CHAPTER 10

OTHER FLATFISH

by

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EXECUTIVE SUMMARY

The following changes have been made to this assessment relative to the November 2008 SAFE:

Changes in the input data

1) The 2009 catch (total and discarded) was updated, and catch through 17 October, 2009 were included in the assessment.

2) 2009 Eastern Bering Sea trawl survey biomass estimates and standard errors of other flatfish species are included in the assessment. A linear regression of the AI survey estimates was used to predict the AI biomass in 2009, when an AI survey did not occur.

	2009 Assessment recommendations	2008 Assessment recommendations
Exploitable biomass	121,342 t	121,495 t
ABC	17,341 t	17,384 t
Overfishing	23,009 t	23,067 t
F_{ABC} for rex sole	0.13	0.13
$F_{overfishing}$ for rex sole	0.17	0.17
F_{ABC} for Dover sole	0.064	0.064
$F_{overfishing}$ for Dover sole	0.085	0.085
F_{ABC} for the remaining species	0.15	0.15
$F_{overfishing}$ for the remaining species	0.20	0.20

Introduction

The Bering Sea/Aleutian Islands "other flatfish" group have typically included those flatfish besides rock sole, yellowfin sole, arrowtooth flounder, and Greenland turbot. Flathead sole (*Hippoglossoides elassodon*) were part of the other flatfish complex until they were removed in 1995, and Alaska plaice was removed from the complex in 2002, as sufficient biological data exists for these species to construct age-structured population models. In contrast, survey biomass estimates are the principal data source used to assess the remaining other flatfish. Although over a dozen species (Table 10.1) of flatfish are found in the BSAI area, the other flatfish biomass consists primarily of starry flounder, rex sole, longhead dab, Dover sole and butter sole.

Catch History

The miscellaneous species of the other flatfish species category are listed in Table 10.1, and their catches from 1995-2009 are shown in Table 10.2. These species are not pursued as fishery targets but are captured in fisheries for other species. Catch from 1995-2003 were obtained from the NMFS Regional Office "blend" data, and the catch for some species are reported by species and in an aggregate flatfish group. The catch estimates for these years were produced by applying the proportional catch, by species, from fishery observer data to the estimated total catch for the aggregate other flatfish group, and adding this total to the catch that was reported by species. In the newer catch accounting system (in use since 2003), catches of other flatfish are reported only in an aggregate group, and the catch estimates for these years were produced by applying the proportional catch, by species, from fishery observer data to the estimated total catch of the aggregate group. In recent years, starry flounder (*Platichthys stellatus*) and rex sole (*Glyptocephalus zachirus*) account for most of the harvest of other flatfish, and contributed 90% of the harvest of other flatfish in 2009.

Other flatfish fisheries are grouped with Alaska plaice, rock sole, and flathead sole in a single prohibited species group (PSC) classification, with seasonal and total annual allowances of prohibited bycatch applied to the group. In past years, this group of fisheries was closed due to the bycatch of halibut (Table 10.3). In 2007 the other flatfish harvest was subject to 3 closures: the first and second seasonal closures to prohibit further halibut retention, and the annual halibut cap closure as detailed in Table 10.3. There have not been any closures in 2008 and 2009.

DATA

Absolute Abundance and Exploitation Rates

The biomass of the other flatfish complex on the eastern Bering Sea shelf was relatively stable from 1983-1995, averaging 54,274 t, and then increased from 1996 to 2003, averaging 84,137 t (Table 10.4). Since 2003 the biomass estimates have been at a higher level averaging 134,376 t. The 2009 estimate of 121,342 t indicates that the "other flatfish "composite of species is at a high level. The estimated increases from the past five years are primarily due to the higher estimates of starry flounder on the Eastern Bering Sea shelf. An estimate of total BSAI biomass for the years in which an AI survey was not conducted (as in 2009) was calculated by fitting a linear trend to the observed survey data (1991-2006 for this assessment), and then adding the predicted AI biomass estimate to the observed EBS estimate. Individual species biomass estimates for the EBS and AI areas from 1997-2008 are shown in Table 10.5. Estimates of total BSAI biomass (Table 10.6) were then used to compute species-specific exploitation rates (catch/biomass).

