

Section 13

ASSESSMENT OF BERING SEA/ALEUTIAN ISLANDS  
ATKA MACKEREL

by  
Sandra A. Lowe and Lowell W. Fritz

EXECUTIVE SUMMARY

Summary of Major Changes

A stock assessment for Atka mackerel was conducted, however, a formal stock assessment chapter was not available in time for the SAFE document, but will be available prior to the December Council meeting. Relative to the November 1999 SAFE report, the following substantive changes have been made in the assessment of Atka mackerel.

Changes in the Input Data

- 1) Catch data were updated.
- 2) The 1999 fishery age composition data were included.
- 3) The 2000 Aleutian survey age composition data were included.
- 4) The 2000 Aleutian survey biomass estimate and associated variance were included.

Changes in the Assessment Methodology

- 1) No substantive changes were made in the assessment model.
- 2) An ABC harvest strategy which incorporates an adjustment to accommodate survey biomass uncertainty was recommended.
- 3) An apportionment strategy which uses a 4-survey (1991, 1994, 1997, and 2000) weighted average was recommended.

Changes in Assessment Results

- 1) The mean recruitment from the stochastic projections is 546 million recruits, which gives an estimated  $B_{40\%}$  level of 154,300 mt.
- 2) The projected age 3+ biomass at the beginning of 2001 is estimated at 553,200 mt.
- 4) The projected female spawning biomass for 2001 is estimated at 159,400 mt.
- 4) The projected 2001 yields at  $F_{40\%}$  and  $F_{ABC}$  are 127,900 and 58,700 mt, respectively.
- 5) The **2001 recommended ABC is 58,700 mt** corresponding to  $F = 0.19$ .
- 6) The projected 2001 overfishing level at  $F_{35\%}$  ( $F = 0.42$ ) is 138,100 mt.

Response to comments by the Scientific and Statistical Committee (SSC)

There were no SSC comments pertaining to the BSAI Atka mackerel assessment from the December 1999 SSC minutes.

Table 13.1. Atka mackerel catches (including discards) by region and corresponding Total Allowable Catches (TAC) set by the North Pacific Fishery Management Council from 1978 to the present. Catches are in mt.

Year	Eastern Bering Sea				Aleutian Islands Region				EBS-AI	
	Foreign	Domestic		Total	Foreign	Domestic		Total	Total	TAC
		JVP	DAP			JVP	DAP			
1977	0	0	0	a	21,763	0	0	21,763	21,763	b
1978	831	0	0	831	23,418	0	0	23,418	24,249	24,800
1979	1,985	0	0	1,985	21,279	0	0	21,279	23,264	24,800
1980	4,690	265	0	4,955	15,533	0	0	15,533	20,488	24,800
1981	3,027	0	0	3,027	15,028	1,633	0	16,661	19,688	24,800
1982	282	46	0	328	7,117	12,429	0	19,546	19,874	24,800
1983	140	1	0	141	1,074	10,511	0	11,585	11,726	24,800
1984	41	16	0	57	71	35,927	0	35,998	36,055	23,130
1985	1	3	0	4	0	37,856	0	37,856	37,860	37,700
1986	6	6	0	12	0	31,978	0	31,978	31,990	30,800
1987	0	12	0	12	0	30,049	0	30,049	30,061	30,800
1988	0	43	385	428	0	19,577	2,080	21,656	22,084	21,000
1989	0	56	3,070	3,126	0	0	14,868	14,868	17,994	20,285
1990	0	0	480	480	0	0	21,725	21,725	22,205	21,000
1991	0	0	2,596	2,596	0	0	24,144	24,144	26,740	24,000
1992	0	0	2,610	2,610	0	0	47,425	47,425	50,035	43,000
1993	0	0	213	213	0	0	65,524	65,524	65,737	64,000
1994	0	0	189	189	0	0	69,401	69,401	69,590	68,000
1995	0	0	a	a	0	0	81,554	81,554	81,554	80,000
1996	0	0	a	a	0	0	103,943	103,943	103,943	106,157
1997	0	0	a	a	0	0	65,845	65,845	65,845	66,700
1998	0	0	a	a	0	0	57,177	57,177	57,177	64,300
1999	0	0	a	a	0	0	53,643	53,643	53,643	66,400
2000c	0	0	a	a	0	0	42,368	42,368	42,368	70,800

