Chapter 7

Assessment of the Kamchatka Flounder stock in the Bering Sea and Aleutian Islands

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Executive Summary

This document is the second analysis of stock status and harvest recommendation for Kamchatka flounder as a single species. It had previously been a constituent of the *Atheresthes* species complex of which arrowtooth flounder had the dominant biomass and ABC's were set based upon its productivity and stock status. Due to the recent development of a targeted fishery on Kamchatka flounder it is now managed as a single species in the BSAI.

Quantity	As estimated or *specified last* year for: 2011	2012	As estimated or *recommended this* year for: 2012	2013
M (natural mortality rate)	0.2	0.2	0.2	0.2
Tier	5	5	5	5
Biomass (t)	128,800	128,800	125,200	125,200
F_{OFL}	0.2	0.2	0.2	0.2
$maxF_{ABC}$	0.15	0.15	0.15	0.15
F_{ABC}	0.15	0.15	0.15	0.15
OFL (t)	23,600	23,600	24,800	24,800
maxABC (t)	17,700	17,700	18,600	18,600
ABC (t)	17,700	17,700	18,600	18,600
Status	As determined *last* year for: 2011	2012	As determined *this* year for: 2012	2013
Overfishing	n/a	n/a	n/a	n/a

Although the 2011 biomass is 3,700 t less than the 2010 estimate, the ABC and OFL values are 900 and 1,200 t higher in 2011 due to the 7 year averaging method of total biomass used to determine ABC and OFL.

SSC Comments

A preponderance of Kamchatka flounder catches occur in the eastern AI. The SSC supports the Plan Team's recommendation that the authors should report catches and exploitation rates separately for the EBS and AI, and analyze options for area apportionment for next year's assessment. Also, the SSC asks the assessment authors to more thoroughly evaluate alternative

methods for estimation of *M*. Longevity is 33 years for both sexes; the preliminary estimate of *M* = 0.2 may be high. Finally, the justification for using a 7-year period of averaging should be reviewed periodically.

The 2011 Kamchatka flounder catch was split nearly evenly between the Bering Sea and Aleutian Islands management areas and in smaller amounts than in the 2010 fishery. Primarily from two areas, 541 and 524, this may represent a shift in harvest location for this emerging fishery from where they were fished in the very recent past. Based on this result in 2011, no area apportionment was pursued in this assessment.

Regarding an exploration of natural mortality for this species**,** our primary focus now is to elevate this assessment to Tier 3 status with the development of an age-structured model in 2012 or 2013. Upon completion of an age reading request we should be able to develop an age-length conversion matrix to incorporate size composition data into a model (a maturity study was recently completed) and then analyze natural mortality. The 7-year averaging technique would then be discontinued.

Introduction

The Kamchatka flounder (*Atheresthes evermanni*) is a relatively large flatfish which is distributed from Northern Japan through the Sea of Okhotsk to the Western Bering Sea north to Anadyr Gulf (Wilimovsky et al. 1967) and east to the eastern Bering Sea shelf and south of the Alaska Peninsula (there is also a catch record from California). In U.S. waters they are found in commercial concentrations in the Aleutian Islands where they generally decrease in abundance from west to east (Zimmerman and Goddard 1996). They are also present in Bering Sea slope waters but are absent in survey catches east of Chirikof Island.

In the eastern part of their range, Kamchatka flounder overlap with arrowtooth flounder (*Atheresthes stomias*) which are very similar in appearance and were not routinely distinguished in the commercial catches until 2007. Until about 1992, these species were also not consistently separated in trawl survey catches (Fig. 7-1) and were combined in the arrowtooth flounder stock assessment (Wilderbuer et al. 2009). However, managing the two species as a complex became undesirable in 2010 due to the emergence of a directed fishery for Kamchatka flounder in the BSAI management area. Since the ABC was determined by the large amount of arrowtooth flounder relative to Kamchatka flounder (complex is about 93% arrowtooth flounder) the possibility arose of an overharvest of Kamchatka flounder as the *Atheresthes sp.* ABC exceeded the Kamchatka flounder biomass. Beginning with the 2011 fishing season, arrowtooth flounder and Kamchatka flounder are managed separately.

Catch History

Historical Kamchatka flounder catch is combined in catch records of arrowtooth flounder and Greenland turbot from the 1960s. The fisheries for Greenland turbot intensified during the 1970s and the bycatch of arrowtooth flounder and Kamchatka flounder is assumed to have also increased. Catches of these species decreased after implementation of the MFCMA and the Kamchatka flounder resource has remained lightly exploited with the combined catches with arrowtooth flounder averaging 12,831 t from 1977-2008 (Table 7-1). It is estimated that only a small fraction (<10%) of this catch was Kamchatka flounder. This decline resulted from catch restrictions placed on the fishery for Greenland turbot and phasing out of the foreign fishery in the U.S. EEZ. Catches in Table 7-1 through 2006 are for arrowtooth flounder and Kamchatka flounder combined, catches thereafter are those estimated for Kamchatka flounder only. The total catch estimated for arrowtooth and Kamchatka flounder by the Alaska Regional Office is a blend of vessel reported catch and observer at-sea sampling of the catch which was not differentiated by species through 2010. However, observers have separately identified the two species from catches aboard trawl vessels since 2007 and their sampling has indicated that the proportion of Kamchatka flounder in the combined catch has steadily increased from 10% in 2007 to 55% in 2010.

year	Percent of combined catch
2007	10
2008	31
2009	45
2010	55

The increased harvest was the result of a recently developed market for Kamchatka flounder which has now become a fishery target. The 2010 estimated catch of Kamchatka flounder was 21,153 t, taken primarily in area 514 and to a lesser extent in area 518. The 2011 catch through October 15 of 9,160 t is less than half of the 2010 total (TAC and ABC = 17,700 t, OFL = 23,600 t) and was mostly split between area 541 in the central Aleutian Islands (51%) and area 524 in the northern Bering Sea (34%). Overall the catch was evenly split between the Bering Sea and the Aleutian Islands in 2011. The Kamchatka catch by week in 2011 (Fig. 7-2) shows that targeting for Kamchatka flounder began May 1 when about one third of the annual total was taken in one week, and then continued in lesser amounts through mid-October.

