	0.002	0.023	0.256	0.505	0.526	0.641	0.710	0.887	1.000	0.671	0.671
Fishery 2023	0.002	0.034	0.284	0.635	0.648	0.652	0.698	0.864	1.000	0.737	0.737
Fishery 2024	0.002	0.034	0.284	0.635	0.648	0.652	0.698	0.864	1.000	0.737	0.737
Fishery Projection Yrs	0.002	0.022	0.201	0.471	0.563	0.666	0.777	0.954	1.000	0.699	0.699
Survey All Yrs	0.006	0.065	0.355	0.495	0.501	0.588	0.822	1.000	0.951	0.796	0.796

Table 17.16. Estimated BSAI Atka mackerel begin-year numbers at age in millions, 1977-2024.

	1	2	3	4	5	6	7	8	9	10	11+
1977	338	539	350	134	106	65	56	46	36	28	88
1978	1,901	250	394	238	85	68	44	40	33	26	85
1979	478	1,407	183	266	153	54	45	31	28	24	81
1980	283	354	1,037	131	179	104	38	32	22	21	77
1981	308	209	261	750	91	123	73	27	23	16	72
1982	198	228	155	190	536	64	87	51	20	17	65
1983	267	147	168	113	137	377	45	63	37	14	61
1984	289	198	108	124	82	99	270	33	46	28	55
1985	466	214	146	78	85	55	66	184	23	33	61
1986	401	345	157	101	51	55	35	43	126	17	68
1987	552	297	254	109	66	33	35	23	29	87	60
1988	426	409	218	179	73	44	22	24	16	20	105
1989	1,171	316	301	155	118	49	30	15	16	11	90
1990	570	867	233	218	108	82	34	21	11	12	73
1991	321	422	641	169	152	75	58	24	15	8	62
1992	513	237	311	463	116	103	51	40	17	11	50
1993	832	380	175	225	317	77	68	34	27	12	42
1994	343	616	280	126	151	201	48	43	22	18	37
1995	361	254	453	200	84	93	120	29	26	14	36
1996	837	267	186	319	126	48	50	63	15	15	30
1997	191	618	195	129	190	65	23	22	28	8	24
1998	293	142	455	139	84	113	37	12	12	16	19
1999	703	217	104	322	87	48	62	20	6	7	21
2000	1,574	520	160	74	207	54	29	36	11	4	17
2001	1,021	1,165	383	113	49	130	33	17	20	7	14
2002	1,123	755	858	269	71	28	73	17	9	12	13
2003	242	832	557	613	176	44	17	41	10	6	16
2004	319	179	613	395	406	110	27	10	25	6	14
2005	425	236	132	437	266	262	70	17	6	16	14
2006	303	314	174	94	293	173	168	44	11	4	21
2007	821	225	231	118	62	189	110	105	28	7	17
2008	715	608	165	157	78	41	122	68	67	19	17
2009	223	530	446	112	101	49	25	73	42	41	23
2010	490	165	388	303	69	58	27	13	39	24	40
2011	347	363	121	271	188	39	31	15	7	22	39
2012	542	257	267	87	184	120	24	19	9	4	38
2013	1,058	401	189	191	59	119	72	14	11	5	24
2014	802	784	297	137	134	41	81	48	9	7	19
2015	213	594	579	207	97	93	28	56	32	6	17
2016	462	158	438	413	141	63	58	17	30	18	14
2017	315	342	116	316	282	93	40	34	9	16	19
2018	536	233	252	84	216	183	58	22	19	5	21
2019	294	397	172	180	57	137	110	34	12	10	15
2020	676	218	293	124	122	37	85	65	19	7	16
2021	390	501	161	207	82	78	23	50	36	11	14
2022	685	289	369	113	133	52	48	13	28	20	15
2023	450	507	213	254	73	85	32	29	8	16	21
2024	447	333	372	146	159	45	53	20	17	4	22

Table 17.17. Estimates of Atka mackerel biomass in metric tons with approximate lower and upper 95% confidence bounds for age 1+ biomass and female spawning biomass (labeled as LCI and UCI; computed for period 1977-2024 from the recommended Model 16.0b.

	Age-1+ Biomass (t)			Female Spawning Biomass (t)		
Year	Estimate	LCI	UCI	Estimate	LCI	UCI
1977	683,113	492,690	947,132	170,875	120,238	242,837
1978	779,696	557,509	1,090,430	175,561	121,007	254,709
1979	822,993	582,111	1,163,550	185,499	125,434	274,327
1980	995,196	699,814	1,415,260	212,336	145,026	310,887
1981	963,749	675,671	1,374,650	275,655	189,523	400,929
1982	868,337	607,546	1,241,070	290,528	198,556	425,102
1983	734,914	515,984	1,046,730	251,319	172,278	366,625
1984	653,091	461,775	923,670	217,022	147,974	318,290
1985	579,610	410,248	818,890	178,672	120,140	265,722
1986	532,464	377,620	750,801	150,390	99,911	226,372
1987	532,982	382,974	741,748	137,266	91,692	205,492
1988	539,039	395,116	735,388	135,172	92,080	198,430
1989	607,472	462,572	797,762	142,146	99,508	203,054
1990	673,277	531,045	853,603	154,461	112,023	212,975
1991	787,268	638,417	970,824	175,549	133,093	231,549
1992	794,453	652,388	967,455	208,081	163,600	264,656
1993	764,045	632,733	922,609	208,927	164,845	264,798
1994	714,813	593,395	861,074	178,348	139,477	228,052
1995	704,280	583,366	850,256	159,832	123,997	206,024
1996	642,465	524,615	786,788	145,225	109,998	191,734
1997	551,617	438,127	694,504	127,669	94,368	172,722
1998	558,191	440,183	707,835	119,330	87,136	163,419
1999	514,014	400,309	660,017	127,495	93,217	174,377
2000	562,505	442,564	714,951	118,192	84,895	164,550
2001	693,430	555,907	864,975	108,772	77,250	153,158
2002	921,422	751,726	1,129,420	146,183	108,771	196,462
2003	1,018,590	839,538	1,235,820	214,330	166,081	276,596
2004	1,018,750	843,027	1,231,110	258,178	203,946	326,830
2005	874,074	720,280	1,060,710	261,191	208,006	327,975
2006	739,777	605,221	904,249	224,192	176,637	284,550
2007	659,768	536,618	811,180	181,426	140,859	233,677
2008	636,991	516,667	785,338	155,800	119,377	203,336
2009	653,261	527,841	808,482	136,810	102,976	181,762
2010	633,510	504,655	795,267	140,494	105,173	187,677
2011	560,182	437,697	716,943	147,364	109,873	197,648
2012	544,929	423,428	701,294	134,431	98,678	183,137
2013	558,762	432,257	722,291	132,050	97,226	179,347
2014	653,498	510,529	836,504	140,118	104,358	188,132
2015	755,171	592,274	962,870	153,386	114,136	206,132
2016	771,355	600,005	991,639	185,370	138,123	248,778
2017	690,532	530,897	898,166	194,527	143,436	263,816
2018	624,507	473,542	823,600	166,493	119,191	232,567
2019	554,637	412,741	745,315	143,791	100,241	206,261
2020	556,293	410,990	752,968	132,066	90,247	193,264
2021	530,636	387,642	726,379	124,287	83,304	185,435
2022	563,030	409,969	773,235	121,525	80,560	183,322
2023	562,249	406,378	777,905	125,178	82,528	189,869
2024	584,610	411,683	830,174	128,919	84,531	196,616

Table 17.18. Estimates of Atka mackerel age 3+ biomass and female spawning biomass in metric tons from the current recommended assessment model, Model 16.0b (1977-2024), compared to results from the last full assessment in 2022.

	Age-3+ Biomass (t)		Female Spawning Biomass (t)	
Year	Current	2022 assessment	Current	2022 assessment
1977	578,266	600,159	170,875	182,608
1978	629,250	644,483	175,561	185,063
1979	572,682	587,768	185,499	194,924
1980	922,756	955,078	212,336	225,633
1981	912,716	914,222	275,655	281,300
1982	820,784	862,184	290,528	308,840
1983	696,145	760,340	251,319	278,431
1984	604,898	665,556	217,022	242,762
1985	518,541	580,312	178,672	204,377
1986	454,549	504,292	150,390	171,283
1987	453,910	491,358	137,266	153,353
1988	449,573	486,845	135,172	151,813
1989	489,265	524,032	142,146	157,795
1990	502,947	536,458	154,461	169,000
1991	701,837	722,075	175,549	189,832
1992	727,017	723,116	208,081	214,867
1993	655,478	666,024	208,927	217,034
1994	597,406	616,146	178,348	189,390
1995	643,123	652,737	159,832	167,558
1996	551,513	547,530	145,225	148,283
1997	442,693	439,670	127,669	131,538
1998	518,700	514,697	119,330	121,405
1999	438,718	426,165	127,495	125,866
2000	388,490	395,076	118,192	121,835
2001	449,701	453,854	108,772	113,387
2002	736,471	722,580	146,183	146,360
2003	872,982	840,080	214,330	209,974
2004	971,830	968,669	258,178	260,828
2005	811,998	825,022	261,191	270,170
2006	672,385	719,477	224,192	243,816
2007	576,388	630,060	181,426	203,159
2008	499,206	541,610	155,800	174,091
2009	556,564	590,388	136,810	152,785
2010	578,868	590,375	140,494	150,435
2011	482,599	492,488	147,364	155,098
2012	472,695	491,512	134,431	145,082
2013	433,565	444,171	132,050	139,850
2014	482,821	488,932	140,118	146,641
2015	648,861	626,003	153,386	154,981
2016	719,472	651,755	185,370	175,310
2017	618,098	563,478	194,527	180,589
2018	556,411	527,336	166,493	157,354
2019	474,773	454,997	143,791	136,916
2020	482,396	522,332	132,066	132,864
2021	428,738	499,957	124,287	137,340
2022	477,406	481,117	121,525	137,720
2023	455,855	-	125,178	-
2024	505,910	-	128,919	-

Table 17.19. Estimates of age-1 Atka mackerel recruitment (millions of recruits) with standard errors (SE) from the recommended assessment model, Model 16.0b. Estimates and SEs of age-1 recruitment from the last full assessment (2022) are shown for comparison.

Year	Current Estimate	Current SE	2022 Estimate	2022 SE
1977	338	82	355	90
1978	1901	379	2029	437
1979	478	109	510	124
1980	283	69	302	78
1981	308	72	330	82
1982	198	50	212	57
1983	267	63	288	72
1984	289	66	312	76
1985	466	98	497	113
1986	401	91	429	105
1987	552	115	584	132
1988	426	95	468	109
1989	1171	175	1175	198
1990	570	113	563	122
1991	321	74	331	81
1992	513	93	514	102
1993	832	120	855	134
1994	343	65	341	71
1995	361	62	335	65
1996	837	108	863	126
1997	191	38	200	43
1998	293	51	307	58
1999	703	96	718	113
2000	1574	167	1626	209
2001	1021	112	1059	138
2002	1123	112	1188	142
2003	242	39	256	45
2004	319	43	342	53
2005	425	51	461	66
2006	303	41	320	50
2007	821	89	850	116
2008	715	85	727	107
2009	223	37	226	42
2010	490	66	490	79
2011	347	51	351	59
2012	542	74	541	86
2013	1058	130	1001	138
2014	802	104	703	102
2015	213	37	197	39
2016	462	73	468	92
2017	315	56	341	77
2018	536	94	775	182
2019	294	59	459	121
2020	676	131	413	155
2021	390	91	443	183
2022	685	212	455	192
2023	450	184	-	-
2024	447	187	-	-
Average 78-22	559	Average 78-20	577	
Median 78-22	465	Median 78-20	464	

Table 17.20. Estimates of full-selection fishing mortality rates (*F*) and exploitation rates (catch/age-3+ biomass) for BSAI Atka mackerel from the recommended assessment model, Model 16.0b. Equivalent estimates from the last full assessment (2022) are shown for comparison.

Year	Current *F*	2022 *F*	Current Catch/Biomass	2022 Catch/Biomass
1977	0.153	0.148	0.038	0.036
1978	0.151	0.144	0.039	0.038
1979	0.095	0.090	0.041	0.040
1980	0.071	0.067	0.022	0.021
1981	0.050	0.047	0.022	0.022
1982	0.051	0.048	0.024	0.023
1983	0.032	0.030	0.017	0.015
1984	0.111	0.103	0.060	0.054
1985	0.145	0.133	0.073	0.065
1986	0.145	0.133	0.070	0.063
1987	0.112	0.102	0.066	0.061
1988	0.117	0.109	0.049	0.045
1989	0.066	0.062	0.037	0.034
1990	0.058	0.055	0.044	0.041
1991	0.092	0.086	0.038	0.037
1992	0.116	0.111	0.067	0.067
1993	0.175	0.168	0.101	0.099
1994	0.217	0.211	0.109	0.106
1995	0.344	0.331	0.127	0.125
1996	0.504	0.485	0.188	0.190
1997	0.295	0.284	0.149	0.150
1998	0.359	0.343	0.110	0.111
1999	0.280	0.270	0.128	0.132
2000	0.268	0.259	0.122	0.120
2001	0.338	0.333	0.137	0.136
2002	0.265	0.257	0.061	0.063
2003	0.231	0.205	0.067	0.064
2004	0.163	0.153	0.062	0.063
2005	0.159	0.149	0.076	0.075
2006	0.171	0.161	0.092	0.086
2007	0.173	0.161	0.102	0.093
2008	0.215	0.196	0.116	0.107
2009	0.341	0.306	0.131	0.123
2010	0.326	0.284	0.119	0.116
2011	0.216	0.187	0.107	0.105
2012	0.277	0.224	0.101	0.097
2013	0.109	0.089	0.053	0.052
2014	0.123	0.105	0.064	0.063
2015	0.307	0.293	0.082	0.085
2016	0.335	0.301	0.076	0.081
2017	0.320	0.300	0.104	0.114
2018	0.314	0.315	0.127	0.133
2019	0.253	0.263	0.121	0.126
2020	0.294	0.340	0.122	0.113
2021	0.302	0.386	0.143	0.123
2022	0.284	0.450	0.122	0.138
2023	0.265	-	0.146	-
2024	0.264	-	0.127	-

[a]Catch/Biomass rate is the ratio of catch to beginning year age 3+ biomass.

Table 17.21. Projections of catch in metric tons, full-selection fishing mortality (*F*), and female spawning biomass (SSB) in metric tons for Atka mackerel for the 7 projection scenarios. The values for $B_{100\%}$, $B_{40\%}$, and $B_{35\%}$ are 264,734 t, 105,894 t, and 92,657 t, respectively.