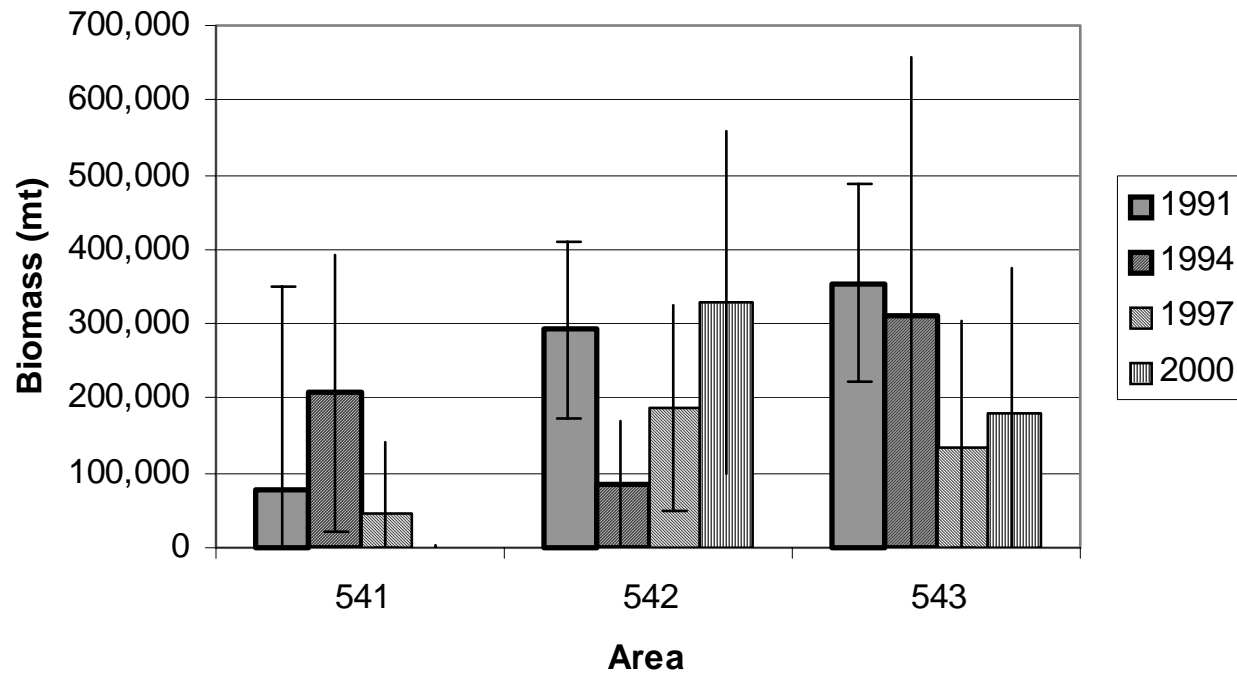
Catch table footnotes:

- a) Eastern Bering Sea catches included with Aleutian Islands.
- b) Atka mackerel was not a reported species group until 1978
- c) 2000 data as of 10/14/00 from NMFS Alaska Regional Office Home Page.