Data

The data used in this assessment includes estimates of total catch and bottom trawl survey biomass estimates from the Bering Sea shelf, slope and Aleutian Islands surveys.

Absolute Abundance from Trawl Surveys

Biomass estimates (t) for Kamchatka flounder from the standard shelf survey area in the eastern Bering Sea, slope surveys and the Aleutian Islands region are shown in Table 7-2. Reliable estimates of Kamchatka flounder became available in 1991 and they were estimated at an average biomass of 45,500 t through 1994 on the Bering Sea shelf (Fig. 7-1). During the following 11 years the biomass was estimated at a lower level (26,800 t average) before increasing to high and stable levels the past 7 years (53,200 t average). On the continental shelf they are usually found in highest concentrations at depths greater than 200 meters around the Pribilof Islands and also in the large shelf area west of St. Matthew Island. Trends of abundance from the slope and Aleutian Islands surveys also indicate an increasing resource. They are common in the deeper waters of the slope area (500 to 800 meters, Zimmerman and Goddard 1996) in both the Aleutian Islands and the eastern Bering Sea slope (Figs. 7-3 and 7-4).

An estimate of total BSAI biomass for the years in which Aleutian Islands and slope surveys were not conducted was calculated by averaging the years in closest temporal (before and after) proximity.

Length-weight, maximum age and natural mortality

Length-weight measurements collected in 1999 from 193 fish indicate that males and females grow by accumulating the same weight for a given size (Fig. 7-5). Age at length calculations from a small sample collected in 1991 indicate that males and females exhibit divergent growth after about age 5-6 with females growing larger than males (Zimmerman and Goddard 1996). Both sexes have been found in relatively equal numbers and the oldest fish have been aged at 33 years indicating that Kamchatka flounder are similar in life history to other Bering Sea flatfish. Accordingly we tentatively set the natural mortality rate at 0.2 for both sexes for this assessment.

Acceptable Biological Catch and exploitation rate

Kamchatka flounder have a wide-spread distribution along the deeper waters of the Bering Sea/Aleutian Islands region and are believed to be at a high level as discerned from the increases in survey estimates from the time-series of Bering Sea shelf, slope and Aleutian Islands surveys. The 2011 combined estimate of total biomass from the three areas is 125,200 t (using a linear model to predict 2011 biomass from the Bering Sea slope and Aleutian Islands in the absence of surveys there in 2011, figure 7-6). Exploitation rates estimated for 2008-2010 have steadily increased from 5% in 2008, 10% in 2009 to 16% in 2010 but have declined to 7% in 2011.

Given the limited amount of biological information available for Kamchatka flounder, they are qualified to be managed under Tier 5 of Amendment 56 to the BSAI groundfish management plan, and thus have harvest recommendations which are directly calculated from estimates of biomass and natural mortality. The Tier 5 formula for calculating ABC is: ABC = 0.75 x M x average biomass.

ABC calculated from this formula is sensitive to the fluctuations in annual biomass estimated from bottom trawl surveys (shelf survey cv is 10%, Aleutians cv = 30%). In order to lessen this effect, annual estimates of Kamchatka flounder abundance (using trawl survey estimates when they are available and filling in missing years from the average of the closest previous and future year which bracket the missing year) from the three surveys were summed and then ABC was calculated using running averages which ranged from 3 to the 7 most recent years (all with M = 0.2). ABC estimates from these five methods indicate that the effect of annual variability on the estimate of ABC and OFL can be dampened by including more years in the estimation calculation which was particularly evident in the years of biomass increase from the past five years (Fig. 7-6 and Table 7-3). The seven year moving average is chosen for the ABC and OFL calculations for 2012 since it has the most resilience to the trawl survey variability and gives estimates which are close to the other moving averages.

The potential yield of Kamchatka flounder in 2012, based on a combined biomass of **125,200 t** from the combined trawl survey estimates is summarized as follows:

F_{ABC}	F_{OFL}	ABC	OFL
0.15	0.20	18,600	24,800

The estimates of F_{abc} and F_{ofl} under tier 5 are 0.75 x *M* and *M*, respectively, and the ABC and OFL levels are the product of the fishing mortality rate and the 7 year running average of estimated biomass.

Ecosystem Considerations

Predators of Kamchatka flounder

Kamchatka flounder have rarely been found in the stomachs of other groundfish species in samples collected by the Alaska Fisheries Science Center. Their presence has only been documented in 17 stomach samples from the BSAI where the predators included Pacific cod, pollock, Pacific halibut, arrowtooth flounder and two sculpin species.

Kamchatka flounder predation

The prey of Kamchatka flounder can be discerned from 152 stomachs collected in 1983 (Yang and Livingston 1986). The principle diet was composed of walleye pollock, shrimp (most Crangonidae) and euphausids. Pollock was the most important prey item for all sizes of fish, ranging from 56 to 86% of the total stomach content weight. An examination of diet overlap with arrowtooth flounder indicated that these two congeneric species basically consume the same resources.