Exploitation rates for starry flounder and rex sole have been low, not exceeding 0.10 from 1997 to 2009 (Table 10.6). The exploitation rates for butter sole have been higher, exceeding 0.14 in 1997, 2000, 2001, and 2003-2009. In 2008 the butter sole catch exceeded the trawl survey biomass estimate. However these biomass estimates calculated for butter sole have large sampling variances, with coefficients of variation ranging from 0.44 to 0.86 in recent EBS trawl surveys dating back to 1999.

The 2003 and 2008 biomass estimates of butter sole are 429 t and 541 t, respectively. These estimates are less than one-fourth the 2002 estimate of 2382, and result in estimated exploitation rate of nearly 70% in 2003 and 1.14 in 2008. However, butter sole were only captured in four hauls in the 2003 EBS trawl survey and in six hauls in the 2008 survey, causing a large coefficient of variation of 0.61 for the estimated biomass. Thus, it is likely that the population of butter sole is larger than that indicated from the survey, and the comparison of survey biomass to harvest should be interpreted accordingly. The 2007 biomass estimate of butter sole was 1104 t, between four and five times the 2003 estimate, with a high CV in both the shelf survey (0.53) and in the Aleutian Islands (0.98). The fishery catches came primarily from waters less than 50 m in January and February, a depth and time not covered by the trawl survey. Butter sole are mostly caught by non-pelagic trawl catcher-processors in the rock sole and Pacific cod target fisheries in areas 509 and 516. The center of abundance for butter sole in Alaska is in the Gulf of Alaska whereas the survey and fishery catches on the north side of the Alaska Peninsula represent butter sole captured at the periphery of their distribution, where they are relatively rare.

Several other species in this management category are relatively rare on the EBS shelf, including Dover sole, Sakhalin sole, and English sole, and it is useful to identify whether the EBS represents the edge of the distribution for these species. The distribution of English sole has been identified as Baja California to Unimak Island, and the distribution of Dover sole has been identified as from Baja California to the Bering Sea (Hart 1973). Thus, the eastern Bering Sea can be considered the periphery of the range for these species. They are much more abundant in the Gulf of Alaska. For example, the abundance of Dover sole in the 1984-2001 GOA surveys has fluctuated between 63,000 t and 96,000 t, the abundance of butter sole has fluctuated between 17,000 t and 30,000 t, and the abundance of English sole has fluctuated between 3,000 t and 14,000 t (Turnock et al. 2005). Dover sole and English sole were most common in the eastern portion of the GOA, consistent with their reported distribution along the west coast of North America. In the case of Sakhalin sole, which prefer colder water and are caught at the northern extent of the survey, their perceived abundance from survey biomass estimates may be related to annual mean bottom water temperature as they tended to be more abundant in colder years during the 1980s and 1990s (Fig 10.1, shown for the standard survey area). The recent trend from trawl surveys estimates Sakhalin sole at low abundance.

PROJECTIONS AND HARVEST ALTERNATIVES

Reference Fishing Mortality Rates and Yields

Other flatfish are assessed 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 natural mortality rates used in age-structured BSAI flatfish assessments can be used as guidance and are presented below:

Species	Natural mortality rate used for stock assessment
BSAI Yellowfin sole	0.12
BSAI Rock sole	0.15
BSAI Flathead sole	0.20
BSAI Alaska plaice	0.25
GOA Rex sole	0.17
GOA Dover sole	0.085

Natural mortlity values for rex and Dover sole are available from age-structured assessments in the Gulf of Alaska SAFE document (Turnock and A'mar 2005 and Stockhausen et al. 2005) and those published values are used for rex and Dover sole in this stock assessment. For the remaining flatfish species, where less information is available, an assumption of M = 0.2 appears reasonable given the range of values shown above. For the case of starry flounder where estimates are available from a west coast stock assessment (Ralston 2005), the high estimates of M (male = 0.45, female = 0.3) are not used here due to the uncertainty of the estimates and the large spatial difference between the two management areas.

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 biomass estimate. Given the F_{abc} and F_{ofl} levels of 0.15 and 0.20, and the biomass estimate of 121,342 t, the resulting ABC and OFL levels are 17,341 and 23,009 t.