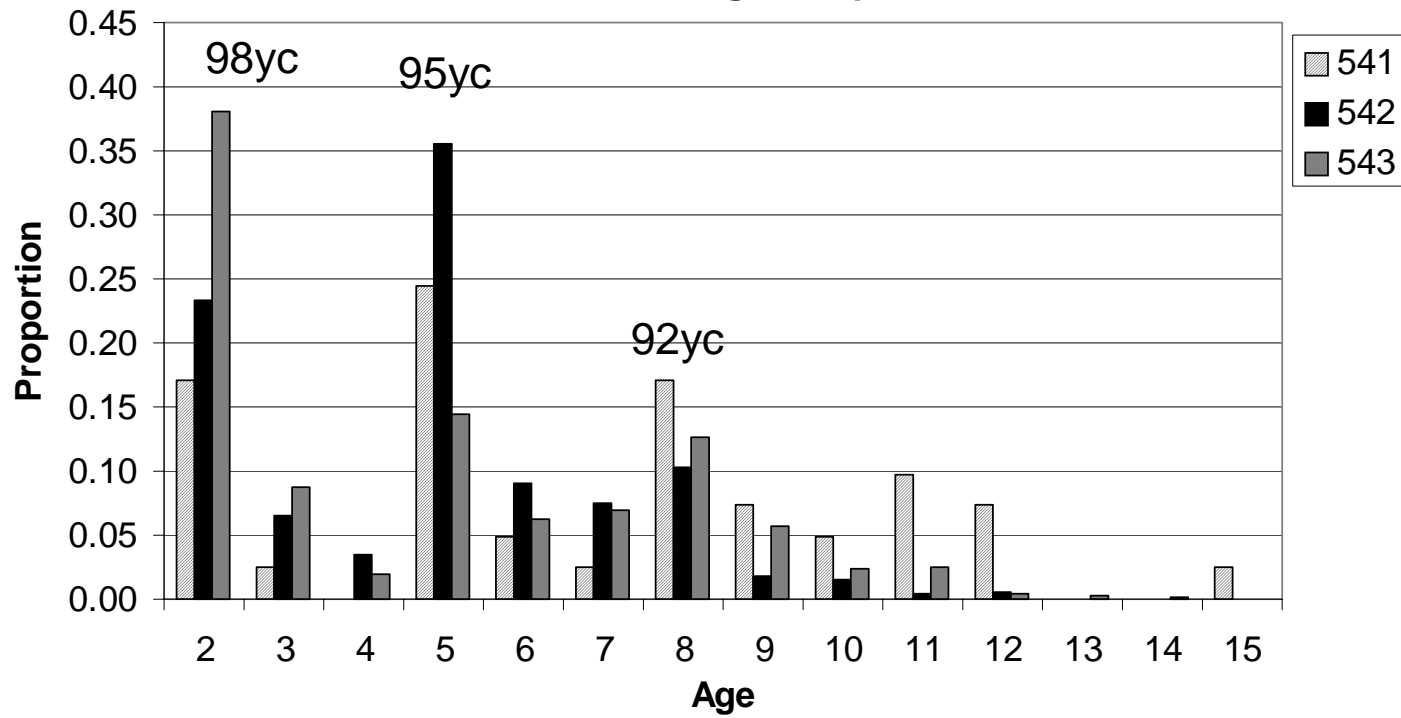
Table 13.5 Atka mackerel biomass (mt), and the percentage distribution and coefficients of variation by management area from the bottom trawl surveys in the Aleutian Islands in 1991, 1994, and 1997. Biomass is also reported by survey depth interval.

Area	Depth (m)	Biomass (mt)				Percent Distribution				Coefficient of Variation			
		1991	1994	1997	2000	1991	1994	1997	2000	1991	1994	1997	2000
Aleutian Islands	1-100	429,826	145,000	188,504	145,001								
	101-200	293,554	455,452	177,663	357,138								
	201-300	538	1,688	127	8,635								
	301-500	-	22	20	82								
	Total	723,918	602,161	366,314	510,857	100%	100%	100%	100%	15%	33%	29%	28%
Western 543	1-100	168,968	93,847	90,824	106,168								
	101-200	185,748	214,228	43,478	65,600								
	201-300	304	1,656	63	7,912								
	301-500	-	6	-	-								
	Total	355,020	309,737	134,364	179,680	49.0%	51.4%	36.7%	35.2%	18%	55%	56%	51%
Central 542	1-100	187,194	50,513	70,458	38,805								
	101-200	104,413	33,517	116,295	290,766								
	201-300	71	13	53	674								
	301-500	-	3	6	9								
	Total	291,679	84,046	186,813	330,255	40.3%	14.0%	51.0%	64.6%	18%	48%	36%	34%
Eastern 541	1-100	73,663	641	27,222	29								
	101-200	3,392	207,707	17,890	772								
	201-300	163	19	11	48								
	301-500	-	12	14	73								
	Total	77,218	208,379	45,137	<b>922</b>	10.7%	34.6%	12.3%	<b>0.2%</b>	83%	44%	68%	74%
Bering Sea	1-100	47	66,562	95,672	1,853								
	101-200	3	30	9	187								
	201-300	11	3	-	4								
	301-500	-	8	-	-								
	Total	61	66,603	95,680	2,044					37%	99%	99%	87%

