Status of the U.S. English sole resource in 2005

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Executive Summary

Stock

This assessment reports the status of the English sole (*Parophrys vetulus*) resource off the coast of the United States from the Mexican Border to the Canadian border. Both commercial and fishery independent data sources are treated separately for a southern (INPFC Conception and Monterey) and a northern (INPFC Eureka, Columbia and U.S. Vancouver) area, however the English sole population is modeled as a single stock.

Catches

Historical landings from 1876 to 2004 were reconstructed from a variety of sources. Peak landings from the southern area occurred in the 1920s with a maximum of 3,976 mt of English sole landed in 1929. Peak landings from the northern area occurred from the 1940s to the 1960s with a maximum of 4,008 mt landed in 1948. Landings in both areas have generally declined since the mid 1960s and are at nearly historical lows in recent years. Model estimates of discarding average 20% by weight over the time series, with higher discards corresponding to periods of large recruitment and due to the associated increase in relative abundance of smaller unmarketable English sole.

Table a. Recent commercial fishery landings by INPFC area and fleet.

Year	Conception	Monterey	South total	Eureka	Columbia	US Vancouver	North total
1995	11	400	411	107	280	327	714
1996	11	423	434	183	353	182	718
1997	12	453	466	283	452	302	1,038
1998	5	224	229	317	329	264	910
1999	9	219	227	216	295	173	685
2000	9	172	181	157	211	200	569
2001	29	170	199	275	335	180	791
2002	6	95	102	293	333	440	1,067
2003	3	60	64	87	262	464	813
2004	31	65	96	210	330	314	853

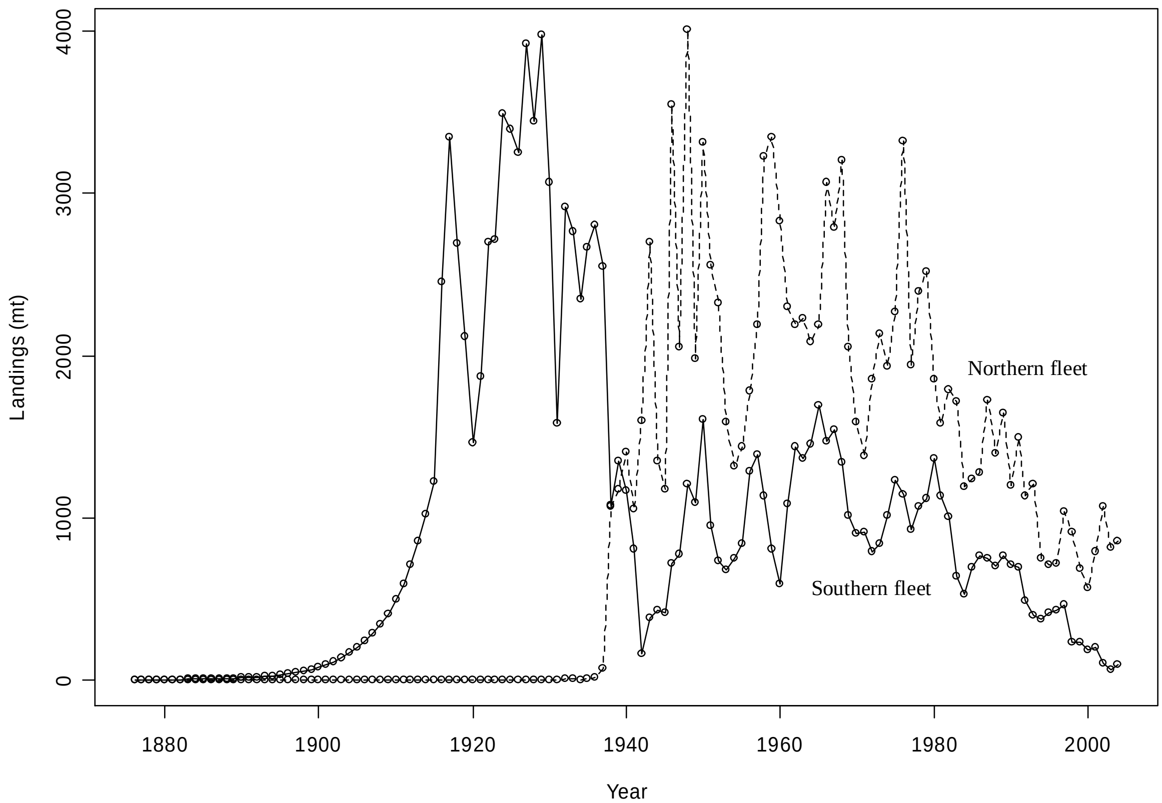

Figure a. Reconstructed historical landings (mt) by year and area, 1876-2004.

Data and assessment

The most recent assessment for English sole was performed in 1993 (Sampson), using an earlier version of the Stock Synthesis program (Methot, 1989). That assessment considered the female portion of the stock off Oregon and Washington during the years 1977-1993. The English sole spawning biomass was found to be increasing and it was concluded that the fishery was sustainable at (then) contemporary harvest levels.

The current assessment uses the Stock Synthesis 2 modeling framework to estimate model parameters and management quantities. The coast-wide English sole population (U.S. only), including both males and females as well as historical landings estimates from over 100 yrs of commercial fishing are included in the model. A fisheries independent estimate of relative biomass, the NMFS triennial groundfish survey, is included from 1980-2004. Life history data from this survey, including maturity observations, length-weight relationships as well as survey length composition and age composition data are also used. Length and age data from commercial fishery landings are included from 1948-2004, as well as fishery discard information from three separate observer programs, 1950-1961, 1985-1987 and 2001-2003.

Stock biomass

English sole spawning biomass was found to be increasing rapidly over the last decade after a period of poor recruitments from the mid 1970s to the mid 1990s, which left the stock at nearly historically low levels. The spawning biomass at the beginning of 2005 was estimated to be 31,379 mt (~ 95% confidence interval: 23,480-39,278), which corresponds to 91.5% (64.5-118.4%) of the unexploited equilibrium level. Current (2004) total catches were estimated to be 1,341 mt, of which 950 mt were landed.

Table b. Recent trend in English sole spawning biomass and depletion level.

Year	Estimated spawning biomass (mt)	~95% confidence interval	Estimated depletion	~95% confidence interval
1995	9,149	4,557-13,741	26.7%	NA
1996	9,469	4,880-14,058	27.6%	NA
1997	9,856	5,303-14,409	28.7%	NA
1998	11,153	6,432-15,874	32.5%	NA
1999	14,198	9,039-19,357	41.4%	NA
2000	17,589	11,926-23,252	51.3%	NA
2001	20,661	14,599-26,723	60.2%	NA
2002	24,138	17,571-30,705	70.3%	NA
2003	27,873	20,580-35,166	81.2%	NA
2004	30,334	22,602-38,066	88.4%	61.6-115.3%
2005	31,379	23,480-39,278	91.5%	64.5-118.4%

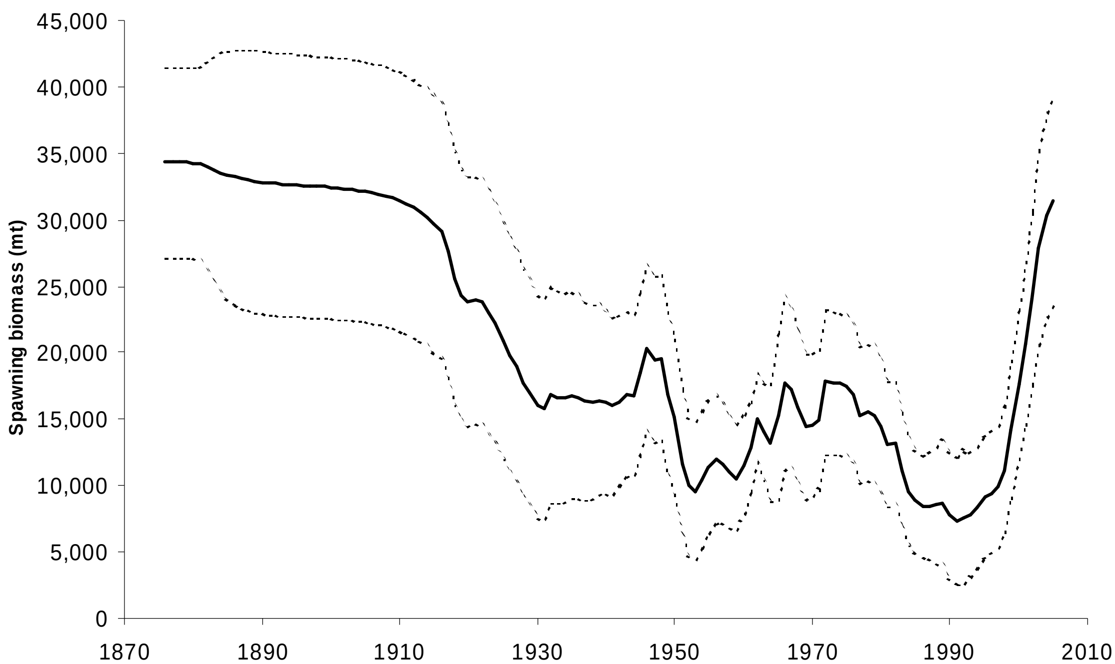

Figure b. Estimated spawning biomass time-series with approximate asymptotic 95% confidence interval.

Recruitment

Following two decades of low recruitments, strong year classes were estimated for 1995, 1996, and 1999. The data indicate that the 1999 year class may be the largest in the time-series, although the magnitude is somewhat uncertain because the assessment contains no age data subsequent to 2000. The effect of this source of uncertainty is discussed further below.

Table c. Recent estimated trend in English sole recruitment.

Year	Estimated recruitment (1000s)	~95% confidence interval
1995	210,815	119,186-302,454
1996	202,183	95,172-309,188
1997	137,126	47,048-227,212
1998	177,488	74,110-280,870
1999	317,501	162,050-472,950
2000	152,242	44,138-260,342
2001	120,796	44,184-197,416
2002	165,799	57,790-273,810
2003	120,123	31,702-208,538
2004	113,420	31,075-195,765
2005	114,578	30,792-198,368

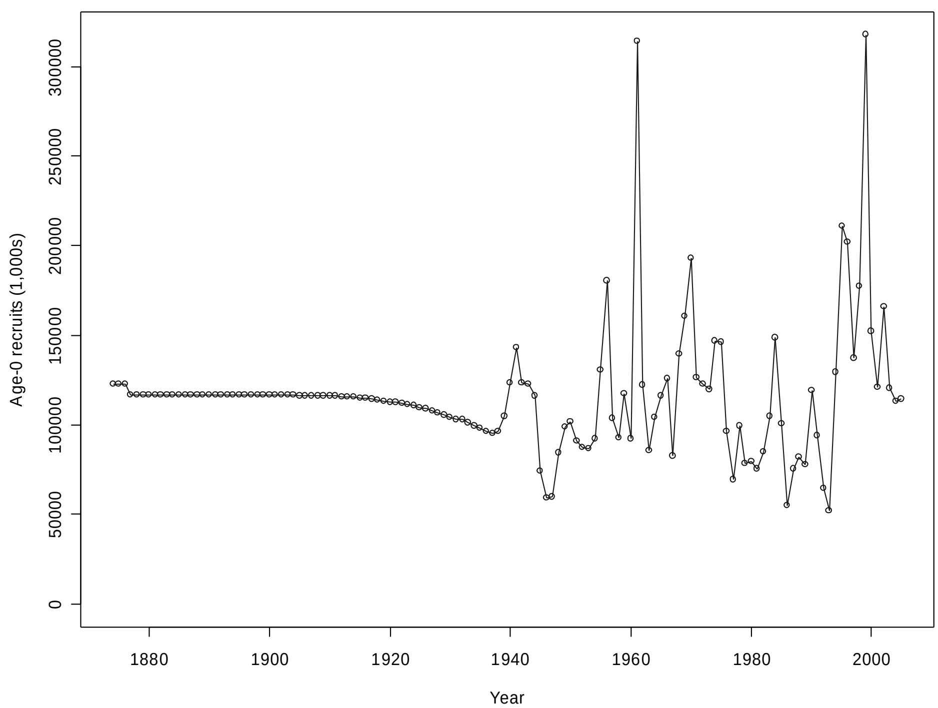

Figure c. Time series of estimated English sole recruitments.

Reference points

Because of temporal changes in growth and maturity, there are two types of reference points reported in this assessment: those based on the assumed population parameters at the beginning of the modeled time period and those based on the most recent time period in a ‘forward projection’ mode of calculation. All strictly biological reference points (e.g., unexploited spawning biomass) are calculated based on the unexploited conditions at the start of the model, whereas management quantities (MSY, SB_{msy}, etc.) are based on the current growth and maturity schedules and are marked throughout this document with an asterisk (*).

Unexploited equilibrium English sole spawning biomass (B_{zero}) was estimated to be 34,312 mt (~ 95% confidence interval: 27,179 - 41,445), with a mean expected recruitment of 122,820 thousand age-0 English sole. MSY, estimated in the assessment model, was 4,080* mt (2,416-5,743). This value is very close to the estimated total average catch from the period of heaviest exploitation, 1917-1991, of 3,764 mt. The spawning stock biomass expected to produce MSY catch levels was 5,696* mt (*1*-12,102, the symmetric approximation of the 95% confidence interval included zero and was therefore rounded up), or 19.1%* of B_{zero} (forward projected). This level of exploitation was estimated to result in a spawning potential ratio (SPR) of 23.8%*.

Exploitation status

The estimated spawning potential ratio for English sole has been above both the proxy target of 40% for flatfish as well as the estimated MSY level of 23.8% for the last decade.

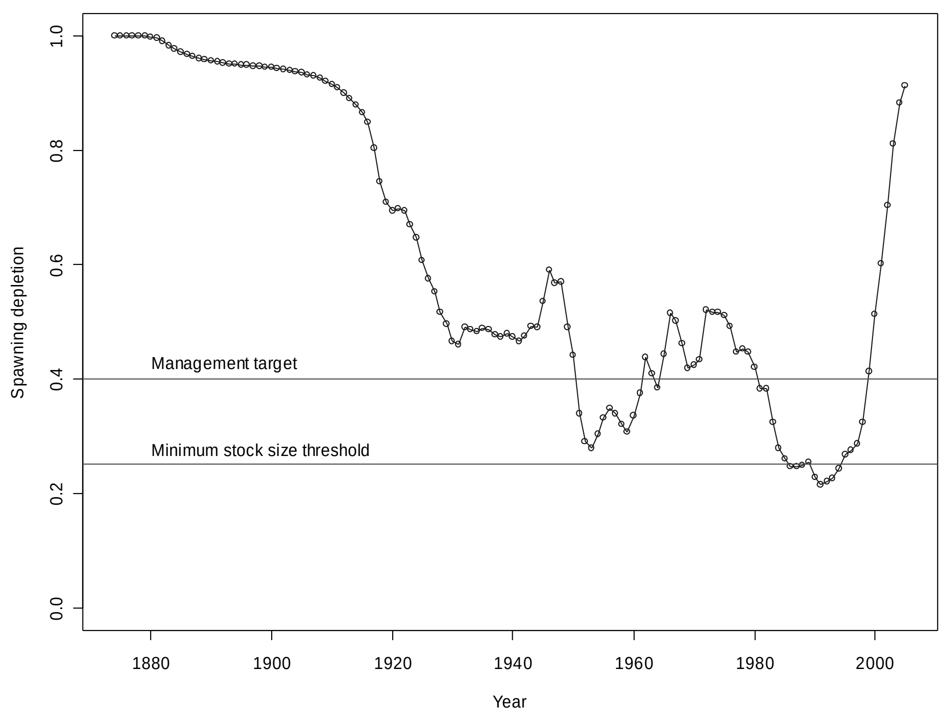

Figure d. Time series of estimated depletion level, 1876-2005.

Table d. Recent trend in spawning potential ratio (SPR).

Year	Estimated SPR	~95% Confidence interval
1995	53.1%	NA
1996	55.2%	NA
1997	49.5%	NA
1998	56.9%	NA
1999	66.3%	NA
2000	76.0%	NA
2001	75.4%	NA
2002	75.3%	NA
2003	82.7%	NA
2004	83.7%	NA

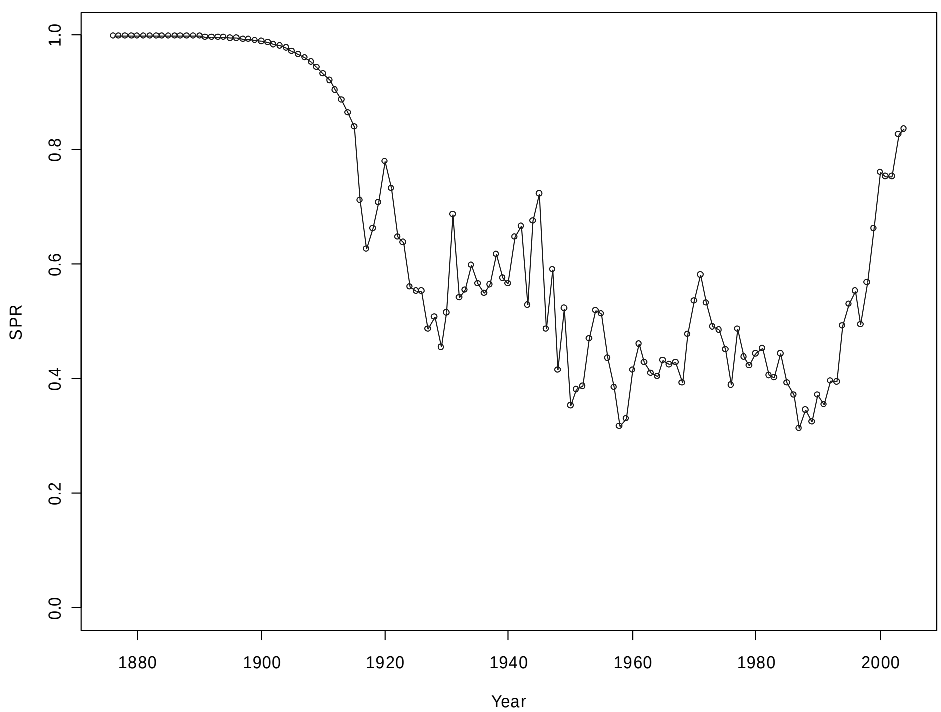

Figure e. Time series of estimated spawning potential ratio.

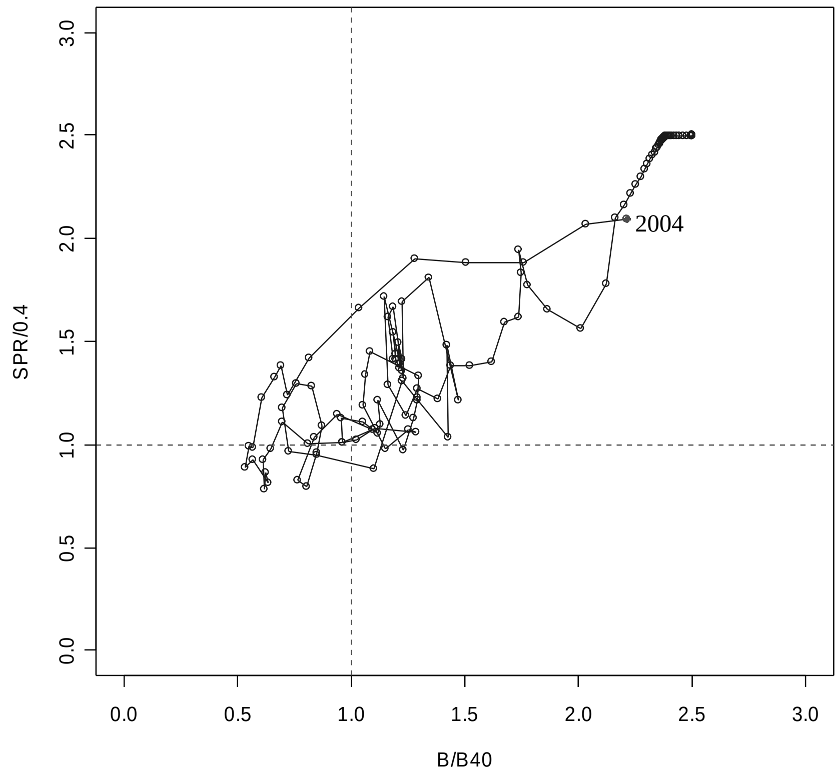

Figure f. Temporal pattern of estimated spawning potential ratio relative to the proxy target of 40% vs. estimated spawning biomass relative to the proxy 40% level.

Management performance

Recent English sole landings and estimated discards have been below both the coast-wide ABC of 3,100 mt and the estimated MSY harvest level of 4,080 mt.

Table e. Recent trend in estimated total English sole catch and landings (mt)

Year	Landings (mt)	Estimated total catch (mt)	Coast-wide ABC
1995	1125	1,817	3,100
1996	1152	1,775	3,100
1997	1504	2,327	3,100
1998	1139	1,910	3,100
1999	912	1,582	3,100
2000	750	1,233	3,100
2001	990	1,533	3,100
2002	1168	1,775	3,100
2003	877	1,306	3,100
2004	950	1,341	3,100

Unresolved problems and major uncertainties

This assessment addresses uncertainty in parameter values and predictions of stock status through asymptotic variance estimates and sensitivity testing of the maximum likelihood estimates. Confidence intervals for population parameters were generally wide, indicating substantial uncertainty in the time series of biomass, recruitment and relative depletion level for English sole. Three specific areas of uncertainty were examined:

1) The 1999 year class strength was estimated to be very large. Alternate model runs constraining this and subsequent year classes indicated that the current stock size was sensitive to the estimated magnitude of these recruitments.
2) A large reduction in the length at 50% maturity combined with slower estimated growth rates in recent years has potentially changed the productivity of the English sole stock. Changes in both of these characteristics were explicitly modeled and alternate models assuming no change were compared.
3) Changes in fishery selectivity and retention appear to have occurred over time and between fleets. Selectivity was allowed to change over time in the model, however, sparse data on the discarded fraction of the catch and for the landed catch over certain time periods results in the need for the modeled patterns of fishery selectivity and retention to be very simple in the current assessment, likely underestimating the uncertainty in population dynamics. An effort was made to explore these simple assumptions through sensitivity testing.

The conclusion that current spawning biomass exceeds the target level ($B_{40\%}$) was found to be robust to all three of these sources of uncertainty as well as other sensitivity analyses included.

Forecasts

Forecasts were generated assuming the maximum potential catch would be removed under the 40:10 harvest control rule. A 10-year average of the relative F contribution from the southern and northern fleets was used for this projection. This ratio was 22.4% for the southern fleet to 77.6% for the northern fleet. Very large potential catches (3-6 times recent average values) are predicted to be possible over the first five years of the projection.

Table f. Projection of potential English sole catch, landings, spawning biomass and depletion for the base case model under the 40:10 rule.

Year	Total catch (mt)	95% interval	Total landings (mt)	Spawning biomass (mt)	95% interval	Depletion	95% interval
2005	10,215	7,656-12,774	7,545	31,379	23,480-39,278	0.915	0.645-1.184
2006	8,249	6,264-10,234	6,002	24,908	18,843-30,973	0.726	0.518-0.934
2007	6,773	5,142-8,404	4,813	20,080	15,126-25,034	0.585	0.419-0.752
2008	5,701	4,280-7,122	3,938	16,645	12,341-20,949	0.485	0.345-0.625
2009	4,972	3,671-6,272	3,318	14,418	10,453-18,383	0.420	0.294-0.546
2010	4,451	2,917-5,985	2,874	13,121	9,294-16,948	0.382	0.262-0.503
2011	4,122	2,707-5,538	2,607	12,434	8,854-16,014	0.362	0.248-0.476
2012	3,945	2,599-5,291	2,473	12,076	8,669-15,483	0.352	0.240-0.464
2013	3,836	2,539-5,132	2,397	11,861	8,600-15,122	0.346	0.234-0.457
2014	3,759	2,498-5,019	2,347	11,714	8,571-14,857	0.341	0.229-0.454
2015	3,701	2,464-4,939	2,311	11,607	8,550-14,664	0.338	0.225-0.451
2016	3,659	2,433-4,885	2,284	11,530	8,529-14,531	0.336	0.222-0.450

Decision table

The format and content of the decision table was a result of extensive discussion during the STAR panel. The strength of recent year classes was closely related to current stock status and was identified as an important source of uncertainty in this assessment; this “axis of uncertainty” was therefore selected for inclusion in the table. The spawning biomass estimated from the base case model was 31,379 mt at the beginning of 2005, with an approximate 95% confidence interval including the range of 23,480–39,278 mt. Due to the relatively large current estimate of spawning biomass, it was agreed that two alternate states of nature reflecting the lower tail of the distribution from the base case would be presented. By imposing a large constraint on the recruitments from 1999 to 2005, the current spawning biomass was reduced to 25,772 mt. Constraining 1998 and subsequent years to the same degree resulted in an estimated 2005 spawning biomass of 23,824 mt. These runs were considered to be “unlikely” and “least likely”, as they represented increasing constraint away from the base case model. The approximate probability of each of these states of nature was calculated from the cumulative distribution of uncertainty in 2005 spawning biomass for the base case model.

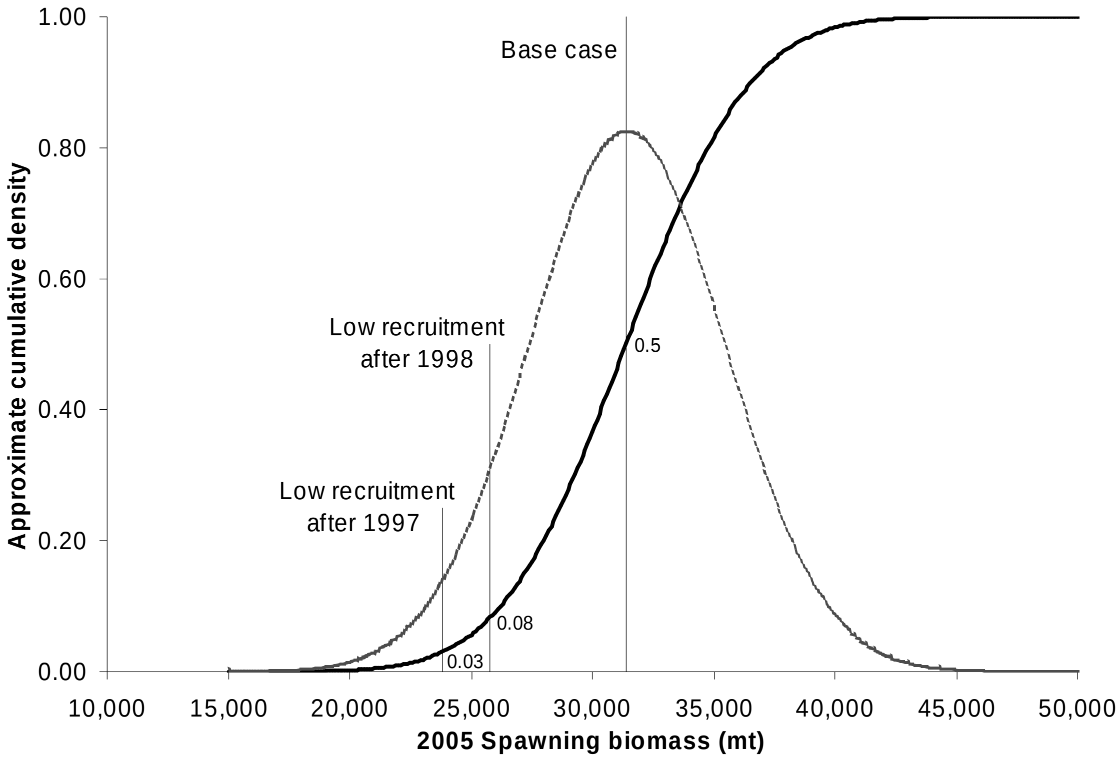

Figure g. Approximate distribution of uncertainty in estimated 2005 spawning biomass from the base case model (dashed line), and cumulative probability that the spawning biomass is less than each state of nature (solid line).

Table g. Decision table as requested by the STAR panel.

			State of nature		
			Base case	Low recruitment after 1998	Low recruitment after 1997
Subjective relative probability			Most likely	Unlikely	Least likely
Approximate probability that spawning biomass < spawning biomass for the assumed state of nature			0.5	0.08	0.03
Management decision	**Quantity**	**Year**			
3-year average landings South = 87 mt, North = 911 mt	Depletion	2005	0.91	0.74	0.70
		2006	0.92	0.74	0.71
		2007	0.91	0.74	0.70
		2008	0.89	0.72	0.69
		2009	0.86	0.71	0.69
		2010	0.83	0.70	0.68
		2016	0.73	0.68	0.68
	Spawning biomass (1000s mt)	2005	31	26	24
		2006	32	26	24
		2007	31	25	24
		2008	30	25	24
		2009	29	25	23
		2010	28	24	23
		2016	25	24	23
200% of 3-year average landings South = 174 mt, North = 1,822 mt	Depletion	2005	0.91	0.74	0.70
		2006	0.89	0.71	0.67
		2007	0.86	0.68	0.64
		2008	0.81	0.64	0.61
		2009	0.76	0.61	0.58
		2010	0.72	0.59	0.56
		2016	0.57	0.51	0.49
	Spawning biomass (1000s mt)	2005	31	26	24
		2006	31	25	23
		2007	29	24	22
		2008	28	22	21
		2009	26	21	20
		2010	25	20	19
		2016	19	18	17
ABC landings estimated from base case	Depletion	2005	0.91	0.74	0.70
		2006	0.73	0.55	0.50
		2007	0.59	0.41	0.37
		2008	0.49	0.32	0.28
		2009	0.42	0.27	0.22
		2010	0.38	0.24	0.19
		2016	0.34	0.18	0.10
	Spawning biomass (1000s mt)	2005	31	26	24
		2006	25	19	17
		2007	20	14	12
		2008	17	11	9
		2009	14	9	7
		2010	13	8	6
		2016	12	6	3
	Landed catch (mt)	2005	7,545		
		2006	6,002		
		2007	4,813		
		2008	3,938		
		2009	3,318		
		2010	2,874		
		2016	2,284		

Research and data needs

A number of crucial data sources would substantially improve the ability of this assessment to reliably and precisely model English sole population dynamics in the future. In order of priority (author's personal opinion):

1) The NWFSC trawl survey is currently collecting otoliths for use in ageing of English sole. A comparison study of otolith and interopercular (used in this assessment) age reading precision and agreement would allow use of survey otoliths and provide a fishery independent source of age information for this assessment. Because the survey selects smaller fish than the commercial fishery, this would improve estimation of both growth curves and recent year class strengths.
2) Collection of maturity data on an ongoing basis from survey or fishery sources that could be used to track future changes affecting modeled spawning stock biomass.
3) This assessment contains little data on the length frequency of the discarded portion of the commercial catch of English sole. This would be valuable data to add to the discard fractions and average individual weights currently being collected.
4) Despite much effort prior to this assessment, there is still uncertainty in some parts of the historical landings series. Specifically needed are: 1) a method for reconstructing landings in Washington prior to 1956 from U.S. waters, 2) landings data from Oregon from 1954-1955 and 3) a thorough study of the mink food fishery in Oregon and California including estimates of the total volume and size structure of catches associated with this fishery.
5) Because the U.S.-Canada border does not appear to be a meaningful biological boundary for the English sole population, extension of this assessment to include Canadian waters may be necessary to better capture population trends.

Rebuilding projections

The stock of English sole off the United States was not found to be currently overfished, and therefore does not require rebuilding projections.

Regional management concerns

The biggest obstacle to modeling the English sole population in the southern and northern areas separately is a lack of data; specifically the length-frequency of discarded fish (to reliably estimate selectivity separately for each fleet), current maturity observations and sufficient age data to allow estimation of the growth curve for each area as well as model changes in growth over time. Without these data it is difficult to speculate on whether regional management is appropriate for English sole, as relatively large historical catches of similar magnitude have been removed from both areas.

Table h. Summary of recent trends in English sole exploitation and stock levels; all values reported at the beginning of the year. Quantities based on the current growth and maturity schedules and are marked with an asterisk (*) and are not comparable to those based on unfished conditions.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total catch (mt)	1,817	1,775	2,327	1,910	1,582	1,233	1,533	1,775	1,306	1,341	NA
Estimated discards (mt)	692	623	824	771	670	484	543	607	429	391	NA
Landings (mt)	1,125	1,152	1,504	1,139	912	750	990	1,168	877	950	NA
ABC (mt)	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100
OY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SPR*	53.1%	55.2%	49.5%	56.9%	66.3%	76.0%	75.4%	75.3%	82.7%	83.7%	NA
Total biomass (mt)	24,146	26,705	29,448	33,343	39,740	43,741	48,245	52,681	54,755	55,990	56,134
Spawning biomass (mt)	9,149	9,469	9,856	11,153	14,198	17,589	20,661	24,138	27,873	30,334	31,379
~95% interval	4,557-13,741	4,880-14,058	5,303-14,409	6,432-15,874	9,039-19,357	11,926-23,252	14,599-26,723	17,571-30,705	20,580-35,166	22,602-38,066	23,480-39,278
Recruitment (1000s)	210,820	202,180	137,130	177,490	317,500	152,240	120,800	165,800	120,120	113,420	114,580
~95% interval	119,186-302,454	95,172-309,188	47,048-227,212	74,110-280,870	162,050-472,950	44,138-260,342	44,184-197,416	57,790-273,810	31,702-208,538	31,075-195,765	30,792-198,368
Depletion	26.7%	27.6%	28.7%	32.5%	41.4%	51.3%	60.2%	70.3%	81.2%	88.4%	91.5%
~95% interval	NA	NA	NA	NA	NA	NA	NA	NA	NA	61.6-115.3%	64.5-118.4%

Table i. Summary of English sole reference points. Quantities based on the current growth and maturity schedules and are marked with an asterisk (*) and are not comparable to those based on unfished conditions. The symmetric approximation of the 95% confidence interval included zero for some quantities, the lower limit is therefore rounded up and in italics.

Quantity	Estimate	~95% Confidence interval
Unfished spawning stock biomass (SB_0, mt)	34,312	27,179 - 41,445
Unfished total biomass (B_0, mt)	63,642	NA
Unfished recruitment (R_0, thousands)	122,820	97,289-148,351
Spawning stock biomass at MSY (SB_{msy})*	5,696	*1*-12,102
Basis for SB_{msy}	Estimated	NA
SPR_{msy}*	23.8%	*0.01%*-52.5%
Basis for SPR_{msy}	Estimated	NA
Exploitation rate corresponding to SPR_{msy}*	0.231	NA
MSY* (mt)	4,080	2,416-5,743

1. Introduction

1.1 Life history

English sole (*Parophrys vetulus*)[1] are a common right-eyed flatfish species, occurring from Northern Baja California to the Aleutian islands off Alaska (Hart, 1973; Eschmeyer and Herald, 1983). English sole inhabit estuaries and near shore areas and range to depths of over 500m (Eschmeyer and Herald, 1983), including Puget Sound and the Strait of Georgia. Starry flounder (*Platichthys stellatus*) and English sole are known to hybridize, however this is rare, and appears to occur primarily in Puget Sound (Eschmeyer and Herald, 1983).

Adult English sole have a diverse diet, consisting mainly of benthic organisms such as polychaetes and amphipods (Kravitz et al., 1976) and tend to occur over sand or sand-mud substrates (Demory et al., 1976). English sole spawn in the winter (roughly December to April) and this does not appear to change over the latitudinal range of the species like some other flatfishes (Castillo, 1995). English sole move toward deeper water during the spawning period, as reflected by catch sampling by depth (Alverson, 1960; Hewitt, 1980), but they do not concentrate into dense aggregations the way petrale sole (*Eopsetta jordani*) do.

English sole eggs are slightly buoyant and hatch a few days after spawning (Forrester, 1969). Larvae are pelagic for a period lasting two to three months (Laroche et al., 1982). Planktonic English sole larvae are common in the surface waters off Oregon after spawning, during the late winter and early spring (Richardson et al., 1980). Pelagic larvae depend on a diet of mainly appendicularians during this phase (Gadomski and Boehlert, 1984). The settling of larvae occurs in spring, in both near shore (Krygier and Pearcy, 1986) and estuary areas. Juveniles spend 1-2 years rearing in coastal estuaries and/or the open coast, especially in the southern end of their range (Kramer, 1991), before moving to deeper waters. In the north, important estuaries include the Columbia River, Willapa Bay, Yaquina Bay and Grays Harbor, in the south, both the San Francisco bay area and the open coast may provide substantial production. Production of recruits and population distribution is limited at the extreme southern end of the range of English sole because of increased water temperatures, especially in the estuaries.

The size composition of juvenile English sole in estuaries is variable, depending on the oceanic conditions and dates of settlement but generally ranges from 2-18 cm (Westrheim, 1955; Toole, 1980). There may be density dependent interactions within a year class during the estuary period, but dietary and spatial partitioning appears to reduce the effect between sequential cohorts (Toole, 1980). Juveniles first occupy tidal, then sub-tidal habitats before they begin to leave the estuaries during the fall of their second year. It has been hypothesized that English sole recruitment to the coast outside the estuaries is relatively constant, due to a density-dependent carrying capacity of estuary rearing areas (Rooper, 2002; Rooper et al., 2004). Total juvenile production is thus likely to be limited by the available estuary habitat and the relatively constant juvenile density among estuaries and across years (Rooper et al., 2004). This stability in recruitment appears to be robust even to changes in environmental conditions due to El Niño events (Rooper et al., 2004).

[1] English sole are variously referred to as "lemon sole" and "pointed-nosed sole", especially in the historical literature.

Upon leaving the estuaries, English sole begin to disperse toward deeper water as they get larger (see analysis of survey data below). Some individuals are mature at age three, but the percentage increases rapidly with size, as does the egg production from roughly 150,000 eggs at 30 cm to 2,000,000 eggs at 43 cm (Forrester, 1969). English sole are relatively small bodied for a commercial species, with most individuals attaining sizes of 30 to 40 cm in the retained catch. Maximum sizes are less than 60 cm for the largest individuals in both the U.S. and Canadian fisheries (Forrester, 1969). English sole display highly sexually dimorphic growth, with females attaining lengths nearly twice that of males. This results in only a small fraction of the commercial catch being composed of males, while survey catches are much closer to 50:50 in sex-ratio.

1.2 Stock structure

Very few English sole are captured by either the commercial fishery or the NMFS triennial survey near the U.S.-Mexico border. This political boundary is therefore a reasonable proxy for the southern extent of the stock. To the north, English sole are abundant at the U.S.-Canada border. The historical fishery from Washington and Oregon frequently fished on both sides of the border (Alverson, 1956) and there appears to be no discontinuity in abundance that would indicate a biological boundary. However, this assessment does not include waters outside the management of the Pacific Council.

Tagging data from research conducted in Puget Sound (Pruter and Van Cleve, 1954; Menasveta, 1958; Day, 1976) and the Strait of Georgia (Ketchen and Forrester, 1955) revealed very little exchange between inland waters and those of the open coast (this review is part of a larger Bayesian mark-recapture analysis currently in prep by the author). Of 24,408 tags released in Puget Sound and the Strait of Georgia, only 12 (0.002%) of the 5,756 recoveries were captured off the open coast. Conversely, only 3 (0.001%) of 4,232 tags recovered from 32,431 tags released on the open coast were recaptured within Puget Sound or the Strait of Georgia. A single study (Forrester, 1969) tagged 282 English sole in the Strait of Juan de Fuca and recovered 34 of 59 tags from the open coast, mostly off Washington, but ranging as far south as Oregon. In aggregate, these results seem to indicate that Puget Sound and the Strait of Georgia are isolated from the open coast, but that mixing of adults does occur to some extent in the Strait of Juan de Fuca. This assessment assumes that the stock of English sole occurring in Puget Sound has little or no exchange with the coastal population.

On the U.S. outer coast, the choice of appropriate stock structure for an English sole stock assessment is difficult. Many English sole tagging programs have been conducted off the coast of both the U.S. and Canada since the 1930s. These include releases off the coast of British Columbia (Manzer, 1946; Taylor, 1946; Ketchen, 1950; Ketchen, 1956; Forrester, 1969), Washington (Pattie, 1969), Oregon (Harry, 1956; Harry, 1959; Golden et al., 1979) and California (Jow, 1969). All studies found limited latitudinal movement by English sole occurring between historical PMFC areas (Pacific Marine Fisheries Commission; many of these studies pre-date the more recent INPFC area designations), but a few individuals that appeared to move much greater distances.

In order to capture some of the spatial variability in the English sole population and the commercial fisheries while still using a simple single-stock assessment model data are delineated into 'northern' and 'southern' areas based on three sources of information: survey biomass distribution, recent fishery catch distribution inferred from logbooks, and catch history. Patterns in all three of these series indicate that there are two areas of increased abundance, one in the north off Oregon and Washington and one off central California and that both have experienced a distinct exploitation history (see analysis of data sources below). Because virtually all data sources have been collected and stratified by INPFC (International North Pacific Fisheries Commission) areas, it was efficient to select an INPFC boundary at which to delineate areas, to the extent that this adequately captured biological considerations. The southern area therefore includes English sole from the U.S.-Mexico border to the north edge of the Monterey INPFC area and the northern area includes English sole from the southern border of the Eureka INPFC area to the U.S.-Canada border (Figure 1). This assessment treats data from both areas together, modeling the U.S. English sole resource as a single population.

1.3 Historical and current fishery

English sole have been captured by the bottom trawl fishery operating off the western coast of North America for over a century. In California, the first paranzella trawl fishing began in 1876, and by 1880 there were 6 boats fishing from San Francisco (Scofield, 1948). By 1888 the fishery was using steam trawling (Scofield, 1948). The fishery was primarily targeting flatfish in the middle depths and it was estimated that 20-25% of the catch was discarded as unmarketable (Scofield, 1948). The fishery increased rapidly, shifting from boats working exclusively out of San Francisco toward the north to include Eureka during the period 1935 to 1940 (Clark, 1935; Scofield, 1948). The first trawl fishing off Oregon began in 1884-1885, but aside from small exploratory catches by a few vessels, it did not become well established until 1937 (Harry and Morgan, 1961). Effort then increased quickly to become a “thriving” fishery with large catches during WWII (Harry and Morgan, 1961).

English sole have also been caught in large numbers from Puget Sound and off the British Columbia coast during much of the historical fishery. English sole were a high value species in Puget sound from 1917 through at least the 1950s (Palmen, 1956). It has been estimated that 1.6 million pounds of English sole were landed in British Columbia between 1956 and 1965 (Forrester, 1969). English sole landings have generally been stable over the last 50 years off British Columbia and Canadian fisheries managers consider the stock to be stable and the fishery sustainable at current levels (DFO, 1999).

The time series of historical U.S. landings was reconstructed from 1876 to 2004 from a variety of sources. Peak catches from the southern area occurred in the 1920s with a maximum of 3,976 mt of English sole landed in 1929. Peak catches from the northern area occurred in the 1940s to the 1960s with a maximum of 4,008 mt landed in 1948. Landings from both areas have generally declined since the mid 1960s and are at nearly historical lows in recent years (Figure 2, Table 1). Ex-vessel price per pound has been quite stable since 1981 at 32 to 40 cents per pound; however when corrected for inflation via the Consumer Price Index the relative price has declined steadily over the time period (Figure 3).

English sole are captured almost exclusively by bottom trawl gear in the west coast fishery along with a mix of other shelf rockfish and flatfish species. Landings of English sole inferred from recent logbook data indicate that most of the commercial catch is from shallow waters. From 1987-2003, 55% of English sole landings came from 60 fathoms or shallower and 82% from 100 fathoms or shallower (Figure 4). English sole have been managed under coast-wide ABCs, which represent the summation of region-specific harvest amounts (Table 2). Actual harvests have not exceeded the ABCs since they were first specified for English sole in 1983. English sole have been grouped into the “other flatfish” category with respect to trip-limits imposed by the Pacific Council. Regulatory limits on the landings of this category have only been specified since 2000 (Table 3). However, it should be noted that processor-imposed landing restrictions (relating to both fish size and landing amount) have also affected retention/discarding patterns in recent decades. Recent development of modified flatfish-targeting trawl gear (King et al., 2004), designed to reduce the incidental catch of rockfish and other species has recently been incorporated into management for the northern portion of the U.S. coast. This action may allow for an increase in fishing activities for English sole and other near-shore flatfish by the commercial fishery in the future.

2. Assessment

2.1 Fishery independent data

The primary fishery independent data source for this assessment is the triennial bottom trawl survey conducted by the AFSC (Alaska Fisheries Science Center), 1977-2001 and NWFSC (Northwest Fisheries Science Center), 2004. This survey was designed to sample rockfish, but has evolved in practice and in application to provide density estimates, length and age frequency distributions as well as a suite of biological information for a diverse group of assessed and unassessed groundfish species (Dark and Wilkins, 1994; Weinberg et al., 2002). The triennial survey methodology and area surveyed have evolved over time, but this survey is generally considered to be a coherent time series for use in groundfish stock assessments.

The sampling design and survey strata commonly used to analyze the triennial survey time-series reflect a compromise for sampling many species with different life-histories over a broad geographical distribution. In an effort to derive meaningful biological strata for English sole that reflect offshore ontogenetic movement patterns, the relationship between average body size of individual English sole in a tow and the depth at which that catch was made was explored. Figure 5 shows the nearly linear increase in body size from 50 to 150m depth and the subsequent stationarity of this relationship at greater depths. Based on this movement toward deeper water as body size increases, a piecewise linear regression (Neter et al., 1996) was fit to the data in order to estimate the depth at which adults appear completely mixed and, presumably, ontogenetic movement ends. This regression had the form:

$$\bar{W} = I_1 \bullet (\beta_1 + \beta_2 \bullet Depth) + I_2 \bullet (\beta_1 + \beta_2 \bullet \beta_3) + \varepsilon$$

$$I_1 = \begin{cases} 1, \text{ where: } Depth \le \beta_3 \\ 0, \text{ where: } Depth > \beta_3 \end{cases}$$

$$I_2 = \begin{cases} 0, \text{ where: } Depth \le \beta_3 \\ 1, \text{ where: } Depth > \beta_3 \end{cases}$$

$$\varepsilon \overset{iid}{\sim} N\left(0, \sigma^2\right)$$

where the linear model with intercept, β_1, and slope, β_2, is joined to a simple mean body weight at depths greater than β_3. Error was assumed to be independent and normally distributed. The likelihood of the observed bodyweight in each tow was weighted by the square-root of the number of fish captured by that tow. Maximum likelihood values for the model parameters were: β_1 = -0.006, β_2 = 0.002, and β_3 = 154.999. The strata boundaries were therefore selected as: 155m to retain all of the relatively homogenous adult stock in a single strata, and 100 m, to divide the area with rapidly increasing body size with depth into roughly equal portions. Parallel analysis indicated that these strata were also appropriate for petrale sole and were used in that assessment as well. This approach represents a form of post-stratification, and, as such, sampling variance estimates around strata biomass may not be entirely statistically valid.

The triennial survey estimates of per haul density of English sole provide a logical basis for exploring potential stock structure of this species. By comparing the cumulative catch per unit effort along the coast, with the total effort expended by the survey, areas of high and low density can be identified. Recognizing that there is small-scale variability between tows, I calculated the cumulative catch per unit effort per 50 tows and then standardized this by the survey effort per 50 tows. This approach results in a latitudinal metric centered around zero (where each catch per unit effort observation would lie if all tows captured the same density). Figure 6 shows the cumulative catch of English sole by latitude. This figure clearly shows two regions with lower than expected density, the area corresponding to the Conception INPFC area (< 36 degrees north) and the area between about 39 and 42 degrees north corresponding to the northern portion of the Monterey INPFC area and the southern portion of the Eureka INPFC area. Based on the analysis, the southern edge of the Eureka INPFC area was identified as a useful area boundary.

Many groundfish stock assessments have used the traditional design-based biomass estimates produced by AFSC staff. This assessment calculated biomass estimates based on the new depth strata identified above, and used traditional estimates for comparison only. Development of a biomass time series used a standard area-swept design based estimator of density, and expanded this estimate based on the area within each of the three depth strata and 5 INPFC strata. See table 4 for strata areas. These strata estimates are reported individually, and were combined into a northern and a southern index of relative abundance used in the assessment model. Both areas appear to be increasing in biomass over the period covered by the survey (Table 5, Figure 7). A comparison of the estimated biomass and coefficients of variation (by area and year) shows little change from traditional estimates (Figure 8). Tables 6-9 give summary statistics for survey effort and catches by strata and year. The high percent positive tows across nearly all strata support the design-based estimator approach.

Biological data collected from the triennial survey by survey staff and other researchers included length frequency information, individual fish weights, maturity observations and a small sample of female English sole ages. Length frequency data were not collected consistently until 1989 (Table 10) when all strata had at least one tow sampled for lengths and at least three individual fish (Table 11). For this reason, triennial survey length frequency data were only included in the assessment model from 1989-2004. Raw length frequency data were expanded using the same stratification applied to the biomass index. The observed length frequency for each sex in each tow was expanded to the total number of English sole in that tow based on the relative number sampled. The expanded numbers were then further expanded based on the area swept for each tow, and then the area within each stratum. The length frequencies for each stratum are reported individually, and summed within each area for use in the model (Table 12, Figures 9-12). All length-frequency data were binned into 18 two-centimeter bins from 11 cm to 45 cm. The triennial survey catches very few English sole less than 17 cm and very few greater than 37 cm. Little evidence of strong year classes is apparent in the length frequency data.

Routinely collected maturity estimates from the triennial survey appeared to be unrealistic and likely confounded with spawning status, as the estimated proportion of mature females decreased among the largest fish. These data were not used in the assessment. However, 1,084 maturity observations were collected from the triennial survey as part of a special project conducted during the 1995 survey season (subsequently published in: Sampson and Al-Jufaily, 1999). These data were used to fit a logistic maturity curve for female English sole. Fitted values matched the summarized observed data very well (Figure 13), with parameter estimates of 23.30 for length at 50% maturity and a slope of -0.61. The length at 50% maturity differs substantially from observations by Harry (1959), who found that 50% of female English sole were mature at 31 cm. Sampson and Al-Jufaily (1999) suggest that maturity may also be higher for small fish of older ages than similarly sized fish that are younger, however this assessment considers maturity as a function only of length.

Age frequency data in this assessment were treated as conditional to the length bin of the fish from they were collected. This approach is implemented in SS2 and was designed to address two issues with combined length and age data: use of ages collected through length stratified sampling and the use of both length and age-frequency distributions in the same model where they are generally from the same individual fish. To avoid arbitrary weighting of the length and age likelihood components to attempt to account for this problem, this assessment treats all age information as an extension of length frequency by sex. To do this, all age data were compiled as conditional age-frequency-at-length bin within each source (survey of fishery), area and year. With this approach, the likelihoods are no longer double counting similar information (sex and size distribution information does not occur in the conditional age-frequency-at-length observations) and the growth curve can be fitted internal to the stock assessment model avoiding potential bias arising from selectivity and retention in sample collection. In this manner, 300 age-length observations collected in association with the maturity study were able to be included as conditional age-frequency at length information for 1995, assuming only that the ages were selected at random within lengths. These fish ranged in age from 2 to 10 years (Table 13, Figure 14).

The relationship between weight and length varies between the sexes, over space and over time for English sole (Forrester and Thomson, 1969). For this analysis, data from three years, 15 hauls and 472 fish were available (Table 14). Increase in body weight with length was modeled assuming multiplicative error and according to the standard 2 parameter growth function:

$$W = aL^b$$

In this model weight in kilograms is predicted based on length in centimeters. Parameters were estimated for females and males separately based on an improvement in AIC when sex was added to the model. Parameter values are given in Table 15, and the fitted curves are shown by sex and stock (plotted but not fitted separately) in Figure 15.

2.2 Fishery dependent data

The most important fishery dependent data in this stock assessment model are the time series of landed catch. However, there is no single source that can provide a continuous time-series of commercial English sole landings back to the beginning of the trawl fishery on the west coast. Therefore, landings data were compiled from a variety of published sources, reports and databases. This process was easiest for the most recent years when landings were compiled by INPFC area from the PacFIN (Pacific coast Fisheries Information Network) system. PacFIN best estimates of landings by all gear types and by INPFC area were used for the period 1981-2004 (extraction date: 1 February 2005; Table 1). For the period 1956-1980 total trawl landings were used as reported in the previous assessment document (Sampson, 1993) and are summarized in Table 16.

Prior to 1956, landings showed a very different pattern of fishery development and were reconstructed for the southern and northern areas separately. The total English sole landings from all sources in California during the period 1924-1965 were reported in Jow (1969). These correspond quite closely with the total landings from the California Fish and Game Bulletin series for the years in which they overlap. From 1931-1955 the total English sole landings in California, reported by Jow, were partitioned between Southern and Northern (that portion of the landings coming from the Eureka area) areas via the following method:

$$E_{North} = E_{California} * \left(\frac{S_{Eureka}}{S_{California}}\right)$$

$$E_{South} = E_{California} - E_{North}$$

where E is landings of English sole, and S is the total sole landings and the subscripts denote the area. The total sole landings for the Eureka area were reported in the California Fishery Bulletins nos. 44-105 (Bureau of Commercial Fisheries, 1935; 1936; Bureau of Marine Fisheries, 1940; 1942; 1944; Bureau of Commercial Fisheries, 1946; 1947; Scofield, 1948; Bureau of Commercial Fisheries, 1949; 1951; 1952; 1953; Marine Fisheries Branch, 1954; 1956; Marine Resources Operations, 1958) and the total sole landings from all of California in Heimann and Carlisle (1970).

From 1921-1930 all of the English sole landings in California were assumed to have come from the southern area; this was based on the ratio of total sole catches in Eureka to those from all of California from 1931-1937. From 1916-1923 the English sole landings in the south were based on the total sole landings in California from Heimann and Carlisle (1970), and the average fraction of the total sole landings comprised of English sole over the period 1924-1927 (0.844, range = 0.827-0.871). This reconstruction indicates large landings all the way back to 1916 with the peak landing of 3,976 mt in 1929 (Table 17, Figure 2).

Since there were only anecdotal reports regarding the development of the trawl fishery off San Francisco beginning with the known start of trawling in 1876, landings were extrapolated from 1876-1915. It was assumed that one metric ton of English sole was captured in that first year, and that the fishery grew at a rate that would result in the 1915 landings equal to half those of the reconstructed landings in 1916 (2,454 mt, Figure 2). This rate was estimated to be 20% per year. Uncertainty in this extrapolation was explored via sensitivity testing to a landings series with landings of only one mt per year before 1915 and another scenario with a linear increase from 1 metric ton to the landings in 1916 (Table 18).

Landings prior to 1956 for the northern area were more problematic due to a lack of unambiguous statistics from the state of Washington. It was estimated that as much as 67.7 percent of the English sole catch landed in Washington came from the BC coast (Alverson, 1956) as far north as Hecate Strait (Alverson, 1960), and much of the fishery occurred in Puget Sound prior to 1956, thereby making it incorrect to assign catch from the “red book” (State of Washington, 1955) to the outer-Washington coast during this period. Because of the lack of detailed sources for Washington landings from the open coast (excluding Puget Sound and the Coast of British Columbia) I was not able to estimate Washington landings prior to 1956. For the period 1954-1955, landings for the port of Astoria only were available (Oregon Fish Commission, 1967) and were combined with the estimate of English sole landings in the Eureka area (from above) as the estimate for the northern area. For 1950-1953, Oregon English sole landings were given in Smith (1956), and Eureka landings were calculated as above. For 1944-1949, English sole landings in Eureka were added to those from Oregon based on Cleaver (1951). There was also a miscellaneous sole category reported during these years, where the landings were not partitioned down to species. A fraction of the miscellaneous category was assigned to English sole based on the fraction of recorded English sole landings to those of Petrale, Rex (*Errex zachirus*), Dover (*Microstomus pacificus*) and arrowtooth flounder (*Atheresthes stomias*). Peak landings of 4,008 mt from the northern stock were observed in 1948. From 1928-1943 all (or nearly all in 1942-1943) English sole landings were reported as miscellaneous sole; this total was partitioned using the average fraction of the total sole catch that was English sole in 1944-1945 (0.235, range = 0.233-0.236). These catches were estimated as zero metric tons in 1928 (only 84 pounds of miscellaneous sole were reported for 1928) and no appreciable fishery landings were assumed to have occurred in the north prior to that year (Table 17).

One uncertainty in the landings history was the mink food fishery beginning in the middle part of the century when a shortage of red meat during WWII caused an increase in the use of marine fish as food for mink farms. Over the period 1950-1956, marine fish landed for mink food in Oregon increased further; 1953-1956 English sole landings for mink food in Oregon were estimated to be between 308,000 lbs and 759,000 lbs (Jones and Harry, 1960). However, these quantities do not correspond well with those reported by Smith (1956) or by the Oregon Fish Commission (1967) and were not directly included in the assessment. Published estimates of length frequency distributions from the mink food landings indicate that all sizes of English sole were being retained, and as a result of the concerns over exploitation of small fish Oregon prohibited the landing of Dover, English or petrale sole less than 11 inches in 1958 (Jones and Harry 1960). A thorough analysis of the landings and fishery characteristics associated with the mink food fishery in this time-period could not be completed for inclusion in this assessment, but would be a useful area for future research.

English sole have been discarded in large numbers throughout the history of the trawl fishery in the United States. In the early California fishery, “there is no question that the greatest waste is of small, immature pointed-nosed sole, for this species is by far the most abundant of any species taken by the nets on most of the grounds” (Scofield, 1948). The fishery was primarily targeting flatfish and it was estimated that 20-25% of the total catch was discarded as unmarketable (Scofield, 1948). The first quantitative estimates of discard fraction available were collected from Hecata bank to Northern Washington by Herrman and Harry (1963), based on a total of 41 trips sampled during the years 1950-1961. The total observed discard fraction from these trips was 24.78%, with year specific estimates ranging from 0.093 (1961) to 0.510 (1959); Table 19 includes annual estimates and sample sizes. A more recent estimate of the English sole discard fraction was derived from the Pikitch study conducted in 1985-1988. This value was 26.61% based on 409 hauls sampled. An estimate of 8.53% English sole discard by weight is available from the Enhanced Data Collection Project (EDCP) conducted from 1995-1999 (Sampson, 2002), however it was noted that these data may not have been representative of the fleet at large, and very few of the tows observed during this program occurred at depths less than 50 fa, where English sole discard would be the highest. The NMFS West Coast Groundfish Observer Program (WCGOP) provides both a discard fraction as well as estimates of the average individual weight in the discard stratified by depth and INPFC area. Estimates of discard rates from 2001-2003 for the northern and southern areas are given in table 20. These rates ranged from 25.2-51.6%. Data from 2004 were not available, because expanded logbooks were not yet available at the time of this assessment. Recent estimates of English sole discarding from the Canadian fishery, 22.75%, appear to be quite similar to those observed in the U.S. fishery (Kate Rutherford, pers. comm. 18 October, 2004, Science Branch, Pacific Region, Fisheries and Oceans, Canada, Pacific Biological Station, Naniamo, B.C., V9T 6N7, Canada). Less than one-half of one percent of these discarded fish were identified as marketable, indicating that discarding is primarily a function of fish size in the Canadian fishery.

Discarding of English sole has been primarily a function of fish size over the history of the fishery. Retention sizes for human consumption have varied over space and time, but have consistently been 25 cm and greater (Westrheim, 1955), which is approximately the size at which it becomes worthwhile to filet a shallow-bodied flatfish. Quantitative estimates of retention-at-length were produced from the Pikitch study 1985-1987. These data on retention by length show a clear increase in retention between 21 and 33 cm based on 1,100 individual fish whose fate was recorded (Table 21, Figure 16). These data were fitted externally, using a logistic function with parameters: inflection (B1) = 27.077 and slope (B2) = 1.424; the asymptote (B3) was assumed to be equal to 1.0. These data were also included in the model as a length frequency distribution for discarded individuals in 1986.

Although it may be possible in the future, no attempt to create a commercial CPUE series was undertaken for this assessment. This choice was based on the availability of a reliable fishery independent measure of relative population abundance from the triennial survey. The trawl fishery landings were not divided into seasons, although a seasonal pattern showing increased depth of maximum catch during the winter season has been shown (Hewitt, 1980). For English sole, this pattern is not as pronounced as that observed in petrale or Dover sole and the magnitude of change in depth (~20 fa) is much less.

Biological information from the commercial fishery was extracted from both the PacFIN system and from CalCOM (CalCOM data, extracted on 25 August 2005 covered only the years 1966-1985 which were not available through PacFIN). These data included the sex-specific length frequency and age-frequency of English sole in the commercial catch. Each of these sources were analyzed based on the sampling protocols used to collect them, and expanded to estimate the corresponding statistic from the entire landed catch for each stock in each year that sampling occurred. This process can be generalized as follows:

1) Extract biological observations and stratify by INPFC area.
2) Count the lengths (or ages) in each size (age) bin and for each sex within each trip as the ‘raw’ frequency data.
3) Expand the raw frequencies to the trip level to account for the landings of each trip.
4) Sum frequencies within INPFC strata.
5) Expand the summed frequencies to account for the total strata landings
6) Calculate the sample sizes (number of fish and number of samples) and normalize to proportions that sum to unity over both sexes within each year.

Samples from CalCOM were available exclusively for the Conception and Monterey areas. Only those CalCOM samples from landings of mixed size (unsorted) were considered, as there was no estimate of the relative abundance of the size categories in sorted catches collected. To complete step 3, the total landing weight was divided by the total weight of all clusters sampled from that landing to compute a multiplicative expansion factor for the observed raw length frequencies of the sample. Where the total weight of the landing was missing, the median weight of landings was used. If the weight of the clusters was missing, the median total weight of clusters from other samples that produced the same (or up to two individuals fewer) number of sample lengths was used. Expansion factors ranged from 1 to 505 in California. The expanded lengths (N at each length times the expansion factor for the sample) were then summed within INPFC areas. The number of samples, total sampled landings (in mt) and the actual number of fish lengths by year, INPFC and sex are reported in Tables 22-24. The expanded and summed lengths in each INPFC area were then expanded again based on the ratio of total to total sampled landings to total landings in each INPFC area. These INPFC-expanded lengths were then summed over INPFC areas within the two stocks and normalized so that the sum over all lengths and both sexes in a single year was equal to one (Table 25).

A similar process was used for samples from California, Oregon and Washington, obtained from the PacFIN system, however, the screening and expansion differed slightly. In Oregon, only those samples that were collected randomly and classified as market samples were considered. The expansion from each sample to the corresponding total landing weight was again the ratio of the total landed weight of the species in a trip divided by the total weight of all clusters in the sample from that trip. The expanded weight provided by ODFW as an improved estimate of the total weight of each landing was used where available. If this value was absent, the total landing weight was used. In many cases, there was no estimated sample weight, so a predicted weight of the sample was computed by applying the length-weight relationship used in the assessment to each length in the sample, then summing these weights. Each expansion factor was computed and anomalies created by very small samples of very large landings were avoided by limiting the expansion factor to a maximum of 500 (less than 20 samples for Oregon, Washington and California combined). There were no other changes to the expansion process as performed with the CalCOM data. The number of fish, samples, total sampled landings and expanded length frequencies are summarized in Tables 22-25.

Both otoliths and interopercular bones have been used as age structures for English sole. Poor agreement between readers has been cited as a reason not to use otoliths, with historical estimates of 75% agreement and 93% agreement for otoliths and interopercula respectively (Palmen, 1956). Age agreement from otolith reads appears to decrease with increasing fish age (Van Cleve and El-Sayed, 1969, Table 26), and otoliths appeared to become increasingly biased from age 5 onward relative to the interopercula (Palmen, 1956, Figure 17 and Tables 27-28). Interopercular readings, although they have not been formally validated, appear to represent a reasonable proxy for true age and are the sole source of age information used in this assessment. Independent studies reported in Palmen (1956), Van Cleve and El Sayed (1969), the 1993 assessment and in a number of duplicate age-readings (one fish, 2-3 readers) from Washington state (available from PacFIN) provide reader agreement based on interopercular ageing (Tables 29-31, Figure 18). Age agreement appears to be nearly exact for ages 0 and 1, but not ages 2+ where the standard deviation of between reader agreement increases with increasing age. Linear and non-linear models were fit to these data (weighted by the number of age structures at each age), and the best predictions, based on AIC values, resulted from a model where between reader standard deviation increased from zero at age 1 as a function of the log of age (Figure 19). This fitted relationship was used in the assessment model.

Because small English sole (< 25 cm) are not generally landed, the estimated length-at-age of young English sole is highly positively biased in commercial samples; i.e. only the fastest growing fish would be observed from the younger ages. Any bias would be a function of the selectivity of the fishing gear, which is estimated internal to the model. All commercial age frequency data were therefore compiled as conditional age-frequency-at-length bin within each stock and year. Tables 32-34 give age sampling statistics and Table 35 and Figures 20-27 give summary age-at-length bin information

A limited quantity of historical biological information from the commercial fishery during the years 1948-1965 was published in Demory and Bailey (1967). Length frequency and age-length data were collected from Oregon and Washington early port sampling programs. Temporal and spatial distributions of sampling are reported in tables 36 and 37. These data were published in a summarized format, but both conditional age-at-length distributions and length frequency distributions were formatted for inclusion into this assessment. The actual number of trips sampled was not reported, so each was assumed to be the minimum number of 50 fish samples possible to produce the observed length or age distributions. Because data were reported by PMFC area and no relative weights were given, observations from each area were treated as independent replicates for that year. Table 38 and Figures 24-25 report the length frequency information included. Some evidence of serial depletion as the fishery progressed to the north can be seen in the length frequency information: the more southerly areas (2C, 2D) tend to have fewer of the largest fish than those areas farther north (3A, 3B) in the late 1940s and early 1950s. It should also be noted that one table (27) in the original publication was mislabeled with regard to species and was therefore excluded. The age-at-length observations are summarized in Table 39 and Figures 26-27.

2.3 History of modeling approaches used for this stock

The English sole stock off Washington and Oregon was last assessed in 1993, by Dr. D. Sampson. This assessment covered the area from the Oregon-California border to the Canadian border. Only female English sole were included in a model for the years 1977-1993. The primary data sources used were the triennial shelf survey estimates of biomass (index calculated in numbers of fish), and the ODFW resource survey from the mid-1970s. No CPUE data were included, because it was felt that catch rates of English sole could be heavily influenced by factors other than the abundance of the species in areas exploited by the trawl fishery. The stock found to be increasing, but the suite of reference points required for current management was not reported.

