

4. Gulf of Alaska Flatfish

by

Benjamin J. Turnock, Thomas K. Wilderbuer and Eric S. Brown

Executive Summary

Summary of Major Changes

Changes in the input data

The 2005 NMFS summer bottom-trawl survey biomass was used to estimate ABC and OFL for 2006.

Changes in assessment methodology

There were no changes to the assessment model relative to the 2004 assessment.

Changes in assessment results

Survey abundance estimates for the shallow-water complex were higher in 2005 compared to 2003 for northern rock sole, southern rock sole, sand sole, deepsea sole and Alaska plaice. The 2005 survey abundance estimate was lower than the 2003 for yellowfin sole, butter sole, English sole and starry flounder.

The 2005 NMFS bottom-trawl survey biomass was used as current biomass for calculation of ABC. Greenland turbot and deepsea sole ABC and OFL were calculated using average catch. The 2006 ABC for shallow-water flatfish was similar to the 2004 ABC (52,073 t) at 51,450 t.

The recommended shallow-water and deep-water(excluding Dover sole) flatfish ABC and OFL levels are:

Year		ABC	OFL
2006	Deep-water	183	244
2006	Shallow-water	51,450	62,418
2007	Deep-water	183	244
2007	Shallow-water	51,450	62,418

ABC and OFL values for Dover sole are contained in a separate chapter using an age-structured assessment.

Response to SSC comments

SSC comments specific to the GOA flatfish assessment:

Reassess natural mortality estimates for flatfish species.

This will be addressed in future assessments as more age data become available.

SSC comments on assessments in general:

From the December, 2004 SSC minutes: *In its review of the SAFE chapter, the SSC noted that there is variation in the information presented. Several years ago, the SSC developed a list of items that should be*

included in the document. The SSC requests that stock assessment authors exert more effort to address each item contained in the list. Items contained in the list are considered critical to the SSC's ability to formulate advice to the Council. The SSC will review the contents of this list at its February meeting.

The flatfish chapter does not include any stock assessment model, so some of the items are not applicable, however, applicable items and formatting will be added to the document as time allows in the future.

Introduction

The "flatfish" species complex previous to 1990 was managed as a unit in the Gulf of Alaska and included the major flatfish species inhabiting the region with the exception of Pacific halibut (*Hippoglossus stenolepis*). The North Pacific Fishery Management Council divided the flatfish assemblage into four categories for management in 1990; "shallow flatfish" and "deep flatfish" (Table 4.1), flathead sole and arrowtooth flounder. This classification was made because of the significant difference in halibut bycatch rates in directed fisheries targeting on shallow-water and deep-water flatfish species. Arrowtooth flounder, because of its present high abundance and low commercial value, was separated from the group and managed under a separate acceptable biological catch (ABC). Flathead sole were likewise assigned a separate ABC since they overlap the depth distributions of the shallow-water and deep-water groups. In 1993 rex sole was split out of the deep-water management category because of concerns regarding the Pacific ocean perch bycatch in the rex sole target fishery.

The major species, which account for the majority of the current biomass for shallow-water flatfish are: northern rock sole (*Lepidopsetta polyxystra*), southern rock sole (*Pleuronectes bilineata*), butter sole (*Pleuronectes isolepis*), yellowfin sole (*Pleuronectes asper*), and starry flounder (*Platichthys stellatus*). The deep-water complex is mainly Dover sole (*Microstomus pacificus*), however, also includes Greenland turbot (*Reinhardtius hippoglossoides*) and Deep-sea sole (*Embassichthys bathybius*). Arrowtooth flounder, rex sole, and flathead assessments are presented in separate chapters. The Dover sole assessment is presented as an appendix to this chapter.

For this assessment, biomass, fishing mortality rates, and ABC estimates are presented for each species and management category.

Beginning with the 1996 triennial trawl survey, rock sole was split into two species, a northern rock sole and a southern rock sole. Due to overlapping distributions, differential harvesting of the two species may occur, requiring separate management in the future.

This report describes flatfish catches taken from 1978 through October 1, 2005 and presents information on the status of flatfish stocks and their potential yield based on Gulf of Alaska demersal trawl survey data through 2005.

Catch history

Since the passage of the MFMCA in 1977, the fishery for flatfish in the Gulf of Alaska has undergone changes. Until 1981, annual harvests were around 15,000 t (including arrowtooth flounder), primarily taken by foreign vessels targeting other species (Table 4.2). Thereafter, catches decreased to a low of 2,441 t in 1986 before increasing to a high of 43,107 t in 1996. Flatfish catches were 27,713 t through October 1, 2005. With the cessation of foreign fishing in 1986, joint venture fishing began to account for the majority of the catch. In 1987, the gulf-wide flatfish catch increased nearly fourfold to 9,925 t with the joint venture fisheries accounting for nearly all of the increase (73% of the gulf-wide catch). After 1988, only domestic fleets harvested flatfish.

The NPFMC Central Gulf management area has produced the majority of the flatfish catch from the Gulf of Alaska (Table 4.2). Since 1988 the majority of the harvest has occurred on the continental shelf and slope east of Kodiak Island. Although arrowtooth flounder comprised about half the catch, the fishery primarily targeted on rock, rex and Dover sole (Table 4.3).

Catch is currently reported for deep-water flatfish, shallow-water flatfish, flathead sole and rex sole by management area (Table 4.3). The catch by species in each year was estimated by using the fraction of each species in their respective group from observer sampling in that year, multiplied by the total catch for that group by gear type and management area (i.e. deep-water or shallow-water group, Tables 4.4 and 4.5). The blend estimate of catch is used as the estimate of total catch. Catches for the deep-water species were estimated from 1978 to 1995 for estimation of the average catch used in ABC calculations (Table 4.6). Most of the catch in the deep-water group has been Dover sole. However, Greenland turbot catch has been quite variable, ranging from 3,012 t in 1992 to 13 t in 1997 (Table 4.6). Table 4.7 documents annual research catches (1977 - 1998) from NMFS longline, trawl, and echo integration trawl surveys.

The flatfish resource was lightly to moderately harvested in 2005 as the shallow-water, deep-water ABC apportionments were 22% and 6%, harvested through October 1, respectively. The 2005 catches were higher for shallow-water and lower for deep-water compared to 2004. The 2005 deep-water flatfish fishery was closed on March 23, April 8, May 3, July 24, September 4, September 10 and October 1 to prevent exceeding the halibut bycatch limit. The 2005 shallow-water flatfish fishery was closed on August 19, September 4, and October 1 due to the attainment of the halibut bycatch limit.

Catches in the deep-water complex declined from 2,285 t in 1999 to 985 t in 2000. The 2004 catch declined to 682 t and the catch through October 1, 2005 was 405 t (Table 4.3). Shallow-water flatfish catches increased from 2,577 t in 1999 to 6,928 t in 2000, decreased to 3,094 t in 2004, then increased to 4,628 t through October 1, 2005. The flatfish fishery is likely to continue to be limited by the potential for high by-catches of Pacific halibut.

Estimates of retained and discarded catch (t) in the various trawl target fisheries, since 1991, by management assemblage, were calculated from discard rates observed from at-sea sampling and industry reported retained catch (Table 4.8). Retention of deep-water flatfish declined from 75% in 2001 to 64% in 2002. Retention of shallow water flatfish was unchanged from 2001 at 91% for 2002.

Condition of stocks

Survey Abundance

The principal source of information for evaluating the condition of flatfish stocks in the Gulf of Alaska is the bottom trawl survey conducted from 1984 to 2005 (Table 4.9 and Figure 4.1). Flatfish biomass estimates from the 2005, 2003 and 2001 survey by INPFC area are given in Tables 4.10a through 4.10c. Sampling for the 2001 survey was conducted in the western and central portions of the gulf only. 2001 survey biomass for the eastern gulf was approximated using the average of the 1993 to 1999 eastern gulf biomass estimates for all flatfish species except Dover sole, butter sole and English sole (Table 4.11). A significant proportion of the survey biomass is in the eastern gulf for Dover sole and English sole, while for other species the proportion is low. The average of the 1993 to 1996 eastern gulf biomass was used for most species because there was no discernable trend in abundance, or there did not appear to be any correlation in biomass between areas (Tables 4.10a to 4.14). Dover sole and butter sole seem to show similar trends in biomass in the eastern and central areas, so eastern gulf biomass estimates for 2001 were obtained by applying the decline in biomass from 1999 to 2001 in the central gulf to the 1999 biomass in the eastern gulf. Both the central and eastern areas showed similar trends for English sole, and the central biomass was very similar from 1999 to 2001, so the eastern gulf biomass for 1999 without any adjustment was used as the estimate for the eastern gulf in 2001.

The apportionment of survey sampling stations on the shelf and slope followed the methods developed for the shelf portion of the 1984 survey (Brown 1986). There was no sampling deeper than 500 meters during 1990 to 1996, and 2001 because of limited vessel time. The 500- 1,000 m depths sampled in 1984 and 1987, and 1999 are generally outside the depth range of most flatfish species with the exception of Dover sole, Greenland turbot, deep-sea sole and, to a lesser extent, Rex sole. The 2003 and 2005 survey

covered depths to 700 m. No deep-sea sole were caught in the surveys with a maximum depth of 500m in 1990, 1993 and 1996. Greenland turbot were only caught in 1984 and 1987 (depths to 1000m) and in 2003.

Northern and southern rock sole have a generally increasing trend in survey biomass through 2005. Northern rock sole biomass increased from 79,998 t in 2003 to 91,525 t in 2005. Southern rock sole increased from 127,267 t in 2003 to 147,693 t in 2005. Yellowfin sole declined slightly from 54,738 t in 2003 to 48,823 t in 2005. Butter sole declined slightly from 31,148 t in 2003 to 26,226 t in 2005. Starry flounder biomass increased from 10,907 t in 1990 to 76,418 t in 2001, then declined to 26,586 t in 2005. English sole increased in abundance from 8,403 t in 1993 to 14,433 t in 1999, and has been at a similar level through 2005 (14,595 t). Alaska plaice has also increased in abundance from 3,639 t in 2001 to 7,939 t in 2005. Sand sole survey biomass has been quite variable over time, most recently increasing from 1,359 t in 2003, to 2,379 t in 2005.