	F_{ABC}	F_{OFL}	ABC	OFL
Rex sole	0.13	0.17	4,390	5,740
Dover sole	0.064	0.085	137	182
Others	0.15	0.20	12,815	17,086
Total Other flatfish			**17,341**	**23,009**

Summary

In summary, several quantities pertinent to the management of the other flatfish are listed below.

Quantity	Value
Tier	5
Year 2009 Total Biomass	121,342 t
OFL	23,009 t
Maximum allowable ABC	17,341 t
Recommended ABC	17,341 t

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Turnock, B.J. and Z. T. A'mar. 2005. Gulf of Alaska rex sole stock assessment. In Stock Assessment and Fishery Evaluation Document for Groundfish Resources in the Gulf of Alaska Region as Projected for 2006. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage Alaska 99510.

Table 10.1. Flatfish species of the Bering Sea/Aleutian Islands "other flatfish" management complex.

Common Name	Scientific Name
Arctic flounder	*Liopsetta glacialis*
butter sole	*Isopsetta isolepis*
curlfin sole	*Pleuronectes decurrens*
deepsea sole	*Embassichths bathybius*
Dover sole	*Microstomus pacificus*
English sole	*Parophrys vetulus*
longhead dab	*Limanda proboscidea*
Pacific sanddab	*Citharichthys sordidus*
petrale sole	*Eopsetta jordani*
rex sole	*Glyptocephalus zachirus*
roughscale sole	*Clidodoerma asperrimum*
sand sole	*Psettichthys melanostictus*
slender sole	*Lyopsetta exilis*
starry flounder	*Platichthys stellatus*
Sakhalin sole	*Pleuronectes sakhalinensis*

Table 10.2. Harvest (t) of other flatfish from 1995-2009. 2009 catch is through October 17, 2009.

Year	Starry Founder	Rex Sole	Butter Sole	longhead dab	Dover sole	English sole	deep sea sole	Sakhalin sole	Total	ABC	TAC
1995	398	673	157	7	59	26	4	0	1324	117000	19540
1996	1171	1148	218	175	6	0	0	30	2748	102000	35000
1997	1043	687	448	211	53	0	29	6	2490	97500	50750
1998	402	998	229	93	41	0	0	0	1765	164000	89434
1999	725	998	230	56	81	27	0	0	2117	154000	154000
2000	1151	1069	458	277	66	4	0	0	3027	117000	83813
2001	755	869	244	62	70	4	6	0	2028	122000	28000
2002	1075	1192	222	107	34	0	1	0	2631	18100	3000
2003	887	1399	296	125	39	2	0	0	2749	16000	3000
2004	2062	1858	514	146	82	6	0	0	4669	13500	3000
2005	2069	2001	487	25	16	1	0	0	4599	21400	3500
2006	1663	1266	261	33	10	0	0	0	3233	18100	3500
2007	4356	812	579	87	4	2	<1	<1	5840	21400	10000
2008	1978	968	618	47	10	2	<1	<1	3623	21600	21600
2009	797	1132	196	7	7	2	0	<1	2141	17,400	17,400

Table10.3. Restrictions on the "other flatfish" fishery from 1995 to 2007 in the Bering Sea – Aleutian Islands management area. Note that in 1994, the other flatfish category included flathead sole. Unless otherwise indicated, the closures were applied to the entire BSAI management area. Zone 1 consists of areas 508, 509, 512, and 516, whereas zone 2 consists of areas 513, 517, and 521.