Prior to the 1993 assessment, the English sole stock in the INPFC Columbia and U.S. Vancouver areas was assessed via Virtual Population Analysis (Golden et al., 1986). This model covered only the years 1966 to 1983. A dynamic pool model was used to get an estimate of MSY based on the recruitments produced by the cohort analysis. Many previous studies using cohort analysis and CPUE statistics have been conducted, although the author is not aware of a previous assessment of the southern portion of the English sole population. Of note from these analyses was that they identified a very large year class in 1961 (Hayman et al., 1980).

The current model has a much wider geographic and temporal scope than any of the previous analyses. Other fundamental changes in modeling approach include the addition of male English sole data from both the survey and fishery, the use of length based selectivity, maturity and the estimation of growth parameters within the assessment model. Based on the magnitude of these changes and the time period elapsed since the last assessment no formal comparisons are performed.

2.4 Model description

This assessment used the Stock Synthesis 2 modeling framework written by Dr. Richard Methot at the NWFSC. Development of the Stock Synthesis 2 code was ongoing during preparation of this assessment, and results using three versions (1.16, 1.18 and 1.19) are reported in this document. Preliminary analyses and some of the sensitivity testing were performed using version 1.16. The base case model, and all analyses performed during the STAR panel used version 1.18. Because only a small change was made in version 1.19, wherever the results may have been influenced by this change revised model runs were performed and reported. Documentation of each version that fully describes the SS2 model framework and improvements made is available (Methot, 2005).

A number of general model specifications provide a framework for this assessment. The English sole population is assumed to be a single stock, but spatial considerations are addressed through separation of data from northern and southern areas. The model includes males and females as separate sexes in both the underlying dynamics and in all data sources where this was possible. The accumulator age for the internal dynamics of the population model was set to 30 yrs, well above the asymptote for growth and the oldest age observations in the data. The years explicitly modeled were 1876-2004. Because of the extensive reconstruction of the historical landings and discard series, initial population conditions were assumed to be in equilibrium at the first year of the model. No initial fishing mortality was estimated and the spawning biomass was assumed equal to B_{zero} in 1876.

The assessment model includes four fleets: two commercial fisheries, north and south, and two triennial survey series, split on the same geographic boundary. The surveys are assumed to occur instantaneously at the middle of July throughout the time-series. Selectivity is assumed to be length based for all fleets, and to have a logistic shape. For the surveys, an ascending slope and inflection as well as the length at peak selectivity are freely estimated. The commercial fleets are assumed to have the same selectivity, with an ascending inflection and peak selectivity estimated. Size selective retention is explicitly modeled throughout the time series, requiring a retention curve (logistic) for the commercial fishing fleets. The slope of this curve is externally estimated, but the inflection is estimated separately for each fleet.

For the base case model, natural mortality is assumed to be age and time independent and equal to 0.26. The stock-recruitment function was a Beverton-Holt parameterization, with the log of mean unexploited recruitment estimated, along with the steepness (*h*) of the stock recruit function. Year-specific recruitment deviations are estimated from 1877 to 2004 (see discussion of uncertainty below). The constraint and bias correction standard deviation, $sigma_R$, is treated as a fixed input quantity in SS2. A value of 0.36 was arrived at by fitting the base case model, externally calculating the root mean squared error (RMSE) of the predicted recruitment deviations over the time period in which they were variable (~1940+) and comparing this value to the input $sigma_R$. These values converged to 0.36 after a small number of iterations, although the RMSE varied slightly depending on exactly which years were used to calculate it. This exercise ensured that the approximate bias-correction term would be appropriate and internally consistent for the variability in predicted recruitment actually estimated in the model.

Maturity of female English sole is assumed to be logistic in shape and a function of length. To accommodate the large observed change between the study of Harry (1956) and the more recent work by Sampson and Al-Jufaily (1999) a series of fixed blocks were used to transition from a length at 50% maturity of 31 cm in 1955 to 23.3 cm in 1995. This change was modeled as a step function, with equal change over the periods 1961-1970, 1971-1980, 1981-1990 and 1991-2004. Fecundity is assumed to be a function only of mass.

Individual growth is modeled via the von Bertalanffy growth equation. Length at age 2 is assumed to be equal for females and males, but separate von Bertalanffy K and length-at-age-20 parameters are estimated for males and females. It is assumed that the variability in length of individuals at each age in the population increases with increasing age through use of a constant (but estimated) CV for each sex. There is evidence from Canadian waters that English sole may show markedly different growth patterns over time (Fargo and Kronlund, 2000). Given the large change in maturity schedules, it was deemed appropriate to allow for potential changes in growth over the time series of the model. Therefore, the base case model allowed growth to differ between blocks of time, based on freely estimating the K parameter for the following blocks: 1876-1960, 1961-1970, 1971-1980, 1981-1990 and 1991-2004.

Sample sizes used in this assessment are the number of trips sampled for commercial samples or the number of tows sampled for survey length and age frequencies. Preliminary model runs explored the degree to which the standard design based estimates for the variance of the triennial survey index of relative abundance was reasonable in the context of the assessment model. The model was unable to reproduce the variability observed in the survey under any conditions explored, so the input variance estimates were doubled in order to bring the input and root mean-squared error estimates closer together. All emphasis factors (lambdas) for each likelihood component are set equal to 1.0 for all data sources. Table 40 lists all estimated model parameters for the base case.

2.5 Priors

Noninformative priors were desired for most model parameters. Although the choice of truly noninformative priors can be difficult given between-parameter correlations (Gelman et al., 1995), a diffuse normal prior with the mean in the plausible range of the parameter and SD = 50 was used throughout. All parameters were bounded, but bounds were selected to be sufficiently wide to avoid truncating the searching procedure during maximum likelihood estimation. Table 40 gives the bounds and noninformative prior distributions used for all estimated model parameters in the base case.

Informative priors for both steepness (*h*) and natural mortality were developed for use in this assessment. The steepness prior was based on the reported quantiles for steepness for 14 stocks within the family Pleuronectidae (Myers et al., 1999) and two distributions were constructed. A Beta distribution with mean = 0.788 and SD = 0.075, and a normal distribution with mean = 0.789 and SD = 0.098 (truncated at 1.0) could approximate the reported interval. These densities, along with a noninformative prior, normally distributed with mean = 0.6 and SD = 50 (truncated between 0.2 and 1.0) are plotted in Figure 28.

The informative prior on natural mortality was derived based on the analysis of Gunderson and Dygert (1988) showing that gonad index (the ratio of gonad to somatic wet weight) was a reasonably good predictor for natural mortality across a range of species. The reported linear regression coefficients were assumed to have a CV of 0.3, because error estimates were not reported. From normal distributions about these coefficients, 100,000 linear regressions were created, and the prediction of expected natural mortality for English sole (based on a uniform distribution over the reported gonad index range for English sole, 16.6-19) was calculated. The resulting approximately normal distribution with mean = 0.329, SD = 0.091 and a reference prior, normally distributed with mean 0.25 and SD = 50 are plotted in Figure 29. Only 1% of the population would reach the age of 14 with a natural mortality rate of 0.329, although fish of this age are frequently encountered in the English sole fishery. It should be noted that because English sole were part of the data set upon which the regression was estimated there is likely some 'information contamination' of the prior with information in other parts of this assessment. Perhaps more difficult to reconcile is that the value for English sole natural mortality assumed in the original analysis (0.26) was well below that predicted by the regression. These concerns were unresolved and the approach is presented for comparative purposes only.

After preliminary model exploration natural mortality was assumed to be inestimable in the context of this assessment, even with an informative prior, and was set at the value used in the last assessment, 0.26. This choice was evaluated through sensitivity testing as described below. Steepness was found to be estimable and reasonably well-behaved in this assessment and the informative prior developed above was not used in the base case model.

2.6 Model selection and evaluation

An effort was made to explore many levels of model complexity in order to achieve a model that reflected parsimony in the number of estimated parameters relative to the available data, while attempting to represent the underlying population dynamics as realistically as possible. Many preliminary models were fit to data and evaluated based on residual patterns, plausibility of estimated model parameters and convergence criteria. Only a subset of these models is retained for sensitivity analysis (Section 2.8 below), but the base case model reflects the best aspects from each these exploratory analyses.

The large quantity of conditional age-at-length data from the commercial fleets (579 year, sex and length bin specific frequencies) provided much flexibility in modeling the growth curves for female and male English sole separately. However, the assumption of constant CV in the distribution of lengths at age was necessitated by very few ages for older English sole (> 15 yrs). Changes in growth over time could be modeled in many different ways in the context of this assessment. Preliminary runs explored using a 'random walk' approach to growth, but revealed that this approach might be over-parameterized based on the small number of ages collected in many years. Since the step function approach was used for maturity it seemed parsimonious to allow growth to vary in the same block design. Early model runs allowing the length at age 20 to vary produced similar results to blocking the K parameter, but it seemed more reasonable to assume that the realized rate of growth dictated by food availability, temperature, currents etc. might be more likely to vary than the theoretical maximum size. Table 41 gives estimates and asymptotic standard deviations for all growth parameters. The fixed change in maturity and the corresponding estimated changes in von Bertalanffy K are shown in Figures 30 and 31. When considered together these growth parameters produce very reasonable growth trajectories for the underlying population, showing the strongly sexually dimorphic growth pattern present for English sole. Both sexes grow rapidly, and show a large amount of variability about the mean trajectory with females achieving a maximum length of just under 40 cm and males just under 24 cm (Figure 32 shows the growth curves for 2005). Fits to conditional age-at-length bin observations are not shown graphically due to the large number of figures needed, but the model appeared to track the distribution of age at length in the observations quite well and this resulted in the observed and calculated effective sample sizes for these observations showing reasonable correspondence for both sexes in the southern and northern commercial data (Figure 33).

The fit to the 1995 survey age-at-length bin data was generally poor, showing the model predicting a younger age distribution for a given length than was observed in the data; this lack of fit is also evident in the comparison of observed and calculated effective sample sizes and Pearson residuals (Figure 34).

Estimated selectivity and retention curves for both the commercial and survey fleets are shown in Figure 35. The shape of these curves appears quite reasonable. Small English sole less than 15 cm are not heavily selected by any fleet as most will be in or near the estuaries until this size. Selectivity for English sole between 15 and 25 cm is much higher for the survey fleets reflecting the small mesh trawls used. The model fits to the length frequency distributions for both of the survey fleets show reasonable predictions given the observed data (Figures 36 and 37). A comparison of observed and calculated effective sample size for the survey length frequencies show no clear relationship, but generally commensurate values with the model fitting slightly better than the input values would suggest (Figure 38). No clear lack-of-fit or pattern is apparent in the Pearson residuals for the northern survey (Figure 39). The southern survey does not appear to fit the data quite as well, and from 1998-2004 the model predicts more large males than observed in the data. Pearson residual plots for the southern survey length frequencies are shown in Figure 40.

The model was able to capture the general trend in the northern and southern survey indices of relative abundance, but not the degree of interannual variation seen in the data (Figure 41). In addition, no model explored during this analysis was able to produce the very low index observed in 1980 in both the north and the south. It seems likely that either net mensuration could not be monitored as well as in more recent surveys or some other unknown factor influenced catchability in that year. The estimated catchability (Q) was about one third as large for the southern survey as the northern survey (Table 42). This may be because more of the shallow (< 55m) habitat that is not covered by the triennial survey is utilized by English sole in southern waters or because there is relatively more suitable habitat in shallow water in the south.

The commercial fishery length frequencies from both the northern and southern fleets appeared to fit the data somewhat better than expected given the relationship between the relative observed and calculated expected sample sizes (Figure 42). Due to the smaller samples sizes the observed length frequencies from the southern commercial fleet were irregular in some years and the sex ratio, most evident in the lack of fit to the male frequencies, was quite variable (Figures 42 and 43). Due to this variability no clear patterns are visible in the Pearson residuals for the males or females from the southern fleet (Figures 44 and 45).

The northern commercial fleet had far more length frequency data than the southern fleet. The model was able to adequately predict length frequencies for many years that closely matched those in the observed data (Figures 46 and 47). Duplicate observations are plotted for the historical length frequency data 1949-1965; although the sample sizes are small, there appear to be more large fish than the model predicts. This may be due to the fleet expanding northward and exploiting new areas with a size-structure that does not reflect the long history of fishing activity which the model assumes should apply to the entire population. There are also two curves plotted in the female fits for 1986. These are the length frequencies from the discarded fraction of the commercial catch sampled by the Pikitch study; although plotted with the females, both the model predictions and observed data are for sexes combined. The model predictions appear to be shifted toward larger fish, however the fit to these data reflect a trade-off in retention and selectivity operating throughout the model. It does not seem surprising that retention of smaller English sole might have been greater during a short voluntary observer program than on average for the entire time period modeled. In recent years, especially since 1980 model predictions of 35+ cm females are larger than observed frequencies. This is most obvious in the Pearson residual plots (Figure 48). This lack of fit was the subject of much exploration during preliminary versions of this assessment. Early model fits showed a much more pronounced pattern that was improved with the addition of time-varying growth. Subsequently, a series of alternate models allowing dome-shaped selectivity, time-varying dome-shaped selectivity, time-varying selectivity inflection were fit in an effort to understand why this pattern might be generated and whether it could be easily explained.

The conclusion of this analysis was that these residuals were not a result of the model being too rigid to fit to these points, but of the trade-off between the fits to males and females. During this time period there are too few males in the retained (and sampled) catch (Figures 47 and 48). If selectivity shifts toward smaller fish, improving the residuals for females, the lack of fit to the missing males becomes even more pronounced. The model can improve the fit to the female length frequencies or the male length frequencies, but cannot do both simultaneously. Two potential explanations seem plausible: growth or selectivity may have changed differently for males and females over time. With relatively few males in the catches this is not easily resolved and models attempting to split selectivity between males and females proved unstable given current data. A third explanation, that males could be underrepresented in the port samples, was also explored, however no conclusive evidence of this could be found in the data available from PacFIN. This appears to be an area for future assessments to explore as time permits.

The discard fraction and mean individual weight in the discard observations from both the southern and northern fleets were fit quite well by model predictions (Figure 49) and the assumed CVs appeared to be appropriate. The paucity of discard observations throughout much of the time series precluded many more realistic alternate models such as time-varying retention, separate retention by fleet and allowing for non-size based discarding.

In aggregate, the base case model seemed to be parameterized enough to fit to observed data, while still maintaining reasonable parameter values and parsimonious explanations for the underlying model processes. The first column of Table 43 provides a full list of maximum likelihood estimates for all model parameters in the base case model.

Convergence of the base case model was assessed prior to the STAR panel using SS2 version 1.16. Multiple model runs explored the ability of the model to recover the similar maximum likelihood estimates when initialized from dispersed starting values. A set of 25 convergence tests was performed where all model parameters were jittered by 1% of the range of the bounds (quite large for many parameters) from the maximum likelihood values. Minimization often started with enormous crash penalties and/or an objective function value that was many orders of magnitude away from the minimum. Each test was run to completion, except that in some tests starting values were so extreme that some part of the likelihood became undefined and minimization was terminated by ADMB. For all completed tests the Hessian matrix was positive definite. The result of this testing shows minor variability in the objective function and current depletion for all completed runs (Table 44), indicating that the base case model estimates are unlikely to represent a local minima in the multivariate likelihood space.

2.7 Base-run results

The base case model predicts a population trajectory for English sole showing rapid exploitation to target spawning biomass levels occurring by the early 1930s, variable population size through the mid 1990s, and a rapid increase in biomass in recent years (Figure 50 and Table 45). The lowest levels of spawning biomass have occurred following periods of below average recruitment in the 1940s and 1980s, but very large recruitments were estimated in 1961 and 1999 (Figure 51). There is little evidence for a strong stock-recruitment relationship, with some of the largest recruitments occurring at moderate levels of spawning biomass (Figure 52). Relative depletion level at the beginning of 2005 was found to be 91.5% (~ 95% confidence interval: 64.5-118.4%) of the unexploited level, with a spawning biomass of 31,379 mt (23,480-39,278).

Total catches from both commercial fleets have been substantially larger than landings, and the absolute volume of discards has been as large as 1,665 mt in 1987 (Figures 53 and 54). The estimated discard fraction by weight has increased over the time series due to changes in relative abundance of small fish and changes growth (Figure 55). Current (2004) total catches were estimated to be 1,341 mt, of which 950 mt was landed.

2.8 Uncertainty and sensitivity analysis

The primary method of assessing uncertainty in this assessment was through the use of asymptotic variance estimates for model parameters and derived quantities of interest. Asymptotic variance estimates for spawning biomass and recruitments were quite wide, indicating a large amount of uncertainty regarding current population status (Figure 56 and Table 46).

It is common for assessment models to have difficulty estimating the most recent year class strengths. In this assessment, the 1999 year class is the largest in the time-series. Although the data sources indicate this was a large year class, there are no age data in the model after 2000, so the magnitude is an important source of uncertainty in this assessment. Exploratory analysis conducted by sequentially deleting various data sources indicated that a large 1999 recruitment was indicated by multiple sources, not only the increase in 2004 survey biomass (See sensitivity section for effect of 2004 survey data on model estimates). Reliable estimation of this year class should improve in future assessments, but due to rapid population growth rates, the most recent recruitments will remain poorly defined without age frequency data from the survey which captures more of the smallest English sole than the commercial fleets.

Many preliminary alternate models were run in order to assess the sensitivity of the assessment results to the specific model configuration used in the base case. These sensitivities used SS2 version 1.16, and although the results are not directly comparable to the base case model presented in this assessment, it is reasonable to assume that the qualitative conclusions gained from this exercise are still relevant to the updated base case assessment model. The following alternate models were considered:

a) ‘Low’ historical catch scenario, 1876-1915
b) ‘High’ historical catch scenario, 1876-1915

c) Natural mortality increased to 0.30
d) Natural mortality decreased to 0.22
e) Remove the 2004 triennial shelf survey data
f) Quadruple survey CVs and decrease survey age-at-length sample sizes by 0.5
g) Force growth and maturity (use 1995 estimate) to be time-invariant
h) Fix retention at externally estimated slope and inflection
i) Force selectivity to be time-invariant (no blocks)

Table 47 reports parameter estimates and summary statistics for each preliminary sensitivity run. In aggregate these sensitivities indicate that modeled population trends using the earlier SS2 version were quite robust to alternate model assumptions.

The first two sensitivity runs (a and b) were intended to determine whether the extrapolated landings prior to 1916 had a large effect on the assessment model results. Very little change in parameter estimates or likelihood components was noted in either case. This is not surprising since even the high scenario did not predict landings as large as those observed during the subsequent 60 year period from which, presumably, the information regarding sustainable exploitation levels in this model is derived.

The second two sensitivity runs (c and d) were intended to explore the effect of assuming natural mortality was equal to 0.26 in the base case. As might be expected, increasing natural mortality to 0.30 implied that the population was more productive and the opposite was true for a reduction in natural mortality to 0.22. The model including the larger natural mortality value fit the data better, based on the total negative log likelihood value, with most of the improvement coming from the age frequency data.

The removal of the triennial survey data from 2004 (sensitivity e) resulted in a decrease in the estimate of unexploited spawning biomass and an increase in current depletion level. This may be due to the change in estimated catchability in the north, but it is apparent that the recent trend of increasing spawning biomass is not merely a function of the large index point at the end of this time series. When the standard deviations of the survey biomass index were quadrupled and the sample sizes for the survey age-at-length observations cut in half (sensitivity f) the current depletion level went down to 66.6%, but the general stock trajectory did not change appreciably. No substantial improvement in fit to the other likelihood components was noted, indicating that there did not appear to be substantial contradictory information obscured by these variance assumptions.

Because the change in maturity and growth parameters over time has the potential to alter biological reference points, one alternate model with no change in these parameters was considered (sensitivity g). The value for length at 50% maturity estimated in 1995 was assumed to apply throughout the time series, and no temporal blocks were estimated for the K parameter. This sensitivity run illustrates a potential trade-off in response to fishing pressure between change in life history parameters and the steepness of the stock-recruit function. Estimated steepness in this alternative dropped to 0.58, which, coupled with a larger unexploited stock, resulted in a similar population trajectory. It should be noted that this alternate model fit both the length and age data quite poorly in comparison to the base case.

With limited data on the discarded fraction of the commercial catch, it seemed important explore the ability of the model to estimate the retention curve internally. Without knowing what the true average retention curve was over the time period modeled (it has certainly varied over time), the estimated curve from the Pikitch study was fixed for an alternate model assumption (sensitivity h). This model fit the age data slightly better, but the fits to the discard and length data were degraded. It was clear from this exercise that if it was desirable to produce a reasonable fit to the available observer data, some flexibility was needed in the retention parameters.

The implications of allowing fishery selectivity to change over time, and between fleets, were explored in the final sensitivity run (i). With no blocks for the peak selectivity, this model showed a degraded fit to the length frequency data, but did not change the perceived population trend. Sparse data on the discarded fraction of the catch and for the landed catch during certain time periods results in the need for the modeled patterns of fishery selectivity and retention to be relatively simple in the current assessment, likely underestimating the uncertainty in the population dynamics.

Prior to the STAR panel and during the review, a number of new alternate models were compared to judge the sensitivity of the base case results:

1) 'High' historical catch scenario, 1916-1955
2) Aggregating the northern and southern survey series into a single coast-wide survey
3) Constrain the 1999 and subsequent recruitments to be closer to the deterministic expectation from the stock-recruit relationship
4) Constrain the 1998 and subsequent recruitments to be closer to the deterministic expectation from the stock-recruit relationship
5) Use only the historical maturity ogive for the entire time-series
6) Use only the recent maturity ogive for the entire time-series

Table 43 reports the results of these sensitivity analyses, which used SS2 version 1.18 and are directly comparable with the base case results (first column of the table).

Given the uncertainty in reconstructed historical landings, the STAR panel recommended a sensitivity run (1) increasing the landings by 50% during the most uncertain period with large landings. Figure 57 shows this revised landings series, which resulted in a slightly larger estimate of unexploited spawning biomass level (Table 43) in order to accommodate the larger removals. Despite this difference to the base case, this sensitivity run converged to a very similar time-series in recent years, and still resulted in a current stock size much larger than the target level.

To explore the effect of separating the survey data into a southern and a northern component, the STAR panel recommended a run with all survey data (indices of abundance and length frequencies) aggregated into one coast-wide series. This sensitivity run resulted in a very similar result to the base case, with the exception that the current stock size was estimated to be slightly larger in relation to unexploited conditions. The likelihood components, by fishing fleet and survey area from the base case and this sensitivity run are reported for comparison in Table 48.

Because there were no age data available after 2000, the model's ability to reliably estimate the 1999 and subsequent year classes is somewhat uncertain. For this reason, two sensitivity runs exploring the change in model results under increasing constraint on recent recruitments were explored. Sensitivity runs three and four reflect an emphasis value of four constraining recent recruitments to be closer to the stock-recruit curve than the data would otherwise indicate. Both sensitivity runs resulted in a reduction in current biomass, but still produced 2005 spawning biomass estimates within the 95% confidence interval for the base case model (Figure 58; see decision table analysis for further use of these results).

The change in maturity modeled in the base case changed the underlying productivity of the English sole stock by allowing younger fish to contribute more to the spawning biomass in recent years. Because this change is based on only two studies and is relatively important in calculating reference points and current stock status, two alternate model runs forcing the model to use only the historical or the recent estimate of the maturity schedule were performed. These alternate runs showed a qualitatively similar time-series, but use of only the historical maturity estimate produced a much lower current stock size relative to the unexploited level (Figure 59).

A preliminary retrospective analysis was performed using SS2 version 1.16, by moving the terminal year of the model backwards in time in one year increments from 2003-2000. Although these results are not directly comparable to the base case reported here, the same data were used and a similar pattern would be predicted from the updated model. Figure 60 shows the time-series of spawning biomass and the slight downward pattern in the retrospective fits for the early part of the time series. The large increase at the end of the 2000 retrospective model is attributed to an unreasonably large estimate of the 1996 year class strength, which had little constraint on it with no data included in the model after 2000. The retrospective fits fell roughly within the confidence interval from the base case model, over most of the time period, indicating that there was no substantial change in conclusion attributable to the most recent four years of data included in the model.

A Bayesian version of this assessment, obtained through integration of the joint posterior distribution of all model parameters was explored through Markov Chain Monte Carlo simulation. However, this effort was restricted by the computationally intensive nature of this model, including extensive use of conditional age frequency distributions by length, sex and year. Because of the time required to obtain a sufficient sample from a converged stationary posterior distribution, it was not possible to complete the Bayesian analysis for this assessment. This should be an area of further effort for this assessment in the future.

3. Additional STAR panel recommendations

During the review (April 18-22, 2005) the STAR panel made a number of recommendations that improved this assessment and clarified selected results and analyses. Specifically, understanding of the base case model was improved through comparing the change in growth, fishery selectivity and maturity over time in a single figure (Figure 61). This illustrated the increased contribution of younger fish to the spawning biomass and the relative availability to the fishery and survey. Sensitivity analyses were summarized through a phase-plot, showing the base case model estimate of 2004 spawning biomass (with confidence interval) and approximate exploitation rate, as well as the estimates from each alternate model (Figure 62). The relative abundance of older English sole and contribution to spawning biomass was explored through examining the proportion of the stock of age 8+ (Figure 63). This revealed that the rapid increase in spawning biomass in recent years does not appear to be driven by a single year class, such as the large recruitment estimated in 1999.

The panel recommended a comparison of the base case model results and a trawl survey conducted by the Oregon Department of Fish and Wildlife off the coast of Oregon and Washington during the period from 1971 to 1976 (Demory et al., 1976). This survey had been used for comparison with the absolute population size in the 1993 assessment (Sampson, 1993). The approximate biomass in this area in the current assessment was estimated based on the ratio of the northern survey series catchability (Q) to the sum of the catchabilities of both survey series. This analysis produced close agreement between the two estimates of abundance in 1974 (Figure 64; assumes that the approximate CV of total biomass is equal to that of the spawning biomass and that the CV of the ODF&W survey was 0.2).

The panel also requested a number of exploratory analyses during the review that are not included in this document, but clarified specific questions or concerns.

4. Rebuilding parameters

Because the population of English sole in US waters was not found to be overfished, no rebuilding parameters are required from this assessment.

5. Reference points (biomass and exploitation rate)

Because of temporal changes in growth and maturity, there are two types of reference points reported in this assessment: those based on the assumed population parameters at the beginning of the modeled time period and those based on the most recent time period in a 'forward projection' mode of calculation. All strictly biological reference points (e.g., unexploited spawning biomass) are calculated based on the unexploited conditions at the start of the model, whereas management quantities (MSY, SB_{msy}, etc.) are based on the current growth and maturity schedules and are marked throughout this document with an asterisk (*).

Unexploited equilibrium English sole spawning biomass (B_{zero}) was estimated to be 34,312 mt (~ 95% confidence interval: 27,179 - 41,445), with a mean expected recruitment of 122,820 thousand age-0 English sole. MSY, estimated in the assessment model, was 4,080* mt (2,416-5,743). This value is very close to the estimated total average catch from the period of heaviest exploitation, 1917-1991, of 3,764 mt. The spawning stock biomass expected to produce MSY catch levels was 5,696* mt (1-12,102, the symmetric approximation of the 95% confidence interval included zero and was therefore rounded up), or 19.1%* of B_{zero} (forward projected). This level of exploitation was estimated to result in a spawning potential ratio (SPR) of 23.8%*.

The estimated spawning potential ratio for English sole was near the 40% proxy target for several decades (Figure 65), but has increased in recent years. For the last decade, SPR has been above both the proxy target of 40% for flatfish as well as the estimated MSY level of 23.8%. Figure 66 shows the trend in both SPR relative to the target and spawning biomass relative to the B_{40} target.

6. Harvest projections and decision tables

Forecasts were generated assuming the maximum potential catch would be removed under the 40:10 harvest control rule. A 10-year average of the relative F contribution from the southern and northern fleets was used for this projection. This ratio was 22.4% for the southern fleet to 77.6% for the northern fleet. Very large potential catches (3-6 times recent average values) are predicted to be possible over the first five years of the projection. Table 49 shows 12 year projections under the base case model.

The format and content of the decision table was a result of extensive discussion during the STAR panel. The strength of recent year classes was closely related to current stock status and was identified as an important source of uncertainty in this assessment; this "axis of uncertainty" was therefore selected for inclusion in the table. The spawning biomass estimated from the base case model was 31,379 mt at the beginning of 2005, with an approximate 95% confidence interval including the range of 23,480–39,278 mt. Due to the relatively large current estimate of spawning biomass, it was agreed that two alternate states of nature reflecting the lower tail of the distribution from the base case would be presented. By imposing a large constraint on the recruitments from 1999 to

2005, the current spawning biomass was reduced to 25,772 mt. Constraining 1998 and subsequent years to the same degree resulted in an estimated 2005 spawning biomass of 23,824 mt. These runs were considered to be "unlikely" and "least likely", as they represented increasing constraint away from the base case model. The approximate probability of each of these states of nature was calculated from the cumulative distribution of uncertainty in 2005 spawning biomass for the base case model (Figure 67). The decision table reports the estimated spawning biomass, relative depletion and catch for each of these alternate states of nature (Table 50).

During the STAR panel, an additional alternate to the three management actions reported in the decision table, a projection intended to approximate the recent ABC of 3,100 mt was discussed. The three year average allocation between the southern (Conception and Monterey) and northern (Eureka, Columbia, and U.S. Vancouver) fishery fleets was applied and the retained catch iterated until the total catch was close to the 3,100 mt ABC. The iterative step was necessary because projection landings had to be specified in the model and discards are an estimated quantity. The relative catch ratio used was 0.22:0.78, and the constant retained catch was 510:1,767 mt for the south and north respectively. These values resulted in a total catch averaging 3,089 mt (range: 2,981-3,237 mt) over the period 2005-2016. Results are provided for the base case model in Table 51; this table would therefore correspond to a new row in the first column of the original decision table (Table 50).

7. Research needs

A number of crucial data sources would substantially improve the ability of this assessment to reliably and precisely model English sole population dynamics in the future. In order of priority (author's personal opinion):

1) The NWFSC trawl survey is currently collecting otoliths for use in ageing of English sole. A comparison study of otolith and interopercular (used in this assessment) age reading precision and agreement would allow use of survey otoliths and provide a fishery independent source of age information for this assessment. Because the survey selects smaller fish than the commercial fishery, this would improve estimation of both growth curves and recent year class strengths.
2) Collection of maturity data on an ongoing basis from survey or fishery sources that could be used to track future changes affecting modeled spawning stock biomass.
3) This assessment contains little data on the length frequency of the discarded portion of the commercial catch of English sole. This would be valuable data to add to the discard fractions and average individual weights currently being collected.
4) Despite much effort prior to this assessment, there is still uncertainty in some parts of the historical landings series. Specifically needed are: 1) a method for reconstructing landings in Washington prior to 1956 from U.S. waters, 2) landings data from Oregon from 1954-1955 and 3) a thorough study of the mink food fishery in Oregon and California including estimates of the total volume and size structure of catches associated with this fishery.

5) Because the U.S.-Canada border does not appear to be a meaningful biological boundary for the English sole population, extension of this assessment to include Canadian waters may be necessary to better capture population trends.

8. Acknowledgements

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10. Tables

Table 1. Recent commercial landings (mt) of English sole for all fishing gears combined by INPFC area and year (source: PacFIN, 1 February, 2005).

	INPFC area					Model area	
Year	Conception	Monterey	Eureka	Columbia	US Vancouver	South Total	North Total
1981	208	925	665	723	191	1,133	1,579
1982	148	858	590	941	255	1,006	1,786
1983	57	584	780	691	244	641	1,715
1984	32	497	518	360	314	529	1,192
1985	55	639	407	518	311	694	1,236
1986	52	711	341	648	284	763	1,274
1987	73	674	615	700	409	747	1,724
1988	83	621	411	558	428	704	1,397
1989	65	703	307	690	647	768	1,644
1990	45	667	200	488	512	712	1,199
1991	39	653	135	860	497	693	1,492
1992	21	467	115	701	318	488	1,134
1993	17	378	128	680	398	396	1,206
1994	12	359	115	300	336	371	751
1995	11	400	107	280	327	411	714
1996	11	423	183	353	182	434	718
1997	12	453	283	452	302	466	1,038
1998	5	224	317	329	264	229	910
1999	9	219	216	295	173	227	685
2000	9	172	157	211	200	181	569
2001	29	170	275	335	180	199	791
2002	6	95	293	333	440	102	1,067
2003	3	60	87	262	464	64	813
2004	31	65	210	330	314	96	853

Table 2. Annual coast-wide English sole ABCs (mt) and regional components.

Year	Conception	Monterey	Eureka	Columbia	US Vancouver	Total
1983	200	900	800	2,000	600	4,500
1984	200	900	800	2,000	600	4,500
1985	-	-	-	-	-	1,500
1986	-	-	-	-	-	1,500
1987	-	-	-	-	-	1,900
1988	-	-	-	-	-	1,900
1989	-	-	-	-	-	1,900
1990	-	-	-	-	-	1,900
1991	-	-	-	-	-	1,900
1992	-	-	-	-	-	1,900
1993	-	-	-	-	-	1,900
1994		1,100		2,000		3,100
1995		1,100		2,000		3,100
1996		1,100		2,000		3,100
1997		1,100		2,000		3,100
1998		1,100		2,000		3,100
1999		1,100		2,000		3,100
2000		1,100		2,000		3,100
2001		1,100		2,000		3,100
2002		1,100		2,000		3,100
2003		1,100		2,000		3,100
2004		1,100		2,000		3,100

Table 3. Historical and management events relevant to the English sole fishery.

Date	Action
Historical events	
1876	Commercial trawling begins in San Francisco (Scofield, 1948).
1937	Modern trawling begins in Oregon (Harry and Morgan, 1961).
1948	California legislation requires 5-inch trawl mesh (Scofield, 1948).
1958	Oregon prohibits the landing of Dover, English or Petrale sole less than 11 inches in length (Jones and Harry 1960).
Recent actions – Pacific Fishery Management Council	
25 July 1985	The use of "tickler chains", which contact the sea floor ahead of the rollers in roller and bobbin trawls, is prohibited.
9 May 1992	Increase in the minimum legal cod-end mesh size for roller gear north of Point Arena, California (40º 30' N latitude) from 3.0 inches to 4.5 inches. Use of double-walled cod-ends prohibited. Removal of provisions regarding rollers and tickler chains for roller gear with cod-end mesh smaller than 4.5 inches.
8 September 1995	The trawl minimum mesh size applied throughout the net. Removal of the legal distinction between bottom and roller trawls and the requirement for continuous rib-lines. Clarified the distinction between bottom and pelagic (mid-water) trawls. Modified chafing gear requirements; changed the term "double-ply mesh" to "double-bar mesh".
2000	New limited entry trawl gear restrictions: large footrope defined as larger than 8 inches, small footrope defined as equal to or less than 8 inches. English sole included in "all other flatfish" limits, no specific trip limit, but small footrope gear required.
1 May 2000	Limited-entry trawl vessels with large footropes may land no more than 400 pounds of flatfish other than Dover sole and rex sole per trip, coast-wide.
1 November 2000	Trip limit increased to 1,000 pounds per trip for "Other flatfish" (flatfish without species-specific trip limits, plus rex sole) taken in the limited entry large footrope trawl fisheries.
2001	Trip limits by region and month: North, January-February, March-April: other flatfish, small footrope: no limit; large footrope: 1,000 pounds per trip. May-June, July-August, September-October: other flatfish, small footrope: 30,000 pounds per month, large footrope: 2,000 pounds per trip. November-December: small footrope: no limit, large footrope: 1,000 pounds per trip. South, all months: other flatfish, small footrope: no limit, large footrope 1,000 pounds per trip.
1 May 2001	Limited entry trawl gear limits for flatfish north of 40º 10' N latitude: May-June, limit increased to 50,000 pounds per month for all flatfish except Dover sole, of which no more than 15,000 pounds may be petrale sole and no more than 10,000 pounds may be arrowtooth flounder.
1 July 2001	Limited entry trawl gear limits for flatfish north of 40º 10' N latitude: small footrope trawl limit decreased to 45,000 pounds per month, the sub-limit for petrale sole remains at 14,000 pounds per month, the arrowtooth flounder limit is no longer a sub-limit and is changed to a per trip limit of no more than 7,500 pounds, not to exceed 30,000 pounds per month.
1 October 2001	Limits remain the same for flatfish. During the November-December period, the coast-wide small footrope trawl limit for flatfish other than Dover sole, rex sole, and arrowtooth flounder is 30,000 pounds per month and the large footrope trawl limit will remain at 1,000 pounds per trip. The current limited entry small footrope trawl limit for yellowtail rockfish taken as bycatch with flatfish north of 40º 10' N latitude is extended through the November-December period: limit equal to the sum of 33 % (by weight) of all flatfish except arrowtooth flounder, plus 10% (by weight) of arrowtooth flounder, not to exceed 7,500 pounds per trip, and not to exceed 15,000 pounds per two months.
2002	Trip limits by region and month: North: January-February, other flatfish, small footrope: 15,000 pounds per month, March-April 35,000 pounds per month, May-June 30,000 pounds per month, no more than 10,000 pounds of which may be petrale sole, July-August 40,000 pounds per month, no more than 15,000 pounds of which may be petrale sole, September-October 50,000 pounds per month, no more than 20,000 pounds of which may be petrale sole, November-December 50,000 pounds per month. South: January-February, March-April, other flatfish, small footrope: 70,000 pounds per month, no more than 40,000 pounds per month may be species other than Pacific sanddabs, May-June, July-August, September-October, small footrope required, 70,000 pounds per month, no more than 40,000 pounds per month may be species other than Pacific sanddabs, of the species other than pacific sanddabs, no more than 15,000 pounds may be petrale sole, November-December 70,000 pounds per month, no more than 40,000 pounds per month may be species other than Pacific sanddabs.

Table 4. Summary of the spatial area (km^2) surveyed by the triennial survey.

		Depth strata			
		Shallow	Mid	Deep	All
Stock	INPFC	55-99 m	100-154 m	155-500 m	Depths
North	US Vancouver	1,026.5	1,912.2	2,165.3	5,104.1
	Columbia	6,768.0	7,280.4	9,428.1	23,476.6
	Eureka	2,160.5	1,502.6	2,539.2	6,202.3
	North Total	9,955.0	10,695.3	14,132.6	34,782.9
South	Monterey	4,835.7	4,007.1	3,503.9	12,346.7
	Conception	4,328.3	2,686.8	11,789.5	18,804.6
	South Total	9,163.9	6,693.9	15293.4	31,151.3

Table 5. Relative biomass estimates (mt) based on the triennial survey 1977-2004. Note that the survey did not extend shallower than 91 meters in 1977 (*) and that the Conception area was not sampled in 1980-1986.

			Year									
Region	INPFC	Depth	1977*	1980	1983	1986	1989	1992	1995	1998	2001	2004
North	US Vanc.	55-99 m	0.00*	593.43	830.36	874.27	1,174.77	643.88	750.32	1,896.11	862.30	4,420.46
	US Vanc.	100-154 m	79.24	54.41	319.88	461.95	594.60	272.36	520.99	564.71	335.45	353.05
	US Vanc.	155-500 m	8.34	59.49	55.75	63.54	174.93	182.32	21.74	146.39	115.76	196.31
	Columbia	55-99 m	1,523.74*	1,566.83	1,549.49	3,298.18	4,476.21	5,589.29	2,805.17	7,112.28	5,315.28	17,581.78
	Columbia	100-154 m	234.92	315.51	468.52	651.34	1,120.21	1,471.09	1,186.38	2,890.97	3,226.48	3,655.57
	Columbia	155-500 m	266.12	536.22	525.87	258.52	296.57	930.19	341.20	514.98	333.65	1,016.82
	Eureka	55-99 m	24.60*	361.56	796.78	621.82	423.70	245.60	268.19	848.59	1,266.26	6,516.03
	Eureka	100-154 m	0.00	20.67	71.28	3.89	122.16	56.49	20.70	1,090.84	960.78	2,041.91
	Eureka	155-500 m	0.46	35.64	33.23	20.73	12.17	118.37	77.62	247.33	134.55	330.97
North total			2,137.43*	3,543.76	4,651.16	6,254.23	8,395.31	9,509.60	5,992.32	15,312.20	12,550.52	36,112.90
South	Monterey	55-99 m	1,504.52*	845.41	2,209.61	2,179.16	2,562.41	763.68	2,971.32	963.50	2,602.36	4,922.58
	Monterey	100-154 m	717.08	138.23	1,365.25	941.06	2,412.06	923.54	1,894.80	685.69	2,096.36	2,973.61
	Monterey	155-500 m	51.18	100.89	352.54	40.90	572.58	639.09	442.91	520.58	503.07	1,387.02
	Conception	55-99 m	82.82*	NA	NA	NA	211.12	25.03	440.21	496.35	1,019.51	1,229.33
	Conception	100-154 m	153.82	NA	NA	NA	229.37	72.66	358.24	149.06	339.98	1501.92
	Conception	155-500 m	38.68	NA	NA	NA	280.11	19.11	5.57	75.05	183.12	198.01
South total (Monterey only)			2,272.79*	1,084.54	3,927.40	3,161.12	5,547.05	2,326.31	5,309.03	2,169.77	5,201.79	9,283.20

Table 6. Number of successful hauls in U.S. waters from the triennial survey by year and depth (excludes “water hauls” as defined by Zimmerman, 2001, and hauls that were conducted outside of the U.S. EEZ).

			Year									
Region	INPFC	Depth	1977	1980	1983	1986	1989	1992	1995	1998	2001	2004
North	US Vancouver	55-99 m	2	4	7	30	8	10	5	5	6	5
	US Vancouver	100-154 m	18	7	26	93	22	19	15	22	16	14
	US Vancouver	155-500 m	45	12	29	49	24	18	18	15	17	16
	Columbia	55-99 m	11	58	86	65	49	58	37	41	37	33
	Columbia	100-154 m	63	72	107	94	79	85	59	62	66	52
	Columbia	155-500 m	137	71	97	49	60	58	85	84	86	73
	Eureka	55-99 m	2	9	18	12	16	19	15	20	18	20
	Eureka	100-154 m	4	7	16	13	14	15	14	15	17	11
	Eureka	155-500 m	25	10	22	6	18	18	31	33	31	29
North Total			307	250	408	411	290	300	279	297	294	253
South	Monterey	55-99 m	11	18	24	25	51	44	35	40	39	28
	Monterey	100-154 m	41	13	26	32	43	41	36	30	34	25
	Monterey	155-500 m	106	20	21	15	26	18	44	55	52	40
	Conception	55-99 m	4	0	0	0	13	7	8	8	8	8
	Conception	100-154 m	15	0	0	0	9	8	6	6	6	7
	Conception	155-500 m	91	0	0	0	8	3	29	32	33	23
South Total (Monterey only)			158	51	71	72	120	103	115	125	125	93

Table 7. Percent positive tows for English sole in the triennial survey, by year and depth.

Stock	INPFC	Depth	1977	1980	1983	1986	1989	1992	1995	1998	2001	2004
North	US Vancouver	55-99 m	0.00	1.00	1.00	0.97	1.00	1.00	1.00	1.00	1.00	1.00
	US Vancouver	100-154 m	0.44	0.29	0.58	0.75	0.64	0.47	0.73	0.82	0.81	0.64
	US Vancouver	155-500 m	0.13	0.42	0.45	0.51	0.33	0.61	0.28	0.60	0.41	0.44
	Columbia	55-99 m	0.73	0.84	0.97	0.95	0.98	0.97	0.97	1.00	1.00	1.00
	Columbia	100-154 m	0.32	0.49	0.62	0.59	0.56	0.62	0.68	0.94	0.82	0.83
	Columbia	155-500 m	0.15	0.31	0.45	0.31	0.25	0.41	0.29	0.43	0.23	0.33
	Eureka	55-99 m	0.50	0.78	1.00	0.75	0.94	0.95	0.87	0.95	1.00	1.00
	Eureka	100-154 m	0.00	0.29	0.50	0.15	0.43	0.40	0.36	1.00	1.00	1.00
	Eureka	155-500 m	0.04	0.50	0.23	0.33	0.39	0.22	0.23	0.36	0.23	0.38
South	Monterey	55-99 m	0.91	0.89	1.00	1.00	0.98	0.98	1.00	0.98	1.00	1.00
	Monterey	100-154 m	0.83	0.62	0.85	0.94	0.86	0.98	0.89	1.00	0.94	0.92
	Monterey	155-500 m	0.28	0.50	0.48	0.47	0.50	0.83	0.57	0.45	0.37	0.53
	Conception	55-99 m	0.75	NA	NA	NA	0.62	0.71	0.88	1.00	1.00	1.00
	Conception	100-154 m	0.73	NA	NA	NA	0.67	0.75	1.00	0.67	1.00	0.86
	Conception	155-500 m	0.10	NA	NA	NA	0.13	0.33	0.03	0.16	0.18	0.26

Table 8. Average cpue ($kg \cdot km^{-2}$) captured by the triennial survey 1977-2004.

			Year									
Region	INPFC	Depth	1977	1980	1983	1986	1989	1992	1995	1998	2001	2004
North	US Vanc.	55-99 m	0.00	578.09	808.90	851.67	1,144.41	627.24	730.93	1,847.10	840.01	4,306.21
	US Vanc.	100-154 m	41.44	28.45	167.28	241.58	310.94	142.43	272.45	295.32	175.42	184.63
	US Vanc.	155-500 m	3.85	27.47	25.75	29.34	80.79	84.20	10.04	67.61	53.46	90.66
	Columbia	55-99 m	225.14	231.51	228.94	487.32	661.38	825.84	414.48	1,050.87	785.36	2,597.78
	Columbia	100-154 m	32.27	43.34	64.35	89.46	153.87	202.06	162.95	397.09	443.17	502.11
	Columbia	155-500 m	28.23	56.87	55.78	27.42	31.46	98.66	36.19	54.62	35.39	107.85
	Eureka	55-99 m	11.39	167.35	368.80	287.82	196.11	113.68	124.14	392.78	586.10	3,015.99
	Eureka	100-154 m	0.00	13.76	47.44	2.59	81.30	37.60	13.78	725.97	639.41	1,358.91
	Eureka	155-500 m	0.18	14.04	13.09	8.16	4.79	46.62	30.57	97.41	52.99	130.34
South	Monterey	55-99 m	311.13	174.83	456.94	450.64	529.90	157.93	614.46	199.25	538.16	1,017.97
	Monterey	100-154 m	178.95	34.50	340.71	234.85	601.95	230.48	472.86	171.12	523.16	742.09
	Monterey	155-500 m	14.61	28.79	100.61	11.67	163.41	182.39	126.41	148.57	143.57	395.85
	Conception	55-99 m	19.13	NA	NA	NA	48.78	5.78	101.71	114.68	235.55	284.02
	Conception	100-154 m	57.25	NA	NA	NA	85.37	27.04	133.33	55.48	126.54	558.99
	Conception	155-500 m	3.28	NA	NA	NA	23.76	1.62	0.47	6.37	15.53	16.80

Table 9. Sampling CV calculated from the triennial survey 1977-2004.

			Year									
Region	INPFC	Depth	1977	1980	1983	1986	1989	1992	1995	1998	2001	2004
North	US Vancouver	55-99 m	NA	0.62	0.35	0.16	0.50	0.35	0.30	0.21	0.24	0.23
	US Vancouver	100-154 m	0.32	0.82	0.42	0.22	0.38	0.41	0.41	0.31	0.36	0.48
	US Vancouver	155-500 m	0.47	0.56	0.51	0.23	0.58	0.47	0.54	0.60	0.54	0.53
	Columbia	55-99 m	0.35	0.21	0.14	0.15	0.23	0.14	0.17	0.12	0.14	0.29
	Columbia	100-154 m	0.46	0.38	0.18	0.21	0.21	0.20	0.26	0.14	0.23	0.26
	Columbia	155-500 m	0.37	0.42	0.22	0.36	0.45	0.38	0.33	0.33	0.36	0.34
	Eureka	55-99 m	1.00	0.53	0.17	0.27	0.17	0.24	0.33	0.16	0.28	0.20
	Eureka	100-154 m	NA	0.67	0.44	0.78	0.77	0.62	0.53	0.64	0.23	0.32
	Eureka	155-500 m	1.00	0.44	0.56	0.78	0.32	0.74	0.63	0.59	0.57	0.46
North			0.26	0.17	0.09	0.09	0.15	0.10	0.11	0.08	0.09	0.15
South	Monterey	55-99 m	0.26	0.23	0.20	0.16	0.16	0.20	0.19	0.12	0.18	0.15
	Monterey	100-154 m	0.28	0.42	0.31	0.18	0.22	0.24	0.16	0.16	0.24	0.34
	Monterey	155-500 m	0.30	0.49	0.59	0.52	0.42	0.30	0.47	0.19	0.29	0.33
	Conception	55-99 m	0.56	NA	NA	NA	0.67	0.44	0.38	0.36	0.44	0.35
	Conception	100-154 m	0.29	NA	NA	NA	0.45	0.53	0.44	0.47	0.61	0.29
	Conception	155-500 m	0.42	NA	NA	NA	1.00	1.00	1.00	0.51	0.62	0.47
South (Monterey only)			0.20	0.19	0.16	0.13	0.13	0.14	0.13	0.09	0.13	0.14

Table 10. Number of hauls in U.S. waters from the triennial survey with at least one length observation collected for English sole by year and depth. Bold values included in assessment.

			Year									
Region	INPFC	Depth	1977	1980	1983	1986	1989	1992	1995	1998	2001	2004
North	US Vancouver	55-99 m	0	1	1	11	**8**	**10**	**5**	**5**	**6**	**5**
	US Vancouver	100-154 m	0	0	2	26	**14**	**6**	**11**	**18**	**13**	**9**
	US Vancouver	155-500 m	0	0	0	2	**7**	**5**	**5**	**9**	**7**	**7**
	Columbia	55-99 m	0	4	7	18	**44**	**38**	**33**	**41**	**36**	**33**
	Columbia	100-154 m	0	1	1	9	**32**	**38**	**19**	**55**	**53**	**42**
	Columbia	155-500 m	0	0	0	2	**10**	**8**	**8**	**32**	**20**	**22**
	Eureka	55-99 m	0	0	2	1	**10**	**15**	**5**	**18**	**17**	**19**
	Eureka	100-154 m	0	0	0	0	**2**	**4**	**2**	**15**	**17**	**10**
	Eureka	155-500 m	0	0	0	0	**2**	**2**	**1**	**11**	**7**	**11**
North Total			0	6	13	69	**129**	**126**	**89**	**204**	**176**	**158**
South	Monterey	55-99 m	0	1	2	3	**50**	**38**	**25**	**22**	**39**	**27**
	Monterey	100-154 m	0	0	0	0	**34**	**33**	**19**	**16**	**31**	**23**
	Monterey	155-500 m	0	0	0	0	**8**	**12**	**16**	**10**	**18**	**21**
	Conception	55-99 m	0	0	0	0	6	1	6	5	7	8
	Conception	100-154 m	0	0	0	0	6	6	6	1	6	6
	Conception	155-500 m	0	0	0	0	1	1	0	2	6	6
South Total (Monterey only)			0	1	2	3	**92**	**83**	**60**	**48**	**88**	**71**

Table 11. Number of English sole lengths collected and used to calculate length-compositions from the triennial survey by year and depth. Note that Length compositions were only used for 1989-2004, and did not include the Conception area.

Area	INPFC	Depth	1977	1980	1983	1986	1989	1992	1995	1998	2001	2004
North	US Vancouver	55-99 m	0	177	204	1,990	1,327	1,145	785	1,902	857	3,075
	US Vancouver	100-154 m	0	0	63	1,860	665	238	631	788	237	298
	US Vancouver	155-500 m	0	0	0	22	133	59	20	101	78	128
	Columbia	55-99 m	0	357	1,512	1,627	5,859	6,731	4,072	13,809	7,518	18,415
	Columbia	100-154 m	0	22	97	742	1,622	2,163	1,429	5,872	5,451	4,559
	Columbia	155-500 m	0	0	0	38	218	222	169	623	364	1,166
	Eureka	55-99 m	0	0	203	34	341	429	112	2,272	2,366	9,137
	Eureka	100-154 m	0	0	0	0	7	78	5	1,808	1,496	1,488
	Eureka	155-500 m	0	0	0	0	3	75	2	288	157	235
South	Monterey	55-99 m	0	90	386	321	5,157	1,818	5,051	1,653	6,384	9,046
	Monterey	100-154 m	0	0	0	0	3,275	1,784	2,124	769	3,182	2,947
	Monterey	155-500 m	0	0	0	0	547	320	818	720	947	1,802
	Conception	55-99 m	0	0	0	0	71	1	251	221	593	822
	Conception	100-154 m	0	0	0	0	92	34	207	37	138	530
	Conception	155-500 m	0	0	0	0	17	1	0	10	50	27
In length compositions		North	0	0	0	0	10,175	11,140	7,225	27,463	18,524	38,501
		South	0	0	0	0	8,979	3,922	7,993	3,142	10,513	13,795
Proportion included		North	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
		South	0.00	0.00	0.00	0.00	0.98	0.99	0.95	0.92	0.93	0.91

Table 12. Length compositions from the triennial survey. Proportions sum to one over both sexes in each stock and year.

Northern area		Length bin lower edge																	
Females	Year	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45+
	1989	0.000	0.000	0.001	0.003	0.011	0.014	0.031	0.070	0.116	0.145	0.135	0.086	0.046	0.023	0.013	0.008	0.004	0.001
	1992	0.000	0.000	0.000	0.003	0.013	0.020	0.046	0.079	0.086	0.098	0.101	0.057	0.042	0.020	0.014	0.005	0.002	0.001
	1995	0.000	0.000	0.000	0.001	0.007	0.038	0.087	0.145	0.142	0.126	0.099	0.053	0.023	0.008	0.003	0.002	0.000	0.001
	1998	0.000	0.000	0.001	0.005	0.035	0.087	0.107	0.105	0.103	0.086	0.055	0.031	0.018	0.006	0.002	0.001	0.000	0.000
	2001	0.000	0.000	0.002	0.011	0.020	0.035	0.066	0.101	0.133	0.118	0.095	0.067	0.033	0.014	0.005	0.002	0.001	0.000
	2004	0.000	0.000	0.000	0.001	0.007	0.015	0.029	0.058	0.116	0.164	0.136	0.115	0.058	0.023	0.006	0.002	0.001	0.000
Males	1989	0.000	0.000	0.001	0.004	0.009	0.032	0.058	0.070	0.066	0.036	0.012	0.004	0.002	0.000	0.000	0.000	0.000	0.000
	1992	0.000	0.000	0.001	0.009	0.033	0.062	0.078	0.099	0.074	0.040	0.010	0.004	0.001	0.000	0.001	0.000	0.000	0.000
	1995	0.000	0.000	0.001	0.002	0.025	0.060	0.065	0.052	0.035	0.013	0.007	0.003	0.000	0.000	0.000	0.000	0.000	0.000
	1998	0.000	0.000	0.001	0.013	0.067	0.106	0.083	0.051	0.019	0.008	0.004	0.001	0.001	0.001	0.000	0.000	0.000	0.001
	2001	0.000	0.000	0.010	0.026	0.044	0.049	0.063	0.052	0.031	0.013	0.005	0.002	0.000	0.001	0.000	0.000	0.000	0.000
	2004	0.000	0.000	0.000	0.003	0.015	0.044	0.059	0.065	0.051	0.020	0.007	0.003	0.001	0.000	0.000	0.000	0.000	0.000
Southern area																			
Females	1989	0.000	0.000	0.000	0.001	0.002	0.018	0.043	0.057	0.087	0.100	0.113	0.087	0.058	0.023	0.005	0.002	0.000	0.000
	1992	0.000	0.000	0.001	0.004	0.018	0.042	0.074	0.096	0.089	0.093	0.072	0.042	0.035	0.012	0.006	0.003	0.000	0.000
	1995	0.000	0.000	0.000	0.004	0.037	0.065	0.080	0.104	0.112	0.108	0.084	0.051	0.019	0.010	0.003	0.001	0.000	0.000
	1998	0.000	0.000	0.002	0.016	0.059	0.080	0.096	0.116	0.120	0.082	0.049	0.033	0.028	0.013	0.005	0.000	0.000	0.000
	2001	0.000	0.000	0.003	0.017	0.055	0.094	0.105	0.115	0.104	0.076	0.056	0.035	0.025	0.010	0.005	0.001	0.000	0.000
	2004	0.000	0.000	0.002	0.018	0.053	0.067	0.081	0.081	0.073	0.080	0.077	0.062	0.036	0.015	0.007	0.002	0.000	0.000
Males	1989	0.000	0.000	0.000	0.004	0.017	0.078	0.117	0.100	0.048	0.027	0.009	0.003	0.001	0.001	0.000	0.000	0.000	0.000
	1992	0.000	0.000	0.000	0.009	0.062	0.110	0.102	0.082	0.031	0.014	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
	1995	0.000	0.000	0.002	0.011	0.026	0.075	0.099	0.070	0.030	0.009	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1998	0.000	0.001	0.019	0.050	0.077	0.072	0.055	0.020	0.008	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2001	0.000	0.000	0.006	0.054	0.087	0.068	0.044	0.021	0.009	0.005	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000
	2004	0.000	0.000	0.007	0.054	0.102	0.100	0.053	0.018	0.008	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000

Table 13. Triennial survey conditional female age-at-length bin frequencies from the north in 1995.

			Age Bin																			
Length bin	Samples (#)	Fish (#)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
15	2	2	0.000	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	4	13	0.000	0.385	0.538	0.077	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	10	39	0.000	0.103	0.410	0.333	0.154	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	24	50	0.000	0.040	0.360	0.320	0.200	0.020	0.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	14	47	0.000	0.000	0.191	0.340	0.255	0.191	0.000	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	16	54	0.000	0.000	0.037	0.259	0.222	0.370	0.093	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	21	49	0.000	0.000	0.000	0.122	0.265	0.367	0.163	0.041	0.020	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	16	37	0.000	0.000	0.000	0.000	0.243	0.243	0.270	0.216	0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	5	5	0.000	0.000	0.000	0.000	0.000	0.400	0.400	0.000	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	2	3	0.000	0.000	0.000	0.000	0.000	0.333	0.000	0.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	1	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 14. English sole weight at length observations from the triennial survey.

Haul	Year	Number of fish	INPFC
1	1989	43	Monterey
2	1989	10	Eureka
3	1989	4	Eureka
4	1989	37	Eureka
5	1989	63	Columbia
6	1989	35	Vancouver
7	1989	49	Vancouver
8	1989	31	Vancouver (Canadian)
9	1995	69	Columbia
10	1995	7	Columbia
11	2001	25	Monterey
12	2001	38	Monterey
13	2001	14	Monterey
14	2001	19	Monterey
15	2001	28	Eureka
15	3	472	5

Table 15. Weight-at length relationship parameter estimates; growth model fitted externally and used as assessment model input.

Parameter	Males	Females
a	0.00000727969	0.00000547424
b	3.072800	3.154470

Table 16. Historical annual trawl landings of English sole used in the stock assessment model by INPFC area, stock and year. Vancouver area includes PMFC area 3B only (source: Sampson, 1993).

	INPFC area					Model area	
Year	Conception	Monterey	Eureka	Columbia	US Vancouver	South Total	North Total
1956	68	1,217	443	470	870	1,285	1,783
1957	100	1,290	784	763	643	1,390	2,190
1958	96	1,036	1,185	1,045	995	1,132	3,225
1959	144	664	1,263	648	1,439	808	3,350
1960	104	490	484	1,067	1,278	594	2,829
1961	287	795	563	739	999	1,082	2,301
1962	250	1,186	509	999	677	1,436	2,185
1963	214	1,153	574	838	818	1,367	2,230
1964	193	1,260	699	608	778	1,453	2,085
1965	411	1,285	579	689	919	1,696	2,187
1966	248	1,222	793	1,491	784	1,470	3,068
1967	171	1,369	1,158	871	757	1,540	2,786
1968	143	1,196	1,364	716	1,120	1,339	3,200
1969	193	819	823	622	604	1,012	2,049
1970	176	726	645	679	269	902	1,593
1971	185	724	540	699	144	909	1,383
1972	132	661	651	912	287	793	1,850
1973	147	689	775	938	421	836	2,134
1974	132	880	836	719	379	1,012	1,934
1975	177	1,050	804	970	493	1,227	2,267
1976	211	932	910	1,718	695	1,143	3,323
1977	210	717	642	1,029	269	927	1,940
1978	120	950	860	1,053	480	1,070	2,393
1979	115	1,000	1,066	1,026	424	1,115	2,516
1980	98	1,264	812	758	281	1,362	1,851

Table 17. Reconstructed historical annual landings (mt) of English sole for the years 1916-1955 used in the stock assessment model by area and year. See text for sources and description of methods.

Year	South Total	North Total
1916	2,454	0
1917	3,343	0
1918	2,692	0
1919	2,118	0
1920	1,464	0
1921	1,866	0
1922	2,698	0
1923	2,714	0
1924	3,491	0
1925	3,393	0
1926	3,247	0
1927	3,923	0
1928	3,442	0
1929	3,976	3
1930	3,065	1
1931	1,580	1
1932	2,919	6
1933	2,762	4
1934	2,350	2
1935	2,667	5
1936	2,801	18
1937	2,547	69
1938	1,076	1,070
1939	1,351	1,176
1940	1,169	1,405
1941	808	1,054
1942	163	1,600
1943	382	2,697
1944	429	1,350
1945	412	1,170
1946	717	3,544
1947	776	2,056
1948	1,208	4,008
1949	1,093	1,977
1950	1,607	3,311
1951	947	2,558
1952	736	2,325
1953	681	1,590
1954	750	1,321
1955	837	1,439

Table 18. Extrapolated annual landings (mt) of English sole for the south used in the stock assessment model for the earliest years of the developing commercial fishery off San Francisco; three scenarios intended to bracket the range of plausible landings based on published qualitative summaries and descriptive reports.

Year	Base case scenario	Low scenario	High scenario
1876	1	1	1
1877	1	1	62
1878	1	1	124
1879	2	1	185
1880	2	1	246
1881	2	1	308
1882	3	1	369
1883	4	1	430
1884	4	1	492
1885	5	1	553
1886	6	1	614
1887	7	1	676
1888	9	1	737
1889	11	1	798
1890	13	1	860
1891	15	1	921
1892	18	1	982
1893	22	1	1,044
1894	26	1	1,105
1895	32	1	1,166
1896	38	1	1,228
1897	45	1	1,289
1898	54	1	1,350
1899	65	1	1,412
1900	78	1	1,473
1901	94	1	1,534
1902	113	1	1,595
1903	135	1	1,657
1904	162	1	1,718
1905	194	1	1,779
1906	233	1	1,841
1907	280	1	1,902
1908	335	1	1,963
1909	402	1	2,025
1910	482	1	2,086
1911	578	1	2,147
1912	694	1	2,209
1913	832	1	2,270
1914	998	1	2,331
1915	1,196	1	2,393

Table 19. Estimates of discard fraction for English sole from Herrman and Harry (1963).

Year	Total catch (lbs)	Total discard (lbs)	Trips sampled	Proportion discarded
1950	123,162	29,241	12	0.2374
1951	18,793	4,852	4	0.2582
1953	35,584	6,484	5	0.1822
1959	33,298	16,979	4	0.5099
1960	22,813	6,777	7	0.2971
1961	41,595	3,866	9	0.0929
Sum	275,245	68,199	41	0.2478

Table 20. Discard fraction (by weight) and average individual weight of discarded fish for English sole from the West coast groundfish observer program.

Year	Model area	Fraction discarded	Average weight (kg)
2001	South	0.3225	0.1743
2001	North	0.2564	0.2161
2002	South	0.3865	0.1937
2002	North	0.2522	0.1975
2003	South	0.5161	0.1688
2003	North	0.2972	0.2251

Table 21. Estimates of discarding by length and fitted predictions based on a logistic model for English sole from the Pikitch Study.

Length bin (cm)	Discarded (#)	Retained (#)	Total (#)	Fraction retained	Fitted values
15	3	0	3	0.000	0.000
17	11	0	11	0.000	0.001
19	36	0	36	0.000	0.003
21	80	0	80	0.000	0.014
23	94	9	103	0.087	0.054
25	84	26	110	0.236	0.189
27	58	43	101	0.426	0.486
29	44	132	176	0.750	0.794
31	7	172	179	0.961	0.940
33	0	157	157	1.000	0.985
35	0	78	78	1.000	0.996
37	0	37	37	1.000	0.999
39	0	20	20	1.000	1.000
41	0	7	7	1.000	1.000
43	0	2	2	1.000	1.000
45	0	0	0	NA	NA
Sum	417	683	1,100		

Table 22. Number of unique samples used to produce fishery length compositions.

	INPFC area						
Year	Conception	Monterey	Eureka	Columbia	US Vancouver	South total	North total
1966	13	0	0	28	0	13	28
1967	10	0	0	0	0	10	0
1968	5	4	0	44	0	9	44
1969	14	2	0	0	0	16	0
1970	2	0	0	49	0	2	49
1971	0	0	3	1	0	0	4
1972	0	4	6	15	0	4	21
1973	7	0	11	13	0	7	24
1974	8	0	11	10	0	8	21
1975	5	2	7	13	0	7	20
1976	1	1	12	0	0	2	12
1977	0	1	6	22	0	1	28
1978	0	0	4	22	0	0	26
1979	0	0	1	15	0	0	16
1980	1	8	51	19	0	9	70
1981	0	0	57	20	0	0	77
1982	0	2	31	24	1	2	56
1983	0	2	21	19	0	2	40
1984	0	1	6	9	0	1	15
1985	0	11	10	12	0	11	22
1986	0	0	0	22	0	0	22
1987	0	0	12	31	0	0	43
1988	0	0	6	18	0	0	24
1989	0	0	7	26	0	0	33
1990	0	0	1	24	5	0	30
1991	0	0	1	22	5	0	28
1992	0	0	0	19	2	0	21
1993	0	0	0	17	5	0	22
1994	0	0	0	14	7	0	21
1995	0	0	0	12	8	0	20
1996	0	0	0	9	9	0	18
1997	0	0	2	22	16	0	40
1998	0	0	5	20	12	0	37
1999	0	0	8	16	11	0	35
2000	0	0	7	19	7	0	33
2001	0	4	9	30	10	4	49
2002	1	4	6	32	7	5	45
2003	1	20	6	23	2	21	31
2004	0	0	6	13	6	0	25

Table 23. Total commercial bottom trawl landings (mt) sampled for length.