Current Exploitable Biomass

With the exception of Greenland turbot and deep-sea sole, the best available estimate of current exploitable biomass is assumed to be the same as the 2005 survey biomass estimate because the non-exploitable (< 30 cm) component of the survey biomass is small and the survey bottom trawl (90 x 105 ft. Noreastern trawl with roller gear) is only partially selected for non-exploitable sizes.

Recent experimental evidence suggests that flatfish biomass estimates derived from the noreastern trawl used in the survey may underestimate true biomass because the escapement portion of the catchability assumption may be large (e.g., Weinberg et al., 2003). Experiments have been conducted to estimate the herding component of catchability for some flatfish species, however, analysis is not complete (Somerton, pers. comm.).

Biological parameters

Natural mortality, Age of recruitment, and Maximum Age

Natural mortality rates for Gulf of Alaska flatfish species were estimated using the methods of Alverson and Carney (1975), Pauly (1980), and Hoenig (1983) in the 1988 assessment (Wilderbuer and Brown 1989). The estimates were different for each method and were not inconsistent with the value of 0.2, used in previous assessments (Wilderbuer and Brown 1989). A natural mortality value of 0.2 was used for all flatfish except Dover sole (Table 4.15).

Length and Weight at Age

Values for the parameters in the Von Bertalanffy age-length relationship were estimated from age structures collected during the trawl surveys (Table 4.16). Length composition data from the triennial surveys are shown in Figures 4.2 to 4.7. Aging of Gulf of Alaska flatfish species has been sporadic since the inception of the triennial surveys. Estimates of survey age compositions for flatfish are shown in Figure 4.8.

The parameters calculated for the length (cm) - weight (g) relationship: $W = aL^b$ (both sexes combined) are shown below:

Species	<i>a</i>	<i>b</i>
Rock sole (northern and southern)	0.009984	3.0468
Yellowfin sole	0.006678	3.1793
Rex sole	0.004459	3.4710

Maturity at Age

Maturity at age and size have been estimated only for northern and southern rock sole in the shallow-water complex. Northern rock sole females from the Kodiak Island area, Alaska, reached 50% maturity at 328 mm and an average age of 7 years. In contrast, southern rock sole females reached 50% maturity at 347 mm and an average age of 9 years (Stark and Somerton 2002). Northern rock sole females grew faster overall ($K=0.24$) than southern rock sole females ($K=0.12$) but reached a smaller maximum length ($L_{inf}=430$ mm) than southern rock sole ($L_{inf}=520$ mm).

Ecosystem Considerations

Food habits

Flatfish consume a variety of benthic organisms (Table 4.18; Livingston and Goiney 1983, Yang 1990). Fish prey make up a large part of the diet of rock sole adults and possibly sand sole (although the sample size was small for sand sole). Other flatfishes consume mostly polychaetes, crustaceans and mollusks.

Acceptable biological catch

Northern and southern rock sole are in tier 4 of the ABC and overfishing (OFL) definitions, where $F_{ABC} = F_{40\%}$ and $F_{OFL} = F_{35\%}$. Northern and southern rock sole were estimated to be approximately fully selected in the survey at about 32 cm (age 7 and 8, respectively), by visual examination of size compositions from the fishery and applying the growth curve. Selectivities were applied as knife-edge for calculation of $F_{40\%}$ and $F_{35\%}$. Southern rock sole $F_{40\%} = 0.162$, $F_{35\%} = 0.192$, northern rock sole $F_{40\%} = 0.204$, $F_{35\%} = 0.245$.

ABCs for all flatfish, except rock soles, deep-sea sole and Greenland turbot, were calculated using $F_{ABC} = 0.75 M$ and $F_{OFL} = M$ (tier 5), since maturity information was not available. Natural mortality was assumed to be 0.2 for butter sole, starry flounder, English sole, Alaska plaice, and sand sole. Greenland turbot and deep-sea sole are in tier 6 since there are no reliable biomass estimates, where $ABC=0.75 OFL$ and $OFL =$ the average catch from 1978 to 1995 (Table 4.6).

Recommended fishing mortality rates for 2006 ABCs are as follows:

Species	F_{ABC}	F_{OFL}
Southern rock sole	0.162	0.192
Northern rock sole	0.204	0.245
All other flatfish (except Greenland turbot and deep-sea sole)	0.15	0.2

The flatfish complex ABCs for the 2006 fishing season were calculated using the catch equation, the F_{ABC} fishing mortality rate, and the 2005 survey biomass estimate for each species, (Table 4.19) except for Greenland turbot and deep-sea sole where average catch was used. Overfishing values and yield are presented in Table 4.20.

The 2006 ABC for deep-water flatfish excluding Dover sole is unchanged from previous years since it is based on average catch (179 t). The 2006 ABC for shallow-water flatfish decreased slightly to 51,450 t from 52,073 t in 2004.

Due to the overlapping distributions of flatfish species, especially in the shallow-water group, it may be difficult to target a species within an arbitrary management group without impacting other flatfish species in that group or other species which were "split-out" and managed separately. Given the present management strategy used by the North Pacific Fishery Management Council for Gulf of Alaska flatfish, some species may be subjected to higher fishing mortalities than that resulting from the recommended ABCs. The ongoing efforts by the observer program to improve species identification will help monitor these fisheries in the event that species compositions change.

Harvest Scenarios To Satisfy Requirements of NPFMC'S Amendment 56, NEPA, and MSFCMA

Under tiers 4 through 6 projections of harvest scenarios equivalent to tier 1 through 3 stocks is not possible. Simplified projections for 2007 are presented in the next section for comparison purposes. Yields for 2006 are computed for scenarios 1-5 as follows:

Scenario 1: F equals the maximum permissible F_{abc} as specified in the ABC/OFL definitions. For tier 4 species the maximum permissible F_{abc} is $F_{40\%}$, for tier 5, $F=0.75*M$ and tier 6, $0.75*$ average catch from 1978 to 1995. The yield for shallow-water flatfish is 51,450 t and for deep-water flatfish (excluding Dover sole) 179 t.

Scenario 2: F equals the stock assessment author's recommended F_{abc} . The recommended yield is 51,450 t for shallow-water flatfish and 179 t for deep-water flatfish (excluding Dover sole).

Scenario 3: F equals the 5-year average F from 1995 to 1999. The 5-year average catch for shallow-water flatfish is 5,740 t. Since the catch of deep-water flatfish other than Dover sole is rare, and tier 6 is used for ABC, the deep-water flatfish yield is 179 t (excluding Dover sole).

Scenario 4: F equals 50% of the maximum permissible F_{abc} as specified in the ABC/OFL definitions. 50% of the ABC for shallow-water flatfish is 25,725 t. 50% of the ABC for deep-water flatfish is 89.5 t (excluding Dover sole).

Scenario 5: F equals 0. The corresponding yield is 0 t.

Biomass projections

The exploitable biomass in the year 2005 is projected using the delay difference equation of Deriso (1980). This model incorporates growth, natural mortality, recruitment, and two years of biomass estimates (2005 and 2003 trawl surveys) to predict future biomass (Table 4.21). Exploitable biomass is predicted under harvest strategies of F_{ABC} , and F_{OFL} . Recruitment biomass is assumed to be constant during the projected years and was approximated from trawl survey biomass estimates.

References

- Alverson, D., and M. Carney. 1975. A graphic review of the growth and decay of population cohorts. *Const. Int. Explor. Mer*, 36(2): 133-143.
- Brown, E. S. 1986. Preliminary results of the 1984 U.S.-Japan cooperative bottom trawl survey of the central and western Gulf of Alaska. In R.L. Major (editor), *Condition of groundfish resources of the Gulf of Alaska as assessed in 1985*, p. 259. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-106.

- Deriso, R. B. 1980. Harvesting strategies and parameter estimation for an age-structured model. *Can. J. Fish. Aquat. Sci.* 37: 268-282.
- Hoening, J. 1983. Empirical use of longevity data to estimate mortality rates. *Fish. Bull.* 82: 898-903.
- Livingston, P., and B. Goiney. 1983. Food habits literature of north pacific marine fishes: A review and selected bibliography. NOAA tech. Mem. NMFS F/NWC-54.
- Murai, S., H. A. Gangmark, and R. R. French. 1981. All-nation removals of groundfish, Herring, and shrimp from the eastern Bering Sea and northeast Pacific Ocean, 1964-80. NWAFC report. 40 p.
- Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. *J. Cons. Int. Explor. Mer.* 39:175-192.
- Stark, J.W. and D.A. Somerton. 2002. Maturation, spawning and growth of rock soles off Kodiak Island in the Gulf of Alaska. *Journal of Fish Biology* 61: 417-431.
- Turnock, B.J., M. Wilkins, M. Saelens and R. Lauth. 1994. Status of west coast Dover sole in 1994. Status of the Pacific coast groundfish fishery through 1994 and recommended acceptable biological catches for 1995. Pacific Fishery Management Council, Portland, Oregon.
- Weinberg, K. L., D. A. Somerton, and P. T. Munro. 2002. The effect of trawl speed on the footrope capture efficiency of a survey trawl. *Fish. Res.* 58:303-313.
- Wilderbuer, T. K., and E. S. Brown. 1989. Flatfish. In T. K. Wilderbuer (editor), Condition of groundfish resources of the Gulf of Alaska as assessed in 1988. p. 199-218. U. S. Dep. Commer., NOAA Tech. Memo, NMFS F/NWC-165.
- Yang, M. S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

Tables

Table 4.1. Flatfish constituents of the 1996 NPFMC Gulf of Alaska deep-water and shallow-water management categories.

Category	Common name	Genus and Species
Deep-water	Dover sole	<u><i>Microstomus pacificus</i></u>
	Greenland turbot	<u><i>Reinhardtius hippoglossoides</i></u>
	Deep-sea sole	<u><i>Embassichthys bathybius</i></u>
Shallow-water	Northern rock sole	<i>Lepidopsetta polyxystra</i>
	Southern rock sole	<u><i>Pleuronectes bilineata</i></u>
	Yellowfin sole	<u><i>Pleuronectes asper</i></u>
	Starry flounder	<u><i>Platichthys stellatus</i></u>
	Butter sole	<u><i>Pleuronectes isolepis</i></u>
	English sole	<u><i>Pleuronectes vetulus</i></u>
	Alaska plaice	<u><i>Pleuronectes quadrituberculatus</i></u>
Sand sole	<u><i>Psettichthys melanostictus</i></u>	

Table 4.2. Catch (t) of flatfish in the Gulf of Alaska (including arrowtooth flounder), by North Pacific Fishery Management Council Regulatory Area, 1978 to October 1, 2005. (Includes discards 1992-2005).