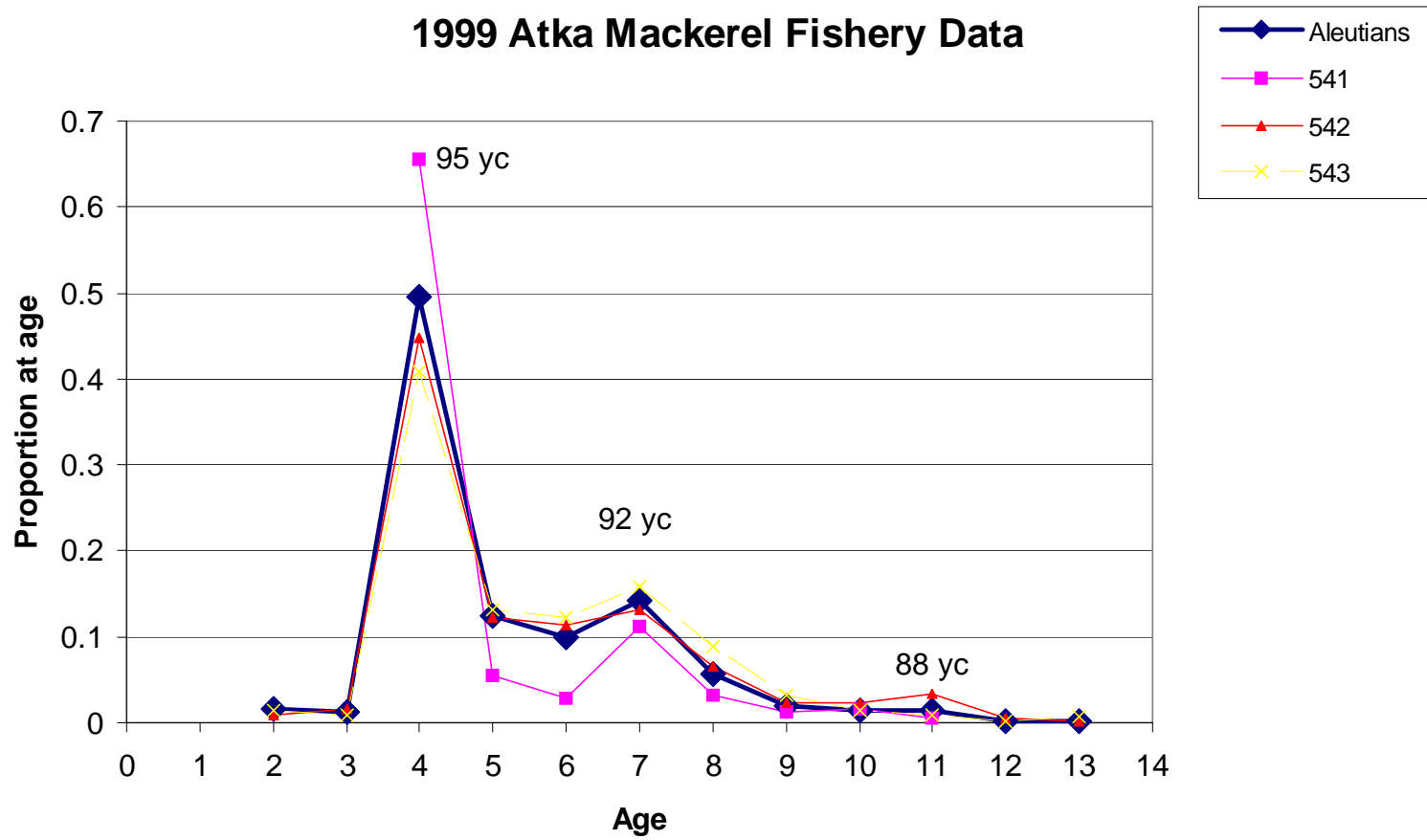
**Atka Mackerel Survey Biomass (mt)**  
**(Bars represent 95% CI)**