Year	Dates	Bycatch Closure
1995	2/21 – 3/30	First Seasonal halibut cap
	4/17 – 7/1	Second seasonal halibut cap
	8/1 – 12/31	Annual halibut allowance
1996	2/26 – 4/1	First Seasonal halibut cap
	4/13 – 7/1	Second seasonal halibut cap
	7/31 – 12/31	Annual halibut allowance
1997	2/20 – 4/1	First Seasonal halibut cap
	4/12 – 7/1	Second seasonal halibut cap
	7/25 – 12/31	Annual halibut allowance
1998	3/5 – 3/30	First Seasonal halibut cap
	4/21 – 7/1	Second seasonal halibut cap
	8/16 – 12/31	Annual halibut allowance
1999	2/26 – 3/30	First Seasonal halibut cap
	4/27 – 7/04	Second seasonal halibut cap
	8/31 – 12/31	Annual halibut allowance
2000	¾ – 3/31	First Seasonal halibut cap
	4/30 – 7/03	Second seasonal halibut cap
	8/25 – 12/31	Annual halibut allowance
2001	3/20 – 3/31	First Seasonal halibut cap
	4/27 – 7/01	Second seasonal halibut cap
	8/24 – 12/31	Annual halibut allowance
2002	2/22 – 12/31	Red King crab cap (Zone 1 closed)
	3/1 – 3/31	First Seasonal halibut cap
	4/20 – 6/29	Second seasonal halibut cap
	7/29 – 12/31	Annual halibut allowance
2003	2/18 – 3/31	First Seasonal halibut cap
	4/1 – 6/21	Second seasonal halibut cap
	7/31 – 12/31	Annual halibut allowance
2004	2/24 – 3/31	First Seasonal halibut cap
	4/10 – 12/31	Bycatch status
2005	3/1 - 3/31	First Seasonal halibut cap
	4/22-6/30	Second Seasonal halibut cap
	5/9-12/31	Bycatch status, TAC attained
2006	2/21 - 3/31	First Seasonal halibut cap
	4/5 – 12/31	Red King crab cap (Zone 1 closed)
	4/12 – 5/31	Second seasonal halibut cap
	5/26	TAC attained, 7,000 t reserve released
	8/7 – 12/31	Annual halibut allowance
2007	2/17 – 3/31	First Seasonal halibut cap
	4/9 – 5/31	Second seasonal halibut cap
	8/6 – 12/31	Annual halibut allowance

Table 10.4. Estimated biomass (t) of other flatfish from the eastern Bering Sea and Aleutian Islands trawl surveys. Species included are Dover sole, longhead dab, rex sole, Sakhalin sole, starry flounder, and butter sole. A linear regression between EBS and AI survey abundance was used to predict AI abundance in years in which an AI survey did not occur.

	Area		
Year	EBS	AI	total
1982	117,763		129,518
1983	66,131	2,700	68,831
1984	59,647		64,956
1985	34,572		37,101
1986	39,517	6,100	45,617
1987	49,764		53,977
1988	44,559		48,195
1989	49,663		53,865
1990	47,126		51,047
1991	72,453	2,144	74,597
1992	53,954		58,632
1993	44,500		48,130
1994	54,368	5,464	59,832
1995	37,891		40,788
1996	60,376		65,766
1997	71,545	7,580	79,125
1998	74,672		81,648
1999	68,557		74,855
2000	70,866	8,149	79,015
2001	78,930		86,378
2002	98,218	8,801	107,019
2003	90,552		99,289
2004	128,740	14,980	143,720
2005	43,970		120,900
2006	132,925		149,292
2007	133,502		149,507
2008	104,608		121,494
2009	103,575		121,342

Table 10.5 --Estimated biomass (t) and coefficient of variation (in parentheses) for the miscellaneous species of the "other flatfish" management complex in the Bering Sea trawl and Aleutian Islands surveys.