Fishery category		Western	Central	Eastern	Total
Foreign	1978	2,538	6,312	5,491	14,341
	1979	2,817	5,026	5,631	13,474
	1980	3,022	6,885	5,590	15,497
	1981	3,224	5,759	5,461	14,444
	1982	1,412	7,516	58	8,986
	1983	2,020	7,459	51	9,530
	1984	603	2,430	0	3,033
	1985	115	55	0	170
	1986 ^a	56	15	0	71
	Joint venture	1978	5	0	0
1979		7	62	1	70
1980		11	198	0	209
1981		0	18	0	18
1982		6	12	0	18
1983		171	2,521	0	2,692
1984		566	2,882	0	3,448
1985		324	2,123	0	2,447
1986		302	659	0	961
1987		2,073	5,134	0	7,207
1988 ^b	tr	1,780	0	1,781	
Domestic	1978	6	86	760	852
	1979	0	55	329	384
	1980	0	46	94	140
	1981	0	77	327	404
	1982	0	71	203	274
	1983	0	88	351	439
	1984	5	246	181	432
	1985	10	254	197	461
	1986	362	774	273	1,409
	1987	184	2,001	533	2,718
1988	810	7,223	461	8,494	
Total	1978	2,549	6,398	6,251	15,198
	1979	2,824	5,143	5,961	13,928
	1980	3,033	7,129	5,684	15,846
	1981	3,224	5,854	5,788	14,866
	1982	1,418	7,599	261	9,278
	1983	2,191	10,068	402	12,661
	1984	1,174	5,558	181	6,913
	1985	449	2,432	197	3,078
	1986	720	1,448	273	2,441
	1987	2,257	7,135	533	9,925
	1988	811	9,003	461	10,275
	1989 ^c	142	4,888	187	5,167
	1990	2,272	12,969	170	15,411
	1991	3,195	16,657	216	20,068
	1992	3,007	27,881	968	31,939
	1993	3,119	33,700	1,036	37,853
	1994	1,962	34,191	2,391	38,544
	1995	2,658	28,182	1,433	32,273
	1996	3,826	37,942	1,339	43,107
	1997	4,179	26,864	2,455	33,498
1998	4,284	18,339	614	23,237	
1999	4,761	19,143	1,125	25,029	
2000	7,917	28,749	637	37,303	
2001	7,405	23,818	511	31,734	
2002	6,219	24,360	141	30,720	
2003	9704	31695	92	41,491	
2004	4356	18411	171	22,938	
2005 ^d	3630	24023	60	27,713	

tr = less than 1 metric ton. ^a Last year of foreign fishing in the Gulf of Alaska. ^b Last year of joint venture fishing in the Gulf of Alaska. ^c All catch from 1989 to the present is from the domestic fleet. ^d Includes catch to October 1, 2005.

Table 4.3. Composition of the 1994 to October 1, 2005 Gulf of Alaska flatfish catch by management category and North Pacific Fishery Management Council regulatory area.

Year	Species group	Area			Total	Percent total
		Western	Central	Eastern		
1994	Shallow-water	189	3,742	12	3,943	30
	Deep-water	21	2,836	272	3,129	23
	Flathead sole	499	2,067	14	2,580	19
	Rex sole	49	3,540	84	3,673	28
1995	Shallow-water	366	5,057	7	5,430	39
	Deep-water	96	1,895	222	2,213	16
	Flathead sole	589	1,563	29	2,181	16
	Rex sole	220	3,627	174	4,021	29
1996	Shallow-water	443	8,876	31	9,350	46
	Deep-water	19	1,954	220	2,193	11
	Flathead sole	840	2,164	103	3,107	15
	Rex sole	504	5,180	190	5,874	29
1997	Shallow-water	400	7,328	47	7,775	45
	Deep-water	13	2,644	1,007	3,664	21
	Flathead sole	449	1,938	59	2,446	14
	Rex sole	681	2,436	177	3,294	19
1998	Shallow-water	270	3,204	91	3,565	35
	Deep-water	16	2,182	88	2,286	22
	Flathead sole	566	1,168	8	1,742	17
	Rex sole	439	2,195	35	2,669	26
1999	Shallow-water	268	2,298	11	2,577	29
	Deep-water	22	1,865	398	2,285	26
	Flathead sole	186	687	27	900	10
	Rex sole	604	2,393	63	3,060	35
2000	Shallow-water	560	6,319	49	6,928	53
	Deep-water	27	816	142	985	8
	Flathead sole	258	1,274	15	1,547	12
	Rex sole	884	2,701	6	3,591	28
2001	Shallow-water	207	5,955	0	6,162	52
	Deep-water	18	667	119	804	7
	Flathead sole	600	1,311	0	1,911	16
	Rex sole	434	2,506	0	2,940	25
2002	Shallow-water	223	5,970	2	6,195	53
	Deep-water	17	521	8	546	5
	Flathead sole	418	1,611	0	2,029	17
	Rex sole	376	2,565	0	2,941	25
2003	Shallow-water	174	4,289	2	4,465	51
	Deep-water	29	896	5	930	11
	Rex sole	727	2,601	2	3,330	38
2004	Shallow-water	135	2,958	1	3,094	
	Deep-water	7	616	59	682	
2005	Shallow-water	104	4,518	6	4,628	
	Deep-water	3	395	7	405	

Table 4.4. Estimated catch of species in the shallow-water flatfish group by area for 1991 to October 1, 2005.

Shallow-water flatfish					
	Year	Western	Central	Eastern	Total
Rock sole sp.	1991	2188	2108	0	4,296
	1992	2440	4766	0	7,206
	1993	407	7580	0	7,987
	1994	180	2251	11	2,442
	1995	332	3845	4	4,181
	1996	423	5752	0	6,175
	1997	313	5611	1	5,924
	1998	7	2095	52	2,154
	1999	180	1640	2	1,823
	2000	511	4481	49	5,041
Northern rock sole	2001	83	2628	0	2,711
	2002	133	2898	0	3,031
	2003	102	1177	0	1,279
	2004	33	420	0	453
	2005	46	1,423	0	1,469
Southern rock sole	2001	113	2349	0	2,462
	2002	72	2051	0	2,123
	2003	94	2009	0	2,103
	2004	96	1372	0	1,468
	2005	56	2,084	0	2,140
Alaska plaice	1991	5	1	1	7
	1992	2	3	0	5
	1993	1	4	0	5
	1994	0	1	0	1
	1995	1	6	0	7
	1996	1	64	0	65
	1997	5	46	0	51
	1998	0	18	1	19
	1999	3	2	0	5
	2000	<1	12	0	12
	2001	3	11	0	14
	2002	<1	4	0	4
	2003	0.6	13.4	0.0	14
	2004	0	16	0	17
	2005	0	14	0	14
English sole	1991	2	71	0	73
	1992	1	47	0	48
	1993	6	77	0	83
	1994	4	42	0	46
	1995	3	42	0	45
	1996	5	82	29	116
	1997	16	70	45	131
	1998	122	35	1	158
	1999	1	14	0	15
	2000	1	71	0	72
	2001	<1	50	0	50
	2002	2	20	0	22
	2003	0.1	27.5	0.0	28
	2004	2	35	0	36
	2005	1	44	0	45

Table 4.4. (continued) Estimated catch of species in the shallow-water flatfish group by area for 1991 to October 1, 2005.

	Western	Central	Eastern	Total
Butter sole				
1991	8	562	0	570
1992	15	1351	0	1,366
1993	8	1429	0	1,437
1994	0	1057	0	1,057
1995	23	894	0	917
1996	2	2351	0	2,353
1997	15	979	0	994
1998	39	488	15	542
1999	0	420	9	429
2000	<1	1263	0	1,263
2001	3	702	0	705
2002	<1	864	0	864
2003	0.2	886	0.1	887
2004	1	992	0	993
2005	0	667	0	667
Sand sole				
1991	0	28	0	28
1992	0	1	0	1
1993	0	12	0	12
1994	0	0	0	0
1995	0	1	0	1
1996	0	19	0	19
1997	1	79	0	79
1998	0	168	0	168
1999	0	7	0	7
2000	5	29	0	34
2001	<1	66	0	66
2002	0	4.5	0	5
2003	0.0	3.0	0.0	3.0
2004	0	27	0	27
2005	0	39	0	39
Yellowfin sole				
1991	4	51	0	55
1992	6	51	0	57
1993	2	35	0	37
1994	4	148	0	152
1995	5	60	0	65
1996	12	55	0	67
1997	42	156	0	198
1998	0	121	20	141
1999	81	10	0	91
2000	21	43	0	64
2001	3	7	0	10
2002	16	<1	0	16
2003	3.9	52.9	1.9	58.8
2004	2	1	0	3
2005	0	31	0	31

Table 4.4. (continued) Estimated catch of species in the shallow-water flatfish group by area for 1991 to October 1, 2005.

	Western	Central	Eastern	Total
Starry flounder				
1991	16	253	0	269
1992	6	94	0	100
1993	0	154	0	154
1994	1	91	0	92
1995	1	179	0	180
1996	0	576	1	577
1997	9	390	1	401
1998	102	279	1	382
1999	2	205	0	207
2000	21	421	0	442
2001	2	142	0	144
2002	<1	128	2	130
2003	0.0	154.6	0.0	154.6
2004	0	95	0	95
2005	0	217	0	217

Table 4.5. Estimated catch by species and area for the deep-water flatfish from 1991 to October 1, 2005.