Ecosystem Effects on the stock

1) Prey availability/abundance trends

Arrowtooth flounder diet varies by life stage as indicated in the previous section. Regarding juvenile prey and its associated habitat, information is not available to assess the abundance trends of the benthic infauna of the Bering Sea shelf. The original description of infaunal distribution and abundance by Haflinger (1981) resulted from sampling conducted in 1975 and 1976 and has not be re-sampled since. Information on pollock abundance is available in Chapter 1 of this SAFE report. It has been hypothesized that predators on pollock, such as adult arrowtooth flounder, may be important species which control (with other factors) the variation in year-class strength of juvenile pollock (Hunt et al. 2002). The populations of arrowtooth flounder which have occupied the outer shelf and slope areas of the Bering Sea over the past twenty years for summertime feeding do not appear food-limited. These populations have fluctuated due to the variability in recruitment success which suggests that the primary infaunal food source has been at an adequate level to sustain the arrowtooth flounder resource.

2) Predator population trends

As juveniles, it is well-documented from studies in other parts of the world that flatfish are prey for shrimp species in near shore areas. This has not been reported for Bering Sea arrowtooth flounder due to a lack of juvenile sampling and collections in near shore areas, but is thought to occur. As late juveniles they are found in stomachs of pollock and Pacific cod, mostly on small arrowtooth flounder ranging from 5 to 15 cm standard length..

Past, present and projected future population trends of these predator species can be found in their respective SAFE chapters in this volume. Encounters between arrowtooth flounder and their predators may be limited as their distributions do not completely overlap in space and time.

3) Changes in habitat quality

Changes in the physical environment which may affect Kamchatka flounder distribution patterns, recruitment success, migration timing and patterns are catalogued in the Ecosystem Considerations Appendix of this SAFE report. Habitat quality may be enhanced during years and warmer bottom water temperatures with reduced ice cover (higher metabolism with more active feeding). Environmental factors important to juvenile survival are presently not well known.

Ecosystem effects on Kamchatka flounder			
Indicator	Observation	Interpretation	Evaluation
Prey availability or abundance trends			
Benthic infauna	Stomach contents	Stable, data limited	Unknown
Predator population trends			
Fish (Pollock, Pacific cod)	Stable	Possible increases to Kamchatka mortality	
Changes in habitat quality			
Temperature regime	Cold years Kamchatka catchability and herding may decrease	Deeper water species so less likely to affect surveyed stock	No concern (dealt with in model)
Winter-spring environmental conditions	Affects pre-recruit survival	Probably a number of factors	Causes natural variability

Arrowtooth flounder **effects on ecosystem**			
Indicator	Observation	Interpretation	Evaluation
Fishery contribution to bycatch			
Prohibited species	Stable, heavily monitored	Minor contribution to mortality	No concern
Forage (including Pollock, shrimp and euphausids)	Stable, heavily monitored	Bycatch levels small relative to forage biomass	No concern
HAPC biota	Low bycatch levels of (spp)	Bycatch levels small relative to HAPC biota	No concern
Marine mammals and birds	Very minor direct-take	Safe	No concern
Sensitive non-target species	Likely minor impact	Data limited, likely to be safe	No concern
Fishery concentration in space and time	Recent high exploitation rate	Little detrimental effect	No concern
Fishery effects on amount of large size target fish	Recent high exploitation rate, but unknown effect	Natural fluctuation	No concern
Fishery contribution to discards and offal production	Stable trend	Improving, but data limited	Possible concern
Fishery effects on age-at-maturity and fecundity	Unknown	NA	Possible concern

References

Wilderbuer, T. K., D. G. Nichol, and K. Aydin 2009. Arrowtooth flounder. In Stock Assessment and Fishery Evaluation Document for Groundfish Resources in the Bering Sea/Aleutian Islands Region as Projected for 2010, Chapter 6. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage Alaska 99510.

Wilimovsky, N. J., A. Peden, and J. Peppar. 1967. Systematics of six demersal fishes of the north Pacific Ocean. Fish. Res. Board Can., Tech. Rep. 34, 52 p.

Yang, M. S. and P. A. Livingston. 1986. Food habits and diet overlap of two congeneric species, Atheresthes stomias and Atheresthes evermanni, in the eastern Bering Sea. Fish. Bull. Vol. 82 (8)615-623.

Zimmermann, Mark, and Pamela Goddard 1996. Biology and distribution of arrowtooth (Atheresthes stomias) and Kamachatka (A. evermanni) flounders in Alaskan waters. Fish. Bull 94:358-370.

Table 7-1. Total combined catch (t) of arrowtooth and Kamchatka flounder in the eastern Bering Sea and Aleutian Islands region[a], 2001-2006. Catches since 2007, when the two species were differentiated in commercial catches, is reported for Kamchatka flounder only in this table

year	catch
1991	22,052
1992	10,382
1993	9,338
1994	14,366
1995	9,280
1996	14,652
1997	10,054
1998	15,241
1999	10,573
2000	12,929
2001	13,908
2002	11,540
2003	12,834
2004	17,809
2005	13,685
2006	13,309
2007	1,183
2008	6,819
2009	12,802
2010	21,153
2011	9,160

Table 7-2 Estimated biomass from the three BSAI bottom trawl surveys.