	INPFC area						
Year	Conception	Monterey	Eureka	Columbia	US Vancouver	South total	North total
1966	4.05	0.00	0.00	14.05	0.00	4.05	14.05
1967	1.33	0.00	0.00	0.00	0.00	1.33	0.00
1968	1.00	0.93	0.00	22.07	0.00	1.94	22.07
1969	7.12	0.48	0.00	0.00	0.00	7.60	0.00
1970	0.06	0.00	0.00	24.58	0.00	0.06	24.58
1971	0.00	0.00	0.14	0.03	0.00	0.00	0.18
1972	0.00	1.52	6.04	1.02	0.00	1.52	7.06
1973	2.70	0.00	19.33	0.51	0.00	2.70	19.84
1974	2.23	0.00	14.91	0.39	0.00	2.23	15.31
1975	1.55	0.37	9.74	0.52	0.00	1.92	10.26
1976	0.04	0.20	31.15	0.00	0.00	0.24	31.15
1977	0.00	0.24	15.56	27.89	0.00	0.24	43.45
1978	0.00	0.00	2.78	29.82	0.00	0.00	32.59
1979	0.00	0.00	0.05	22.70	0.00	0.00	22.75
1980	0.31	7.85	25.54	15.00	0.00	8.16	40.54
1981	0.00	0.00	30.57	16.48	0.00	0.00	47.05
1982	0.00	8.95	16.92	17.85	0.39	8.95	35.16
1983	0.00	0.62	12.52	8.48	0.00	0.62	21.01
1984	0.00	0.31	4.40	3.64	0.00	0.31	8.04
1985	0.00	8.28	7.09	7.48	0.00	8.28	14.57
1986	0.00	0.00	0.00	26.93	0.00	0.00	26.93
1987	0.00	0.00	10.37	35.85	0.00	0.00	46.23
1988	0.00	0.00	4.15	13.35	0.00	0.00	17.50
1989	0.00	0.00	3.08	15.99	0.00	0.00	19.06
1990	0.00	0.00	0.74	18.17	17.02	0.00	35.93
1991	0.00	0.00	1.17	26.47	3.74	0.00	31.38
1992	0.00	0.00	0.00	21.85	3.69	0.00	25.53
1993	0.00	0.00	0.00	22.60	5.19	0.00	27.79
1994	0.00	0.00	0.00	8.53	5.47	0.00	14.00
1995	0.00	0.00	0.00	6.49	27.00	0.00	33.48
1996	0.00	0.00	0.00	6.69	15.37	0.00	22.06
1997	0.00	0.00	0.75	17.55	26.63	0.00	44.92
1998	0.00	0.00	16.32	18.77	18.87	0.00	53.95
1999	0.00	0.00	5.48	11.33	11.58	0.00	28.39
2000	0.00	0.00	8.69	16.18	11.33	0.00	36.19
2001	0.00	4.53	12.26	28.59	8.06	4.53	48.91
2002	0.00	8.23	2.34	23.49	7.43	8.23	33.26
2003	0.03	37.59	2.36	25.88	4.73	37.63	32.96
2004	0.00	0.00	4.66	8.93	6.84	0.00	20.43

Table 24. Number of fish sampled for length from the bottom trawl fishery.

	INPFC area						
Year	Conception	Monterey	Eureka	Columbia	US Vancouver	South total	North total
1966	387	0	0	1,601	0	387	1,601
1967	233	0	0	0	0	233	0
1968	125	133	0	2,283	0	258	2,283
1969	561	75	0	0	0	636	0
1970	75	0	0	2,564	0	75	2,564
1971	0	0	300	100	0	0	400
1972	0	125	300	1,376	0	125	1,676
1973	175	0	442	1,299	0	175	1,741
1974	200	0	460	986	0	200	1,446
1975	125	49	339	1,300	0	174	1,639
1976	24	25	566	0	0	49	566
1977	0	50	299	2,169	0	50	2,468
1978	0	0	200	2,217	0	0	2,417
1979	0	0	50	1,501	0	0	1,551
1980	25	400	2,982	1,809	0	425	4,791
1981	0	0	3,817	1,975	0	0	5,792
1982	0	51	2,195	2,313	102	51	4,610
1983	0	99	1,267	1,067	0	99	2,334
1984	0	49	310	451	0	49	761
1985	0	550	503	610	0	550	1,113
1986	0	0	0	1,110	0	0	1,110
1987	0	0	591	1,509	0	0	2,100
1988	0	0	300	904	0	0	1,204
1989	0	0	350	1,301	0	0	1,651
1990	0	0	50	1,454	404	0	1,908
1991	0	0	62	1,812	435	0	2,309
1992	0	0	0	1,665	180	0	1,845
1993	0	0	0	1,455	428	0	1,883
1994	0	0	0	1,178	671	0	1,849
1995	0	0	0	1,026	771	0	1,797
1996	0	0	0	717	844	0	1,561
1997	0	0	142	1,788	1,440	0	3,370
1998	0	0	259	1,615	1,175	0	3,049
1999	0	0	489	1,356	976	0	2,821
2000	0	0	417	1,468	676	0	2,561
2001	0	122	558	2,137	826	122	3,521
2002	9	107	292	2,207	384	116	2,883
2003	3	305	343	1,471	118	308	1,932
2004	0	0	215	789	418	0	1,422

Table 25. Expanded fishery length compositions. Proportions sum to one over both sexes within year and area.

Northern area		Length bin lower edge																	
Females	Year	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45+
	1966	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.085	0.237	0.236	0.175	0.081	0.040	0.012	0.007
	1968	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.006	0.057	0.167	0.237	0.202	0.139	0.065	0.021	0.006
	1970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.026	0.096	0.178	0.196	0.149	0.093	0.053	0.021	0.008
	1971	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.045	0.044	0.187	0.205	0.114	0.086	0.036	0.016	0.004
	1972	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.051	0.181	0.236	0.219	0.100	0.058	0.029	0.009	0.005
	1973	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.003	0.025	0.145	0.239	0.229	0.146	0.078	0.028	0.009	0.005
	1974	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.037	0.138	0.221	0.209	0.133	0.079	0.030	0.014	0.010
	1975	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.002	0.008	0.037	0.154	0.219	0.206	0.135	0.078	0.033	0.008	0.007
	1976	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.014	0.054	0.120	0.154	0.114	0.084	0.067	0.022	0.009	0.001
	1977	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.034	0.103	0.189	0.191	0.129	0.085	0.041	0.017	0.005
	1978	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.072	0.147	0.262	0.190	0.135	0.088	0.036	0.005	0.005
	1979	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.003	0.038	0.200	0.210	0.225	0.126	0.071	0.025	0.002	0.001
	1980	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.068	0.183	0.235	0.187	0.124	0.064	0.037	0.016	0.013
	1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.115	0.212	0.222	0.175	0.108	0.058	0.021	0.008	0.004
	1982	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.041	0.132	0.254	0.222	0.143	0.074	0.032	0.014	0.007	0.001
	1983	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.014	0.144	0.240	0.249	0.153	0.067	0.035	0.015	0.006	0.001
	1984	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.015	0.080	0.111	0.285	0.183	0.144	0.075	0.027	0.021	0.001	0.000
	1985	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.068	0.206	0.261	0.155	0.133	0.054	0.016	0.005	0.005	0.002
	1986	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.030	0.212	0.347	0.213	0.093	0.029	0.010	0.001	0.000	0.000
	1987	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.010	0.099	0.216	0.241	0.202	0.106	0.032	0.014	0.003	0.001	0.000
	1988	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.139	0.253	0.220	0.165	0.067	0.032	0.013	0.006	0.001
	1989	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.017	0.154	0.298	0.259	0.134	0.057	0.023	0.007	0.000	0.001
	1990	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.011	0.064	0.261	0.311	0.186	0.072	0.025	0.007	0.002	0.000
	1991	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.007	0.068	0.202	0.234	0.150	0.073	0.036	0.018	0.004	0.002
	1992	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.036	0.185	0.286	0.214	0.133	0.060	0.021	0.007	0.001	0.001
	1993	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.007	0.140	0.336	0.278	0.138	0.049	0.014	0.005	0.002	0.000
	1994	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.029	0.186	0.314	0.214	0.108	0.063	0.019	0.008	0.003	0.002
	1995	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.061	0.185	0.246	0.189	0.118	0.080	0.045	0.043	0.014	0.005
	1996	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.047	0.268	0.279	0.189	0.100	0.036	0.024	0.009	0.005	0.001
	1997	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.021	0.154	0.325	0.224	0.126	0.066	0.020	0.016	0.001	0.009
	1998	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.070	0.197	0.294	0.194	0.096	0.048	0.040	0.022	0.009	0.003
	1999	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.067	0.201	0.286	0.219	0.105	0.047	0.026	0.013	0.005	0.002
	2000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.060	0.186	0.290	0.181	0.115	0.056	0.045	0.039	0.006	0.002

Table 25 continued. Expanded fishery length compositions. Proportions sum to one over both sexes within year and area.

Northern area		Length bin lower edge																	
Females	Year	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45+
	2001	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.009	0.045	0.146	0.267	0.264	0.131	0.066	0.034	0.013	0.007	0.003
	2002	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.008	0.029	0.134	0.258	0.276	0.145	0.067	0.030	0.011	0.007	0.003
	2003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.117	0.291	0.230	0.185	0.065	0.024	0.012	0.000	0.000
	2004	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.013	0.073	0.286	0.270	0.201	0.083	0.026	0.007	0.002	0.000
Males	1966	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.045	0.041	0.018	0.003	0.001	0.001	0.000	0.000
	1968	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.008	0.036	0.039	0.010	0.001	0.000	0.000	0.000	0.000
	1970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.035	0.074	0.045	0.017	0.001	0.001	0.000	0.000	0.000
	1971	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.108	0.098	0.034	0.004	0.001	0.000	0.000	0.000	0.000
	1972	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.030	0.049	0.018	0.005	0.000	0.000	0.000	0.000	0.000
	1973	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.020	0.034	0.023	0.009	0.003	0.000	0.000	0.000	0.000
	1974	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.009	0.025	0.048	0.029	0.009	0.001	0.000	0.000	0.000	0.000
	1975	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.004	0.012	0.017	0.051	0.020	0.007	0.001	0.000	0.000	0.000	0.000
	1976	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.039	0.124	0.146	0.042	0.001	0.001	0.000	0.000	0.000	0.000
	1977	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.024	0.059	0.081	0.031	0.003	0.001	0.000	0.000	0.000	0.000
	1978	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.013	0.018	0.007	0.002	0.001	0.000	0.000	0.000	0.000
	1979	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.032	0.043	0.021	0.001	0.000	0.000	0.000	0.000	0.000
	1980	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.006	0.025	0.023	0.008	0.002	0.000	0.000	0.000	0.000	0.000
	1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.027	0.019	0.007	0.001	0.000	0.000	0.000	0.000	0.000
	1982	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.018	0.025	0.013	0.008	0.000	0.000	0.000	0.000	0.000	0.000
	1983	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.003	0.026	0.027	0.010	0.004	0.000	0.000	0.000	0.000	0.000
	1984	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.006	0.016	0.024	0.006	0.001	0.000	0.000	0.000	0.000	0.000	0.000
	1985	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.034	0.021	0.015	0.002	0.000	0.000	0.000	0.000	0.000	0.000
	1986	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.011	0.032	0.008	0.004	0.000	0.000	0.000	0.000	0.000	0.000
	1987	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.012	0.033	0.015	0.008	0.002	0.000	0.000	0.000	0.000	0.000	0.000
	1988	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.030	0.022	0.010	0.003	0.000	0.000	0.000	0.000	0.000
	1989	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.007	0.017	0.020	0.003	0.000	0.000	0.000	0.000	0.000	0.000
	1990	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.007	0.018	0.026	0.003	0.000	0.000	0.000	0.000	0.000	0.000
	1991	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.023	0.030	0.062	0.022	0.036	0.016	0.009	0.000	0.000

Table 25 continued. Expanded fishery length compositions. Proportions sum to one over both sexes within year and area.

Northern area		Length bin lower edge																	
Males	Year	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45+
	1992	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.035	0.008	0.000	0.000	0.000	0.000	0.000	0.000
	1993	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.008	0.016	0.003	0.001	0.000	0.000	0.000	0.000	0.000
	1994	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.030	0.016	0.001	0.000	0.000	0.000	0.000	0.000	0.000
	1995	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.004	0.004	0.000	0.001	0.000	0.000	0.000	0.000
	1996	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.011	0.016	0.002	0.000	0.000	0.000	0.000	0.000	0.000
	1997	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.005	0.012	0.011	0.003	0.002	0.001	0.000	0.000	0.000	0.000
	1998	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.010	0.003	0.000	0.001	0.000	0.000	0.000	0.000	0.000
	1999	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.012	0.005	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.002	0.007	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.003	0.007	0.002	0.000	0.001	0.000	0.001	0.000	0.000	0.000
	2002	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.004	0.017	0.005	0.002	0.000	0.000	0.000	0.000	0.000	0.000
	2003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.015	0.016	0.011	0.009	0.000	0.000	0.000	0.000	0.000
	2004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.015	0.012	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Southern area																			
Females	1966	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.038	0.086	0.066	0.177	0.158	0.078	0.019	0.013	0.000	0.000
	1967	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.025	0.176	0.290	0.176	0.130	0.075	0.016	0.027	0.001
	1968	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.037	0.127	0.214	0.208	0.194	0.119	0.032	0.016	0.006
	1969	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.036	0.086	0.077	0.180	0.117	0.026	0.008	0.003	0.000	0.000
	1970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.038	0.019	0.160	0.271	0.332	0.120	0.009	0.000	0.009
	1972	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.034	0.202	0.222	0.269	0.145	0.080	0.014	0.000	0.000
	1973	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.114	0.130	0.193	0.207	0.078	0.036	0.003	0.019
	1974	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.024	0.104	0.163	0.195	0.223	0.191	0.043	0.016	0.001
	1975	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.039	0.282	0.407	0.190	0.067	0.009	0.004	0.002
	1976	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.012	0.019	0.254	0.149	0.189	0.217	0.142	0.000	0.000	0.000
	1977	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.220	0.400	0.180	0.160	0.020	0.000	0.000
	1980	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.092	0.276	0.255	0.151	0.102	0.033	0.015	0.003	0.000
	1982	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.102	0.541	0.115	0.102	0.102	0.025	0.000	0.000	0.000
	1983	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.091	0.253	0.242	0.263	0.081	0.020	0.020	0.000	0.000

Table 25 continued. Expanded fishery length compositions. Proportions sum to one over both sexes within year and area.

Southern area		Length bin lower edge																	
Females	Year	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45+
	1984	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.204	0.265	0.286	0.122	0.061	0.020	0.000	0.000	0.000
	1985	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.044	0.191	0.258	0.252	0.169	0.050	0.018	0.000	0.001	0.000
	2001	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.067	0.151	0.325	0.171	0.141	0.032	0.000	0.004	0.000	0.000
	2002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.176	0.151	0.137	0.052	0.235	0.144	0.060	0.000	0.045	0.000
	2003	0.000	0.000	0.000	0.000	0.000	0.083	0.036	0.045	0.065	0.181	0.269	0.118	0.038	0.005	0.003	0.058	0.000	0.000
Males	1966	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.034	0.122	0.081	0.082	0.033	0.000	0.000	0.000	0.000	0.000	0.000
	1967	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.020	0.042	0.005	0.000	0.000	0.000	0.000	0.000	0.000
	1968	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.011	0.011	0.011	0.000	0.000	0.000	0.000	0.000
	1969	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.134	0.181	0.131	0.019	0.001	0.000	0.000	0.000	0.000	0.000
	1970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.021	0.021	0.000	0.000	0.000	0.000	0.000	0.000
	1972	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.011	0.000	0.000	0.000	0.000	0.000	0.000
	1973	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.044	0.061	0.071	0.000	0.015	0.000	0.000	0.000	0.000
	1974	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.015	0.015	0.006	0.000	0.000	0.000	0.000	0.000	0.000
	1975	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
	1976	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1980	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1983	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.035	0.011	0.009	0.006	0.000	0.000	0.000	0.000	0.000
	1985	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 26. Age reading agreement between two readers for English sole otoliths (surface) collected from Puget Sound (Van Cleve and El-Sayed, 1969).

		Reader 1														
	Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
	1	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	2	0	**10**	0	0	0	0	0	0	0	0	0	0	0	0	10
	3	0	0	**44**	0	0	0	0	0	0	0	0	0	0	0	44
	4	0	0	0	**17**	1	1	0	0	0	0	0	0	0	0	19
	5	0	0	1	2	**34**	0	0	0	0	0	0	0	0	0	37
	6	0	0	0	1	2	**29**	1	0	0	0	0	0	0	0	33
Reader	7	0	0	0	0	0	1	**13**	7	1	1	0	0	0	0	23
2	8	0	0	0	0	0	1	2	**15**	7	1	2	0	0	0	28
	9	0	0	0	0	0	0	1	3	**12**	1	0	1	0	0	18
	10	0	0	0	0	0	1	0	1	1	**5**	6	1	1	0	16
	11	0	0	0	0	0	0	1	1	1	1	**12**	4	0	0	20
	12	0	0	0	0	0	0	0	0	0	0	2	**1**	1	0	4
	13	0	0	0	0	0	0	0	0	0	1	0	0	**0**	0	1
	14	0	0	0	0	0	0	0	0	0	0	0	1	0	**0**	1
	Total	1	10	45	20	37	33	18	27	22	10	22	8	2	0	255

Table 27. Age reading agreement between interopercula and otoliths (surface) collected from market samples (Palmen, 1956).

		Read from interoperculum														
	Age	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	3	**35**	1	0	0	0	0	0	0	0	0	0	0	0	0	36
	4	11	**216**	15	1	0	0	0	0	0	0	0	0	0	0	243
	5	3	53	**222**	29	5	0	1	0	0	0	0	0	0	0	313
	6	1	10	38	**185**	33	2	0	1	0	0	0	0	0	0	270
	7	0	1	5	42	**160**	25	4	6	1	2	0	0	0	0	246
Read	8	0	0	0	7	26	**46**	11	4	5	1	0	0	0	0	100
from	9	0	0	0	0	3	6	**30**	21	5	4	0	0	0	0	69
otolith	10	0	0	0	0	0	2	6	**15**	10	10	3	1	0	0	47
	11	0	0	0	0	0	0	1	5	**12**	9	4	4	0	2	37
	12	0	0	0	0	0	0	0	0	0	**4**	3	2	3	1	13
	13	0	0	0	0	0	0	1	0	1	0	**2**	1	4	1	10
	14	0	0	0	0	0	0	0	0	0	0	0	**1**	2	2	5
	15	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0
	Total	50	281	280	264	227	81	54	52	34	30	12	9	9	6	1,389

Table 28. Age reading agreement between interopercula and otoliths (surface) from Puget Sound (Van Cleve and El-Sayed, 1969).

		Read from interoperculum																
	Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	1	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	2	0	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
	3	0	0	**44**	2	1	1	0	0	0	0	0	0	0	0	0	0	48
	4	0	0	0	**16**	3	0	0	0	0	0	0	0	0	0	0	0	19
	5	0	0	0	0	**37**	4	0	0	0	0	0	0	0	0	0	0	41
	6	0	0	0	1	4	**31**	7	2	1	0	0	0	0	0	0	0	46
Read from otolith	7	0	0	0	0	1	4	**18**	4	1	0	0	0	1	0	0	0	29
	8	0	0	0	0	0	0	4	**17**	2	0	1	0	1	0	0	1	26
	9	0	0	0	0	0	0	0	2	**13**	2	4	0	4	0	0	0	25
	10	0	0	0	0	0	0	0	0	0	**4**	5	0	0	0	0	1	10
	11	0	0	0	0	0	0	1	0	1	1	**11**	4	2	4	1	0	25
	12	0	0	0	0	0	0	0	0	0	0	2	**2**	1	2	0	2	9
	13	0	0	0	0	0	0	0	0	0	0	0	0	**1**	3	0	1	5
	14	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	1	0	1
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0
	Total	1	10	44	19	46	40	30	25	18	7	23	6	10	9	2	5	295

Table 29. Age reading agreement between two readers based on interopercula from Puget Sound (Van Cleve and El-Sayed, 1969).

		Reader 1																		
	Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Reader 2	1	**51**	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56
	2	0	**156**	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	166
	3	0	0	**36**	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	44
	4	0	0	2	**76**	12	2	0	0	0	0	0	0	0	0	0	0	0	0	92
	5	0	0	0	8	**109**	10	1	0	0	0	0	0	0	0	0	0	0	0	128
	6	0	0	0	0	11	**82**	9	2	0	0	0	0	0	0	0	0	0	0	104
	7	0	0	0	0	0	11	**62**	2	0	0	0	0	0	0	0	0	0	0	75
	8	0	0	0	0	0	2	6	**49**	0	0	0	0	0	0	0	0	0	0	57
	9	0	0	0	0	0	0	0	4	**25**	1	0	0	0	0	0	0	0	0	30
	10	0	0	0	0	0	0	0	1	3	**42**	2	0	0	0	0	0	0	0	48
	11	0	0	0	0	0	0	0	0	2	4	**22**	3	0	0	0	0	0	0	31
	12	0	0	0	0	0	0	0	0	1	1	3	**19**	0	0	0	0	0	0	24
	13	0	0	0	0	0	0	0	0	0	0	1	2	**20**	1	0	0	0	0	24
	14	0	0	0	0	0	0	0	0	0	0	0	0	6	**7**	1	0	0	0	14
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**7**	0	0	0	7
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**	1	0	3
	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**0**	0	1
	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	1
	Total	51	161	47	91	134	107	78	58	31	48	28	24	26	8	9	2	1	1	905

Table 30. Age reading agreement experiment conducted in 1991 between opercula read by both ODFW and WDFW; reported in Sampson (1993).

		Read by ODFW											
	Age	3	4	5	6	7	8	9	10	11	12	13	Total
Read by WDFW	3	**0**	0	0	0	0	0	0	0	0	0	0	0
	4	0	**10**	6	2	2	0	0	0	0	0	0	20
	5	0	1	**23**	5	0	0	0	0	0	0	0	29
	6	0	0	1	**25**	4	0	0	0	0	0	0	30
	7	0	0	3	7	**9**	1	0	0	0	0	0	20
	8	0	0	0	1	7	**18**	0	0	0	0	0	26
	9	0	0	0	2	5	12	**11**	0	0	0	0	30
	10	0	0	0	1	1	5	4	**3**	2	0	0	16
	11	0	0	0	0	0	0	0	0	**0**	0	0	0
	12	0	0	0	0	0	1	1	2	2	**5**	2	13
	13	0	0	0	0	0	0	0	2	1	1	**6**	10
	Total	0	11	33	43	28	37	16	7	5	6	8	194

Table 31. Age agreement between multiple reads of opercula by WDFW (source: PacFIN).

		Subsequent readings (up to 2 per structure)											
	Age	3	4	5	6	7	8	9	10	11	12	13	Total
First read	3	**10**	7	1	0	0	0	0	0	0	0	0	18
	4	4	**69**	29	1	0	1	0	0	0	0	0	104
	5	0	9	**68**	20	4	0	0	0	0	0	0	101
	6	1	0	20	**78**	16	1	0	0	0	0	0	116
	7	0	0	1	14	**44**	8	0	0	0	0	0	67
	8	0	0	1	2	8	**37**	17	3	1	1	0	70
	9	0	0	0	0	0	9	**27**	1	3	0	0	40
	10	0	0	0	0	0	0	4	**18**	4	3	1	30
	11	0	0	0	0	0	0	1	2	**2**	1	0	6
	12	0	0	0	0	0	0	0	2	0	**0**	0	2
	13	0	0	0	0	0	0	0	0	0	0	**0**	0
	Total	15	85	120	115	72	56	49	26	10	5	1	554

Table 32. Number of unique samples used to create interopercular age compositions from the trawl fishery. Conception and Monterey data are from CalCOM, Eureka, Columbia and Vancouver data are from PacFIN.

	INPFC Area						
Year	Conception	Monterey	Eureka	Columbia	US Vancouver	South total	North total
1966	0	0	0	26	0	0	26
1967	0	0	0	0	0	0	0
1968	3	3	0	43	0	6	43
1969	12	2	0	0	0	14	0
1970	1	0	0	48	0	1	48
1971	0	0	3	1	0	0	4
1972	0	4	2	15	0	4	17
1973	7	0	0	13	0	7	13
1974	8	0	0	9	0	8	9
1975	5	2	0	11	0	7	11
1976	0	0	0	0	0	0	0
1977	0	0	0	19	0	0	19
1978	0	0	0	21	0	0	21
1979	0	0	0	11	0	0	11
1980	1	0	9	18	0	1	27
1981	0	0	19	20	0	0	39
1982	0	1	13	24	1	1	38
1983	0	2	5	19	0	2	24
1984	0	1	5	9	0	1	14
1985	0	9	10	12	0	9	22
1986	0	0	0	6	0	0	6
1987	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0
1989	0	0	0	24	0	0	24
1990	0	0	0	24	5	0	29
1991	0	0	0	22	3	0	25
1992	0	0	0	0	0	0	0
1993	0	0	0	9	3	0	12
1994	0	0	0	11	4	0	15
1995	0	0	0	11	8	0	19
1996	0	0	0	8	3	0	11
1997	0	0	0	17	6	0	23
1998	0	0	1	4	1	0	6
1999	0	0	0	0	0	0	0
2000	0	0	0	0	1	0	1
2001	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0

Table 33. Total commercial bottom trawl landings (mt) sampled for interopercular age.

	INPFC area						
Year	Conception	Monterey	Eureka	Columbia	US Vancouver	South total	North total
1966	0.00	0.00	0.00	12.27	0.00	0.00	12.27
1967	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1968	0.39	0.72	0.00	20.28	0.00	1.10	20.28
1969	7.04	0.48	0.00	0.00	0.00	7.52	0.00
1970	0.02	0.00	0.00	22.64	0.00	0.02	22.64
1971	0.00	0.00	0.14	0.03	0.00	0.00	0.18
1972	0.00	1.52	0.08	0.99	0.00	1.52	1.07
1973	2.70	0.00	0.00	0.51	0.00	2.70	0.51
1974	2.23	0.00	0.00	0.36	0.00	2.23	0.36
1975	0.98	0.25	0.00	0.43	0.00	1.23	0.43
1976	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	27.77	0.00	0.00	27.77
1978	0.00	0.00	0.00	29.78	0.00	0.00	29.78
1979	0.00	0.00	0.00	16.72	0.00	0.00	16.72
1980	0.20	0.00	5.40	14.91	0.00	0.20	20.31
1981	0.00	0.00	15.83	16.48	0.00	0.00	32.31
1982	0.00	0.20	8.46	17.85	0.39	0.20	26.70
1983	0.00	0.39	3.40	8.48	0.00	0.39	11.88
1984	0.00	0.20	4.33	3.64	0.00	0.20	7.97
1985	0.00	6.87	7.09	7.48	0.00	6.87	14.57
1986	0.00	0.00	0.00	14.97	0.00	0.00	14.97
1987	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1988	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1989	0.00	0.00	0.00	15.83	0.00	0.00	15.83
1990	0.00	0.00	0.00	18.17	17.02	0.00	35.19
1991	0.00	0.00	0.00	26.47	1.74	0.00	28.22
1992	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1993	0.00	0.00	0.00	9.30	4.88	0.00	14.18
1994	0.00	0.00	0.00	7.65	4.63	0.00	12.28
1995	0.00	0.00	0.00	6.36	27.00	0.00	33.36
1996	0.00	0.00	0.00	6.51	5.42	0.00	11.93
1997	0.00	0.00	0.00	16.05	15.62	0.00	31.66
1998	0.00	0.00	1.08	1.97	3.41	0.00	6.46
1999	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	0.00	0.00	0.00	0.00	0.15	0.00	0.15
2001	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2002	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 34. Number of fish sampled for interopercular age from the trawl fishery.

	INPFC area						
Year	Conception	Monterey	Eureka	Columbia	US Vancouver	South total	North total
1966	0	0	0	1,397	0	0	1,397
1967	0	0	0	0	0	0	0
1968	75	70	0	2,231	0	145	2,231
1969	357	50	0	0	0	407	0
1970	25	0	0	2,511	0	25	2,511
1971	0	0	299	100	0	0	399
1972	0	100	200	1,354	0	100	1,554
1973	175	0	0	1,296	0	175	1,296
1974	200	0	0	879	0	200	879
1975	124	44	0	1,099	0	168	1,099
1976	0	0	0	0	0	0	0
1977	0	0	0	1,842	0	0	1,842
1978	0	0	0	2,084	0	0	2,084
1979	0	0	0	1,085	0	0	1,085
1980	25	0	904	1,708	0	25	2,612
1981	0	0	1,825	1,900	0	0	3,725
1982	0	25	1,187	2,223	94	25	3,504
1983	0	47	447	972	0	47	1,419
1984	0	24	239	422	0	24	661
1985	0	225	472	579	0	225	1,051
1986	0	0	0	303	0	0	303
1987	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0
1989	0	0	0	1,165	0	0	1,165
1990	0	0	0	1,432	396	0	1,828
1991	0	0	0	1,731	261	0	1,992
1992	0	0	0	0	0	0	0
1993	0	0	0	802	229	0	1,031
1994	0	0	0	868	364	0	1,232
1995	0	0	0	908	698	0	1,606
1996	0	0	0	635	264	0	899
1997	0	0	0	1,382	438	0	1,820
1998	0	0	71	308	82	0	461
1999	0	0	0	0	0	0	0
2000	0	0	0	0	99	0	99
2001	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0

Table 35. Commercial fishery conditional age-at-length bin compositions aggregated over all years.

Length bin	Age Bin 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
Southern area - Males																				
27	0.000	0.000	0.000	0.006	0.138	0.146	0.282	0.427	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.000	0.015	0.114	0.299	0.001	0.159	0.311	0.066	0.010	0.020	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.000	0.000	0.033	0.000	0.000	0.023	0.152	0.531	0.159	0.060	0.000	0.011	0.030	0.002	0.000	0.000	0.000	0.000	0.000	0.000
33	0.000	0.000	0.000	0.232	0.000	0.314	0.018	0.009	0.061	0.044	0.072	0.054	0.093	0.041	0.000	0.062	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.920	0.000	0.000	0.000	0.006	0.000	0.000	0.074	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern area - Males																				
15	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.596	0.000	0.000	0.000	0.221	0.000	0.182	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.080	0.242	0.000	0.198	0.000	0.479	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.039	0.087	0.325	0.113	0.010	0.158	0.268	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.011	0.147	0.318	0.074	0.187	0.094	0.100	0.033	0.022	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.002	0.030	0.110	0.156	0.200	0.095	0.135	0.088	0.099	0.037	0.024	0.001	0.006	0.001	0.016	0.000	0.000	0.000	0.000
31	0.000	0.000	0.015	0.071	0.101	0.148	0.126	0.112	0.104	0.145	0.082	0.049	0.026	0.014	0.002	0.003	0.000	0.000	0.000	0.000
33	0.000	0.000	0.008	0.053	0.069	0.104	0.097	0.117	0.189	0.160	0.076	0.055	0.038	0.020	0.006	0.007	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.066	0.065	0.082	0.114	0.095	0.109	0.118	0.138	0.083	0.059	0.028	0.042	0.000	0.000	0.000	0.000	0.000
37	0.000	0.000	0.012	0.000	0.284	0.151	0.160	0.046	0.039	0.076	0.030	0.031	0.080	0.091	0.000	0.000	0.000	0.000	0.000	0.000
39	0.000	0.000	0.000	0.000	0.000	0.366	0.000	0.134	0.000	0.426	0.000	0.074	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
41	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
43	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Southern area - Females																				
27	0.000	0.000	0.398	0.085	0.438	0.079	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.023	0.364	0.195	0.192	0.141	0.037	0.005	0.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.000	0.010	0.175	0.199	0.168	0.187	0.085	0.034	0.111	0.026	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	0.000	0.000	0.066	0.143	0.186	0.164	0.133	0.127	0.104	0.008	0.037	0.000	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.024	0.094	0.083	0.146	0.167	0.178	0.099	0.102	0.044	0.044	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.000	0.000	0.000	0.042	0.077	0.153	0.158	0.168	0.189	0.042	0.089	0.044	0.009	0.004	0.025	0.000	0.000	0.000	0.000	0.000
39	0.000	0.000	0.000	0.082	0.067	0.115	0.079	0.129	0.060	0.220	0.097	0.087	0.007	0.057	0.000	0.000	0.000	0.000	0.000	0.000

Table 35 continued. Commercial fishery conditional age-at-length bin compositions aggregated over all years.

Length bin	Age Bin 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
Southern area- Females																				
41	0.000	0.000	0.000	0.022	0.010	0.131	0.184	0.049	0.113	0.114	0.051	0.091	0.199	0.036	0.000	0.000	0.000	0.000	0.000	0.000
43	0.000	0.000	0.000	0.000	0.000	0.012	0.339	0.089	0.000	0.004	0.050	0.173	0.331	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45	0.000	0.000	0.000	0.000	0.149	0.000	0.000	0.223	0.000	0.000	0.000	0.167	0.347	0.114	0.000	0.000	0.000	0.000	0.000	0.000
Northern area - Females																				
15	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.248	0.677	0.011	0.065	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.023	0.303	0.421	0.222	0.014	0.002	0.000	0.000	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.007	0.174	0.342	0.287	0.112	0.060	0.011	0.001	0.003	0.000	0.002	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.008	0.134	0.268	0.288	0.173	0.083	0.031	0.009	0.005	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.000	0.002	0.066	0.216	0.298	0.214	0.111	0.056	0.022	0.009	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	0.000	0.000	0.026	0.139	0.293	0.241	0.155	0.076	0.043	0.015	0.006	0.003	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000
35	0.000	0.000	0.010	0.078	0.207	0.265	0.207	0.105	0.067	0.034	0.013	0.007	0.003	0.001	0.001	0.000	0.000	0.000	0.000	0.000
37	0.000	0.000	0.002	0.038	0.125	0.196	0.213	0.186	0.118	0.067	0.027	0.014	0.007	0.002	0.002	0.000	0.001	0.000	0.000	0.000
39	0.000	0.000	0.001	0.015	0.073	0.122	0.179	0.186	0.181	0.092	0.073	0.038	0.022	0.011	0.003	0.002	0.002	0.002	0.000	0.000
41	0.000	0.000	0.000	0.008	0.020	0.081	0.142	0.144	0.167	0.184	0.116	0.064	0.034	0.016	0.014	0.003	0.002	0.002	0.005	0.000
43	0.000	0.000	0.000	0.009	0.026	0.032	0.072	0.119	0.166	0.173	0.144	0.107	0.068	0.024	0.020	0.025	0.000	0.002	0.000	0.013
45	0.000	0.000	0.000	0.033	0.029	0.053	0.034	0.055	0.127	0.160	0.173	0.142	0.064	0.030	0.007	0.041	0.013	0.026	0.003	0.013

Table 36. Sampling information from historical length frequency observations from Demory and Bailey (1967) used for the northern area.

Year	PMFC area	Assumed number of samples	Number of fish
1949	2C	6	288
1949	3A	4	201
1950	2B	16	802
1950	2C	21	1,062
1950	2D	71	3,556
1951	2D	46	2,313
1951	3B	12	600
1960	2D	21	1,056
1960	3A	8	407
1961	2D	23	1,153
1961	3B	10	477
1963	2C	2	99
1963	2D	10	500
1964	2C	2	101
1964	2D	54	2,711
1964	3A	4	208
1965	2B	2	100
1965	2D	58	2,892
1965	3B	2	100

Table 37. Sampling information from historical age-at-length observations from Demory and Bailey (1967) used for the northern area.

Year	PMFC area	Assumed number of samples	Number of fish
1948	2D	11	547
1948	3A	1	22
1949	2D	9	437

Table 38. Female length compositions from the historical commercial fishery in the north. Proportions sum to one over both sexes in each area and year.

		Length bin lower edge																	
Year	Area	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45+
Females																			
1949	2C	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.028	0.139	0.295	0.226	0.153	0.111	0.031	0.017
1949	3A	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.025	0.050	0.085	0.075	0.119	0.159	0.085	0.114	0.095
1950	2B	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.011	0.091	0.167	0.242	0.209	0.146	0.055	0.021	0.005
1950	2C	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.019	0.072	0.187	0.247	0.212	0.125	0.037	0.016	0.005
1950	2D	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.016	0.067	0.130	0.177	0.152	0.124	0.073	0.047	0.027
1951	2D	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.015	0.052	0.115	0.138	0.162	0.147	0.096	0.045	0.028
1951	3B	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.030	0.045	0.122	0.148	0.150	0.098	0.098
1960	2D	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.010	0.064	0.197	0.305	0.205	0.122	0.055	0.022	0.014	0.004
1960	3A	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.039	0.233	0.349	0.167	0.081	0.052	0.039	0.037
1961	2D	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.058	0.286	0.276	0.206	0.070	0.054	0.027	0.018
1961	3B	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.067	0.159	0.235	0.270	0.132	0.065	0.042	0.021
1963	2C	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.040	0.192	0.232	0.232	0.212	0.071	0.000	0.010	0.010
1963	2D	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.098	0.208	0.172	0.124	0.118	0.086	0.044	0.030
1964	2C	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.267	0.277	0.168	0.020	0.010	0.010	0.000
1964	2D	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.019	0.113	0.195	0.176	0.131	0.077	0.043	0.018	0.008
1964	3A	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.135	0.135	0.139	0.154	0.087	0.019	0.024	0.019
1965	2B	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.160	0.250	0.240	0.200	0.070	0.000	0.000
1965	2D	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.031	0.163	0.245	0.190	0.102	0.059	0.032	0.015	0.009
Males																			
1949	3A	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.055	0.095	0.035	0.000	0.000	0.000	0.000	0.000
1950	2B	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.005	0.021	0.016	0.004	0.000	0.001	0.000	0.000	0.000
1950	2C	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.021	0.037	0.013	0.005	0.003	0.000	0.000	0.000	0.000
1950	2D	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.032	0.069	0.059	0.018	0.003	0.001	0.000	0.000	0.000
1951	2D	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.007	0.058	0.085	0.038	0.006	0.001	0.001	0.000	0.000
1951	3B	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.035	0.125	0.110	0.030	0.003	0.000	0.000	0.000
1963	2D	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.042	0.040	0.022	0.004	0.000	0.004	0.000	0.000
1964	2C	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.109	0.050	0.020	0.010	0.000	0.000	0.000
1964	2D	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.009	0.048	0.075	0.057	0.022	0.005	0.002	0.000	0.000	0.000
1964	3A	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.034	0.135	0.067	0.029	0.000	0.000	0.000	0.000	0.000
1965	2B	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.020	0.020	0.000	0.010	0.000	0.010	0.000
1965	2D	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.010	0.036	0.058	0.037	0.010	0.000	0.000	0.000	0.000	0.000

Table 39. Historical commercial fishery conditional age-at-length bin compositions from the north aggregated over all years and areas.

	Age Bin																			
Length bin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
Females																				
25	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.500	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.033	0.267	0.433	0.200	0.067	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.000	0.000	0.143	0.446	0.304	0.089	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	0.000	0.000	0.044	0.221	0.336	0.265	0.124	0.000	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.088	0.213	0.390	0.206	0.074	0.022	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.000	0.000	0.000	0.060	0.156	0.269	0.263	0.180	0.054	0.012	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.000	0.000	0.000	0.000	0.061	0.193	0.377	0.228	0.105	0.009	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
41	0.000	0.000	0.000	0.010	0.039	0.098	0.284	0.235	0.216	0.069	0.020	0.020	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
43	0.000	0.000	0.000	0.000	0.000	0.049	0.232	0.195	0.280	0.171	0.061	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45	0.000	0.000	0.000	0.000	0.000	0.020	0.102	0.143	0.204	0.245	0.184	0.082	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Males																				
25	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.400	0.200	0.200	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.250	0.458	0.250	0.000	0.042	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.000	0.000	0.041	0.184	0.265	0.265	0.143	0.061	0.020	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	0.000	0.000	0.000	0.078	0.255	0.235	0.235	0.118	0.059	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.063	0.375	0.250	0.188	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
41	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 40. Description of all model parameters used in the base case assessment model.

Parameter	Number estimated	Bounds (low, high)	Prior (Mean, SD)
Natural mortality	-	NA	Fixed at 0.26
Stock and recruitment			
Ln(R_{zero})	1	(5,25)	~N(13,50)
Steepness	1	(0.2,1.0)	~N(0.80,50)
Sigma R	-	NA	Fixed at 0.51
Ln(Recruitment deviations): 1877-2004	128	(-10, 10)	~Ln(N(0,Sigma R))
Catchability			
Ln(Survey south)	1	(-5,0.0)	~N(-1,50)
Ln(Survey north)	1	(-5,0.0)	~N(-1,50)
Selectivity (double Logistic) and retention (Logistic)			
North and South Fisheries:			
Initial selectivity	-	NA	Fixed at 0.0
Ascending inflection (arcsin trans.)	1	(-10,10)	~N(0.4,50)
Ascending slope	-	NA	Fixed at 0.1
Length at peak selectivity	1	(25,45)	~N(33,50)
Final selectivity (arcsin trans.)	-	NA	Fixed at 99
Inflection of retention	2	(25-35)	~N(30,50)
Slope of retention	-	NA	Fixed at 1.42
Asymptote of retention	-	NA	Fixed at 1.0
Block offsets for length at peak selectivity (1981-1985,1986-1990,1991-1995,1996-2004)	4	(-10,10)	~N(0,50)
North and South Surveys:			
Initial selectivity	-	NA	Fixed at 0.0
Ascending inflection (arcsin trans.)	2	(-10,10)	~N(0.7,50)
Ascending slope	2	(0.001,10.0)	~N(0.2,50)
Length at peak selectivity	2	(20,45)	~N(40,50)
Final selectivity (arcsin trans.)	-	NA	Fixed at 99
Individual growth			
Females:			
Length at age 2	1	(5,25)	~N(10,50)
Length at age 20	1	(25,55)	~N(35,50)
von Bertalanffy K	1	(0.01,1.5)	~N(0.12,50)
CV of length at age 2	1	(0.01,0.9)	~N(0.11,50)
Males:			
Length at age 2 offset to females	-	NA	Fixed at 0.0
Length at age 20 offset to females	1	(-5,5)	~N(0.0,50)
von Bertalanffy K offset to females	1	(-5,5)	~N(0.0,50)
CV of length at age 2 offset to Females	1	(-5,5)	~N(0.0,50)
Both sexes:			
Block offsets for von Bertalanffy K (1961-1970,1971-1980,1981-1990,1991-2004)	4	(-10,10)	~N(-0.1,50)
Total: 29+ 128 recruitment devs = 157 estimated parameters			

Table 41. Estimated English sole growth parameters.

Parameter	Value	SD
Females:		
Length at age 2 (cm)	16.232	0.366
Length at age 20 (cm)	39.768	0.351
Von Bertalanffy K:		
1876-1960	0.397	0.031
1961-1970	0.353	NA
1971-1980	0.279	NA
1981-1990	0.239	NA
1991-2004	0.233	NA
CV of length at age	0.101	0.002
Males:		
Length at age 2 (cm)	16.232	0.366
Length at age 20 (cm)	23.869	NA
Von Bertalanffy K:		
1876-1960	0.484	NA
1961-1970	0.430	NA
1971-1980	0.340	NA
1981-1990	0.291	NA
1991-2004	0.284	NA
CV of length at age	0.195	NA

Table 42. Estimated English sole stock-recruitment and catchability parameters.

Parameter	Value	SD
Catchability:		
Southern survey catchability (*Q*)	0.187	NA
Northern survey catchability (*Q*)	0.582	NA
Stock-recruitment:		
R_0	122,820	13,026
Steepness (*h*)	0.834	0.157

Table 43. Summary results of sensitivity analyses; see text for description of each.

Quantity	Base case	Sensitivity 1	Sensitivity 2	Sensitivity 3	Sensitivity 4
Convergence					
Log determinant Hessian	532.287	534.179	526.016	540.268	540.828
Maximum gradient component	0.010373	0.000411	0.022025	0.034880	0.011203
Likelihoods					
Objective function	2,257.0	2,253.0	2,084.9	2,263.0	2,266.0
Indices	41.8	41.1	22.6	44.2	44.9
Discard	24.9	24.4	26.3	26.3	25.7
Length frequencies	323.9	321.3	297.5	328.9	330.8
Age frequencies	1,831.9	1,832.1	1,703.8	1,832.0	1,832.8
Mean body weights	1.1	1.1	1.1	1.0	1.1
Recruitment	27.6	28.0	27.5	28.0	25.5
Priors	0.1	0.1	0.1	0.1	0.1
Penalties	0.0	0.0	0.0	0.0	0.0
Parameters					
Stock-Recruit function					
log Rzero	11.718	11.871	11.728	11.732	11.709
Steepness	0.834	0.760	0.776	0.831	0.877
Sigma R	0.360	0.360	0.360	0.360	0.360
Catchability, selectivity and retention					
log survey south catchability	-1.679	-1.706	-0.198	-1.633	-1.615
log survey north catchability	-0.541	-0.579	NA	-0.480	-0.480
Fishery peak selectivity	34.198	34.227	34.437	34.225	34.251
Fishery selectivity inflection	1.596	1.601	1.652	1.576	1.547
Fishery south retention inflection	30.528	30.548	30.516	30.557	30.572
Fishery north retention inflection	30.385	30.394	30.408	30.421	30.438
Survey south peak	39.762	39.724	28.510	39.584	39.780
Survey south inflection	-0.499	-0.492	1.450	-0.482	-0.512
Survey south slope	0.628	0.624	0.061	0.607	0.631
Survey north peak	28.930	27.362	NA	28.431	28.840
Survey north inflection	1.128	1.647	NA	1.428	1.166
Survey north slope	0.423	0.031	NA	0.221	0.395
Fishery peak offset 1981-1985	-0.097	-0.100	-0.093	-0.095	-0.095
Fishery peak offset 1986-1990	-0.073	-0.075	-0.068	-0.071	-0.070
Fishery peak offset 1991-1995	-0.060	-0.061	-0.066	-0.061	-0.062
Fishery peak offset 1996-2004	-0.066	-0.068	-0.072	-0.068	-0.070
Individual growth					
Female lmin	16.232	16.254	17.701	16.303	16.263
Female lmax	39.768	39.785	40.137	39.783	39.733
Female VBK	0.397	0.426	0.374	0.393	0.397
Female cv young	0.101	0.101	0.094	0.102	0.101
Male lmax offset	-0.510	-0.513	-0.484	-0.510	-0.511
Male VBK offset	0.198	0.209	0.213	0.213	0.183
Male cv young offset	0.655	0.650	0.584	0.639	0.660
VBK offset 1961-1970	-0.117	-0.191	-0.120	-0.116	-0.119
VBK offset 1971-1980	-0.353	-0.427	-0.369	-0.351	-0.355
VBK offset 1981-1990	-0.507	-0.582	-0.542	-0.509	-0.510
VBK offset 1991-2004	-0.534	-0.606	-0.487	-0.546	-0.546
Management quantities					
SBzero	34,312	42,268	35,763	34,661	33,923
Rzero	122,811	143,100	123,971	124,468	121,613
2005 spawning biomass	31,379	33,360	34,982	25,772	23,824
Current (2005) depletion	0.915	0.789	0.978	0.744	0.702
2004 Catch	1,341	1,342	1,346	1,328	1,345
2004 Landings	950	950	950	950	950
2004 SPR*	0.837	0.845	0.849	0.814	0.799
SBmsy*	5,696	8,134	7,120	5,783	4,876
SPRmsy*	0.238	0.310	0.280	0.242	0.201
MSY*	4,080	4,042	4,119	4,066	4,328
Bmsy/Bzero*	0.191	0.233	0.217	0.193	0.166

Table 43 continued. Summary results of sensitivity analyses.

Quantity	Base case	Sensitivity 5	Sensitivity 6
Convergence			
Log determinant Hessian	532.287	534.386	532.275
Maximum gradient component	0.010373	0.000801	0.000106
Likelihoods			
Objective function	2,257.0	2,257.4	2,257.3
Indices	41.8	41.8	41.9
Discard	24.9	25.1	25.0
Length frequencies	323.9	324.0	323.8
Age frequencies	1,831.9	1,831.8	1,831.9
Mean body weights	1.1	1.1	1.1
Recruitment	27.6	28.1	27.7
Priors	0.1	0.1	0.1
Penalties	0.0	0.0	0.0
Parameters			
Stock-Recruit function			
log Rzero	11.718	11.642	11.666
Steepness	0.834	0.995	0.933
Sigma R	0.360	0.360	0.360
Catchability, selectivity and retention			
log survey south catchability	-1.679	-1.680	-1.675
log survey north catchability	-0.541	-0.556	-0.538
Fishery peak selectivity	34.198	34.187	34.188
Fishery selectivity inflection	1.596	1.591	1.594
Fishery south retention inflection	30.528	30.537	30.530
Fishery north retention inflection	30.385	30.391	30.389
Survey south peak	39.762	39.753	39.765
Survey south inflection	-0.499	-0.500	-0.500
Survey south slope	0.628	0.626	0.628
Survey north peak	28.930	27.352	28.937
Survey north inflection	1.128	1.641	1.126
Survey north slope	0.423	0.033	0.424
Fishery peak offset 1981-1985	-0.097	-0.096	-0.096
Fishery peak offset 1986-1990	-0.073	-0.073	-0.073
Fishery peak offset 1991-1995	-0.060	-0.062	-0.061
Fishery peak offset 1996-2004	-0.066	-0.066	-0.066
Individual growth			
Female lmin	16.232	16.213	16.226
Female lmax	39.768	39.775	39.770
Female VBK	0.397	0.399	0.399
Female cv young	0.101	0.101	0.101
Male lmax offset	-0.510	-0.511	-0.511
Male VBK offset	0.198	0.200	0.198
Male cv young offset	0.655	0.655	0.656
VBK offset 1961-1970	-0.117	-0.124	-0.122
VBK offset 1971-1980	-0.353	-0.358	-0.356
VBK offset 1981-1990	-0.507	-0.513	-0.511
VBK offset 1991-2004	-0.534	-0.543	-0.540
Management quantities			
SBzero	34,312	31,973	40,357
Rzero	122,811	113,812	116,576
2005 spawning biomass	31,379	19,662	30,954
Current (2005) depletion	0.915	0.615	0.767
2004 Catch	1,341	1,338	1,340
2004 Landings	950	950	950
2004 SPR*	0.837	0.792	0.836
SBmsy*	5,696	952	4,103
SPRmsy*	0.238	0.051	0.168
MSY*	4,080	5,012	4,568
Bmsy/Bzero*	0.191	0.049	0.145

Table 44. Convergence testing for the base case model (using version 1.16), based on a jitter of 1% added to all model parameters from maximum likelihood estimates.

Test	Objective function	Maximum gradient	SB_{zero} (mt)	2005 depletion
1	2,234.01	0.000287	40,638.2	0.722198
2	2,234.03	0.006103	40,623.7	0.729685
3	2,234.01	0.001154	40,638.2	0.722198
4	2,234.01	0.002755	40,638.3	0.722197
5	Terminated during minimization			
6	2,234.03	0.000355	40,623.7	0.729685
7	Terminated during minimization			
8	2,234.03	0.009240	40,623.7	0.729685
9	Terminated during minimization			
10	2,234.03	0.004075	40,623.7	0.729685
11	2,234.01	0.003993	40,638.2	0.722198
12	2,234.03	0.000554	40,623.7	0.729685
13	2,234.01	0.001684	40,638.2	0.722198
14	2,234.03	0.000570	40,623.7	0.729685
15	2,234.03	0.004539	40,623.7	0.729685
16	2,234.01	0.000407	40,638.2	0.722198
17	Terminated during minimization			
18	2,234.03	0.001673	40,623.7	0.729685
19	2,234.03	0.000080	40,623.7	0.729685
20	2,234.03	0.000945	40,623.7	0.729685
21	2,234.03	0.017344	40,623.8	0.729684
22	2,234.01	0.000449	40,638.2	0.722198
23	2,234.01	0.034397	40,638.2	0.722198
24	2,234.01	0.000998	40,638.2	0.722198
25	2,234.01	0.014333	40,638.2	0.722197

Table 45. Time series of population estimates.

Year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits (1000s)	Total catch (mt)	Total landings (mt)
1876	63,642	34,312	1.00	122,817	1	1
1877	63,556	34,311	1.00	116,936	1	1
1878	63,482	34,311	1.00	116,936	1	1
1879	63,339	34,310	1.00	116,936	2	2
1880	63,069	34,299	1.00	116,934	2	2
1881	62,723	34,195	1.00	116,916	2	2
1882	62,361	33,996	0.99	116,882	3	3
1883	62,023	33,769	0.98	116,842	5	4
1884	61,726	33,554	0.98	116,804	5	4
1885	61,477	33,368	0.97	116,771	6	5
1886	61,271	33,213	0.97	116,742	7	6
1887	61,102	33,085	0.96	116,719	8	7
1888	60,965	32,981	0.96	116,699	10	9
1889	60,852	32,895	0.96	116,682	12	11
1890	60,759	32,824	0.96	116,668	15	13
1891	60,683	32,765	0.95	116,656	17	15
1892	60,619	32,716	0.95	116,645	20	18
1893	60,564	32,674	0.95	116,635	25	22
1894	60,515	32,636	0.95	116,626	31	27
1895	60,471	32,601	0.95	116,616	36	32
1896	60,430	32,569	0.95	116,606	43	38
1897	60,391	32,537	0.95	116,595	52	46
1898	60,350	32,504	0.95	116,582	63	55
1899	60,308	32,469	0.95	116,568	75	66
1900	60,262	32,430	0.95	116,552	90	79
1901	60,211	32,388	0.94	116,532	108	95
1902	60,153	32,338	0.94	116,508	130	114
1903	60,085	32,281	0.94	116,480	156	137
1904	60,006	32,214	0.94	116,446	188	165
1905	59,911	32,134	0.94	116,405	225	198
1906	59,800	32,039	0.93	116,355	270	237
1907	59,667	31,926	0.93	116,294	325	285
1908	59,508	31,791	0.93	116,221	390	342
1909	59,317	31,630	0.92	116,134	467	410
1910	59,089	31,436	0.92	116,031	561	492
1911	58,815	31,205	0.91	115,910	674	591
1912	58,487	30,926	0.90	115,769	809	709
1913	58,092	30,592	0.89	115,601	972	851
1914	57,618	30,191	0.88	115,394	1,168	1,021
1915	57,050	29,709	0.87	115,138	1,403	1,225
1916	56,366	29,131	0.85	114,831	2,815	2,454
1917	54,573	27,619	0.80	114,274	3,852	3,343
1918	52,162	25,569	0.75	113,513	3,123	2,692
1919	50,758	24,352	0.71	112,913	2,469	2,118
1920	50,154	23,835	0.69	112,485	1,710	1,464
1921	50,303	23,989	0.70	112,245	2,179	1,866
1922	50,022	23,828	0.69	111,869	3,151	2,698
1923	48,918	22,983	0.67	111,243	3,178	2,714
1924	47,921	22,195	0.65	110,593	4,101	3,491
1925	46,262	20,864	0.61	109,659	4,009	3,393
1926	44,904	19,776	0.58	108,707	3,857	3,247
1927	43,858	18,965	0.55	107,736	4,680	3,923
1928	42,234	17,721	0.52	106,476	4,134	3,442
1929	41,266	17,012	0.50	105,447	4,798	3,979
1930	39,827	15,962	0.47	104,061	3,721	3,066

Table 45. Continued. Time series of population estimates.

Year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits (1000s)	Total catch (mt)	Total landings (mt)
1931	39,449	15,763	0.459	103,058	1,920	1,581
1932	40,611	16,816	0.490	102,655	3,526	2,925
1933	40,179	16,684	0.486	101,298	3,331	2,766
1934	39,851	16,598	0.484	99,625	2,830	2,352
1935	39,896	16,795	0.489	97,888	3,208	2,672
1936	39,510	16,676	0.486	96,144	3,383	2,819
1937	38,907	16,394	0.478	95,055	3,140	2,616
1938	38,504	16,245	0.473	96,586	2,566	2,146
1939	38,661	16,443	0.479	104,953	3,014	2,527
1940	38,629	16,251	0.474	123,488	3,068	2,574
1941	38,937	15,971	0.465	142,966	2,224	1,862
1942	40,107	16,303	0.475	123,249	2,107	1,763
1943	42,115	16,884	0.492	122,935	3,705	3,079
1944	43,047	16,808	0.490	116,249	2,167	1,779
1945	44,631	18,420	0.537	74,012	1,909	1,582
1946	45,829	20,240	0.590	59,244	5,074	4,261
1947	43,292	19,491	0.568	59,925	3,366	2,832
1948	41,396	19,572	0.570	84,550	6,096	5,216
1949	36,372	16,848	0.491	98,802	3,576	3,070
1950	33,833	15,115	0.441	101,577	5,740	4,918
1951	30,214	11,625	0.339	91,007	4,236	3,505
1952	29,185	9,981	0.291	87,318	3,826	3,061
1953	29,179	9,597	0.280	86,853	2,877	2,271
1954	30,111	10,400	0.303	92,201	2,591	2,071
1955	31,582	11,380	0.332	130,392	2,804	2,276
1956	33,322	11,942	0.348	180,301	3,751	3,068
1957	33,447	11,650	0.340	103,637	4,412	3,580
1958	34,496	11,004	0.321	92,978	5,541	4,357
1959	35,760	10,519	0.307	117,333	5,467	4,158
1960	35,808	11,535	0.336	91,851	4,366	3,423
1961	39,254	12,893	0.376	314,404	4,200	3,383
1962	38,150	15,044	0.438	122,408	4,502	3,621
1963	38,985	14,056	0.410	85,337	4,578	3,597
1964	42,137	13,198	0.385	104,172	4,899	3,538
1965	43,788	15,234	0.444	115,914	5,190	3,883
1966	43,389	17,680	0.515	125,899	5,677	4,538
1967	40,943	17,225	0.502	82,739	5,319	4,326
1968	39,700	15,850	0.462	139,379	5,639	4,539
1969	38,389	14,390	0.419	160,647	3,872	3,061
1970	39,283	14,557	0.424	193,156	3,133	2,495
1971	40,707	14,915	0.435	126,386	2,897	2,292
1972	40,789	17,840	0.520	122,532	3,395	2,643
1973	41,527	17,737	0.517	119,964	3,896	2,970
1974	42,191	17,717	0.516	146,587	3,959	2,946
1975	42,448	17,520	0.511	145,983	4,645	3,494
1976	41,308	16,902	0.493	96,417	5,851	4,466
1977	38,946	15,320	0.446	69,184	3,805	2,867
1978	38,562	15,523	0.452	99,217	4,614	3,463
1979	36,390	15,322	0.447	78,607	4,796	3,631
1980	33,678	14,405	0.420	79,334	4,167	3,213
1981	31,367	13,142	0.383	75,487	3,894	2,711
1982	28,422	13,164	0.384	85,169	4,048	2,793
1983	26,103	11,129	0.324	104,545	3,486	2,355
1984	25,398	9,581	0.279	148,346	2,645	1,721
1985	25,269	8,916	0.260	100,736	3,061	1,930

Table 45. Continued. Time series of population estimates.

Year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits (1000s)	Total catch (mt)	Total landings (mt)
1986	24,872	8,455	0.246	54,924	3,238	2,037
1987	24,948	8,473	0.247	75,151	4,136	2,471
1988	23,971	8,546	0.249	82,059	3,617	2,101
1989	22,965	8,700	0.254	77,529	3,947	2,412
1990	22,148	7,831	0.228	118,996	3,027	1,912
1991	21,792	7,337	0.214	94,162	3,404	2,185
1992	20,941	7,568	0.221	64,558	2,630	1,622
1993	20,894	7,771	0.226	52,134	2,675	1,601
1994	21,785	8,306	0.242	129,296	1,908	1,122
1995	24,146	9,149	0.267	210,815	1,817	1,125
1996	26,705	9,469	0.276	202,183	1,775	1,152
1997	29,448	9,856	0.287	137,126	2,327	1,504
1998	33,343	11,153	0.325	177,488	1,910	1,139
1999	39,740	14,198	0.414	317,501	1,582	912
2000	43,741	17,589	0.513	152,242	1,233	750
2001	48,245	20,661	0.602	120,796	1,533	990
2002	52,681	24,138	0.703	165,799	1,775	1,168
2003	54,755	27,873	0.812	120,123	1,306	877
2004	55,990	30,334	0.884	113,420	1,341	950
2005	56,134	31,379	0.915	114,578	NA	NA

Table 46. Asymptotic standard deviation estimates for spawning biomass and recruitment.

Year	SD Spawning biomass (mt)	SD Age-0 recruits (1000s)	Year	SD Spawning biomass (mt)	SD Age-0 recruits (1000s)	Year	SD Spawning biomass (mt)	SD Age-0 recruits (1000s)
1876	3,639	13,026	1926	4,487	39,281	1976	2,658	13,139
1877	3,639	44,049	1927	4,435	38,791	1977	2,619	10,956
1878	3,639	44,048	1928	4,383	38,188	1978	2,630	13,508
1879	3,639	44,048	1929	4,333	37,677	1979	2,636	13,514
1880	3,641	44,047	1930	4,277	37,021	1980	2,547	13,877
1881	3,723	44,035	1931	4,224	36,473	1981	2,404	13,967
1882	3,997	44,013	1932	4,172	36,102	1982	2,357	16,305
1883	4,318	43,988	1933	4,103	35,348	1983	2,198	18,548
1884	4,580	43,963	1934	4,036	34,430	1984	2,058	19,898
1885	4,763	43,942	1935	3,966	33,456	1985	1,969	14,825
1886	4,883	43,924	1936	3,889	32,474	1986	1,956	10,110
1887	4,957	43,908	1937	3,811	31,758	1987	2,034	12,360
1888	5,002	43,895	1938	3,725	32,144	1988	2,214	14,053
1889	5,027	43,884	1939	3,629	35,266	1989	2,354	13,351
1890	5,040	43,874	1940	3,518	42,452	1990	2,417	18,115
1891	5,045	43,865	1941	3,399	47,965	1991	2,458	16,062
1892	5,046	43,857	1942	3,279	40,774	1992	2,576	12,189
1893	5,045	43,850	1943	3,174	38,556	1993	2,428	12,244
1894	5,042	43,843	1944	3,116	34,065	1994	2,339	29,101
1895	5,038	43,835	1945	3,132	21,349	1995	2,343	46,752
1896	5,034	43,827	1946	3,181	16,527	1996	2,341	54,596
1897	5,030	43,819	1947	3,202	17,565	1997	2,323	45,960
1898	5,026	43,809	1948	3,190	26,744	1998	2,409	52,745
1899	5,022	43,798	1949	3,105	32,893	1999	2,632	79,311
1900	5,018	43,785	1950	2,950	32,083	2000	2,889	55,154
1901	5,015	43,770	1951	2,778	28,986	2001	3,093	39,090
1902	5,011	43,752	1952	2,667	27,364	2002	3,351	55,107
1903	5,008	43,731	1953	2,622	26,890	2003	3,721	45,111
1904	5,004	43,705	1954	2,620	28,865	2004	3,945	42,013
1905	5,000	43,675	1955	2,572	42,591	2005	4,030	42,749
1906	4,996	43,638	1956	2,447	43,802			
1907	4,991	43,594	1957	2,281	28,599			
1908	4,986	43,542	1958	2,123	24,038			
1909	4,980	43,480	1959	2,028	23,778			
1910	4,973	43,408	1960	1,898	22,212			
1911	4,964	43,325	1961	1,742	27,041			
1912	4,955	43,229	1962	1,706	19,569			
1913	4,943	43,117	1963	1,859	13,850			
1914	4,930	42,982	1964	2,223	13,299			
1915	4,914	42,818	1965	3,218	14,412			
1916	4,896	42,627	1966	3,332	15,295			
1917	4,875	42,298	1967	3,066	14,779			
1918	4,848	41,871	1968	2,884	18,713			
1919	4,815	41,538	1969	2,800	23,756			
1920	4,782	41,295	1970	2,761	27,646			
1921	4,748	41,146	1971	2,657	23,113			
1922	4,707	40,927	1972	2,776	19,307			
1923	4,656	40,587	1973	2,720	17,537			
1924	4,600	40,237	1974	2,713	18,395			
1925	4,542	39,760	1975	2,675	17,361			

Table 47. Preliminary sensitivity runs using version SS2 version 1.6.