	Western	Central	Eastern	Total
Greenland turbot				
1991	430	16	0	446
1992 ^a	233	1478	1301	3,012
1993	13	3	0	16
1994	13	4	0	17
1995	81	17	5	103
1996	11	3	1	15
1997	9	3	1	13
1998	<1	6	66	72
1999	10	5	6	21
2000	25	<1	1	26
2001	<1	<1	0	<1
2002	<1	<1	0	<1
2003	7.7	5.3	0.1	13.0
2004	0	0	1	1
2005	1	3	0	4
Dover sole				
1991	751	8872	118	9,741
1992 ^b	106	8165	92	8,364
1993	93	3653	59	3,804
1994	8	2777	268	3,053
1995	15	1877	189	2,082
1996	8	1951	219	2,178
1997	4	2649	1007	3,659
1998	16	2138	20	2,174
1999	12	1860	392	2,263
2000	2	814	141	957
2001	<1	515	21	536
2002	<1	492	<1	492
2003	21.3	890.7	4.9	917
2004	7	616	55	678
2005	2	392	7	401
Deep-sea sole				
1991	0.1	1.5	0	1.6
1992	0.2	2.3	0	2.5
1993	0	3.1	0	3.1
1994	0	3.3	0.6	3.9
1995	0	1.3	0.1	1.4
1996	0	0.4	0	0.4
1997	0	1	0	1
1998	0.0	38.1	1.8	39.9
1999	0	<1	<1	<1
2000	0	1	0	1
2001	0	<1	0	<1
2002	0	<1	0	<1
2003	0.0	0.1	0.0	0.1
2004	0	0	3	3
2005	0	0	0	0

^a Catch of Greenland turbot in the blend database was used for 1992 because estimated catch was lower than reported catch.

^b Catch of Dover sole in 1992 estimated by subtracting Greenland turbot from the deep-water flatfish catch

Table 4.6. Dover sole, Greenland turbot and deep-sea sole catch 1978 to October 1, 2005. Average catch for Greenland turbot for 1978 to 1995 = 238 t. Average catch for Dover sole for 1978 to 1995 = 1,969 t. Average catch for Deepsea sole for 1978 to 1995 = 6.0 t.

Year	Greenland turbot	Dover sole	Deep-sea sole
1978	51	827	4.9
1979	24	530	5.1
1980	57	570	2.2
1981	8	457	8.3
1982	23	457	30.5
1983	145	354	11.1
1984	18	132	0.8
1985	<1	43	3.2
1986	<1	23	0
1987	44	56	0
1988	256	1,087	0
1989	56	1,521	0
1990	<1	2,348	29.6
1991	446	9,741	1.6
1992	3012	8,364	2.5
1993	16	3,804	3.1
1994	17	3,053	3.9
1995	103	2,082	1.4
1996	15	2,178	0.4
1997	13	3,659	1
1998	72	2,174	39.9
1999	21	2,263	<1
2000	26	957	1
2001	<1	536	<1
2002	<1	492	<1
2003	13	917	<1
2004	1	678	3
2005	4	401	0

Table 4.7. Catch (t) from longline and trawl research cruises from 1977 to 1998.

Year	Dov. Sole	Turb.	Deepsea sole	Rock sole	North Rock	South Rock	Yell.fin sole	Butter sole	Starry flou.	English sole	Sand dab	Alaska plaice	Flathead sole	Rex sole
1977	1.12	0.00	0.00	4.26			1.17	0.22	0.12	0.04	0.00	0.01	10.32	1.97
1978	5.99	0.30	0.00	44.72			3.76	2.61	1.85	1.74	3.69	0.39	23.65	8.47
1979	5.04	0.00	0.00	0.96			0.00	0.06	0.00	0.02	0.00	0.00	5.47	12.60
1980	0.92	0.04	0.00	15.83			8.98	2.70	0.98	0.31	0.31	0.48	29.70	4.64
1981	15.8	0.08	0.01	30.84			10.91	5.05	1.86	0.53	0.24	0.75	49.47	17.2
1982	5.71	0.03	0.00	26.15			2.48	3.45	1.07	0.64	0.16	0.19	20.07	7.73
1983	7.71	0.14	0.00	3.32			1.67	0.30	0.02	0.02	0.00	0.03	19.99	7.21
1984	15.79	0.18	0.01	19.10			9.08	1.88	0.97	0.39	0.09	0.17	39.33	18.27
1985	17.58	0.17	0.00	3.22			0.05	0.23	0.02	0.14	0.00	0.03	17.46	14.05
1986	1.25	46.79	0.00	4.18			4.09	0.08	0.03	0.13	0.00	0.03	41.42	3.74
1987	16.16	0.09	0.01	24.56			6.85	1.43	1.52	0.87	0.00	0.53	37.58	21.12
1988	0.06	0.01	0.00	0.37			2.56	0.00	0.01	0.00	0.00	0.03	2.70	0.08
1989	1.90	0.02	0.00	1.12			1.78	0.07	0.13	0.00	0.00	0.25	8.87	1.77
1990	11.7	0.02	0.00	11.13			2.84	0.94	0.44	0.31	0.01	0.30	22.50	12.0
1991	0.02	0.01	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.01
1992	0.97	0.04	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.04
1993	14.8	0.03	0.00	16.53			7.26	2.17	3.19	0.59	0.04	0.26	27.36	12.7
1994	0.06	0.07	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.03
1995	0.00	0.01	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
1996	7.39	0.04	0.00	0.44	5.08	7.06	3.67	0.96	0.94	0.37	0.05	0.35	14.46	7.04
1997	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
1998	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	1.58	4.09

Table 4.8. Percent (by weight) of catch by species group that is retained for the Gulf of Alaska flatfish fisheries.

Year	Deep-water flatfish*	shallow-water flatfish	Flathead sole	rex sole
1991			59%	
1992			66%	
1993	90%	82%	66%	
1994	75%	73%	67%	89%
1995	79%	71%	71%	90%
1996	72%	86%	77%	95%
1997	82%	81%	83%	92%
1998	90%	83%	83%	97%
1999	80%	77%	62%	96%
2000	73%	88%	83%	97%
2001	75%	91%	87%	95%
2002	64%	91%	86%	95%

*Includes rex sole for 1993

Table 4.9. Biomass estimates from the NMFS bottom-trawl surveys from 1984 to 2005. In 1984, 1987 and 1999 depths surveyed were to 1000 meters. In 1990, 1993 and 1996 depths were surveyed to 500 meters. In 2003 and 2005 the survey extended to 700 meters.

	1984	1987	1990	1993	1996	1999	2001	2003	2005
<i>Deep-water flatfish</i>									
Dover sole	68,525	63,397	96,602	85,422	79,531	74,365	68,211	99,327	80,537
Greenland turbot	292	143	0	0	0	0	0	109	0
Deep-sea sole	218	160	0	0	0	97	52	180	262
<i>Shallow-water flatfish</i>									
Rock sole total	137,472	123,221	159,452	173,361	206,343	166,603	190,297	207,265	239,218
Northern rock sole	-	-	-	-	78,845	61,081	64,240	79,998	91,525
Southern rock sole	-	-	-	-	127,390	105,522	126,057	127,267	147,693
Yellowfin sole	91,341	56,135	61,290	81,329	47,789	48,309	55,303	54,738	48,823
Butter sole	22,504	19,273	17,307	29,809	20,916	14,188	9,812	31,148	26,226
Starry flounder	14,293	14,141	10,907	40,288	27,309	46,652	76,418	58,530	26,586
English sole	3,202	7,243	-	8,403	7,946	14,432	14,166	17,832	14,595
Sand sole	1,216	82	-	479	940	234	357	1,359	2,379
Alaska plaice	1,912	4,830	-	2,583	4,870	8,680	3,639	5,078	7,939

Table 4.10a. Biomass estimates (t) for Gulf of Alaska flatfish, based on the 2005 bottom trawl survey, by North Pacific Fishery Management Council regulatory area and species.

Species	Area			Total
	Western	Central	Eastern	
<i>Deep-water flatfish</i>				
Dover sole	2,832	38,881	38,824	80,537
Greenland turbot	0	0	0	0
Deep-sea sole	0	140	122	262
<i>Shallow-water flatfish</i>				
Rock sole total	122,628	107,495	9,095	239,218
Northern rock sole	58,648	32,877	0	91,525
Southern rock sole	63,980	74,618	9,095	147,693
Yellowfin sole	23,405	25,418	0	48,823
Butter sole	5,952	20,242	31	26,226
Starry flounder	16,122	10,106	358	26,586
English sole	825	4,396	9,374	14,595
Sand sole	61	2,318	0	2,379
Alaska plaice	2,480	5,459	0	7,939

Table 4.10b. Biomass estimates (t) for Gulf of Alaska flatfish, based on the 2003 bottom trawl survey, by North Pacific Fishery Management Council regulatory area and species.

Species	Area			Total
	Western	Central	Eastern	
<i>Deep-water flatfish</i>				
Dover sole	3,149	49,314	46,865	99,327
Greenland turbot	109	0	0	109
Deep-sea sole	12	117	51	180
<i>Shallow-water flatfish</i>				
Rock sole total				
Northern rock sole	43,127	36,871	0	79,998
Southern rock sole	55,116	65,251	6,900	127,267
Yellowfin sole	42,178	12,560	0	54,738
Butter sole	3,370	25,123	2,655	31,148
Starry flounder	5,355	49,793	3,382	58,530
English sole	334	5,363	12,135	17,832
Sand sole	0	1,331	28	1,359
Alaska plaice	2925.8	2152.2	0	5078
Flathead sole	67,055	172,167	19,388	258,609
Rex sole	13,265	58,027	28,659	99,950

Table 4.10c. Biomass estimates (t) for Gulf of Alaska flatfish, based on the 2001 bottom trawl survey, by North Pacific Fishery Management Council regulatory area and species.

Species	Area			Total
	Western	Central	Eastern	
<i>Deep-water flatfish</i>				
Dover sole	896	31,639	35,676	68,211
Greenland turbot	0	0	0	0
Deep-sea sole	0	52	0	52
<i>Shallow-water flatfish</i>				
Rock sole total	96,178	89,264	4,855	190,297
Northern rock sole	36,987	27,237	16	64,240
Southern rock sole	59,191	62,027	4,839	126,057
Yellowfin sole	49,586	5,612	105	55,303
Butter sole	3,338	5,578	896	9,812
Starry flounder	14,291	57,469	4,658	76,418
English sole	89	3,274	10,803	14,166
Sand sole	43	232	82	357
Alaska plaice	2,116	1,523	0	3,639
Flathead sole	67,787	85,961	17,167	170,915
Rex sole	9,624	41,723	19,979	71,326

Table 4.11. Survey biomass in the Eastern Gulf of Alaska for 1993, 1996 and 1999. The biomass used for the Eastern Gulf in 2001 is shown in the column labeled estimated 2001. See text for the method used to estimate the 2001 biomass.