Eastern Bering Sea Shelf survey

Year	Dover Sole	Rex Sole	longhead dab	Sakhalin sole	starry flounder	butter sole	slender sole	sand sole
1982	--	5994 (0.16)	103806 (0.16)	--	7781 (0.32)	182 (0.82)	--	--
1983	--	7272 (0.18)	51386 (0.38)	--	7436 (0.25)	37 (0.45)	--	1559(0.94)
1984	--	13058 (0.28)	35308 (0.16)	137 (0.43)	8913 (0.36)	2231 (0.64)	--	--
1985	10 (1.04)	10751 (0.20)	9107 (0.13)	102 (0.37)	12181 (0.24)	2421 (0.83)	--	--
1986	15 (1.00)	12886 (0.22)	10889 (0.14)	274 (0.48)	9112 (0.33)	6341 (0.58)	--	--
1987	81 (0.91)	12931 (0.19)	11897 (0.19)	110 (0.58)	22702 (0.63)	2043 (0.38)	--	--
1988	38 (0.59)	15445 (0.15)	16710 (0.19)	1061 (0.40)	9222 (0.30)	2083 (0.47)	--	1128(1.0)
1989	--	12939 (0.15)	13086 (0.16)	129 (0.57)	22205 (0.35)	1304 (0.54)	--	--
1990	47 (0.58)	11857 (0.21)	18601 (0.15)	587 (0.36)	15048 (0.26)	986 (0.60)	--	--
1991	55 (0.70)	16014 (0.28)	18680 (0.14)	345 (0.68)	34303 (0.23)	3056 (0.50)	--	--
1992	137 (0.58)	14001 (0.24)	10827 (0.17)	212 (0.48)	27544 (0.22)	1233 (0.70)	--	--
1993	37 (0.75)	14567 (0.32)	11690 (0.21)	179 (0.31)	16510 (0.22)	1517 (0.75)	--	--
1994	73 (0.72)	15943 (0.38)	18533 (0.26)	506 (0.52)	18218 (0.22)	1095 (0.97)	--	--
1995	--	10420 (0.28)	8402 (0.15)	214 (0.27)	17652 (0.29)	1203 (0.54)	--	--
1996	--	10532 (0.40)	8567 (0.20)	185 (0.56)	40409 (0.45)	683 (0.53)	--	--
1997	--	8233 (0.27)	18003 (0.21)	1407 (0.84)	41018 (0.21)	2884 (0.43)	--	--
1998	41 (0.44)	7588 (0.22)	14737 (0.19)	770 (0.86)	49605 (0.30)	1942 (0.38)	--	--
1999	16 (0.65)	8020 (0.28)	12087 (0.21)	907 (0.63)	43375 (0.25)	4152 (0.62)	--	--
2000	11 (1.02)	9348 (0.19)	13511 (0.30)	473 (0.43)	45810 (0.19)	1713 (0.56)	--	--
2001	16 (0.84)	21660 (0.23)	12764 (0.26)	117 (0.32)	43026 (0.25)	796 (0.50)	--	--
2002	7 (0.80)	26053 (0.20)	9740 (0.22)	173 (0.90)	59877 (0.23)	2254 (0.64)	--	--
2003	350 (0.66)	28023 (0.15)	8827(0.22)	280 (0.75)	52893 (0.17)	179 (0.61)	3	
2004	31(0.51)	28762 (0.19)	11290 (0.23)	1118 (0.98)	86698 (0.38)	841 (0.86)	--	--
2005	157(0.19)	23171(0.19)	11556 (0.21)	961(0.97)	71673(0.26)	958(0.81)	--	--
2006	90(0.53)	21515(0.28)	13204(0.25)	125(0.58)	96900(0.37)	1091(0.53)	--	--
2007	73(0.53)	17025(0.25)	16733(0.24)	30(0.34)	98623(0.17)	1018(0.44)	--	--
2008	364(0.90)	18788(0.31)	10884(0.22)	77(0.36)	74077(0.21)	418(0.44)	--	--
2009	469(0.95)	18142(0.39)	5,011(0.23)	55(0.44)	79,366(0.19)	532(0.60)	--	--

Aleutian Islands Surveys

Year	Dover Sole	Rex Sole	Species longhead dab	Sakhalin sole	starry flounder	butter sole	English sole
1991	174 (0.45)	1694 (0.18)	--	--	142 (0.85)	86 (0.73)	47 (0.80)
1994	438 (0.41)	4306 (0.15)	--	--	134 (0.69)	505 (0.98)	83 (0.81)
1997	386 (0.34)	6378 (0.16)	--	--	459 (0.90)	346 (0.98)	12 (0.72)
2000	630 (0.38)	6526 (0.18)	--	--	590 (0.71)	310 (0.99)	95 (0.97)
2002	575 (0.28)	7381 (0.15)	--	--	671 (0.72)	127 (0.83)	47 (0.94)
2004	870 (0.28)	13717 (0.18)	--	--	123 (0.72)	235 (0.93)	35(1.00)
2006	2155 (0.57)	14230 (0.19)	--	--	17 (0.97)	13(0.98)	25(0.84)

Table 10.6. Estimated exploitation rates of rex sole, starry flounder and butter sole from 1997 to 2008.

