Status of Kelp Greenling (*Hexagrammos decagrammus*) in Oregon and California Waters as Assessed in 2005

by

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Executive Summary

Stock

This is the first assessment of the population status of kelp greenling (*Hexagrammos decagrammus* [Pallas]) along the coasts of California and Oregon (Figure 1). Two substocks (the Oregon substock and the California substock) are delineated for the purposes of this assessment at the Oregon-California border. This substock designation is based on fishery history and management needs of the two areas. There is no commercial fishery for kelp greenling in Washington waters nor are there substantial recreational removals of kelp greenling in that state's coastal waters. Washington was therefore not included in this assessment.

Extensive exploration of the California model before and during the STAR Panel made it clear that, given the current knowledge of kelp greenling life history in California (specifically the paucity of information on age and growth and natural mortality) and major inconsistencies in the available data streams, there is no suitable model structure for California at present. Catch histories and data summaries are provided for California, but no assessment outcomes are given.

Catches

Kelp greenling removals were assigned to six fleets (two commercial and four recreational; Figures E-1–E-2; Tables E-1-E-2) for each substock because each of these fleets targets a different component of the population. The assessment for each substock considered a non-live and live-fish commercial fishery and CPFV and PBR recreational modes. Additionally man-made and beach/bank recreational modes were considered for Oregon while shore (combining the man-made and beach/bank modes) and spearfishing modes were considered for California. Removals were reconstructed for each of these fleets back to 1981 (Oregon) and 1916 (California). Historically, the shore modes have been the primary source of removals of kelp greenling. The commercial catch of kelp greenling has become a major source of removals in the last 10 years because of the developing live-fish fishery in both states. Discard mortality is assumed to be negligible because kelp greenling can generally survive catch and release.

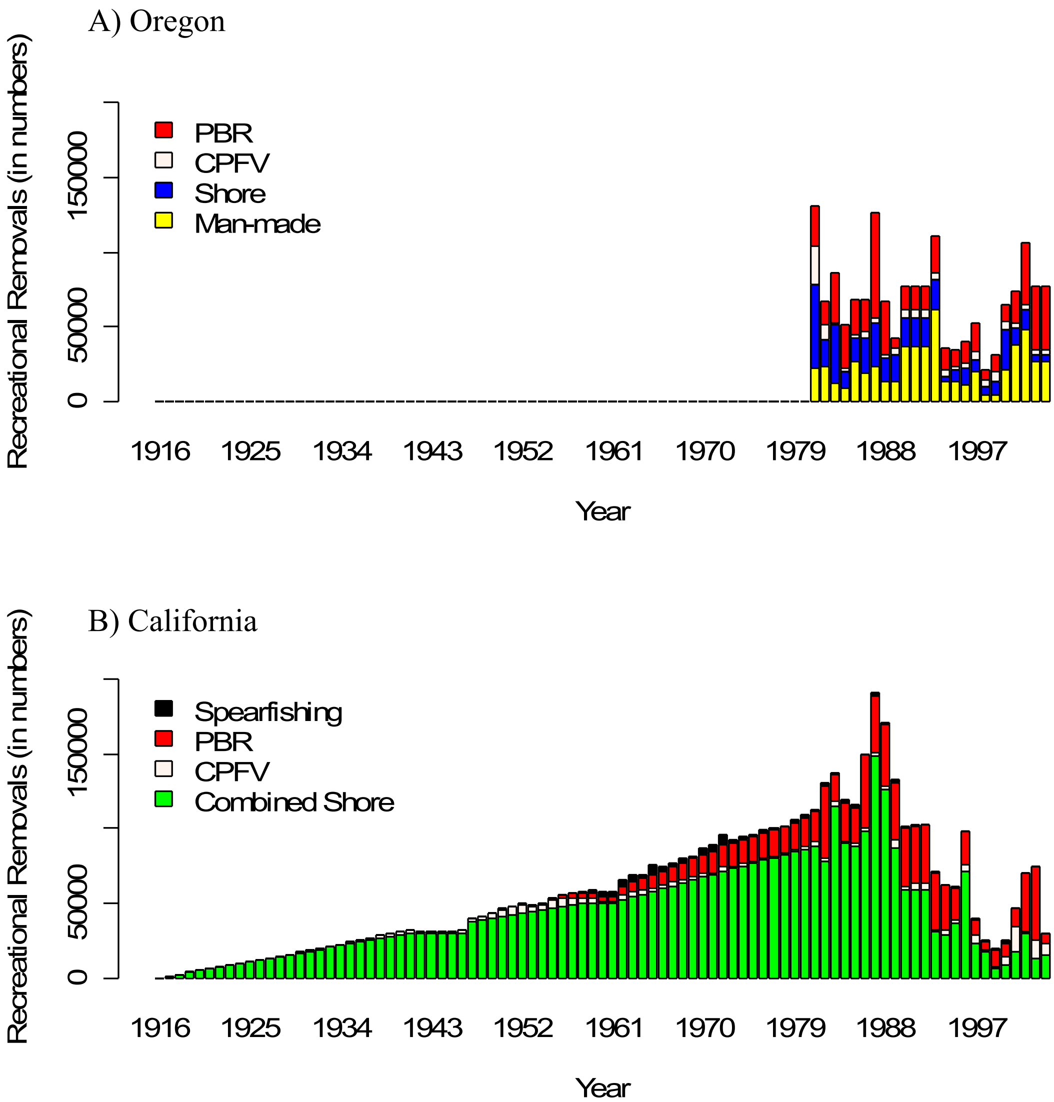
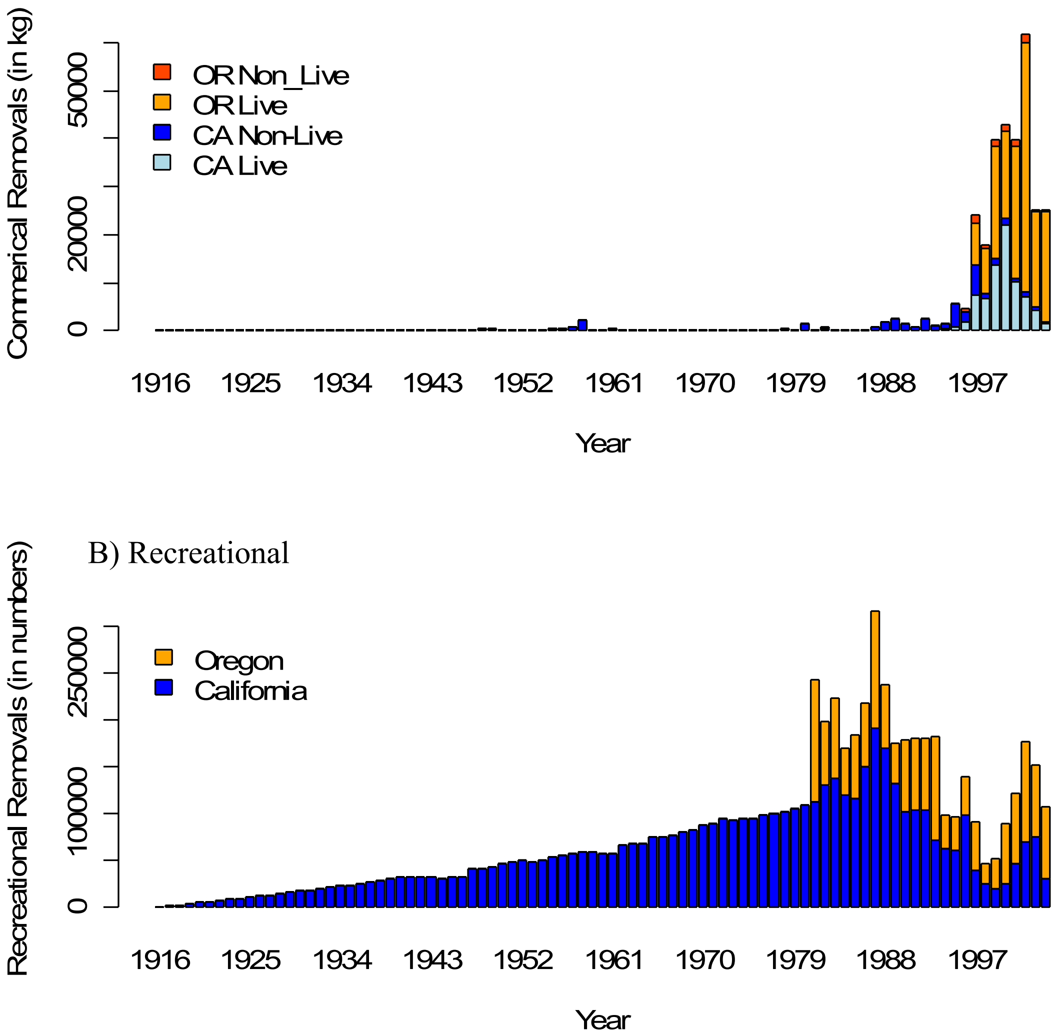