Species	1993	1996	1999	Estimate 2001
Dover sole	39,664	40,928	38,612	35,676
Greenland turbot	0	0	0	0
Deepsea sole	0	0	0	0
Northern rock sole		0	31	16
Southern rock sole		3,323	6,355	4,839
Yellowfin sole	0	229	85	105
Butter sole	2,906	104	1,274	896
Starry flounder	5,193	1,518	7,262	4,658
English sole	5,341	5,713	10,803	10,803
Sand sole	8	183	56	82
Alaska plaice	0	0	0	0
Flathead sole	16,843	16,059	18,598	17,167
Rex sole	20,901	19,560	19,476	19,979

Table 4.12. Biomass estimates (t) for Gulf of Alaska flatfish, based on the 1999 bottom trawl survey, by North Pacific Fishery Management Council regulatory area and species.

Species	Area			Total
	Western	Central	Eastern	
<i>Deep-water flatfish</i>				
Dover sole	1,430	34,323	38,612	74,365
Greenland turbot	0	0	0	0
Deep-sea sole	0	97	0	97
<i>Shallow-water flatfish</i>				
Rock sole total	89,487	70,730	6386	166,603
Northern rock sole	44,731	16,319	31	61,081
Southern rock sole	44,756	54,411	6,355	105,522
Yellowfin sole	36,368	11,856	85	48,309
Butter sole	4,985	7,929	1,274	14,188
Starry flounder	10,627	28,763	7,262	46,652
English sole	563	3,066	10,803	14,432
Sand sole	61	117	56	234
Alaska plaice	5,647	3,033	0	8,680
Flathead sole	49,295	139,627	18,598	207,520
Rex sole	12,333	42,796	19,476	74,605

Table 4.13. Biomass estimates (t) for Gulf of Alaska flatfish, based on the 1996 bottom trawl survey, by North Pacific Fishery Management Council regulatory area and species.

Species	Area			Total
	Western	Central	Eastern	
<i>Deep-water flatfish</i>				
Dover sole	1,458	37,144	40,928	79,531
Greenland turbot	0	0	0	0
Deep-sea sole	0	0	0	0
<i>Shallow-water flatfish</i>				
Rock sole total	110,303	92,718	3,323	206,343
Northern rock sole	62,883	15,962	0	78,845
Southern rock sole	47,420	76,647	3,323	127,390
Yellowfin sole	29,857	17,704	229	47,789
Butter sole	6,265	14,547	104	20,916
Starry flounder	16,181	9,610	1,518	27,309
English sole	297	1,936	5,713	7,946
Sand sole	0	757	183	940
Alaska plaice	2,295	2,575	0	4,870
Flathead sole	66,732	122,730	16,059	205,521
Rex sole	9,419	43,778	19,560	72,757

Table 4.14. Biomass estimates (t) for Gulf of Alaska flatfish, based on the 1993 bottom trawl survey, by North Pacific Fishery Management Council regulatory area and species.

Species	Area			Total
	Western	Central	Eastern	
<i>Deep-water flatfish</i>				
Dover sole	2,371	43,388	39,664	85,422
Greenland turbot	0	0	0	0
Deep-sea sole	0	0	0	0
<i>Shallow-water flatfish</i>				
Rock sole total	88,644	83,163	1,554	173,361
Yellowfin sole	70,669	10,660	0	81,329
Butter sole	3,626	23,277	2,906	29,809
Starry flounder	3,778	31,318	5,193	40,288
English sole	1,189	1,874	5,341	8,403
Sand sole	81	390	8	479
Alaska plaice	1,667	917	0	2,583
Flathead sole	57,871	113,976	16,843	188,690
Rex sole	10,700	55,442	20,901	87,042

Table 4.15. Estimates of natural mortality, growth (von Bertalanffy k), and age of recruitment for the major Gulf of Alaska flatfish species in the shallow water complex.

Species	Natural mortality	Age at recruitment
Northern rock sole	0.2	7
Southern rock sole	0.2	8
Yellowfin sole	0.2	9

Table 4.16. Von Bertalanffy parameter estimates for principal flatfish species in the Gulf of Alaska.

Species	Linf	K	t0
Northern Rock sole(Stark and Somerton 2002)			
males	38.2	0.261	0.16
females	42.9	0.236	0.387
Southern Rock sole(Stark and Somerton 2002)			
males	38.7	0.182	-0.962
females	52	0.12	-0.715
Yellowfin sole 1987 survey			
males	32.8	0.19	-2.24
females	38.2	0.14	-2.18
combined	34	0.18	-1.82

Table 4.17. Maturity schedule (proportion females mature at age) for Gulf of Alaska northern and southern rock sole used for ABC calculations.

Age	Northern	Southern
1	0.00	0.00
2	0.00	0.00
3	0.00	0.00
4	0.00	0.00
5	0.02	0.01
6	0.24	0.04
7	0.72	0.15
8	0.93	0.37
9	0.98	0.63
10	0.99	0.82
11	1.00	0.91
12	1.00	0.96
13	1.00	0.98
14	1.00	0.99
15	1.00	0.99
16	1.00	0.99
17	1.00	1.00
18	1.00	1.00
19	1.00	1.00
20	1.00	1.00

Table 4.18. Food habits of flatfish. Percent observed stomach contents in parentheses where available (Livingston and Goiney, 1983).

Fish species	Observed stomach contents
Rex sole	Polychaetes, euphausiids, pandalus sp.
Flathead sole	various fishes(38%), mysids(36%), shrimp(15%), clams(6%), polychaetes(3%)
rock sole-adults	fish(40%) polychaetes(27%), clam siphons(10%)
rock sole-juveniles	fish(10%), polychaetes(45%), clam siphons(15%), gammarids(8%)
yellowfin sole	Polychaetes, shrimp, fish, tanner crab, clam siphons
Dover sole	Polychaetes(64%), crustaceans(11%), mollusks(18%), echinoderms(3%), coelenterates(3%)
English sole	Polychaetes, ophiuroidea, ophiura sarsi, amphipoda, bivalves
sand sole	fish with a high frequency of arrowtooth flounder(only 4 stomachs out of 10 with food)
starry flounder	Echiuroidea(starfish), ophiuroidea(brittle star), fish, shrimp, crabs
butter sole	Polychaetes, ophiuroidea, crustacea, shrimp, tanner crab, fish

Table 4.19. Acceptable biological catch (t) for 2006 Gulf of Alaska flatfish, based on biomass estimates from the 2005 bottom trawl survey and F_{ABC} . Presented by North Pacific Fishery Management Council regulatory area. Split to Western, Central and Eastern management areas for the shallow water complex was estimated by applying the fraction of the 2005 survey biomass in each area. The split in the deep-water complex was estimated from average catch.

AREA

	Western	Central	West Yakutat	East Yakutat/SE	Total
<i>Deep-water flatfish</i>					
Greenland turbot ^a	122	40	9	8	179
Deep-sea sole ^a	0	4	0	0	4
Total (except Dover)	122	44	9	8	183
<i>Shallow-water flatfish</i>					
Northern Rock sole	9,842	5,518	0	0	15,360
Southern Rock sole	8,696	10,142	186	1,050	20,074
Total Rock sole	18,539	15,659	186	1,050	35,434
Yellowfin sole	2,962	3,217	0	0	6,179
Butter sole	753	2,562	4	0	3,319
Starry flounder	2,040	1,279	45	0	3,365
English sole	104	556	392	794	1,847
Sand sole	8	293	0	0	301
Alaska plaice	314	691	0	0	1,005
Total shallow-water	24,721	24,258	628	1,844	51,450

^a 0.75 * Average catch used to calculate ABC level.

Table 4.20. Overfishing values (t) for 2006 for Gulf of Alaska flatfish, based on biomass estimates from the 2005 bottom trawl survey and F_{OFL} .

Species	Yield(t)
<i>Deep-water flatfish</i>	
Greenland turbot ^a	238
Deep-sea sole ^a	6
Total Deep-water(except Dover sole)	244
<i>Shallow-water flatfish</i>	
Northern rock sole	18,099
Southern rock sole	23,459
Total rock sole	41,558
Yellowfin sole	8,048
Butter sole	4,323
Starry flounder	4,382
English sole	2,406
Sand sole	392
Alaska plaice	1,309
Total shallow-water	62,418

^a Average catch used to calculate overfishing level.

Table 4.21. Acceptable biological catch (t) for 2007 Gulf of Alaska flatfish, based on projections of biomass estimates from the 2003 and 2005 bottom trawl survey and F_{ABC} . Presented by North Pacific Fishery Management Council regulatory area. Split to Western, Central and Eastern management areas for the shallow water complex was estimated by applying the fraction of the 2005 survey biomass in each area. The split in the deep-water complex was estimated from average catch.

AREA

	Western	Central	West Yakutat	East Yakutat/SE	Total
<i>Deep-water flatfish</i>					
Greenland turbot ^a	122	40	9	8	179
Deep-sea sole ^a	0	4	0	0	4
Total (excluding Dover)	122	44	9	8	183
<i>Shallow-water flatfish</i>					
Northern Rock sole	9,707	5,442	0	0	15,149
Southern Rock sole	8,684	10,128	186	1,048	20,047
Total Rock sole	18,392	15,570	186	1,048	35,196
Yellowfin sole	2,769	3,008	0	0	5,777
Butter sole	690	2,347	4	0	3,040
Starry flounder	1,277	800	28	0	2,106
English sole	96	510	360	728	1,693
Sand sole	8	308	0	0	316
Alaska plaice	328	722	0	0	1,050
Total shallow-water	23,560	23,265	578	1,776	49,179

^a 0.75*Average catch used to calculate ABC level.

Table 4.22. Overfishing values (t) for 2007 for Gulf of Alaska flatfish, based on projections, the 2003 and 2005 bottom trawl survey biomass estimates, and F_{OFL} .

Species	Yield(t)
<i>Deep-water flatfish</i>	
Greenland turbot ^a	238
Deep-sea sole ^a	6
Total Deep-water(except Dover sole)	244
<i>Shallow-water flatfish</i>	
Northern rock sole	17,850
Southern rock sole	23,428
Total rock sole	41,278
Yellowfin sole	7,524
Butter sole	3,960
Starry flounder	2,743
English sole	2,206
Sand sole	411
Alaska plaice	1,368
Total shallow-water	59,490

^a Average catch used to calculate overfishing level.