Reliable estimates of Kamchatka flounder biomass are only available after 1991.

	shelf	slope	Aleutian islands
1982	0		
1983	17,299		1,034
1984	20,695		
1985	31		
1986	0		565
1987	40		
1988	13,723		
1989	17,108		
1990	32,799		
1991	37,152		16,255
1992	50,081		
1993	38,376		
1994	56,268		49,156
1995	28,393		
1996	24,196		
1997	18,282		37,664
1998	23,474		
1999	18,974		
2000	21,551		28,535
2001	31,120		
2002	25,213	18,645	49,035
2003	27,531		
2004	29,663	14,740	39,219
2005	46,084		
2006	61,644		45,369
2007	65,191		
2008	53,967	24,822	
2009	47,252		
2010	51,927	27,875	49,069
2011	46,094		

Table 7-3. Total biomass, ABC and OFL values calculated from 5 methods using running averages from 3 to 7 years.

running averages for total biomass

	7 yr	6 yr	5 yr	4 yr	3 yr
1991					
1992					
1993					87,774
1994				104,945	104,945
1995			99,462	99,462	99,462
1996		95,671	95,671	95,671	98,303
1997	91,064	91,064	91,064	91,887	81,811
1998	88,098	88,098	88,163	79,674	76,734
1999	85,336	84,930	77,493	74,742	71,557
2000	82,337	75,707	73,149	70,362	69,603
2001	77,263	75,391	73,609	73,852	74,047
2002	77,891	76,823	77,660	78,759	82,090
2003	78,470	79,442	80,677	83,655	89,280
2004	80,039	81,168	83,648	87,866	88,289
2005	85,024	87,733	91,924	93,256	93,377
2006	93,314	97,736	99,964	101,732	106,192
2007	102,658	105,335	107,823	112,692	122,382
2008	108,288	110,854	115,355	123,288	128,331
2009	112,278	116,266	122,795	126,453	126,340
2010	118,067	123,807	126,937	126,973	125,233
2011	124,004	126,645	126,615	125,220	124,958

running averages for ABC calculation

	7 yr	6 yr	5 yr	4 yr	3 yr
1991					
1992					
1993					13166.09
1994				15741.75	15741.75
1995			14919.26	14919.26	14919.26
1996		14350.63	14350.63	14350.63	14745.47
1997	13659.66	13659.66	13659.66	13783.05	12271.59
1998	13214.69	13214.69	13224.42	11951.17	11510.13
1999	12800.44	12739.49	11623.91	11211.32	10733.51
2000	12350.53	11356.05	10972.41	10554.33	10440.51
2001	11589.42	11308.61	11041.39	11077.79	11107.09
2002	11683.66	11523.48	11649.02	11813.8	12313.44
2003	11770.49	11916.28	12101.56	12548.22	13392.04
2004	12005.86	12175.19	12547.25	13179.87	13243.28
2005	12753.57	13160.02	13788.67	13988.43	14006.6
2006	13997.03	14660.41	14994.57	15259.73	15928.78
2007	15398.74	15800.26	16173.52	16903.76	18357.24
2008	16243.26	16628.15	17303.26	18493.25	19249.7
2009	16841.69	17439.88	18419.19	18968.01	18950.98
2010	17709.99	18571.1	19040.54	19045.9	18784.96
2011	18600.57	18996.68	18992.2	18783.07	18743.66

running averages for OFL

	7 yr	6 yr	5 yr	4 yr	3 yr
1991					
1992					
1993					17,555
1994				20,989	20,989
1995			19,892	19,892	19,892
1996		19,134	19,134	19,134	19,661
1997	18,213	18,213	18,213	18,377	16,362
1998	17,620	17,620	17,633	15,935	15,347
1999	17,067	16,986	15,499	14,948	14,311
2000	16,467	15,141	14,630	14,072	13,921
2001	15,453	15,078	14,722	14,770	14,809
2002	15,578	15,365	15,532	15,752	16,418
2003	15,694	15,888	16,135	16,731	17,856
2004	16,008	16,234	16,730	17,573	17,658
2005	17,005	17,547	18,385	18,651	18,675
2006	18,663	19,547	19,993	20,346	21,238
2007	20,532	21,067	21,565	22,538	24,476
2008	21,658	22,171	23,071	24,658	25,666
2009	22,456	23,253	24,559	25,291	25,268
2010	23,613	24,761	25,387	25,395	25,047
2011	24,801	25,329	25,323	25,044	24,992