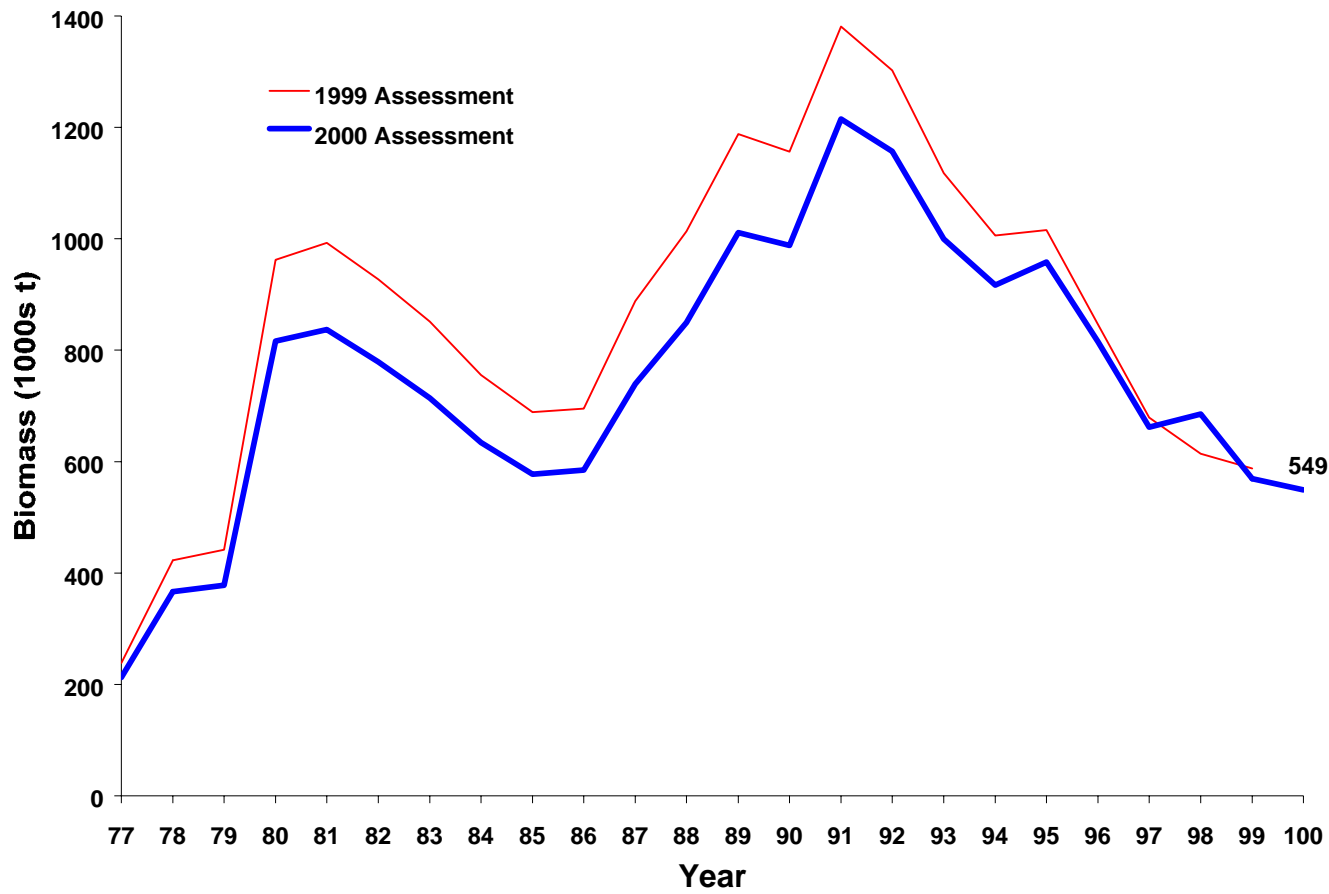


**2000 Aleutian Survey  
Atka Mackerel Age Composition**

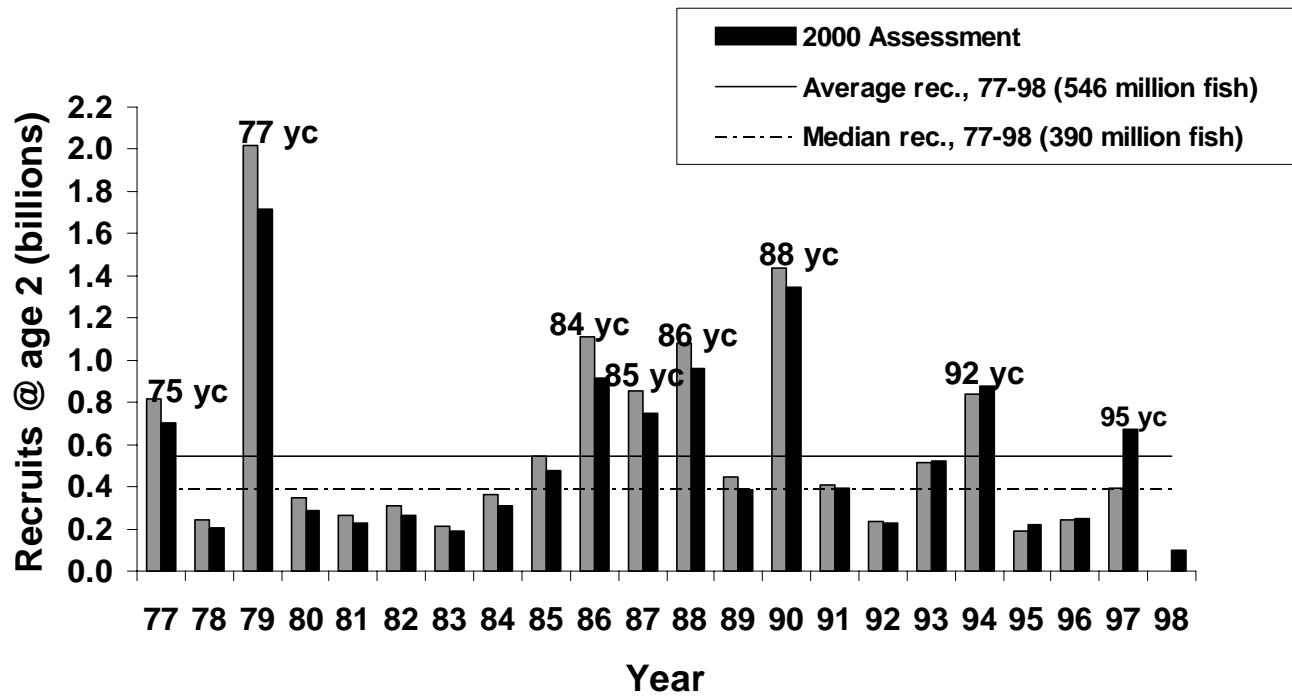


### 1999 Atka Mackerel Fishery Data





Aleutian Islands Atka mackerel biomass estimates (ages 3+) from 1977-2000 estimated by stock synthesis in the current assessment and last year's assessment.



Numbers of age 2 Atka mackerel recruits by year (1977-98) as estimated by stock synthesis.



13.7.1 Reference Fishing Mortality Rates and Yields

The overfishing and maximum allowable ABC fishing mortality rates ( $F_{OFL}$  and  $max F_{ABC}$ , respectively) are given in terms of percentages of unfished female spawning biomass per recruit ( $F_{SPR\%}$ ), on fully selected age groups. The associated long-term average female spawner biomass that would be expected under average estimated recruitment from 1977-1998 (546 million recruits) and  $F = F_{40\%}$ , denoted  $B_{40\%}$ , is estimated to be 154,300 mt. The projected 2001 female spawning biomass ( $SB_{01}$ ) is 159,400 mt. Given reliable estimates of current spawning biomass ( $SB_{01}$ ),  $B_{40\%}$ ,  $F_{40\%}$ ,  $F_{35\%}$ , and that  $SB_{01}$  is greater than  $B_{40\%}$ , Atka mackerel fall into Tier 3a of the ABC/OFL definitions (Amendment 56 to the BSAI FMP). According to the definitions and results from the current assessment,  $F_{OFL} = F_{35\%} = 0.42$ , and  $max F_{ABC} = F_{40\%} = 0.35$ . Projected 2001 yields associated with  $F_{OFL}$  and  $max F_{ABC}$  are 138,100 and 127,900 mt, respectively.

Harvest Strategy	$F_{SPR\%}$	Fishing Mortality Rate	2001 Projected Yield (mt)