Catch	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
2025	103,247	103,247	89,836	26,523	0	103,666	112,833
2026	92,361	92,361	84,621	28,956	0	87,946	98,982
2027	86,594	86,594	83,744	31,628	0	88,922	92,767
2028	86,658	86,658	84,038	33,834	0	91,655	92,988
2029	88,147	88,147	84,804	35,601	0	93,971	94,387
2030	88,902	88,902	85,244	36,702	0	94,984	95,068
2031	89,490	89,490	85,773	37,738	0	95,199	95,200
2032	89,781	89,781	86,086	38,460	0	95,331	95,328
2033	90,215	90,215	86,476	38,937	0	96,056	96,057
2034	90,879	90,879	86,903	39,333	0	96,629	96,631
2035	90,663	90,663	86,848	39,495	0	96,462	96,463
2036	91,013	91,013	87,094	39,707	0	96,620	96,620
2037	90,814	90,814	87,042	39,801	0	96,589	96,589
2038	91,077	91,077	87,220	39,935	0	96,783	96,783
F	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
2025	0.526	0.526	0.448	0.121	0.00	0.618	0.526
2026	0.514	0.514	0.448	0.121	0.00	0.558	0.591
2027	0.486	0.486	0.448	0.121	0.00	0.552	0.562
2028	0.481	0.481	0.448	0.121	0.00	0.556	0.559
2029	0.483	0.483	0.448	0.121	0.00	0.562	0.562
2030	0.485	0.485	0.448	0.121	0.00	0.564	0.564
2031	0.485	0.485	0.448	0.121	0.00	0.564	0.564
2032	0.486	0.486	0.448	0.121	0.00	0.563	0.563
2033	0.486	0.486	0.448	0.121	0.00	0.566	0.566
2034	0.488	0.488	0.448	0.121	0.00	0.567	0.567
2035	0.488	0.488	0.448	0.121	0.00	0.567	0.567
2036	0.488	0.488	0.448	0.121	0.00	0.567	0.567
2037	0.488	0.488	0.448	0.121	0.00	0.568	0.568
2038	0.488	0.488	0.448	0.121	0.00	0.568	0.568
SSB	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
2025	119,853	119,853	123,057	137,661	143,542	101,651	110,326
2026	106,274	106,274	112,357	145,750	161,053	92,677	98,267
2027	104,638	104,638	111,259	158,444	182,609	93,991	96,111
2028	106,598	106,598	112,993	170,288	202,434	96,734	97,434
2029	108,385	108,385	114,619	179,058	218,032	98,550	98,747
2030	109,487	109,487	115,786	185,563	230,342	99,406	99,451
2031	109,620	109,620	116,016	189,405	238,752	99,401	99,410
2032	109,697	109,697	116,176	192,260	245,480	99,435	99,438
2033	110,038	110,038	116,593	194,566	250,867	99,718	99,720
2034	110,657	110,657	117,332	196,656	255,321	100,264	100,266
2035	110,642	110,642	117,414	197,792	258,353	100,175	100,176
2036	110,694	110,694	117,525	198,506	260,457	100,236	100,236
2037	110,718	110,718	117,604	199,167	262,284	100,229	100,229
2038	110,743	110,743	117,641	199,499	263,470	100,251	100,251

Figures

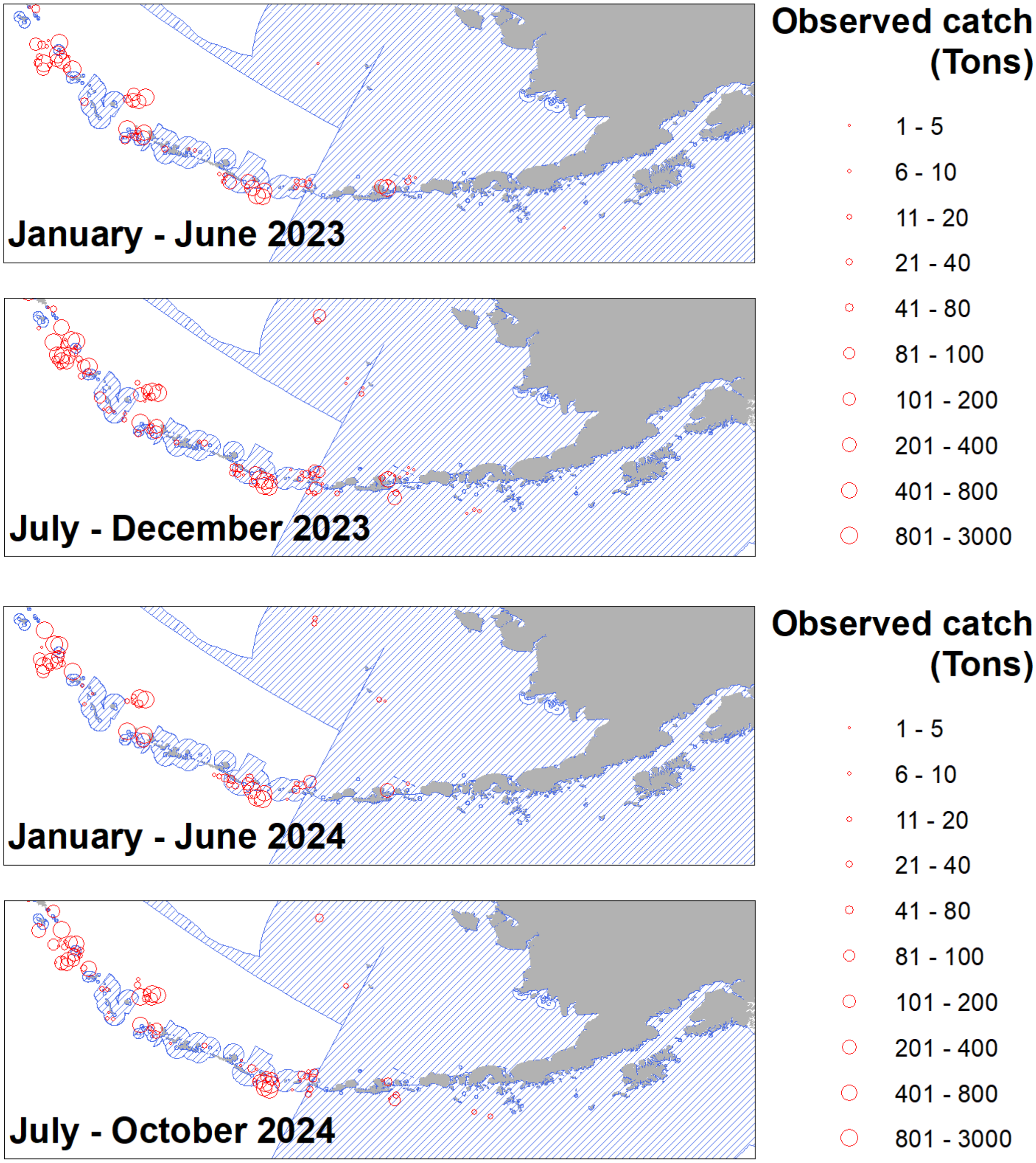


Figure 17.1. Observed catches of Atka mackerel summed for 20 km^2 cells for January-June/July-December 2023, and January-June/July-October 2024, where observed catch per haul was greater than 1 t. Shaded areas represent areas closed to directed Atka mackerel fishing. Maps provided by S. Barbeaux (AFSC).

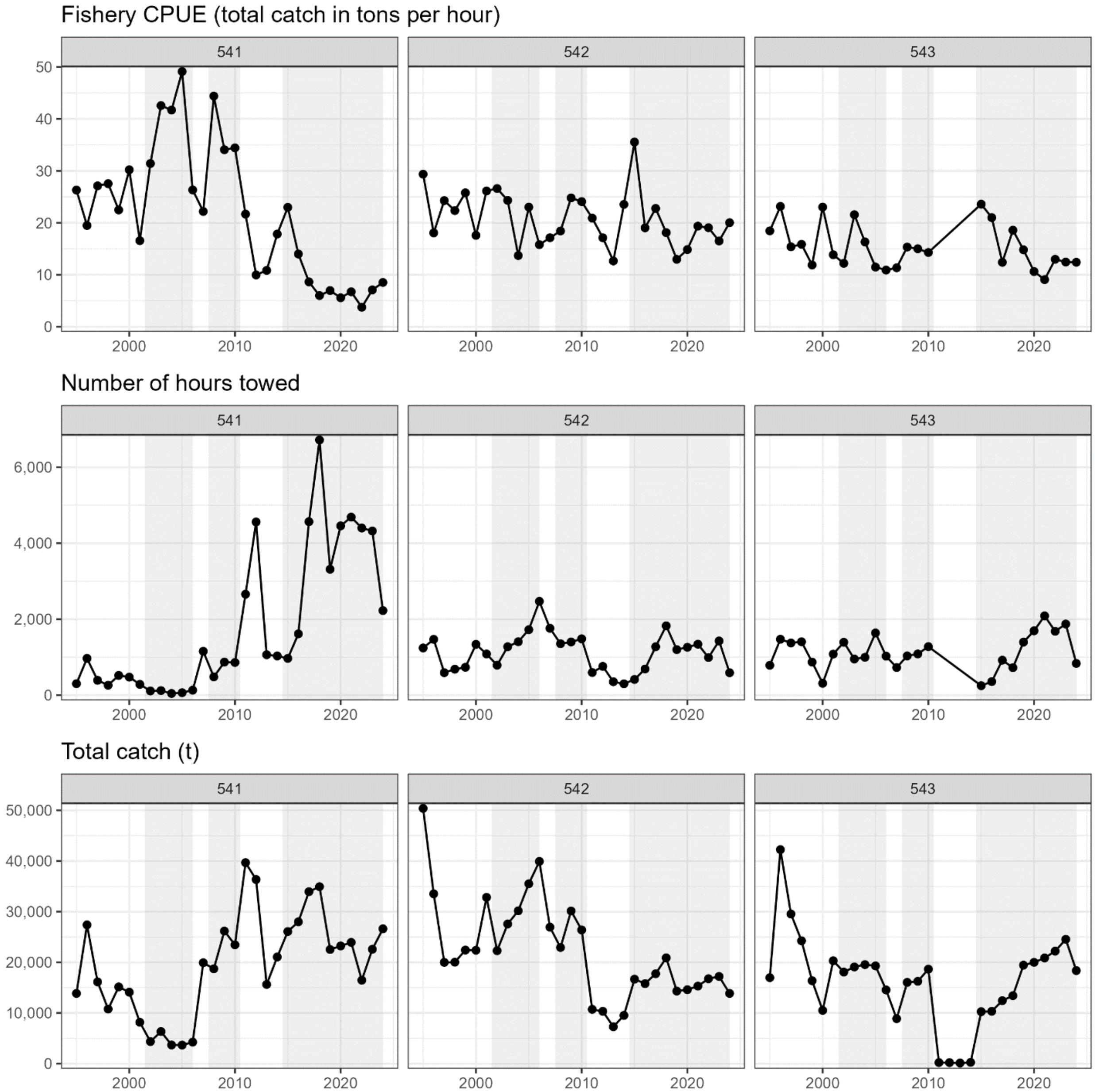


Figure 17.2. Nominal fishery catch per unit effort (CPUE) as defined by total catch in metric tons per hour towed (top), total number of hours towed (middle), and total catch in metric tons (bottom) in the Eastern Aleutians (541), Central Aleutians (542), and Western Aleutians (543). Alternating background shading between white and light grey in each panel represents major changes to management in the Atka mackerel fishery as described in the Management history section.

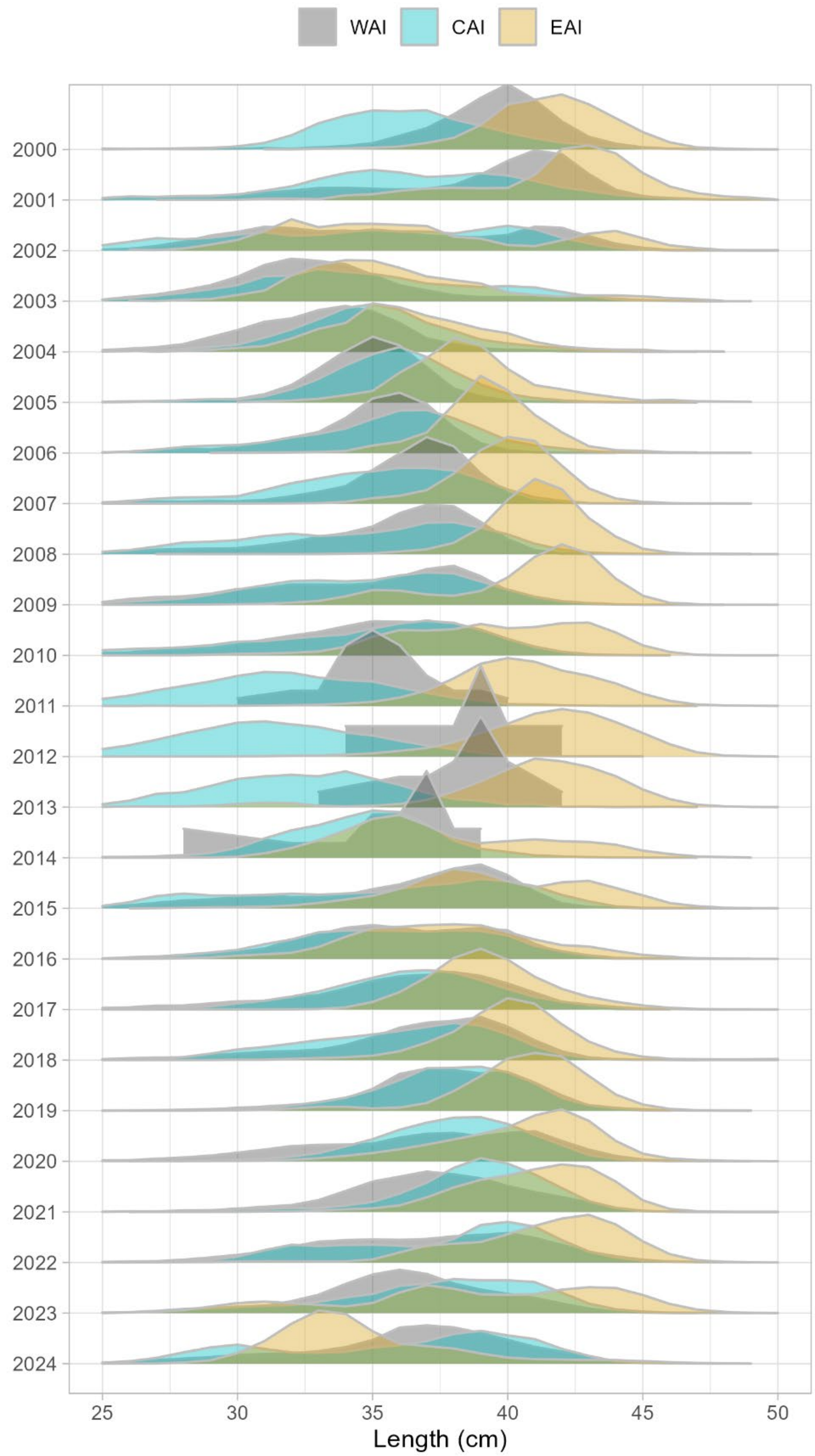


Figure 17.3 Atka mackerel fishery length-frequency data by area fished (see Figure 17.1).