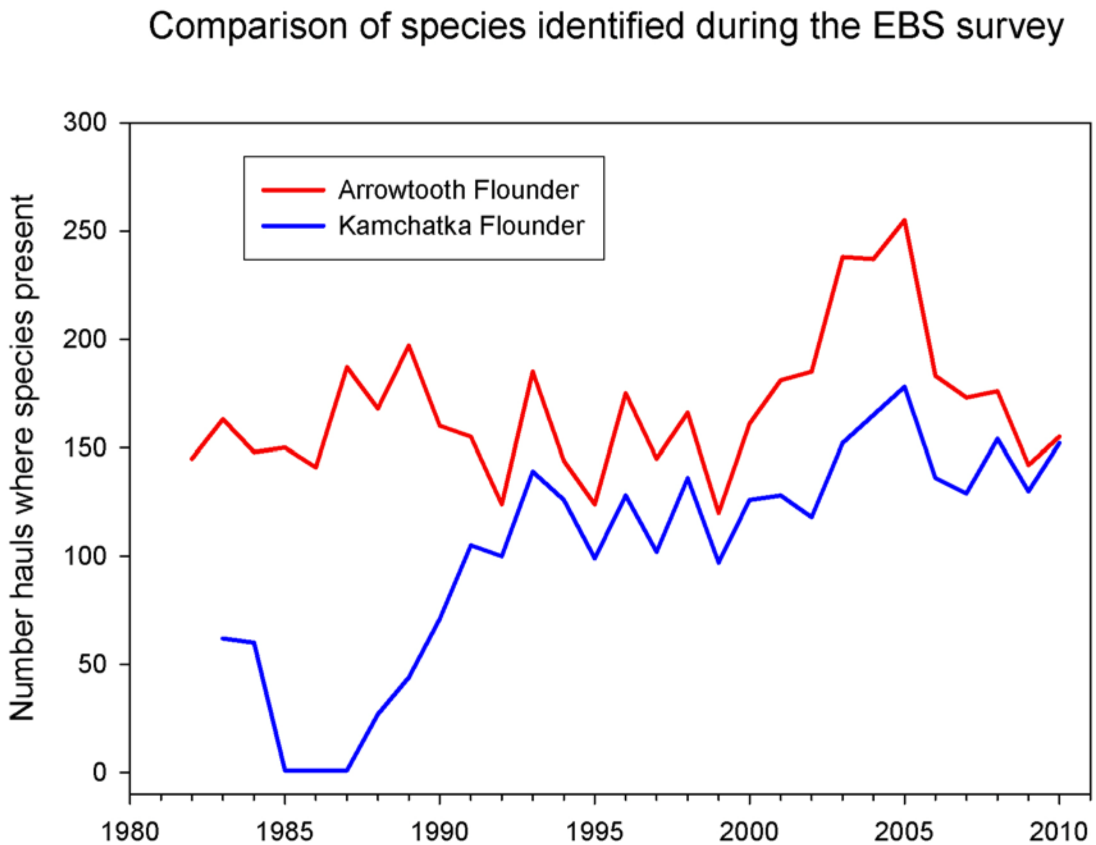

Figure 7.1—Number of hauls where arrowtooth flounder and Kamchatka flounder were identified during the annual Bering Sea shelf surveys, 1982-2010.

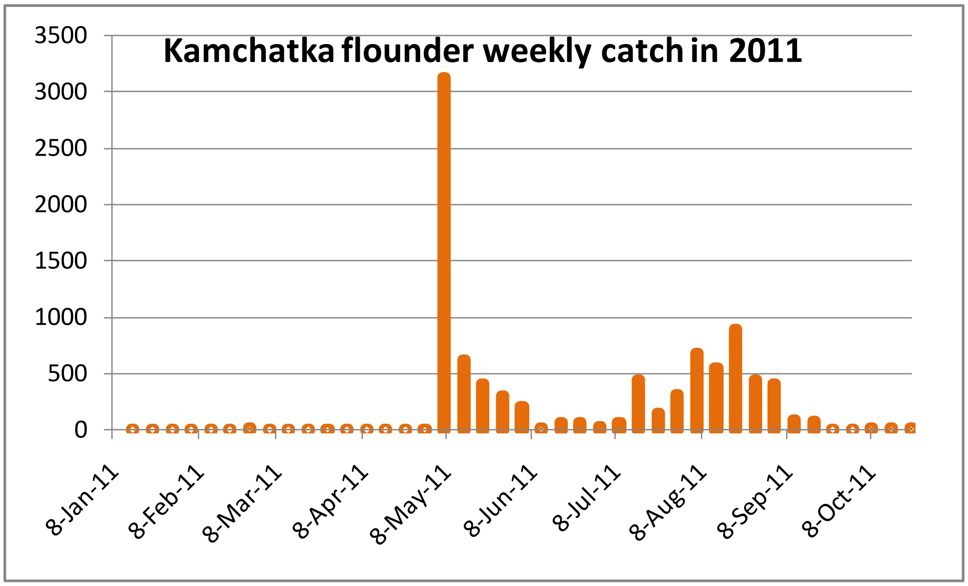

Figure 7-2 Arrowtooth and Kamchatka flounder catch (t) by week from Alaska Regional Office catch reports.