Figure E-1. Recreational kelp greenling removals (in numbers) by fleet for A) Oregon and B) California.

A) Commercial



B) Recreational

Figure E-2. A) Commercial and B) recreational kelp greenling removals (in kg) by substock.

Table E-1. Commercial removals (in mt) of kelp greenling by substock and fleet.

	OREGON		CALIFORNIA			OREGON		CALIFORNIA	
Year	Non-live	Live	Non-live	Live	Year	Non-live	Live	Non-live	Live
1916			0	0	1961			0.3996	0
1917			0	0	1962			0.2635	0
1918			0	0	1963			0.0000	0
1919			0.0213	0	1964			0	0
1920			0.2935	0	1965			0	0
1921			0.0136	0	1966			0	0
1922			0.0458	0	1967			0	0
1923			0.0172	0	1968			0	0
1924			0	0	1969			0.1905	0
1925			0.0340	0	1970			0.0662	0
1926			0	0	1971			0	0
1927			0	0	1972			0	0
1928			0	0	1973			0	0
1929			0	0	1974			0	0
1930			0	0	1975			0	0
1931			0	0	1976			0	0
1932			0	0	1977			0.0200	0
1933			0	0	1978			0.5910	0
1934			0	0	1979			0.1334	0
1935			0.0136	0	1980			1.4261	0
1936			0.0268	0	1981	0.0362	0	0.0984	0
1937			0.0259	0	1982	0.0362	0	0.6700	0
1938			0.2567	0	1983	0.0362	0	0.1433	0
1939			0.0109	0	1984	0.0362	0	0.0721	0
1940			0	0	1985	0.0362	0	0.0358	0
1941			0.0649	0	1986	0.0362	0	0.2762	0
1942			0	0	1987	0.0362	0	0.7158	0
1943			0	0	1988	0.0803	0	1.8969	0
1944			0	0	1989	0.0767	0	2.6562	0
1945			0	0	1990	0.0032	0	1.5572	0
1946			0	0	1991	0.0227	0	0.8228	0
1947			0.0522	0	1992	0.0132	0.0027	2.5075	0
1948			0.3289	0	1993	0.0236	0.0594	1.1952	0.0576
1949			0.3338	0	1994	0.0390	0.1420	0.8246	0.6563
1950			0.1864	0	1995	0.0308	0.0073	4.6992	0.8419
1951			0.2644	0	1996	0.6400	0.0249	1.9736	2.0339
1952			0.2191	0	1997	1.7695	8.8015	6.3675	7.3083
1953			0.0630	0	1998	0.7643	9.0700	1.0628	6.8973
1954			0	0	1999	1.3227	23.2979	1.6456	13.6041
1955			0.3411	0	2000	1.2864	18.1278	1.3163	22.0813
1956			0.5384	0	2001	1.3268	27.5870	0.8106	10.0620
1957			0.8283	0	2002	1.5948	51.8955	0.9430	7.1736
1958			2.1546	0	2003	0.3556	19.7340	0.6187	4.3631
1959			0	0	2004	0.5302	22.7477	0.3475	1.6896
1960			0	0					

Table E-2. Recreational removals (in numbers) of kelp greenling by substock and fleet.