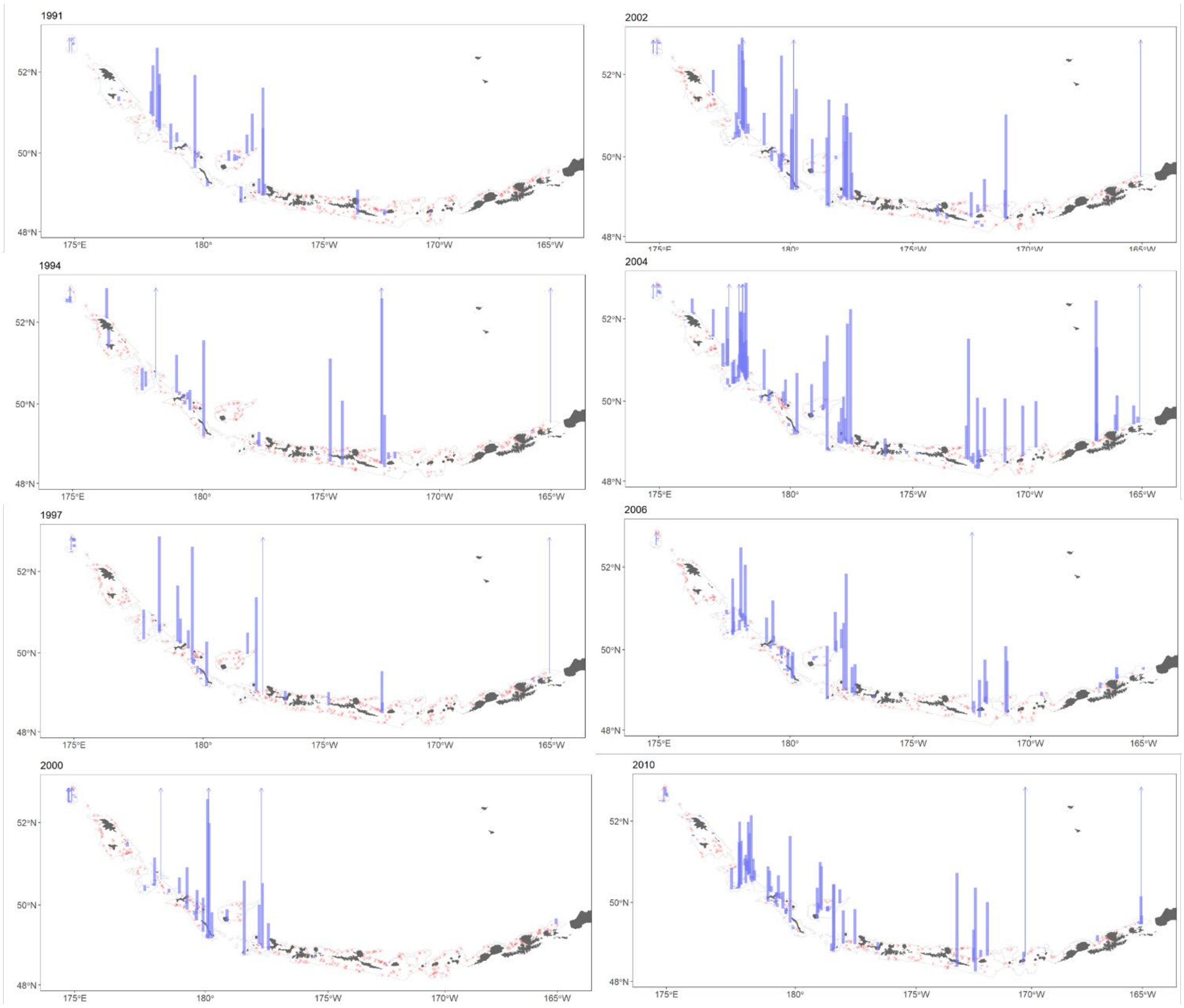


Figure 17.4. Bottom-trawl survey CPUE distributions of Atka mackerel catches during the summers of 1991-2024. Purple bars reflect the relative magnitude by haul and are standardized across years. Large catches that exceeded the plot margins are shown as vertical bars with arrows at the top. Stations with zero catches of Atka are shown with a red 'x'. Maps provided by M. Siple (AFSC).

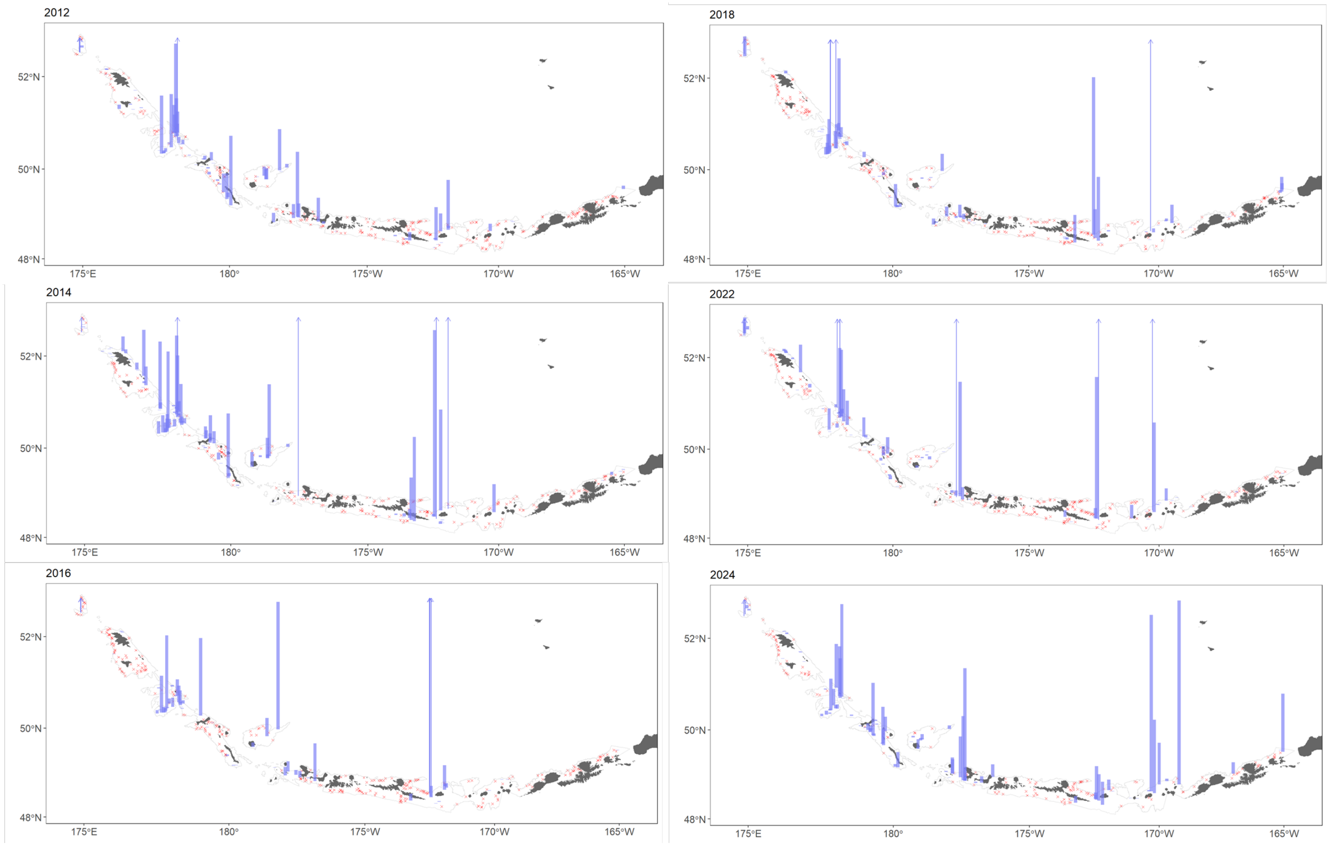


Figure 17.4. cont. Bottom-trawl survey CPUE distributions of Atka mackerel catches during the summers of 1991-2024. Purple bars reflect the relative magnitude by haul and are standardized across years. Large catches that exceeded the plot margins are shown as vertical bars with arrows at the top. Stations with zero catches of Atka are shown with a red 'x'. Maps provided by M. Siple (AFSC).

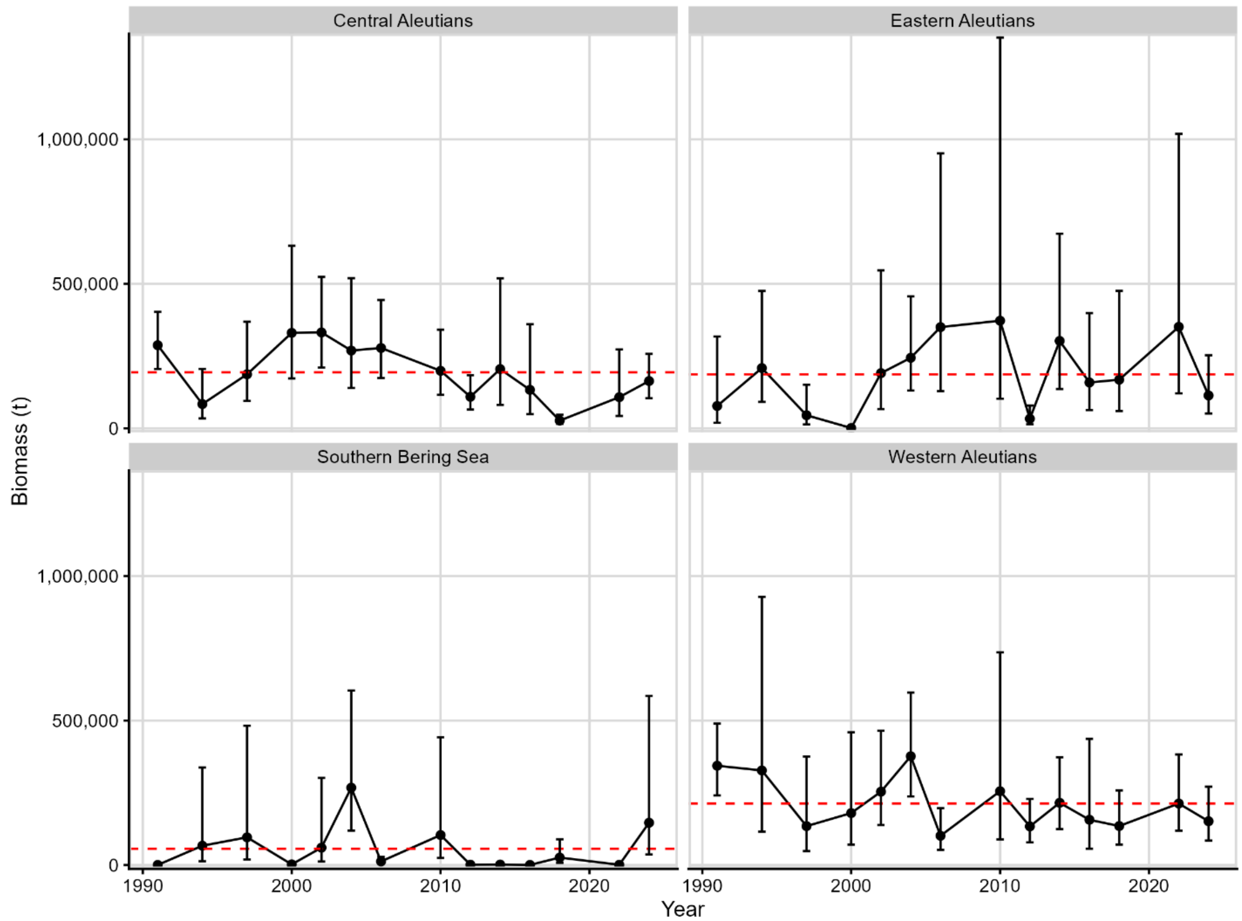


Figure 17.5. Atka mackerel Aleutian Islands survey biomass estimates (t) by area and survey year. Error bars represent the 95% confidence intervals of the survey biomass estimates based on the log standard error (coefficient of variation on the arithmetic scale).