Quantity	Base case model	Sensitivity a	b	c	d	e
Convergence						
Log determinant Hessian	388.341	388.286	388.53	384.791	391.228	387.402
Maximum gradient component	0.000071	0.004034	0.008626	0.027526	0.000351	0.003242
Likelihoods						
Objective function	2,234.0	2,234.0	2,233.9	2,211.4	2,265.1	2,208.0
Indices	44.4	44.4	44.3	43.9	44.6	41.1
Discard	26.9	26.9	26.8	26.9	27.9	26.7
Length frequencies	321.8	321.8	322.0	315.3	332.1	304.1
Age frequencies	1,825.4	1,825.5	1,825.3	1,809.9	1,845.1	1,821.2
Mean body weights	1.0	1.0	1.0	1.0	1.1	1.0
Recruitment	14.4	14.4	14.5	14.5	14.2	13.8
Priors	0.1	0.1	0.1	0.1	0.1	0.1
Penalties	0.0	0.0	0.0	0.0	0.0	0.0
Parameters						
Stock-Recruit function						
log Rzero	11.867	11.861	11.888	12.268	11.477	11.731
Steepness	0.729	0.735	0.707	0.620	0.848	0.855
Sigma R	0.510	0.510	0.510	0.510	0.510	0.510
Catchability, selectivity and retention						
log survey south catchability	-1.676	-1.676	-1.680	-1.792	-1.580	-1.677
log survey north catchability	-0.504	-0.503	-0.507	-0.611	-0.417	-0.578
Fishery peak selectivity	34.150	34.148	34.155	34.302	34.039	34.159
Fishery selectivity inflection	1.616	1.616	1.617	1.693	1.504	1.595
Fishery south retention inflection	30.555	30.554	30.558	30.534	30.564	30.596
Fishery north retention inflection	30.375	30.376	30.375	30.335	30.421	30.404
Survey south peak	39.297	39.298	39.289	38.768	39.498	32.006
Survey south inflection	-0.449	-0.449	-0.448	-0.377	-0.494	0.224
Survey south slope	0.590	0.590	0.589	0.584	0.594	0.558
Survey north peak	28.415	28.415	28.415	28.502	28.334	28.371
Survey north inflection	1.558	1.558	1.559	1.598	1.509	1.513
Survey north slope	0.036	0.036	0.035	0.028	0.081	0.061
Fishery peak offset 1981-1985	-0.090	-0.090	-0.090	-0.095	-0.084	-0.090
Fishery peak offset 1986-1990	-0.071	-0.071	-0.071	-0.077	-0.064	-0.069
Fishery peak offset 1991-1995	-0.052	-0.052	-0.052	-0.053	-0.054	-0.055
Fishery peak offset 1996-2004	-0.065	-0.065	-0.065	-0.070	-0.060	-0.068
Individual growth						
Female lmin	16.427	16.426	16.432	16.607	16.238	16.459
Female lmax	39.782	39.780	39.786	39.899	39.665	39.896
Female VBK	0.404	0.404	0.402	0.383	0.428	0.404
Female cv young	0.102	0.102	0.102	0.103	0.101	0.102
Male lmax offset	-0.507	-0.507	-0.507	-0.480	-0.532	-0.503
Male VBK offset	0.237	0.237	0.238	0.146	0.326	0.253
Male cv young offset	0.613	0.613	0.612	0.569	0.656	0.594
VBK offset 1961-1970	-0.151	-0.152	-0.148	-0.127	-0.183	-0.163
VBK offset 1971-1980	-0.386	-0.386	-0.383	-0.363	-0.417	-0.398
VBK offset 1981-1990	-0.540	-0.540	-0.537	-0.518	-0.568	-0.551
VBK offset 1991-2004	-0.582	-0.583	-0.579	-0.553	-0.618	-0.586
Management quantities						
SBzero	40,638	40,433	41,412	42,076	40,683	35,927
Rzero	142,472	141,690	145,481	212,798	96,471	124,331
2005 spawning biomass	29,349	29,290	29,566	31,724	27,832	28,735
Current (2005) depletion	0.722	0.724	0.714	0.754	0.684	0.800
2004 Catch	1,298	1,298	1,298	1,302	1,300	1,295
2004 Landings	950	950	950	950	950	950
2004 SPR*	0.838	0.838	0.839	0.869	0.802	0.837
SBmsy*	8,418	8,277	8,943	10,399	6,529	5,429
SPRmsy*	0.333	0.328	0.351	0.419	0.238	0.223
Exploitation rate at msy*	0.133	0.136	0.124	0.103	0.180	0.209
MSY*	3,807	3,830	3,723	3,869	3,830	4,269
Bmsy/Bzero*	0.245	0.242	0.255	0.286	0.193	0.180

Table 47 Continued. Preliminary sensitivity runs using version SS2 version 1.6.

Quantity	Base case model	Sensitivity f	Sensitivity g	Sensitivity h	Sensitivity i
Convergence					
Log determinant Hessian	388.341	385.255	357.563	382.939	355.809
Maximum gradient component	0.000071	0.017344	0.000022	0.001193	0.006873
Likelihoods					
Objective function	2,234.0	2,145.8	2,359.2	2,444.9	2,244.9
Indices	44.4	13.1	39.6	41.5	44.6
Discard	26.9	27.2	21.6	151.0	24.0
Length frequencies	321.8	319.7	374.3	381.2	338.2
Age frequencies	1,825.4	1,771.4	1,907.7	1,849.5	1,822.9
Mean body weights	1.0	1.0	1.0	2.5	1.1
Recruitment	14.4	13.3	14.9	19.1	14.1
Priors	0.1	0.1	0.1	0.1	0.1
Penalties	0.0	0.0	0.0	0.0	0.0
Parameters					
Stock-Recruit function					
log Rzero	11.867	11.714	12.135	11.655	11.840
Steepness	0.729	0.868	0.580	0.733	0.796
Sigma R	0.510	0.510	0.510	0.510	0.510
Catchability, selectivity and retention					
log survey south catchability	-1.676	-1.545	-1.924	-1.524	-1.649
log survey north catchability	-0.504	-0.376	-0.799	-0.391	-0.475
Fishery peak selectivity	34.150	34.165	35.736	35.025	32.701
Fishery selectivity inflection	1.616	1.604	1.582	1.964	1.561
Fishery south retention inflection	30.555	30.519	30.682	27.077	30.701
Fishery north retention inflection	30.375	30.397	30.394	27.077	30.464
Survey south peak	39.297	39.266	40.038	39.779	39.265
Survey south inflection	-0.449	-0.440	-0.629	-0.533	-0.437
Survey south slope	0.590	0.584	0.663	0.629	0.589
Survey north peak	28.415	28.580	27.224	27.468	28.436
Survey north inflection	1.558	1.566	1.540	1.604	1.569
Survey north slope	0.036	0.027	0.037	0.021	0.036
Fishery peak offset 1981-1985	-0.090	-0.098	-0.152	-0.084	0.000
Fishery peak offset 1986-1990	-0.071	-0.069	-0.134	-0.090	0.000
Fishery peak offset 1991-1995	-0.052	-0.057	-0.113	-0.027	0.000
Fishery peak offset 1996-2004	-0.065	-0.063	-0.138	-0.130	0.000
Individual growth					
Female lmin	16.427	16.718	16.207	16.143	16.441
Female lmax	39.782	39.899	38.876	39.632	39.777
Female VBK	0.404	0.409	0.281	0.419	0.427
Female cv young	0.102	0.098	0.112	0.100	0.102
Male lmax offset	-0.507	-0.506	-0.501	-0.534	-0.505
Male VBK offset	0.237	0.208	0.315	0.237	0.189
Male cv young offset	0.613	0.638	0.547	0.712	0.621
VBK offset 1961-1970	-0.151	-0.163	0.000	-0.132	-0.196
VBK offset 1971-1980	-0.386	-0.400	0.000	-0.359	-0.441
VBK offset 1981-1990	-0.540	-0.555	0.000	-0.522	-0.603
VBK offset 1991-2004	-0.582	-0.569	0.000	-0.569	-0.644
Management quantities					
SBzero	40,638	35,842	48,606	32,979	41,198
Rzero	142,472	122,259	186,186	115,289	138,621
2005 spawning biomass	29,349	23,855	38,252	26,613	28,777
Current (2005) depletion	0.722	0.666	0.787	0.807	0.699
2004 Catch	1,298	1,314	1,298	1,043	1,298
2004 Landings	950	950	950	950	950
2004 SPR*	0.838	0.802	0.874	0.854	0.835
SBmsy*	8,418	5,252	14,724	6,703	7,211
SPRmsy*	0.333	0.210	0.429	0.325	0.282
Exploitation rate at msy*	0.133	0.222	0.103	0.136	0.163
MSY*	3,807	4,402	4,551	3,116	4,132
Bmsy/Bzero*	0.245	0.172	0.303	0.239	0.217

Table 48. Comparison of likelihood components from base case model and aggregated survey sensitivity run (2). Bold values indicate directly comparable quantities.

Likelihood component		Base case model	Aggregated survey
Total negative log likelihood		2,256.95	2,220.38
Total indices		41.82	24.90
	South survey	19.45	NA
	North survey	22.36	24.90
Total discard		**24.88**	**41.43**
	South fishery	**7.09**	**6.95**
	North fishery	**17.80**	**34.48**
Total length comps		323.93	295.12
	South fishery	**58.13**	**58.06**
	North fishery	**167.16**	**169.48**
	South survey	48.92	NA
	North survey	49.73	67.58
Total age comps		1,831.92	1,826.55
	South fishery	**364.25**	**365.21**
	North fishery	**1,372.77**	**1,366.24**
	South survey	NA	NA
	North survey	**94.91**	**95.10**
Mean body weight		**1.14**	**1.16**
Recruitment variability		**27.65**	**25.57**
Parameter priors		**0.06**	**0.06**
Forecast (and recent) recruitment variability		**5.54**	**5.61**

Table 49. Projection of potential English sole catch, spawning biomass and depletion for the base case model.

Year	Total catch (mt)	95% interval	Total landings (mt)	Spawning biomass (mt)	95% interval	Depletion	95% interval
2005	10,215	7,656-12,774	7,545	31,379	23,480-39,278	0.915	0.645-1.184
2006	8,249	6,264-10,234	6,002	24,908	18,843-30,973	0.726	0.518-0.934
2007	6,773	5,142-8,404	4,813	20,080	15,126-25,034	0.585	0.419-0.752
2008	5,701	4,280-7,122	3,938	16,645	12,341-20,949	0.485	0.345-0.625
2009	4,972	3,671-6,272	3,318	14,418	10,453-18,383	0.420	0.294-0.546
2010	4,451	2,917-5,985	2,874	13,121	9,294-16,948	0.382	0.262-0.503
2011	4,122	2,707-5,538	2,607	12,434	8,854-16,014	0.362	0.248-0.476
2012	3,945	2,599-5,291	2,473	12,076	8,669-15,483	0.352	0.240-0.464
2013	3,836	2,539-5,132	2,397	11,861	8,600-15,122	0.346	0.234-0.457
2014	3,759	2,498-5,019	2,347	11,714	8,571-14,857	0.341	0.229-0.454
2015	3,701	2,464-4,939	2,311	11,607	8,550-14,664	0.338	0.225-0.451
2016	3,659	2,433-4,885	2,284	11,530	8,529-14,531	0.336	0.222-0.450

Table 50. Decision table as requested by the STAR panel.

			State of nature		
			Base case	Low recruitment after 1998	Low recruitment after 1997
Subjective relative probability			Most likely	Unlikely	Least likely
Approximate probability that spawning biomass < spawning biomass for the assumed state of nature			0.5	0.08	0.03
Management decision	**Quantity**	**Year**			
3-year average landings South = 87 mt, North = 911 mt	Depletion	2005	0.91	0.74	0.70
		2006	0.92	0.74	0.71
		2007	0.91	0.74	0.70
		2008	0.89	0.72	0.69
		2009	0.86	0.71	0.69
		2010	0.83	0.70	0.68
		2016	0.73	0.68	0.68
	Spawning biomass (1000s mt)	2005	31	26	24
		2006	32	26	24
		2007	31	25	24
		2008	30	25	24
		2009	29	25	23
		2010	28	24	23
		2016	25	24	23
200% of 3-year average landings South = 174 mt, North = 1,822 mt	Depletion	2005	0.91	0.74	0.70
		2006	0.89	0.71	0.67
		2007	0.86	0.68	0.64
		2008	0.81	0.64	0.61
		2009	0.76	0.61	0.58
		2010	0.72	0.59	0.56
		2016	0.57	0.51	0.49
	Spawning biomass (1000s mt)	2005	31	26	24
		2006	31	25	23
		2007	29	24	22
		2008	28	22	21
		2009	26	21	20
		2010	25	20	19
		2016	19	18	17
ABC landings estimated from base case	Depletion	2005	0.91	0.74	0.70
		2006	0.73	0.55	0.50
		2007	0.59	0.41	0.37
		2008	0.49	0.32	0.28
		2009	0.42	0.27	0.22
		2010	0.38	0.24	0.19
		2016	0.34	0.18	0.10
	Spawning biomass (1000s mt)	2005	31	26	24
		2006	25	19	17
		2007	20	14	12
		2008	17	11	9
		2009	14	9	7
		2010	13	8	6
		2016	12	6	3
	Landed catch (mt)	2005	7,545		
		2006	6,002		
		2007	4,813		
		2008	3,938		
		2009	3,318		
		2010	2,874		
		2016	2,284		

Table 51. Supplementary management table; projection of the English sole relative depletion and spawning biomass under a constant catch of ~3,100 mt using the base case model.

Year	Total catch (mt)	Relative depletion	Spawning biomass (mt)
2005	3,083	0.91	31,379
2006	3,028	0.89	30,387
2007	2,994	0.84	28,807
2008	2,981	0.78	26,918
2009	2,995	0.73	25,077
2010	3,030	0.68	23,476
2011	3,072	0.64	22,117
2012	3,111	0.61	20,961
2013	3,147	0.58	19,975
2014	3,179	0.56	19,127
2015	3,209	0.54	18,393
2016	3,237	0.52	17,751

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11. Figures

Figure 1. INPFC and data areas used in this assessment.

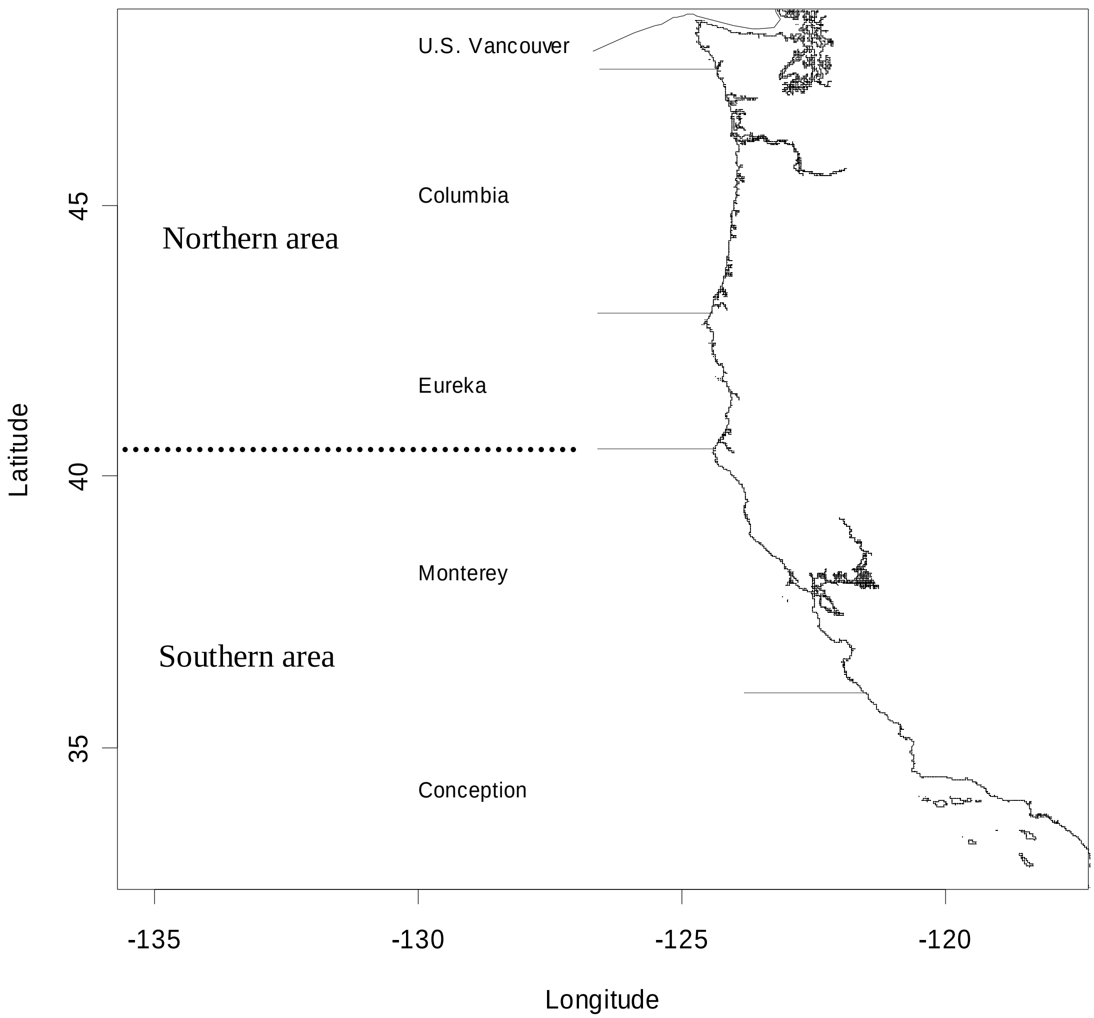


Figure 2. Reconstructed historical landings by year and area used in the base case run, 1876-2004.

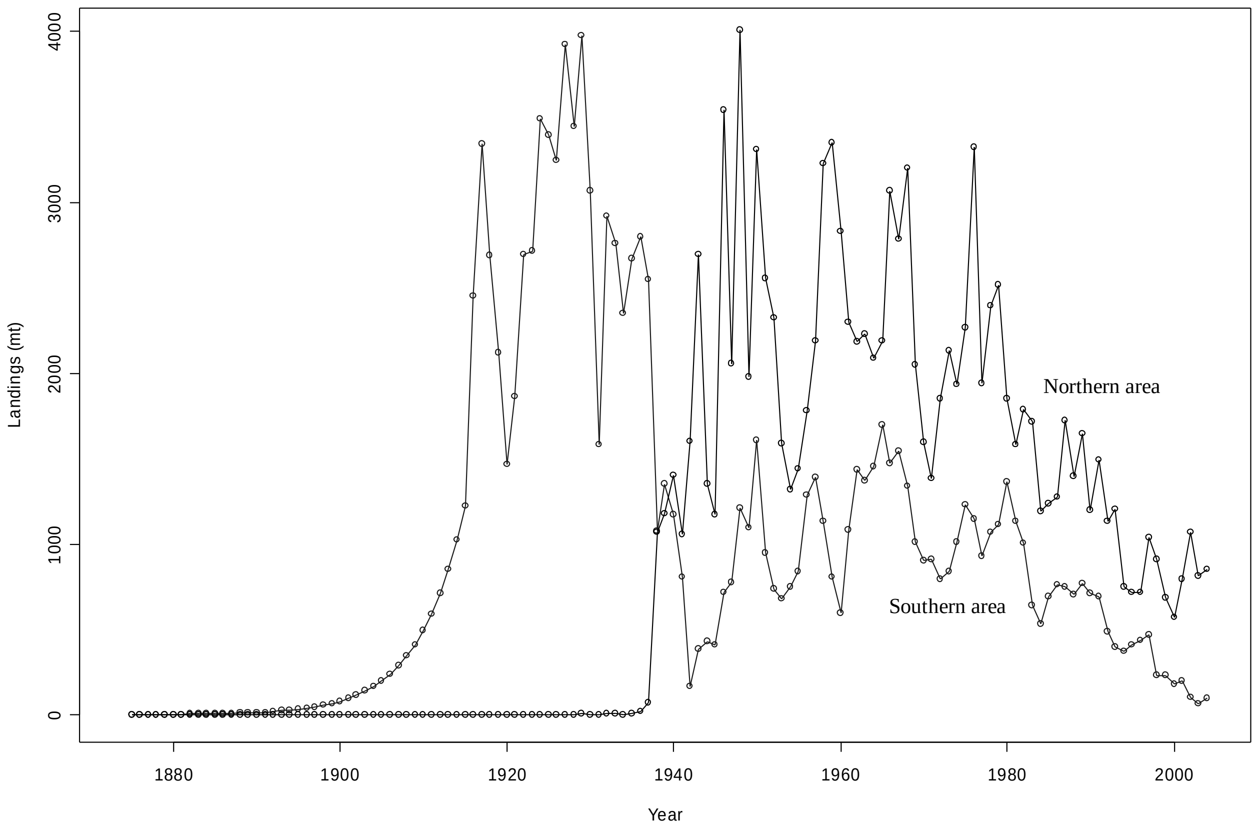


Figure 3. Average ex-vessel price per pound for English sole from PacFIN; raw (open circles) and Consumer Price Index adjusted to the average of 1982-1984 (filled circles).

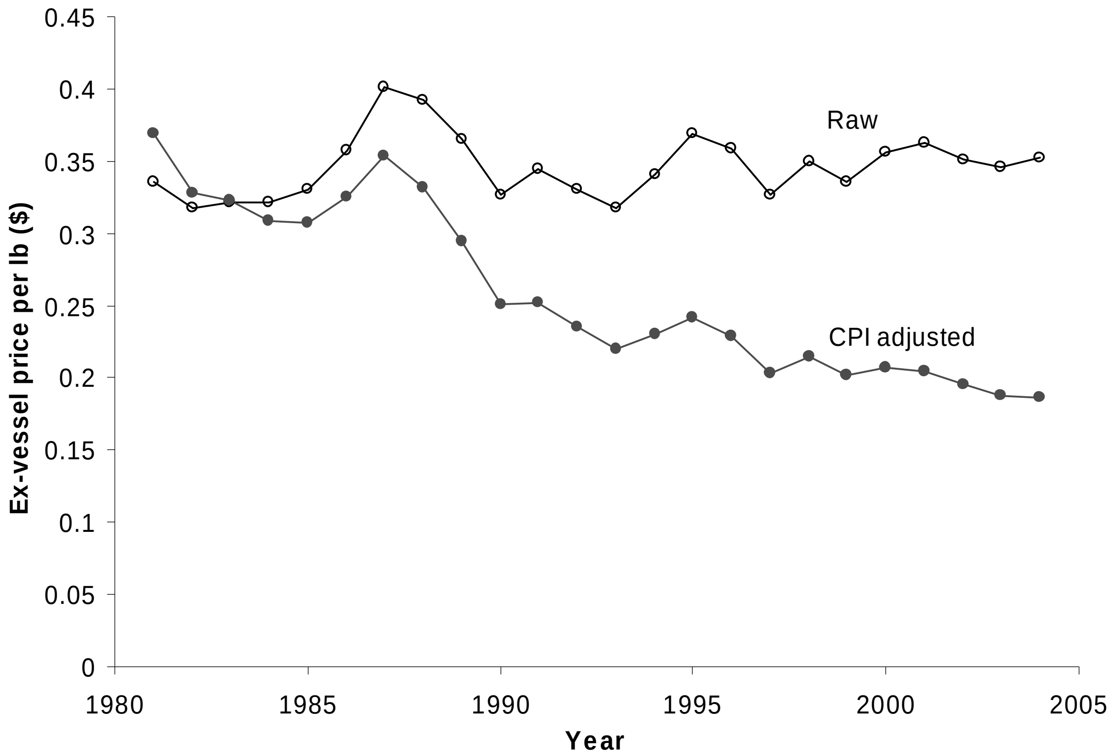


Figure 4. English sole logbook landings from 1987-2003 summarized by depth and latitude for the commercial bottom trawl fishery. Horizontal lines indicate INPFC boundaries. Catches plotted at 140 fathoms include all greater depths.

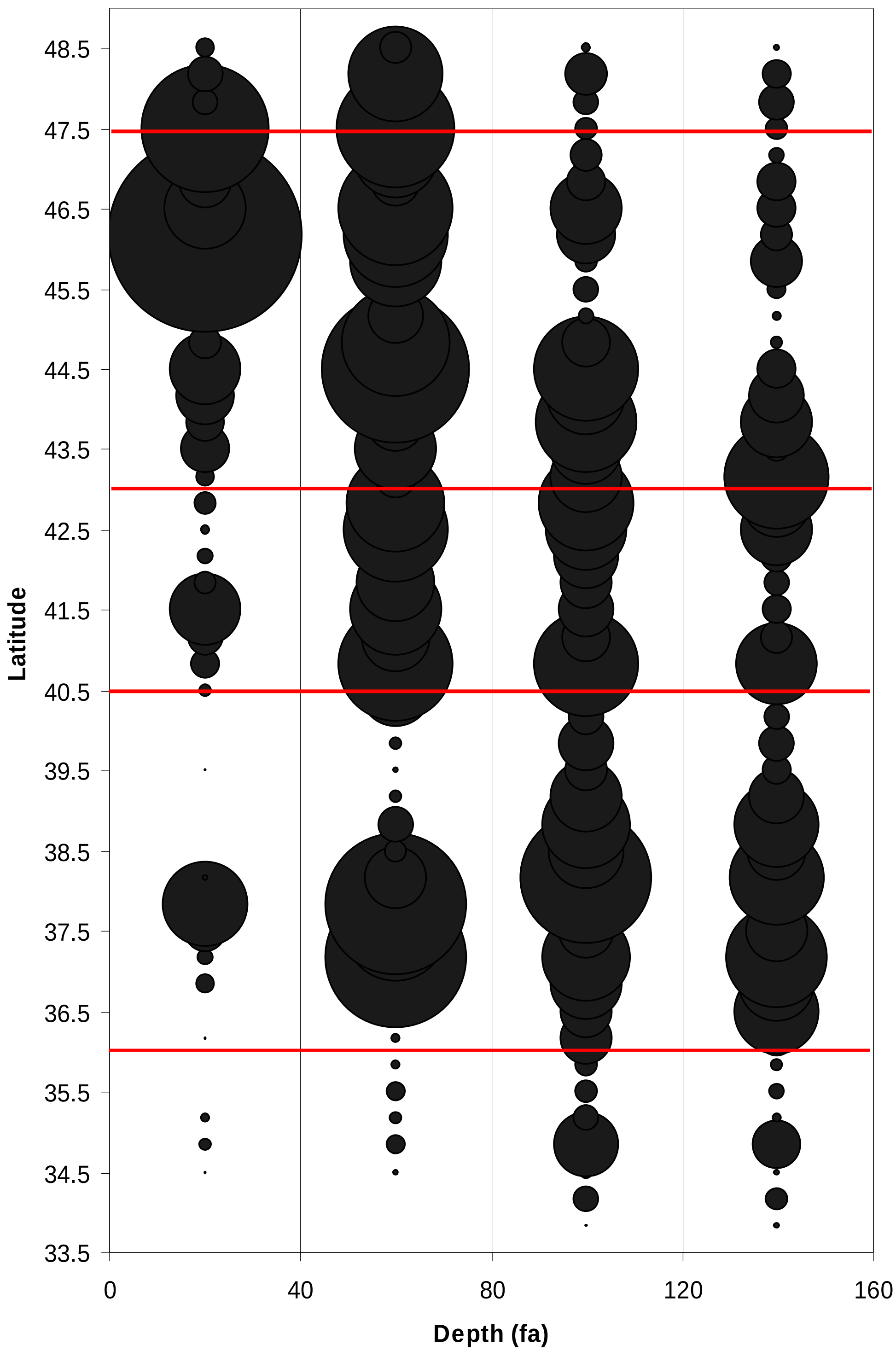


Figure 5: Change in body size with increasing depth fit with a piecewise regression. Vertical lines indicate revised strata boundaries.

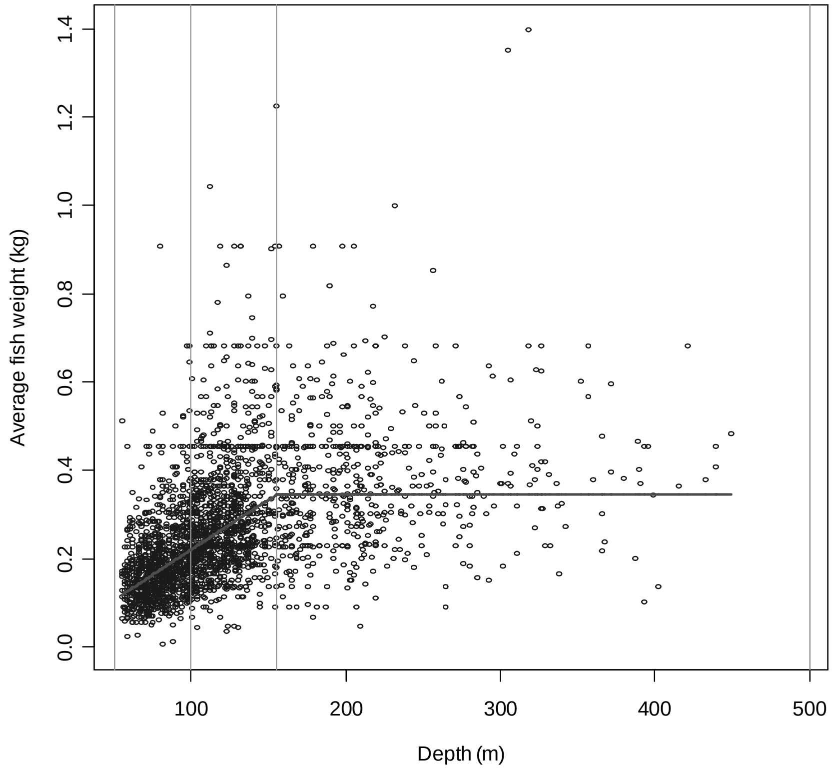


Figure 6: Standardized Triennial survey CPUE increment per 50 tows (all years combined) by latitude. Vertical lines indicate INPFC area boundaries.

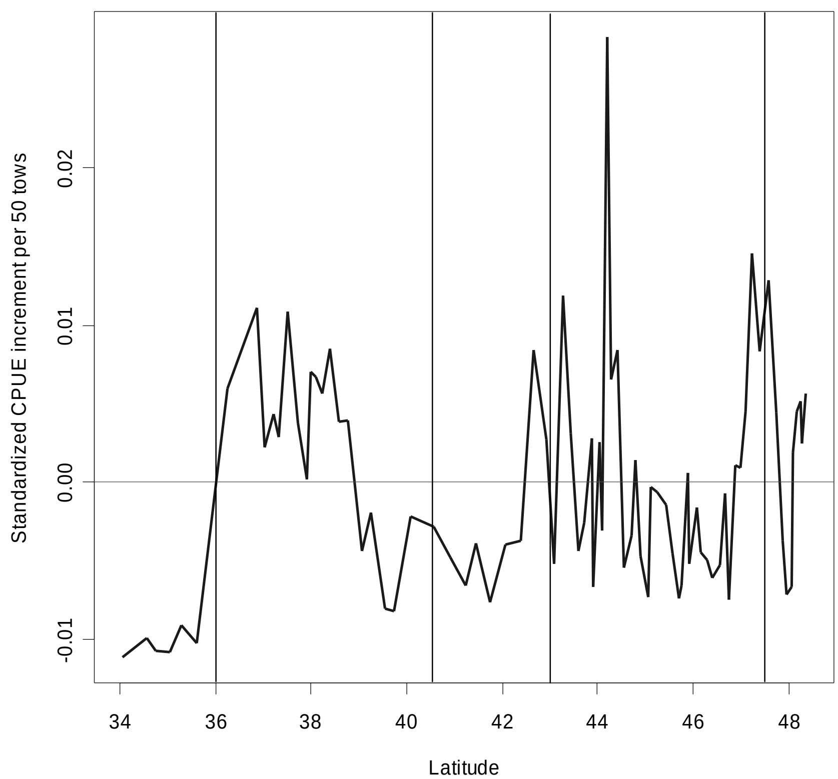


Figure 7: Biomass estimates and 95% sampling error interval from the triennial survey.

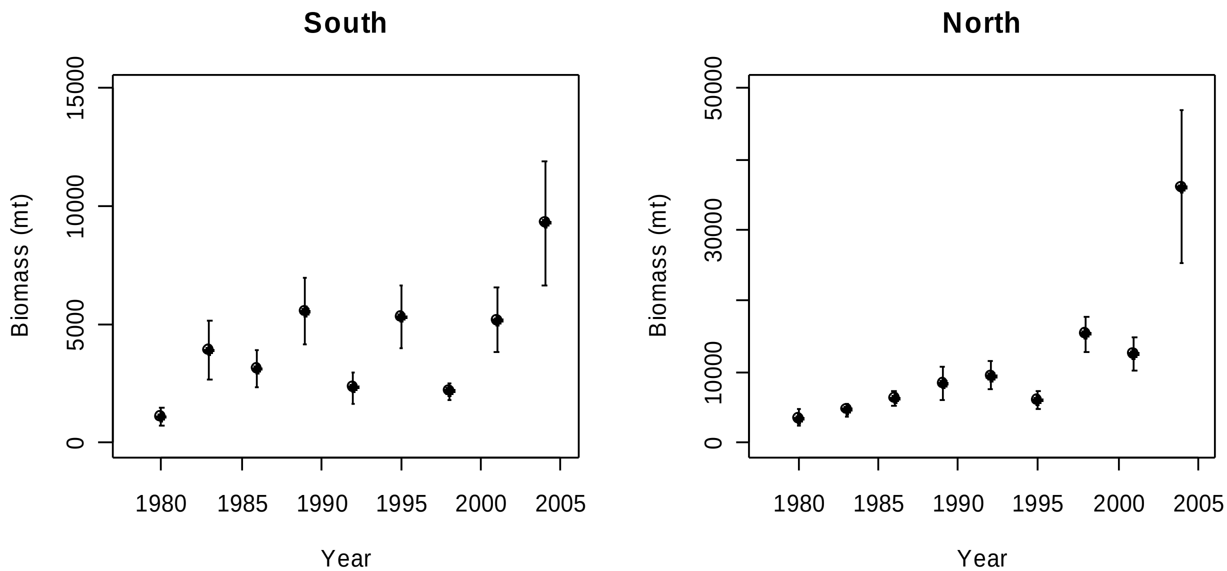
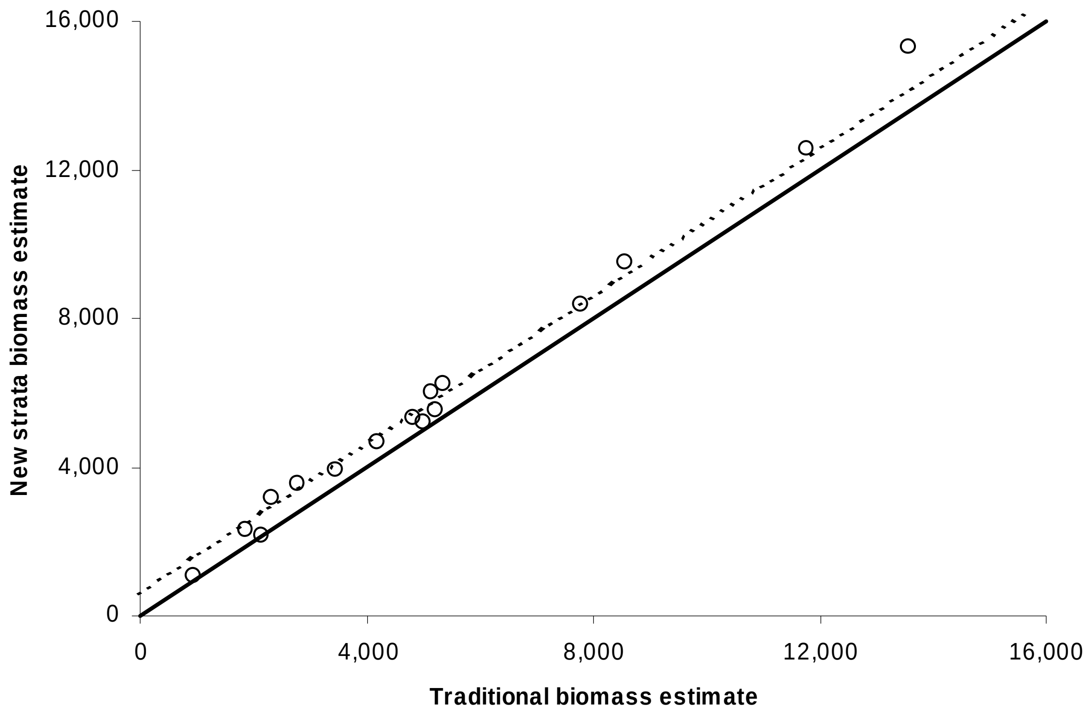


Figure 8: Comparison of traditional and post-stratified estimates of area and year specific biomass and coefficient of variation of biomass from triennial survey data. One-to-one lines plotted (dark); note that the difference from the 1:1 line in the upper panel is due to exclusion of the biomass in the deepest strata from the traditional estimates.



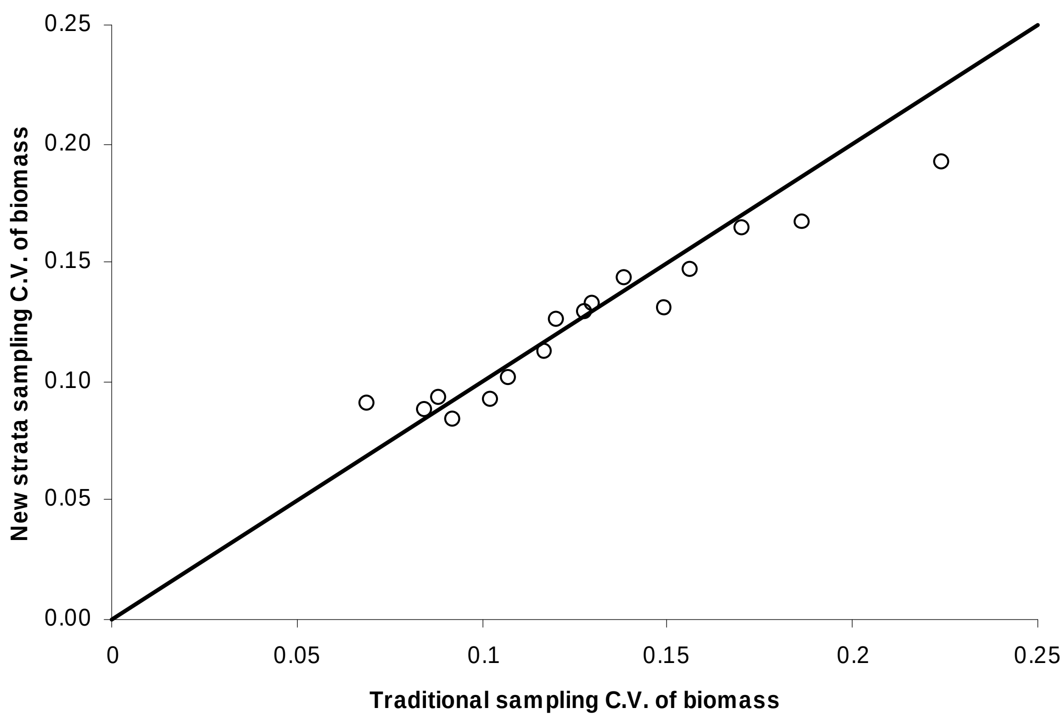


Figure 9. Length frequency distributions for female English sole from the Triennial survey in the south.

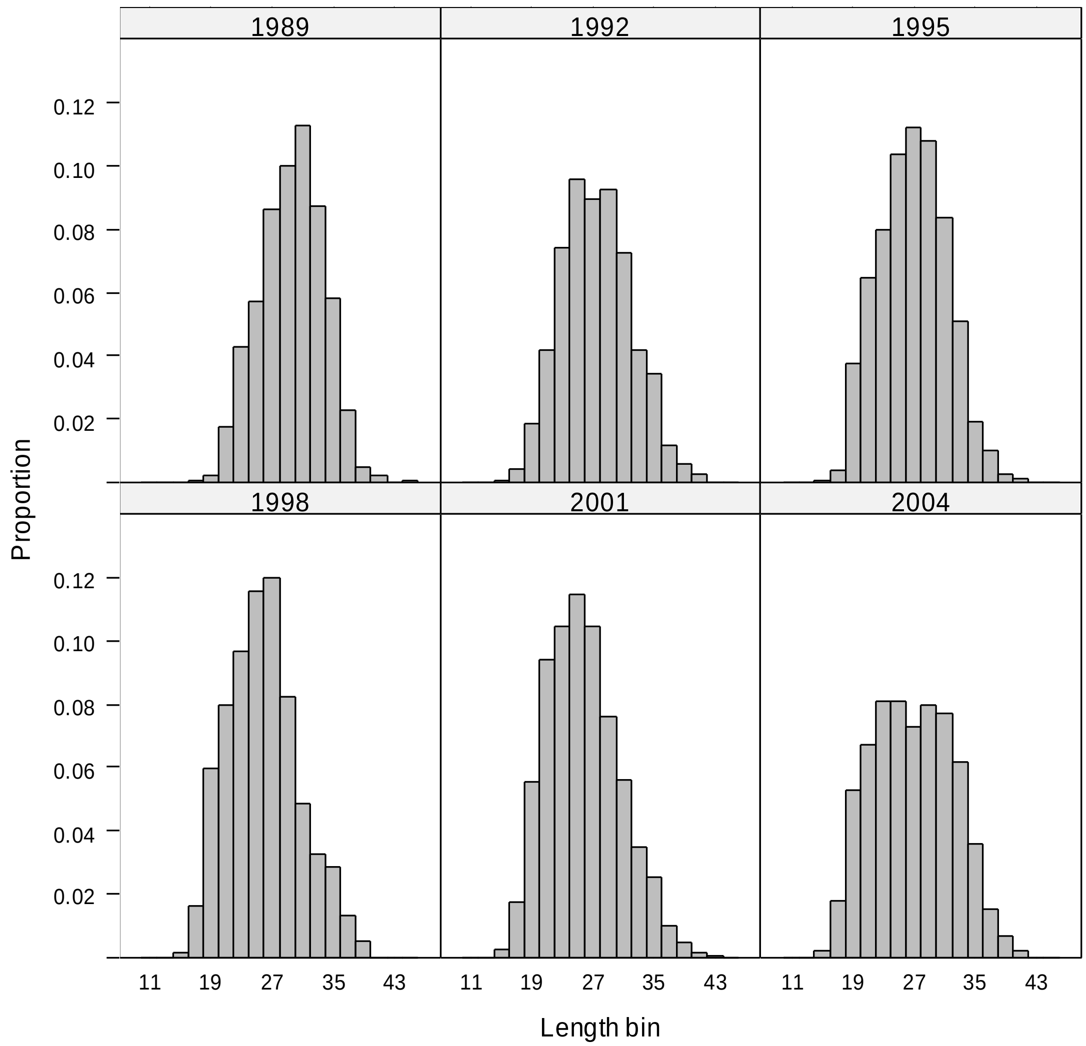


Figure 10. Length frequency distributions for male English sole from the Triennial survey in the south.

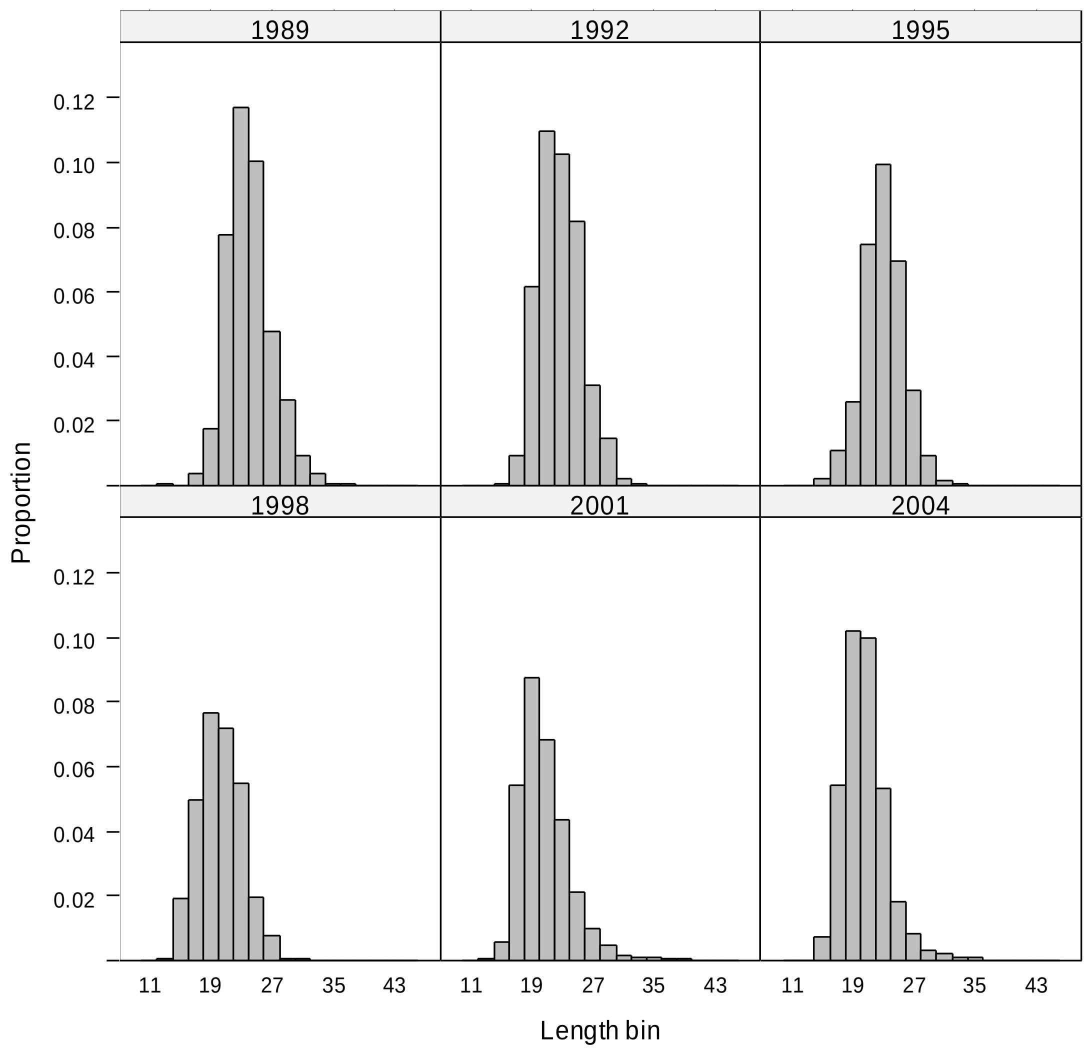


Figure 11. Length frequency distributions for female English sole from the Triennial survey in the north.

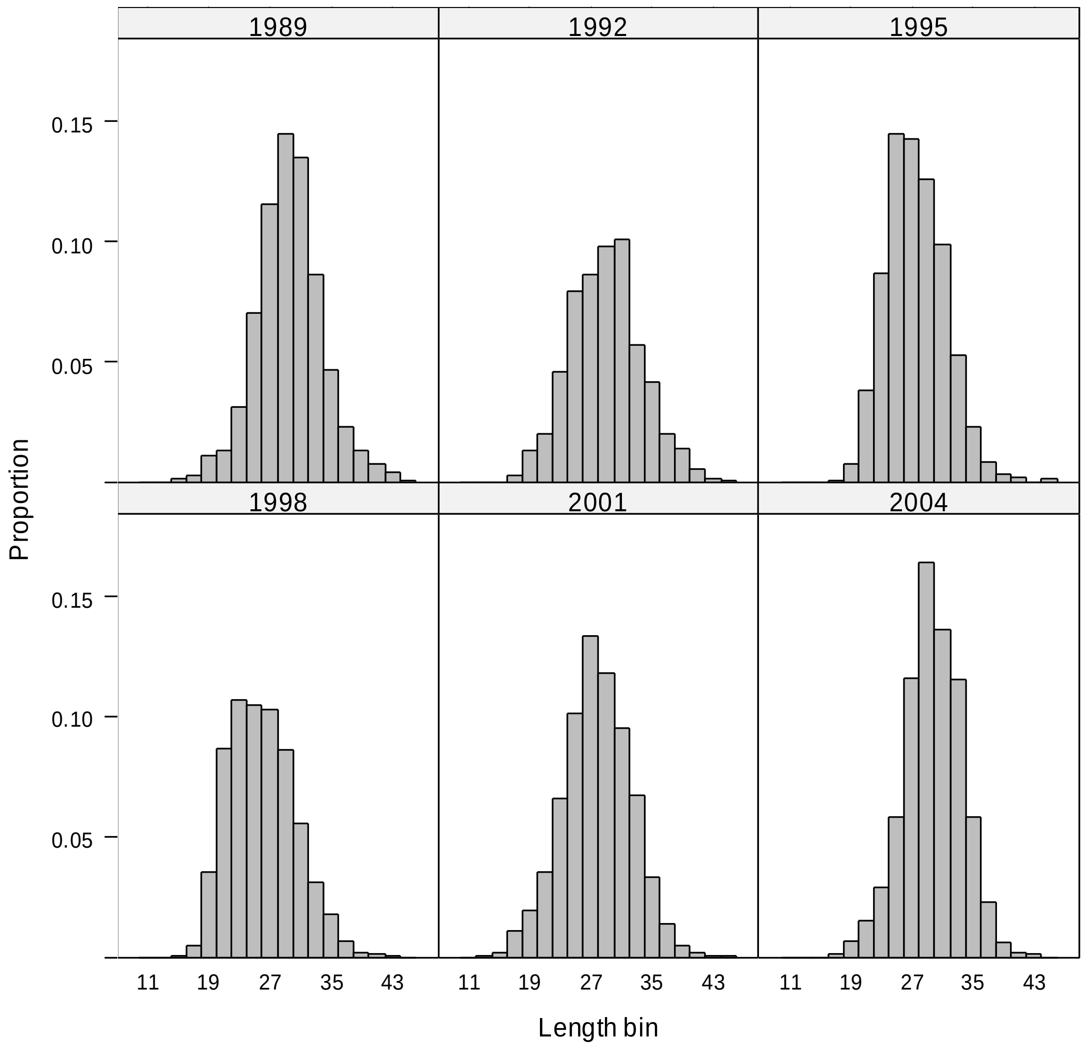


Figure 12. Length frequency distributions for male English sole from the Triennial survey in the north.

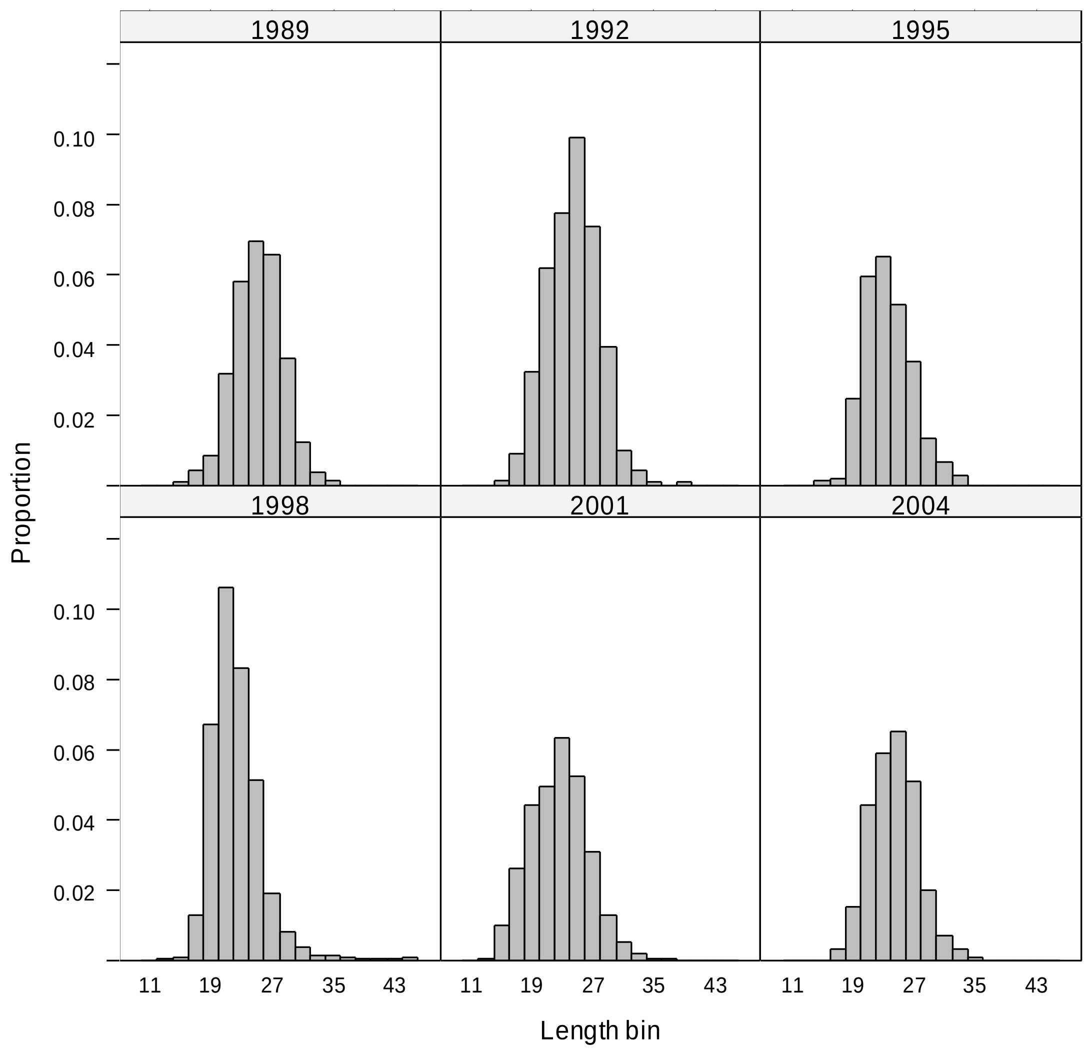


Figure 13: Fitted female maturity at length from female English sole collected by the 1995 triennial survey; data from Sampson and Al-Jufaily (1999).

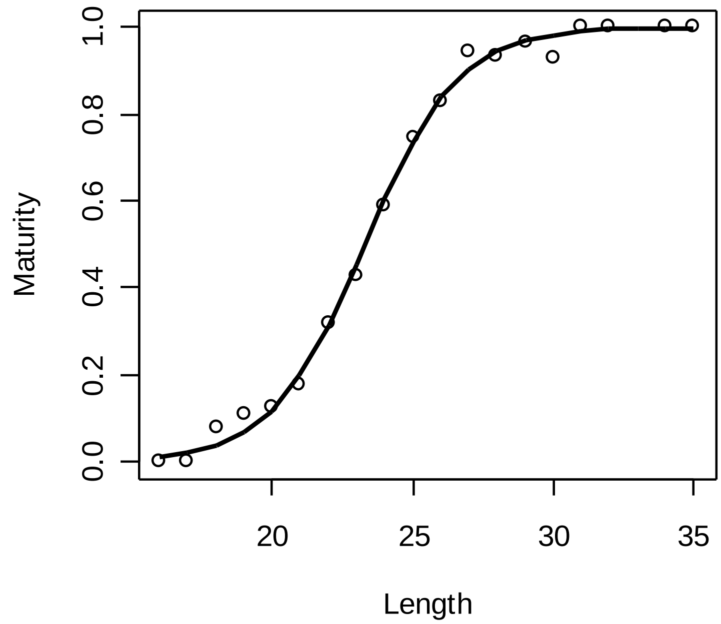


Figure 14. Conditional age-at-length distribution for female English sole collected from the 1995 Triennial survey.

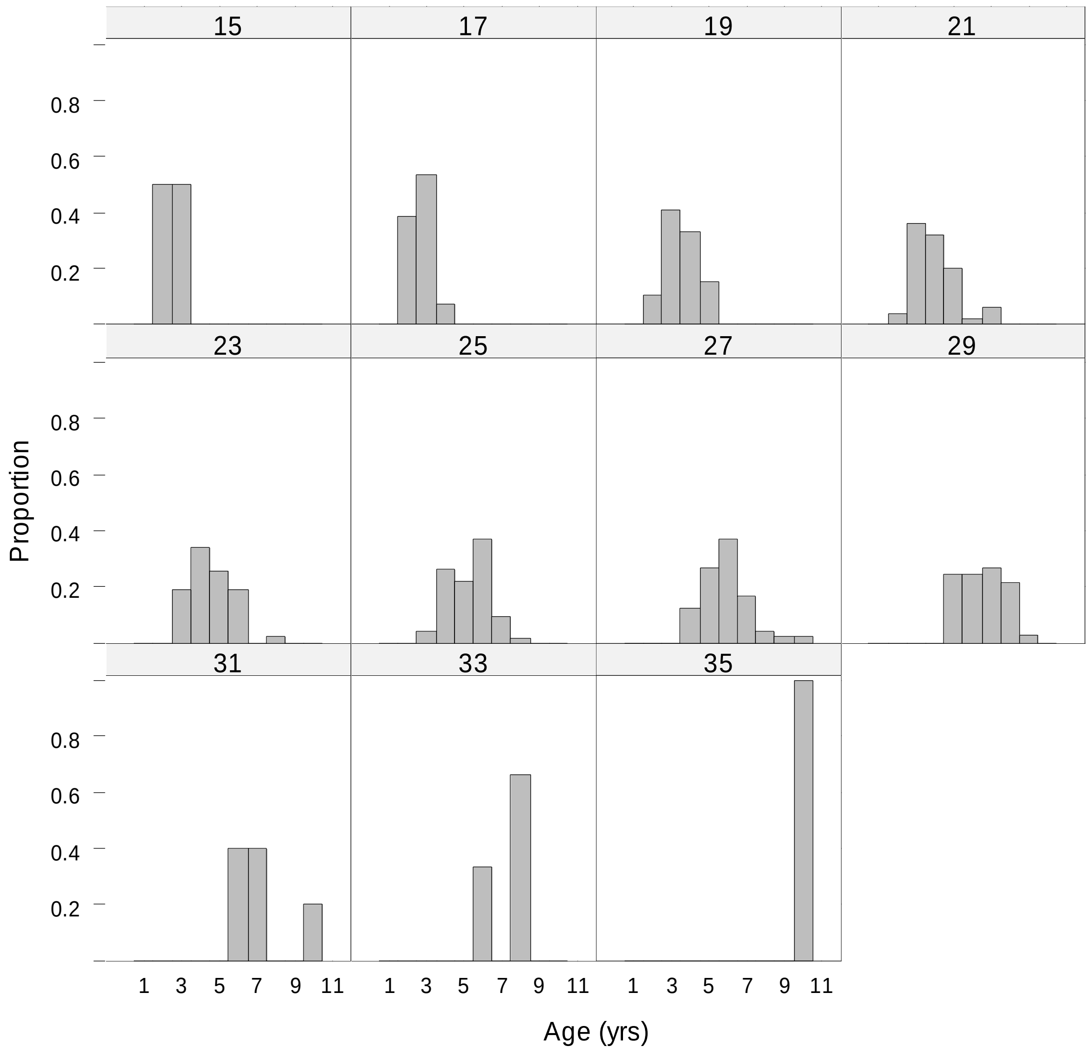


Figure 15: Fitted weight at length relationship for English sole. The northern and southern areas are plotted separately, but were fit with the same model parameters.

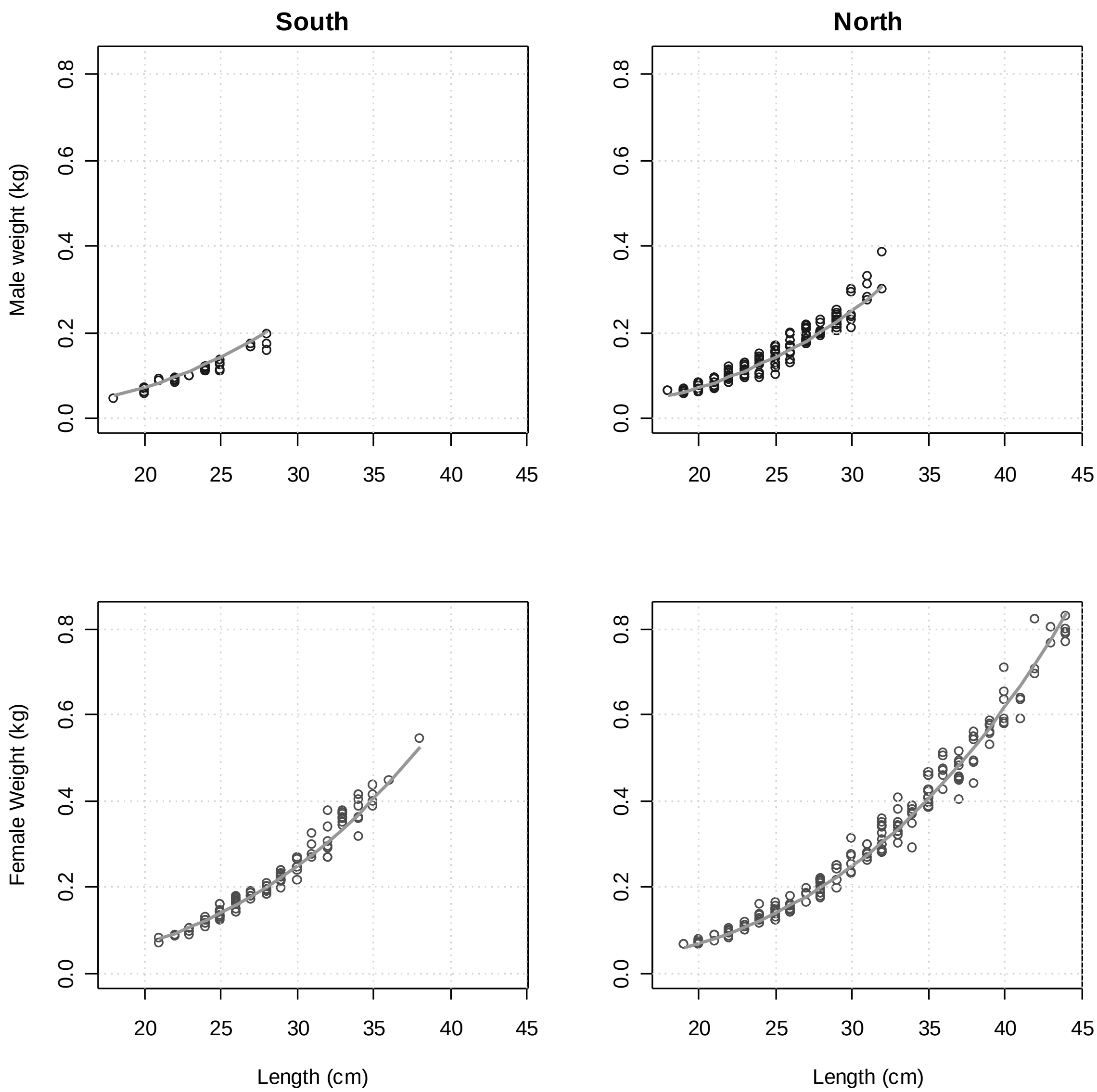


Figure 16. Externally fitted retention curve based on data collected by the Pikitch study 1985-1988.

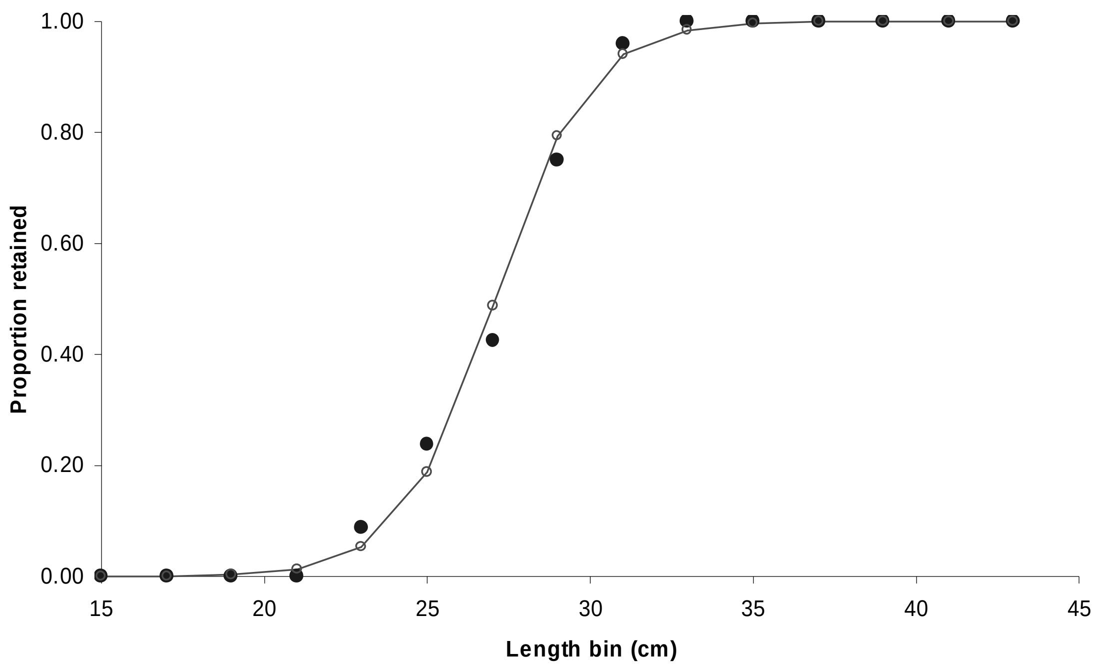


Figure 17. Surface and interopercular age agreement.

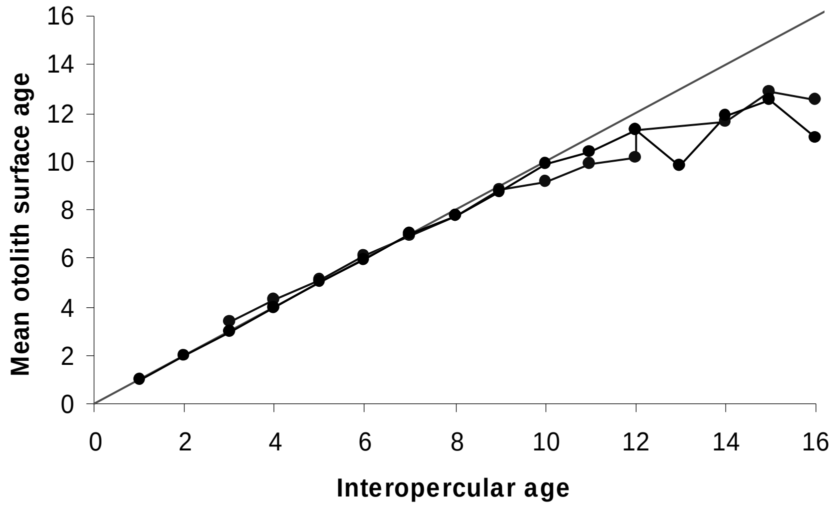


Figure 18. Between reader agreement of interopercular ages.

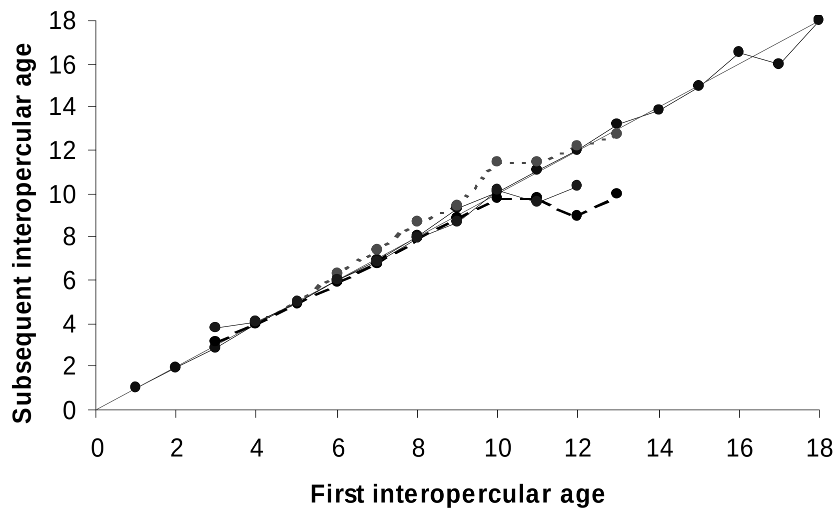


Figure 19: Estimates of between reader standard deviation and fitted linear trend used to describe ageing error from interopercular ages in the assessment model.