	OREGON				CALIFORNIA			
Year	Man-made	Beach/Bank	CPFV	PBR	Shore Combined	CPFV	PBR	Spearfishing
1916					1	0	0	0
1917					1202	0	0	0
1918					2404	0	0	0
1919					3605	0	0	0
1920					4807	0	0	0
1921					6008	0	0	0
1922					7209	0	0	0
1923					8411	0	0	0
1924					9612	0	0	0
1925					10814	0	0	0
1926					12015	0	0	0
1927					13216	0	0	0
1928					14418	0	0	0
1929					15619	77	1	0
1930					16821	213	2	0
1931					18022	349	2	0
1932					19223	485	3	0
1933					20425	621	4	0
1934					21626	757	5	0
1935					22828	893	7	0
1936					24029	1287	9	0
1937					25231	1794	12	0
1938					26432	2339	15	0
1939					27633	2443	20	0
1940					28835	2411	26	0
1941					30000	2379	35	0
1942					30000	1256	46	0
1943					30000	1209	60	0
1944					30000	1011	79	0
1945					30000	1239	103	0
1946					30000	1884	136	1
1947					37245	2947	178	2
1948					38446	2691	234	3
1949					39647	3200	308	6
1950					40849	4897	404	11
1951					42050	5289	531	20
1952					43252	5469	697	37
1953					44453	2938	916	68
1954					45654	3246	1203	125
1955					46856	5200	1581	229
1956					48057	5354	2077	418
1957					49259	4246	2728	765
1958					50460	2772	3579	1401
1959					50460	2730	3579	1751
1960					50460	548	3579	3308
1961					50460	422	3579	2867
1962					52334	3030	5277	4891
1963					54208	3202	6623	4501
1964					56081	3186	7781	1557
1965					57955	2327	8817	6408
1966					59828	1956	9765	3230
1967					61702	2656	10646	1479
1968					63575	1862	11473	3100
1969					65449	2106	12255	1855
1970					67322	2238	13001	4359
1971					69196	1444	13714	4359
1972					71069	3135	14399	6862
1973					72943	1978	15059	2685
1974					74816	1875	15697	1972
1975					76690	1178	16316	1258
1976					78563	1093	16916	2543
1977					80437	962	17501	1505
1978					82310	962	18070	337
1979					84184	1232	18626	1660
1980					86057	1502	19169	2750
1981	7213	16761	18561	13502	87929	3729	19702	778
1982	5711	4147	7598	7061	77790	2616	48354	1699
1983	3272	8640	589	13301	114412	4103	17499	1427
1984	2182	3306	1481	11901	90047	1591	25261	1972
1985	5713	3744	1209	7421	88377	1452	23868	1881
1986	5702	6969	2825	7860	97604	3170	48201	934
1987	7827	9566	2408	24277	148107	2742	38139	1414
1988	4265	5212	1618	14920	126273	2513	41012	739
1989	4731	5782	2625	2460	87161	4781	38727	1583
1990	12240	8026	2950	6364	59030	2627	38261	1712
1991	12240	8026	2950	6364	59030	4360	38261	1258
1992	12240	8026	2950	6364	59030	4763	38261	713
1993	19750	10269	3275	10268	30899	1711	37796	597
1994	4845	1282	3397	7600	29019	2914	29872	389
1995	5040	2058	1272	4365	36387	2866	21240	389
1996	4924	3776	2470	6157	71196	4547	22110	402
1997	6319	2904	3119	7832	22863	5413	10397	746
1998	1940	1198	2385	2989	17795	417	5612	1090
1999	1643	2668	3980	5266	6381	1648	10872	350
2000	6583	7617	3605	4598	8930	5711	8705	2037
2001	14561	3818	2143	7615	17355	16558	12721	259
2002	20015	4719	2235	16282	29638	847	39248	65
2003	10944	1098	2670	13783	12636	12739	49265	78
2004	10944	1098	2670	13783	15505	7809	6795	78

Data and assessment

Four potential indices of abundance (based on the RecFIN database) were considered for Oregon: 1) Man-made, 2) Beach/Bank, 3) CPFV, and 4) PBR modes. There are two potential indices of abundance for California: 1) Shore mode (RecFIN) and 2) CPFV Observer index. Fishery mean weight and catch-length composition data are also used to fit the model, with gender-specific data available for the Oregon CPFV mode. Gender-specific age-composition data for two years (2003 and 2004) are available for Oregon and implemented in the model as conditional age-at-length data. The assessment for Oregon is based on the program Stock Synthesis 2, developed specifically to use age-and length-structured data.

Unresolved problems and major uncertainties

Several sources of uncertainty were recognized and explored using sensitivity analyses. For California, substantial uncertainty remains regarding growth and natural mortality rates, as well as the shape of the selectivity pattern for the shore mode fishery. These factors made formulation of a model for California impossible. The estimates of absolute abundance are very uncertain for Oregon although depletion is relatively well determined. The Oregon assessment is most sensitive to assumptions regarding natural mortality, the extent of variation in recruitment (σ_R), the relationship between CPUE and abundance (linear or non-linear), the values for stock-recruitment parameters such as steepness (*h*), the number of years for which recruitment residuals are estimated, the size of the historical recreational catch, and the length-at-age CVs.

Reference points

Reference points for Oregon from the base-case model are listed in Table E-3. Figure E-3 includes reference points based on federal guidelines (the 40-10 control rule with a $F_{45\%}$ F_{MSY} proxy). In Oregon, fishing mortality has been below F_{MSY} and spawning stock biomass above SB_{MSY} for all years considered in the assessment.

Table E-3. Reference points for Oregon under different states of nature.

	Low R_0	Base Case	High R_0
Unfished Spawning Stock Biomass (SB_0)	206	321	437
Unfished Summary (2+) Age Biomass (B_0)	821	1295	1766
Unfished Recruitment (R_0)	706	1118	1525
Spawning Stock Biomass at MSY proxy ($F_{45\%}$)	79	123	168
MSY ($F_{45\%}$)	52	82	112
Exploitation Rate corresponding to MSY proxy ($F_{45\%}$)	0.125	0.125	0.125