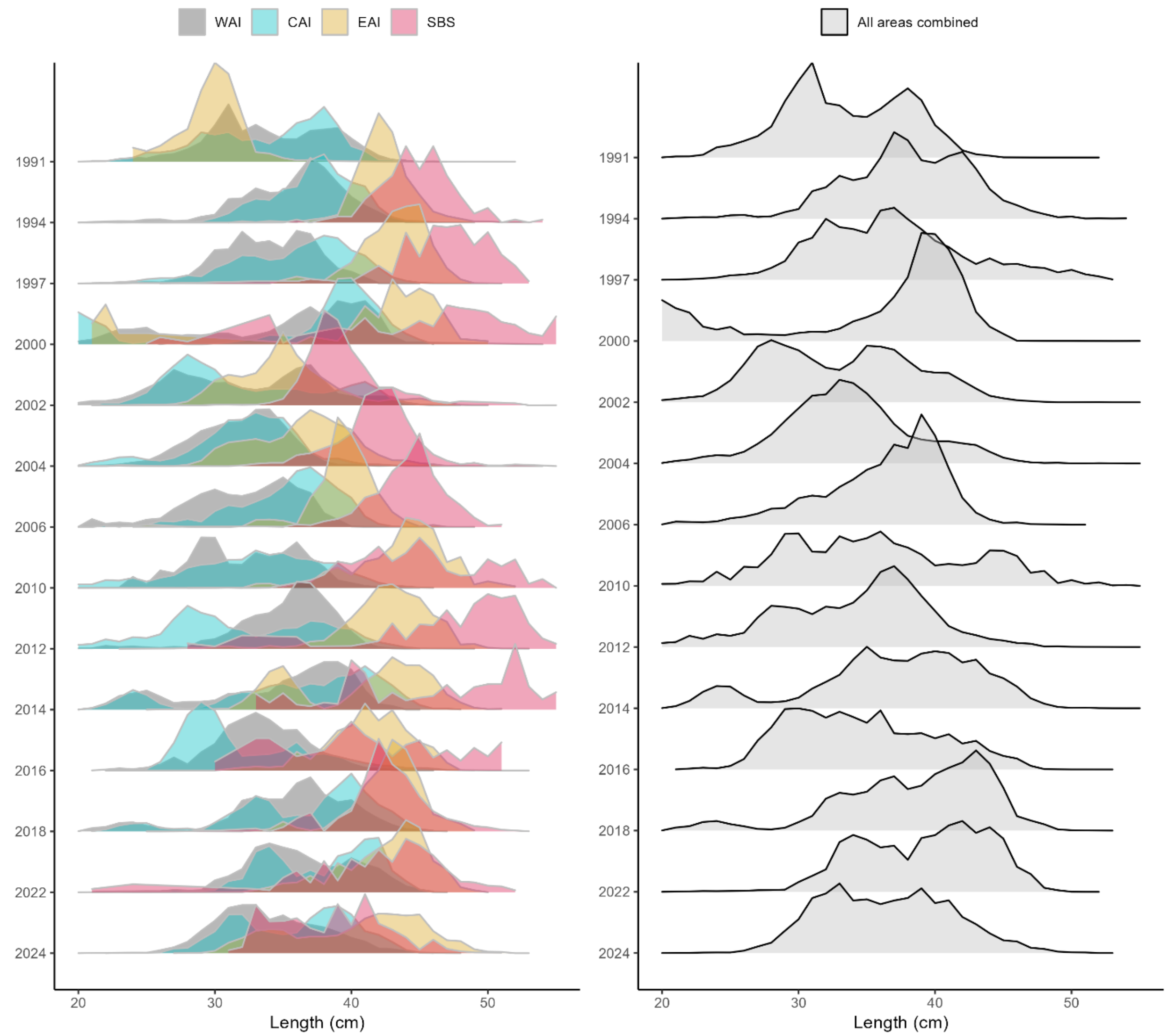


Figure 17.6. Atka mackerel bottom trawl survey length composition data by subarea (left) and for all areas (right), 1991-2024. Subareas are defined as western Aleutian Islands (WAI), central AI (CAI), eastern AI (EAI), and southern Bering Sea (SBS).

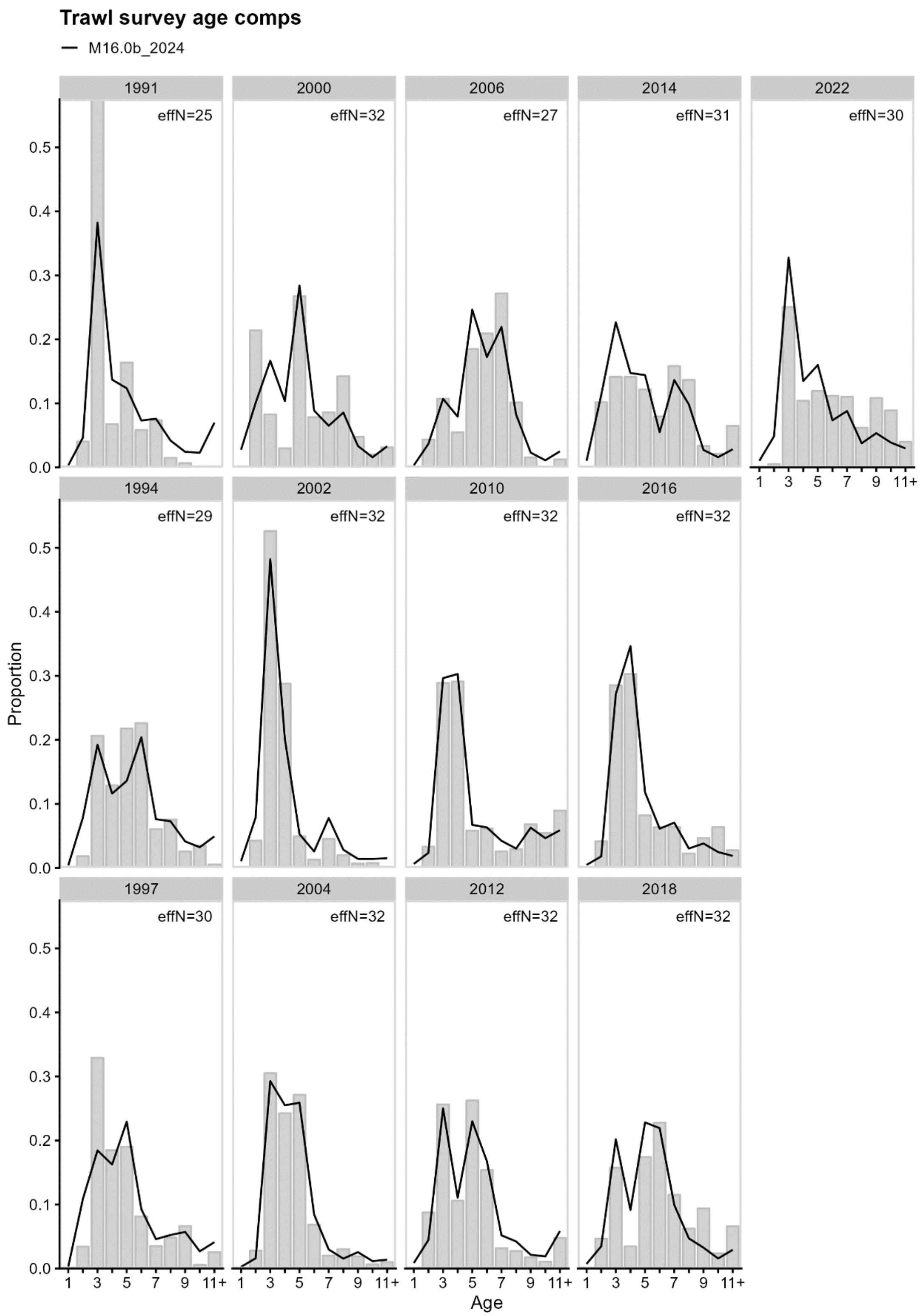


Figure 17.7. Observed and predicted **survey** proportions-at-age for BSAI Atka mackerel, 1991-2022. Lines are the model predictions and columns are the observed proportions-at-age. The annual effective sample sizes ("effn") based on Francis reweighting are shown in the top right of each panel.

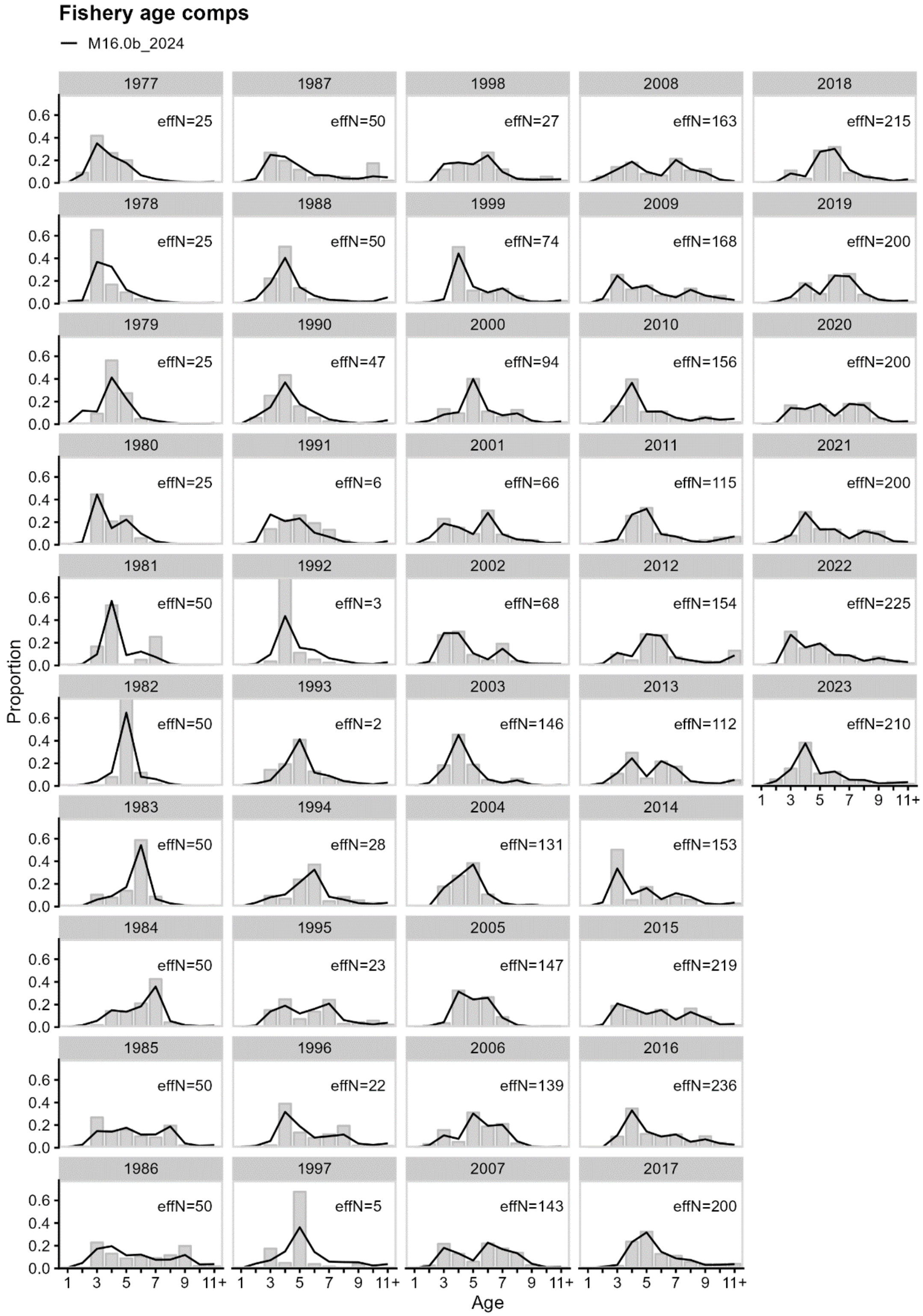


Figure 17.8. Observed and predicted Atka mackerel **fishery** proportions-at-age for BSAI Atka mackerel, 1977-2023. Lines are the model predictions and columns are the observed proportions-at-age. The annual effective sample sizes ("effn") are shown in the top right of each panel.

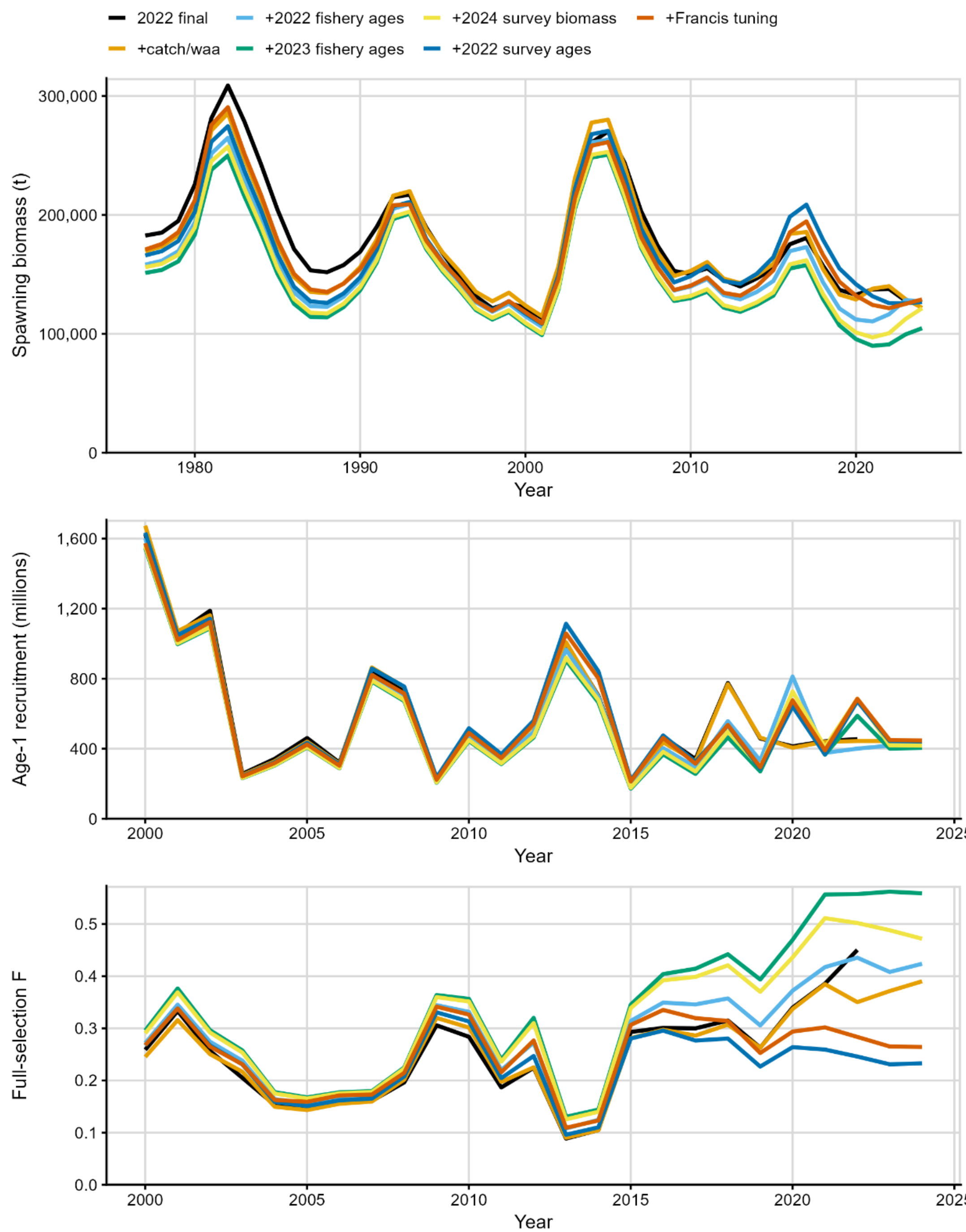


Figure 17.9. Changes in estimated spawning biomass in metric tons (top), age-1 recruitment in millions (middle), and full-selection fishing mortality (bottom) as new data were added successively to the last full assessment model in 2022, ordered by row in the legend at the top.