$F_{OFL}$	$F_{35\%}$	0.42	138,100
$max F_{ABC}$	$F_{40\%}$	0.35	127,900

The harvest strategy used to set the 2000 Atka mackerel ABC is given below with the projected 2001 yield:

Harvest Strategy	$F_{SPR\%}$	Fishing Mortality Rate	2001 Projected Yield (mt)
2000 $F_{ABC}$	$F_{52\%}$	0.23	69,300

13.7.2 ABC Considerations

Yield determinations for Atka mackerel using various reference points ( $F_{52\%}$ ,  $F_{40\%}$ ,  $F_{OFL\%}$ ) have been computed with no confidence bounds surrounding them. These are the point estimates based on current year biomass, age composition, and biological characteristics of the species. A large component of the variance (uncertainty) for Atka mackerel is survey biomass estimates, a crucial value in the stock assessment in that it scales the population abundance trend. The 1986, 1991, 1994, 1997, and 2000 survey estimates for Atka mackerel are treated as absolute abundance estimates in the model. We suggest that this uncertainty be incorporated in the ABC by setting the fishing mortality rate associated with ABC ( $F_{ABC}$ ) at a specified fraction of the maximum allowable fishing mortality rate ( $max F_{ABC}$ ), where this fraction varies directly with the uncertainty (variance) of the survey biomass estimates. Specifically, this is accomplished by computing the average coefficient of variation (CV) for the survey biomass estimates in the time series, and then computing the lower bound of the 90 percent confidence interval for a lognormal distribution with this CV and a median of unity. This lower bound is the specified fraction by which to reduce  $max F_{ABC}$ .