	Rex sole			Starry Flounder			Butter sole		
Year	Biomass (t)	Harvest (t)	Exp. Rate	Biomass (t)	Harvest (t)	Exp. Rate	Biomass (t)	Harvest (t)	Exp. Rate
1997	14611	401	0.03	41477	814	0.02	3230	336	0.10
1998	14250	569	0.04	49950	242	0.00	2210	157	0.07
1999	15415	516	0.03	43750	597	0.01	4416	167	0.04
2000	15874	569	0.04	46400	770	0.02	2023	266	0.13
2001	30524	507	0.02	43829	479	0.01	1059	147	0.14
2002	33411	1227	0.04	60633	1023	0.02	2382	187	0.08
2003	38349	1399	0.04	53353	887	0.02	429	296	0.69
2004	42479	1858	0.04	86821	2062	0.02	1076	514	0.48
2005	34963	1830	0.05	72176	1892	0.03	1201	445	0.37
2006	35745	1266	0.04	96917	1663	0.02	1104	261	0.24
2007	31,052	812	0.03	98941	4,356	0.04	1153	579	0.50
2008	33,613	961	0.03	74,397	1,964	0.03	541	614	1.14
2009	33,766	1,132	0.03	79,688	797	0.01	642	196	0.31

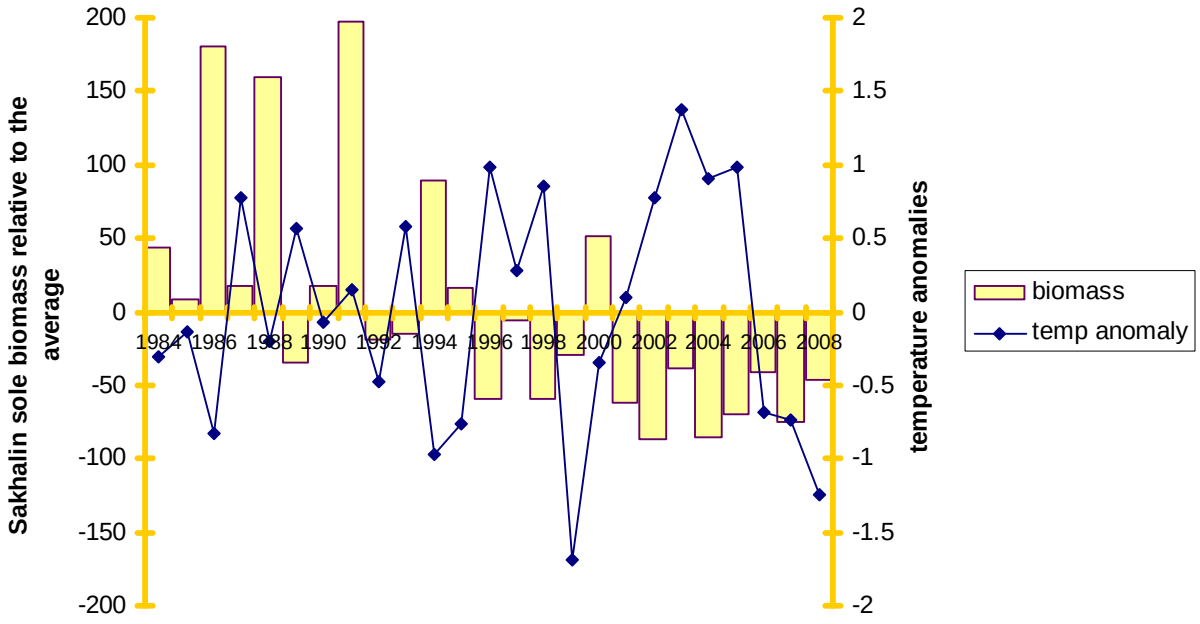

Figure 10.1—Relationship between annual survey bottom water temperature anomalies and Sakhalin sole biomass estimates.

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