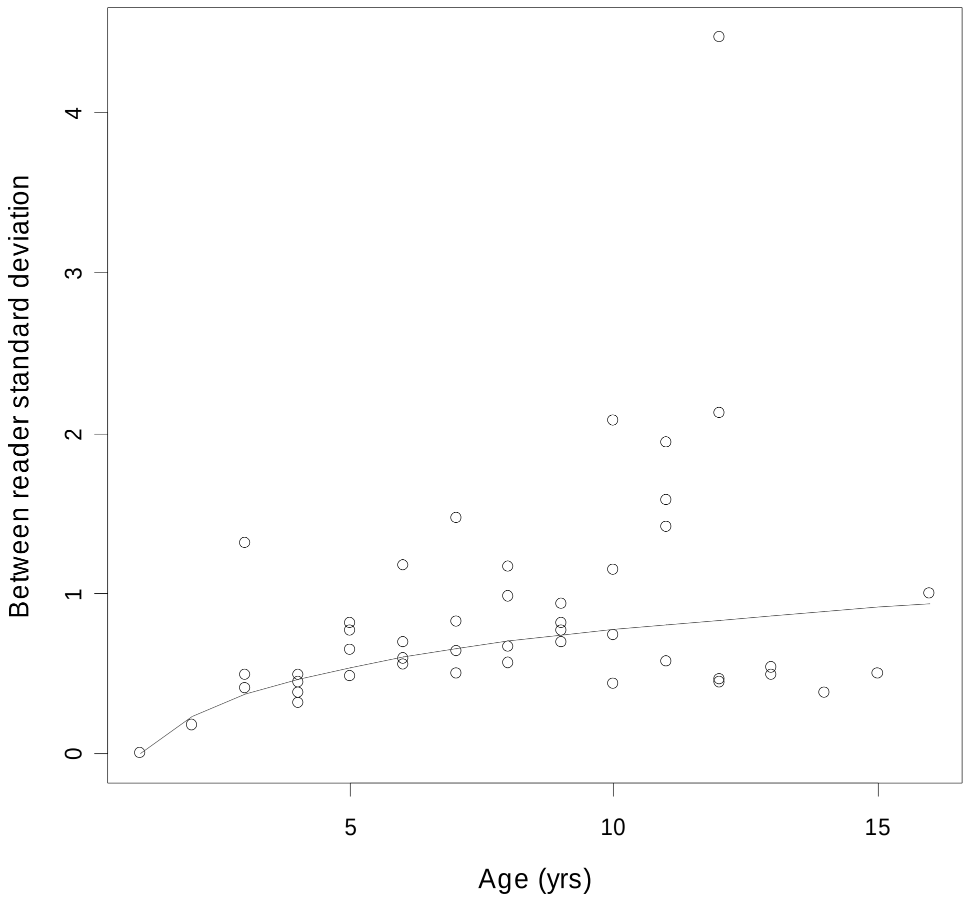


Figure 20. Conditional age-at-length distribution for female English sole sampled from the commercial fishery in the south aggregated over all years.

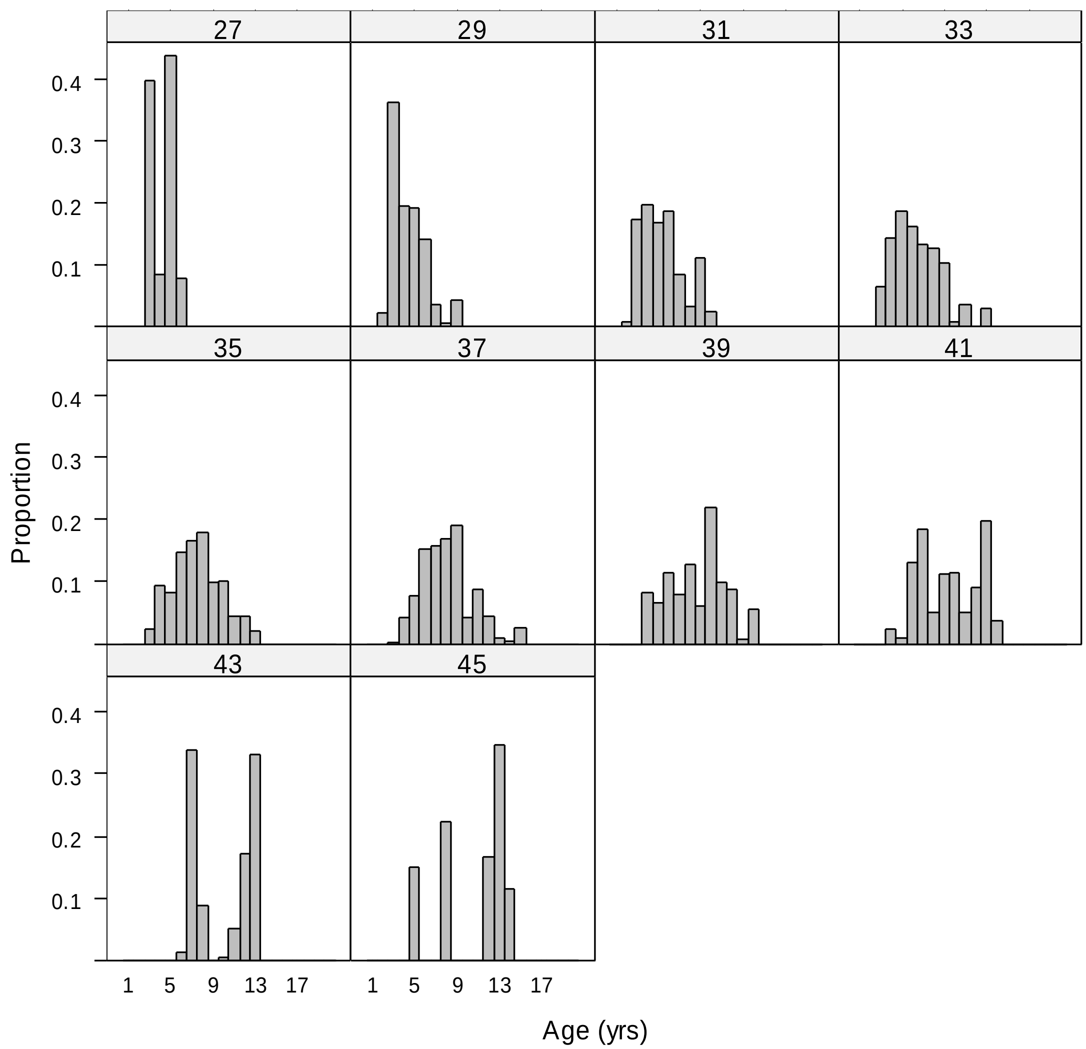


Figure 21. Conditional age-at-length distribution for male English sole sampled from the commercial fishery in the south aggregated over all years.

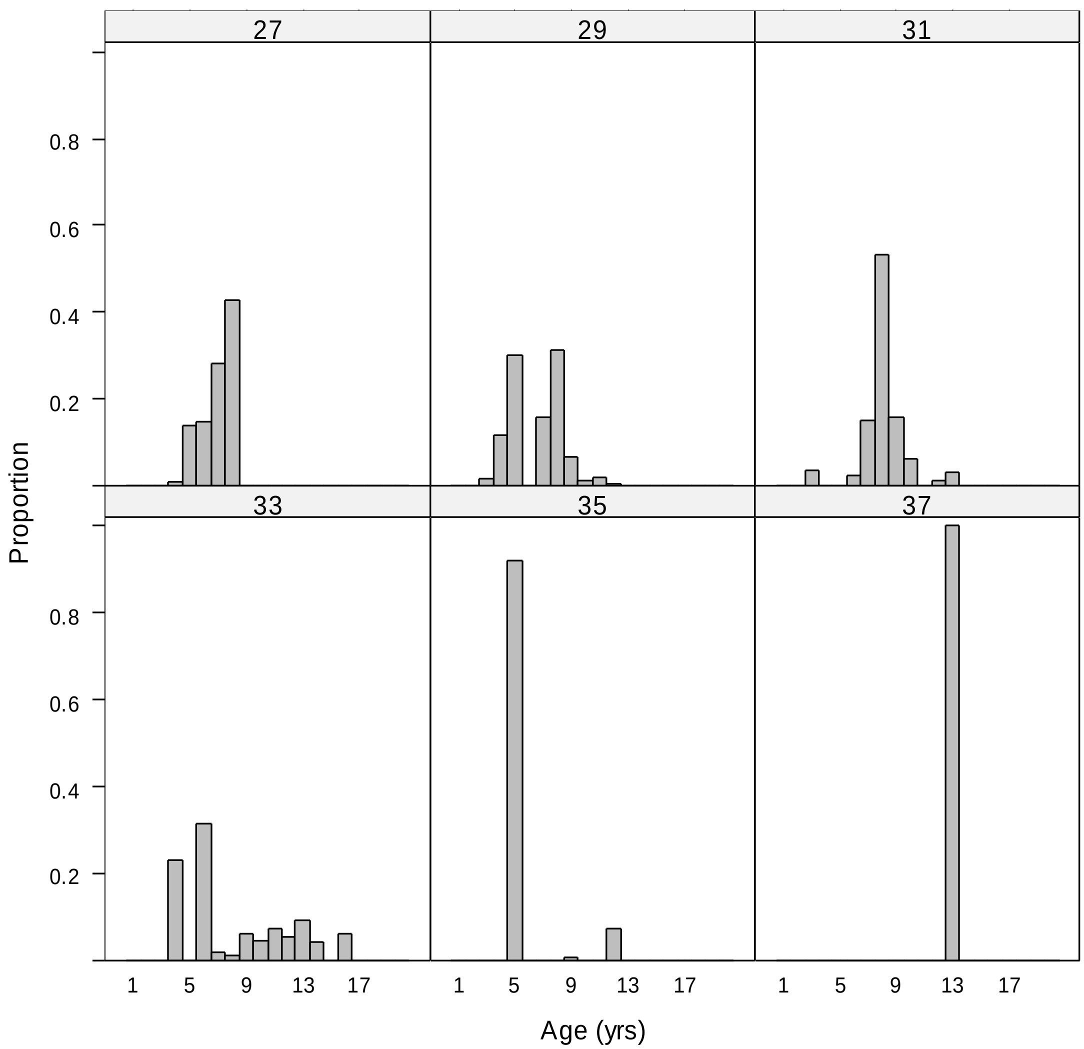


Figure 22. Conditional age-at-length distribution for female English sole sampled from the commercial fishery in the north aggregated over all years.

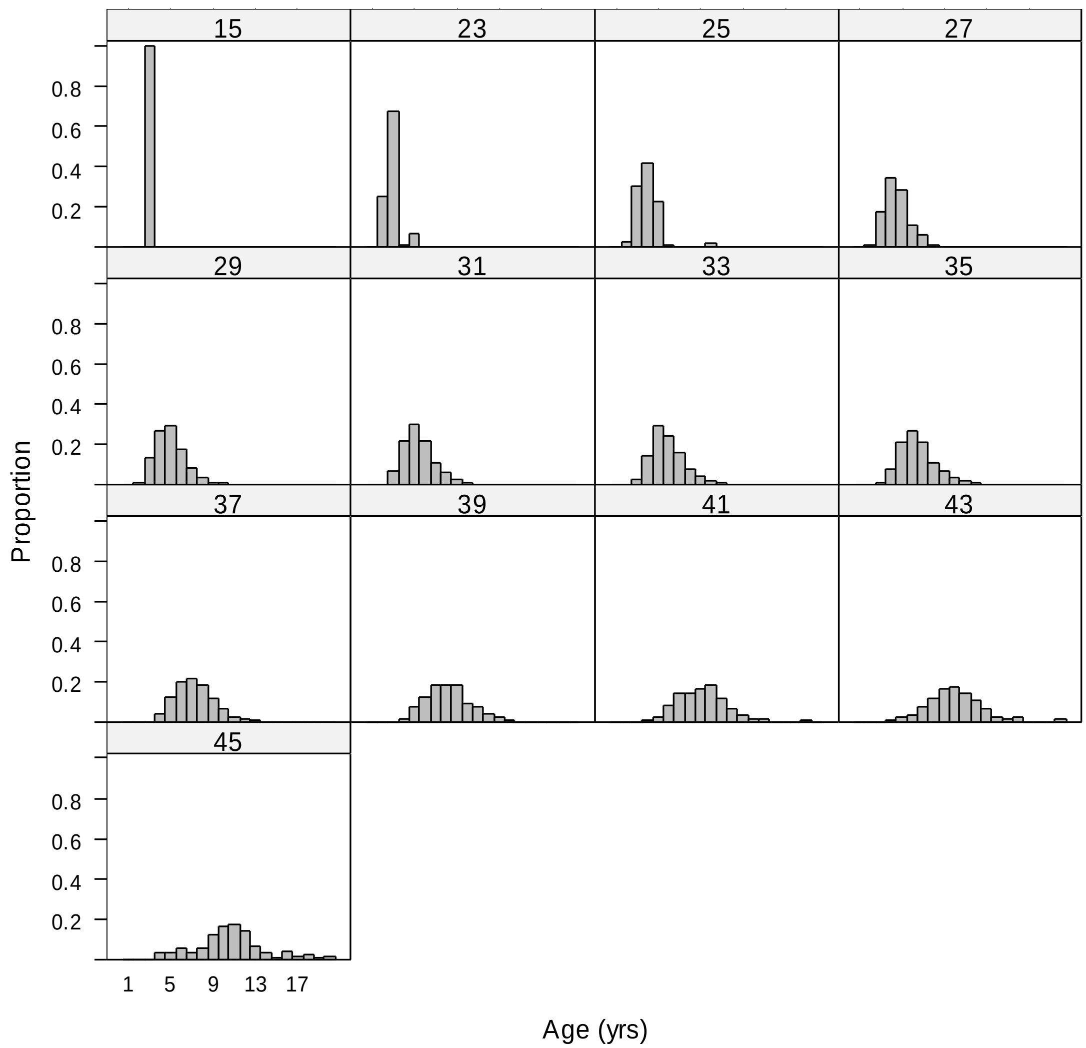


Figure 23. Conditional age-at-length distribution for male English sole sampled from the commercial fishery in the north aggregated over all years.

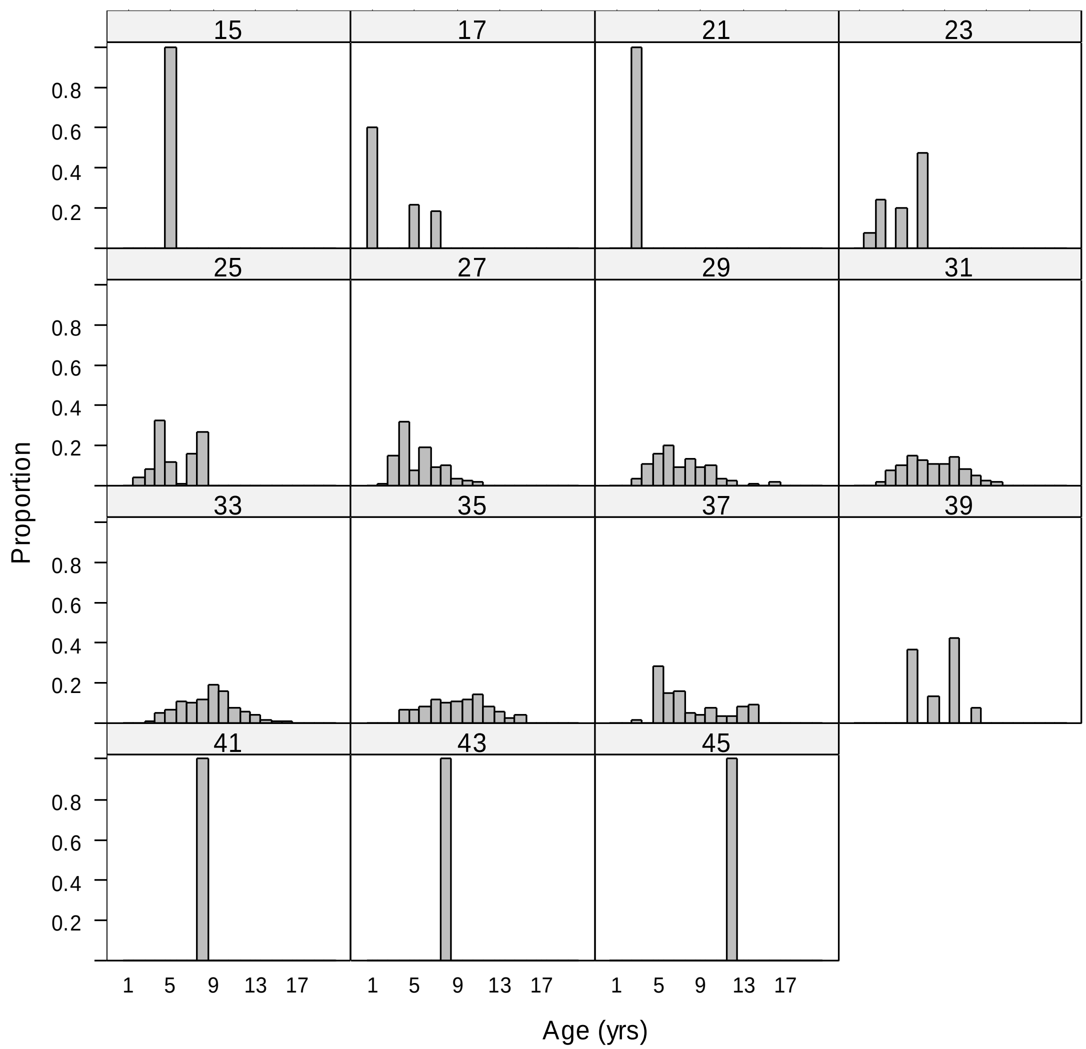


Figure 24. Historical fishery length distribution for female English sole in the north by year and PMFC area.

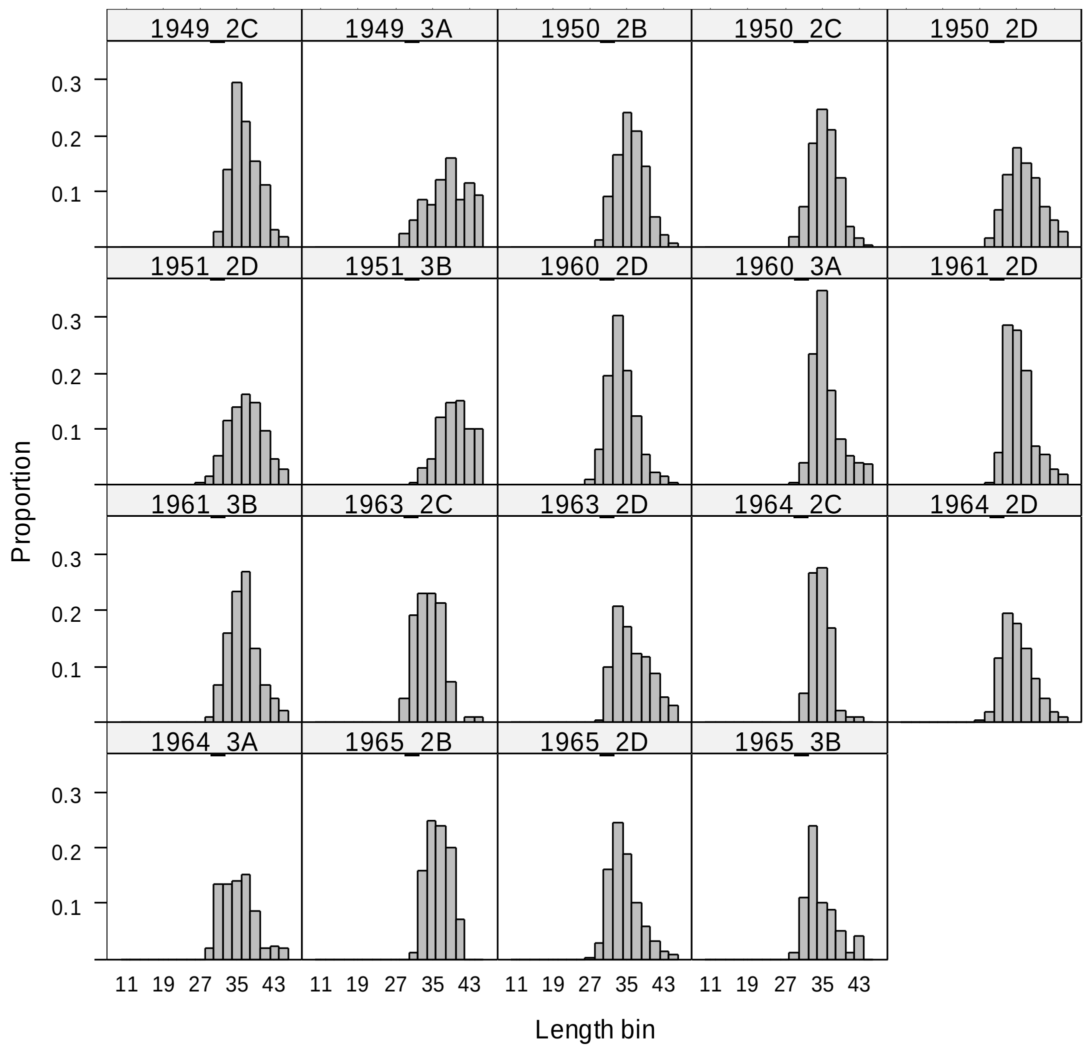


Figure 25. Historical fishery length distribution for male English sole in the north by year and PMFC area.

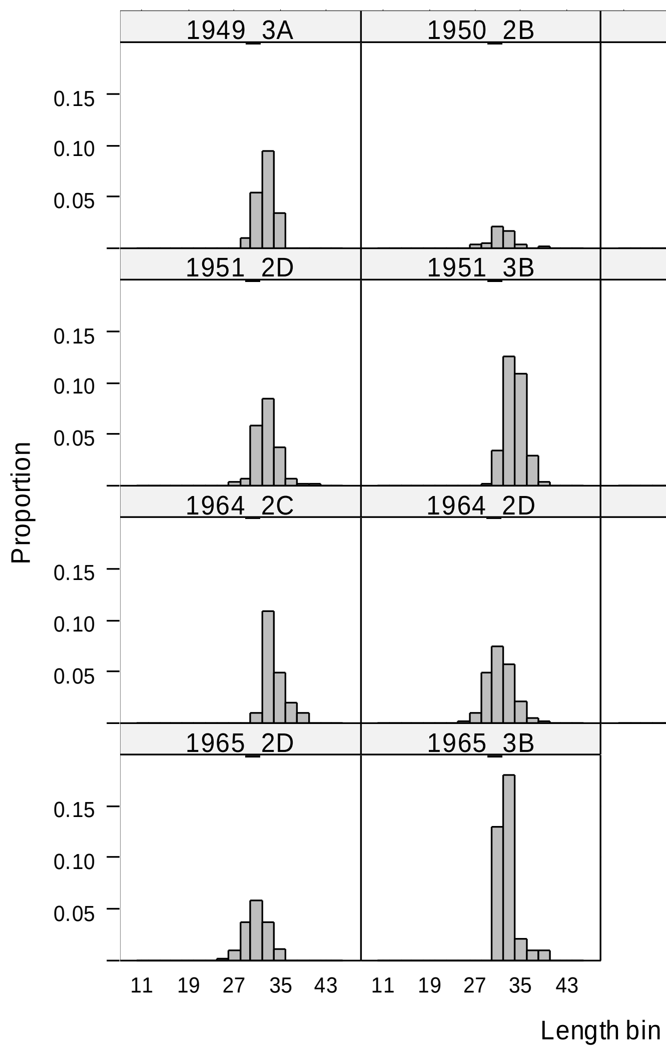


Figure 26. Conditional age-at-length distribution for female English sole sampled from the historical commercial fishery in the north aggregated over all years and areas.

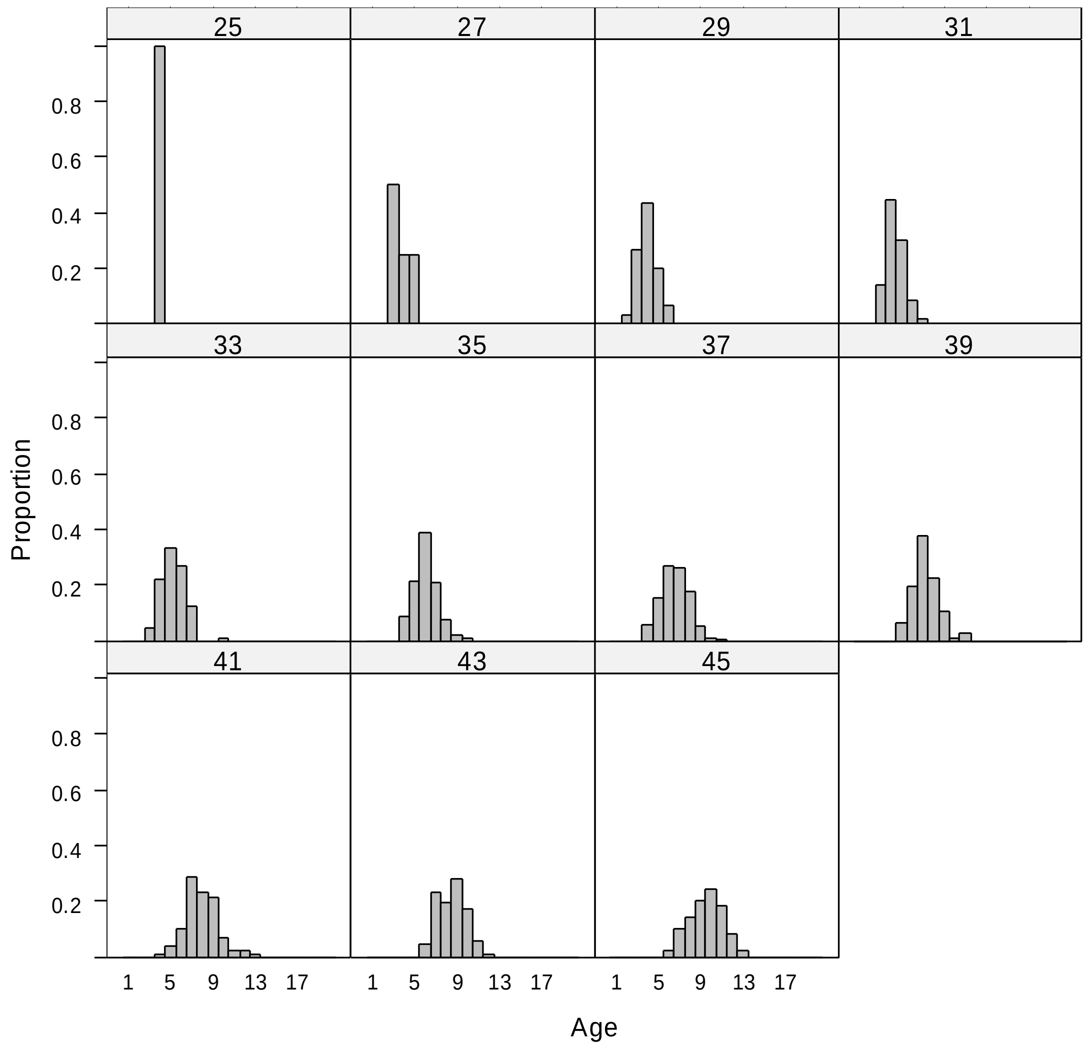


Figure 27. Conditional age-at-length distribution for male English sole sampled from the historical commercial fishery in the north aggregated over all years and areas.

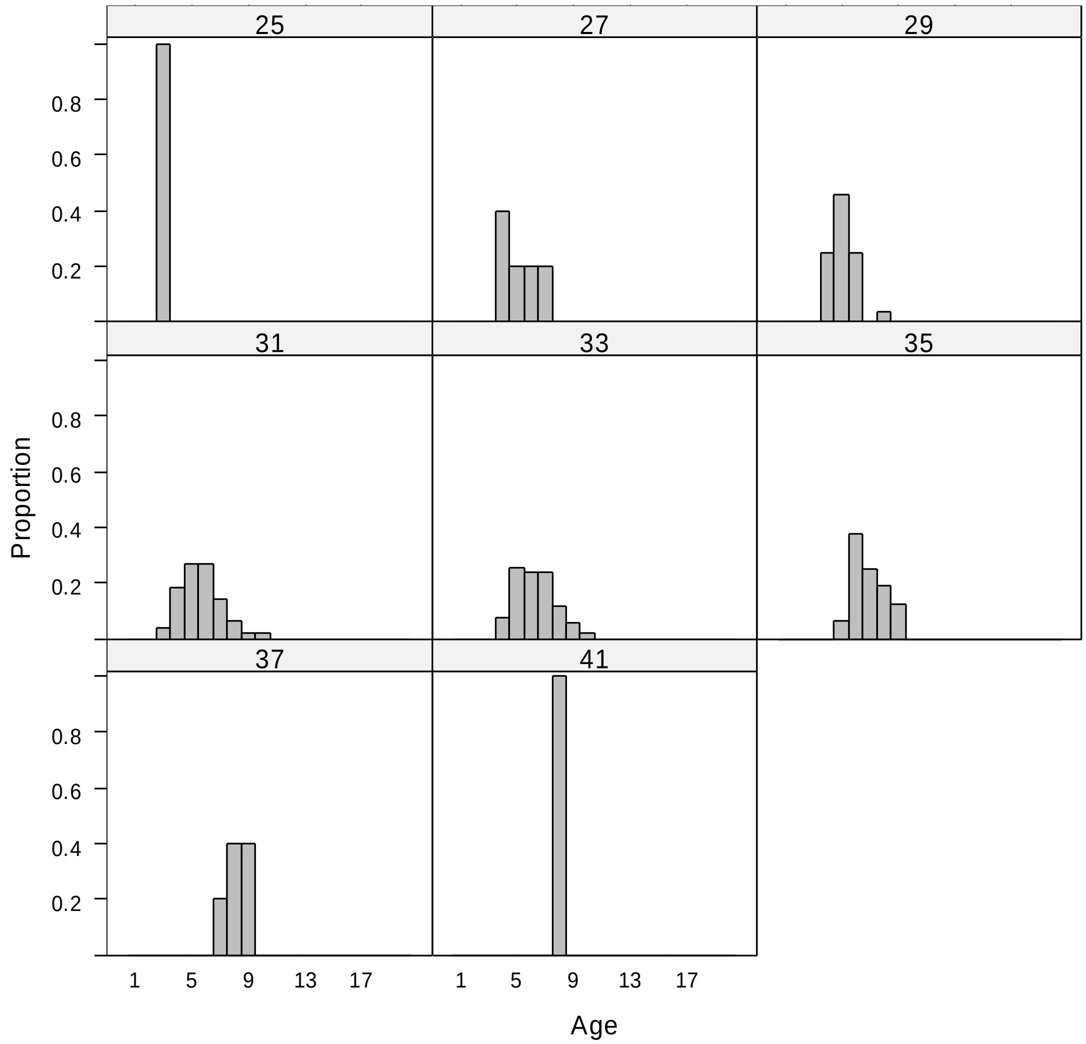


Figure 28. Prior distributions for steepness (*h*); noninformative, and two interpretations of the distribution described by Myers et al. (1999) for the family Pleuronectidae (Mean, SD).

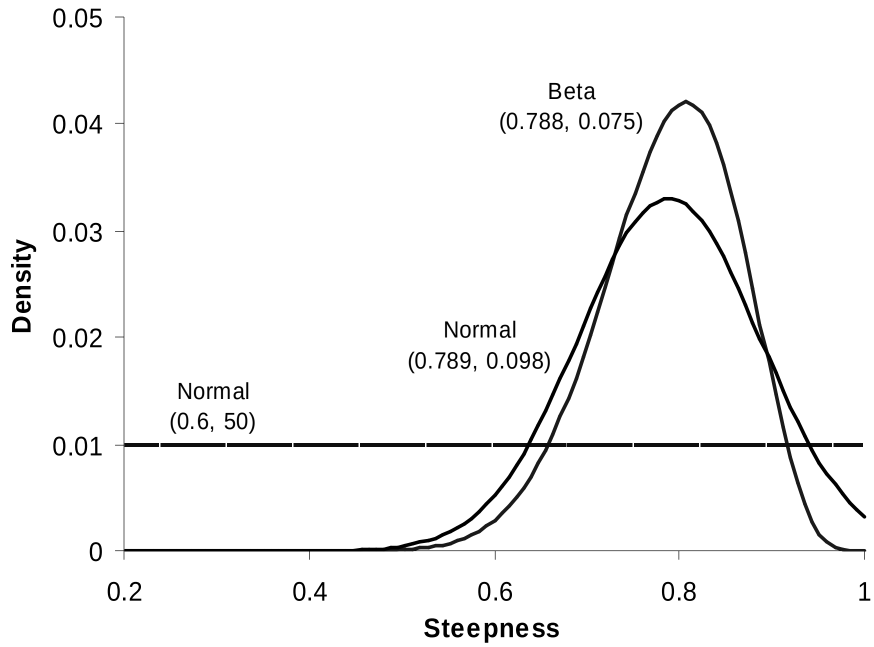


Figure 29. Prior distributions for natural mortality; noninformative, and an estimate based on the analysis of Gunderson and Dygert (1988) and approximated by a normal distribution with mean = 0.329, SD = 0.091.

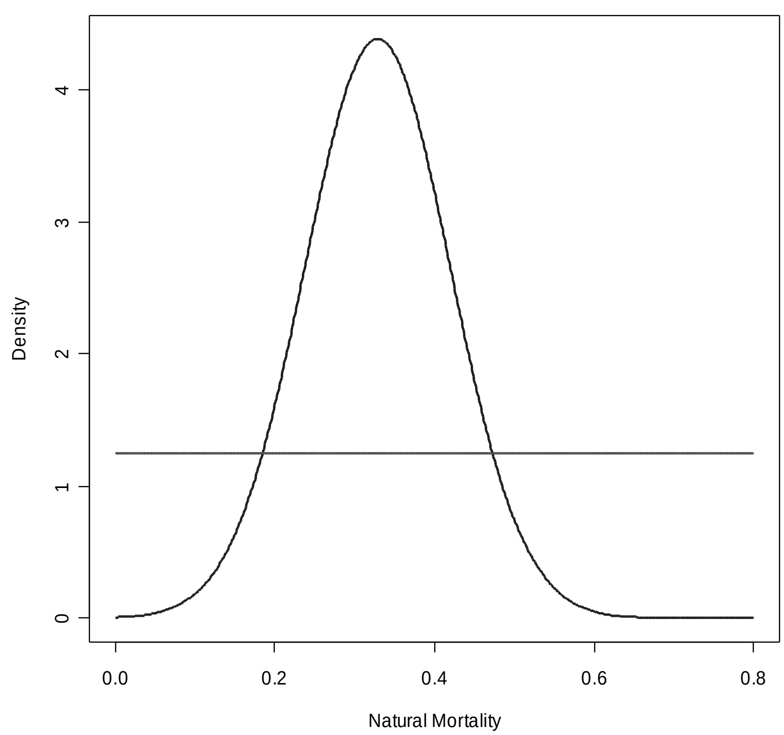


Figure 30. Change in length at 50% maturity in the base case model. Line indicates the estimate from the 1950s.

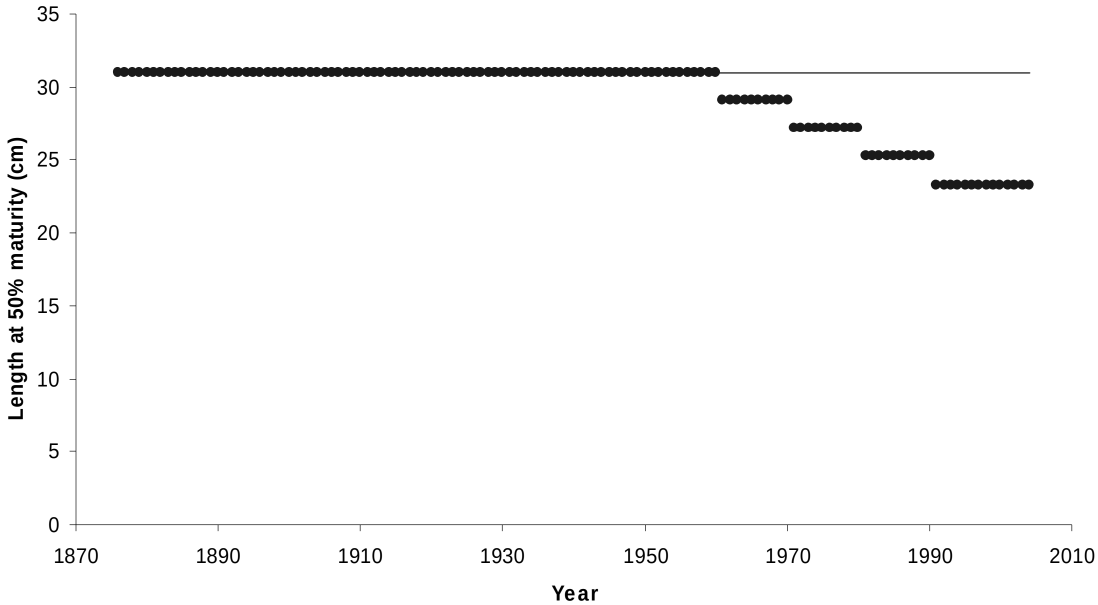


Figure 31. Estimated change in the von Bertalanffy K parameter for female English sole.

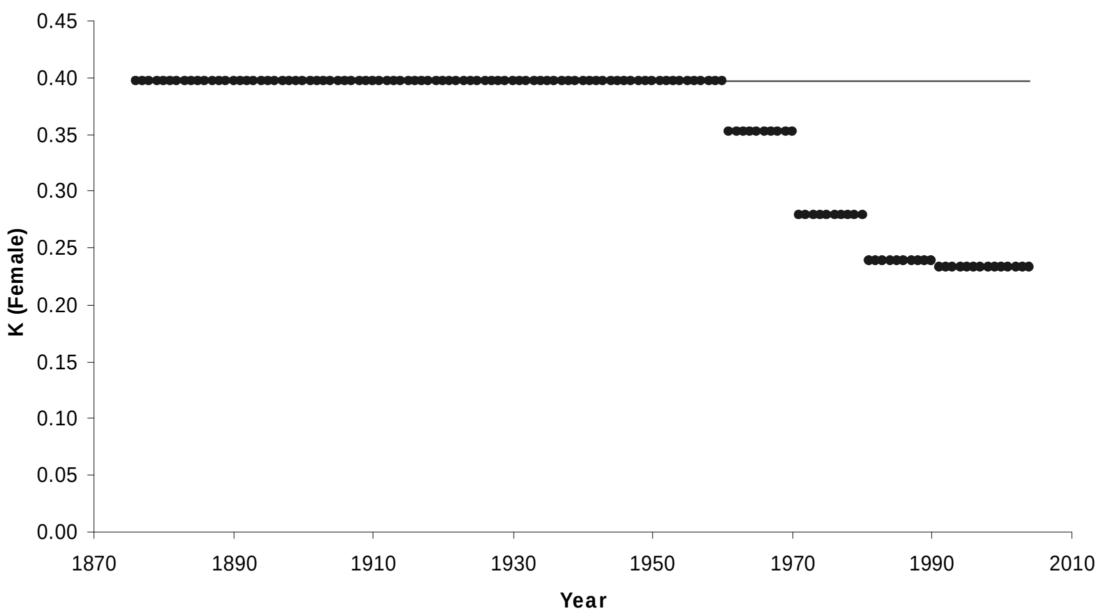


Figure 32. Growth curve for females (upper line) and males with ~95% interval for individual variability in length at age for the last year of the model.

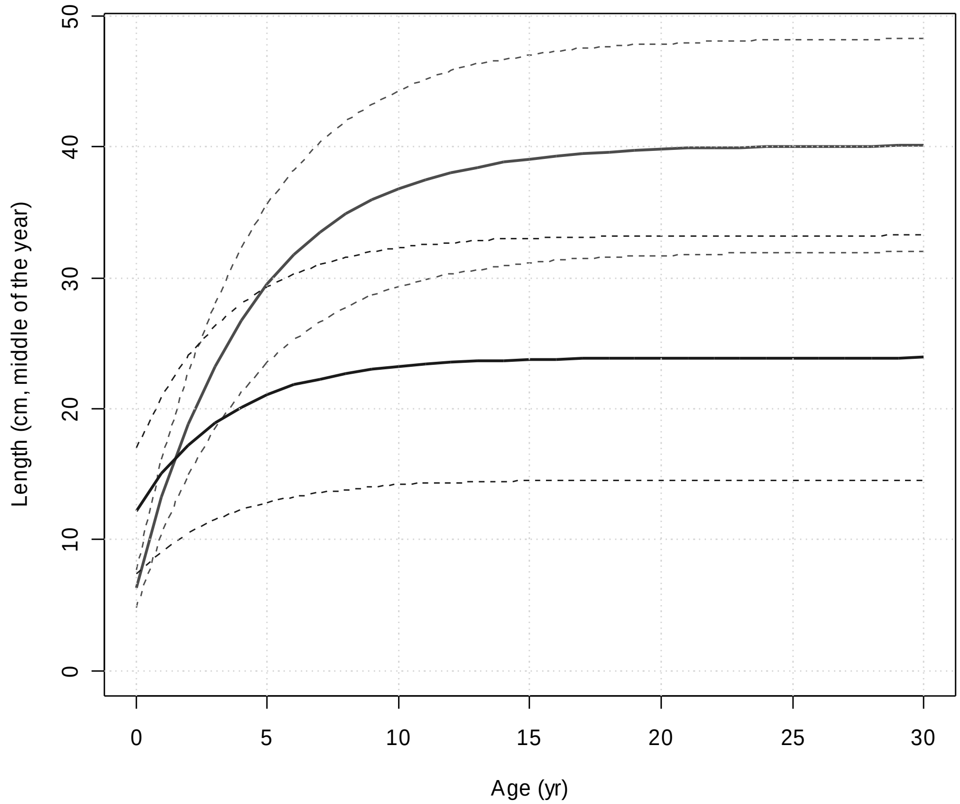


Figure 33. Observed and effective sample sizes for conditional age at length bin observations from the commercial fishing fleets.

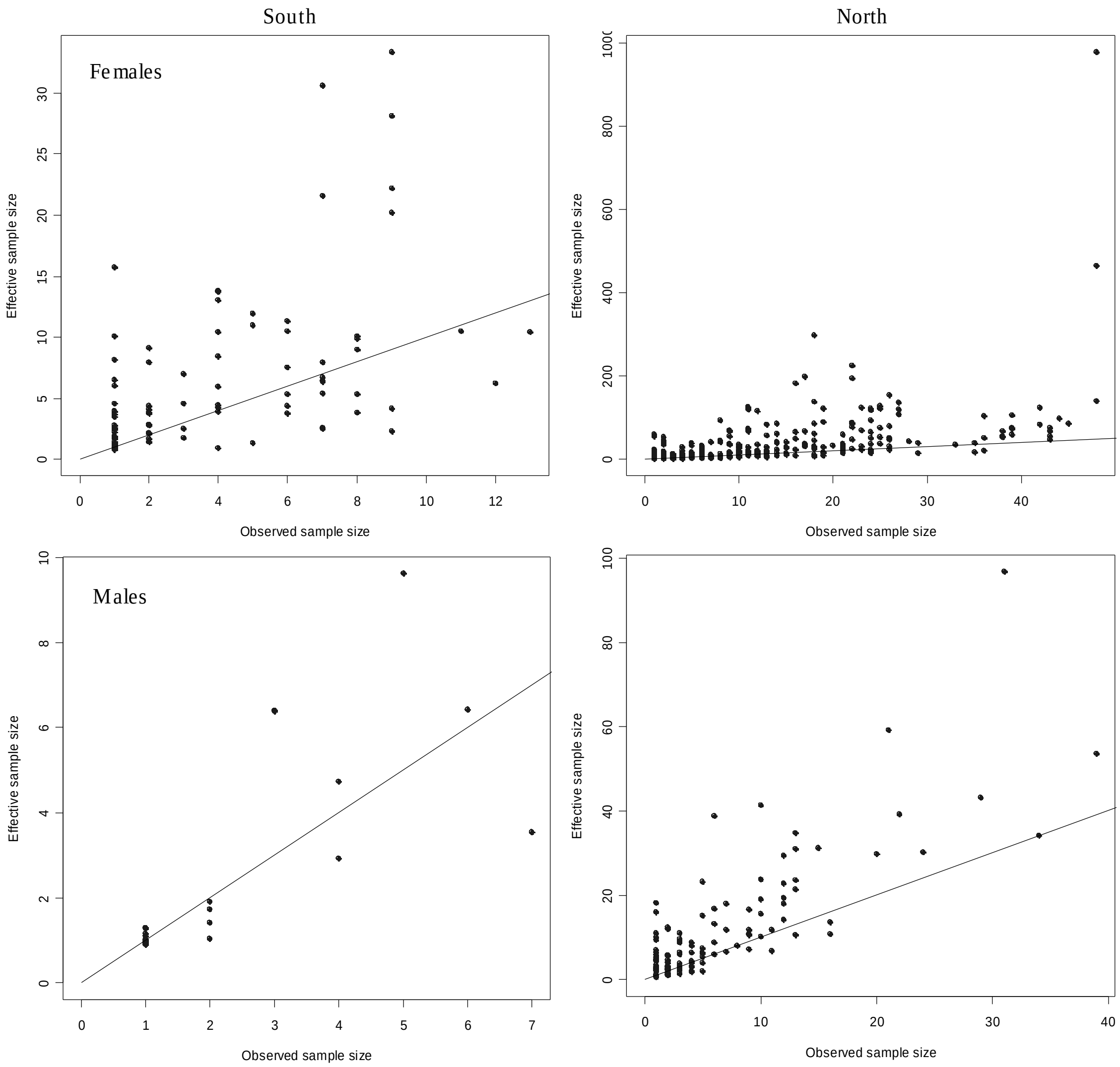
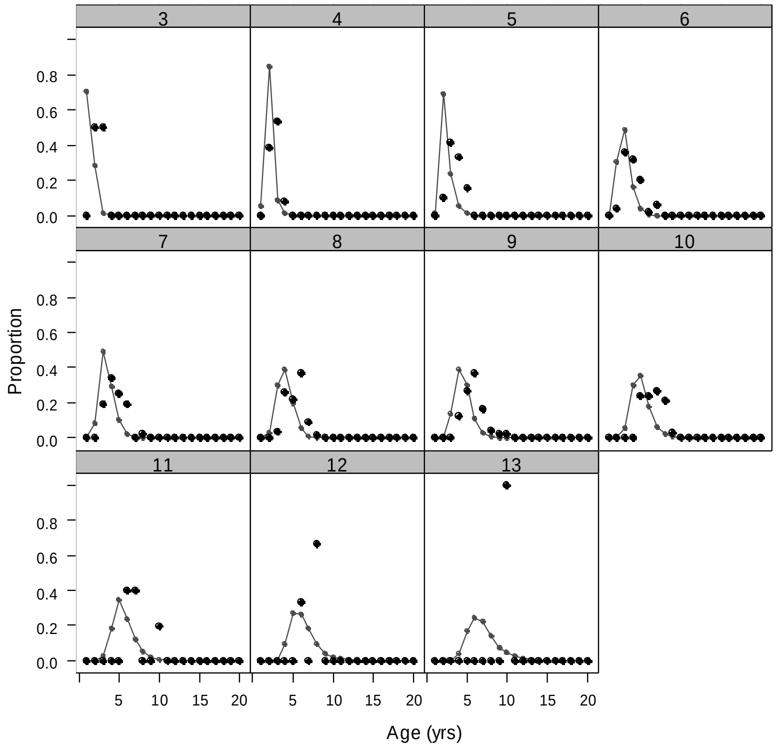
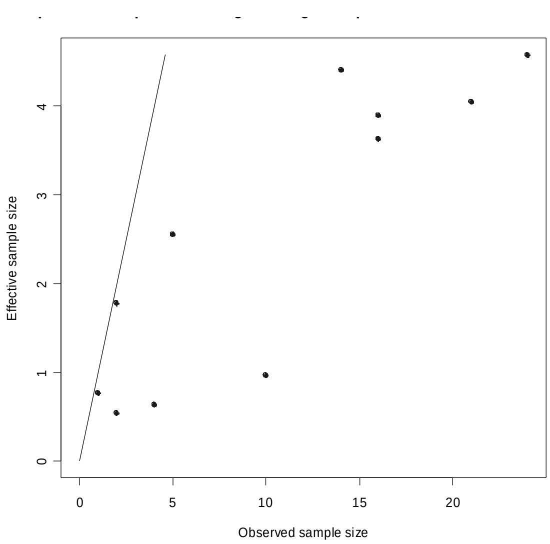


Figure 34. Age frequency at length bin observations, Pearson residuals, observed and effective sample sizes from the triennial survey project in 1995.





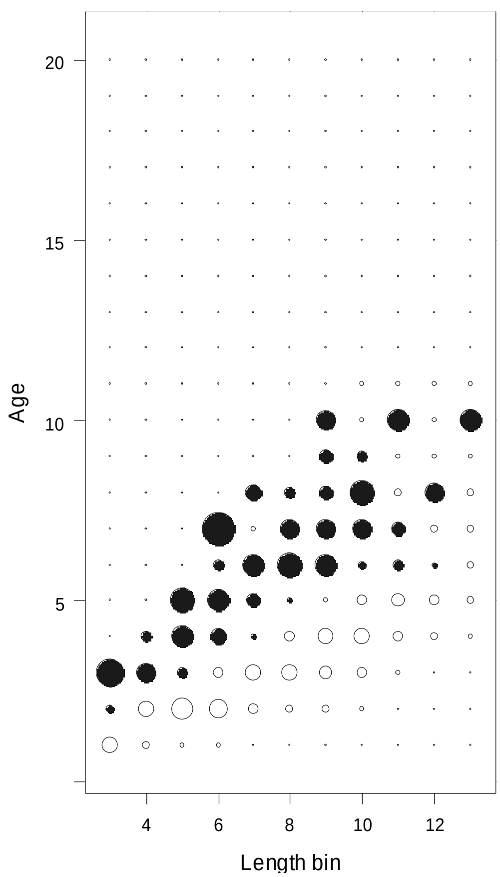


Figure 35. Estimated selectivity and retention curves for the base case model. Note that the selectivity curve for the southern fleet reflects selectivity for both fleets at the end of the modeled time period, the northern fleet reflects selectivity for both fleets at the beginning of the modeled time period. Retention curves are time invariant.

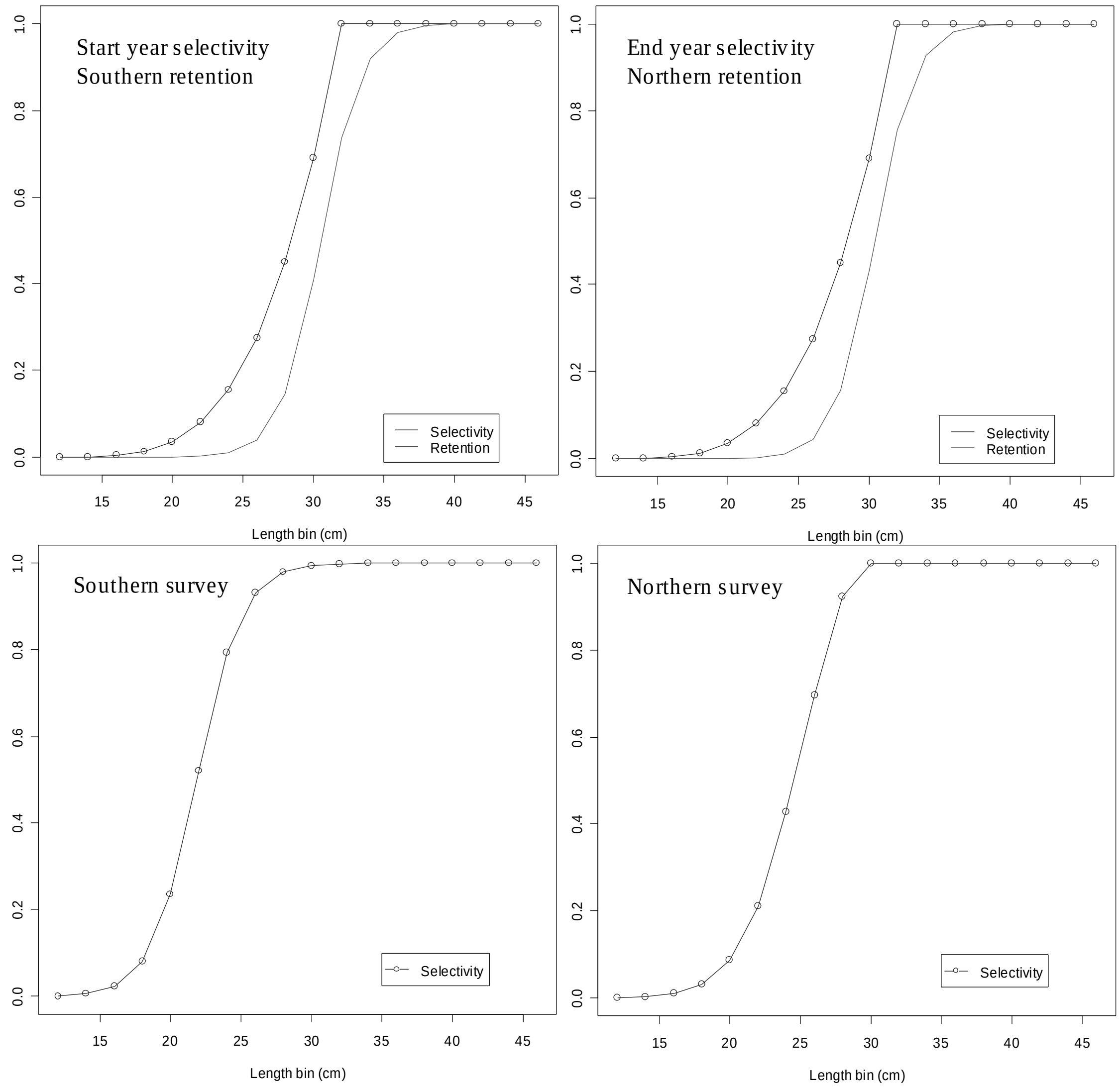


Figure 36. Fit to the northern survey female (upper panel) and male (lower panel) length frequencies.

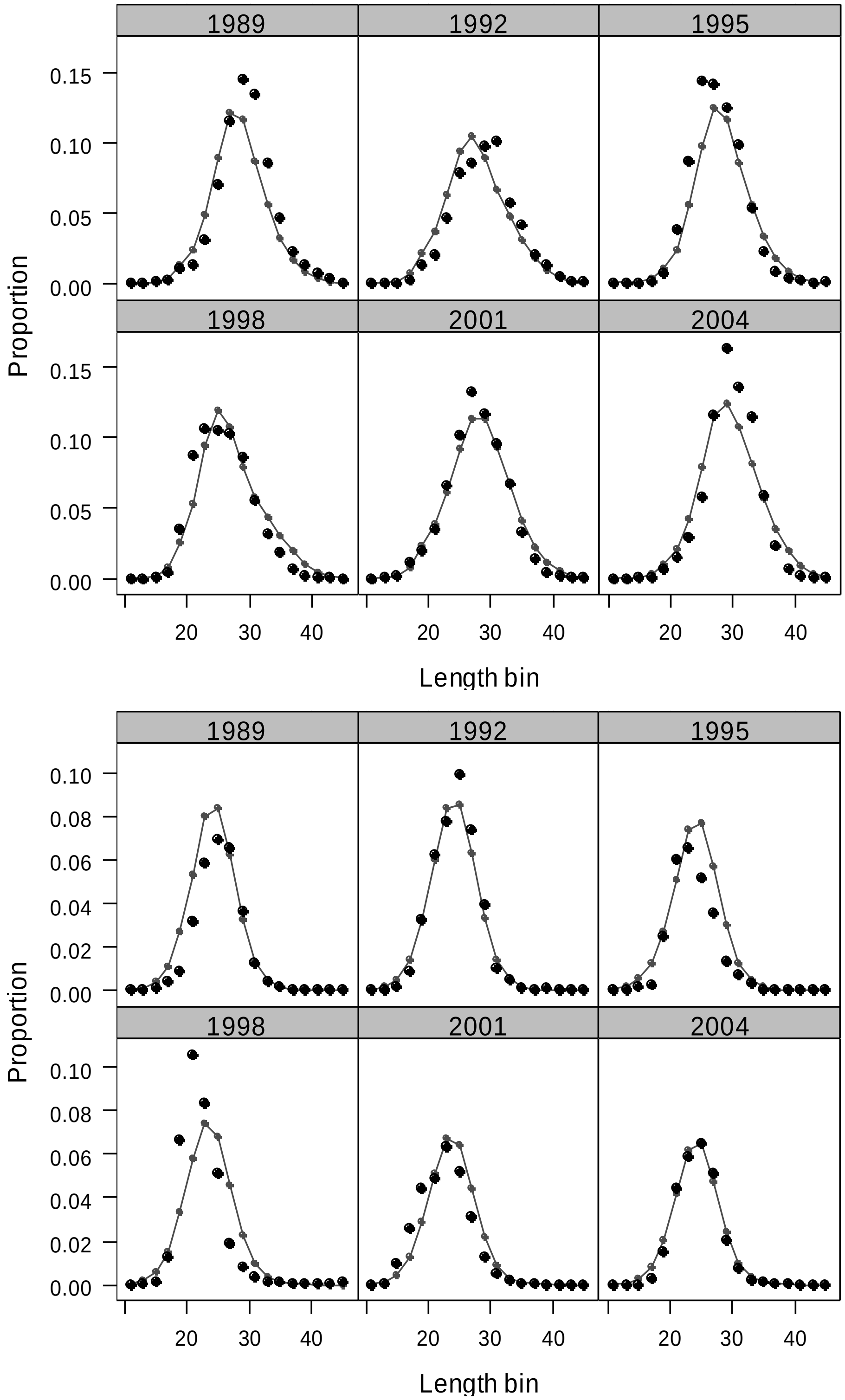


Figure 37. Fit to the southern survey female (upper panel) and male (lower panel) length frequencies.

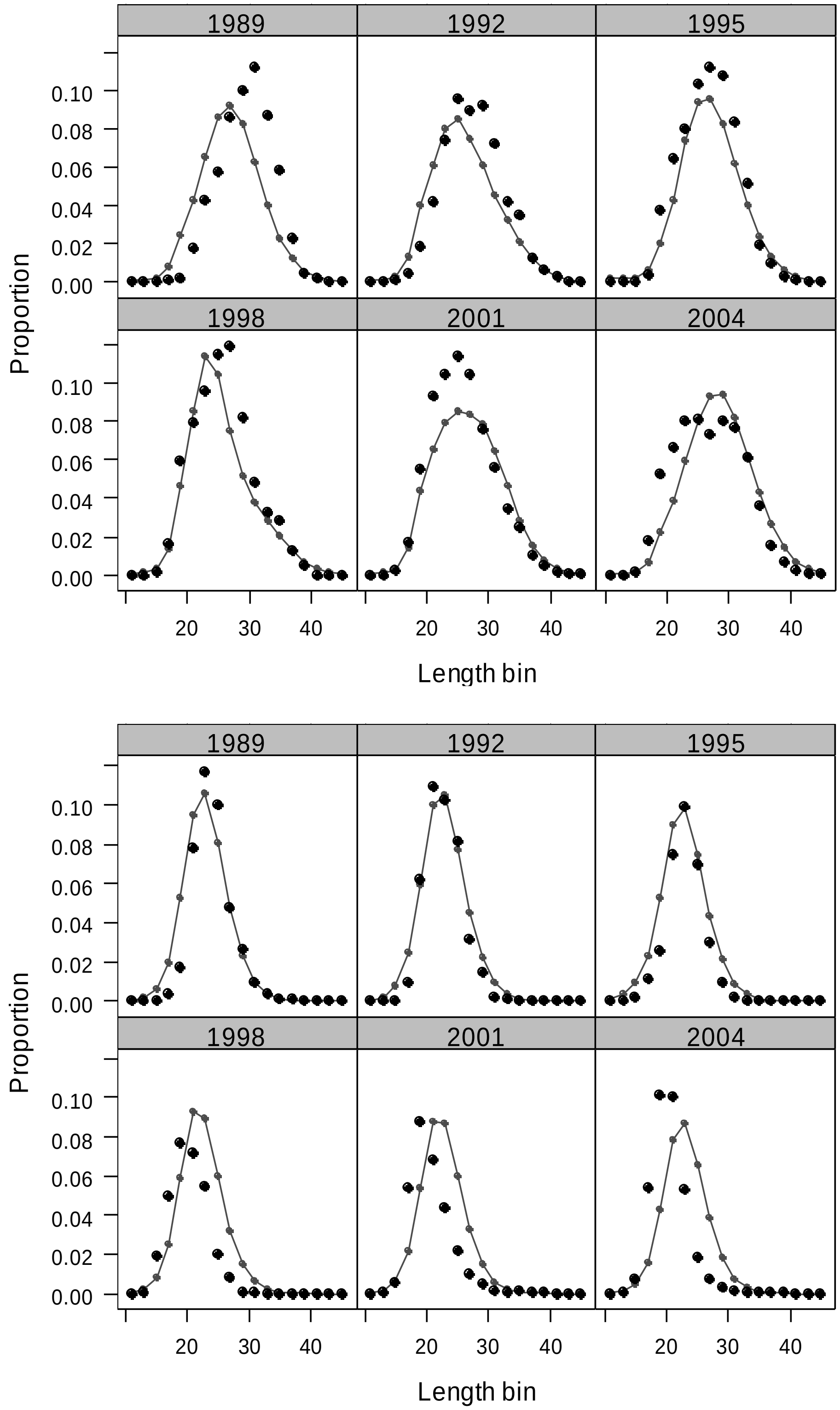


Figure 38. Observed and effective sample sizes for the northern (upper panel) and southern (lower panel) survey length frequencies (sexes combined).

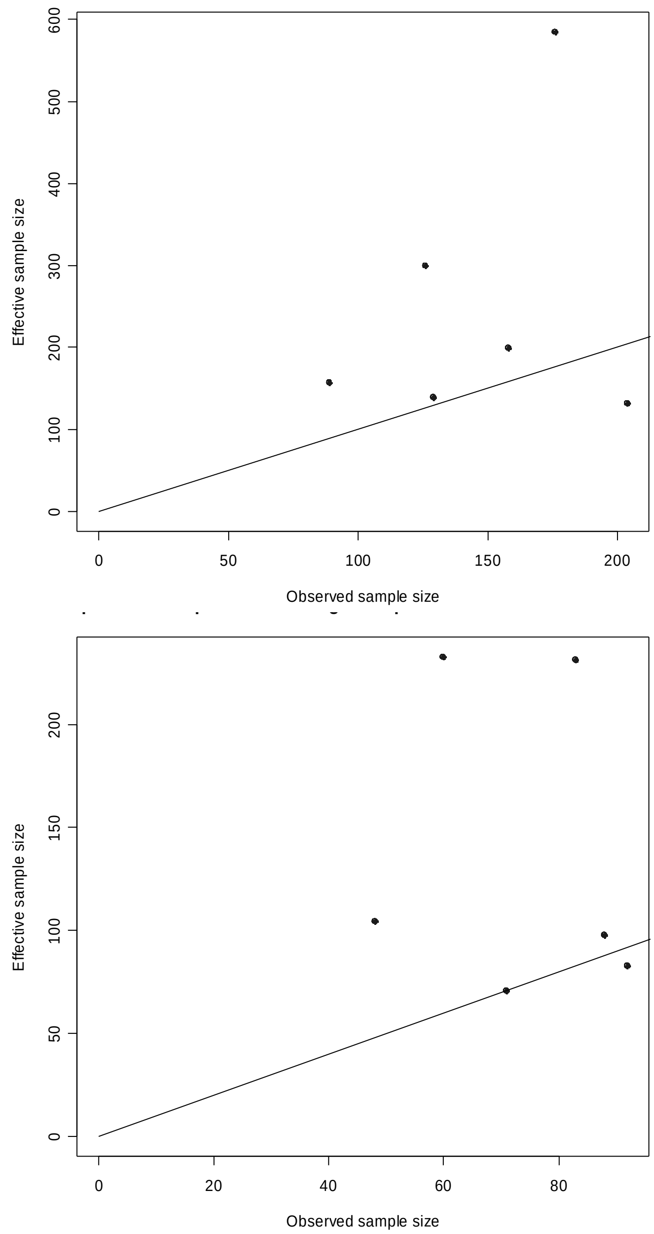


Figure 39. Pearson residuals for the northern survey length frequencies.

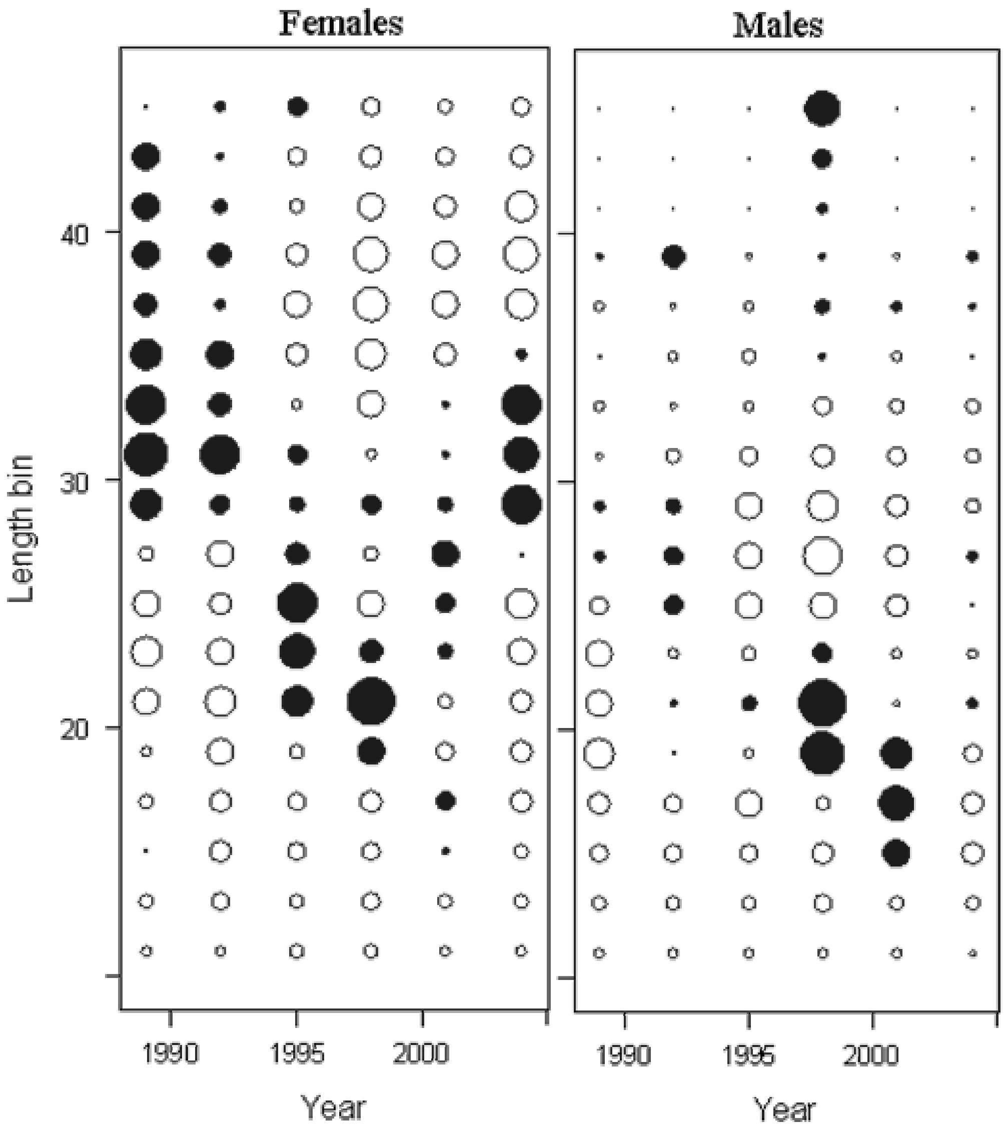


Figure 40. Pearson residuals for the southern survey length frequencies.