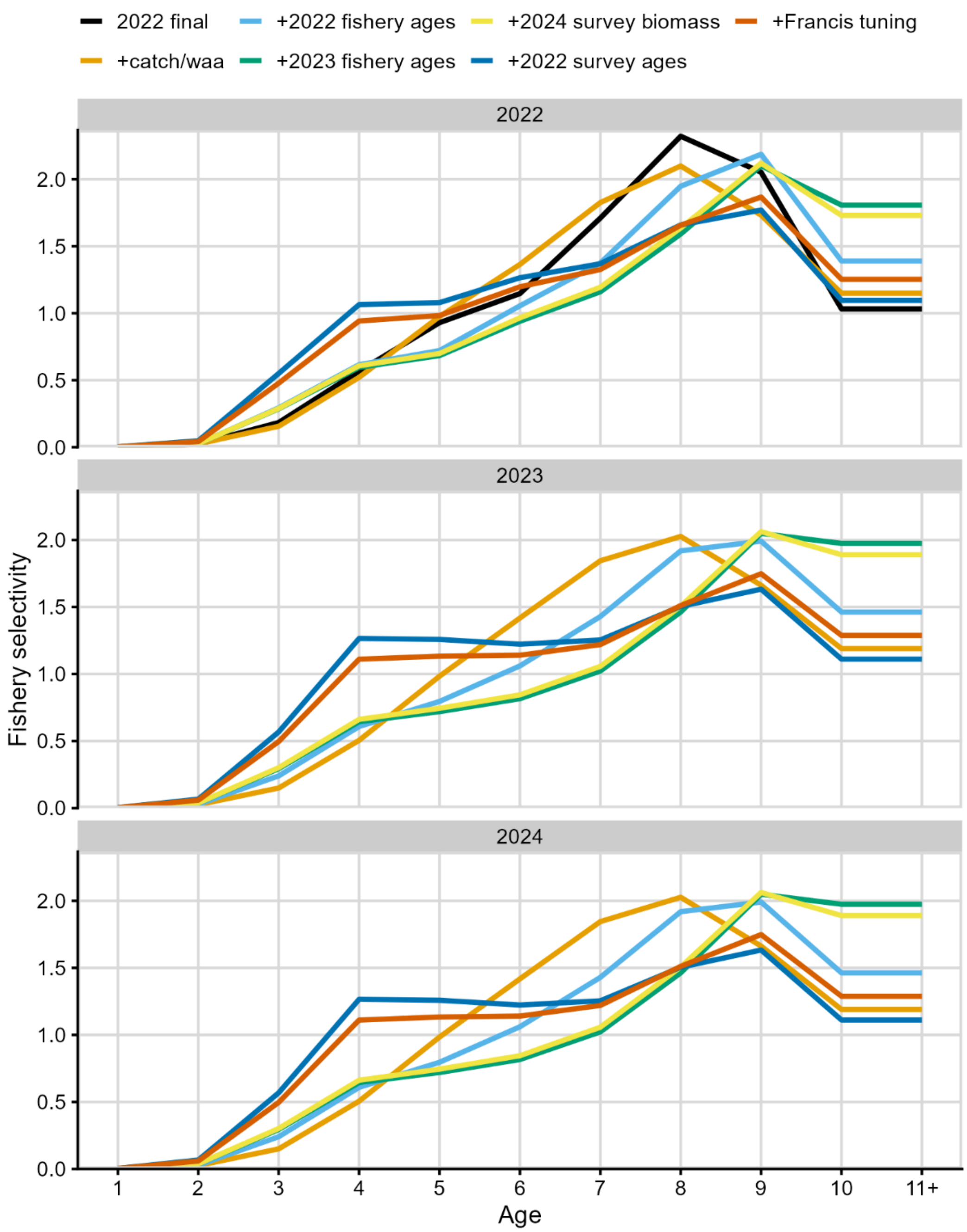


Figure 17.10. Changes in estimated fishery selectivity for 2022-2024 as new data were added successively to the last full assessment model in 2022, ordered by row in the legend at the top.

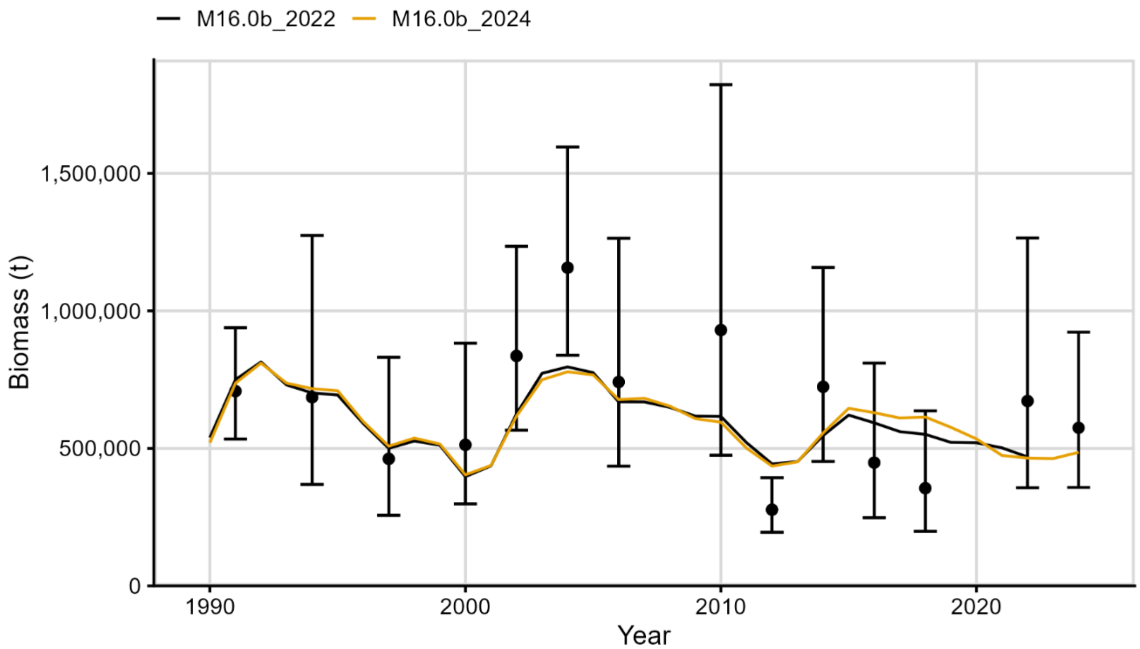


Figure 17.11. Observed (dots) and predicted (trend line) survey biomass estimates (t) for Bering Sea/Aleutian Islands Atka mackerel from the recommended model this year (M16.0b_2024) and the last full assessment (M16.0b_2022). Error bars represent the 95% confidence intervals of the survey biomass estimates based on the log standard error (coefficient of variation on the arithmetic scale) assumed in the stock assessment.

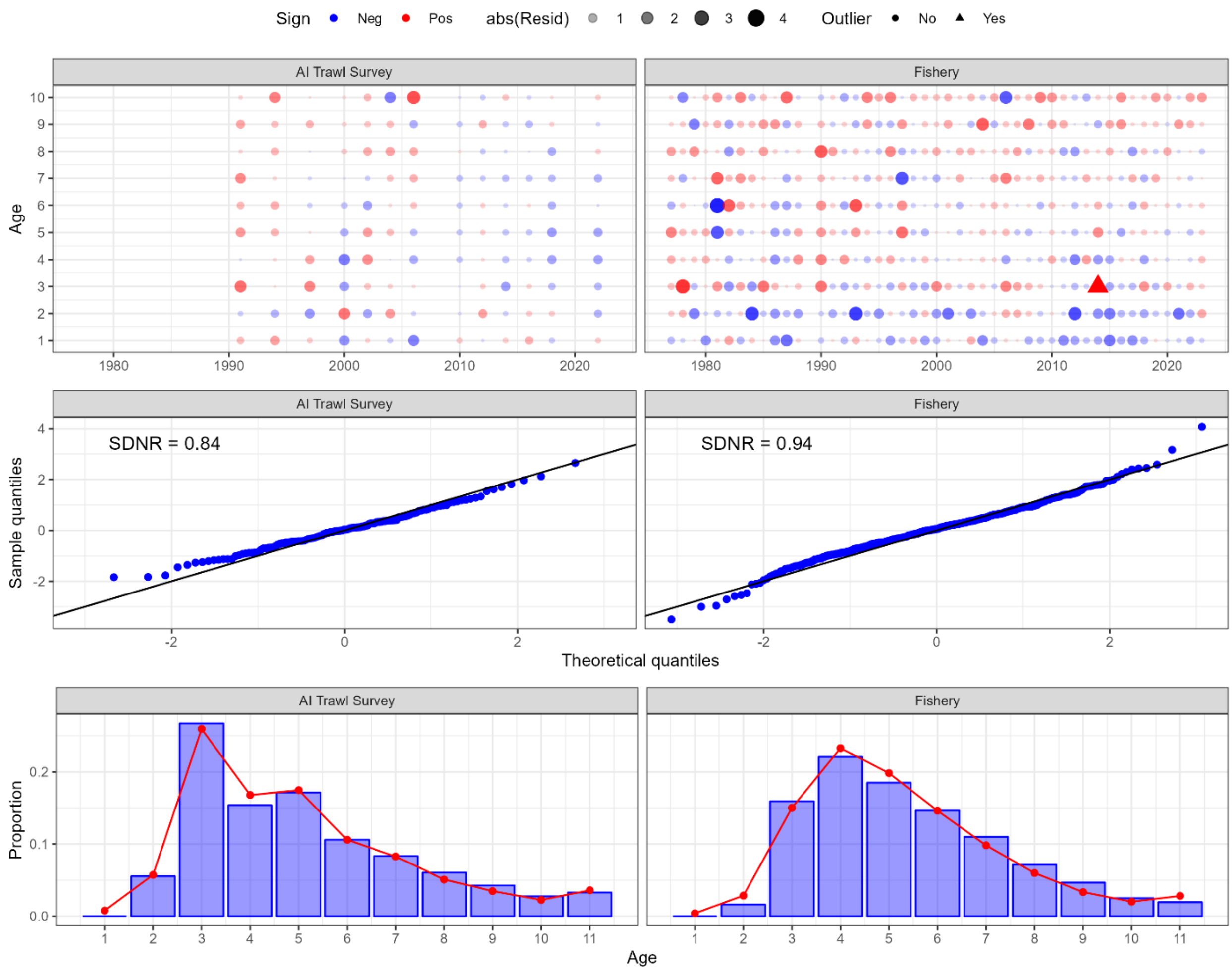


Figure 17.12. Bubble plots for the one-step ahead (OSA) residuals (top) with associated standard normal QQ-plots (middle) and aggregated fits to the age composition data (bottom) for the Aleutian Island bottom trawl survey (left) and fishery (right). The QQ-plots include the standard deviation of the normalized residual (SDNR) statistic, which should equal 1 under a correctly specified model.

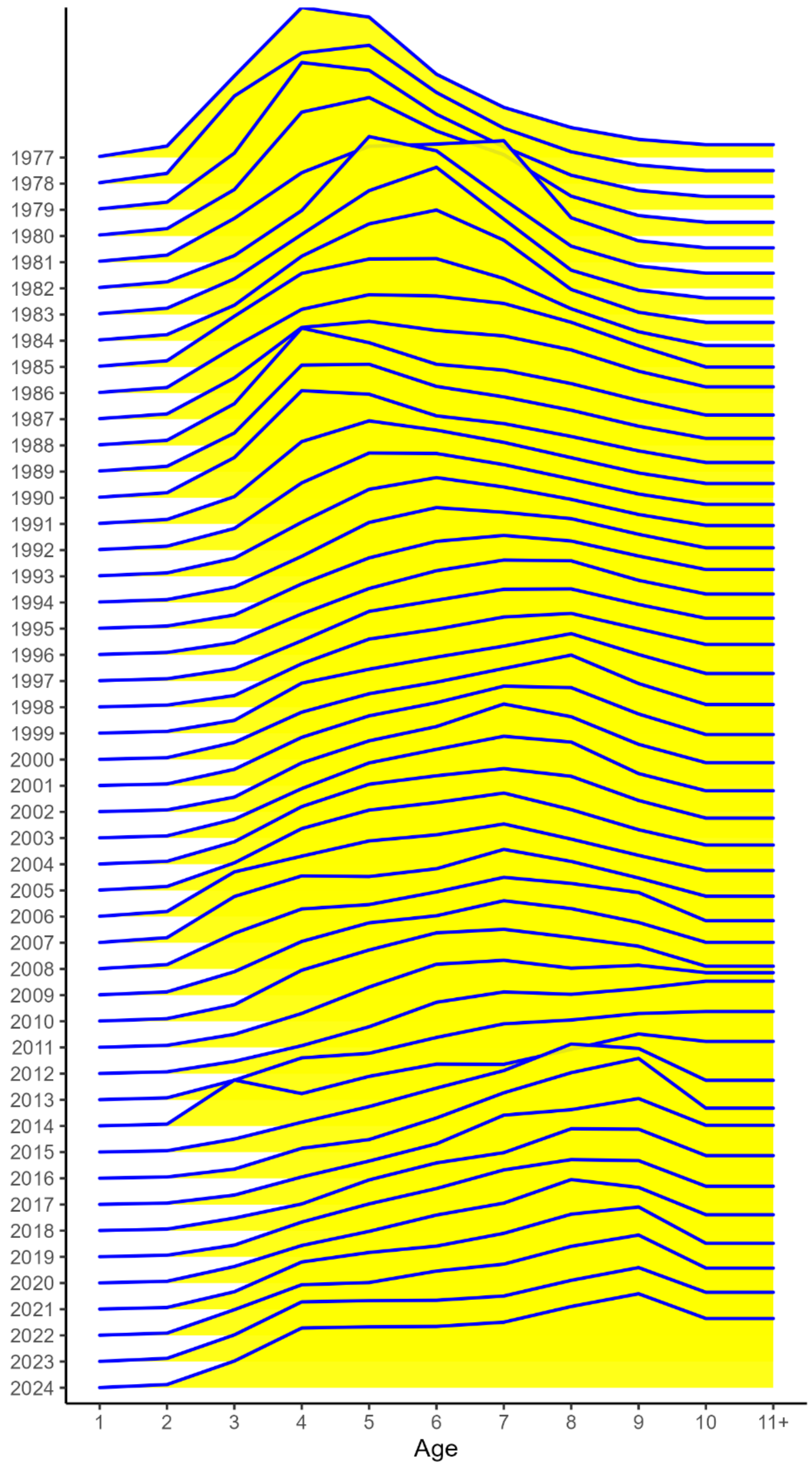


Figure 17.13. Fishery selectivity estimates over time for BSAI Atka mackerel from the recommended model (Model 16.0b).