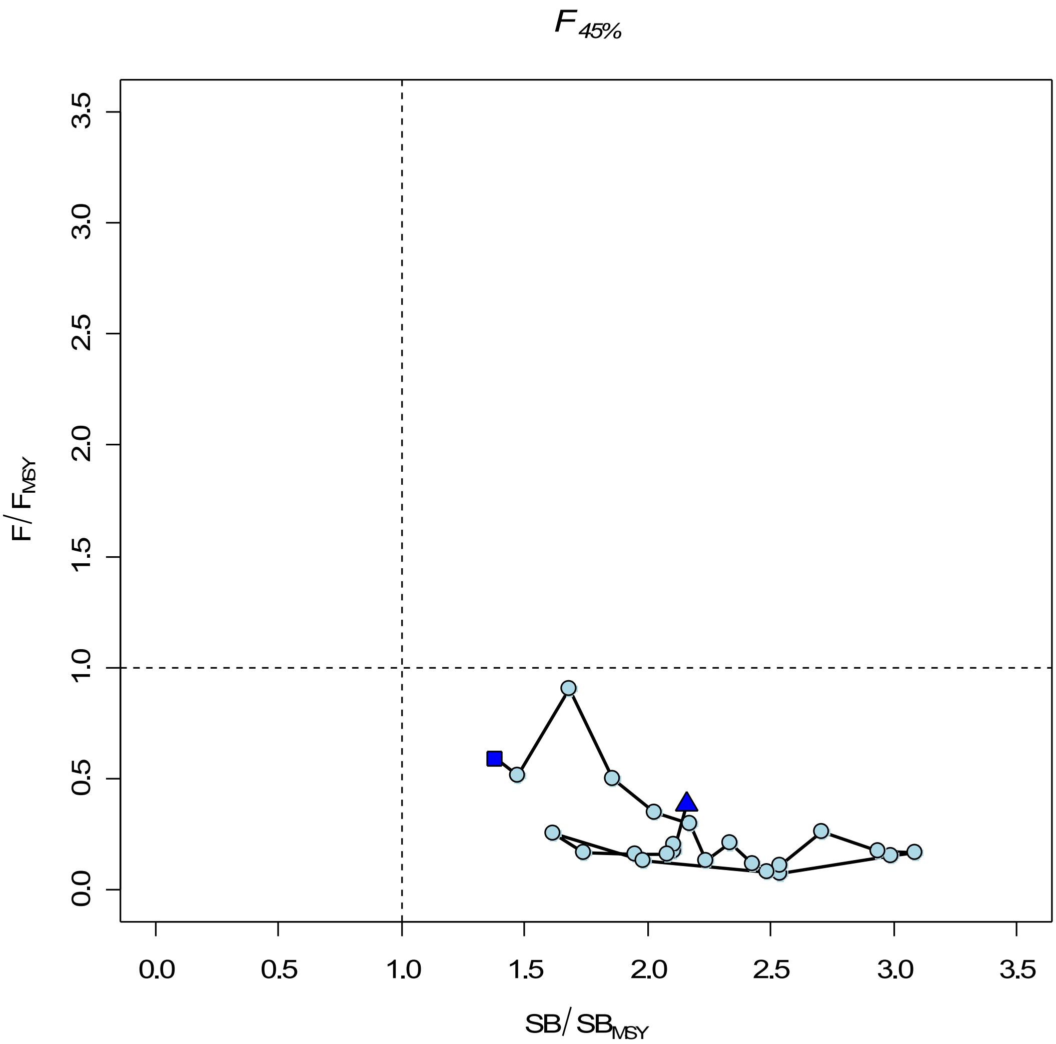


Figure E-3. Spawning stock biomasses and exploitation rates for Oregon relative to target levels. The triangle and square represent the start and end of the time period.

Stock biomass

The unfished reproductive output of kelp greenling in Oregon is estimated to be 321 mt while the reproductive output at the start of 2005 is estimated to be 157 mt (Figure E-4). This leads to an estimated depletion level of 48.8%.

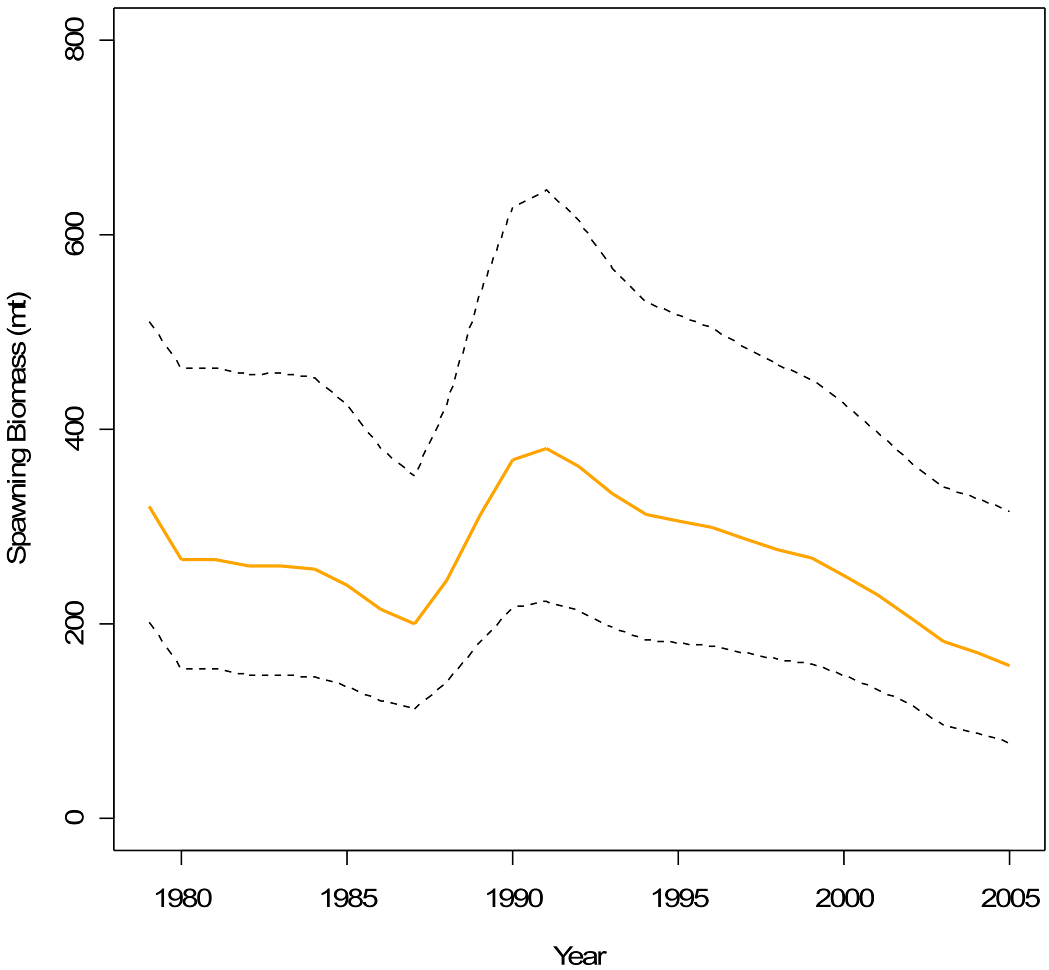


Figure E-4. Time-trajectory of reproductive output (measured in spawning biomass) for Oregon. Bold lines are point estimates; broken lines represent the approximate 95% confidence intervals.

Recruitment

A Beverton-Holt stock-recruit relationship with lognormal process error is used to characterize the spawner-recruitment relationship of kelp greenling. The steepness parameter is set to 0.7 for the base model. Recruitment residuals are estimated for 1981–2003. There were two major recruitment events during the mid-1980s in Oregon (Figure E-5).