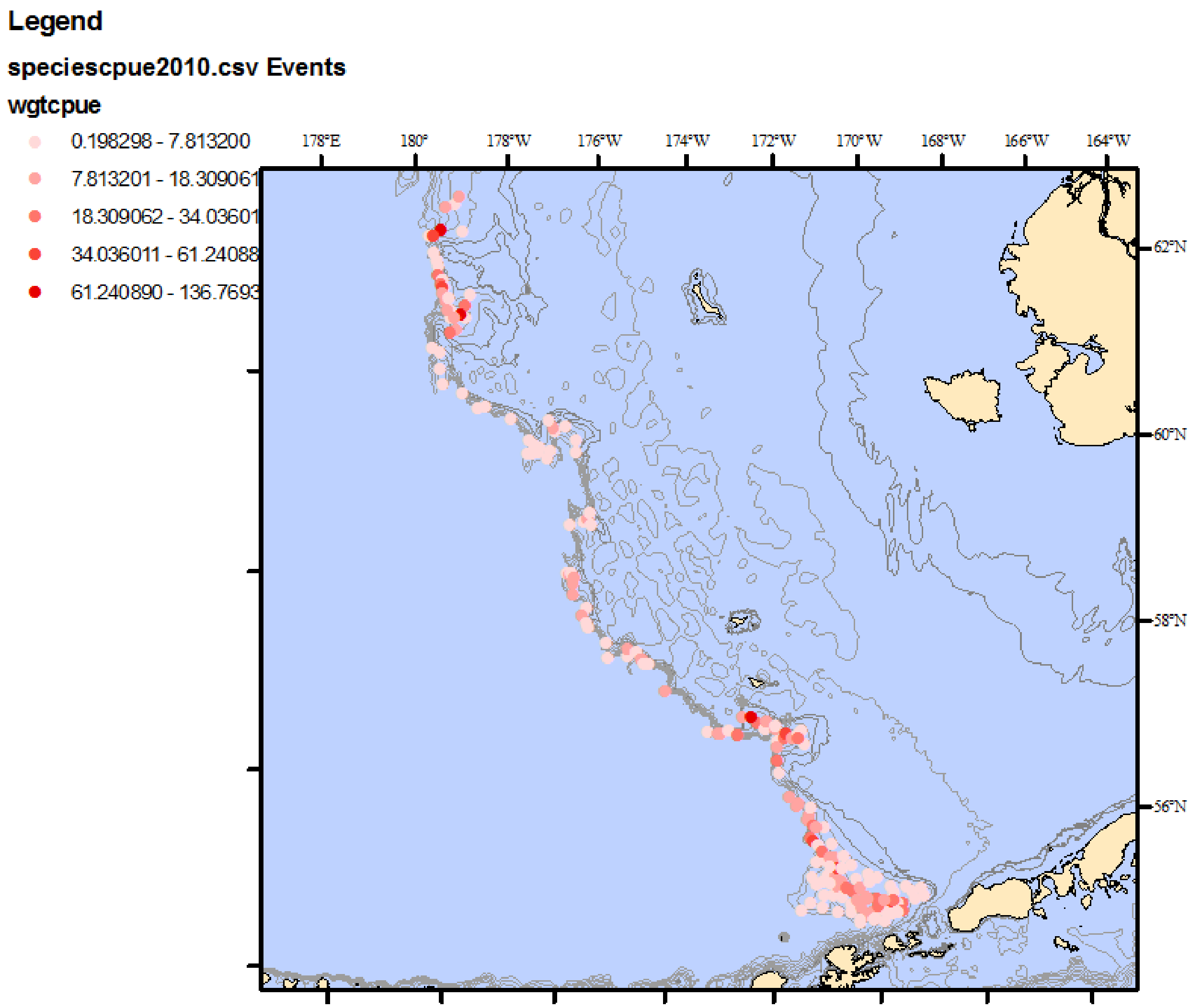

Figure 7-3. Distribution and relative of abundance of Kamchatka flounder from the 2010 slope survey.

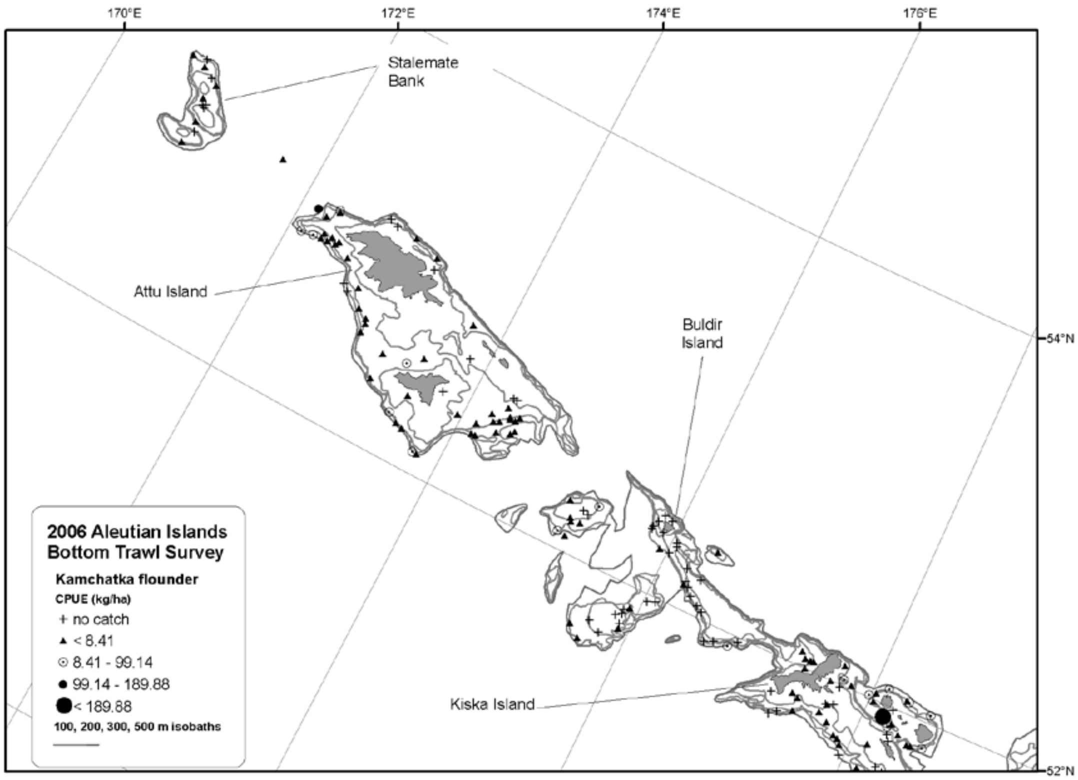

Figure 7-4. Distribution and relative abundance of Kamchatka flounder from the 2006 Aleutain Islands survey.