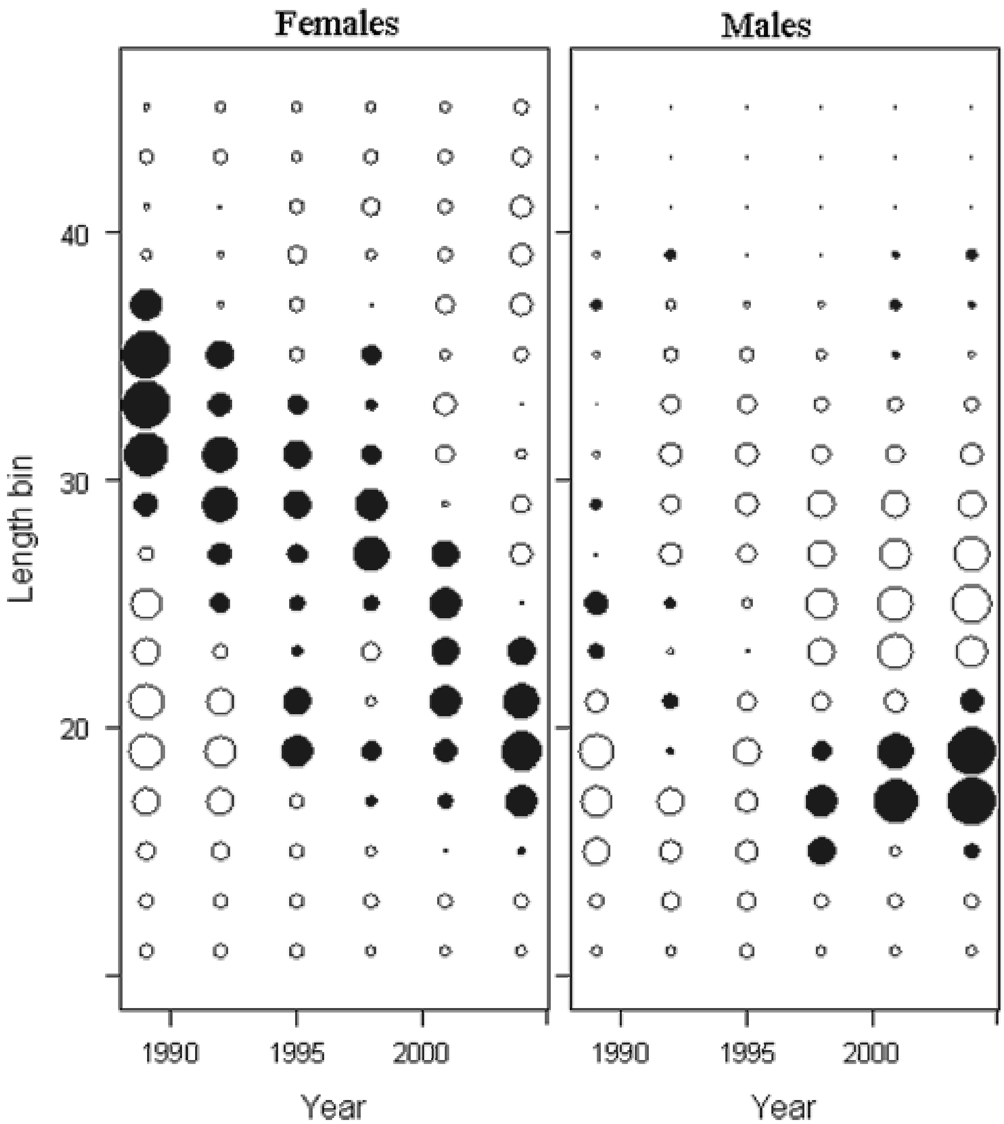


Figure 41. Fit to southern (top panel) and northern (bottom panel) survey indices of abundance.

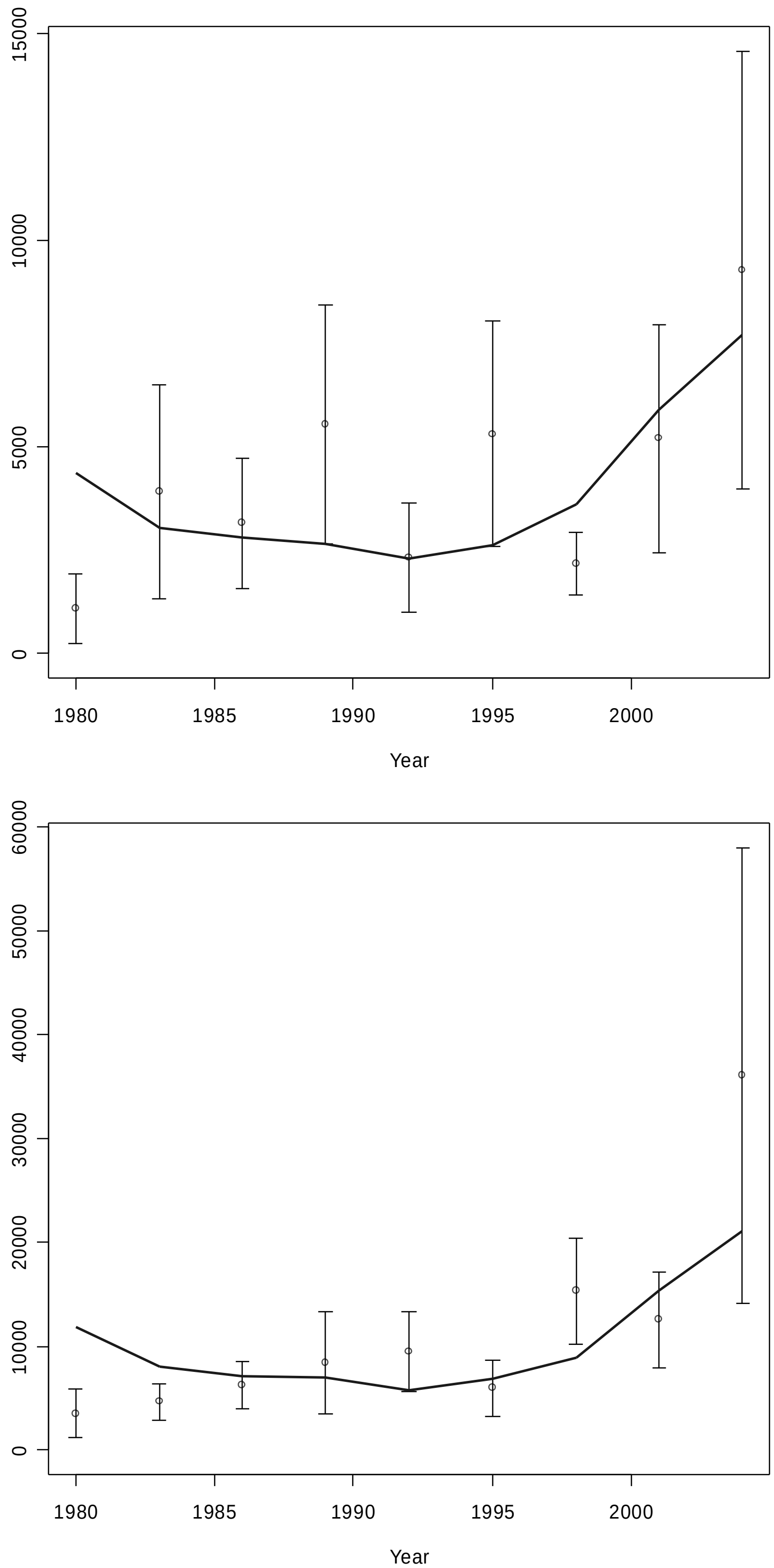


Figure 42. Observed and effective sample sizes for length frequencies from the southern and northern commercial fishery fleets.

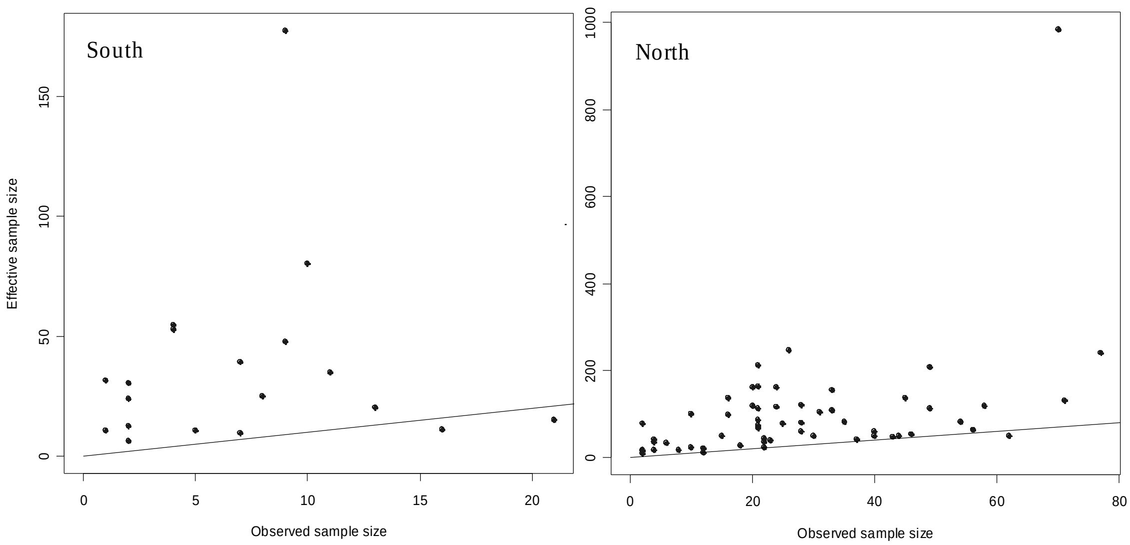


Figure 42. Fit to length frequency data for females from the southern commercial fishery fleet.

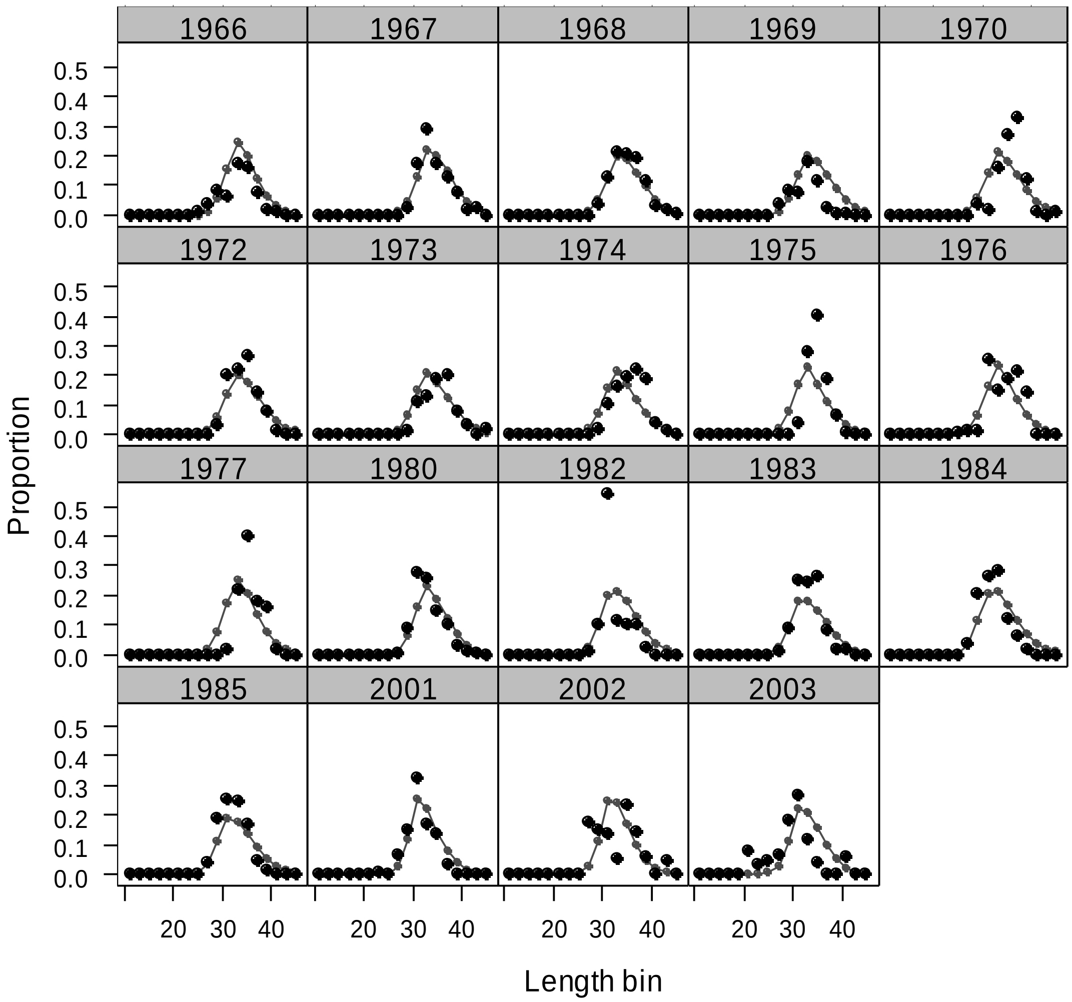


Figure 43. Fit to length frequency data for males from the southern commercial fishery fleet.

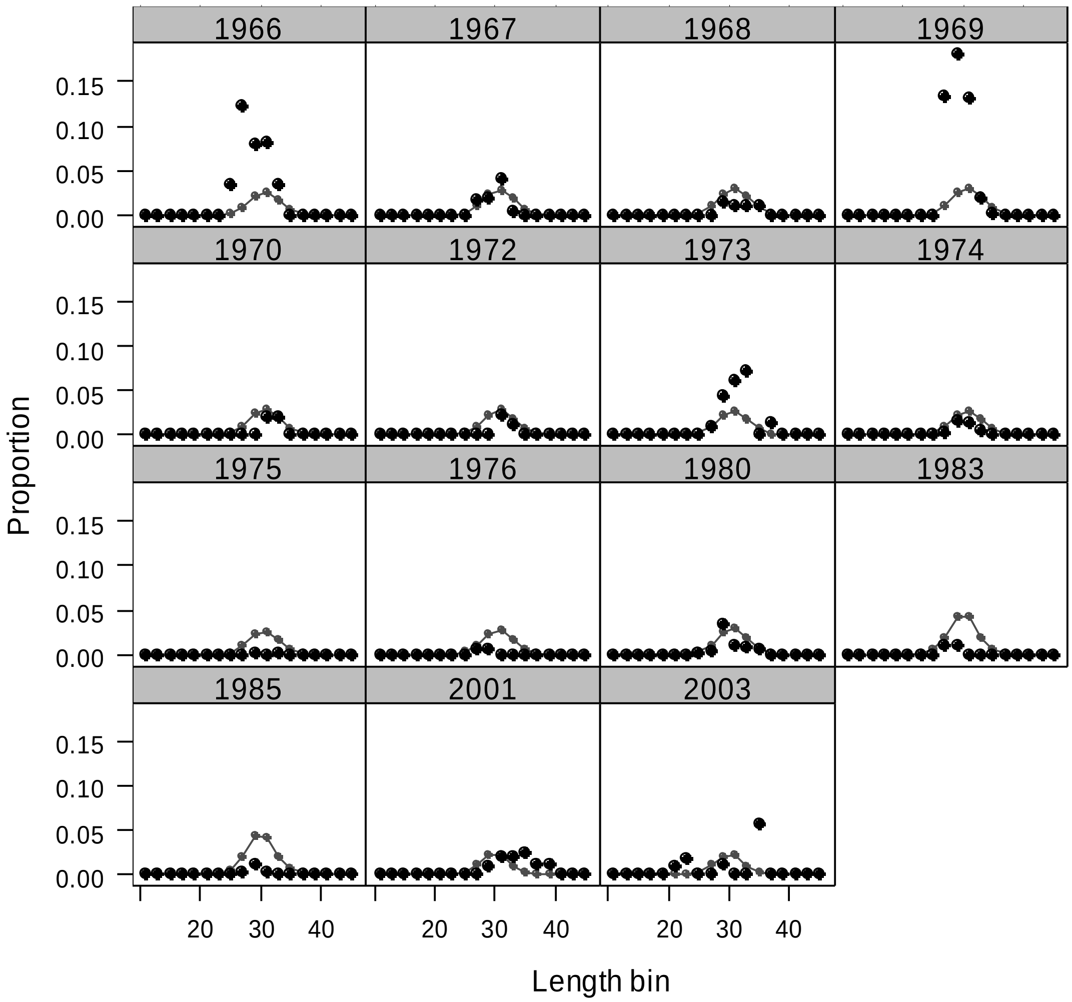


Figure 44. Pearson residuals for the fit to length frequencies for females from the southern fleet.

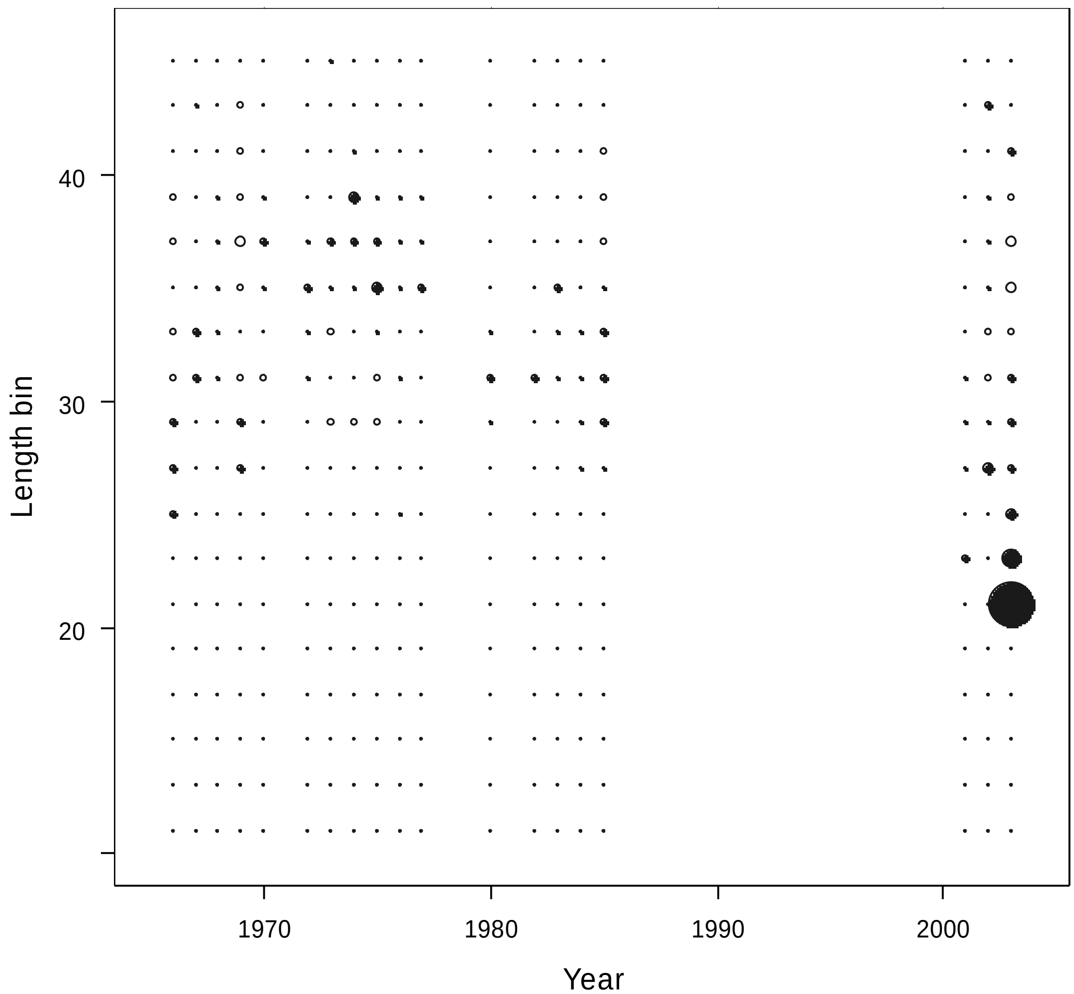


Figure 45. Pearson residuals for the fit to length frequencies for males from the southern fleet.

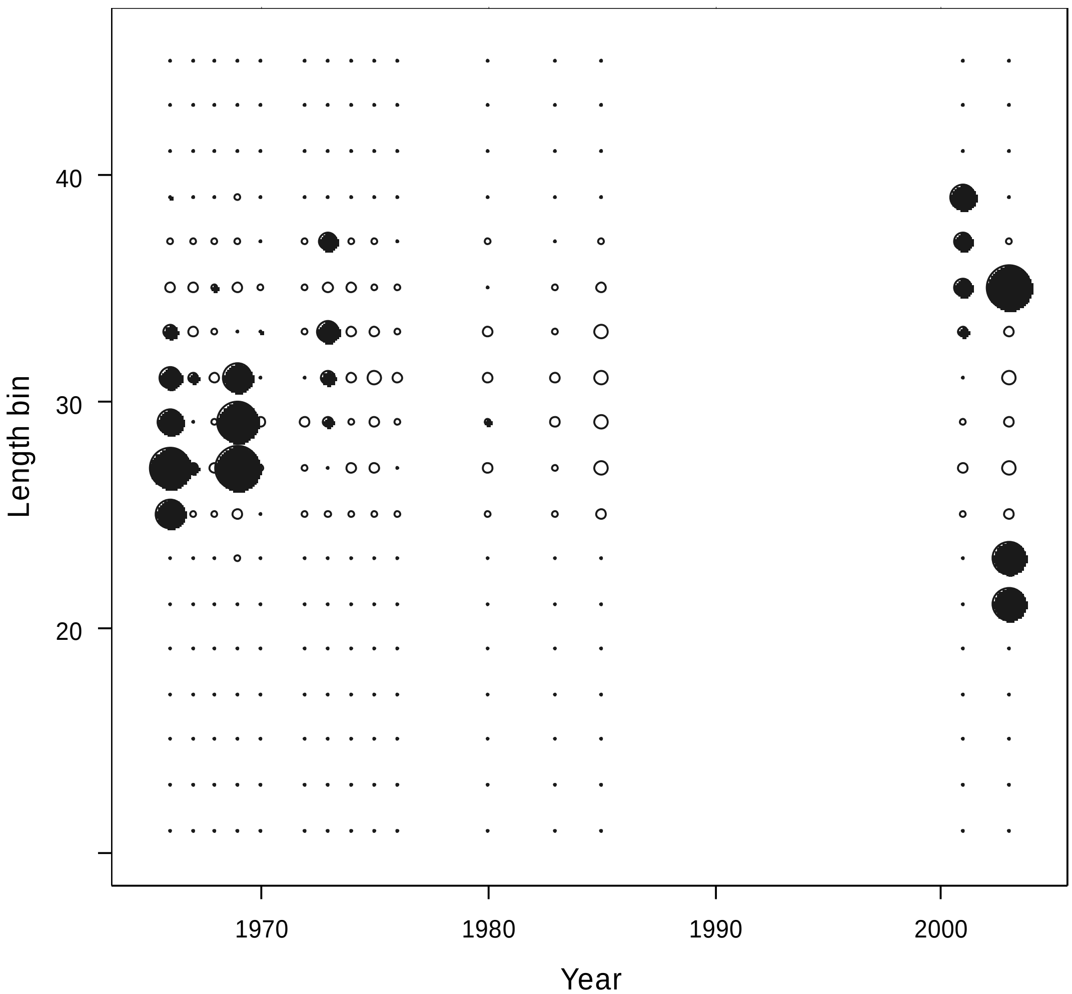


Figure 46. Fit to female length frequency observations from the northern commercial fishery fleet.

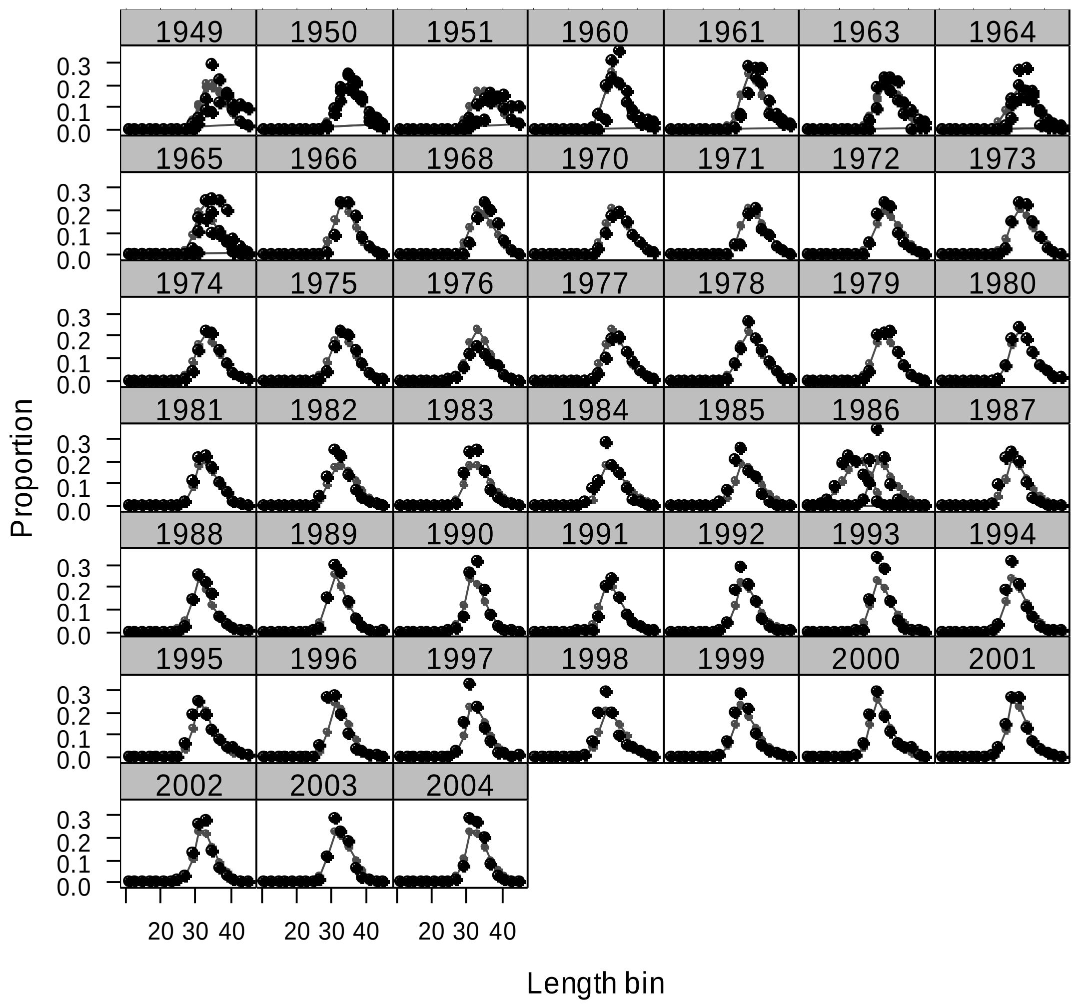


Figure 47. Fit to male length frequency observations from the northern commercial fishery fleet.

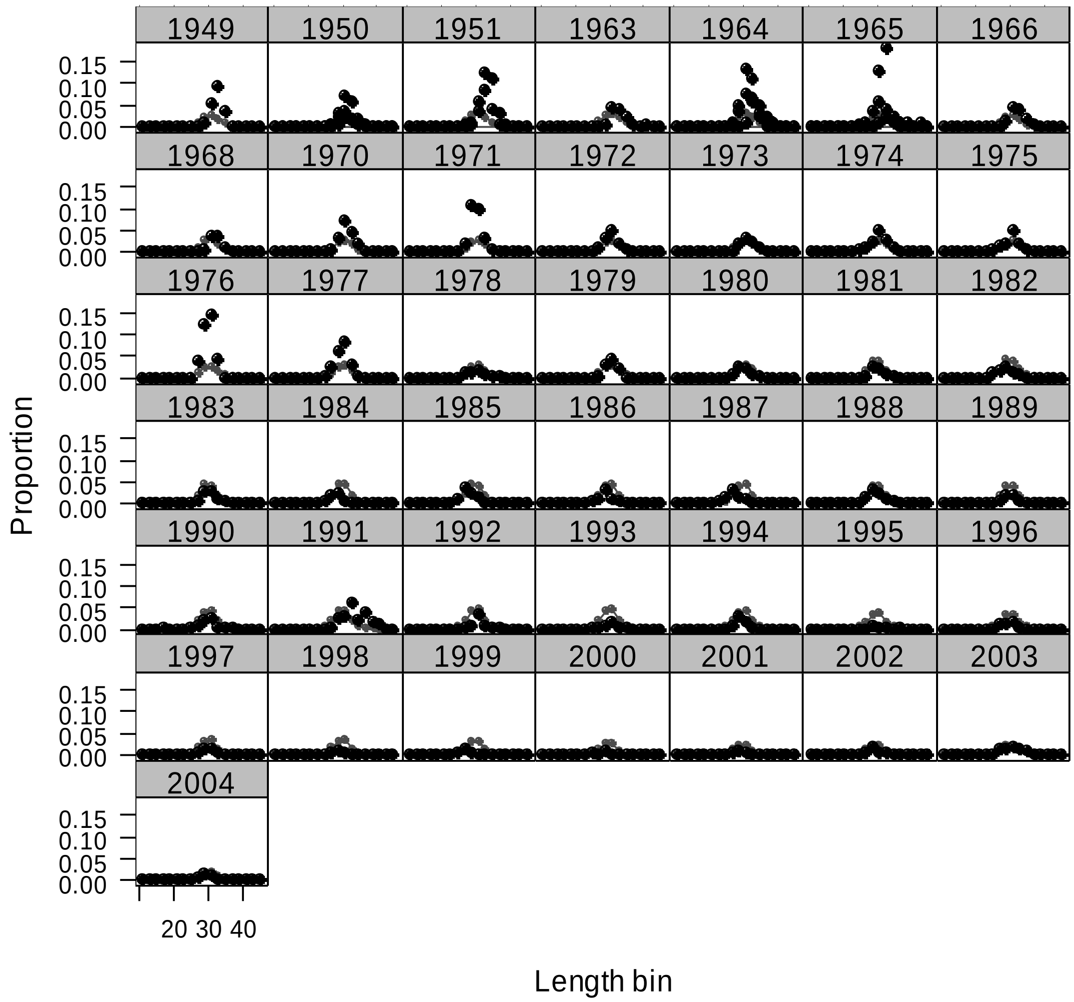


Figure 48. Pearson residuals for length frequencies females (upper panel) and males (lower panel) from the northern commercial fishery fleet.

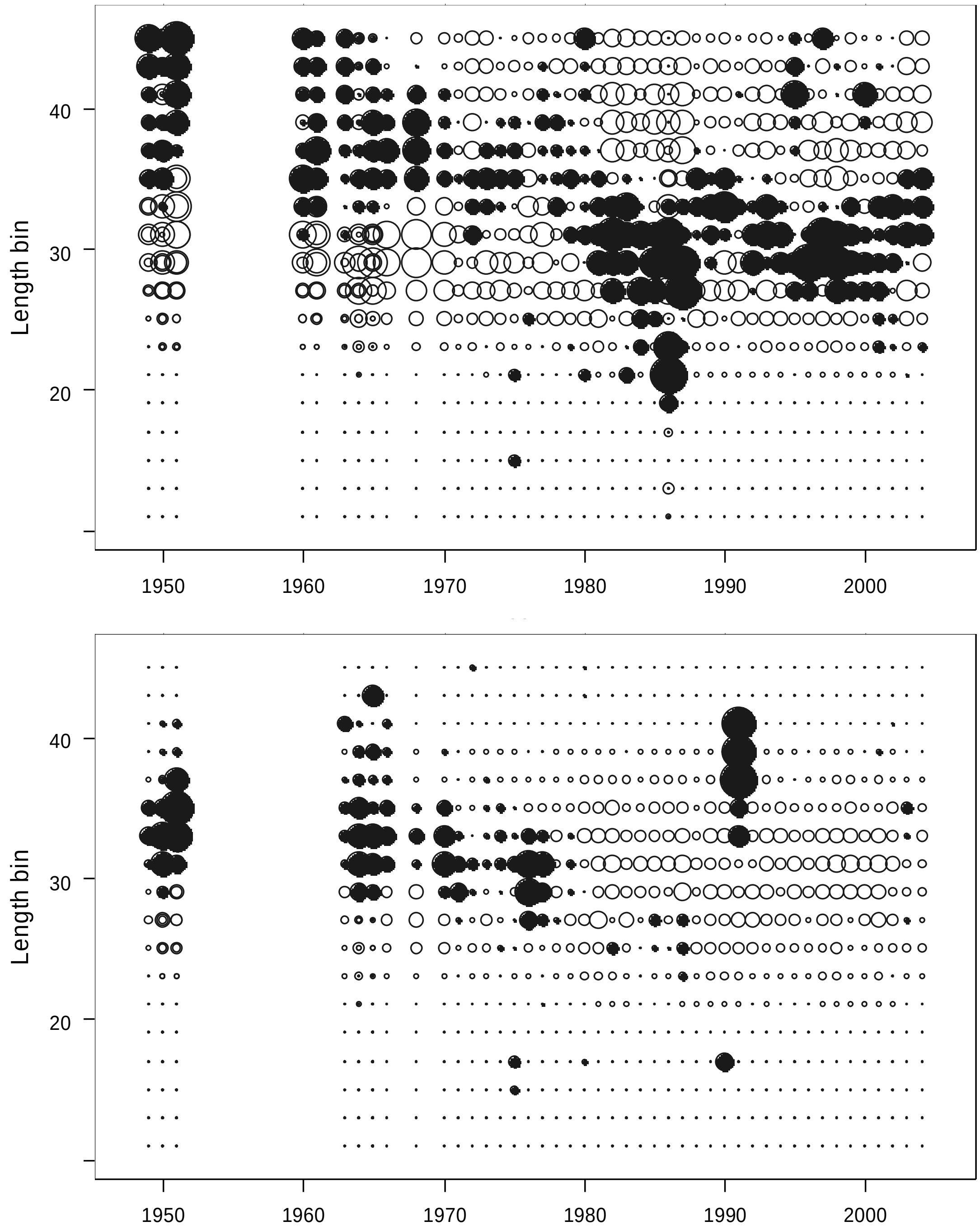


Figure 49. Fit to discard fraction and mean body weight data.

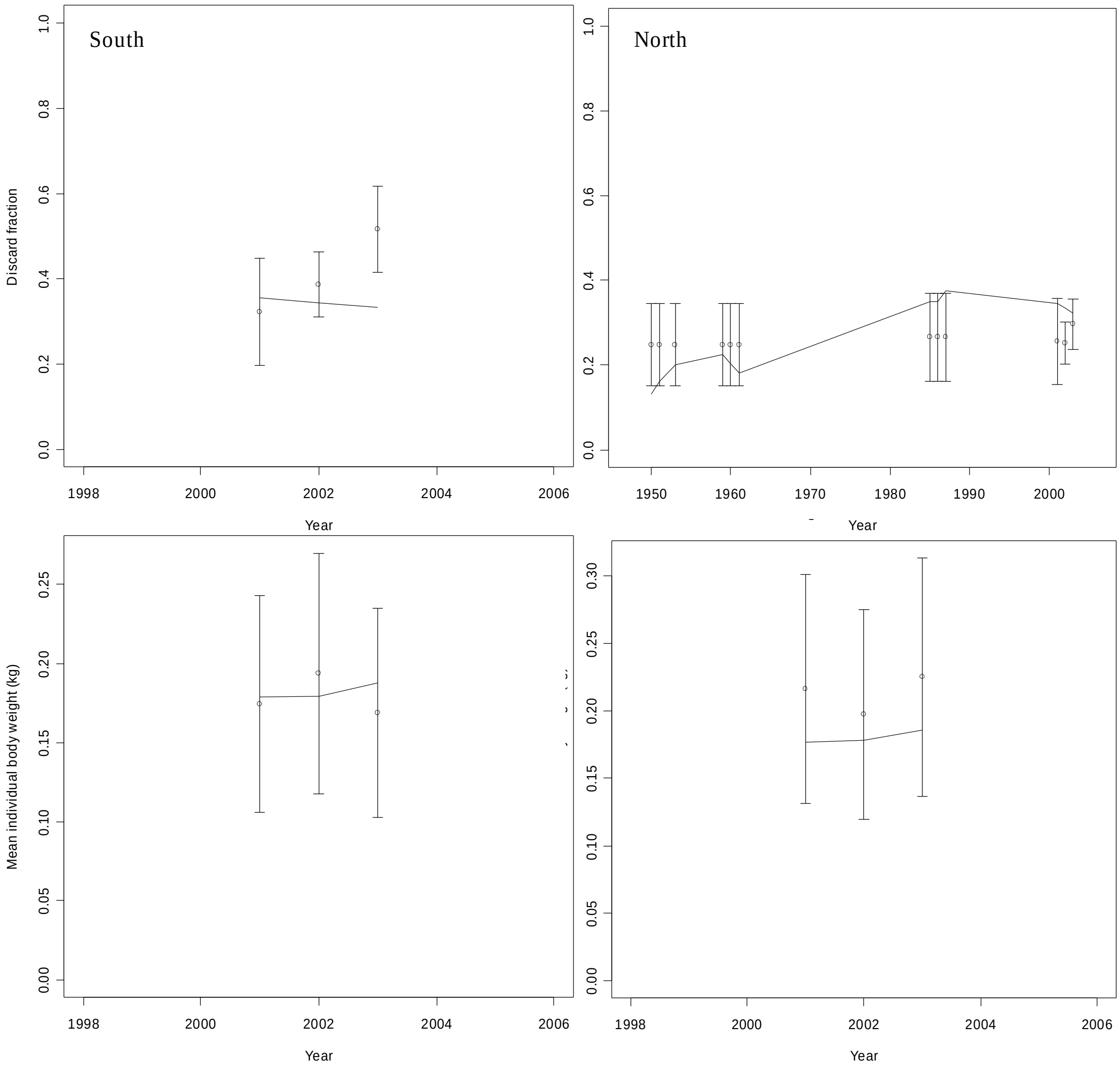


Figure 50. Time series of estimated depletion level, 1874-2005.

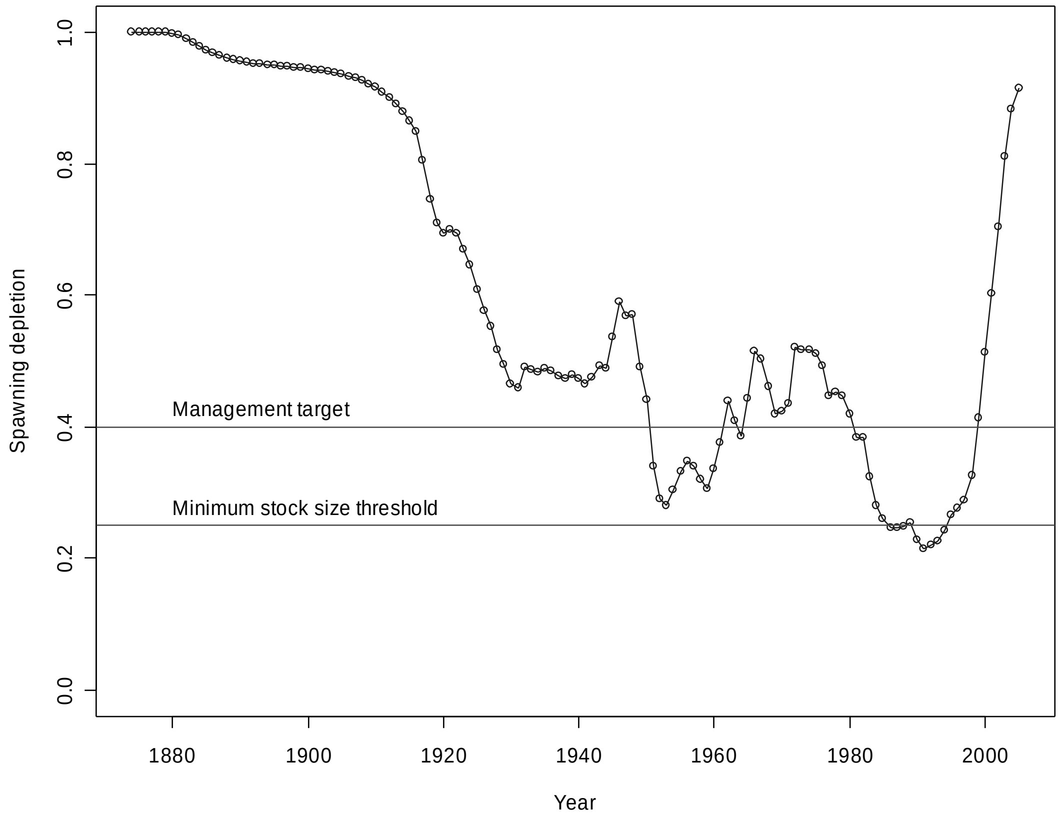


Figure 51. Time series of estimated English sole recruitments.

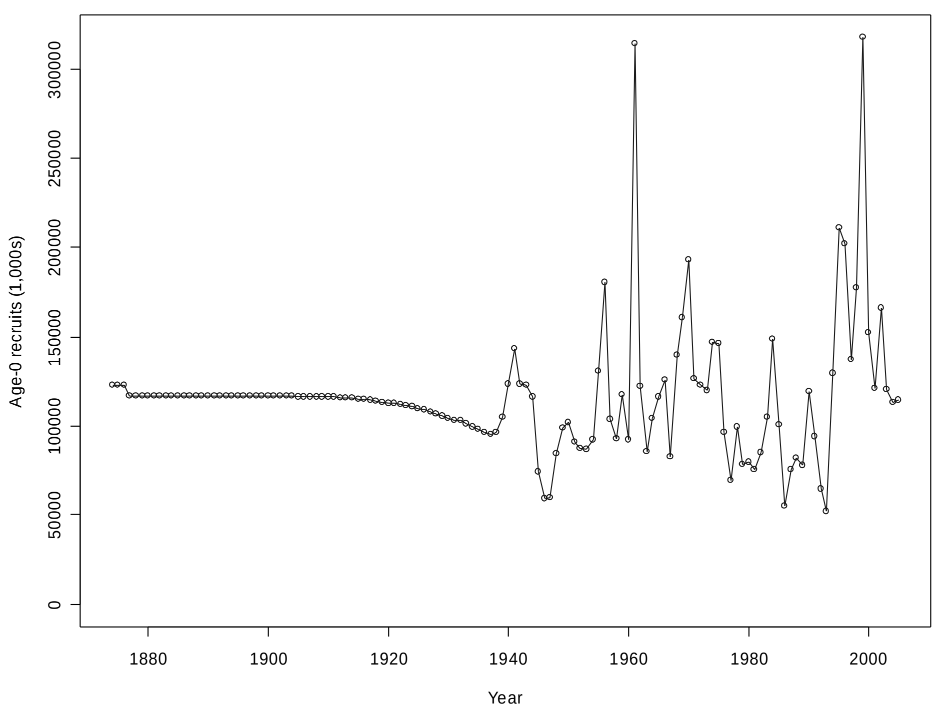


Figure 52. Stock-recruit function with predicted recruitments.

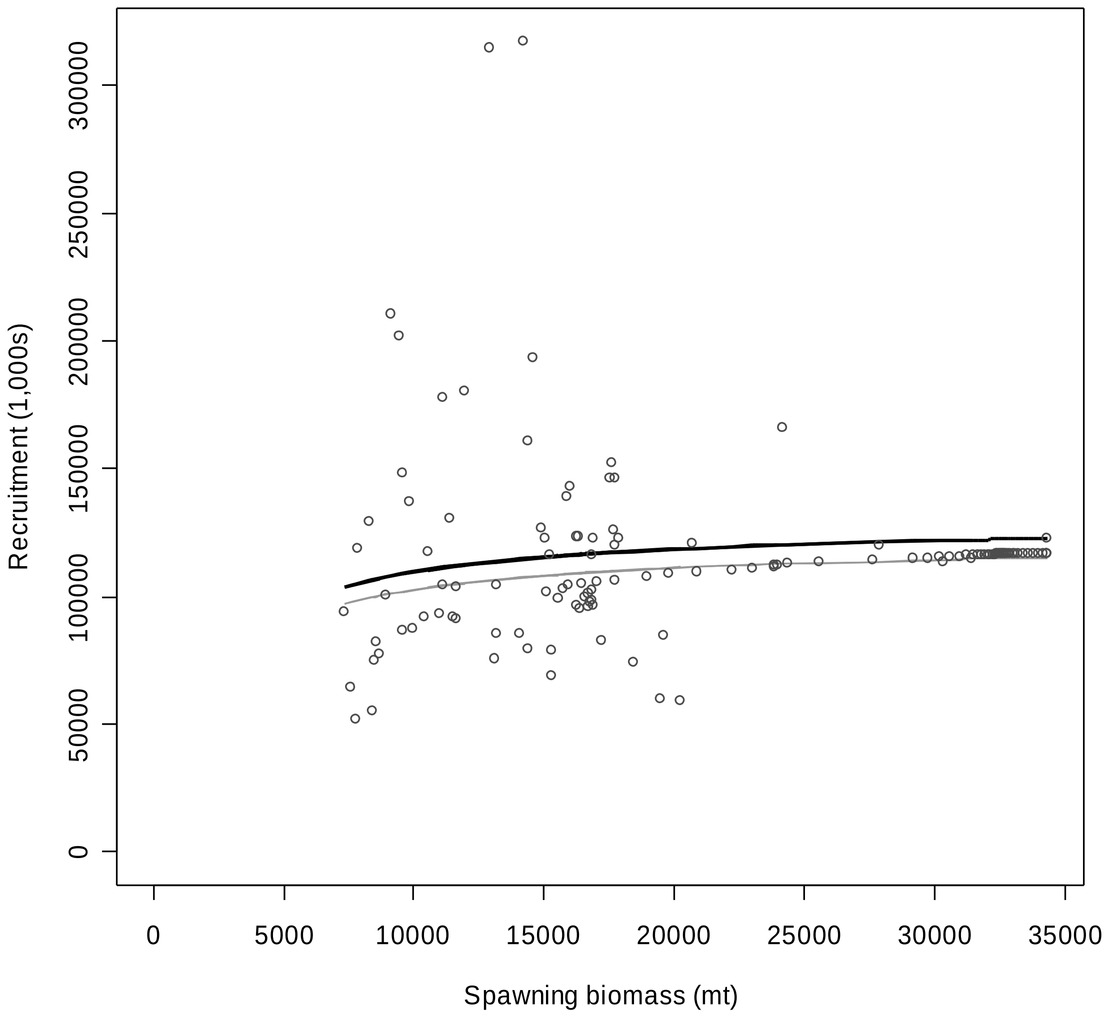


Figure 53. Time series of estimated total catch. Northern and southern fleets shown as light lines; southern fleet is the lower line over the period 1940+.

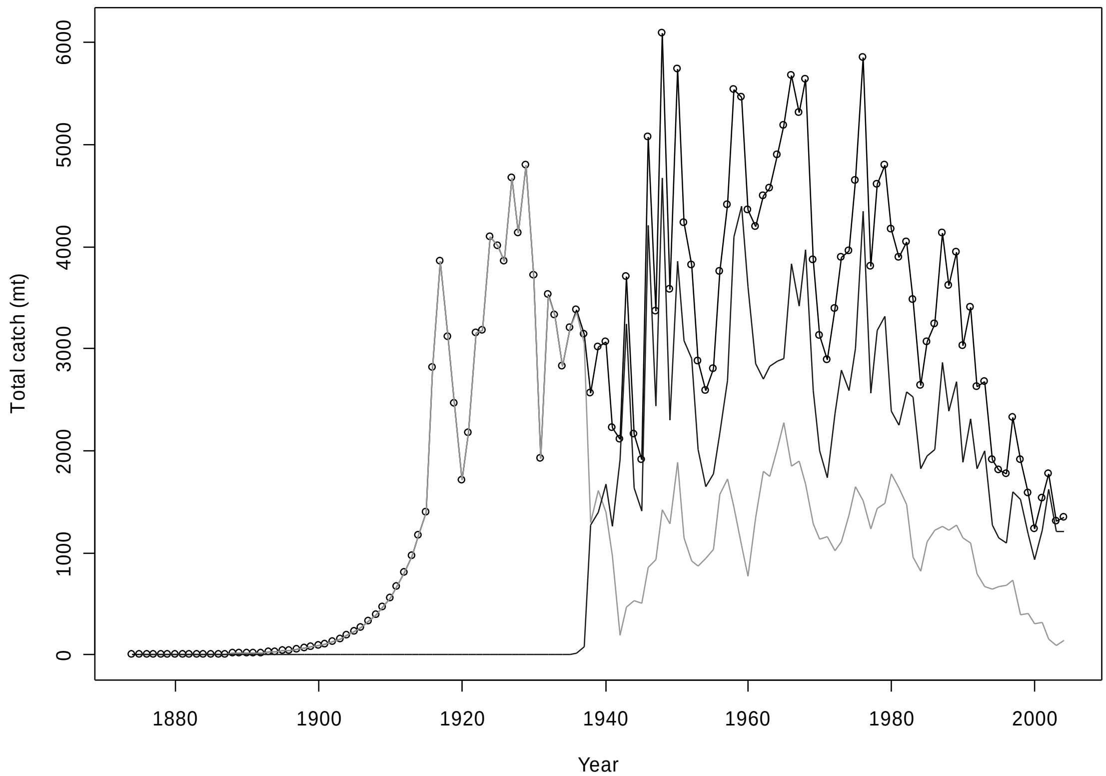


Figure 54. Time series of estimated discards. Northern and southern fleets shown as light lines; southern fleet is the lower line over the period 1940+.

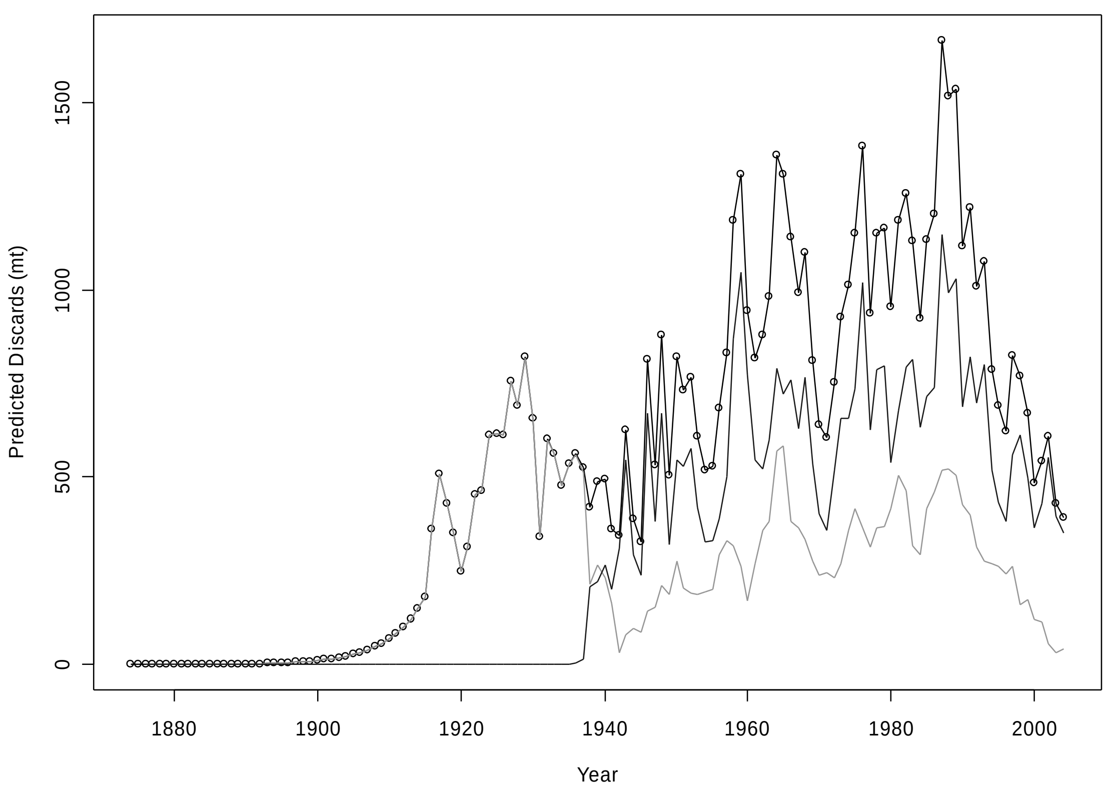


Figure 55. Time series of estimated discard fraction by weight, plotted are total (line with markers), southern and northern fleets separately (thin lines).

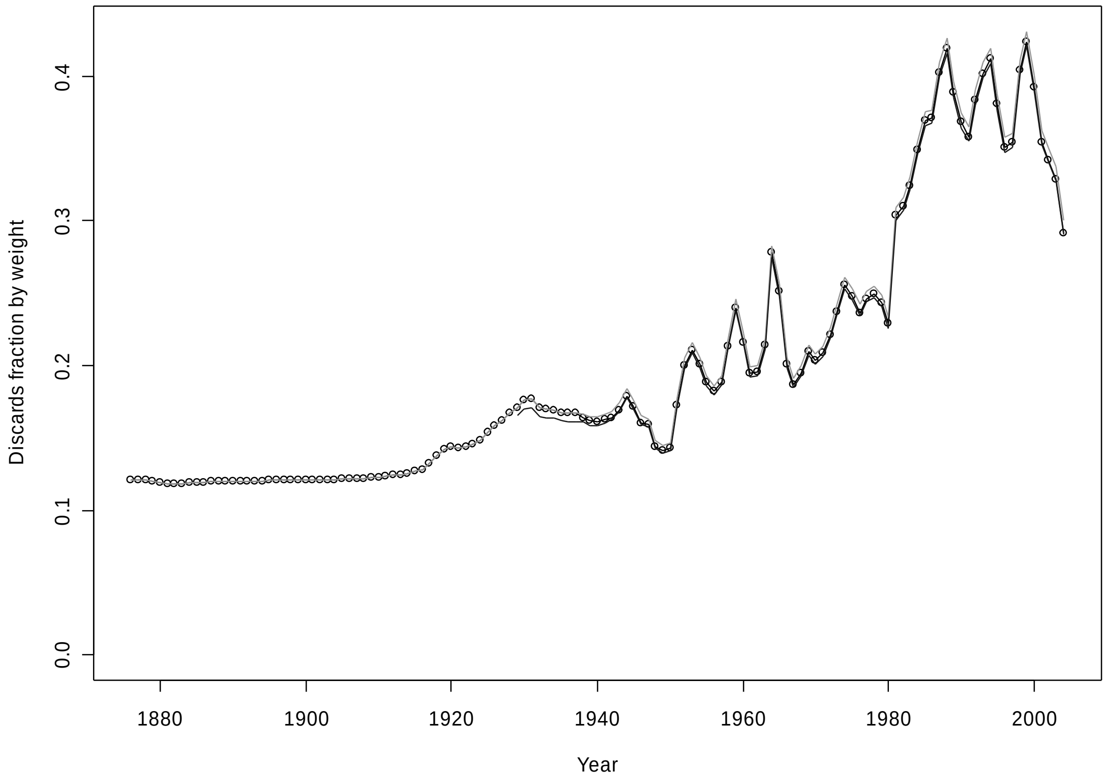


Figure 56. Estimated spawning biomass time-series with approximate asymptotic 95% confidence interval.

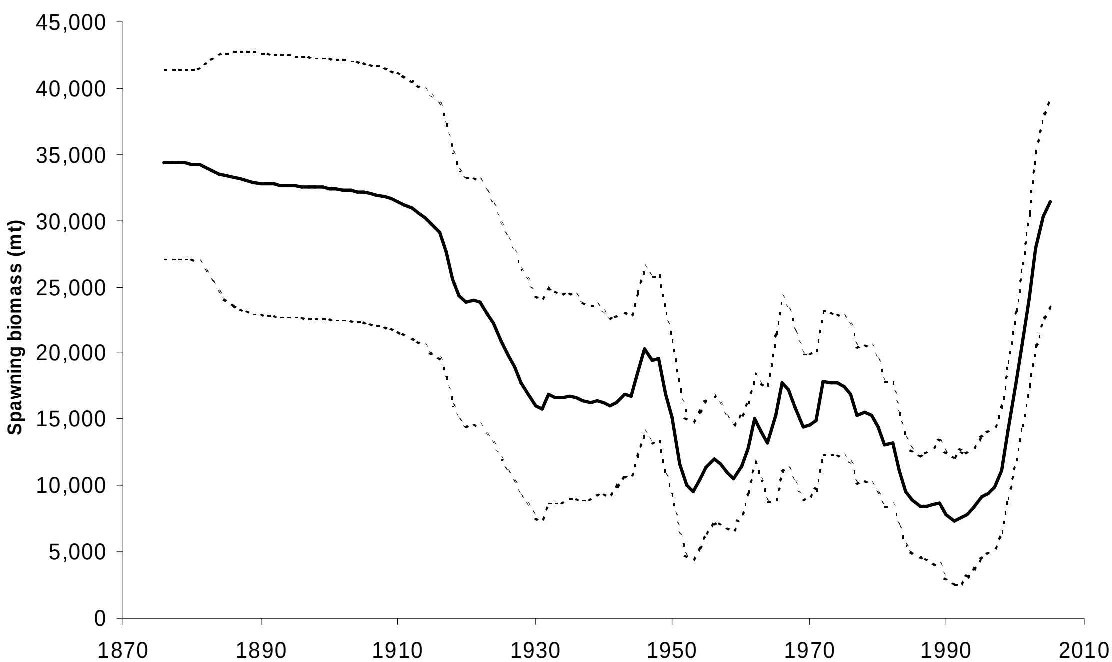


Figure 57. Historical landings series inflated by 50% from the reconstructed values (sensitivity 1).

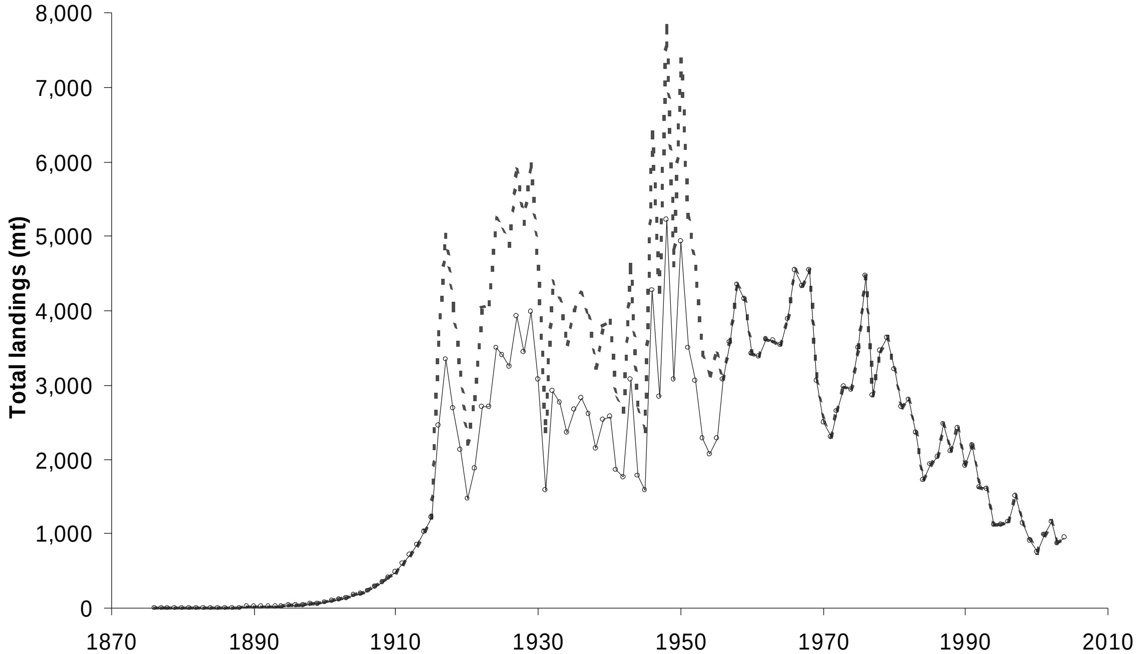


Figure 58. Base case model estimate of recent spawning biomass (with ~95% confidence intervals between the dotted lines) and sensitivity runs constraining recent recruitment after 1998 (run 3) and 1997 (run 4) to be much closer to the deterministic stock-recruit curve.

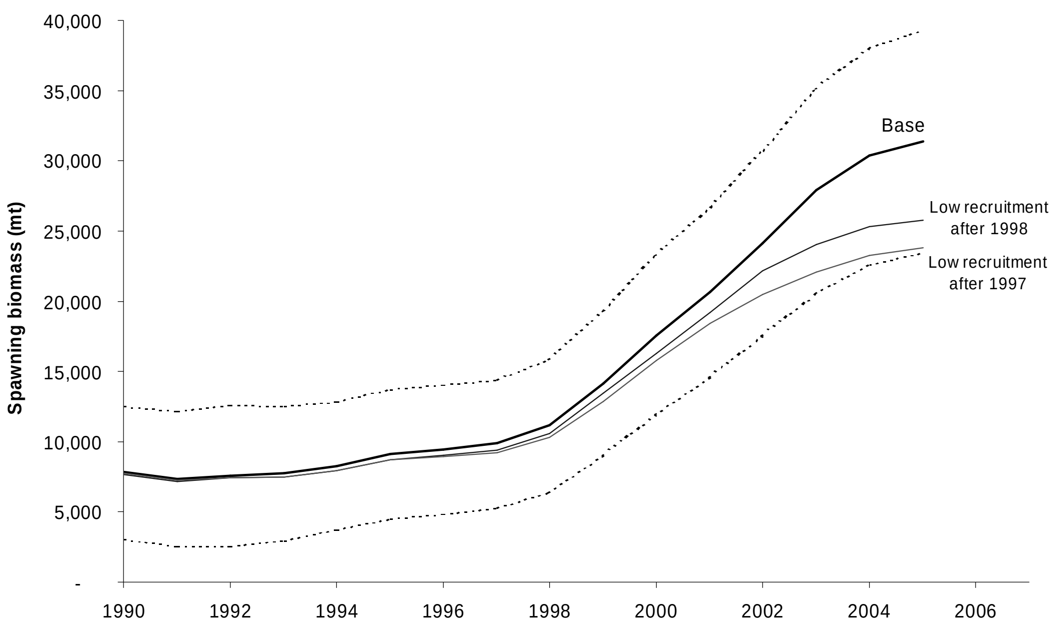


Figure 59. Spawning biomass trajectories from: base case with maturity changing over time, fixed maturity at 1956 estimates (sensitivity 5) and fixed maturity at 1995 estimates (sensitivity 6).

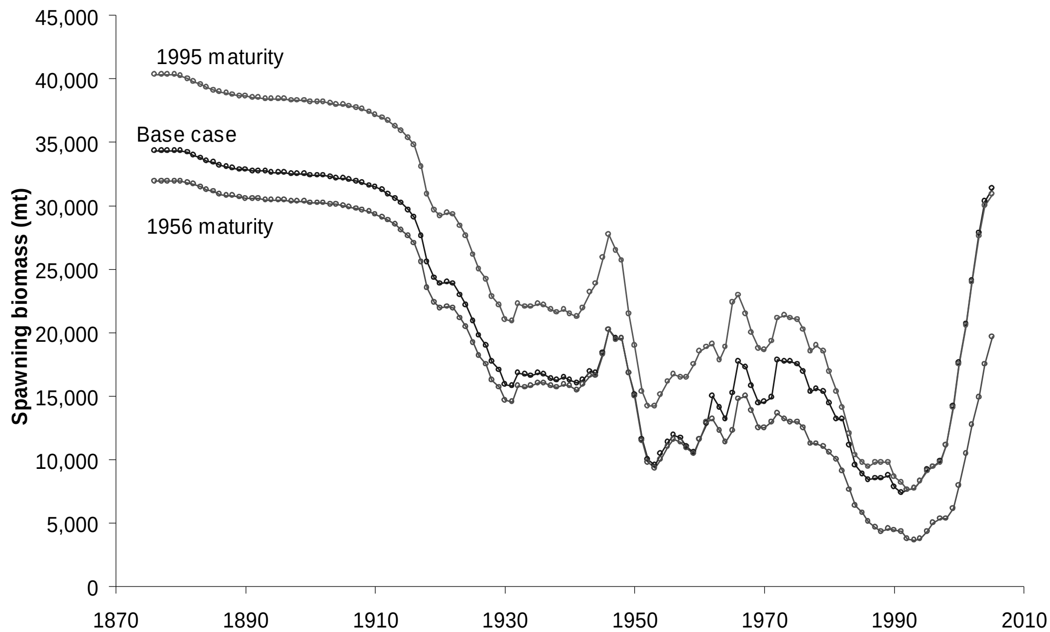


Figure 60. Results of retrospective analyses for the base case model using SS2 version 1.16.