Figures

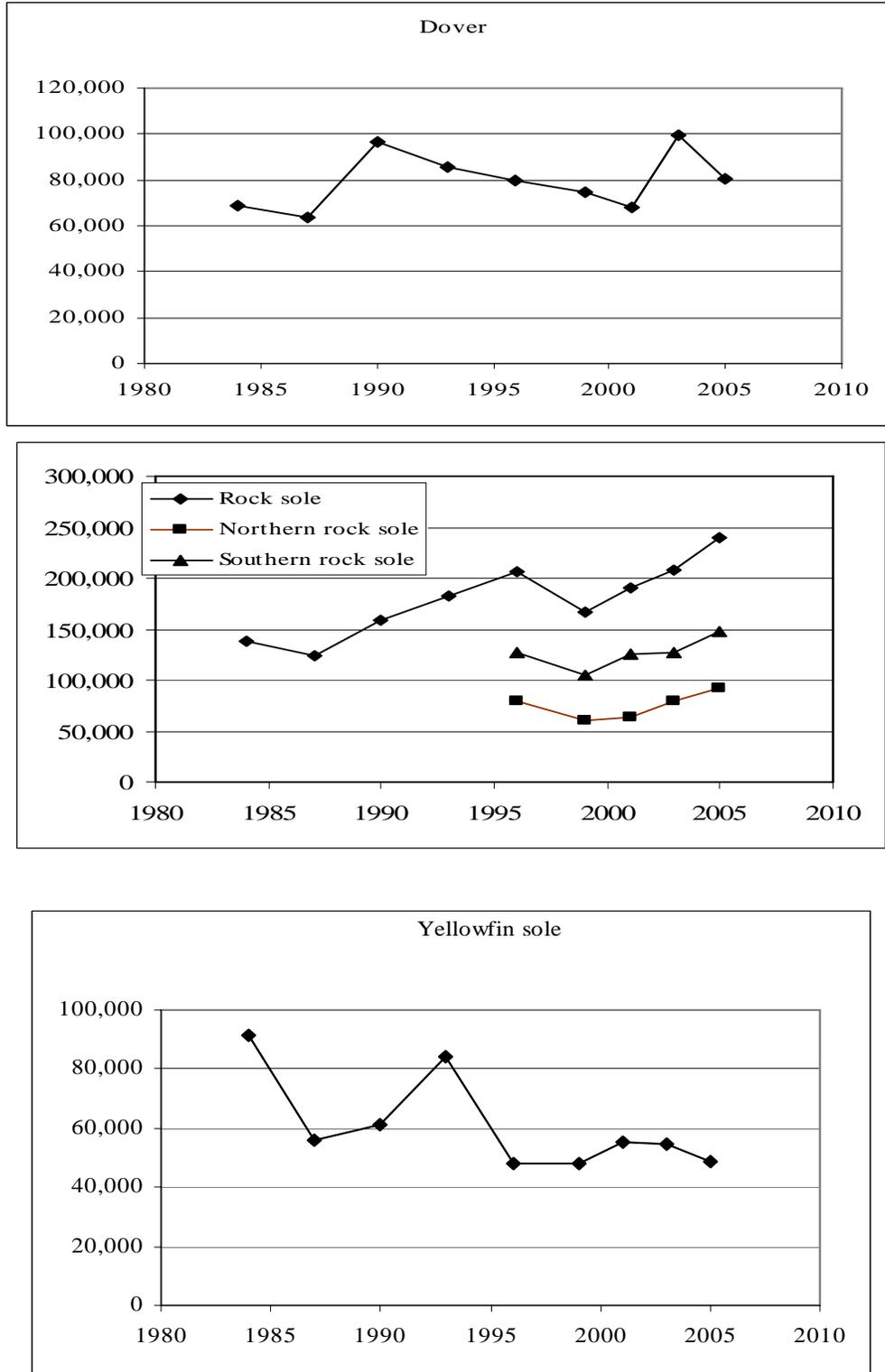


Figure 4.1. NMFS survey biomass estimates by flatfish species for 1984 to 2005.

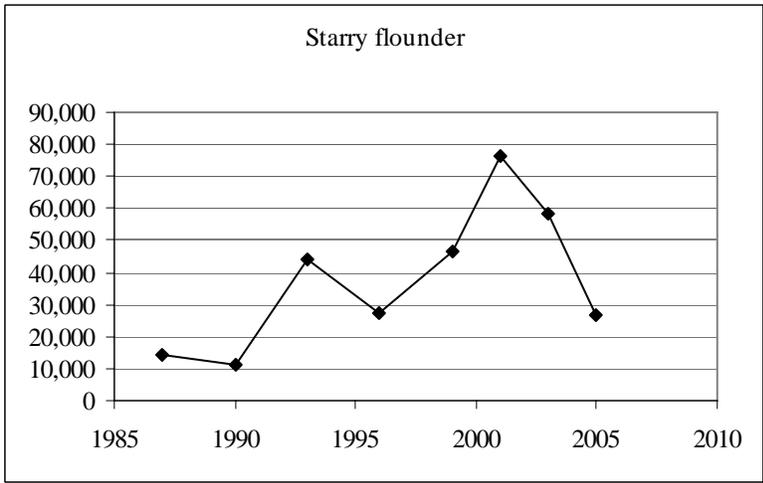
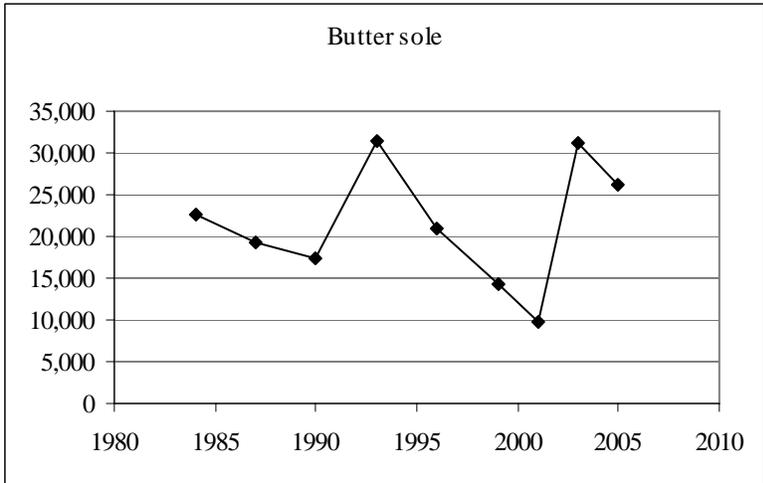


Figure 4.1. NMFS survey biomass estimates by flatfish species for 1984 to 2005.

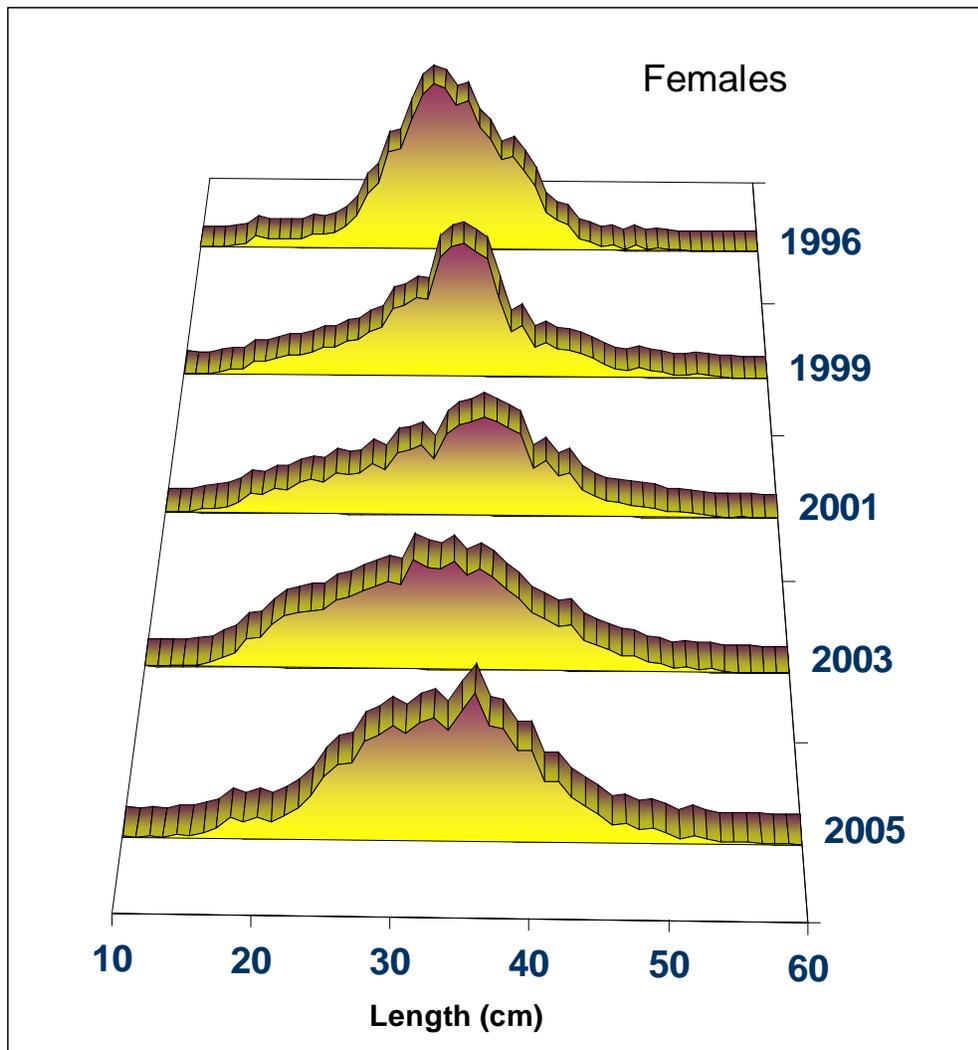


Figure 4.2. Population size composition (females only) of northern rock sole as estimated from the NMFS bottom trawl surveys, 1984-2005.