The point estimates of Atka mackerel biomass and the respective coefficients of variation (CV) are listed in the table below.

<u>Survey Year</u>	<u>Mean Biomass (mt)</u>	<u>CV</u>
1986	544,800	0.630
1991	723,900	0.266
1994	602,200	0.366
1997	366,400	0.277
2000	510,900	0.283
<b>Average</b>		0.364

Estimates of the coefficient of variation (*CV*) for Aleutian Islands Atka mackerel survey biomass estimates ranged from 27% in 1991 to 63% in the 1986 survey. The average *CV* for the Atka mackerel survey biomass estimates in the time series is 36.4%. The lower bound of the 90% confidence interval for a lognormal distribution with this *CV* and a median of unity is estimated at 0.56. This lower bound value is the specified fraction by which  $max F_{ABC}$  ( $F_{40\%}$  for Atka mackerel) was reduced in the projection model to accommodate survey imprecision. This reduction to  $F_{40\%}$  resulted in the estimated recommended 2001  $F_{ABC}$  for Atka mackerel.

#### 13.7.4 ABC Recommendation, Overfishing Level, and Status Determination

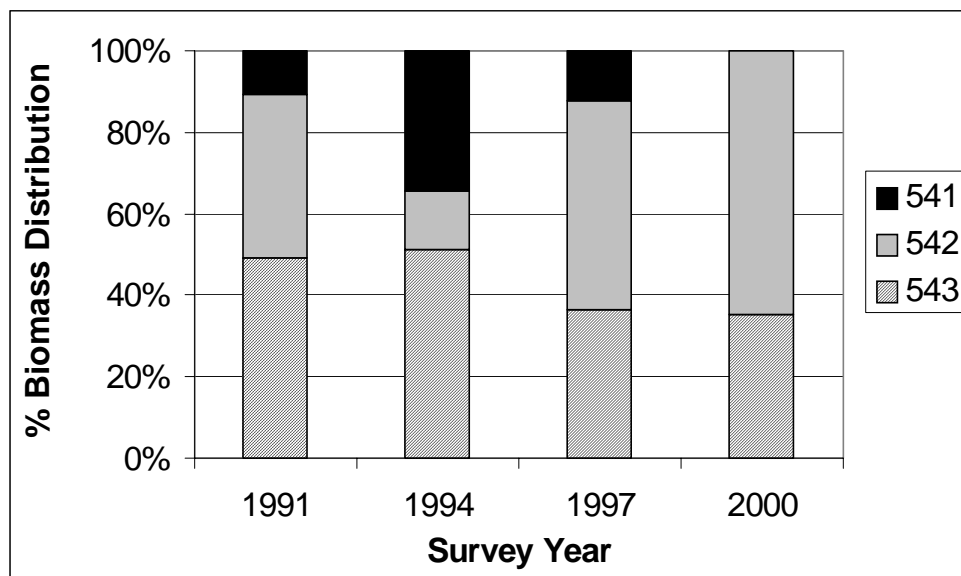
As a means of incorporating an adjustment to accommodate uncertainty associated with survey biomass estimates, and as a direct application of the approach used in the NMFS Supplemental Environmental Impact Statement (SEIS) and applied to all target groundfish, we explored an alternative harvest strategy determined by multiplying  $max F_{ABC} = F_{40\%} = 0.35$  by 0.56, resulting in an  $F = 0.19$ . The factor 0.56 was determined as outlined in the above section and used for the harvest projection. Short-term stochastic projections under an  $F = 0.19$ , result in female spawning biomass remaining above  $B_{40\%}$  within 12 years, compared to harvesting at  $F_{40\%}$  in which projected female spawning biomass drops below  $B_{40\%}$  in 2001, 2002, and 2003. Based on a comparison of the  $F_{40\%}$  strategy versus an  $F = 0.19$  in the projections, we recommend that  $F_{ABC} = 0.19$ . **The associated 2001 yield with a fishing mortality rate of 0.19 is 58,700 mt, which is our 2001 ABC recommendation for BSAI Atka mackerel.**

**The  $F_{35\%}$  overfishing level is 138,100 mt.** The estimated  $B_{35\%}$  female spawner biomass is 135,000 mt. Female spawning biomass for 2001 is projected to be above  $B_{35\%}$  thus, the BSAI Atka mackerel stock is determined to be *above* its minimum stock size threshold (MSST) and is *not overfished*. Female spawning biomass for 2013 is projected to be above  $B_{35\%}$  thus the BSAI Atka mackerel stock is *not* expected to fall below its MSST in two years and is *not approaching an overfished condition*.