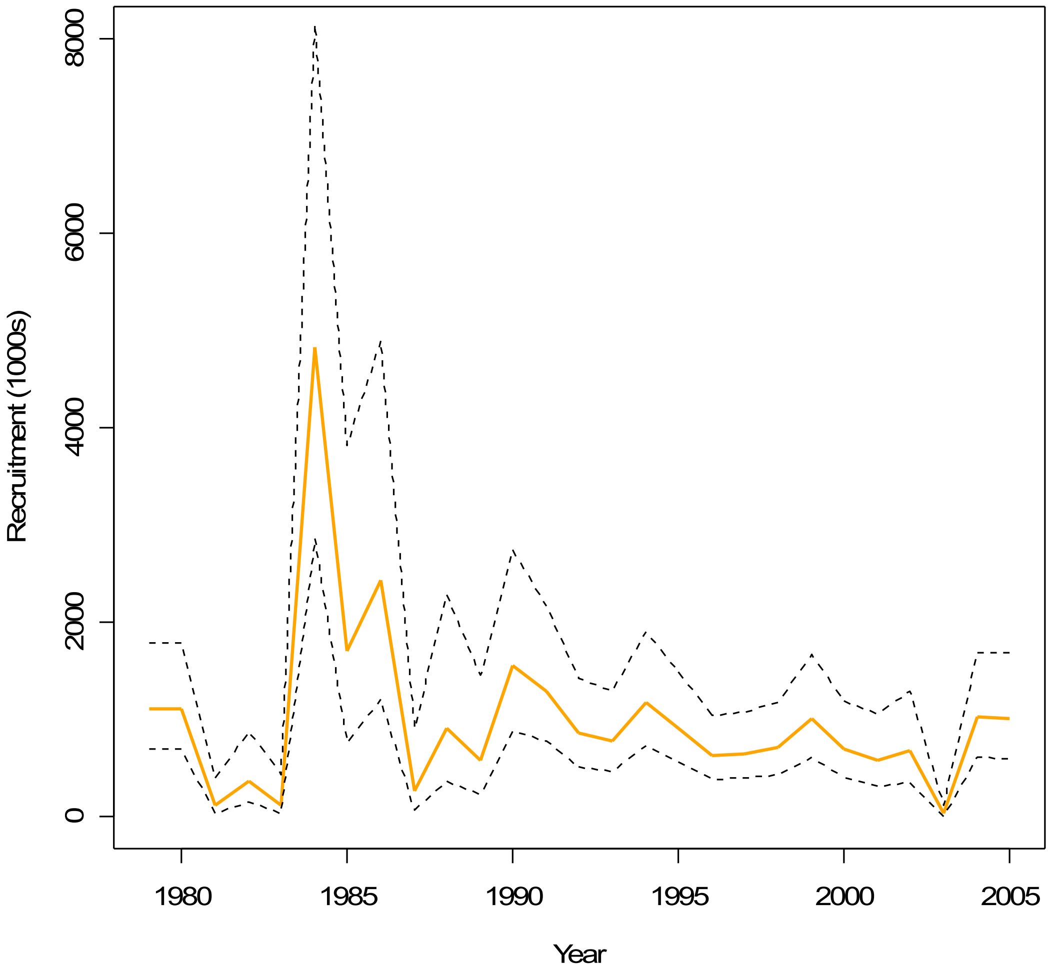


Figure E-5. Time-trajectory of recruitment (1000s) for Oregon. Bold lines are point estimates; broken lines represent the approximate 95% confidence intervals.

Exploitation status

The current (2005) reproductive output of kelp greenling in Oregon is estimated to be about 48.8% of the unfished level (Table E-4; Fig.E-6). The Oregon substock seems healthy at this time, and is above its target level, but the absolute population size is highly uncertain and the conditions prior to 1979 are unknown.

Table E-4. Ten year summary of catches, exploitation rates, spawning potential ratios, biomasses, recruitments and depletion levels for the kelp greenling in Oregon. Parenthetic values are asymptotic standard deviations.

Year	State OY	Total Catch	Exploitation Rate	Spawning Potential Ratio (SPR)	Summary Age (2+) Biomass	Spawning Stock Biomass	Recruitment	Depletion level
1995	--	13	1%	91%	1190	306 (111)	918 (301)	95%
1996	--	18	2%	89%	1168	300 (107)	635 (216)	93%
1997	--	31	3%	82%	1140	288 (103)	652 (221)	90%
1998	--	18	2%	89%	1073	276 (99)	715 (242)	86%
1999	--	38	4%	78%	1010	268 (96)	1008 (347)	83%
2000	--	42	4%	72%	936	250 (92)	695 (258)	78%
2001	--	57	6%	64%	896	230 (87)	583 (241)	71%
2002	--	97	11%	47%	840	207 (82)	680 (303)	65%
2003	20	49	6%	64%	738	181 (80)	41 (36)	56%
2004	29	52	7%	60%	694	170 (79)	1021 (353)	53.0 (8.6)%
2005	29	--	--	--	597	157 (78)	1005 (355)	48.8 (9.4)%