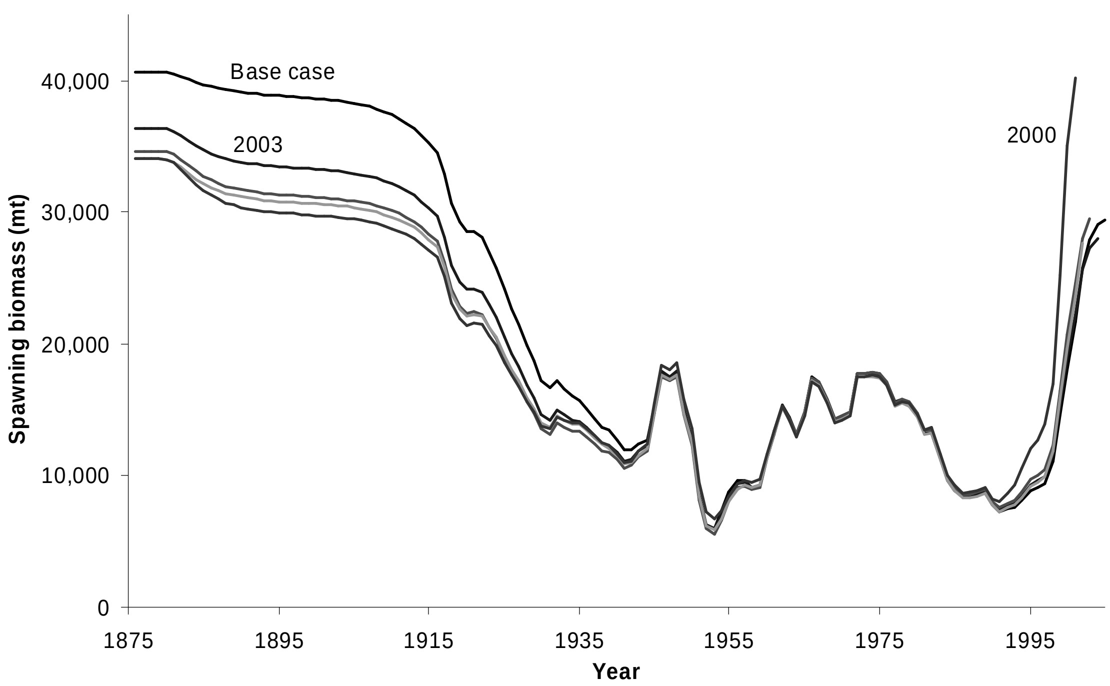


Figure 61. Enhanced growth curve figure for female English sole from the base case model, showing the change in estimated mean length at age, fishery selectivity and length at 50% maturity over the modeled time period.

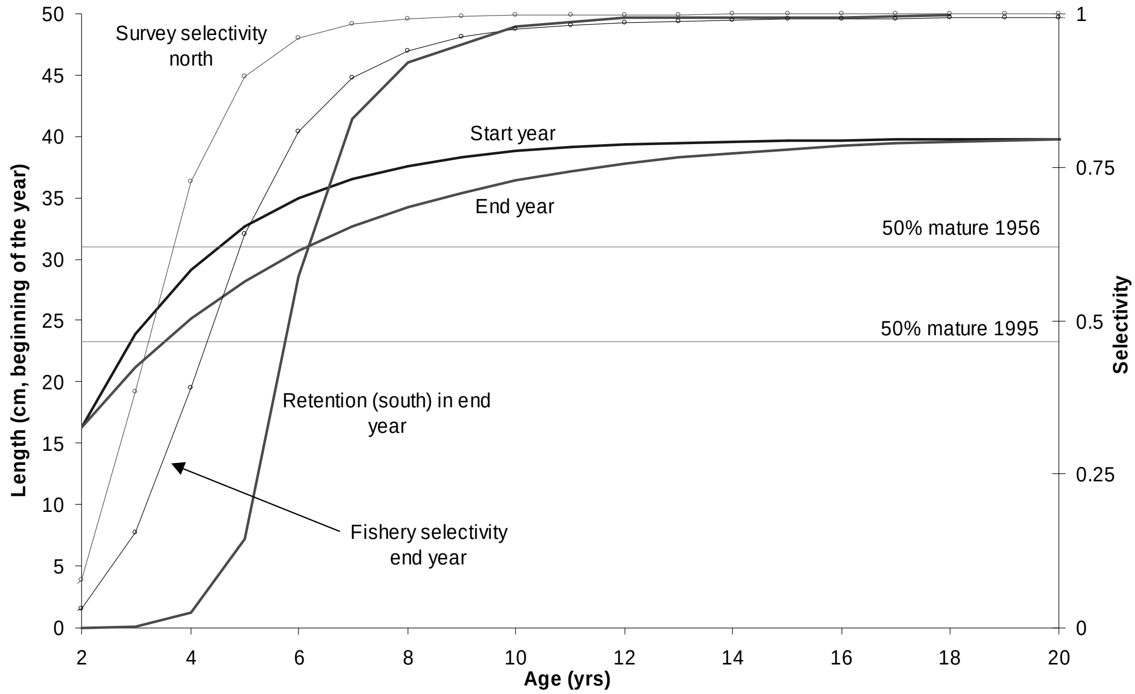


Figure 62. Phase plot of the base case run and sensitivities including the approximate 95% confidence interval for the base case (horizontal line). Estimates of target spawning biomass (B_{40}) are plotted on the x-axis using the same symbols.

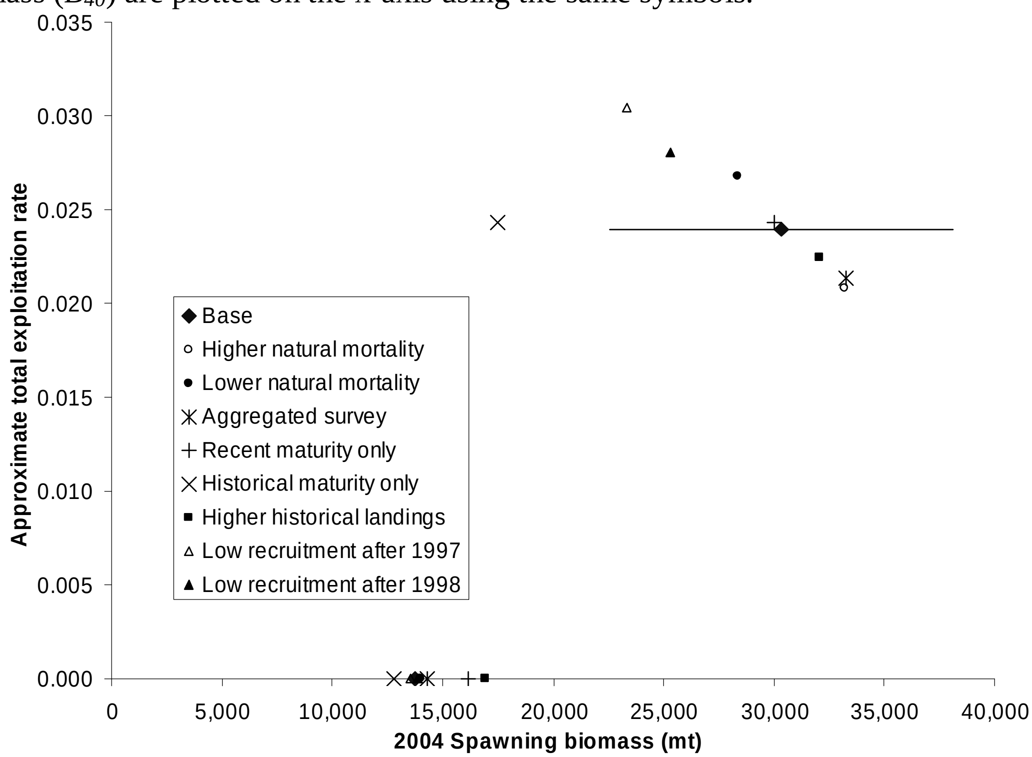


Figure 63. Estimated and predicted future age 8+ biomass and the proportion of the spawning biomass made up of these ages.

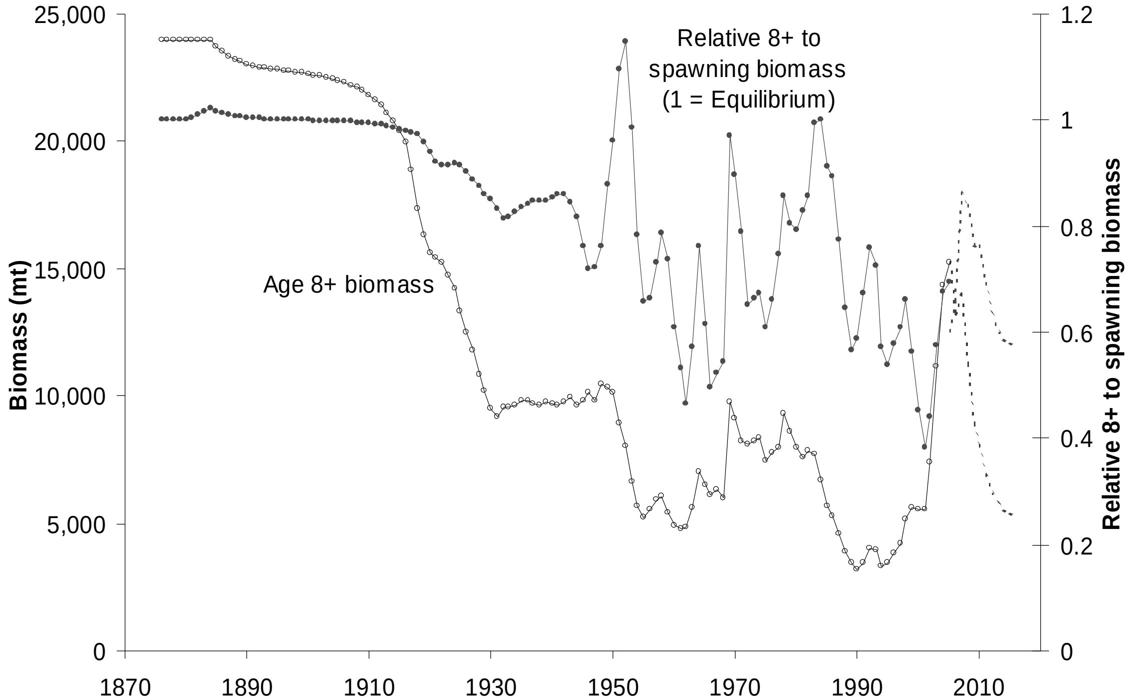


Figure 64. Comparison of the 1971-1976 ODF&W flatfish survey (point and vertical line) to estimates of biomass from the base case model (series). Approximate 95% confidence interval shown for both, based on the estimated CV for spawning biomass from the base case model and assumed CV of 0.2 for the ODF&W survey estimate.

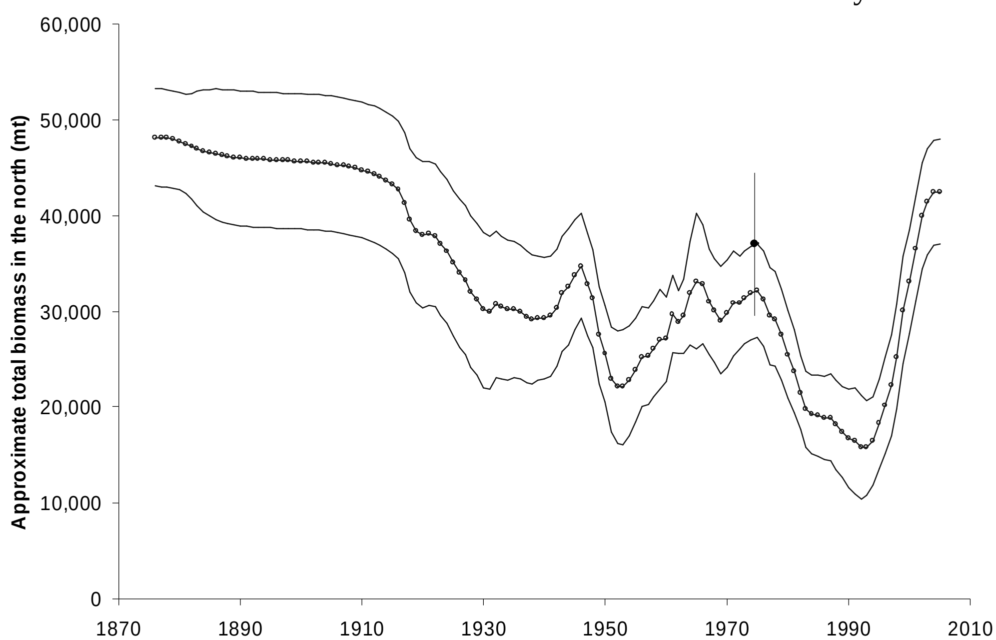


Figure 65. Time series of estimated spawning potential ratio from the base case model.

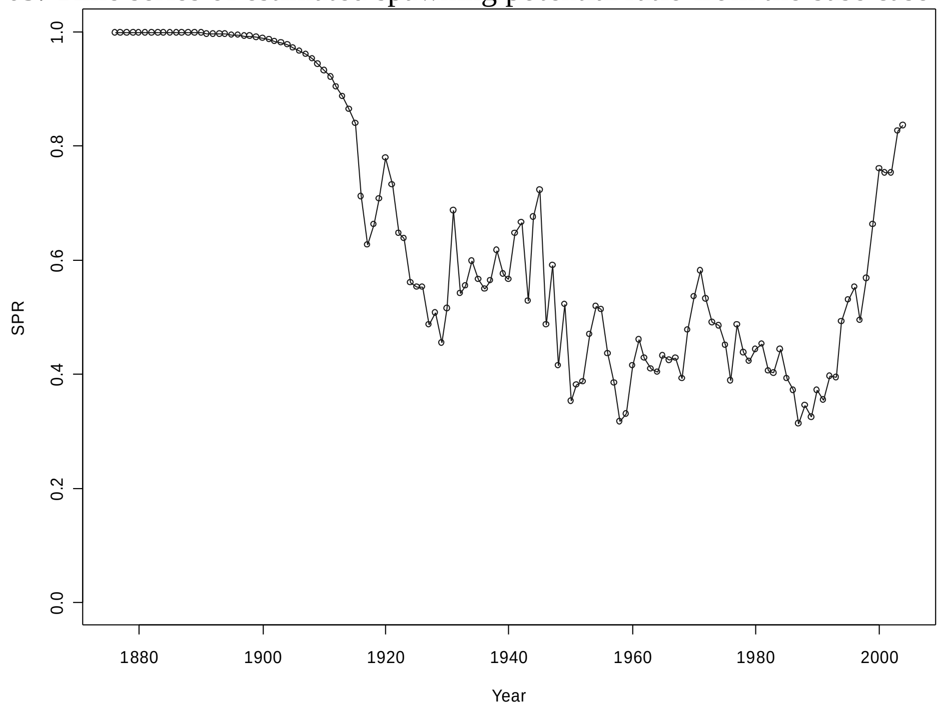


Figure 66. Temporal pattern of estimated spawning potential ratio relative to the proxy target of 40% vs. estimated spawning biomass relative to the proxy 40% level.

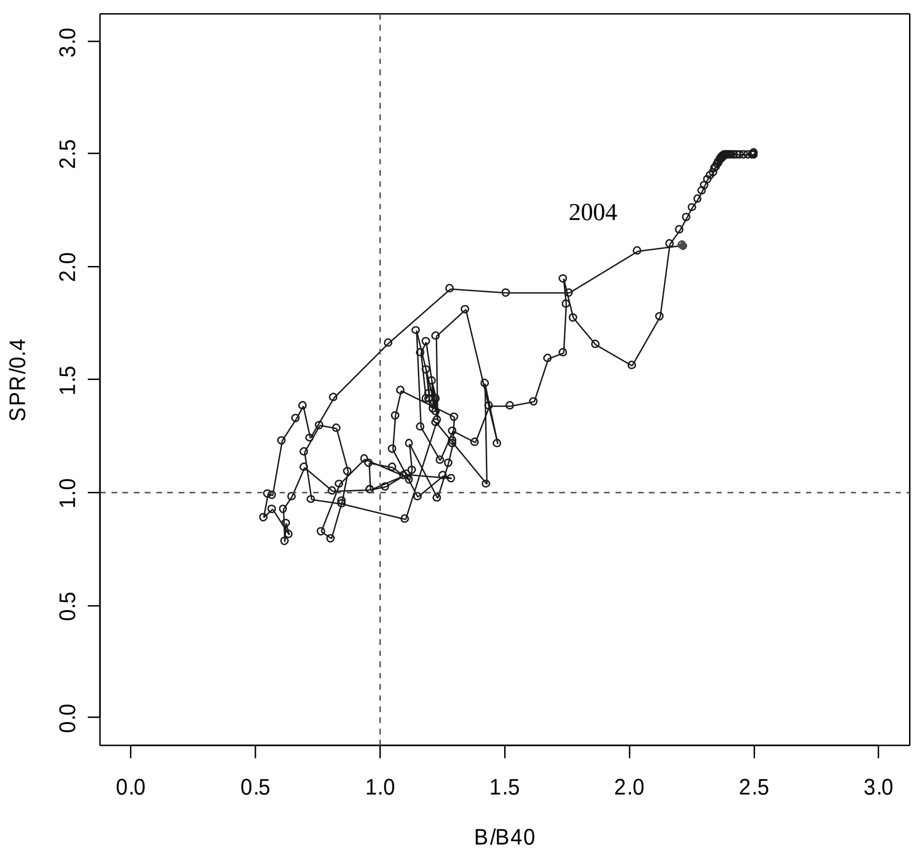
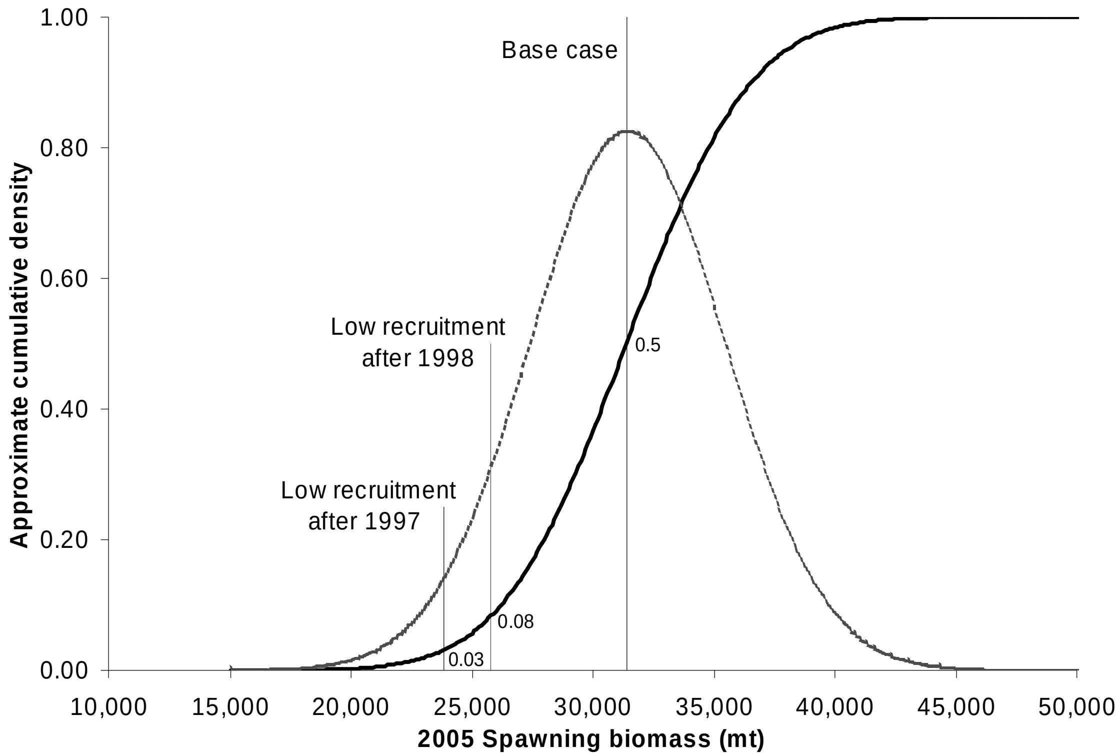


Figure 67. Approximate distribution of uncertainty in estimated 2005 spawning biomass from the base case model (dashed line), and cumulative probability that the spawning biomass is less than each state of nature (solid line).



12. Appendix A: SS2 data file

```
# .dat file for 2005 English sole assessment – base case model
# Most recent update: 3/17/05

### Global model specifications ###
 1876       # Start year
 2004       # End year
 1          # Number of seasons/year
 12         # Number of months/season (vector, by season)
 1          # Spawning occurs at beginning of season
 2          # Number of fishing fleets
 2          # Number of surveys
 # Fleet names (separated by "%")
 South_fishery%North_fishery%South_survey%North_survey
 # Fleet timing (proportion of season)
 0.5417     0.5417     0.5417     0.5417     # Middle of July
 2          # Number of genders (1/2)
 30         # Accumulator age

### Catch section ###
# Initial equilibrium catch (landings + discard in mt) by fishing fleet
 0          # Fleet 1
 0          # Fleet 2
# Landed catch (only) time series (mt) by fleet: current on Feb 1, 2005
# South fishery       North fishery       #       Year
 1                    0                   #       1876
 1                    0                   #       1877
 1                    0                   #       1878
 2                    0                   #       1879
 2                    0                   #       1880
 2                    0                   #       1881
 3                    0                   #       1882
 4                    0                   #       1883
 4                    0                   #       1884
 5                    0                   #       1885
 6                    0                   #       1886
 7                    0                   #       1887
 9                    0                   #       1888
 11                   0                   #       1889
 13                   0                   #       1890
 15                   0                   #       1891
 18                   0                   #       1892
 22                   0                   #       1893
 27                   0                   #       1894
 32                   0                   #       1895
 38                   0                   #       1896
 46                   0                   #       1897
 55                   0                   #       1898
 66                   0                   #       1899
 79                   0                   #       1900
 95                   0                   #       1901
 114                  0                   #       1902
 137                  0                   #       1903
 165                  0                   #       1904
 198                  0                   #       1905
 237                  0                   #       1906
 285                  0                   #       1907
 342                  0                   #       1908
 410                  0                   #       1909
 492                  0                   #       1910
 591                  0                   #       1911
 709                  0                   #       1912
 851                  0                   #       1913
 1021                 0                   #       1914
 1225                 0                   #       1915
 2454                 0                   #       1916
 3343                 0                   #       1917
 2692                 0                   #       1918
```

2118	0	#	1919
1464	0	#	1920
1866	0	#	1921
2698	0	#	1922
2714	0	#	1923
3491	0	#	1924
3393	0	#	1925
3247	0	#	1926
3923	0	#	1927
3442	0	#	1928
3976	3	#	1929
3065	1	#	1930
1580	1	#	1931
2919	6	#	1932
2762	4	#	1933
2350	2	#	1934
2667	5	#	1935
2801	1	#	1936
2547	69	#	1937
1076	1070	#	1938
1351	1176	#	1939
1169	1405	#	1940
808	1054	#	1941
163	1600	#	1942
382	2697	#	1943
429	1350	#	1944
412	1170	#	1945
717	3544	#	1946
776	2056	#	1947
1208	4008	#	1948
1093	1977	#	1949
1607	3311	#	1950
947	2558	#	1951
736	2325	#	1952
681	1590	#	1953
750	1321	#	1954
837	1439	#	1955
1285	1783	#	1956
1390	2190	#	1957
1132	3225	#	1958
808	3350	#	1959
594	2829	#	1960
1082	2301	#	1961
1436	2185	#	1962
1367	2230	#	1963
1453	2085	#	1964
1696	2187	#	1965
1470	3068	#	1966
1540	2786	#	1967
1339	3200	#	1968
1012	2049	#	1969
902	1593	#	1970
909	1383	#	1971
793	1850	#	1972
836	2134	#	1973
1012	1934	#	1974
1227	2267	#	1975
1143	3323	#	1976
927	1940	#	1977
1070	2393	#	1978
1115	2516	#	1979
1362	1851	#	1980
1132.56574	1578.83494	#	1981
1006.0827	1786.47472	#	1982
640.80524	1714.58573	#	1983
529.46582	1191.72513	#	1984
693.65606	1235.9994	#	1985
762.9424	1273.68482	#	1986
746.71822	1724.3838	#	1987
703.98619	1397.12826	#	1988

```
768.19312       1643.77719      #       1989
712.49918       1199.29876      #       1990
692.54427       1492.22493      #       1991
487.71128       1133.93966      #       1992
395.50127       1205.53523      #       1993
371.05758       751.19658 #     1994
410.91257       714.05373 #     1995
433.91513       717.72954 #     1996
465.57864       1037.94394      #       1997
229.23724       909.76402 #     1998
227.41519       684.92666 #     1999
181.06749       568.737         #       2000
199.12321       790.58066 #     2001
101.7096        1066.59335      #       2002
63.5602         813.42591 #     2003
96.45472        853.25042 #     2004

### Abundance indices ###
18      # Total number of observations (all fleets)
# South triennial survey series (N=9)
# Year  Seas    Type    Value           s(log space)
1980    1       3       1084.54         0.38051708
1983    1       3       3927.4          0.3262809
1986    1       3       3161.12         0.25073778
1989    1       3       5547.05         0.26028458
1992    1       3       2326.31         0.28554624
1995    1       3       5309.03         0.25781002
1998    1       3       2169.77         0.17551974
2001    1       3       5201.79         0.26424808
2004    1       3       9283.2          0.28494962
# North triennial survey series (N=9)
# Year  Seas    Type    Value           s(log space)
1980    1       4       3543.76         0.3308871
1983    1       4       4651.16         0.1851065
1986    1       4       6254.23         0.18143098
1989    1       4       8395.31         0.291573
1992    1       4       9509.6          0.20274062
1995    1       4       5992.32         0.22419568
1998    1       4       15312.2         0.16765022
2001    1       4       12550.52 0.18482484
2004    1       4       36112.9         0.30253094

### Discard section ###
# Discard observation setup
2       # Type: 1 = biomass (mt),2 = fraction (D/(D+R)) by weight
15      # Total number of discard observations all fleets and years
# Year Season   Type    Value           CV
# Herrman and Harry
1950    1       2       0.247776 0.2
1951    1       2       0.247776 0.2
1953    1       2       0.247776 0.2
1959    1       2       0.247776 0.2
1960    1       2       0.247776 0.2
1961    1       2       0.247776 0.2
# Pikitch
1985    1       2       0.266101 0.2
1986    1       2       0.266101 0.2
1987    1       2       0.266101 0.2
# WCGOP
2001    1       1       0.322514 0.2
2001    1       2       0.256417 0.2
2002    1       1       0.386503 0.1
2002    1       2       0.252199 0.1
2003    1       1       0.516129 0.1
2003    1       2       0.297193 0.1

# Mean body weight observations
6       # Total number of mean body weight observations
# Partition = 1: discarded catch
#                       2: retained catch
```

```
#                               0: whole catch (R+D)
# Year  Seas   Type   Partition          Value (kg) CV
 2001   1      2      1                  0.216064   0.2    # North
 2001   1      1      1                  0.174273   0.2    # South
 2002   1      2      1                  0.197522   0.2    # North
 2002   1      1      1                  0.193660   0.2    # South
 2003   1      2      1                  0.225127   0.2    # North
 2003   1      1      1                  0.168816   0.2    # South

### Length and age frequencies ###
 -1     # Minimum proportion for compressing tails of observed compositional data
 0.0001 # Constant added to expected frequencies
 18     # Number of length bins for data inputs
# Lower edge of length bins by bin
 11     13     15     17     19     21     23     25     27     29     31     33
        35     37     39     41     43     45
 88     # Total number of length observations all fleets and years
# Gender = 0: sexes combined into length bins
#                   1: females only (enter zeros for male length bins)
#       2: males only (enter zeros for female length bins)
#       3: both males and females, total should sum to 1.0
# Survey length data for the south (N=6)
# Year  Seas   Type   Gender  Partition  Nsamp   Data: females then males
 1989   1             3                  3              0                92
        0      0      9.0593E-05         0.000543558    0.001882805      0.017690798
        0.043032522   0.05740095         0.086522499    0.099978647      0.112685463
        0.087397378   0.058144033        0.022712904    0.00470682       0.001997912
        0.000215643   0.000362943        0    0.000271779    0          0.003816385
        0.017461519   0.077863095        0.117018195    0.100298085      0.047523997
        0.026590702   0.009099757        0.003385488    0.000687416      0.000618113   0
        0      0      0
 1992   1             3                  3              0                83
        0      0      0.000709075        0.004018089    0.018290575      0.041913472
        0.074019795   0.095752434        0.089234429    0.092693326      0.072448716
        0.042045624   0.034634168        0.011855165    0.005987782      0.002768271   0
        0      0      0      0.000472716     0.009165093     0.061705911     0.109878009
        0.10237328    0.081626761        0.031179904    0.014389128      0.002048266
        0.000553654   0      0           0.000236358    0       0        0
 1995   1             3                  3              0                60
        0      0      0.000369845        0.003608979    0.037434326      0.064605332
        0.079816026   0.103606205        0.112234338    0.10780415       0.083694642
        0.051006802   0.018805137        0.009819756    0.002592208      0.001152464
        0.000263412   0      0           0    0.002124794     0.01070435      0.025734117
        0.074687528   0.099265818        0.069597155    0.029722568      0.009463339
        0.001524483   0.000362228        0      0       0       0       0       0
 1998   1             3                  3              0                48
        0      0      0.001643203        0.016224501    0.059462041      0.079856283
        0.096493625   0.11563298         0.119971335    0.082227827      0.048622211
        0.032886529   0.028206564        0.012898205    0.004895907      0       0       0
        0      0.000547734   0.018896838     0.049702636     0.07674426      0.071820043
        0.054585234   0.019674855        0.007760518    0.000623335      0.000623335   0
        0      0      0      0      0      0
 2001   1             3                  3              0                88
        0      0      0.002584248        0.017094995    0.055457738      0.09387469
        0.104852024   0.114530704        0.104450125    0.076034623      0.055928952
        0.034813796   0.025232426        0.010028357    0.004798327      0.001395712
        0.000386404   9.2333E-05         0    0.000275023    0.005535617     0.054015703
        0.0874694 0.06849439   0.043602578     0.02132164      0.009456799     0.004501565
        0.001621893   0.000775647        0.000890185    0.000340248      0.000143858   0
        0      0
 2004   1             3                  3              0                71
        0      0      0.001683594        0.017802739    0.052502596      0.06651942
        0.080579359   0.080997636        0.073139101    0.080201267      0.077080755
        0.061542448   0.036309612        0.01486525     0.006501602      0.001935215
        0.000376271   0.000138364        0    7.42559E-05     0.006875097     0.053734703
        0.101652412   0.100287227        0.052678281    0.018237181      0.007644036
        0.003092956   0.001630937        0.000637952    0.000570831      0.000423487
        0.000285416   0      0           0
# Survey length data for the north (N=6)
# Year  Seas   Type   Gender  Partition  Nsamp   Data: females then males
```

1989 1 4 3 0 129
0 8.48359E-05 0.001093002 0.002672045 0.011299104 0.013525611
0.031282953 0.07020961 0.115576671 0.144904208 0.134982615
0.086023082 0.046439598 0.02292265 0.013228431 0.007649961
0.00385482 0.000691735 0 0 0.001093002 0.004260209
0.008768149 0.031815373 0.058159954 0.069637743 0.065663243
0.036385814 0.0123338 0.003621121 0.001588045 7.55025E-05 0.000157111
0 0 0
1992 1 4 3 0 126
0 0 0 0.002929655 0.01326888 0.02047313 0.046059307
0.079203921 0.085944669 0.09808213 0.100882175 0.057225573
0.041764258 0.020433095 0.01359351 0.005265782 0.001652169
0.000833518 0 3.23438E-05 0.001377011 0.008863454 0.032626791
0.062041854 0.077903864 0.099238363 0.074099575 0.039509259
0.010232545 0.004360946 0.00093805 0.00016613 0.000998041 0
0 0
1995 1 4 3 0 89
0 0 4.9166E-05 0.000965118 0.007423183 0.038455658
0.086626206 0.144685143 0.142331412 0.125595742 0.098745792
0.053099166 0.023269908 0.008241572 0.003336421 0.002004675 9.8332E-
05 0.001488045 0 0.000182527 0.001414367 0.00201552 0.024755217
0.05972357 0.065325399 0.051520561 0.035168752 0.013395084
0.006914826 0.003075651 9.29858E-05 0 0 0 0 0
1998 1 4 3 0 204
0 0 0.00070698 0.004726735 0.035293332 0.08701707
0.106776942 0.104809801 0.103097165 0.086028795 0.05534553
0.031271021 0.017991773 0.006469067 0.002238109 0.000924187
0.00027375 3.12008E-05 0 0.000121053 0.001062274 0.012798197
0.066871353 0.106051552 0.083448037 0.051276637 0.018710711
0.007953769 0.003572276 0.001371374 0.001295737 0.000772575
0.00017326 0.00013141 0.000320383 0.001067944
2001 1 4 3 0 176
0 0.000179413 0.001870202 0.010891118 0.019558364 0.035304413
0.066135938 0.101249019 0.133245854 0.117782676 0.095376783
0.067132429 0.033303745 0.013944654 0.004653144 0.001868397
0.00085079 0.000376384 0 0.000164483 0.009706475 0.026136267
0.0440181 0.049207914 0.063255887 0.052120029 0.031083111 0.012726195
0.005233086 0.001657857 0.000347316 0.000511864 0 0 0
0
2004 1 4 3 0 158
0 0 0.000190083 0.001158237 0.006508908 0.014560214
0.028699945 0.058134695 0.116224176 0.164183128 0.136589405
0.115406718 0.058604694 0.022664915 0.006218393 0.002273437
0.000596889 0.000408828 0 0 0 0.002538751 0.015176722
0.044008563 0.058849114 0.064818935 0.050896126 0.020486649
0.006958786 0.002143725 0.001030113 0.000444921 0.000224928 0
0 0
Fishery length data for the south (N=19)
Year Seas Type Gender Partition Nsamp Data: females then males
1966 1 1 3 2 13 0 0 0 0 0 0
0 0.010607436 0.038161767 0.086263561 0.066428276 0.176553162
0.158431476 0.078419986 0.019039408 0.013394351 0.000111291
0.000333873 0 0 0 0 0 0 0 0.033938235
0.1222925 0.080633331 0.081629846 0.033371981 0 0 0.000389519
0 0 0
1967 1 1 3 2 10 0 0 0 0 0 0
0 0 0 0.024546112 0.176346335 0.290402633 0.176215142
0.129626353 0.075362418 0.015785784 0.027012708 0.000538939 0
0 0 0 0 0 0 0 0.017530921 0.020222219
0.041739629 0.004670806 0 0 0 0 0 0
1968 1 1 3 2 9 0 0 0 0 0 0
0 0 0 0.037236577 0.126660417 0.213758019 0.207508638
0.193871176 0.118744315 0.032428144 0.015769191 0.006160661 0
0 0 0 0 0 0 0 0 0.014756803
0.011290712 0.011290712 0.010524635 0 0 0 0 0
1969 1 1 3 2 16 0 0 0 0 0 0
0 0 0.035727698 0.085724305 0.077301371 0.179771059
0.116516961 0.026249729 0.008325402 0.003135378 0.000192444 0
0 0 0 0 0 0 0 0 0.134489816

0.180720433 0.131318713 0.01936231 0.001164383 0 0 0
0 0
1970 1 1 3 2 2 0 0 0 0 0 0
0 0 0 0.037862594 0.018931297 0.160000001 0.27053435
0.331603053 0.119999992 0.009465653 0 0.009465653 0 0
0 0 0 0 0 0 0 0 0.021068703
0.021068703 0 0 0 0 0 0
1972 1 1 3 2 4 0 0 0 0 0 0
0 0 0 0.034345885 0.201838121 0.222055512 0.269116848
0.14498059 0.080456134 0.013975155 0 0 0 0 0
0 0 0 0 0 0 0 0.022598991 0.010632764
0 0 0 0 0 0
1973 1 1 3 2 7 0 0 0 0 0 0
0 0 0 0.017961646 0.114368039 0.130427896 0.193238272
0.206826937 0.07835061 0.035517212 0.003414131 0.019089967 0
0 0 0 0 0 0 0 0.009544983 0.043879876
0.06126344 0.071479316 0 0.014637674 0 0 0 0
1974 1 1 3 2 8 0 0 0 0 0 0
0 0 0 0.024254155 0.104070662 0.162554991 0.194718726
0.22322011 0.191412222 0.043177798 0.016160568 0.001428438 0
0 0 0 0 0 0 0 0.002958906 0.015054915
0.014857655 0.006130854 0 0 0 0 0 0
1975 1 1 3 2 7 0 0 0 0 0 0
0 0 0 0 0.038883815 0.281605388 0.406505073
0.189856129 0.066752285 0.008825705 0.00384879 0.001729793 0
0 0 0 0 0 0 0 0 0.001128126 0
0.000864897 0 0 0 0 0 0
1976 1 1 3 2 2 0 0 0 0 0 0
0 0.006213925 0.012427849 0.018641771 0.253919189 0.14856638
0.188814935 0.216635646 0.142352456 0 0 0 0 0
0 0 0 0 0 0 0.006213925 0.006213925 0
0 0 0 0 0 0 0
1977 1 1 1 2 1 0 0 0 0 0 0
0 0 0 0 0.019999999 0.22 0.4 0.18 0.160000001
0.019999999 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1980 1 1 3 2 9 0 0 0 0 0 0
0 0 0.006359144 0.091780051 0.276280825 0.255473239
0.150941949 0.102065136 0.033350636 0.01509522 0.002768222 0
0 0 0 0 0 0 0 0.001340749 0.003352362
0.035277712 0.011421153 0.008958662 0.00553494 0 0 0
0 0
1982 1 1 1 2 2 0 0 0 0 0 0
0 0 0.012747559 0.101980474 0.541087867 0.114728033
0.101980474 0.101980474 0.025495118 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
1983 1 1 3 2 2 0 0 0 0 0 0
0 0 0.01010101 0.090909091 0.252525253 0.242424242
0.262626263 0.080808081 0.02020202 0.02020202 0 0 0
0 0 0 0 0 0 0 0.01010101 0.01010101
0 0 0 0 0 0 0 0
1984 1 1 1 2 1 0 0 0 0 0 0
0 0 0.040816327 0.204081633 0.265306122 0.285714285
0.12244898 0.06122449 0.020408163 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
1985 1 1 3 2 11 0 0 0 0 0 0
0 0.000433257 0.043925308 0.190977069 0.258208311 0.251713258
0.16868985 0.050088443 0.017616238 0 0.00074324 0.000433257
0 0 0 0 0 0 0.00074324 0 0.002607729
0.011479376 0.002341425 0 0 0 0 0 0 0
2001 1 1 3 2 4 0 0 0 0 0 0
0.007853185 0 0.066898002 0.151474997 0.3246029 0.171179446
0.140944193 0.031935509 0 0.004204471 0 0 0 0
0 0 0 0 0 0 0 0.008408942 0.021022354
0.021022354 0.025226825 0.012613412 0.012613412 0 0 0
2002 1 1 1 2 5 0 0 0 0 0 0
0 0 0.175815912 0.150938249 0.136623909 0.052401915
0.234800431 0.144040065 0.059954233 0.000348683 0.045076605 0

0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
2003 1 1 3 2 21 0 0 0 0 0
0.082862978 0.036076746 0.045095932 0.064593145 0.181300362
0.268700283 0.117757072 0.038082331 0.005274845 0.003363787
0.057813514 0 0 0 0 0 0 0 0.009019186
0.018038373 0 0 0.010844143 0.001681894 0.001681894
0.057813514 0 0 0 0 0
Historical fishery length data for the north (N=19)
Year Seas Type Gender Partition Nsamp Data: females then males
1949 1 2 1 2 6
0 0 0 0 0 0 0 0 0 0
0.027777778 0.138888889 0.295138889 0.225694444 0.152777778
0.111111111 0.03125 0.017361111 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0
1949 1 2 3 2 4
0 0 0 0 0 0 0 0 0 0.024875622
0.049751244 0.084577114 0.074626866 0.119402985 0.15920398
0.084577114 0.114427861 0.094527363 0 0 0 0 0
0 0 0 0 0.009950249 0.054726368 0.094527363
0.034825871 0 0 0 0 0
1950 1 2 3 2 16
0 0 0 0 0 0 0 0 0.001246883
0.011221945 0.091022444 0.167082294 0.241895262 0.209476309
0.145885287 0.054862843 0.021197007 0.004987531 0 0 0
0 0 0 0 0 0.003740648 0.004987531 0.021197007
0.016209476 0.003740648 0 0.001246883 0 0 0
1950 1 2 3 2 21
0 0 0 0 0 0 0 0 0.001883239
0.018832392 0.071563089 0.187382298 0.246704331 0.211864407
0.125235405 0.036723164 0.016007533 0.004708098 0 0 0
0 0 0 0 0 0.00094162 0.020715631 0.036723164
0.013182674 0.004708098 0.002824859 0 0 0 0
1950 1 2 3 2 71
0 0 0 0 0 0 0 0 0.001968504
0.015748031 0.067210349 0.129640045 0.176602925 0.151856018
0.124015748 0.072834646 0.047244094 0.026996625 0 0 0
0 0 0 0 0.000281215 0.002530934 0.032339708
0.069460067 0.059055118 0.018278965 0.002812148 0.000843645
0.000281215 0 0
1951 1 2 3 2 46
0 0 0 0 0 0 0 0.000864678 0.002594034
0.014699524 0.051880674 0.114569823 0.137916126 0.162127108
0.146995244 0.096411587 0.044530912 0.028102032 0 0 0
0 0 0 0 0 0.003026373 0.007349762 0.058365759
0.084738435 0.038045828 0.006052745 0.000864678 0.000864678 0
0
1951 1 2 3 2 12
0 0 0 0 0 0 0 0 0 0
0.003333333 0.03 0.045 0.121666667 0.148333333 0.15 0.098333333
0.098333333 0 0 0 0 0 0 0 0 0
0.001666667 0.035 0.125 0.11 0.03 0.003333333 0 0 0
1960 1 2 1 2 21
0 0 0 0 0 0 0 0.00094697 0.010416667
0.064393939 0.196969697 0.304924242 0.205492424 0.122159091
0.054924242 0.021780303 0.014204545 0.003787879 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0
1960 1 2 1 2 8
0 0 0 0 0 0 0 0 0 0.002457002
0.039312039 0.233415233 0.348894349 0.167076167 0.081081081
0.051597052 0.039312039 0.036855037 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0
1961 1 2 1 2 23
0 0 0 0 0 0 0 0 0.000867303
0.004336513 0.05810928 0.286209887 0.275802255 0.205550737
0.070251518 0.053772767 0.026886383 0.018213356 0 0 0

0 0 0 0 0 0 0 0 0 0 0
0 0 0 0
1961 1 2 1 2 10
0 0 0 0 0 0 0 0 0 0.008385744
0.067085954 0.15932914 0.234800839 0.270440252 0.132075472
0.064989518 0.041928721 0.020964361 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0
1963 1 2 1 2 2
0 0 0 0 0 0 0 0 0 0.04040404
0.191919192 0.232323232 0.232323232 0.212121212 0.070707071 0
0.01010101 0.01010101 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1963 1 2 3 2 10
0 0 0 0 0 0 0 0 0 0.002 0.098
0.208 0.172 0.124 0.118 0.086 0.044 0.03 0 0 0 0
0 0 0 0 0 0.006 0.042 0.04 0.022 0.004 0
0.004 0 0
1964 1 2 3 2 2
0 0 0 0 0 0 0 0 0 0
0.04950495 0.267326733 0.277227723 0.168316832 0.01980198
0.00990099 0.00990099 0 0 0 0 0 0 0
0 0 0 0 0.00990099 0.108910891 0.04950495
0.01980198 0.00990099 0 0 0
1964 1 2 3 2 54
0 0 0 0 0 0 0 0 0.001844338
0.018812246 0.112504611 0.19476208 0.175580966 0.131316857
0.077462191 0.043157506 0.017705644 0.007746219 0 0 0
0 0 0 0 0.000737735 0.008852822 0.048321653
0.074880118 0.057174474 0.021763187 0.004795278 0.002213205
0.000368868 0 0
1964 1 2 3 2 4
0 0 0 0 0 0 0 0 0 0.019230769
0.134615385 0.134615385 0.139423077 0.153846154 0.086538462
0.019230769 0.024038462 0.019230769 0 0 0 0 0
0 0 0 0.004807692 0.033653846 0.134615385 0.067307692
0.028846154 0 0 0 0 0
1965 1 2 3 2 2
0 0 0 0 0 0 0 0 0 0 0.01
0.16 0.25 0.24 0.2 0.07 0 0 0 0 0 0
0 0 0 0 0 0 0.01 0.02 0.02 0 0.01
0 0.01 0
1965 1 2 3 2 58
0 0 0 0 0 0 0 0 0.001037344
0.03077455 0.162863071 0.244813278 0.189834025 0.101659751
0.059128631 0.031811895 0.014868603 0.008990318 0 0 0
0 0 0 0 0.001728907 0.010027663 0.036307054
0.058091286 0.037344398 0.010373444 0.000345781 0 0 0
0
1965 1 2 3 2 2
0 0 0 0 0 0 0 0 0 0.01 0.11
0.24 0.1 0.09 0.05 0.01 0.04 0 0 0 0 0
0 0 0 0 0 0 0.13 0.18 0.02 0.01 0.01
0 0 0
Fishery length data for the north (N=37)
Year Seas Type Gender Partition Nsamp Data: females then males
1966 1 2 3 2 28 0 0 0 0 0
0 0 0.000398218 0.007141577 0.084841569 0.236806184
0.235849976 0.174768315 0.081066912 0.040317047 0.011694455
0.006685375 0 0 0 0 0 0 0 0
0.000398218 0.010845735 0.045331116 0.04071029 0.017918836
0.003054382 0.001455929 0.000715866 0 0
1968 1 2 3 2 44 0 0 0 0 0 0
0 0 0.003099141 0.00602395 0.057151528 0.166740995
0.237033714 0.201746115 0.139491103 0.065195181 0.021470303
0.006316929 0 0 0 0 0 0 0 0
0.001616854 0.007863181 0.036316829 0.038691503 0.009948399
0.001294275 0 0 0 0
1970 1 2 3 2 49 0 0 0 0 0 0
0 0 0.00194005 0.026205775 0.09568038 0.177862664

0.196341131 0.148590806 0.092522716 0.052874776 0.021146742
0.008268895 0 0 0 0 0 0 0 0
0.004971286 0.034532646 0.074259906 0.04511957 0.017181584
0.001476647 0.001024426 0 0 0

1971 1 2 3 2 4 0 0 0 0 0 0
0 0 0 0.044554971 0.044268224 0.187483791 0.205280122
0.113817702 0.085878887 0.035685785 0.015536969 0.003635004 0
0 0 0 0 0 0 0 0.019094987 0.108204932
0.097918183 0.033867716 0.003551108 0.001221621 0 0 0
0
1972 1 2 3 2 21 0 0 0 0 0 0
0 0 0.000656976 0.050945409 0.1810294 0.236159888 0.219160708
0.099646376 0.057506809 0.029432687 0.00949972 0.004814072 0
0 0 0 0 0 0 0 0.008456988 0.030425382
0.048769672 0.017756195 0.005184688 0.000291271 0 0 0
0.000263757

1973 1 2 3 2 24 0 0 0 0 0 0
0.000558788 0 0.002894346 0.02468277 0.145002575 0.239381535
0.229452428 0.145515112 0.078207557 0.028412538 0.009435581
0.005036661 0 0 0 0 0 0 0 0
0.003054437 0.019888862 0.034335441 0.022511899 0.008642586
0.002986886 0 0 0 0
1974 1 2 3 2 21 0 0 0 0 0 0
0 0.000528431 0.002664034 0.036867084 0.137835744 0.221447385
0.2087711 0.132543246 0.079235576 0.030403468 0.013896076 0.009677815
0 0 0 0 0 0 0.000659593 0.005227729
0.008623415 0.024912999 0.047899455 0.02869296 0.009453195
0.000660694 0 0 0 0
1975 1 2 3 2 20 0 0 0.000444529 0 0
0.000580079 0.000221255 0.001528679 0.007959608 0.036857658
0.154492778 0.218561024 0.205659718 0.134645969 0.077955029
0.032698607 0.008430655 0.007131523 0 0 0.000444529
0.000984697 0 0 0 0.003604672 0.012385001 0.01685295
0.051423312 0.019820469 0.006765204 0.000552053 0 0 0
0
1976 1 2 3 2 12 0 0 0 0 0 0
0 0.007375556 0.014231945 0.054433131 0.119867555 0.153514694
0.114183243 0.08385726 0.066752843 0.022256459 0.00892969
0.001406651 0 0 0 0 0 0 0 0
0.039270874 0.12368803 0.146156406 0.042479501 0.000725529
0.000580423 0.000290212 0 0 0
1977 1 2 3 2 28 0 0 0 0 0 0
0.00040848 0.00122544 0.003647779 0.033504656 0.103445001
0.189046309 0.191402648 0.128975002 0.085351793 0.040638306
0.016792376 0.004502741 0 0 0 0 0 0.00020424
0.000454137 0.001862206 0.023516652 0.059188395 0.080805965
0.030845742 0.003260907 0.00077679 0.000144435 0 0 0
1978 1 2 3 2 26 0 0 0 0 0 0
0 0 0.004862245 0.071553195 0.147226578 0.262400755
0.189773928 0.134661787 0.087620987 0.036484721 0.005080877
0.004711669 0 0 0 0 0 0 0.000128675
0.000273968 0.013892274 0.013468626 0.018162476 0.007246146
0.001560565 0.00089053 0 0 0 0
1979 1 2 3 2 16 0 0 0 0 0 0
0.000840095 0 0.002726772 0.03802854 0.200312417 0.210427762
0.224864788 0.125815989 0.070618471 0.025021007 0.001868434
0.001129045 0 0 0 0 0 0 0 0
0.001764231 0.031919344 0.042665568 0.021124714 0.000872821 0
0 0 0 0
1980 1 2 3 2 70 0 0 0 0 0
0.000307867 6.53063E-05 0.000247961 0.006354848 0.067562126
0.183100336 0.235449011 0.187430447 0.123700887 0.064090279
0.037188612 0.016321535 0.013473924 0 0 0 0.000175336
0 0 1.61013E-05 0.000552798 0.006053166 0.025103399
0.022522231 0.008118144 0.001639218 0.000155493 0.000244673 5.60913E-
05 3.51049E-05 3.51049E-05
1981 1 2 3 2 77 0 0 0 0 0 0
0 1.06129E-05 0.01583641 0.114781354 0.212484192 0.222357492

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	0.17527266	0.107954849	0.05795843	0.021245393	0.008344491
	0.00441745	0	0	0	0	0	2.49675E-05	0.000142475
	0.000411974	0.004457305	0.026677466	0.018881481	0.007063435
	0.001344289	0.000333273	0	0	0	0
1982	1	2	3	2	56	0	0	0	0	0	0
	1.67984E-05	0.004126523	0.04140353	0.132188871	0.25422672
	0.222497326	0.142682387	0.07409827	0.032155884	0.014095562
	0.007291864	0.001323989	0	0	0	0	0	0	0
	0.010923713	0.017944561	0.024915066	0.012554382	0.007506658	0
	4.78963E-05	0	0	0	0
1983	1	2	3	2	40	0	0	0	0	0
	0.00098221	0.000776329	0.000918154	0.013530599	0.144117974
	0.240022576	0.249070792	0.153465889	0.06734098	0.03527053
	0.014812226	0.005676195	0.001211404	0	0	0	0	0
	0	0.000401487	0.002051515	0.002762469	0.026016945	0.027488281
	0.010309239	0.003534948	0	0.000239259	0	0	0
1984	1	2	3	2	15	0	0	0	0	0	0
	0.004252285	0.015004414	0.079891554	0.110771176	0.28517521
	0.182569345	0.14375253	0.074746054	0.026619864	0.020986713
	0.00128547	0.000374708	0	0	0	0	0	0
	0.00128368	0.005902459	0.016048838	0.024383515	0.00616662
	0.000785563	0	0	0	0	0	0
1985	1	2	3	2	22	0	0	0	0	0	0
	0	0.014171678	0.068023031	0.205624737	0.261486258	0.155353081
	0.133064733	0.053585624	0.015634878	0.004647547	0.004762517
	0.001538955	0	0	0	0	0	0	0	0.009123444
	0.034381599	0.020959398	0.01537641	0.002266108	0	0	0
	0	0	0
1986	1	2	3	2	22	0	0	0	0	0	0
	0.000383955	0.002589048	0.030462737	0.211823137	0.347199153
	0.213350417	0.092535469	0.029247583	0.010264379	0.000840357
	0.000353325	0	0	0	0	0	0	0	0
	0.006529329	0.010868048	0.031998093	0.008040253	0.003514715	0
	0	0	0	0	0
# Pikitch obs
1986	1	2	0	1	62
	0	0	0.007194245	0.026378897	0.086330935	0.191846523
	0.225419664	0.201438849	0.139088729	0.105515588	0.016786571	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0
# back to commercial
1987	1	2	3	2	43	0	0	0	0	0	0
	0.003381676	0.009791324	0.098986581	0.216044487	0.240996983
	0.201621549	0.105817735	0.031816983	0.014456463	0.003106298
	0.000792168	0.000415233	0	0	0	0	0	0
	0.00318361	0.012226478	0.03315394	0.014546362	0.007628169
	0.001865683	0.000168281	0	0	0	0	0
1988	1	2	3	2	24	0	0	0	0	0	0
	0	0	0.023050051	0.139107608	0.253275841	0.220172083
	0.165069441	0.066754151	0.031648612	0.012721483	0.00578838
	0.001347929	0	0	0	0	0	0	0	0.000102151
	0.014898943	0.029616068	0.022190582	0.010479876	0.00338365
	0.00039315	0	0	0	0

1989	1	2	3	2	33	0	0	0	0	0	0
	0.000169316	0.000693389	0.017294276	0.154488814	0.298375837
	0.259449076	0.13359991	0.056963233	0.023072075	0.00718577
	0.000169316	0.00108399	0	0	0	0	0	0	0
	0.000806729	0.006748733	0.017276716	0.019611739	0.002810899
	0.000200181	0	0	0	0	0
1990	1	2	3	2	30	0	0	0	0	0	0
	0	0.004874329	0.010564809	0.063919937	0.260980778	0.311485514
	0.185940773	0.071628855	0.025095702	0.006752134	0.00200764	1.37244E-
05	0	0	0	0.002161899	0	0	0	0.000296621
	0.007067611	0.018278993	0.025754971	0.002549936	0.000493715
	0.00013206	0	0	0	0
1991	1	2	3	2	28	0	0	0	0	0	0
	0.000935117	0.00097184	0.007466654	0.067899343	0.202474513
	0.233709488	0.150172252	0.07328019	0.035940139	0.018304702
```

0.004067037 0.00205588 0 0 0 0 0 0 1.83615E-
05 7.90141E-05 0.004206689 0.023045953 0.030419417 0.062030303
0.021788924 0.035802934 0.016298053 0.009033195 0 0
1992 1 2 3 2 21 0 0 0 0 0 0
0 0.002398181 0.036168281 0.185328006 0.285569284 0.214016124
0.133463605 0.060109784 0.021390773 0.007117727 0.000793145
0.000710579 0 0 0 0 0 0 0 0
0.000457054 0.008630735 0.035413186 0.007817958 0.000459026
0.000156552 0 0 0 0
1993 1 2 3 2 22 0 0 0 0 0 0
0 0.000600437 0.007221178 0.139675008 0.335989277 0.278033094
0.137946363 0.048752365 0.0141866 0.005173285 0.001781375 0 0
0 0 0 0 0 0 0.000353967 0.00290256
0.008070376 0.015779159 0.002695167 0.000839788 0 0 0
0 0
1994 1 2 3 2 21 0 0 0 0 0 0
0 0.00214107 0.02919103 0.186051363 0.313791792 0.213761152
0.108086668 0.062581789 0.018618921 0.007907084 0.0026761 0.001615484
0 0 0 0 0 0 0 0 0.006748615
0.029807799 0.016206649 0.000814483 0 0 0 0 0
0
1995 1 2 3 2 20 0 0 0 0 0 0
0 0.001480507 0.060693682 0.185004984 0.246224022 0.189142547
0.117904552 0.079601444 0.044739428 0.042968986 0.014306338 0.0046036
0 0 0 0 0 0 0 0 0.00463352
0.00366309 0.003935489 0 0.00109781 0 0 0 0
1996 1 2 3 2 18 0 0 0 0 0 0
0 0.000448544 0.046965818 0.267866694 0.278512952 0.18892308
0.100280859 0.035725459 0.023904136 0.009115527 0.005488542
0.000904656 0 0 0 0 0 0 0 0
0.012263688 0.011169259 0.016274151 0.002156635 0 0 0
0 0 0
1997 1 2 3 2 40 0 0 0 0 0 0
0.00017479 0.001573223 0.021115534 0.154019971 0.325260238
0.224448344 0.126384475 0.065717763 0.019669947 0.01637184
0.001426505 0.008734846 0 0 0 0 0 0
0.00020147 0.001747092 0.005393462 0.011767082 0.010870148
0.002580932 0.001862804 0.000679534 0 0 0 0
1998 1 2 3 2 37 0 0 0 0 0 0
0 0.007005948 0.069839545 0.19740155 0.294342444 0.194390771
0.096147525 0.048316411 0.040291003 0.021939419 0.009112164
0.002753536 0 0 0 0 0 0 0 0.000212559
0.005141474 0.009524021 0.002670837 0 0.000910794 0 0
0 0 0
1999 1 2 3 2 35 0 0 0 0 0 0
0.000621811 0.004913329 0.066759358 0.201217706 0.285734879
0.218809701 0.105344105 0.046928121 0.026415325 0.013338192
0.004849667 0.001526503 0 0 0 0 0 0
0.00053469 0.004128821 0.012316458 0.004906897 0.001654437 0
0 0 0 0 0 0
2000 1 2 3 2 33 0 0 0 0 0 0
0.000452413 0.005541726 0.060329914 0.18618456 0.289894905
0.181397721 0.114982603 0.056103641 0.04537064 0.038511953
0.006080613 0.002432047 0 0 0 0 0 0 0
0.003136081 0.001737753 0.006636383 0.001207047 0 0 0
0 0 0 0
2001 1 2 3 2 49 0 0 0 0 0 0
0.001820036 0.008536456 0.04487535 0.145703344 0.266911159
0.263940848 0.130618041 0.065714156 0.03402294 0.012694986
0.00738723 0.002735519 0 0 0 0 0 0 0
0.001634415 0.002621643 0.007203155 0.002050424 0.000387105
0.000571596 0 0.000571596 0 0 0
2002 1 2 3 2 45 0 0 0 0 0 0
0.001613378 0.007920282 0.029333642 0.133741159 0.257826754
0.276032491 0.145116012 0.066882455 0.029798687 0.011462718
0.007259481 0.003176036 0 0 0 0 0 0
0.00093543 0.001196154 0.003600989 0.017026125 0.004537248
0.002126275 2.86741E-05 0.000352134 0 3.38765E-05 0 0
2003 1 2 3 2 31 0 0 0 0 0
0.00014921 0.000181818 0.000393999 0.012316582 0.116553253 0.2908383

```
	0.229533462	0.184672228	0.065309856	0.024465034	0.011581891
	0.000257925	2.62491E-05	0	0	0	0	0	0	8.25738E-
05	0.00014921	0.013029391	0.014974349	0.015712772	0.011116799
	0.008505885	0.00014921	0	0	0	0
2004	1	2	3	2	25	0	0	0	0	0	0
	0.001199821	0.001079802	0.01305043	0.073310754	0.286465428
	0.270316679	0.200592445	0.082685794	0.02555047	0.007386303
	0.001623304	0	0	0	0	0	0	0	0	0
	0.008043723	0.014789366	0.012347108	0.001558573	0	0	0
	0	0	0