#### 13.7.5 Apportionment of Catch

Amendment 28 of the Bering Sea/Aleutian Islands 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 TACs. The Council used the average of the 1994 and 1997 survey biomass distributions of Atka mackerel to apportion the 1999 and 2000 ABC.

The triennial Aleutian trawl survey occurs every three years in the summer months. The historical pattern or rather lack of pattern in the Atka mackerel biomass distribution likely indicates a high degree of observation and process error. The sensitivity of the 2000 biomass distribution to an extremely large decline in biomass in the Eastern Aleutians (541) is also a concern.



	1991	1994	1997	2000	2000 TAC Apportionment (ave. 1994 & 1997)	4 survey unweighted average	4 survey weighted average
543	49.0%	51.4%	36.4%	35.2%	42%	43.0%	<b>40.2%</b>
542	40.3%	14.0%	51.0%	64.6%	35%	42.5%	<b>48.5%</b>
541	10.7%	34.6%	12.3%	0.2%	23%	14.5%	<b>11.2%</b>
Weights	8	12	18	27			

As a more robust way of apportioning biomass, we suggest using a longer term weighted average. A four-survey average (1991, 1994, 1997, and 2000) is suggested to capture changes in the average biomass distribution. A weighted average with the highest weights given to the most recent survey year is also recommended to adapt to current information and the possibility of autocorrelation, that is, the tendency for the true biomass distribution to be similar from one year to the next

Following the apportionment method used for GOA rockfish, we assume that observation error contributes 2/3 of the total variability in predicting the distribution of biomass; (the survey variability for Atka mackerel is similar to the level of survey variability estimated for most rockfish), thus the weight of a prior survey should be 2/3 the weight of the subsequent survey. This resulted in weights of 8:12:18:27 for the 1991, 1994, 1997, and 2000 surveys, respectively.

ABC Apportionment of 58,700 mt			
	2000 survey	4 survey unweighted average	4 survey weighted <sup>1</sup> average
543	20,700	25,200	<b>23,600</b>
542	37,900	25,000	<b>28,500</b>
541	100	8,500	<b>6,600</b>
Total	58,700	58,700	<b>58,700</b>

<sup>1</sup>The weighting scheme is based on the assumption that survey error (measurement error) contributes 2/3 of the total variability in predicting biomass distribution, and the weight of a prior survey should be 2/3 the weight of the subsequent survey.

The apportionment based on the 4 survey weighted average is the recommendation for the 2001 ABC: **23,600 mt for 543, 28,500 mt for 542, and 6,600 mt for 541.**

A Regulatory Amendment for the Bering Sea/Aleutian Islands Atka mackerel fishery mandated percent allocations of Atka mackerel catch to A and B seasons for all subareas, and inside and outside of Steller sea lion critical habitat in areas 542 and 543, beginning in 1999. The BSAI Atka mackerel TAC is divided into two equal seasonal allowances. The percentage allocations that would be applied to the subarea apportionments of the 2001 recommended TAC within a season under this amendment are as follows:

#### Spatial Allocation of 2001 TAC

Subarea	541 & EBS	542		543	
		Inside	Outside	Inside	Outside
Critical Habitat					
% Allocation within a season		54%	46%	49%	51%

## SUMMARY

$$M = 0.30$$

$$2000: \quad F_{ABC} = 0.23 \quad \text{yield} = \mathbf{70,800 \text{ mt}}$$

2001

$$\text{Maximum permissible ABC} \quad F_{40\%} = 0.35 \quad \text{yield} = 127,900 \text{ mt}$$

$$\text{Recommended ABC:} \quad F_{ABC\%} = 0.19 \quad \text{yield} = 58,700 \text{ mt}$$

$$\text{Overfishing } F_{OFL}: \quad F_{35\%} = 0.42 \quad \text{yield} = 138,100 \text{ mt}$$

$$B_{40\%} \text{ female spawning biomass} = 154,300 \text{ mt}$$

$$B_{35\%} \text{ female spawning biomass} = 135,000 \text{ mt}$$

$$\text{Projected 2001 3+ biomass} = 553,200 \text{ mt}$$

$$\text{Projected 2001 female spawning biomass} = 159,400 \text{ mt}$$

Note: The  $F$  values are the full-selection fishing mortality rates.