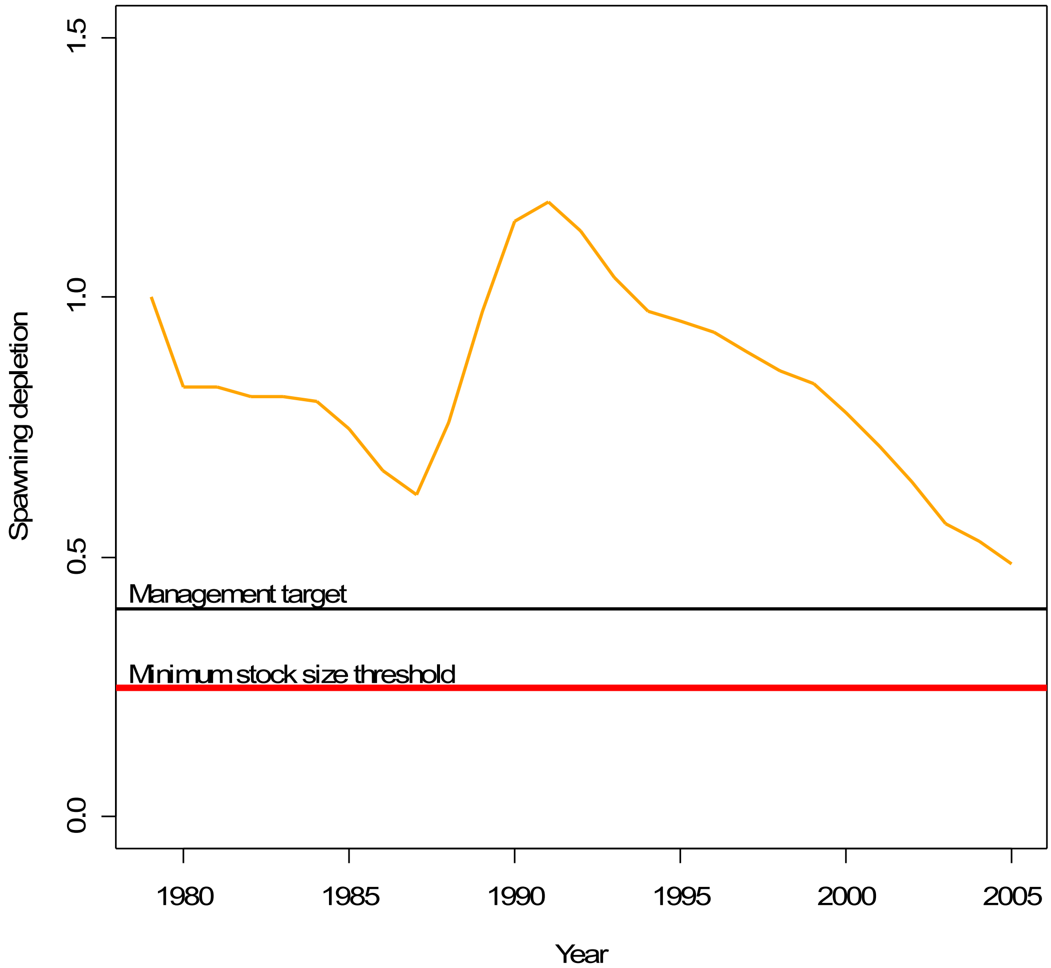


Figure E-6. Time-trajectory (1979-2005) of spawning depletion for Oregon in relation to management targets.

Management performance

No management regulations existed specifically for recreationally caught kelp greenling in California before 1999 when a size limit (12-inches) and a recreational bag limit of 10fish/day were implemented. Kelp greenling is currently included in the California recreational regulatory complex Rockfish, Cabezon, and Greenlings (the RCG complex) and subject to seasonal closures for recreational fishers. In Oregon, recreational kelp greenling removal was limited to a 15 fish cabezon/kelp greenling bag limit, but no size limitation was implemented until 2003 when a 15 inch limit was established. Catch limits for recreationally caught kelp greenling in Oregon were first set in 2003.

Historically, commercial landings of kelp greenling were monitored as part of a mixed group called “Other Fish”. This group of species includes sharks, skates, rays, grenadiers and other groundfish. This group has been defined historically as groundfish species that do not have directed or economically important fisheries. The coastwise ABC for this entire group of species was 14,700mt during 1999–2002 (5,200mt for the Eureka, Monterey and Conception INPFC areas and 9,500mt for the Columbia and Vancouver INPFC areas). Since 2000, California have managed kelp greenling on a state-wide basis, setting annual state-based allowable catches. In California, the kelp greenling fishery is independently monitored and regulated by analyzing two-month cumulative trip limits. From 2001-4, the kelp greenling season closed on or earlier than September 1, when the annual commercial allocations were reached before ends year. Commercial catch limits were first implemented in Oregon in 2003.

Regional Management

Kelp greenling was managed on a coastwide basis until 2000, when state management began. The results of this assessment separate kelp greenling in the two states for assessment purposes. More work and sampling effort is needed to evaluate whether kelp greenling in these two areas differ biologically (growth, maturity, etc.). The results of this assessment indicate that the biomass of kelp greenling in Oregon is currently above the target level. The data and models do not provide the basis for conducting an assessment for California on which management advice can be based. Regional management is an important consideration in relatively sedentary nearshore reef species such as kelp greenling, and future assessments should continue to attempt to analyze data on increasingly finer spatial scales.

Forecasts

Twelve-year projections are conducted for Oregon under the standard PFMC OY control rule for groundfish of $F_{45\%}$ with a 40-10 adjustment for stocks below the target level of 40% of the unfished reproductive output (Table E-5). The relative proportion of the six fleets in future harvests is assumed to be the same as in the last year in the model (2004). The first two years of projected catches are set to the current (2004) OY values because management based on this assessment would not be implemented until 2007. Table E-5 suggests that a reduction in population size will occur over the projection period, although there will be an upturn in biomass towards the end of this period.

Table E-5. Summary of forecast outputs for kelp greenling in Oregon.

	40-10/$F_{45\%}$				
Year	OY	ABC	SB_{2+}	SB	Depletion
2005	29	69	569	150	48%
2006	29	60	527	141	45%
2007	63	55	509	126	41%
2008	60	57	506	107	34%
2009	61	61	532	98	31%
2010	64	65	563	98	31%
2011	68	68	586	103	33%
2012	71	70	601	108	35%
2013	73	71	610	112	36%
2014	75	72	616	114	37%
2015	76	74	622	115	37%
2016	76	75	627	116	37%

Decision table

Projections based on alternative states of nature for initial recruitment (R_0) were explored to capture uncertainty in current (2005) absolute spawning biomass. The probability assigned to the low and high states of nature by the STAR Panel was 0.25 while that assigned to the base-case model was 0.5. The values of lnR_0 for the low and high states of nature were calculated by assuming a normal probability density function parameterized by the maximum likelihood estimate for R_0 and its asymptotic standard deviation from the base-case model (see Table E-3 for summary results for all three states of nature).

Decision analysis population projections are provided in Table E-6 for each state of nature and several state-dependent future catch series. The Oregon substock will drop below 0.25 B_0 if catch levels are based on the high R_0 scenario, but the true state of nature is either the base case or the low R_0 scenario. This also occurs if catches are based on the base-case model, but the low R_0 state of nature is correct. All other scenarios lead to depletion levels above 0.25 B_0 in 2016.

Table E-6. Decision analyses of different states of nature under different catch histories for Oregon under the 40-10 control rule with an F_{MSY} proxy of $F_{45\%}$. p denotes the probability associated with each state of nature. The shaded areas indicate when depletion is less than 0.25.

		State of Nature					
		Low R_0 p = 0.25		Base Case R_0 p = 0.50		High R_0 p = 0.25	
Year	OY	Spawning Biomass	Depletion	Spawning Biomass	Depletion	Spawning Biomass	Depletion
2005	29	72	35%	156	49%	244	56%
2006	29	65	31%	147	46%	233	53%
2007	26	55	27%	133	41%	213	49%
2008	26	50	24%	122	38%	197	45%
2009	29	50	24%	120	37%	191	44%
2010	34	54	26%	126	39%	199	46%
2011	38	60	29%	138	43%	216	49%
2012	41	65	31%	150	47%	234	53%
2013	44	68	33%	160	50%	249	57%
2014	45	70	34%	168	52%	262	60%
2015	47	72	35%	174	54%	272	62%
2016	48	73	36%	179	56%	280	64%
2005	29	72	35%	156	49%	244	56%
2006	29	65	31%	147	46%	233	53%
2007	63	55	27%	133	41%	213	49%
2008	60	41	20%	113	35%	187	43%
2009	61	34	17%	104	32%	175	40%
2010	64	32	16%	104	32%	176	40%
2011	68	32	15%	109	34%	186	43%
2012	71	30	15%	115	36%	198	45%
2013	73	27	13%	119	37%	208	48%
2014	75	23	11%	122	38%	216	49%
2015	76	18	9%	124	38%	222	51%
2016	76	14	7%	125	39%	227	52%
2005	29	72	35%	156	49%	244	56%
2006	29	65	31%	147	46%	233	53%
2007	100	55	27%	133	41%	213	49%
2008	98	32	16%	104	32%	178	41%
2009	97	19	9%	86	27%	157	36%
2010	99	11	5%	79	25%	151	35%
2011	103	5	3%	78	24%	154	35%
2012	106	0	0%	77	24%	159	36%
2013	107	0	0%	74	23%	163	37%
2014	108	0	0%	71	22%	165	38%
2015	109	0	0%	66	21%	166	38%
2016	109	0	0%	62	19%	166	38%

Research Recommendations

1. Collection of sex-specific data: Given the ease of outward sexual identification of gender in kelp greenling, gender-specific information should be collected. This is especially the case for California as there are currently no sex-specific data for this area.