20	# Number of age bins for data inputs
# Lower edge of age bins (first is a minus group, last is a plus group)
1	2	3	4	5	6	7	8	9	10	11	12
	13	14	15	16	17	18	19	20
1	# Number of ageing error types
# Vectors of: Average age at true age (to accumulator age)
#	SD of ageing precision at true age
# Type 1: Interopercular ages
0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5	22.5
	23.5	24.5	25.5	26.5	27.5	28.5	29.5	30.5
0.001	0.001	0.2336773	0.3703697	0.4673546	0.5425818	0.604047	0.6560151	0.7010318	0.7407394	0.7762591	0.8083906
	0.8377243	0.8647087	0.8896923	0.9129516	0.9347091	0.9551472	0.9744167	0.9926441	1.0099364	1.0263848	1.0420678
	1.0570536	1.0714015	1.0851637	1.098386	1.1111092	1.1233696	1.1351998	1.1466288
590	# Total number of age observations
# Survey north: age-at-length bin observations (N=11)
# Year	Season	Type	Gender	Partition	ageerr	Lbin_lo	Lbin_hi	Nsamps	Data: females then males
1995	1		4		1		0			1
	3		3		2		0	0.5	0.5	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0
1995	1		4		1		0			1
	4		4		4		0	0.384615385		0.538461538
	0.076923077	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0
1995	1		4		1		0			1
	5		5		10		0	0.102564103		0.41025641
	0.333333333	0.153846154	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0
1995	1		4		1		0			1
	6		6		24		0	0.04	0.36	0.32	0.2
	0.02	0.06	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0
1995	1		4		1		0			1
	7		7		14		0	0	0.191489362
	0.340425532	0.255319149	0.191489362	0	0.021276596	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
1995	1		4		1		0			1
	8		8		16		0	0	0.037037037
	0.259259259	0.222222222	0.37037037	0.092592593	0.018518519	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
1995	1		4		1		0			1
	9		9		21		0	0	0	0.12244898
	0.265306122	0.367346939	0.163265306	0.040816327	0.020408163
	0.020408163	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
```

1995	1		4		1		0			1	
	10		10		16		0	0	0	0	
	0.243243243		0.243243243		0.27027027		0.216216216		0.027027027		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1995	1		4		1		0			1	
	11		11		5		0	0	0	0	0
	0.4	0.4	0	0	0.2	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1995	1		4		1		0			1	
	12		12		2		0	0	0	0	0
	0.333333333		0	0.666666667		0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1995	1		4		1		0			1	
	13		13		1		0	0	0	0	0
	0	0	0	0	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									

Fishery south: sorted by year, gender, age-at-length bin observations (N=117)

# Year	Season	Type	Gender	Partition	ageerr	Lbin_lo	Lbin_hi	Nsamp	Data: females then males		
1968	1		1		1		2			1	
	10		10		1		0	0.5	0.5	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1968	1		1		1		2			1	
	11		11		4		0	0.081638518		0.347723141	
	0.55692938		0.013708961		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					
1968	1		1		1		2			1	
	12		12		4		0	0	0.024252414		
	0.319689118		0.514976383		0.141082085		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1968	1		1		1		2			1	
	13		13		6		0	0	0	0.299804874	
	0.021166499		0.373431101		0.106772949		0.101942515		0.011160602		0
	0	0	0.08572146		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0		
1968	1		1		1		2			1	
	14		14		6		0	0	0	0.0611623	
	0.110442834		0.075327502		0.170052408		0.184994334		0.14572114		
	0.018818652		0.006223491		0.110442834		0.00637167		0	0.110442834	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1968	1		1		1		2			1	
	15		15		6		0	0	0	0.035470056	
	0.049659407		0.084499298		0.095326928		0.289628043		0.011085431		
	0.039206333		0.192148438		0.01082763		0	0.192148438		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1968	1		1		1		2			1	
	16		16		3		0	0	0	0	0
	0.412507201		0.412507201		0	0	0	0	0.069269328		
	0.105716271		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				

1968	1		1		1		2			1	
	17		17		2		0	0	0	0	0
	0	0.461271057		0	0	0	0	0.077457887		0.461271057	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1968	1		1		1		2			1	
	18		18		2		0	0	0	0	0
	0	0	0.23811223		0	0	0	0	0.76188777		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1968	1		1		2		2			1	
	10		10		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1968	1		1		2		2			1	
	11		11		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1968	1		1		2		2			1	
	12		12		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	1	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1968	1		1		2		2			1	
	13		13		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	1	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1969	1		1		1		2			1	
	9		9		1		0	0	1	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1969	1		1		1		2			1	
	10		10		5		0	0	0.938946686		
	0.061053314		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1969	1		1		1		2			1	
	11		11		9		0	0	0.647157763		
	0.221332223		0.036523636		0.077179139		0.017807238		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1969	1		1		1		2			1	
	12		12		13		0	0	0.29212643		
	0.303153735		0.204392721		0.073175115		0.117884614		0.007837187		
	0.001383809		4.64E-05	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1969	1		1		1		2			1	
	13		13		12		0	0	0.264356342		
	0.283193279		0.016571803		0.096883907		0.163555479		0.078012639		
	0.074786617		0.01637002		0.003134957		0	0.003134957		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1969	1		1		1		2			1	
	14		14		11		0	0	0.005733499		0
	0.040264112		0.210444575		0.055306471		0.320958321		0.24836934		

	0.015234787		0.042957141		0.010516252		0.002422677		0.047792826		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1969	1		1		1		2			1	
	15		15		9		0	0	0	0.011540898	
	0.047726999		0.023682497		0.00570295		0.058399635		0.352252342		
	0.158817528		0.167685984		0.001069644		0.136847599		0.031908029		0
	0.004365895		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1969	1		1		1		2			1	
	16		16		7		0	0	0	0	0
	0.011627111		0.003560802		0	0.088537236		0.073702361		0.078812423	
	0.124382645		0.358750834		0.257777946		0	0.002848642		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1969	1		1		1		2			1	
	17		17		2		0	0	0	0	0
	0	0	0.915178574		0	0	0	0	0	0	
	0.084821426		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1969	1		1		2		2			1	
	9		9		3		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0.13753193		
	0.149538669		0.288326865		0.424602535		0	0	0	0	0
	0	0	0	0	0	0	0				
1969	1		1		2		2			1	
	10		10		5		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.109778576		0.329335732	
	0.001636148		0.129948989		0.331789954		0.074924152		0.011999866		
	0.010586583		0	0	0	0	0	0	0	0	0
1969	1		1		2		2			1	
	11		11		7		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0.01211279	
	0.127221762		0.64524254		0.186982932		0.01211279		0	0.013729819	
	0	0.002597366		0	0	0	0	0	0		
1969	1		1		2		2			1	
	12		12		6		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0.140785608	
	0	0.032778443		0.018790686		0.167533376		0.167533376		0.155515945	
	0.140785608		0.155515945		0	0.020761012		0	0	0	0
1969	1		1		2		2			1	
	13		13		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0.078912549		0	0	0.921087451		0	0	0	0
	0	0	0	0							
1970	1		1		1		2			1	
	10		10		1		0	0	0	1	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1970	1		1		1		2			1	
	11		11		1		0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1970	1		1		1		2			1	
	12		12		1		0	0	0	0	0.2
	0.2	0.4	0.2	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1970	1		1		1		2			1	
	13		13		1		0	0	0	0	0
	0.399999963		0.399999963		0		0.200000074		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1970	1		1		1		2			1	
	14		14		1		0	0	0	0	
	0.125000014		0	0.250000029		0.250000029		0.374999928		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1970	1		1		1		2			1	
	15		15		1		0	0	0	0	0
	0	0	0	0.600000037		0.399999963		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1972	1		1		1		2			1	
	10		10		3		0	0	0.357695613		0
	0	0.294067069		0.348237318		0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1972	1		1		1		2			1	
	11		11		4		0	0	0	0.199537458	
	0.256873458		0.153664321		0.264452888		0	0.125471875		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1972	1		1		1		2			1	
	12		12		4		0	0	0	0.096437237	
	0.172552155		0.226893816		0.334139005		0.107402542		0.062575246		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1972	1		1		1		2			1	
	13		13		4		0	0	0	0.077609994	
	0.189845986		0.146384389		0.141855548		0.040834797		0.24119634		
	0.092185151		0.070087795		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1972	1		1		1		2			1	
	14		14		4		0	0	0	0.053679451	
	0.053679451		0.081682232		0.202789037		0.107358902		0.230791818		
	0.095430135		0.120909523		0.053679451		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0										
1972	1		1		1		2			1	
	15		15		3		0	0	0	0	0
	0.106647707		0	0	0	0.189595923		0.189595923		0.514160446	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					
1972	1		1		1		2			1	
	16		16		1		0	0	0	0	0
	0	0	0	0.5	0.5	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1972	1		1		2		2			1	
	11		11		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.39656312		0	0	0
	0	0	0	0.60343688		0	0	0	0	0	0
	0	0	0	0							

1972	1		1		2		2			1	
	12		12		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1973	1		1		1		2			1	
	10		10		2		0	0	0	0.814940577	
	0.185059423		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1973	1		1		1		2			1	
	11		11		7		0	0	0.125054409		
	0.204501693		0.607250093		0.034129988		0.029063818		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
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1973	1		1		1		2			1	
	12		12		7		0	0	0	0.127819333	
	0.142846845		0.508746102		0.166407906		0.028694684		0	0.02548513	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1973	1		1		1		2			1	
	13		13		7		0	0	0.049394891		
	0.093381163		0.328032625		0.284010174		0.142847787		0.036569148		
	0.023198239		0.022366145		0	0	0.020199828		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
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	14		14		7		0	0	0	0.115152871	
	0.046149614		0.289390117		0.114316002		0.20696956		0.086843843		
	0.085337362		0.002801414		0.034166531		0.016071271		0	0.002801414	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1973	1		1		1		2			1	
	15		15		6		0	0	0	0	
	0.121434769		0.060717385		0.042424326		0.165399028		0.169591157		
	0.092243719		0.042424326		0.219765918		0.085999372		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1973	1		1		1		2			1	
	16		16		6		0	0	0	0	0
	0.096126108		0.105373901		0	0	0.133941934		0.016313441		
	0.109901074		0.428442468		0.109901074		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
1973	1		1		1		2			1	
	17		17		1		0	0	0	0	0
	0	0	1	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1973	1		1		1		2			1	
	18		18		1		0	0	0	0	0.5
	0	0	0	0	0	0	0.5	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1973	1		1		2		2			1	
	9		9		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0									

1973	1		1		2		2			1	
	10		10		4		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0.077806314		0
	0	0.551110441		0	0	0.293276931		0.077806314		0	0
	0	0	0	0	0	0					
1973	1		1		2		2			1	
	11		11		4		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0.23345453	
	0	0.238930009		0.155304506		0	0	0	0.372310955		0
	0	0	0	0	0	0					
1973	1		1		2		2			1	
	12		12		3		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0.271336091	
	0.066554136		0	0.204781956		0	0	0.047763906		0.204781956	
	0	0	0.204781956		0	0	0	0			
1973	1		1		2		2			1	
	14		14		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	1	0	0	0	0	0
	0	0									
1974	1		1		1		2			1	
	10		10		2		0	0.252775406		0.249074868	
	0.498149727		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1974	1		1		1		2			1	
	11		11		5		0	0.008921674		0.037353378	
	0.473438868		0.24782846		0.23245762		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1974	1		1		1		2			1	
	12		12		8		0	0	0.15782358		
	0.451855844		0.054704564		0.24300172		0.074411798		0	0	0
	0	0	0	0	0	0	0	0	0.018202494		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0		
1974	1		1		1		2			1	
	13		13		8		0	0	0.051449827		
	0.379051525		0.329253749		0.178124479		0.062120421		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1974	1		1		1		2			1	
	14		14		8		0	0	0	0.12137639	
	0.292851649		0.310144272		0.072742588		0.013255554		0.027063424		
	0.054188707		0	0.054188707		0	0.054188707		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0										
1974	1		1		1		2			1	
	15		15		8		0	0	0	0.066766325	
	0.268615118		0.180303306		0.26264545		0.078118755		0.01231333		
	0.131237716		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
1974	1		1		1		2			1	
	16		16		7		0	0	0	0	
	0.130125236		0	0.021503748		0.097042548		0.021503748		0.177280051	
	0.344104051		0.068528421		0	0.139912198		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1974	1		1		1		2			1	
	17		17		4		0	0	0	0	0
	0.170887925		0	0.531110457		0	0.057453705		0	0.240547912	

	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					
1974	1		1		1		2			1	
	18		18		1		0	0	0	0	0
	0	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1974	1		1		2		2			1	
	9		9		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	1	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1974	1		1		2		2			1	
	10		10		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.196540877		0	0.803459123	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1974	1		1		2		2			1	
	11		11		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
	0.185873602		0	0	0	0	0	0.814126398		0	0
	0	0	0	0	0						
1974	1		1		2		2			1	
	12		12		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1975	1		1		1		2			1	
	11		11		4		0	0	0.031262957		0
	0.119945546		0	0	0	0.818831162		0.029960334		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					
1975	1		1		1		2			1	
	12		12		7		0	0	0	0	
	0.025222932		0.004163096		0.142224415		0.200858156		0.323537993		0
	0.161768993		0	0.142224415		0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
1975	1		1		1		2			1	
	13		13		7		0	0	0	0.010276078	
	0.037431026		0.111786844		0.135894049		0.284103295		0.102044962		
	0.204089929		0.024657706		0.089716112		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0										
1975	1		1		1		2			1	
	14		14		7		0	0	0	0.02853077	
	0.076552481		0.074643629		0.212519082		0.029802768		0.281607734		
	0.032508104		0.212490219		0.025672607		0.025672607		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1975	1		1		1		2			1	
	15		15		6		0	0	0	0.035279546	
	0.071735078		0.229464053		0.13388588		0	0.027047653		0.475540138	
	0.013523826		0	0	0.013523826		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
1975	1		1		1		2			1	
	16		16		5		0	0	0	0.127822751	
	0	0	0.29399233		0.240093739		0.122496807		0	0.097997441	
	0.117596932		0	0	0	0	0	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1975	1		1		1		2			1	
	17		17		3		0	0	0	0	0
	0	0.269662923		0	0	0	0.280898883		0.224719097		
	0.224719097		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1975	1		1		1		2			1	
	18		18		2		0	0	0	0	0
	0	0	0.5	0	0	0	0	0	0.5	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1975	1		1		2		2			1	
	10		10		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1975	1		1		2		2			1	
	12		12		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	1	0	0	0	0	0	0	0
	0	0									
1980	1		1		1		2			1	
	11		11		1		0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1980	1		1		1		2			1	
	12		12		1		0	0	0	0	0.8
	0.2	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1980	1		1		1		2			1	
	13		13		1		0	0	0	0	0.25
	0	0.25	0.25	0.25	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1980	1		1		1		2			1	
	14		14		1		0	0	0	0	0
	0	0.285714286		0.428571429		0.285714286		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1980	1		1		1		2			1	
	15		15		1		0	0	0	0	
	0.166666667		0	0	0.5	0	0.333333333		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1980	1		1		1		2			1	
	16		16		1		0	0	0	0	0
	0	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1980	1		1		1		2			1	
	17		17		1		0	0	0	0	0
	0	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1982	1		1		1		2			1	
	9		9		1		0	0	1	0	0

	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1982	1		1		1		2			1	
	10		10		1		0	0	0.5	0.166666667	
	0.166666667		0.166666667		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1982	1		1		1		2			1	
	11		11		1		0	0	0.285714286		
	0.285714286		0.142857143		0.142857143		0	0	0	0.142857143	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1982	1		1		1		2			1	
	12		12		1		0	0	0	0.25	0
	0.25	0.25	0.25	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1982	1		1		1		2			1	
	13		13		1		0	0	0	0	0.25
	0	0.5	0	0	0.25	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1982	1		1		1		2			1	
	14		14		1		0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1982	1		1		1		2			1	
	15		15		1		0	0	0	1	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1983	1		1		1		2			1	
	9		9		1		0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1983	1		1		1		2			1	
	10		10		2		0	0	0	0	
	0.253246748		0.246753252		0	0	0.5	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1983	1		1		1		2			1	
	11		11		2		0	0	0	0	
	0.378640778		0.245954696		0	0.249190937		0.126213589		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1983	1		1		1		2			1	
	12		12		2		0	0	0	0	
	0.182897859		0.185273161		0	0.361045132		0.180522566		0.090261283	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1983	1		1		1		2			1	
	13		13		2		0	0	0	0	
	0.063311686		0	0.063311686		0.561688318		0	0.061688312		
	0.124999999		0.063311686		0.061688312		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

1983	1		1		1		2			1	
	14		14		2		0	0	0	0	0
	0	0	0.5	0.253246748		0	0.246753252		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1983	1		1		1		2			1	
	15		15		2		0	0	0	0	0
	0	0	0.506493497		0	0.493506503		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1983	1		1		1		2			1	
	16		16		1		0	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1984	1		1		1		2			1	
	9		9		1		0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1984	1		1		1		2			1	
	10		10		1		0	0	0	0.25	0.5
	0.25	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1984	1		1		1		2			1	
	11		11		1		0	0	0	0	0
	0.571428571		0	0.142857143		0.285714286		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1984	1		1		1		2			1	
	12		12		1		0	0	0	0	
	0.142857143		0.428571429		0	0.285714286		0.142857143		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1984	1		1		1		2			1	
	13		13		1		0	0	0	0	0
	0	0	0	0.333333333		0	0.333333333		0.333333333		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1984	1		1		1		2			1	
	14		14		1		0	0	0	0	0
	0	0	1	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1985	1		1		1		2			1	
	9		9		4		0	0	0.065683289		
	0.387254321		0.188648178		0.358414212		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1985	1		1		1		2			1	
	10		10		9		0	0	0.133605475		
	0.426584917		0.247035259		0.061721697		0.068908393		0.029031871		
	0.033112387		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1985	1		1		1		2			1	
	11		11		9		0	0	0.066326226		
	0.090127561		0.267012013		0.281215882		0.259040712		0	0	0
	0.018138803		0.018138803		0	0	0	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
1985	1		1		1		2			1	
	12		12		9		0	0	0	0.076914119	
	0.304818461		0.328947886		0.187001463		0.032376661		0.025928328		
	0.022978718		0.021034365		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1985	1		1		1		2			1	
	13		13		9		0	0	0.007892154		
	0.010752554		0.066347868		0.122392647		0.380611955		0.173330287		
	0.13448968		0.037859128		0.063463327		0	0	0	0	0.0028604
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1985	1		1		1		2			1	
	14		14		8		0	0	0	0.082377018	
	0.082377018		0.354149119		0.186303252		0.077084333		0	0.21770926	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1985	1		1		1		2			1	
	15		15		4		0	0	0	0	
	0.285353213		0.285353213		0.078560568		0	0.090579815		0	
	0.260153191		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0		
1985	1		1		1		2			1	
	17		17		1		0	0	0	0	0
	0	0	1	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1985	1		1		2		2			1	
	9		9		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1985	1		1		2		2			1	
	10		10		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.194163605		0.805836395		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							

Historical fishery north: sorted by year, gender, age-at-length bin observations (N=42)

# Year	Season	Type	Gender	Partition	ageerr	Lbin_lo	Lbin_hi	Nsamp	Data: females then males		
1948	1		2		1		2			1	
	8		8		1		0	0	0	1	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1948	1		2		1		2			1	
	9		9		1		0	0	0.666666667		
	0.333333333		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1948	1		2		1		2			1	
	10		10		1		0	0	0.380952381		
	0.380952381		0.19047619		0.047619048		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1948	1		2		1		2			1	
	11		11		1		0	0	0.186046512		
	0.488372093		0.279069767		0.023255814		0.023255814		0	0	0
	0	0	0	0	0	0	0	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1948	1		2		1		2			1	
	11		11		1		0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1948	1		2		1		2			1	
	12		12		2		0	0	0.051948052		
	0.285714286		0.363636364		0.207792208		0.090909091		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1948	1		2		1		2			1	
	12		12		1		0	0	0.25	0.25	0.25
	0	0.25	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1948	1		2		1		2			1	
	13		13		2		0	0	0	0.131578947	
	0.289473684		0.302631579		0.197368421		0.065789474		0.013157895		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1948	1		2		1		2			1	
	13		13		1		0	0	0	0	0
	0.166666667		0.333333333		0	0.333333333		0.166666667		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					
1948	1		2		1		2			1	
	14		14		2		0	0	0	0.085106383	
	0.14893617		0.319148936		0.244680851		0.170212766		0.021276596		0
	0.010638298		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0		
1948	1		2		1		2			1	
	14		14		1		0	0	0	0	
	0.333333333		0	0.666666667		0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1948	1		2		1		2			1	
	15		15		2		0	0	0	0	
	0.032786885		0.262295082		0.37704918		0.196721311		0.081967213		
	0.016393443		0.032786885		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1948	1		2		1		2			1	
	15		15		1		0	0	0	0	0
	0	0.333333333		0.666666667		0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1948	1		2		1		2			1	
	16		16		2		0	0	0	0.016949153	
	0.06779661		0.06779661		0.338983051		0.152542373		0.220338983		
	0.084745763		0	0.033898305		0.016949153		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0										
1948	1		2		1		2			1	
	16		16		1		0	0	0	0	0
	0.666666667		0	0.333333333		0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							

1948	1		2		1		2			1	
	17		17		1		0	0	0	0	0
	0.042553191		0.276595745		0.255319149		0.276595745		0.085106383		
	0.063829787		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0		
1948	1		2		1		2			1	
	18		18		1		0	0	0	0	0
	0.066666667		0.133333333		0.066666667		0.2	0.266666667		0.2	
	0.066666667		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1948	1		2		1		2			1	
	18		18		1		0	0	0	0	0
	0	0.5	0.5	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1948	1		2		2		2			1	
	9		9		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1948	1		2		2		2			1	
	10		10		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.333333333		0.333333333	
	0.333333333		0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1948	1		2		2		2			1	
	11		11		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.1	0.25	0.3	0.25	0.05
	0	0	0.05	0	0	0	0	0	0	0	0
	0	0									
1948	1		2		2		2			1	
	12		12		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.181818182		0.272727273	
	0.181818182		0.181818182		0.181818182		0	0	0	0	0
	0	0	0	0	0	0	0				
1948	1		2		2		2			1	
	13		13		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0.166666667	
	0.166666667		0.333333333		0.333333333		0	0	0	0	0
	0	0	0	0	0	0					
1948	1		2		2		2			1	
	14		14		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
	0.333333333		0.333333333		0.333333333		0	0	0	0	0
	0	0	0	0	0	0					
1949	1		2		1		2			1	
	9		9		1		0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1949	1		2		1		2			1	
	10		10		1		0	0.111111111		0	
	0.555555556		0.222222222		0.111111111		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1949	1		2		1		2			1	
	11		11		1		0	0	0	0.333333333	
	0.333333333		0.333333333		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1949	1		2		1		2			1	
	12		12		1		0	0	0	0.0625	0.28125
	0.4375	0.1875	0	0	0.03125	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1949	1		2		1		2			1	
	13		13		2		0	0	0	0.037037037	
	0.12962963		0.537037037		0.203703704		0.092592593		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1949	1		2		1		2			1	
	14		14		2		0	0	0	0.028571429	
	0.157142857		0.214285714		0.271428571		0.2	0.1	0.028571429		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1949	1		2		1		2			1	
	15		15		1		0	0	0	0	0.1
	0.12	0.38	0.24	0.14	0	0.02	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1949	1		2		1		2			1	
	16		16		1		0	0	0	0	0
	0.1	0.225	0.35	0.225	0.05	0.05	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1949	1		2		1		2			1	
	17		17		1		0	0	0	0	0
	0.057142857		0.171428571		0.114285714		0.285714286		0.285714286		
	0.057142857		0.028571429		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
1949	1		2		1		2			1	
	18		18		1		0	0	0	0	0
	0	0.0625	0.15625	0.21875	0.25	0.1875	0.09375	0.03125	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1949	1		2		2		2			1	
	8		8		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1949	1		2		2		2			1	
	9		9		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1949	1		2		2		2			1	
	10		10		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.2	0.533333333		0.2
	0	0.066666667		0	0	0	0	0	0	0	0
	0	0	0	0							
1949	1		2		2		2			1	
	11		11		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.137931034		0.24137931	
	0.275862069		0.206896552		0.103448276		0.034482759		0	0	0
	0	0	0	0	0	0	0	0			
1949	1		2		2		2			1	
	12		12		1		0	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.05	0.25	0.25	0.25
	0.1	0.075	0.025	0	0	0	0	0	0	0	0
	0	0									
1949	1		2		2		2			1	
	13		13		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0.1	0.5	0.3
	0.1	0	0	0	0	0	0	0	0	0	0
	0	0									
1949	1		2		2		2			1	
	14		14		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0.5	0.5	0	0	0	0	0	0	0	0	0
	0	0									
1949	1		2		2		2			1	
	16		16		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0									

Fishery north: sorted by year, gender, age-at-length bin observations (N=420)

# Year	Season	Type	Gender	Partition	ageerr	Lbin_lo	Lbin_hi	Nsamp	Data: females then males		
1966	1		2		1		2			1	
	9		9		1		0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1966	1		2		1		2			1	
	10		10		5		0	0.202530155		0.098306969	
	0.361471473		0.230709143		0	0.10698226		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1966	1		2		1		2			1	
	11		11		25		0	0.009670538		0.125274768	
	0.411157003		0.382543858		0.061137319		0.010216514		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1966	1		2		1		2			1	
	12		12		26		0	0	0.063889112		
	0.377000761		0.449624668		0.073307781		0.032692319		0.003485358		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0		
1966	1		2		1		2			1	
	13		13		26		0	0.003786224		0.01508697	
	0.273139736		0.483532213		0.127033235		0.074473539		0.010823738		
	0.008612921		0.003511424		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0										
1966	1		2		1		2			1	
	14		14		26		0	0	0.004574023		
	0.123310552		0.458746435		0.176355826		0.127564651		0.04411395		
	0.035347955		0.019610363		0.010376243		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1966	1		2		1		2			1	
	15		15		26		0	0	0	0.101252098	
	0.279498267		0.243273679		0.116743349		0.139160494		0.047421662		
	0.020207714		0.029926982		0.015870063		0.006645692		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									

1966	1		2		1		2			1	
	16		16		21		0	0	0	0.02781124	
	0.06048689		0.178690003		0.301813958		0.107073717		0.086837704		
	0.08999261		0.040171058		0.040171058		0.05356141		0	0.013390352	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1966	1		2		1		2			1	
	17		17		11		0	0	0	0	
	0.061443815		0.068356594		0.140032516		0.075116835		0.302658808		
	0.160136811		0.048063655		0.048063655		0	0.048063655		0	
	0.048063655		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1966	1		2		1		2			1	
	18		18		8		0	0	0	0	
	0.10400268		0	0.10095004		0	0.221717716		0.098088505		
	0.320285199		0.078966906		0	0	0	0.075988954		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1966	1		2		2		2			1	
	9		9		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1966	1		2		2		2			1	
	10		10		10		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0.062731881		0.068200926		0.23440661	
	0.386375172		0.114254095		0	0.134031317		0	0	0	0
	0	0	0	0	0	0	0	0			
1966	1		2		2		2			1	
	11		11		21		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.03283623		0.134899959		
	0.175603202		0.200798235		0.162632824		0.075753988		0.077042971		
	0.105624295		0.017587208		0.017221089		0	0	0	0	0
	0	0	0								
1966	1		2		2		2			1	
	12		12		20		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.092888361		0.108492085	
	0.050299726		0.131533762		0.134258879		0.145465087		0.160404289		
	0.063118773		0.018661211		0.056252672		0.018212635		0.020412519		0
	0	0	0	0							
1966	1		2		2		2			1	
	13		13		13		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.045469289		0.095208883	
	0.14358779		0.125357489		0	0.095208883		0.174368875		0.182220703	
	0.049966052		0.048899508		0.039712529		0	0	0	0	0
	0										
1966	1		2		2		2			1	
	14		14		4		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0.257565421	
	0.300956633		0	0	0	0	0	0.172649699		0.268828248	
	0	0	0	0	0	0					
1966	1		2		2		2			1	
	15		15		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0.512888967	
	0	0	0	0.487111033		0	0	0	0	0	0
	0	0	0	0							
1966	1		2		2		2			1	
	16		16		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

	1	0	0	0	0	0	0	0	0	0	0
	0	0									
1968	1		2		1		2			1	
	9		9		5		0	0	0.660880659		
	0.339119341		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1968	1		2		1		2			1	
	10		10		6		0	0	0.504197724		
	0.495802276		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1968	1		2		1		2			1	
	11		11		35		0	0.014439284		0.16986628	
	0.49390669		0.246340964		0.058079725		0.017367057		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1968	1		2		1		2			1	
	12		12		43		0	0	0.098964734		
	0.284015847		0.277837761		0.186236215		0.136291661		0.011507178		
	0.002641604		0	0.002505	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1968	1		2		1		2			1	
	13		13		43		0	0.003819952		0.026846838	
	0.133439772		0.210647161		0.296920264		0.278006833		0.03239057		
	0.011477233		0	0.002881188		0.001952142		0.001618047		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1968	1		2		1		2			1	
	14		14		43		0	0	0.009344038		
	0.050814425		0.114702536		0.2732023	0.391835414		0.087551502		0.045239373	
	0.009579291		0.008195425		0.004385802		0.005149894		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1968	1		2		1		2			1	
	15		15		43		0	0	0	0.014140671	
	0.076127741		0.18667307		0.406274531		0.169646628		0.081407519		
	0.037069073		0.021142063		0.001941258		0.005577446		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1968	1		2		1		2			1	
	16		16		42		0	0	0	0.006667737	
	0.046212172		0.147535501		0.367597356		0.174639799		0.101072433		
	0.084011686		0.040090696		0.026888177		0.005284443		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1968	1		2		1		2			1	
	17		17		28		0	0	0	0	0
	0.073762747		0.265521841		0.254212167		0.173155745		0.098883297		
	0.085662121		0.030328406		0.018473677		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1968	1		2		1		2			1	
	18		18		13		0	0	0	0	0
	0	0.193002413		0.144390515		0.054095195		0.242600242		0.060625732	
	0.160750307		0.072267798		0.072267798		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
1968	1		2		2		2			1	
	9		9		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.327874746		0	0	

	0.344250509		0.327874746		0	0	0	0	0	0	0
	0	0	0	0	0	0					
1968	1		2		2		2			1	
	10		10		10		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.10238361		0.247136727	
	0.171123609		0.184937158		0.174533642		0	0	0.05848694		0
	0.061398313		0	0	0	0	0	0	0		
1968	1		2		2		2			1	
	11		11		31		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.013723074		0.072215315		
	0.142688443		0.145426212		0.239582912		0.132197432		0.127888171		
	0.024591241		0.027529898		0.062061551		0.01209575		0	0	0
	0	0	0	0							
1968	1		2		2		2			1	
	12		12		29		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.022620048		0.034464746		
	0.059289111		0.079352748		0.24049526		0.153381936		0.110109491		
	0.160747408		0.033009368		0.023881931		0.047275719		0.023814148		0
	0.011558087		0	0	0	0					
1968	1		2		2		2			1	
	13		13		16		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.045631885		0.047742744	
	0.046428567		0.170751501		0.028304446		0.229751707		0.040506993		
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	0	0									
1968	1		2		2		2			1	
	14		14		3		0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0.319481378	
	0	0.680518622		0	0	0	0	0	0	0	0
	0	0	0	0							
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	9		9		3		0	0	0	1	0
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1970	1		2		1		2			1	
	10		10		24		0	0	0.087705958		
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
1970	1		2		1		2			1	
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	0.32218239		0.328379839		0.146846687		0.048032045		0.017711777		
	0.003829986		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1970	1		2		1		2			1	
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	0.041839238		0.00901191		0.004792833		0	0	0.002566447		0
	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0								
1970	1		2		1		2			1	
	13		13		48		0	0	0.016029203		
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	0	0	0								
1970	1		2		1		2			1	
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0.162742197 0.045410706 0.017545842 0.004766424 0.011101696
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0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
1970 1 2 1 2 1
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0.004058387 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0
1970 1 2 1 2 1
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0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
1970 1 2 1 2 1
17 17 23 0 0 0 0 0
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1970 1 2 2 2 1
9 9 8 0 0 0 0 0
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0 0 0 0 0 0 0
1970 1 2 2 2 1
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0 0
1970 1 2 2 2 1
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0 0 0
1970 1 2 2 2 1
14 14 2 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
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0 0.276944395 0.223055605 0.223055605 0 0.276944395 0
0 0 0 0 0 0

1970	1		2		2		2			1	
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0						
1971	1		2		1		2			1	
	10		10		1		0	0	0.285714247		
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					
1971	1		2		1		2			1	
	11		11		4		0	0	0.055787189		
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	0	0	0	0	0	0	0				
1971	1		2		1		2			1	
	12		12		4		0	0	0.113754342		
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	0										
1971	1		2		1		2			1	
	13		13		4		0	0	0.091128689		
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	0	0	0	0	0	0	0	0	0	0	0
	0										
1971	1		2		1		2			1	
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1971	1		2		1		2			1	
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	0										
1971	1		2		1		2			1	
	16		16		3		0	0	0	0	
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	0	0	0	0	0	0	0	0	0	0	0
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1971	1		2		1		2			1	
	17		17		3		0	0	0	0.078209144	
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	0	0	0	0	0	0	0	0	0	0	
1971	1		2		1		2			1	
	18		18		3		0	0	0	0	
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					
1971	1		2		2		2			1	
	9		9		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.333333333		0.666666667		0
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1971	1		2		2		2			1	
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	0	0	0	0	0.058823521		0	0	0	0	
1971	1		2		2		2			1	
	11		11		2		0	0	0	0	0
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	0	0	0	0	0	0	0	0.065003199		0	
	0.130006429		0.065003199		0	0.130006429		0.284964717		0.195009628	
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1971	1		2		2		2			1	
	12		12		4		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0.036829466		0
	0	0	0.411512229		0.411512319		0	0	0.034704472		
	0.06940896		0	0.036032554		0	0	0	0		
1971	1		2		2		2			1	
	13		13		2		0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0							
1971	1		2		2		2			1	
	14		14		1		0	0	0	0	0
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	0	0	0	0	0	0	0	0	1	0	0
	0	0	0	0	0	0	0	0	0	0	0
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1972	1		2		1		2			1	
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1972	1		2		1		2			1	
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	0.132700718		0	0	0	0	0	0	0	0	0
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1972	1		2		1		2			1	
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1972	1		2		1		2			1	
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	0.001014108		0	0	0	0	0	0	0	0	0
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1972	1		2		1		2			1	
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1972	1		2		1		2			1	
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1972	1		2		1		2			1	
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	0	0									
1972	1		2		1		2			1	
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	0.360981431		0.00454449		0.04484368		0.040311992		0.004820419		0
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1972	1		2		1		2			1	
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	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1972	1		2		1		2			1	
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	0.481416528		0	0.038388818		0	0.032573972		0	0	0
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1972	1		2		2		2			1	
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1972	1		2		2		2			1	
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1972	1		2		2		2			1	
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1972	1		2		2		2			1	
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1972	1		2		2		2			1	
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	0										
1972	1		2		2		2			1	
	14		14		1		0	0	0	0	0
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1973	1		2		1		2			1	
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1973	1		2		1		2			1	
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1973	1		2		1		2			1	
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	0										
1973	1		2		1		2			1	
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	0	0	0	0	0	0	0	0	0	0	0
	0										
1973	1		2		1		2			1	
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	0.009632765		0.003208693		0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0
	0										
1973	1		2		1		2			1	
	14		14		13		0	0	0	0.022789047	
	0.220824314		0.285069756		0.2901867	0.113461906		0.039458387		0.005363737	
	0.011410551		0.006071862		0.005363737		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
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1973	1		2		1		2			1	
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	0	0	0	0	0	0	0	0	0	0	0
	0										
1973	1		2		1		2			1	
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	0.16782316		0.082634666		0	0	0	0	0	0	0
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1973	1		2		1		2			1	
	17		17		8		0	0	0	0	
	0.077476762		0	0	0.074111321		0.462135976		0.154673322		0
	0.077193092		0.154409527		0	0	0	0	0	0	0
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	18		18		4		0	0	0	0.192617116	
	0	0.192617116		0	0	0	0	0.409464959		0	
	0.205300808		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
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	9		9		2		0	0	0	0	0
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0 0
1974 1 2 1 2 1
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0 0 0 0
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0
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1974 1 2 1 2 1
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18 18 5 0 0 0 0 0
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0 0
1974 1 2 2 2 1
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1974 1 2 2 2 1
9 9 3 0 0 0 0 0
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0 0 0 0 0 0 0 0
1974 1 2 2 2 1
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1974 1 2 2 2 1
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	0	0	0	0	0	0	0	0	0	0.184099066	
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1974	1		2		2		2			1	
	14		14		1		0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1975	1		2		1		2			1	
	3		3		1		0	0	1	0	0
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
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1975	1		2		1		2			1	
	9		9		3		0	0	0.818196527		
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1975	1		2		1		2			1	
	10		10		8		0	0	0	0.294110391	
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	0	0	0	0	0	0	0	0			
1975	1		2		1		2			1	
	11		11		11		0	0	0.097498015		
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	0	0	0	0	0	0	0	0	0	0	0
	0										
1975	1		2		1		2			1	
	12		12		11		0	0	0.032154661		
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	0	0	0								
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	13		13		11		0	0	0.004272325		
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1975	1		2		1		2			1	
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1975	1		2		1		2			1	
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0 0 0 0
1975 1 2 1 2 1
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0 0 0 0 0 0 0 0 0 0
1975 1 2 1 2 1
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0 0 0 0 0 0 0 0 0
1975 1 2 2 2 1
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0 0 0 0 0 0 0 0 0 0 0
0 0
1975 1 2 2 2 1
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0 0 0 0
1975 1 2 2 2 1
8 8 3 0 0 0 0 0
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1975 1 2 2 2 1
9 9 3 0 0 0 0 0
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0 0 0 0 0 0 0 0 0
1975 1 2 2 2 1
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1977	1		2		1		2			1	
	8		8		1		0	0	0.499999998		
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1977	1		2		1		2			1	
	9		9		8		0	0	0.383840867		
	0.441334994		0.174824138		0	0	0	0	0	0	0
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1977	1		2		1		2			1	
	10		10		13		0	0	0.281799154		
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1977	1		2		1		2			1	
	11		11		19		0	0	0.061424594		
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	0	0	0	0	0	0	0	0	0	0	0
1977	1		2		1		2			1	
	12		12		19		0	0	0.020221378		
	0.198200431		0.425403464		0.199230433		0.103234034		0.038155729		
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	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1977	1		2		1		2			1	
	13		13		18		0	0	0	0.044255171	
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1977	1		2		1		2			1	
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1977	1		2		1		2			1	
	15		15		17		0	0	0	0	
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	0.006807448		0.008859675		0.006807448		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					
1977	1		2		1		2			1	
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	0	0									
1977	1		2		1		2			1	
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1977	1		2		1		2			1	
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1977	1		2		2		2			1	
	6		6		1		0	0	0	0	0
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	0	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1977	1		2		2		2			1	
	7		7		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.449731769		0	0.550268231	
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1981	1		2		1		2			1	
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	0.036048299		0.022851202		0.002852494		0	0.000184305		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1981	1		2		1		2			1	
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	0.088069976		0.270024506		0.276260093		0.18172449		0.087668712		
	0.020746742		0.01998853		0.006051604		0	0	0.000684732		0
	0	0	0	0	0	0	0	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1981	1		2		1		2			1	
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	0.100518115		0.072542513		0.07376551		0.005328504		0.000880458		0
	0	0.00037714		0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1981	1		2		1		2			1	
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	0.105449027		0.10696933		0.058739869		0.027540485		0.038750834		0
	0.000703232		0.000703232		0	0	0	0	0	0	0
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1981	1		2		1		2			1	
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1981	1		2		1		2			1	
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	0.055548628		0.003804356		0.005057557		0	0	0.005413102		0
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1981	1		2		1		2			1	
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	0	0	0	0.282132256		0.228595379		0.047545235		0.003551626	
	0.398073455		0	0.008793979		0	0	0	0	0.031308069	
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1981	1		2		2		2			1	
	9		9		1		0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0.428571433	
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	0	0	0	0	0	0	0.104598756		0	0.104598756	
	0.104598756		0.145401245		0.104598756		0.040802487		0.29080249		0
	0	0	0.104598756		0	0	0	0	0	0	
1981	1		2		2		2			1	
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	0	0	0	0	0	0	0	0	0	0	0
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1982	1		2		1		2			1	
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1982	1		2		1		2			1	
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1982	1		2		1		2			1	
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1982	1		2		1		2			1	
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	0.020334747		0.002650904		0.0012532	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0
	0										
1982	1		2		1		2			1	
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	0										
1982	1		2		1		2			1	
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1982	1		2		1		2			1	
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1982	1		2		1		2			1	
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1982	1		2		1		2			1	
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	0.229557204		0.136807093		0.051314523		0.016920264		0.01107314		0
	0.011422258		0	0.015199008		0	0	0	0	0	0
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	0	0	0	0							
1982	1		2		1		2			1	
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1982	1		2		1		2			1	
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1983	1		2		1		2			1	
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	0	0	0	0	0	0	0	0	0	0	0
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1983	1		2		1		2			1	
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0.372127484 0 0 0 0 0 0 0 0 0
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1983 1 2 1 2 1
9 9 8 0 0 0.306313568
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11 11 24 0 0 0.003573786
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12 12 24 0 0 0 0.039894524
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14 14 21 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0

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1984	1		2		1		2			1	
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1984	1		2		1		2			1	
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	0	0									
1984	1		2		1		2			1	
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1984	1		2		1		2			1	
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	0										
1984	1		2		1		2			1	
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1984	1		2		1		2			1	
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1984	1		2		1		2			1	
	16		16		9		0	0	0	0	0
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1984	1		2		1		2			1	
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1984	1		2		1		2			1	
	18		18		1		0	0	0	0	0
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1985	1		2		1		2			1	
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1985	1		2		1		2			1	
	9		9		12		0	0	0.138710359		
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	0.009253935		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
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1985	1		2		1		2			1	
	10		10		21		0	0	0.114009999		
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1985	1		2		1		2			1	
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	0.048370877		0.021631296		0.009662589		0.000832128		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1985	1		2		1		2			1	
	12		12		22		0	0	0.000657255		
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	0	0	0								
1985	1		2		1		2			1	
	13		13		22		0	0	0	0.00408522	
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	0	0	0								
1985	1		2		1		2			1	
	14		14		18		0	0	0	0	
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1985	1		2		1		2			1	
	15		15		10		0	0	0	0	
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0										
1985	1		2		1		2			1	
	16		16		5		0	0	0	0	0
	0	0.397524745		0.496972321		0	0	0.105502934		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1985	1		2		1		2			1	
	17		17		4		0	0	0	0	0

	0	0.099714026		0	0.05736043		0	0	0.821356922		0
	0	0.021568623		0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					
1985	1		2		1		2			1	
	18		18		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0.042888669	
	0	0	0.957111331		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1986	1		2		1		2			1	
	9		9		3		0	0	0.595947729		
	0.040488869		0.121187801		0.121187801		0	0	0	0	0
	0	0	0.121187801		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
1986	1		2		1		2			1	
	10		10		5		0	0.076972966		0.307891865	
	0.303362639		0.18181944		0.095301534		0.03299823		0	0	0
	0	0.001653327		0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0		
1986	1		2		1		2			1	
	11		11		6		0	0	0.143594565		
	0.422320683		0.294092078		0.084230705		0.041987229		0.011652177		
	0.001061282		0	0.001061282		0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0										
1986	1		2		1		2			1	
	12		12		6		0	0	0.067005539		
	0.321106612		0.1954831	0.075411802		0.216543023		0.078522561		0.024703862	
	0.004389529		0	0.016833972		0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0
1986	1		2		1		2			1	
	13		13		6		0	0	0	0.105941662	
	0.270608407		0.299579187		0.121466341		0.17541363		0.005405599		
	0.005405599		0.016179575		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1986	1		2		1		2			1	
	14		14		3		0	0	0	0	
	0.081642416		0.301419711		0.384585602		0.150709856		0.06906744		
	0.012574976		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
1986	1		2		1		2			1	
	15		15		2		0	0	0	0	
	0.951452786		0	0	0	0	0	0.048547214		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1986	1		2		2		2			1	
	8		8		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.5	0	0	0
	0.5	0	0	0	0	0	0	0	0	0	0
	0	0									
1986	1		2		2		2			1	
	9		9		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0.158074946		0.420962527		0.420962527	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1986	1		2		2		2			1	
	10		10		5		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0.006215794		0	0	0	

	0.365460808		0.091489058		0.213309327		0.155960214		0	0.167564798	
	0	0	0	0	0	0	0	0	0		
1986	1		2		2		2			1	
	11		11		3		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.156021473		0.116441565	
	0	0	0.571515488		0	0.156021473		0	0	0	0
	0	0	0	0	0	0					
1986	1		2		2		2			1	
	12		12		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	1	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1989	1		2		1		2			1	
	9		9		7		0	0	0.021880185		
	0.294278136		0.432384057		0.251457623		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1989	1		2		1		2			1	
	10		10		21		0	0	0.02320648		
	0.188204322		0.320881936		0.300561775		0.087971622		0.064233909		
	0.01255769		0	0.002382266		0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0
	0										
1989	1		2		1		2			1	
	11		11		23		0	0	0.006119173		
	0.100635819		0.336900835		0.342854177		0.102973646		0.047710379		
	0.033001478		0.020988489		0.006137895		0.002678109		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1989	1		2		1		2			1	
	12		12		24		0	0.000230948		0	
	0.034341253		0.285672307		0.35567289		0.140796092		0.067343154		
	0.058101052		0.023465172		0.01568077		0.01211001		0.001893811		
	0.000467554		0	0.004224987		0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1989	1		2		1		2			1	
	13		13		24		0	0	0	0.007937187	
	0.215662599		0.217941575		0.232916544		0.113217756		0.093132669		
	0.051608244		0.018620773		0.024696101		0.006531859		0.013238013		
	0.004496679		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1989	1		2		1		2			1	
	14		14		19		0	0	0	0	
	0.099349829		0.143475183		0.06453429		0.193708939		0.232970479		
	0.077183225		0.067730564		0.08164926		0.009023686		0	0.030374544	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1989	1		2		1		2			1	
	15		15		15		0	0	0	0	0
	0.144417319		0.232536346		0.085096552		0.113632732		0.094355698		
	0.192888078		0.085021546		0	0.052051729		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1989	1		2		1		2			1	
	16		16		6		0	0	0	0	0
	0.14021478		0.311554531		0	0.012200316		0.03112497		0.233856793	
	0	0.090382045		0.180666565		0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0		
1990	1		2		1		2			1	
	8		8		3		0	0	0.617470843		
	0.261599412		0	0.120929745		0	0	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					
1990	1		2		1		2			1	
	9		9		7		0	0	0.151708455		
	0.374835791		0.325548349		0.0654865	0.016934403		0	0	0.0654865	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1990	1		2		1		2			1	
	10		10		24		0	0	0.234149162		
	0.179064167		0.293136977		0.234488621		0.041662185		0.008661743		
	0.005927643		0.002909502		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0										
1990	1		2		1		2			1	
	11		11		29		0	0	0.058050886		
	0.239402452		0.455465138		0.177434924		0.047166296		0.01622357		
	0.002947319		0.000614724		0.00150102		0.000578948		0	0	
	0.000614724		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1990	1		2		1		2			1	
	12		12		29		0	0	0.022495316		
	0.108408443		0.423163402		0.345197186		0.05510741		0.016834764		
	0.013579525		0.010744208		0.000478689		0.003991057		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1990	1		2		1		2			1	
	13		13		29		0	0	0.000786172		
	0.011195727		0.252816808		0.346931483		0.306056809		0.0503575	0.008759502	
	0.01979925		0.002235377		0.000978976		0	0	8.24E-05	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0										
1990	1		2		1		2			1	
	14		14		26		0	0	0	0	
	0.087561983		0.220820566		0.258447593		0.205071188		0.115332087		
	0.065610025		0.02968049		0.002507827		0	0.010714507		0	0
	0.004253734		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1990	1		2		1		2			1	
	15		15		18		0	0	0	0.048996051	
	0	0.193589119		0.032225321		0.1501047	0.33920475		0.063752134		
	0.076468357		0.038192698		0.048941168		0	0	0.008525703		0
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	0	0	0	0	0	0	0	0	0	0	0
	0										
1990	1		2		1		2			1	
	16		16		6		0	0	0	0	
	0.254018658		0.002952776		0.002371224		0.30671705		0.058603944		0.005324
	0.118946468		0.251065881		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
1990	1		2		1		2			1	
	17		17		4		0	0	0	0	0
	0.552275379		0	0	0.006572588		0.18941737		0.013145176		0
	0	0	0.238589486		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1990	1		2		1		2			1	
	18		18		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	1	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									

1990	1		2		2		2			1	
	4		4		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1990	1		2		2		2			1	
	8		8		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1990	1		2		2		2			1	
	9		9		4		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.131847871		0.041681344	
	0.698105524		0.083362688		0	0.003321229		0.041681344		0	0
	0	0	0	0	0	0	0	0			
1990	1		2		2		2			1	
	10		10		11		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.007728633		0.444232105	
	0.289296855		0.051221211		0.147687449		0.059833748		0	0	0
	0	0	0	0	0	0	0	0			
1990	1		2		2		2			1	
	11		11		13		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.005684038		0.112131522		
	0.129004086		0.230713192		0.027149957		0.104146905		0.16238428		
	0.004926119		0.104146905		0.104146905		0	0	0.01556609		0
	0	0	0	0							
1990	1		2		2		2			1	
	12		12		3		0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0.916272273	
	0.004359155		0.079368572		0	0	0	0	0	0	0
	0	0	0	0	0						
1990	1		2		2		2			1	
	13		13		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1990	1		2		2		2			1	
	14		14		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1991	1		2		1		2			1	
	7		7		1		0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1991	1		2		1		2			1	
	8		8		2		0	0.961674138		0	
	0.038325862		0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1991	1		2		1		2			1	
	9		9		5		0	0.205263009		0.237790323	
	0.556946668		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1991	1		2		1		2			1	
	10		10		18		0	0.063617506		0.189417867	
	0.298980044		0.167327978		0.143347555		0.123260563		0	0.014048488	

	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0		
1991	1		2		1		2			1	
	11		11		25		0	0	0.069356725		
	0.239278254		0.274248833		0.256987832		0.112583539		0.034860747		
	0.008753829		0.002951963		0	0	0	0.000978278		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1991	1		2		1		2			1	
	12		12		25		0	0	0.01655686		
	0.095042297		0.212363533		0.343736785		0.260812762		0.05199808		
	0.015375957		0.003284514		0.000297864		0.000531346		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1991	1		2		1		2			1	
	13		13		25		0	0	0.005304582		
	0.031232476		0.148496748		0.310522159		0.303935606		0.119031999		
	0.053036447		0.017096326		0.000596483		0.010641472		0.000105702		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1991	1		2		1		2			1	
	14		14		24		0	0	0	0.036231754	
	0.008214621		0.279525688		0.264907342		0.300411876		0.07110535		
	0.019756732		0.001774544		0.016960411		0.001111681		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1991	1		2		1		2			1	
	15		15		21		0	0	0	0	
	0.061306798		0.096285245		0.174291867		0.207823222		0.241681147		
	0.101682761		0.083956039		0.03032981		0.001699474		0.000943637		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1991	1		2		1		2			1	
	16		16		12		0	0	0	0	0
	0.216995268		0.138156798		0.204428179		0.141403887		0.031163912		
	0.010533249		0.226164785		0.030472312		0	0.000681609		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0										
1991	1		2		1		2			1	
	17		17		6		0	0	0	0	0
	0	0	0	0	0.039124427		0.078248847		0.193421815		
	0.039124427		0.112283386		0	0.193421815		0	0	0	
	0.344375283		0	0	0	0	0	0	0	0	0
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	0	0	0	0	0						
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1991	1		2		2		2			1	
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	0	0	0	0	0	0	0	0.223425809		0.128483548	
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1993	1		2		2		2			1	
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1994	1		2		1		2			1	
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1994	1		2		1		2			1	
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1994	1		2		1		2			1	
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1994	1		2		1		2			1	
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1994	1		2		2		2			1	
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1994	1		2		2		2			1	
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1994	1		2		2		2			1	
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1995	1		2		1		2			1	
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1995 1 2 1 2 1
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1996	1		2		1		2			1	
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1996	1		2		1		2			1	
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1996	1		2		1		2			1	
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	0	0	0	1	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1996	1		2		1		2			1	
	17		17		2		0	0	0	0	0
	0	0	0	0.793290388		0	0	0.206709612		0	0

	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1996	1		2		2		2			1	
	9		9		4		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.165717157		0.139457641	
	0.374631712		0	0	0.154476332		0	0.165717157		0	0
	0	0	0	0	0	0	0				
1996	1		2		2		2			1	
	10		10		5		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.33274929		0	
	0.151120258		0.24559837		0	0.230694189		0	0.039837892		0
	0	0	0	0	0	0	0	0			
1996	1		2		2		2			1	
	11		11		4		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.082877851		0	
	0.157657726		0.077256131		0.157657726		0	0	0.297147803		0
	0.157657726		0	0	0.069745039		0	0	0	0	
1996	1		2		2		2			1	
	12		12		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
	0.119737726		0	0.880262274		0	0	0	0	0	0
	0	0	0	0	0						
1997	1		2		1		2			1	
	7		7		1		0	0	0.5	0.5	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1997	1		2		1		2			1	
	8		8		4		0	0	0.511282391		
	0.413132501		0	0	0.075585108		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					
1997	1		2		1		2			1	
	9		9		16		0	0.003430092		0.248399528	
	0.354895854		0.142664033		0.132222052		0.066927386		0.041986664		
	0.009474391		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1997	1		2		1		2			1	
	10		10		22		0	0	0.087951291		
	0.23686146		0.244655969		0.247434176		0.100597175		0.046466207		
	0.025862378		0.008661651		0.000754846		0	0.000754846		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1997	1		2		1		2			1	
	11		11		22		0.000804106		0	0.043511752	
	0.122902066		0.201066368		0.350581341		0.169830158		0.065401429		
	0.018725799		0.012116458		0.004923531		0.010136991		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
1997	1		2		1		2			1	
	12		12		23		0.000111355		0	0.014790685	
	0.063818882		0.130311677		0.317336937		0.218888083		0.101319226		
	0.08466267		0.028999551		0.01317615		0.007231549		0.003246667		
	0.004830386		0.011276181		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1997	1		2		1		2			1	
	13		13		23		0.000428783		0	0.009945655	
	0.026360855		0.079001676		0.314878126		0.235839981		0.11511381		
	0.096626327		0.060717782		0.038097615		0.021837228		0.001152161		0

	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1997	1		2		1		2			1	
	14		14		20		0	0	0	0	
	0.037301461		0.295796013		0.251361604		0.186555947		0.044093197		
	0.079395958		0.02025705		0.08523877		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0										
1997	1		2		1		2			1	
	15		15		7		0	0	0	0.205599735	
	0	0.006958232		0.181272191		0.15196083		0.256455719		0.08780465	
	0	0.105309823		0	0	0	0.004638821		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
1997	1		2		1		2			1	
	16		16		9		0	0	0	0	0
	0.141366702		0.087991896		0.039996948		0.195772282		0.009549687		
	0.297705189		0.218067608		0.002387422		0.002387422		0.002387422		
	0.002387422		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1997	1		2		1		2			1	
	17		17		1		0	0	0	0	0
	0	0.099999996		0	0.099999996		0.099999996		0.300000008		
	0.099999996		0.300000008		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0		
1997	1		2		1		2			1	
	18		18		2		0	0	0	0	0
	0	0	0	0	0	0.022652572		0.977347428		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1997	1		2		2		2			1	
	7		7		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0.5	0.5	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1997	1		2		2		2			1	
	8		8		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.278248454		0.278248454		
	0.443503092		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					
1997	1		2		2		2			1	
	9		9		4		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.082768144		0.710351586		
	0.028717366		0	0.149445537		0	0.028717366		0	0	0
	0	0	0	0	0	0	0	0			
1997	1		2		2		2			1	
	10		10		5		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0.017918407		0	0.043113394		
	0.212655281		0.020629813		0	0.017918407		0.262454138		0	0
	0.212655281		0	0.212655281		0	0	0	0	0	0
1997	1		2		2		2			1	
	11		11		3		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0.117044071	
	0.027657662		0	0	0.570198845		0	0.285099423		0	0
	0	0	0	0	0	0					
1997	1		2		2		2			1	
	12		12		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

	0	0	0	1	0	0	0	0	0	0	0
	0	0									
1998	1		2		1		2			1	
	8		8		1		0	0	1	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
1998	1		2		1		2			1	
	9		9		5		0	0	0.333198266		
	0.395947686		0.263965123		0	0.006888925		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0				
1998	1		2		1		2			1	
	10		10		6		0	0	0.203643221		
	0.317818105		0.225828738		0.020563391		0.185045048		0.047101497		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0		
1998	1		2		1		2			1	
	11		11		6		0	0	0.051685653		
	0.381299149		0.221759869		0.132267731		0.120895879		0.08152424		
	0.010567479		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1998	1		2		1		2			1	
	12		12		6		0	0	0	0.248179774	
	0.326945786		0.11769286		0.155498058		0.131313275		0.003316493		
	0.017053754		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
1998	1		2		1		2			1	
	13		13		6		0	0	0	0.062477568	
	0.186925555		0.361233525		0.175451806		0.066768698		0.053661865		
	0.00238124		0.045478385		0	0.045621359		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0										
1998	1		2		1		2			1	
	14		14		5		0	0	0	0	
	0.119340845		0.316386352		0.23861331		0.086870041		0.226390971		
	0.012398482		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
1998	1		2		1		2			1	
	15		15		4		0	0	0	0	0
	0	0.0559219	0.472781473		0.088710983		0	0	0	0.382585644	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1998	1		2		1		2			1	
	16		16		2		0	0	0	0	0
	0	0	0.91745552		0	0.08254448		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
1998	1		2		1		2			1	
	17		17		1		0	0	0	0	
	0.666666667		0	0	0.333333333		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
1998	1		2		2		2			1	
	8		8		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.666666667		0.333333333		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							

1998	1		2		2		2			1	
	9		9		3		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.256750611		0.255985883		0
	0.244014116		0.24324939		0	0	0	0	0	0	0
	0	0	0	0	0	0					
1998	1		2		2		2			1	
	10		10		3		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.251507803		0.37405347		0
	0.122930925		0	0.128962135		0.122545667		0	0	0	0
	0	0	0	0	0	0	0				
1998	1		2		2		2			1	
	11		11		2		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0.332984389		
	0.332984389		0	0	0	0	0	0	0	0.334031223	
	0	0	0	0	0	0					
1998	1		2		2		2			1	
	13		13		1		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0									
2000	1		2		1		2			1	
	9		9		1		0	0	0	0.333333333	
	0.666666667		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
2000	1		2		1		2			1	
	10		10		1		0	0	0.047619048		
	0.23809524		0.571428567		0.047619048		0.095238096		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
2000	1		2		1		2			1	
	11		11		1		0	0	0	0.100000001	
	0.499999997		0.300000002		0.05	0.05	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
2000	1		2		1		2			1	
	12		12		1		0	0	0	0.095238097	
	0.285714285		0.238095237		0.238095237		0.095238097		0.047619048		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
2000	1		2		1		2			1	
	13		13		1		0	0	0	0	0.2
	0.1	0.4	0.2	0.1	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0									
2000	1		2		1		2			1	
	14		14		1		0	0	0	0.047619048	
	0	0.095238096		0.285714282		0.190476191		0.190476191		0.095238096	
	0.047619048		0	0	0.047619048		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
2000	1		2		1		2			1	
	15		15		1		0	0	0	0	
	0.333333333		0	0	0	0	0	0.333333333		0.333333333	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					

0 # Total number of size-at-age observations
0 # Total number of environmental variables
0 # Total number of environmental observations
999 # End of file marker

13. Appendix B: SS2 control file

```
# .ctl file for 2005 English sole assessment - base case model

# Growth morphs
 2        # Number of growth morphs
# Sex of each morph (1=female, 2=male)
 1        # Morph 1
 2        # Morph 2

# Areas and migration
 1        # Number of areas
# Each fleet operates in only one area
 1        # Area for fleet 1 south fishery
 1        # Area for fleet 2 north fishery
 1        # Area for fleet 3 south survey
 1        # Area for fleet 4 north survey
 0        # Do migration (0/1) 0 = no migration, 1 for multi-area models

# Time blocks for time-varying parameters
 2        # Number of time block designs for time varying parameters
 4        # Blocks in design 1
 4        # Blocks in design 2
 # Block years design 1
 1981    1985
 1986    1990
 1991    1995
 1996    2004
 # Block years design 2
 1961    1970
 1971    1980
 1981    1990
 1991    2004

# Mortality and growth specifications
 4        # Last age for M young
 10       # First age for M old
 2        # Age for growth Lmin
 20       # Age for growth Lmax
 -50      # Mortality and growth parameter dev phase

# Mortality and growth parameters
# Lo Hi Init Prior Prior Prior Param Env Use Dev Dev Dev Block block
# bnd bnd value mean type SD phase var dev minyr maxyr SD design switch
# Morph 1: Females
 0.00   0.8  0.26 0.26   0        50        -50        0     0     0
        0            0    0           0     # M young
 -5            5      0          0          0         50          -50
        0      0     0           0          0     0           0   # M old:
exp offset to M young
 5             25     16.16   10          0         50          1
        0      0     0           0          0     0           0   # Lmin
 25            55     38.97   35.0   0          50         1           0
        0      0            0           0     0           0     # Lmax
 0.01   1.5  0.28 0.12   0        50        1          0     0     0
        0            0    2           0     # VBK
```

0.01 0.9 0.11 0.05 0 50 1 0 0 0
0 0 0 0 # CV young
-5 5 0 0 0 50 -50
0 0 0 0 0 0 0 # CV
old: exp offset to CV young
Morph 2: Males
-5 5 0 0 0 50 -50
0 0 0 0 0 0 0 # M
young: exp offset to morph 1
-5 5 0 0 0 50 -50
0 0 0 0 0 0 0 # M old:
exp offset to young
-5 5 0 0 0 50 -50
0 0 0 0 0 0 0 # Lmin:
exp offset to morph 1
-5 5 -0.459 0 0 50 1
0 0 0 0 0 0 0 # Lmax:
exp offset to morph 1
-5 5 0.27 0 0 50 1
0 0 0 0 0 0 0 # VBK:
exp offset to morph 1
-5 5 0.56 0 0 50 1
0 0 0 0 0 0 0 # CV
young: exp offset to morph 1
-5 5 0 0 0 50 -50
0 0 0 0 0 0 0 # CV
old: exp offset to CV young

Weight-Length relationship parameters (L in cm, W in kg)
Female Maturity-at-length Logistic function parameters
eggs per gram relationship
Lo Hi Init Prior Prior Prior Param Env Use Dev Dev
Dev Block block
bnd bnd value mean type SD phase var dev minyr maxyr
SD design switch
Morph 1: females
0 0.5 0.00000547424 0 0 50 -50 0
0 0 0 0 0 0 # W-L scale
0 5 3.154473 0 50 -50 0
0 0 0 0 0 0 # W-L power
0 50 31 25 0 50 -50
0 0 0 0 0 2 0 #
Maturity to start blocking
-1 1 -0.6104999 -0.5 0 50 -50 0
0 0 0 0 0 0 # Maturity slope
0 1 1 1 0 50 -50
0 0 0 0 0 0 0 #
intercept eggs/kg
0 1 0 0 0 50 -50
0 0 0 0 0 0 0 # slope
eggs/kg
Morph 2: Males
0 0.5 0.00000727969 0 0 50 -50 0
0 0 0 0 0 0 # W-L scale

```
 0		5	 3.0728	3		0		50		-50
	0	0	0		0		0	0		0	# W-L
power

# Distribute recruitment among morphs
# Lo	Hi	 Init	Prior	Prior	Prior	Param	Env	Use	Dev		Dev
	Dev	Block	block
# bnd	bnd  value		mean	type	SD		phase	var	dev	minyr	maxyr
	SD	design	switch
# Area 1
 0		1	 0.5	0.5		0		50		-50
	0	0	0		0		0	0		0	# Morph
1
 0		1	 0.5	0.5		0		50		-50
	0	0	0		0		0	0		0	# Morph
2
# Distribute recruitment among areas
 0		1	 1		1		0		50		-50
	0	0	0		0		0	0		0	# Area 1

 0 # Custom environmental linkage setup for mortality and growth parameters
 1 # Custom block setup for mortality and growth parameters
 # Lo	Hi	Init	Prior	P_type	SD	Phase
   -10	10	-0.1	0	0	50	1    # MG block
   -10	10	-0.1	0	0	50	1    # MG block
   -10	10	-0.2	0	0	50	1    # MG block
   -10	10	-0.3	0	0	50	1    # MG block
   -10	10	-0.064110	0	50	-50   # maturity block
   -10	10	-0.132610	0	50	-50   # maturity block
   -10	10	-0.206150	0	50	-50   # maturity block
   -10	10	-0.285530	0	50	-50   # maturity block

# Spawner-recruit parameters
 1	# spawner recruit function: 1 = B-H, 2 = options to come
# Lo	Hi	Init	Prior	Prior	Prior	Param
# bnd	bnd	value	mean	type	SD		phase
 5		25  12.60		13		0		50		1
	# Ln(R0)
 0.2	1	0.80	0.6		0		50		2		#
Steepness w/ diffuse prior
 0		2	0.51	0		0		50		-50
	# Sigma R
 -5		5	0		0		0		50		-50
	# Environmental link coefficient
 -5		5	0		0		0		50		-50
	# Initial equilibrium offset to virgin

 0 # index of environmental variable to be used

# Recruitment residuals
 1877	# Start year recruitment residuals
 1998	# End year recruitment residuals
 -10	# Lower bound
 10		# Upper bound
 1		# Phase
```

Initial F setup by fleet
Lo Hi Init Prior P_type SD Phase
0 1 0 0.01 0 50 -50 # Fleet 1: south
fishery
0 1 0 0.01 0 50 -50 # Fleet 2: north
fishery

Catchability (Q) setup (0/1)
One parameter row for each positive entry in cols 1-5 below, by fleet
Float Power Environ Dev Environ par Num/Bio(0/1)
0 0 0 0 0 1 # Fleet
1: south fishery
0 0 0 0 0 1 # Fleet
2: north fishery
1 0 0 0 0 1 # Survey
1: survey south
1 0 0 0 0 1 # Survey
2: survey north
Catchability (Q) parameters
Lo Hi Init Prior P_type SD Phase
-5 0 -1.96 -1 0 50 1 # Ln(Q)
Survey 1 south
-5 0 -0.84 -1 0 50 1 # Ln(Q)
Survey 2 north

Selex and retention parameters
Size based selectivity setup
Selex_type Do_retention(0/1) Do_male Mirror selex (#)

7 1 0 0
Fleet 1: 7 = smooth double logistic (8 params)
5 1 0 1
Fleet 2: mirror
7 0 0 0
Fleet 3: 7 = smooth double logistic (8 params)
7 0 0 0
Fleet 4: 7 = smooth double logistic (8 params)
Age based selectivity setup
Selex_type Do_retention(0/1) Do_male Mirror selex (#)

10 0 0 0
Fleet 1: fishery south, 10 = flat (0 params)
10 0 0 0
Fleet 2: fishery north, 10 = flat (0 params)
10 0 0 0
Fleet 3: survey south, 10 = flat (0 params)
10 0 0 0
Fleet 4: survey north, 10 = flat (0 params)

Size based selectivity and retention parameters
Lo Hi Init Prior Prior Prior Param Env Use Dev Dev
Dev Block block
bnd bnd value mean type SD phase var dev minyr maxyr
SD design switch
Fleet 1 size based selectivity

25 45 33 44 0 50 2
0 0 0 0 0 1 0 # Length
at peak
0.0001 0.6 0.0 0.1 0 50 -50
0 0 0 0 0 0 0 # Initial
selectivity
-10 100.45 0.7 0 50 2 0 0
0 0 0 0 0 # Inflection
0.001 10 0.10 0.2 0 50 -7 0
0 0 0 0 0 0 # Slope
-10 10 99 5 0 50 -2 0
0 0 0 0 0 0 # Final selectivity
-10 10 0.1 0.0 0 50 -2
0 0 0 0 0 0 0 #
Inflection 2
0.001 10 0.1 1 0 50 -3
0 0 0 0 0 0 0 # Slope
2
1 35 1 30 0 50 -50
0 0 0 0 0 0 0 # Width
of top
Fleet 1 retention parameters
25 35 30.7474 27 0 50 2
0 0 0 0 0 0 0 #
Inflection
1 2 1.42386 1.0 0 50 -50
0 0 0 0 0 0 0 # Slope
0.8 1 1.0 1 0 50 -50
0 0 0 0 0 0 0 #
Asymptote
-10 10 0 0 0 50 -50
0 0 0 0 0 0 0 # Male
offset on inflection
Fleet 2 as mirror
1 45 1 44 0 50 -50
0 0 0 0 0 0 0 # min
bin mirror
1 45 18 18 0.1 50 -50
0 0 0 0 0 0 0 # max
bin mirror
Fleet 2 retention parameters
23 35 30.7 27 0 50 2
0 0 0 0 0 0 0 #
Inflection
0 4 1.42386 1.4 0 50 -50
0 0 0 0 0 0 0 # Slope
0.8 1 1.0 1 0 50 -50
0 0 0 0 0 0 0 #
Asymptote
-10 10 0 0 0 50 -50
0 0 0 0 0 0 0 # Male
offset on inflection
Fleet 3 size based selectivity
20 46 40 40 0 50 2
0 0 0 0 0 0 0 # Length
at peak

```
 0.0    0.6    0.0    0.1    0    50    -50    0    0    0    0    0    0    0    # Initial selectivity
 -10    10-0.63    0.7    0    50    2    0    0    0    0    0    0    0    # Inflection
 0.001    10    0.66    0.5    0    50    2    0    0    0    0    0    0    0    # Slope
 -10    10    99    5    0    50    -50    0    0    0    0    0    0    0    # Final selectivity
 -10    10    0.0    0.0    0    50    -50    0    0    0    0    0    0    0    # Inflection 2
 0.1    10    1    1    0    50    -50    0    0    0    0    0    0    0    # Slope 2
 1    35    30    2    0    50    -50    0    0    0    0    0    0    0    # Width of top
# Fleet 4 size based selectivity
 20    46    40    40    0    50    2    0    0    0    0    0    0    0    # Length at peak
 0.0    0.6    0.0    0.1    0    50    -50    0    0    0    0    0    0    0    # Initial selectivity
 -10    10-0.27    0.7    0    50    2    0    0    0    0    0    0    0    # Inflection
 0.001    10    0.56    0.2    0    50    2    0    0    0    0    0    0    0    # Slope
 -10    100    99    5    0    50    -50    0    0    0    0    0    0    0    # Final selectivity
 -5    5    0.0    0.0    0    50    -50    0    0    0    0    0    0    0    # Inflection 2
 0.1    10    1    1    0    50    -50    0    0    0    0    0    0    0    # Slope 2
 1    35    30    3    0    50    -50    0    0    0    0    0    0    0    # Width of top

# Custom environmental read setup
 0    # 0 = Read one setup, apply to all, 1 = Custom, read one each
# Custom block read setup
 1    # 0 = Read one setup, apply to all, 1 = Custom, read one each
# Lo    Hi    Init    Prior    P_type    SD    Phase
  -5    5    0    0    0    50    3    # block par 81-85
  -5    5    0    0    0    50    3    # block par 86-90
  -5    5    0    0    0    50    3    # block par 91-95
  -5    5    0    0    0    50    3    # block par 96-04

 -50    # Phase for selex parameter devs
 1    # Max number of lambda phases: read this number of values for each component below
 0    # SD offset (CPUE, discard, mean body weight, recruitment devs): 0 = omit log(s) term, 1 = include
```

Lambda values for all likelihood components by fleet
CPUE data
0
0
1 # Fleet 3: survey south
1 # Fleet 4: survey north
Discard fraction/biomass data
1 # Fleet 1: fishery south
1 # Fleet 2: fishery north
0
0
Mean body weight data (one value for all fleets)
1
Length frequency data
1 # Fleet 1: fishery south
1 # Fleet 2: fishery north
1 # Fleet 3: survey south
1 # Fleet 4: survey north
Age frequency data
1 # Fleet 1: fishery south
1 # Fleet 2: fishery north
0
1 # Fleet 4: survey north
Size at age data
0
0
0
0
Initial F
0
Recruitment residuals
1
Parameter priors
1
Parameter time series devs
1
999 # End of file marker