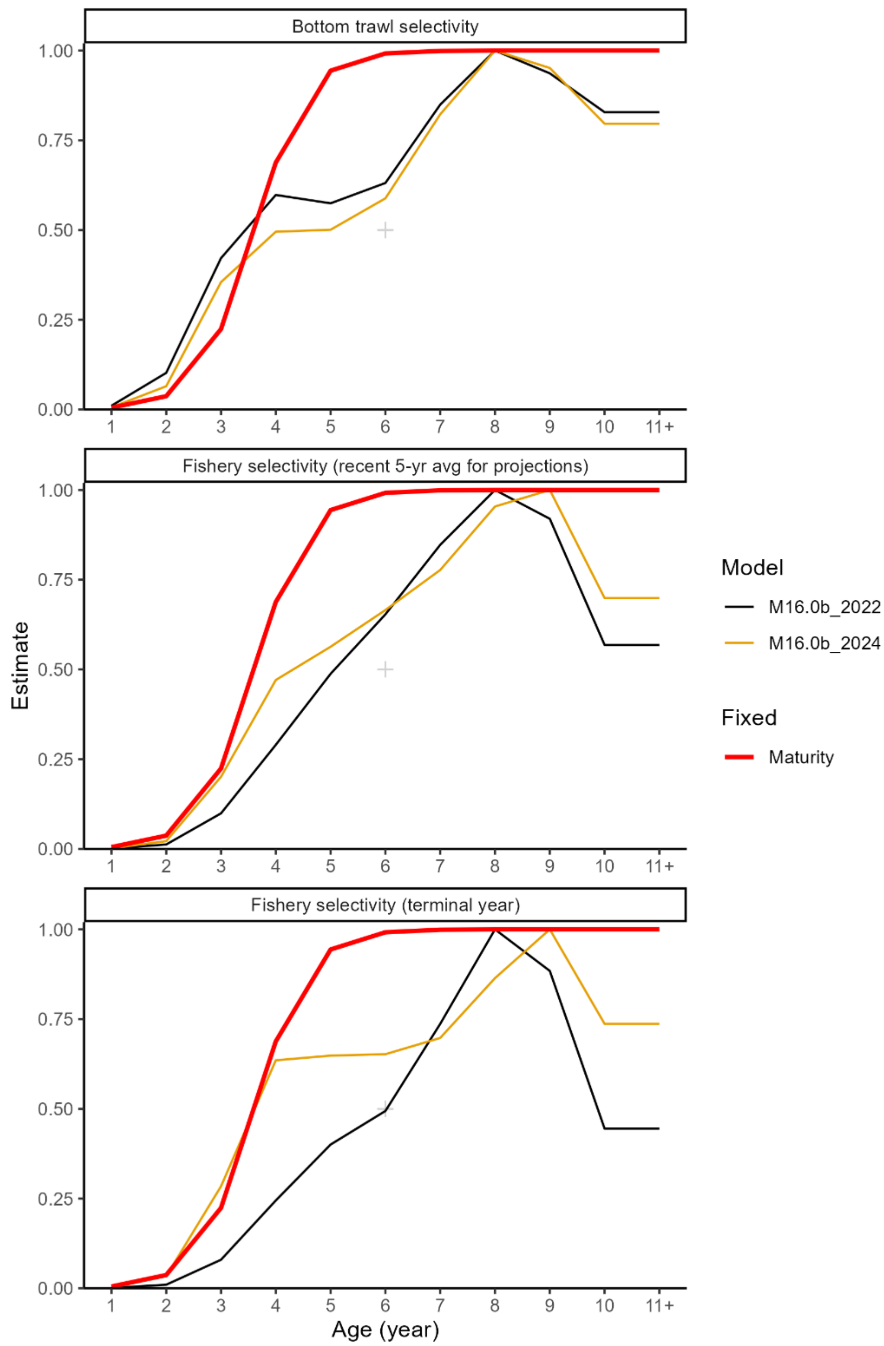


Figure 17.14. Estimated bottom trawl survey selectivity (top panel), estimated fishery selectivity for projections, which uses the average of the most recent 5 years (middle panel), and fishery selectivity in the terminal year, which is based on the most recent year with age data fishery selectivity patterns in the current assessment (bottom panel) for the last full assessment (M16.0b_2022) and the current assessment (M16.0b_2024). Each panel includes maturity-at-age schedules for BSAI Atka mackerel, which are fixed in Model 16.0b and have not changed between assessments.

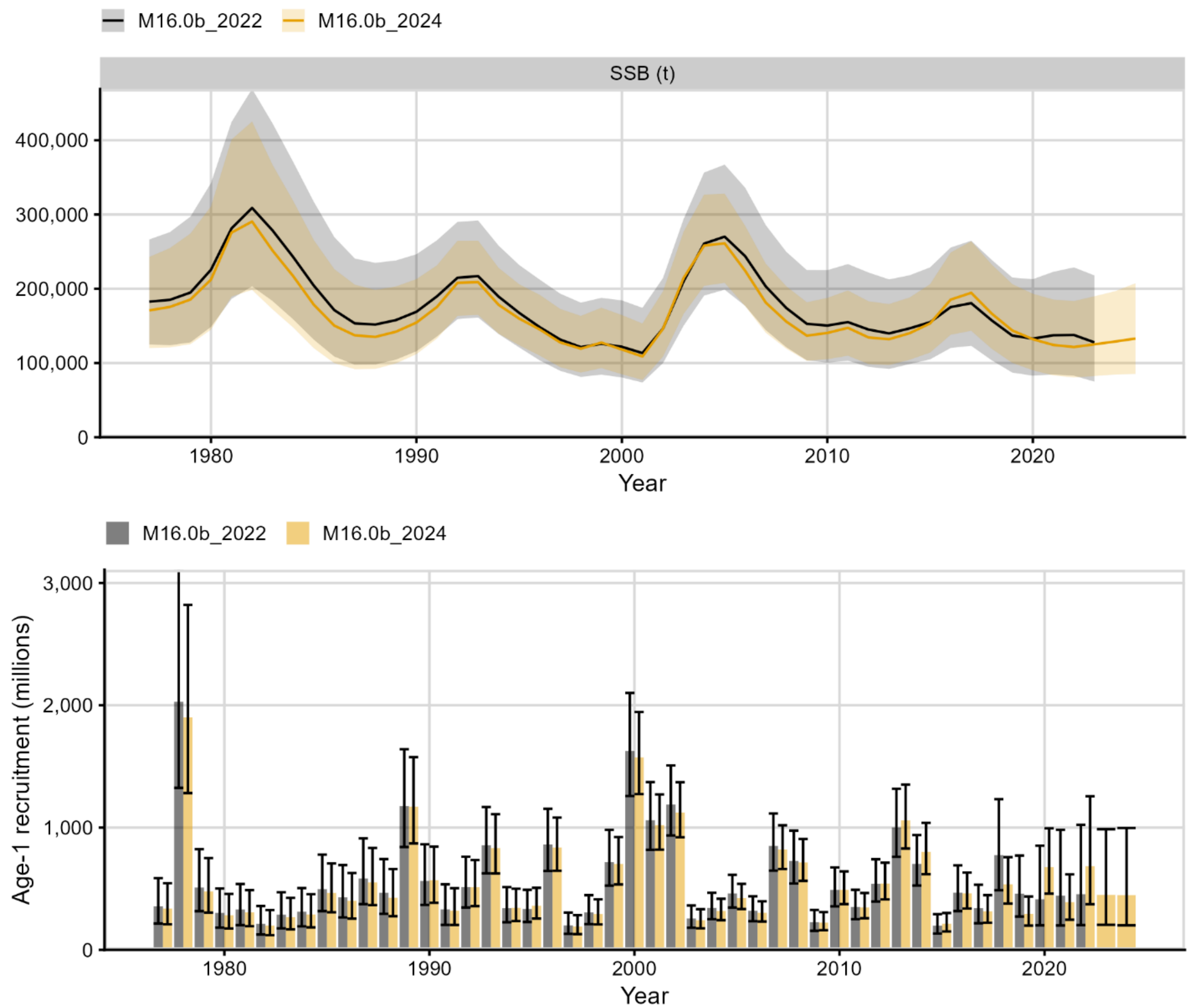


Figure 17.15. Time series of estimated Aleutian Islands Atka mackerel female spawning biomass (t) with approximate 95% confidence bounds (top), and recruitment at age-1 (millions, bottom) from the current assessment (M16.0b_2024) compared to the last full assessment (M16.0b_2022).

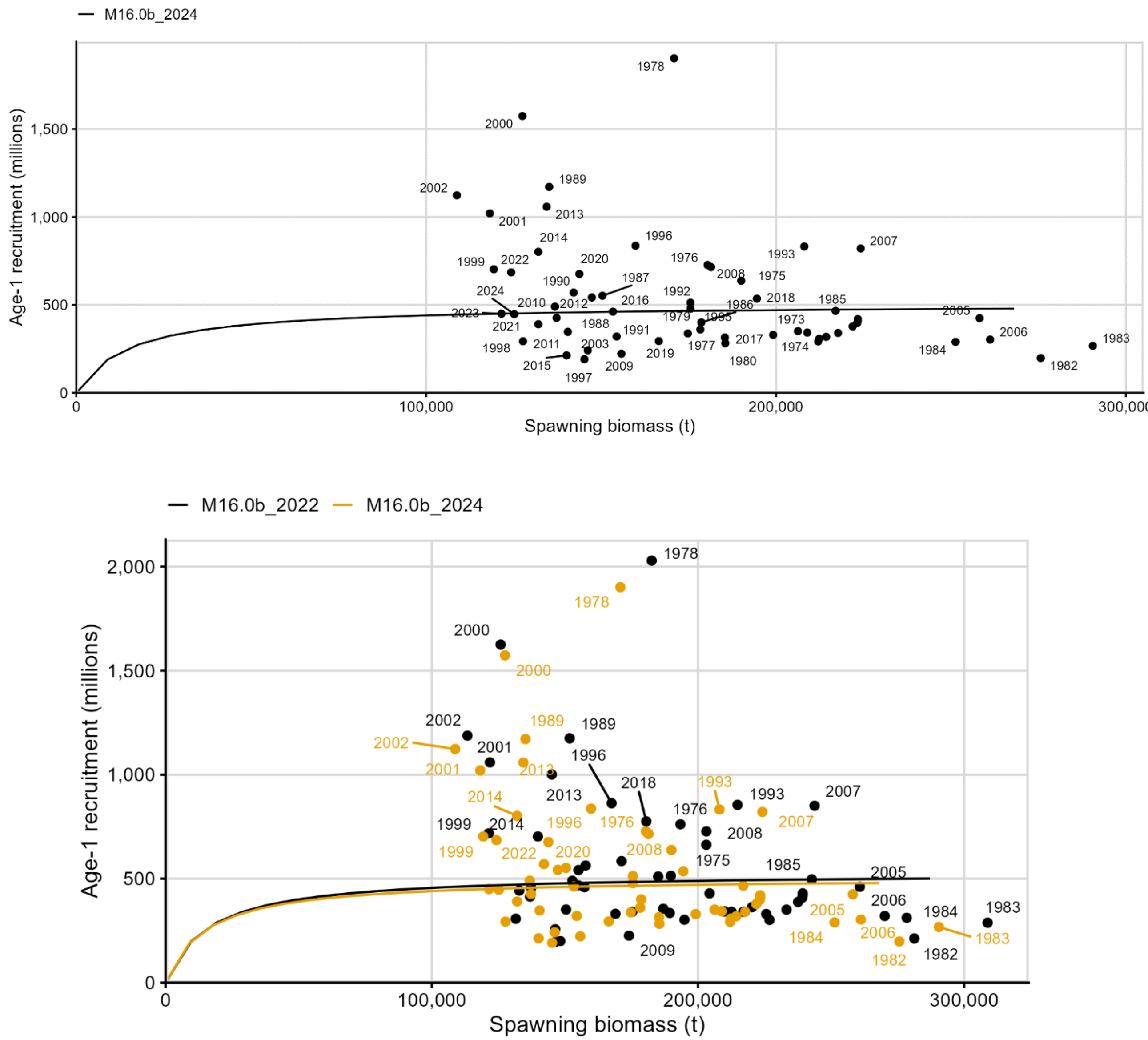


Figure 17.16 Estimated age 1 recruits (millions) versus female spawning biomass (t) for BSAI Atka mackerel. Solid line indicates Beverton-Holt stock recruitment curve (with steepness *h*=0.8). The top graph shows only estimates from the current assessment (M16.0b_2024), while the bottom graph shows a comparison of the current assessment to the last full assessment (M16.0b_2022).

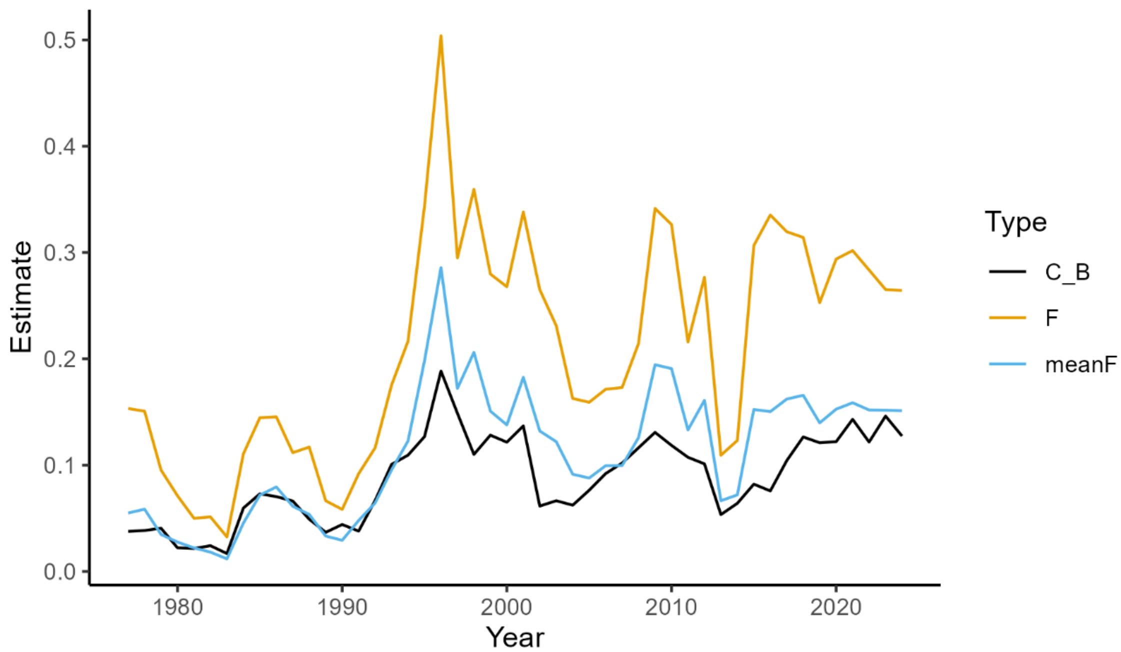


Figure 17.17 Estimated time series of the current recommended Model 16.0b mean and full-selection fishing mortality and catch/biomass (C_B) exploitation rates of Atka mackerel, 1977-2024. Catch/biomass rates are the ratios of catch to beginning year age 3+ biomass.