2 Accurate accounting of removals, especially from the recreational and live-fish fisheries: Fisheries exploited primarily by recreational and live-fish commercial fisheries are traditionally hard to monitor. More effort to monitor these fishery sectors may be necessary to accurately monitor fishing mortality.

3. A fishery-independent survey of kelp greenling population abundance: A current fishery-independent survey being developed for cabezon in Morro Bay may also provide information for kelp greenling. The development of surveys like this will become an important input into future assessments of kelp greenling. Expansion of this survey will increase its usefulness as an index of abundance for central and northern California.

4. A study of the stock structure of kelp greenling: Kelp greenling stock structure needs to be studied and the results accounted for in future assessments.

5. Age validation/ age determination: Catch age-composition data were limited in this assessment. Accurate ageing is crucial to understand the population dynamics of a species, especially those for which there is limited information on trends in abundance. Information on the age-structure of the catches for each fishery sector would substantially improve some aspects of the assessment. This is especially true for California Even one year of catch-at-age data may be able to reconcile growth, mortality, and other issues currently effecting development of an assessment for this area.

6. Documentation on the historical Oregon recreational fishery: Extending the catch time series for Oregon back in time should be a priority for the next assessment. Accomplishing this will require collaboration with scientists from Oregon to reconstruct recreational fishing activity prior to the MRFSS program.

7. Alternative substock designations: In additional to further identifying spatial sub-units for assessment purposes, consideration should be given to assessing the combination of California north of Cape Mendocino and Oregon, particularly if a coastwide California assessment remains difficult.

8. Alternative assessment procedures: The need for greater spatial resolution in the management of nearshore fisheries also increases the amount of data required to perform traditional stock assessments. Alternative assessment procedures that are less data-hungry, but still provide relevant management outputs should be developed to address this need. In addition, the nest-guarding behavior of males indicates males in the kelp greenling population should be incorporated into the depletion rates. A metric other than spawning biomass may be needed to help account for the male portion of the population in reference points.

Purpose

This is the first assessment of the population status of kelp greenling (*Hexagrammos decagrammus* [Pallas]) along the coasts of California and Oregon (Figure 1). There is no commercial fishery for kelp greenling in Washington waters nor are there substantial recreational removals of kelp greenling in that state's coastal waters. Washington was therefore not included in this assessment. This assessment is intended to provide information that will be of use by managers at both the state and federal levels and to address the needs of future assessment. This document follows, to the extent possible given the available information, the Terms of Reference for stock assessments established by the PFMC Scientific and Statistical Committee.

Two objectives are addressed in this document. First, the life history of kelp greenling is described and all the available data sources that were considered for use in the assessment are explained. This document only provides detailed information for those data sources that were considered for use in the population modeling. Many other sources of information were considered, but ultimately rejected, and are not included in this document for brevity. Second, the document describes the results of the population assessment and decision analysis using Stock Synthesis 2 v.1.19 (SS2; Methot 2005).

This assessment differs from those performed for most other west coast groundfish species because there is no fishery-independent index of abundance that covers the range of the stock. It consequently relies on indices of abundance based on recreational CPUE and spatially-restricted fishery-independent data. Although no state- or federally-funded biomass indices are currently available for this species, these alternative data sources are considered to be adequate for estimating the values of the parameters of a population dynamics model, though much uncertainty remains in regard to the assumption that changes in recreational CPUE are linearly proportional to changes in population size. There is limited information on the age-structure of the catches (age-structure data are only available for Oregon). Therefore, although the model is age-structured, it is fit mainly to mean weights and length-composition data by converting the model-predicted catch age-compositions to catch size-compositions using internally fit growth curves and externally determined weight-length relationships.

Acronyms used in this document:

ABC – Allowable Biological Catch
AIC – Akaike Information Criterion
BIC – Bayesian Information Criterion
CalCOM - California Commercial Cooperative Groundfish Program
CDF&G – California Department of Fish and Game
CenCAL – Central California Council of Diving Clubs
CPFV – Commercial Passenger Fishing Vessel
CPUE – Catch per unit of effort
CRFS – California Recreational Fisheries Survey
CV – Coefficient of variation
EEZ – Economic Exclusive Zone
FMP – Groundfish Fishery Management Plan
GLM – Generalized Linear Model
MODE – Fishing Method (man-made, beach/bank, shore, private boat, charter boat)
MPD – Maximum of the posterior density function
MRFSS - Marine Recreational Fisheries Statistics Survey
NFMP – Nearshore Fishery Management Plan
ORBS - Ocean Recreational Boat Sampling Programme
NWFSC – Northwest Fisheries Science Center
ODF&G – Oregon Depart of Fish and Wildlife
PBR – Private Boat and Rental
PFEL – Pacific Fisheries Environmental Laboratory
PFMC – Pacific Fishery Management Council
PSFMC – Pacific States Marine Fisheries Commission
RecFIN – Recreational Fisheries Information Network
SS2 – Stock Synthesis 2
SWFSC – Southwest Fishery Science Center
WAVE – Bi-Monthly period of catches
OY- Optimum Yield
VBGF- Von Bertalanffy growth function

Introduction

Kelp greenlings (*Hexagrammos decagrammus*) are a member of the family Hexagrammidae, which also includes lingcod, and are commonly found in nearshore waters along the Northeast Pacific. Kelp greenlings have historically been desired targets of recreational fishers and are commonly taken by shore fishers. Current knowledge of kelp greenling life history is sparse, and is usually based on information collected from a limited extent of the range of the species. The population status of kelp greenling was previously unknown. Kelp greenling is currently managed at the state level as part of a nearshore complex of fishes that include several species of rockfishes and cabezon.

This is the first quantitative assessment of the population status of kelp greenling. Two putative populations ("substocks") of kelp greenling are delineated at the Oregon-California border for the purposes of this assessment. The substock distinction was made because fisheries history (particularly the known histories), behavior, and management vary between these states. Washington was not included because there is no substantial commercial or recreational fishery for greenling along its coastal waters.