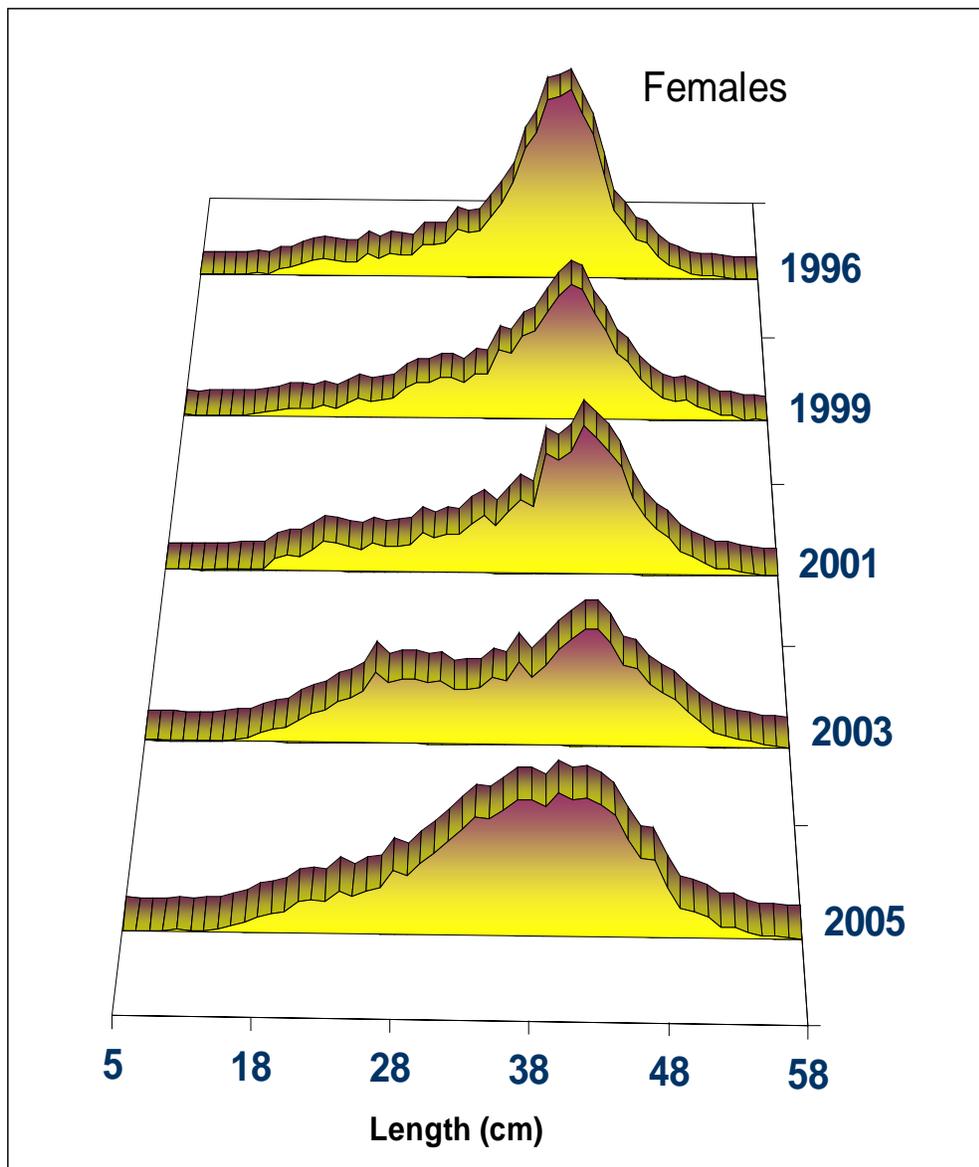


Figure 4.3. Population size composition (females only) of southern rock sole as estimated from the NMFS bottom trawl surveys, 1984-2005.

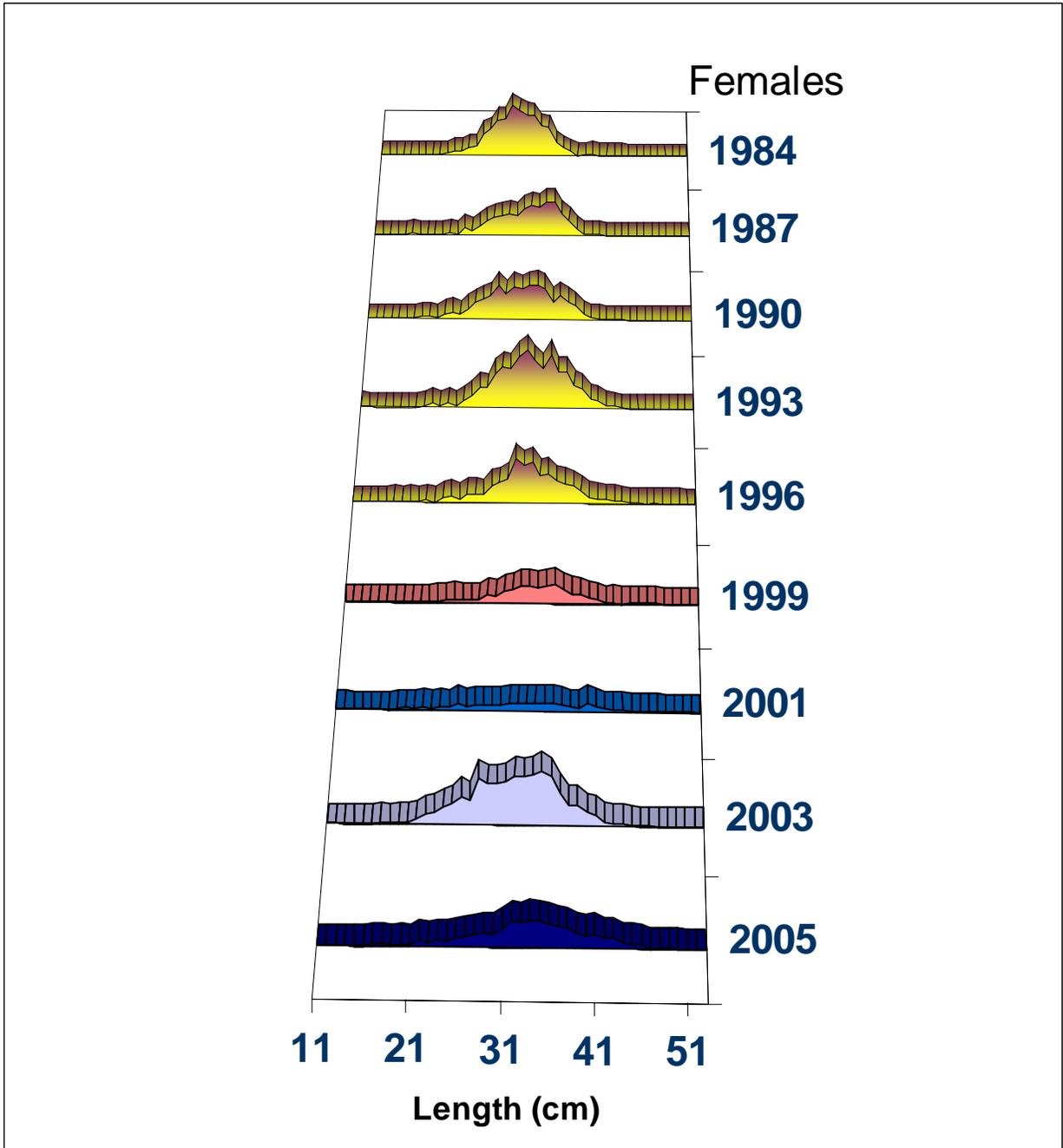


Figure 4.4. Population size composition (females only) of butter sole as estimated from the NMFS bottom trawl surveys, 1984-2005.

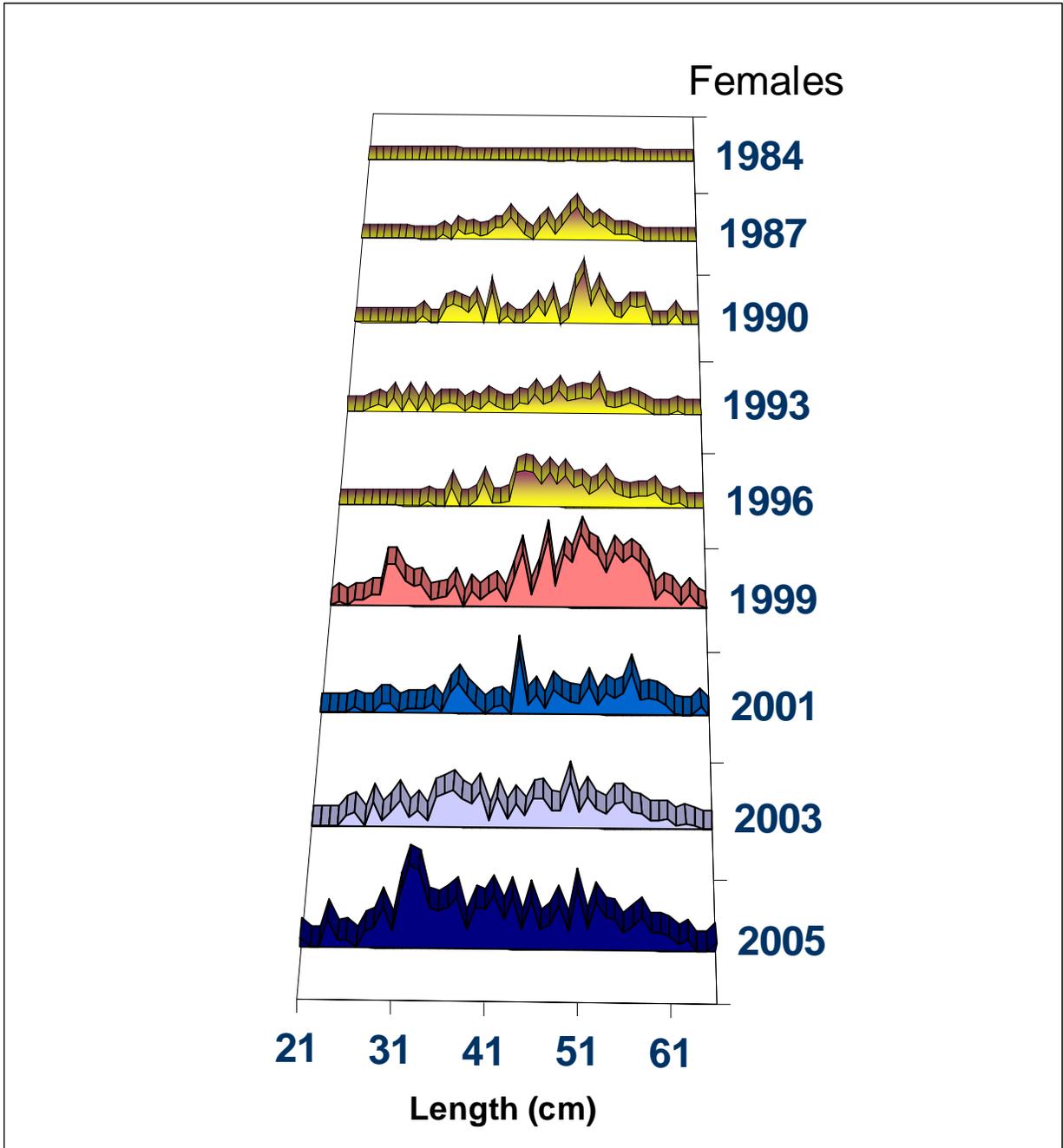


Figure 4.5. Population size composition (females only) of Alaska plaice as estimated from the NMFS bottom trawl surveys, 1984-2005