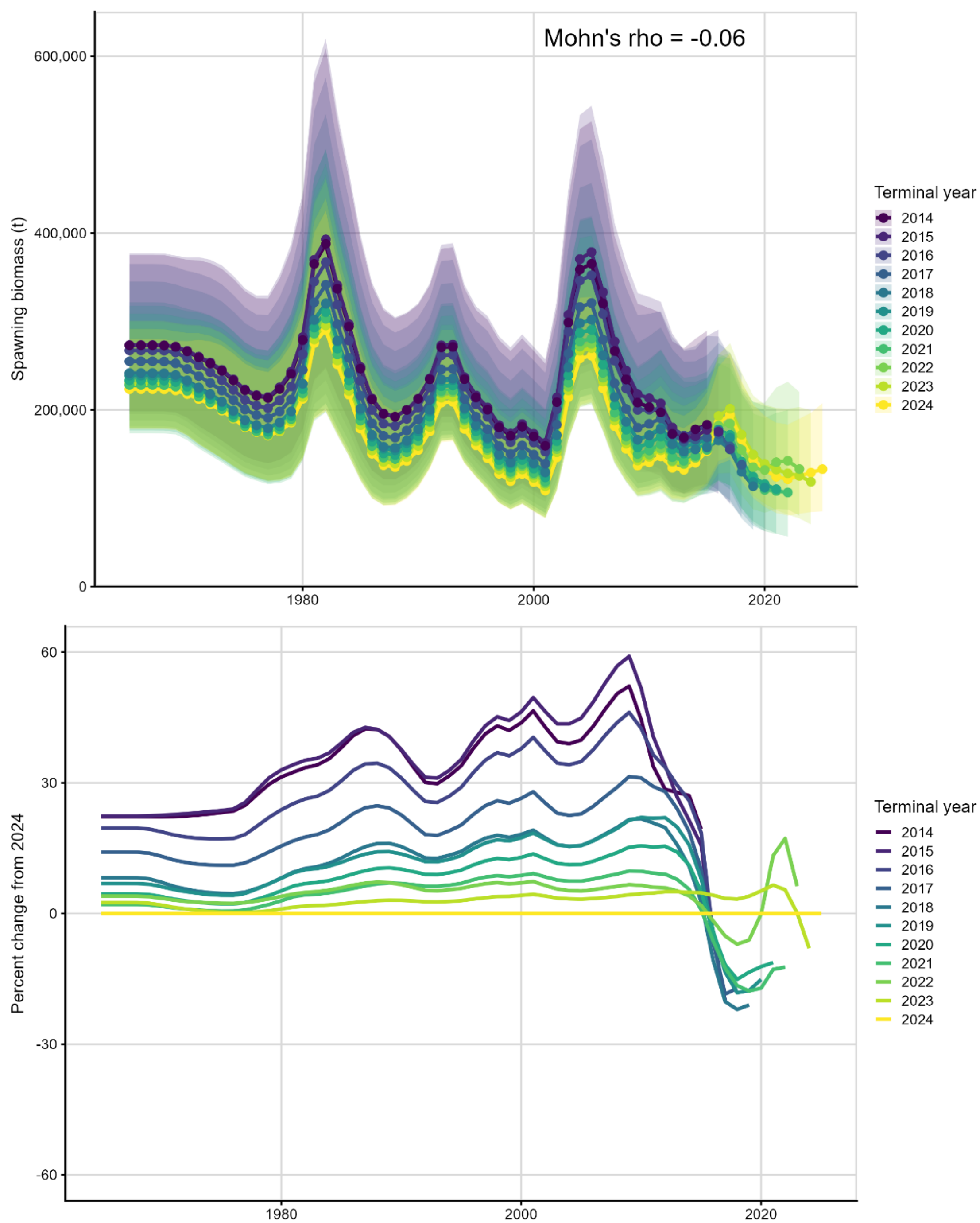


Figure 17.18. Retrospective plots showing the BSAI Atka mackerel spawning biomass over time (top) and the percent change from the terminal year of the assessment (bottom) over 10 different "peels". Mohn's rho was -0.06.

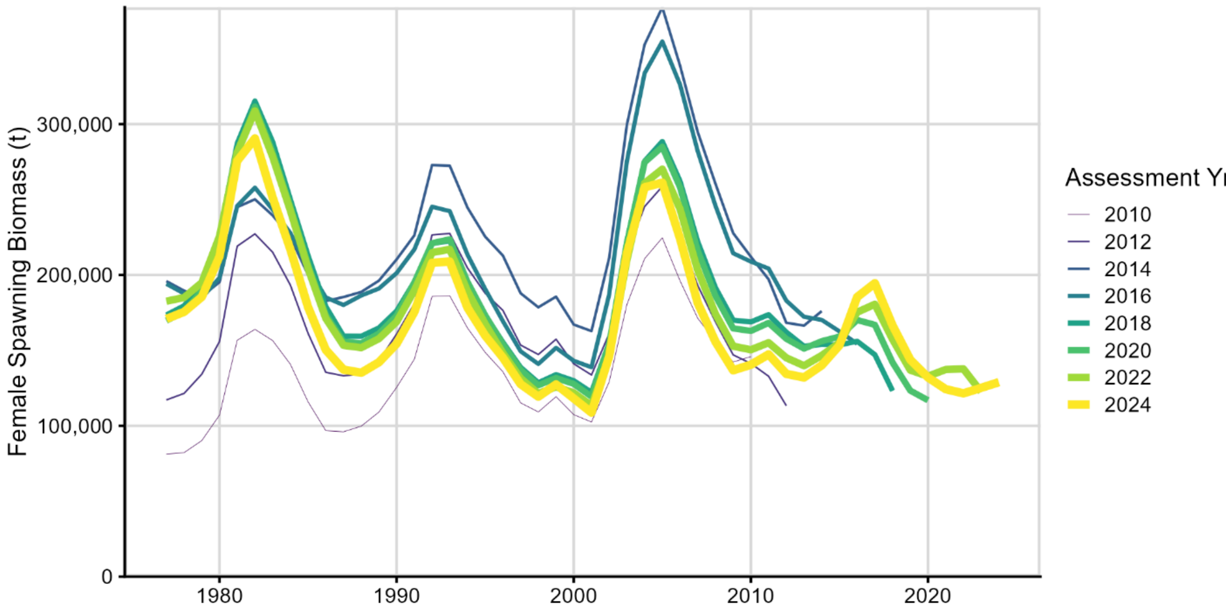
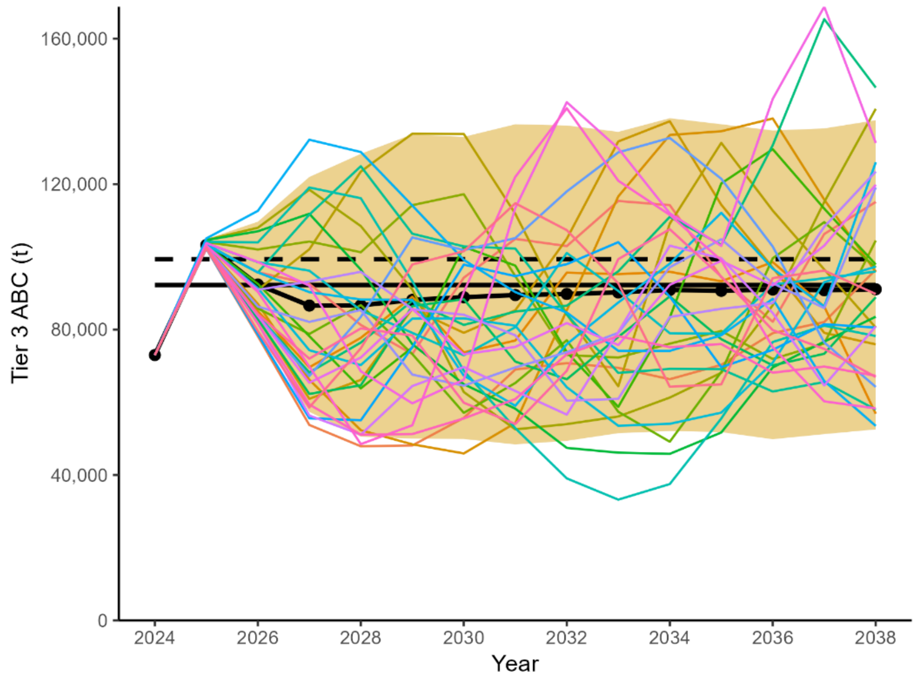


Figure 17.19. A comparison of female spawning biomass trajectories in metric tons from even year assessments, 2010-2024.



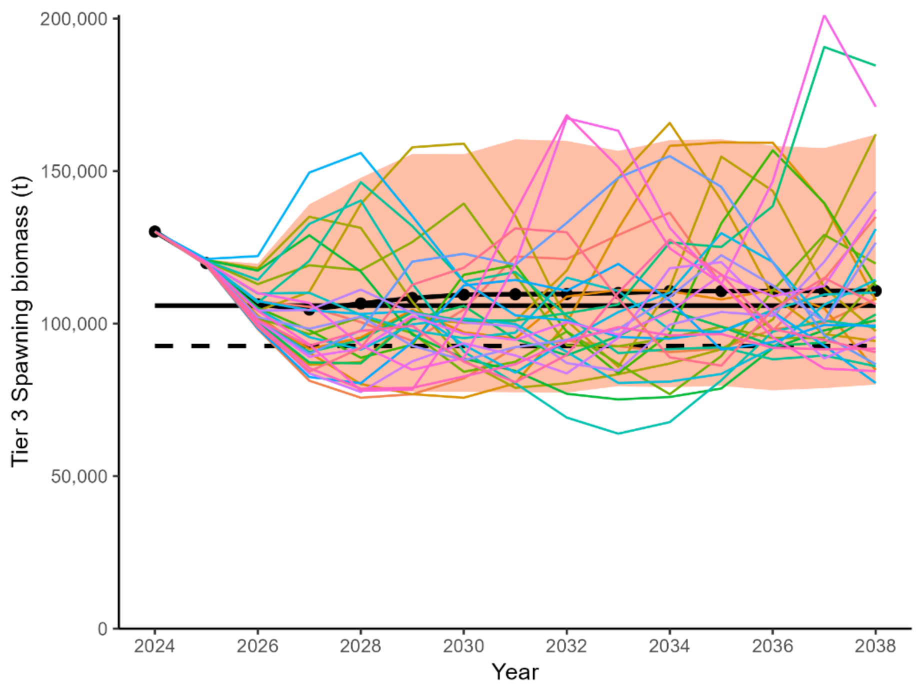


Figure 17.20. Projected Atka mackerel catch (assuming TAC taken in 2024 and reduced catches in 2025 and 2026; top) and spawning biomass (bottom) in thousands of metric tons under maximum permissible harvest control rule specifications after 2025. The black lines with points represent the mean trajectories, the colored shaded regions represent the 95% confidence intervals, and the individual colored lines represent a sample of simulated trajectories. On the top panel, the dashed horizontal black line represents the overfishing limit (OFL) and the solid horizontal black line represents the allowable biological catch (ABC). In the lower panel, these lines represent the target $B_{40\%}$ and $B_{35\%}$ biological reference points.

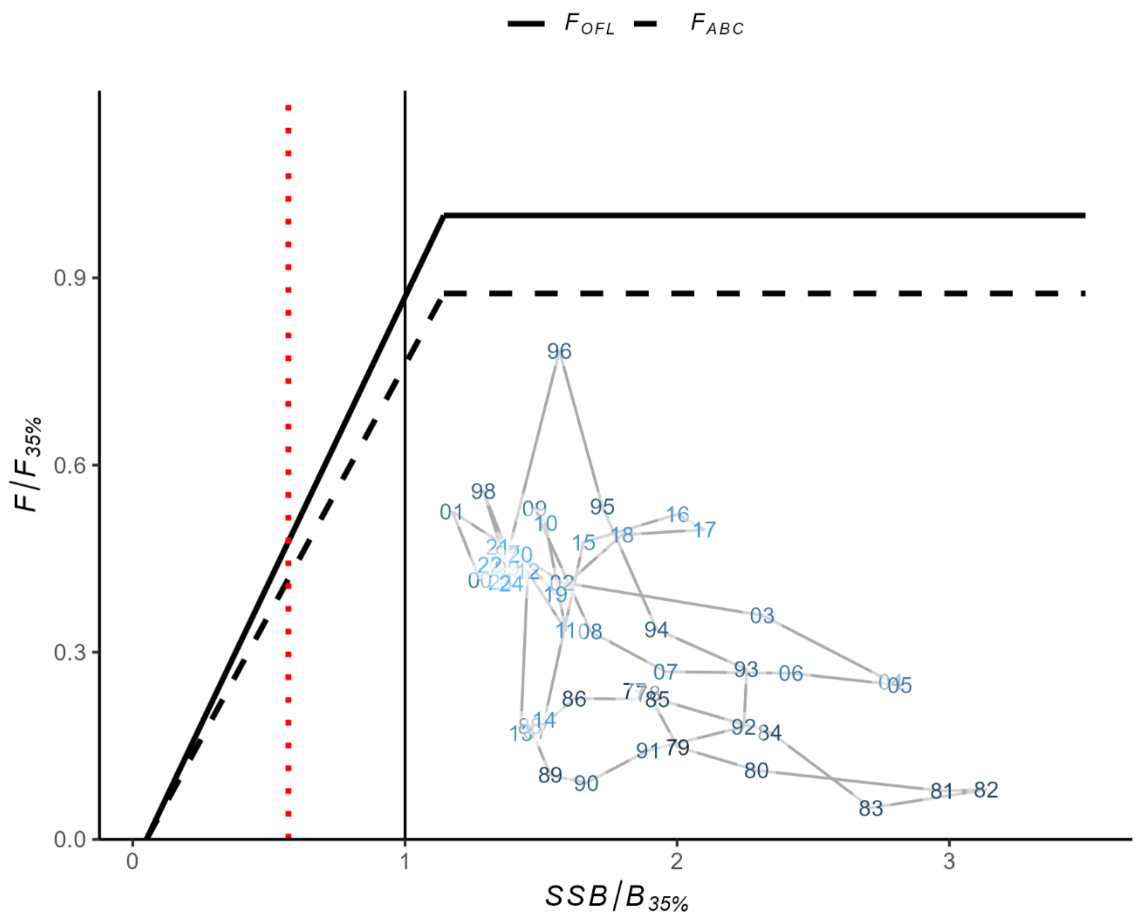


Figure 17.21. Aleutian Islands Atka mackerel spawning biomass relative to $B_{35\%}$ and fishing mortality relative to F_{OFL} (1977-2024). The vertical solid black line at $SSB/B_{35\%} = 1$ represents $B_{35\%}$, and the vertical dotted red line represents $B_{20\%}$, a threshold below which further stellar sea lion protections are triggered. The ratio of fishing mortality to F_{OFL} is calculated using the estimated selectivity pattern in that year. Estimates of spawning biomass and $B_{35\%}$ are based on current estimates of weight-at-age and mean recruitment. Because these estimates change as new data become available, this figure can only be used in a general way to evaluate management performance relative to biomass and fishing mortality reference levels.