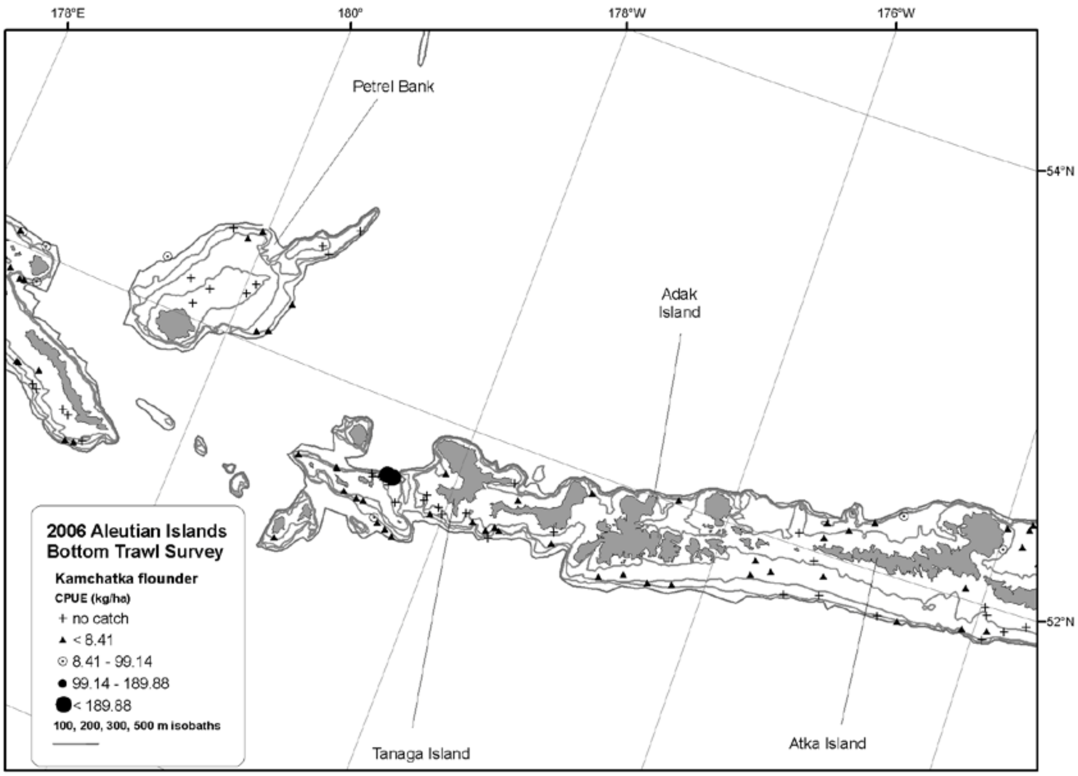

Figure 7-4 (continued).

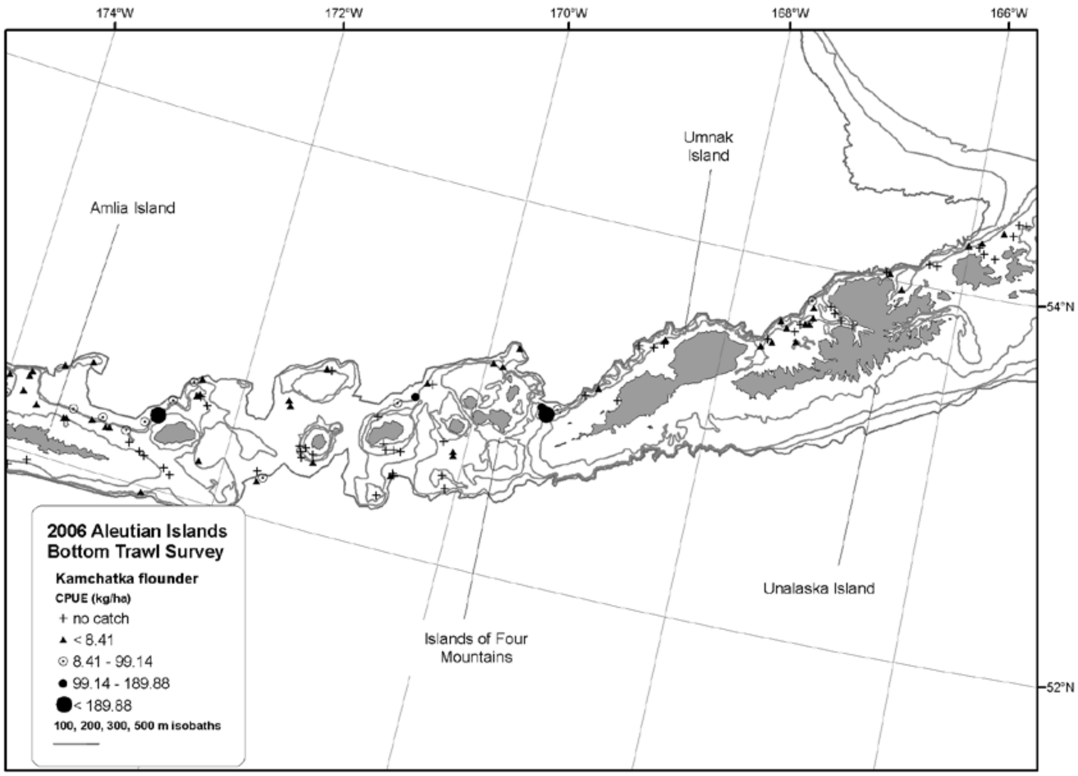

Figure 7-4 (continued).