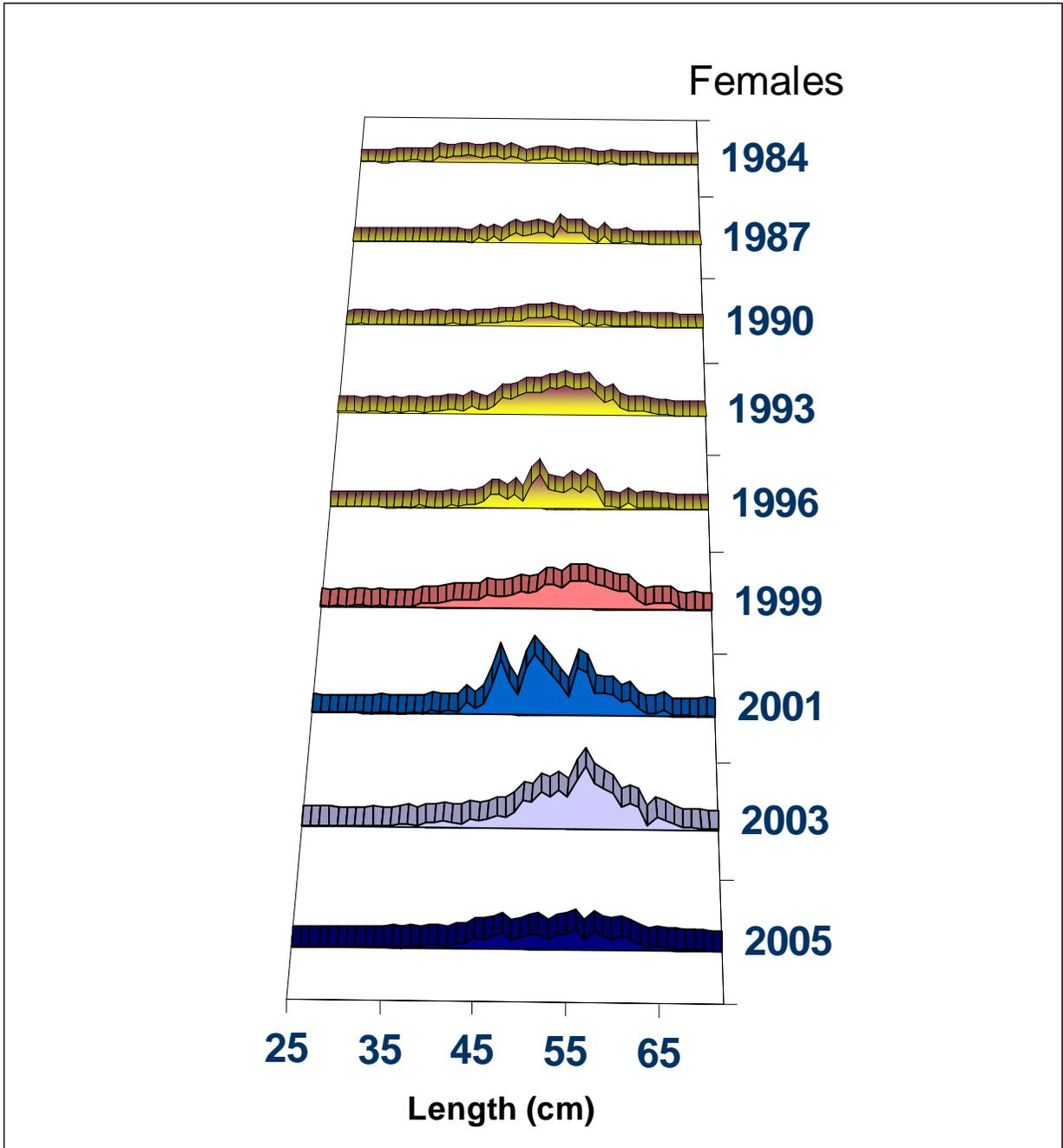


Figure 4.6. Population size composition (females only) of starry flounder as estimated from the NMFS bottom trawl surveys, 1984-2005

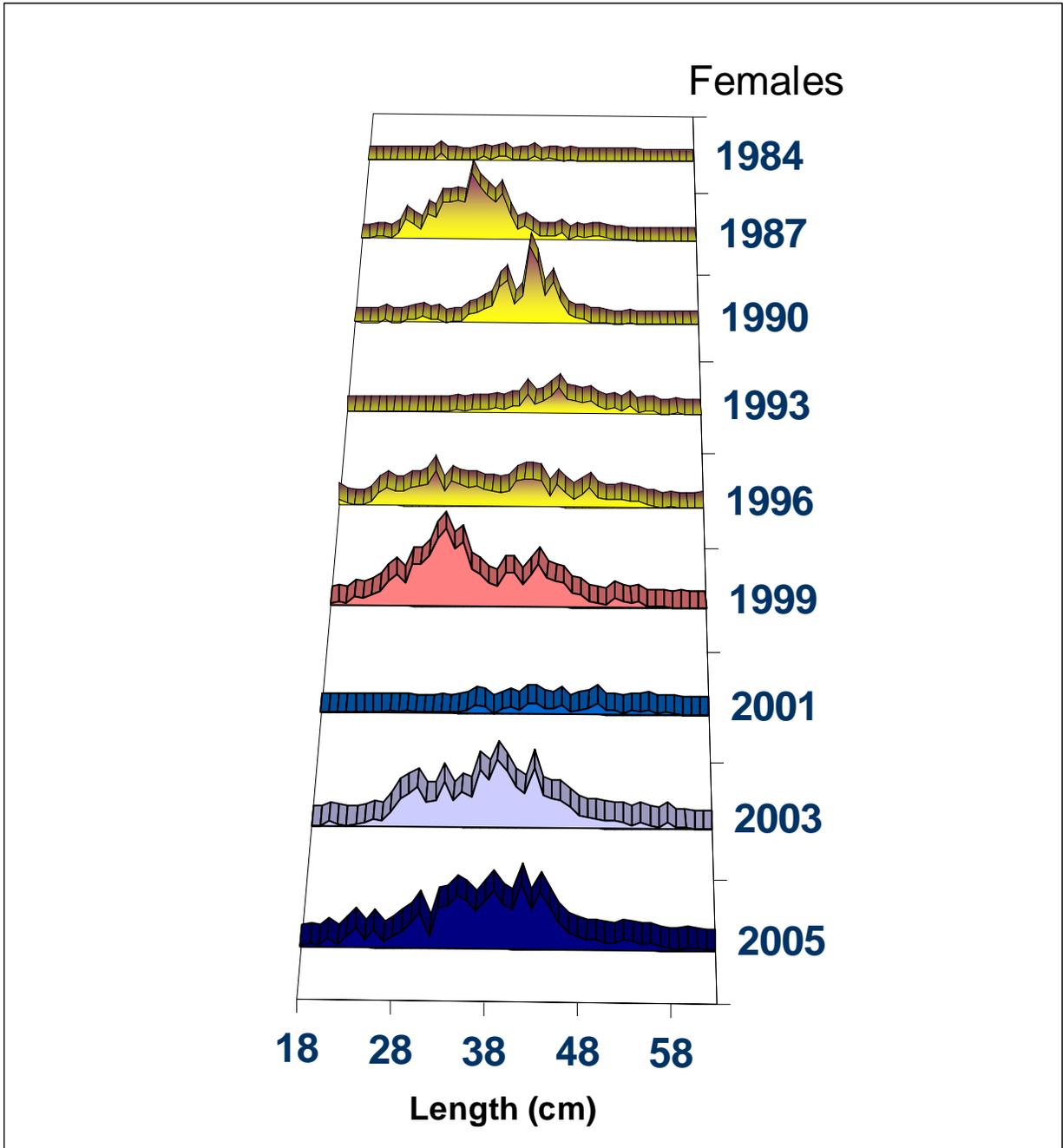


Figure 4.7. Population size composition (females only) of English sole as estimated from the NMFS bottom trawl surveys, 1984-2005.

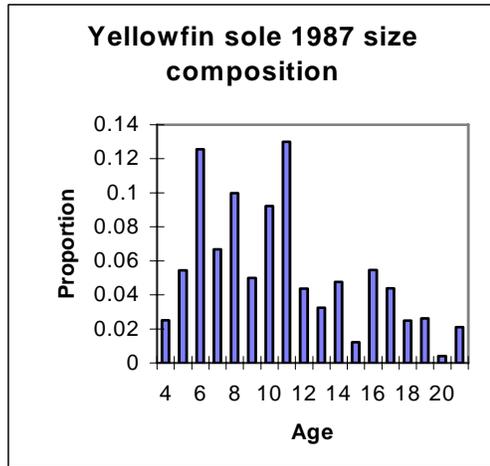
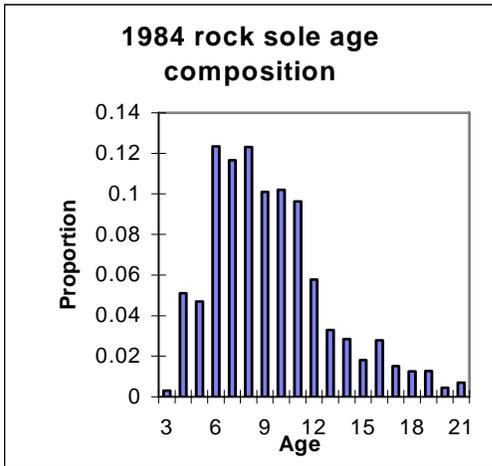


Figure 4.8. Flatfish age compositions from NMFS surveys.