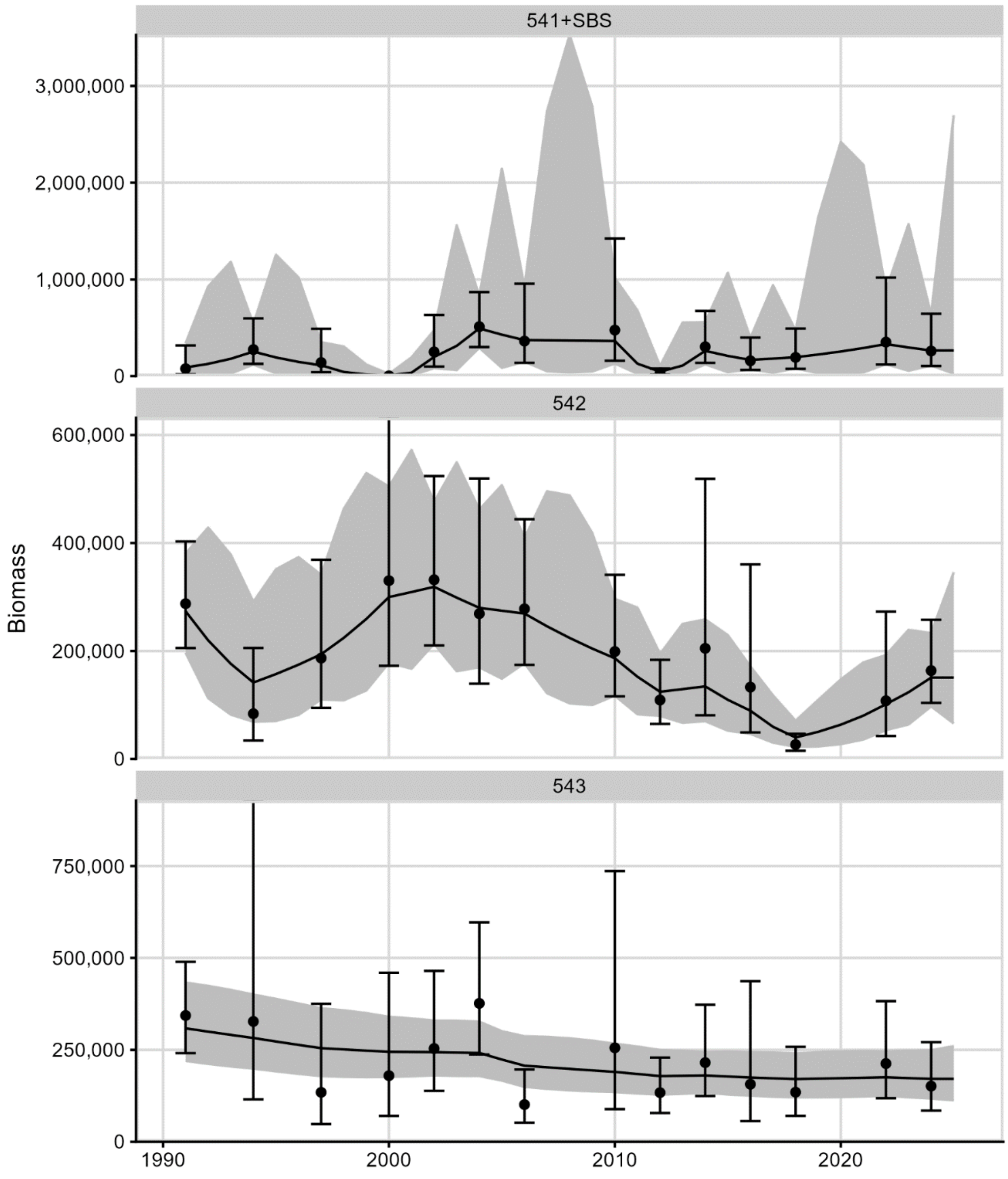


Figure 17.22. Atka mackerel bottom trawl survey biomass by subarea 1991-2024 with random effects model fitting for area apportionment purposes. The random effects biomass estimates for 2024 in the Eastern Aleutians (541) + Southern Bering Sea (SBS) is 265,082 t (45.2%), Central Aleutians (542) is 150,644 t (25.7%), and Western Aleutians (543) is 170,963 t (29.1%).

Appendix 17A Supplemental catch data

In order to comply with the Annual Catch Limit (ACL) requirements, a new dataset was generated to help estimate total catch and removals from NMFS stocks in Alaska.

The dataset represents the non-commercial removals and estimates total available removals that do not occur during directed groundfish fishing activities. These include removals incurred during research, subsistence, personal use, recreational, and exempted fishing permit activities, but do not include removals taken in fisheries other than those managed under the groundfish FMP. These estimates represent additional sources of removals to the existing Catch Accounting System (CAS) estimates. Estimates for Atka mackerel from this dataset are shown along with trawl survey removals from 2000-2023 in Table 17A-1. Recent removals from activities other than directed fishing totaled 1 t in 2021, 104 t 2022, and <1 t in 2023. This is approximately <0.1 % of the 2020-2023 ABCs. These low levels of non-commercial catch represent a negligible risk to the stock. These removals were not incorporated in the stock assessment. If these removals were accounted for in the stock assessment model, the recommended ABCs for 2025 and 2026 would likely change very little.

Table 17A-1. Total removals of BSAI Atka mackerel (t) from activities not related to directed fishing, since 2000. "Trawl" refers to a combination of the NMFS echo-integration, small-mesh, large-mesh, and Aleutian Islands bottom trawl surveys, and occasional short-term research projects involving trawl gear. "Other" refers to recreational, personal use, and subsistence harvest.

Year	Source	Trawl	NMFS Longline Survey	IPHC Longline Survey	Other	Total
2000	AFSC	105				105
2001	AFSC	0				0
2002	AFSC	171				171
2003	AFSC	0				0
2004	AFSC	240				240
2005	AFSC	0				0
2006	AFSC	99				99
2007	AFSC	0				0
2008	AFSC	0				0
2009	AFSC	0				0
2010	AFSC	140				140
2011	AFSC	1,529				1,529
2012	AFSC	62				62
2013	AFSC	0				0
2014	AFSC	111				111
2015	AFSC	4				4
2016	AFSC	78				78
2017	AFSC	2				2
2018	AFSC	71				71
2019	AFSC	0				0
2020	AFSC	0				0
2021	AFSC	1				1
2022	AFSC	104				104
2023	AFSC	0				0

Appendix 17B. BSAI Atka Mackerel Economic Performance Report

Russel Dame

Atka mackerel is predominantly caught in the Aleutian Islands, and almost exclusively by the Amendment 80 Fleet. The fishery for Atka mackerel has been a catch share fishery since 2008 when Amendment 80 was implemented rationalizing the fleet of catcher/processor vessels in the Bering Sea and Aleutian Islands region targeting flatfish, Atka mackerel and Pacific ocean perch.[4] Atka mackerel is an important source of revenue for the Amendment 80 fleet because of its comparatively high price relative to other species. In 2023 Atka mackerel total and retained catch remained above the 2014-2018 average, reaching the highest level in the past five years. Commensurate with the change in catch, first wholesale production increased to 38.8 thousand tons. The increase in production was accompanied by a 5% increase in price to $1.06 per pound resulting in a 20% increase in first-wholesale revenue to $90.3 million.

COVID-19 had an unprecedented impact on fisheries in Alaska. Undoubtedly, one of the significant economic impacts experienced by the industry were the mitigation costs experienced by the fishing and processing industries to continue to supply national and global markets for seafood. Existing data collections do not adequately capture these costs, and as such, this report focuses on catch, revenues, and effort and changes occurring during the most recent year. Atka mackerel catch levels relative to TAC were within a typical range suggesting that COVID-19 did not have a significant impact on catch levels. In contrast to changes in landings, however, there was a notable decrease in prices for many of the products with significant exports to China for reprocessing and Japan, which ultimately go to food service sectors. This includes Atka mackerel, which has significant end markets in Japan, China, and South Korea in both foodservice and retail. The downward pressure on these prices is likely the result of COVID-19 related logistical difficulties in international shipping and inspections, as well as foodservice closures, and compounded the downward pressure on prices from tariffs. This downward pressure on fish product prices in the first-wholesale market coupled with cost pressure from COVID-19 mitigation efforts likely resulted in negative impacts on net revenues. The impacts from COVID-19 lingered throughout 2022, but we are beginning to see an upward trend in wholesale and export value and prices beyond pre-COVID-19 levels.

The U.S. (Alaska), Japan and Russia are the major producers of Atka mackerel.[5] Typically, over 98% of the Alaska caught Atka mackerel production value is processed as head-and-gut (H&G) products, the remainder is mostly sold as whole fish (Table 17B-1). Virtually all of Alaska's Atka mackerel production is exported, mostly to Asian markets. In Asia it undergoes secondary processing into products like surimi, salted-and-split and other consumable product forms. Industry reports that the domestic market is minimal and data indicate U.S. imports are approximately 0.1% of global production. Export prices have been relatively flat since 2016, declining only $0.01 from the 2014-2018 average to $1.24 in 2023 despite increases in international supply. Global production increased from an average of 114.6 thousand t between 2014-2018 to an average of 129 thousand t between 2019-2022 (Table 17B-2). The U.S. share of global catch decreased from an average of 48% between 2014-2018 to 46% between 2019-2022, largely driven by the high retained catch in 2021. Since 2019, the increase in international supply outpaced the increase in total catch causing the U.S. share of global production to decline each subsequent year. In 2022, the decline in global production was greater than the reduction in total catch causing the U.S. share of global production to slightly increase.

[4] Because Atka mackerel is only targeted by at-sea catcher/processor vessel there is not an effective ex-vessel market for it. Though ex-vessel statistics are computed for national reporting purposes.
[5] Japan and Russia catch the distinct species Okhotsk Atka mackerel (*Pleurogrammus azonus*) which are substitutes as the markets treat the two species identically.

The first-wholesale price has declined from the 2014-2018 average ($1.23) to a low of $0.91 in 2021 before increasing to $1.06 in 2023. Because Atka is primarily exported to Japan, which constitutes roughly 70% of the export value, the U.S. exchange rate can influence first-wholesale prices. The exchange rate has remained stable since 2016, though the U.S. dollar weakened somewhat against the Yen in 2020, it was within its historical range (Table 17B-2). In 2022, the value of the U.S. dollar increased significantly against the Yen making U.S. seafood exports relatively more expensive to Japanese importers compared to historical levels. The value of the U.S. dollar continued to increase in 2023 to a historical high. Despite the increase in the value of the U.S. dollar, total export value and the share of export value to Japan increased in 2023. This may partially be due to the changes in size composition of exports. Atka mackerel is typically exported in boxes weighing approximately 19 kilograms (kg). Each box, commonly referred to as a “pack”, is “packed” with specific counts of frozen H&G fish of similar weight allowing the count to indicate the approximate size of each fish. As the count of fish in a pack increases, the average size of each fish within the pack decreases. Alaska typically exports 48-count packs, but due to a decline in large-sized fish, an increase of 70-count packs is being exported with prices remaining relatively stable. Because of China’s significance as an export market (approximately 25% of export volume), the tariffs between the U.S. and China which begun in 2018, may have put downward pressure on Atka mackerel prices which has inhibited value growth in that market. Atka mackerel was among the species to receive relief under the USDA Seafood Tariff Relief Program in 2019-2020. The COVID-19 pandemic created supply chain logistical difficulties, which may have put downward pressure on prices.

Table 17B-1. Atka mackerel catch and first-wholesale market data. Total and retained catch (thousand metric tons, kt), number of vessels, first-wholesale production (thousand metric tons, kt), value (million US$), price (US$ per pound), and head and gut share of production; 2014-2018 average and 2019-2023.

	2014-2018 Average	**2019**	**2020**	**2021**	**2022**	**2023**
Total catch kt	55.88	58.7	59.5	62.3	59	67.1
Retained catch kt	54.496	57.75	58.64	61.18	58.19	65.9
Vessels #	15.6	18	16	18	17	18
First-wholesale production kt	34.61	33.93	34.19	35.63	33.91	38.74
First-wholesale value M US$	$94.19	$86.63	$79.07	$71.54	$75.29	$90.34
First-wholesale price/lb US$	$1.23	$1.16	$1.05	$0.91	$1.01	$1.06
H&G share of value	91.46%	98.86%	98.87%	99.6%	99.9%	98.25%

Source: NMFS Alaska Region Blend and Catch-accounting System estimates; NMFS Alaska Region At-sea Production Reports; and ADF&G Commercial Operators Annual Reports (COAR). Data compiled and provided by the Alaska Fisheries Information Network (AKFIN).

Table 17B-2. Atka mackerel U.S. trade and global market data. Global production (thousand metric tons, kt), U.S. share of global production, U.S. export volume (thousand metric tons, kt), U.S. export value (million US$), U.S. export price (US$ per pound) and the share of U.S. export value from Japan; 2014-2018 average and 2019-2023.

	2014-2018 Average	**2019**	**2020**	**2021**	**2022**	**2023**
Global production kt	114.65	118.11	129.31	139.93	130.12	-
U.S. Share of global catch	48%	49%	45%	44%	45%	-
Export volume kt	31.17	28.11	29.72	33.13	30.89	35.69
Export value M US$	$86.24	$77.34	$81.59	$90.04	$83.73	$97.7
Export price/lb US$	$1.25	$1.25	$1.25	$1.23	$1.23	$1.24
Japan's share of export value	70.23%	63.22%	68.3%	74.5%	67.02%	70.94%
Exchange rate, Yen/Dollar	111.67	109.01	106.77	109.76	131.5	140.49

Source: FAO Fisheries & Aquaculture Dept. Statistics http://www.fao.org/fishery/statistics/en. NOAA Fisheries, Fisheries Statistics Division, Foreign Trade Division of the U.S. Census Bureau, http://www.st.nmfs.noaa.gov/commercial-fisheries/foreign-trade/index. U.S. Department of Agriculture http://www.ers.usda.gov/data-products/agricultural-exchange-rate-data-set.aspx.