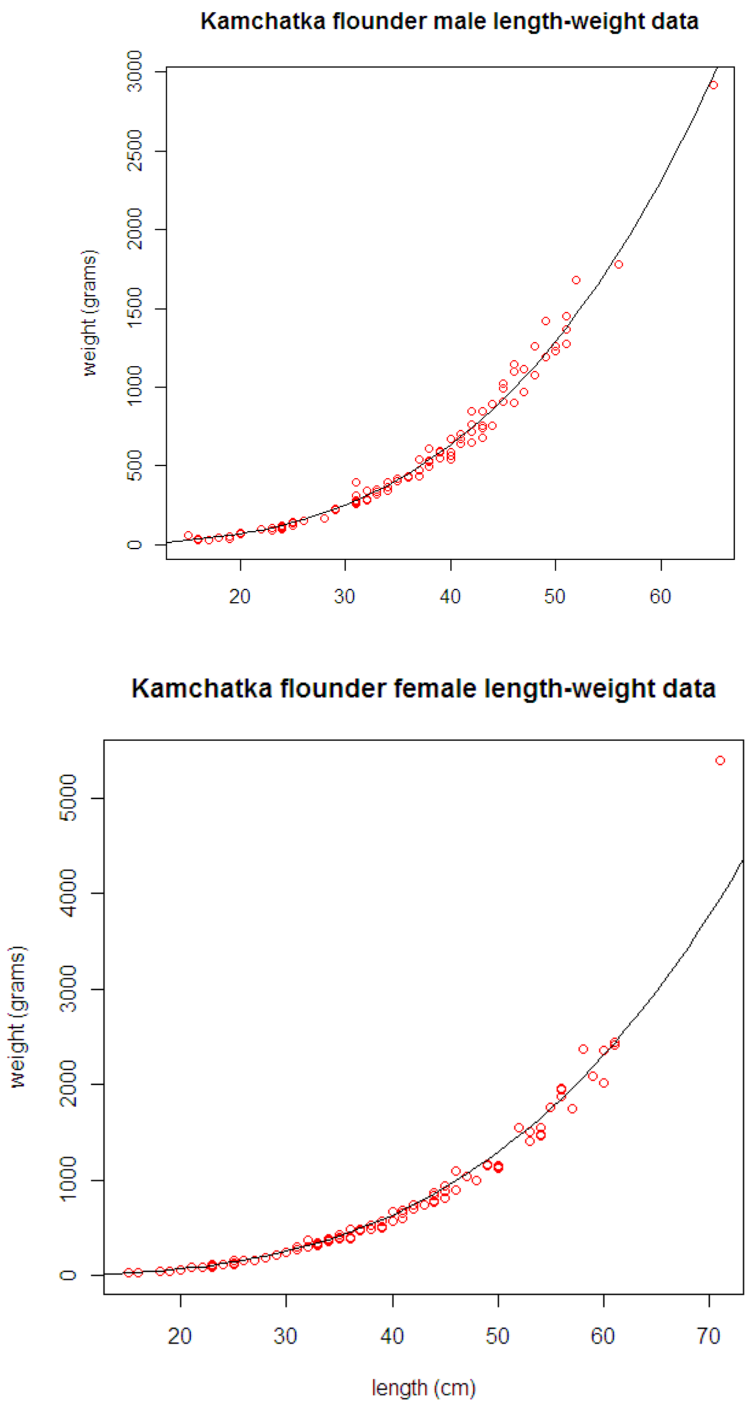

Figure 7-5 Kamchatka flounder length-weight plots for male and females.

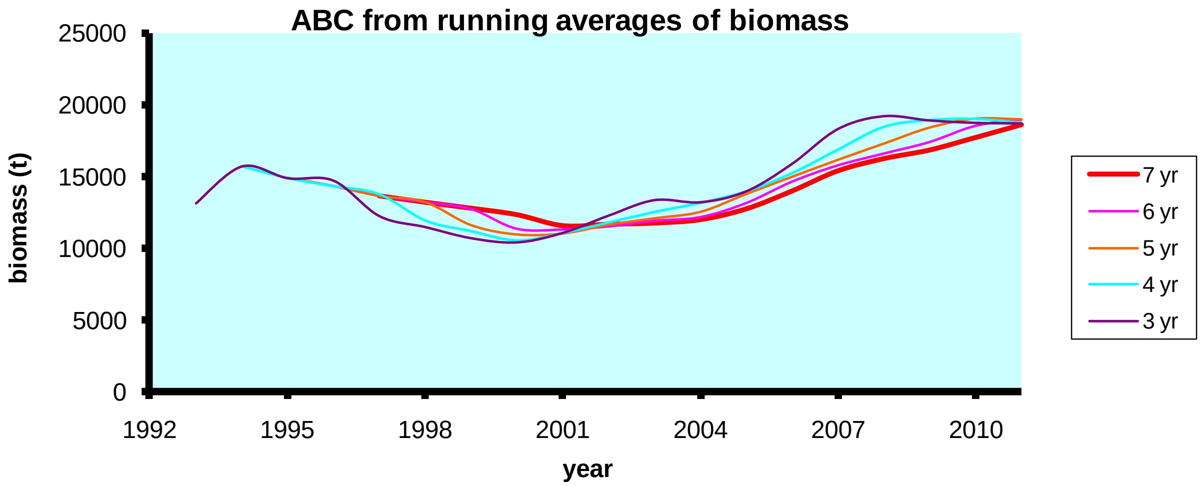

Figure 7-6 Estimated ABC (t), by year, from five methods each using a different number of years to calculate a moving average from shelf, slope and Aleutian Islands biomass estimates.