Stock Structure

There is little direct information on the stock structure of kelp greenling off the U.S. west coast. Little is also known of kelp greenling movement patterns, but given their nearshore distribution and the territorial behavior of adults (Barker 1979; Bryant 1978; DeMartini 1986), they are not believed to migrate at great distances. Typical of nearshore reef fishes, kelp greenling subpopulations are often spatially discrete, suggesting the possibility of increasing genetic differentiation as distance along the coast increases (Palumbi 2003). Spatially discrete population distribution, regardless to the extent of genetic differentiation, can be susceptible to serial depletion, which suggests the need to examine population trends at small spatial scales. The extent to which this assessment can be conducted at small spatial scales is, however, limited by data.

Kelp greenling is subject to both federal and state management requirements. Primary management responsibility, though, for the Oregon and California kelp greenling resource is based on each state's nearshore fisheries management plans (NFMPs). For management purposes, it is therefore sensible to separate kelp greenling into substocks at the California-Oregon border. Given the concomitant difference in the available data series, and thus baseline populations, for each state, this distinction is further supported. Therefore this assessment addresses two kelp greenling substocks: 1) California (CA) and 2) Oregon (OR).

Life History

Distribution

Kelp greenlings range from southern California, north to the Aluetian Islands, Alaska (Miller and Lea 1972; Eschmeyer et al. 1983), but are rarely found south of Point

Conception, California (Feder *et al.* 1974, Fitch 1953). The main population range and fisheries activities are from central California (including the Channel Islands) north through Oregon. Kelp greenling is primarily a nearshore species found intertidally and among rocks and kelp, usually down to depths of <50m, though they can be found out to depths >150m (Miller and Lea 1972; Love et al. 1996).

Species Associations

Kelp greenling is a member of a nominal statewide nearshore assemblage of fishes, though members of this assemblage do not necessarily co-occur with each other. This assemblage includes several *Sebastes* species (*e.g. S. atrovirens, S. auriculatus, S. carnarus, S. caurinus, S. chrysomelas, S. dallii, S. maliger, S. melanops, S. mystinus, S. nebulosus*, *S. rastrelliger, S. serranoides,* and *S. serriceps*), cabezon (*Scorpaenichthys marmoratus*), rock greenling (*H. lagocephlaus*), monkeyface prickleback (*Cebidichthys violaceus)*), California scorpionfish (*Scorpaena guttata*), and California sheephead (*Semicossyphus pulcher*). These 19 fishes are included in California's Nearshore Fishery Management Plan (CDF&G 2002), an FMP required by mandate of the 1999 Marine Life Management Act. Of these fishes, cabezon (Cope et al 2004, Cope and Punt 2005), California scorpionfish (Maunder et al. 2005), California sheephead (Alonzo et al. 2004), black rockfish (Ralston and Dick 2003), gopher rockfish (Key et al 2005), and vermilion rockfish (MacCall 2005) have been assessed.

Age and Size relationships

Kelp greenlings are moderate sized members of the Hexagrammidae family, reaching a maximum size of 53 cm (Eschmeyer et al. 1983). Very few studies have examined the age and growth of kelp greenling. Moulton (1977) and Barker (1979) provided Von Bertalanffy growth function (VBGF) parameter estimates for kelp greenling in Puget Sound, Washington. The only estimates available for the areas of the present assessments come from Bryant (1978), who provided sex-specific VBGF estimates for central California based on whole otolith reads. No sectioned or break and burn aging of kelp greenling has been reported. Kelp greenling growth was also discussed in Burge and Schultz (1973) and Rothrock (1983), but no estimates were provided. The values from Bryant (1978) were therefore used for the California (Table 1). In 2004, the Oregon Department of Fish and Wildlife (ODF&W) collected and has currently aged (via the break-and-burn technique) several hundred kelp greenlings for assessment purposes (B. Hannah, pers. com.). These data were used to calculate VBGF parameters for Oregon, and the resulting growth curve is very similar to that of Bryant (1978). Female kelp greenling are larger than males of the same age (Figure 2).

Weight-length relationships for kelp greenling are provided in Moulton (1977; total length; combined sexes) and Barker (1979; standard length; combined sexes) for Puget Sound, WA, and Rothrock (1983; standard length; sex-specific relationships only for individuals >24cm) for central California. The Puget Sound studies were not considered here because of potential intraspecific biological differences in Puget Sound versus coastal populations of fishes (Buonaccorsi et al. 2002). Raw length-weight data were available from ODF&W to calculate sex-specific length-weight relationships. The Oregon data were used to determine the weight-length relationship by sex for both

California and Oregon because the Rothrock (1983) estimates were based on small sample sizes for a few age classes and only distinguished sex above 24 cm, (Table 1).

Spawning and Early Life History

Kelp greenling spawn subtidally in shallow rocky areas. Spawning females can be found laying egg-masses from September to December on rocks, rock crevices and kelp or other biological substrata that males claim as nests (Matarese et al. 1989; Rothrock 1983). Males guard nests through the winter and have been documented to carry up to 11 different egg masses at once (Crow 1995; Crow et al.; 1997; DeMartini 1986; Howard and Silberberg 2001). Laid eggs are sticky and adhere to the surface where deposited. After hatching, the young of the year spend several months as epipelagic larvae and juveniles (Gorbunova 1970). Settlement takes place in the nearshore after the young fish have attained 5-6 cm in length (Burge and Schultz 1973; Matarese et al 1989; Robinson et al. 1968a, b). It is apparent that females lay multiple batches in different nests, but whether these eggs are temporally distinct enough to qualify for separate spawning events has not been determined (Crow 1995; Crow et al. 1997; Rothrock 1983).

The relationship between age / size and number of eggs spawned is uncertain because of the possibility of multiple spawnings. Therefore, rather than attempting to determine this relationship, reproductive output has, for the purposes of this assessment, been defined to be proportional to the product of maturity-at-age and body weight at the start of the year. For California, information on maturity-at-length for kelp greenling is scarce and limited to maturity-at-age estimates (Barker 1979; Rothrock 1983). A female maturity-at-length ogive (as required by SS2) was estimated for California by converting the maturity-at-age data to length using the Von Bertalanffy growth function. Maturity-at-length ogives for Oregon were provided by Bob Hannah (ODF&G). Values for each substock are given in Table 1.

Natural Mortality (*M*)

Little is known about the natural mortality rate of kelp greenling, so empirical models using life history traits (growth rate (k), age-at-maturity (a_M), maximum age (ω)) were used to estimate sex-specific natural mortality. Sex-specific differences in natural mortality rates are expected because of differential growth between the sexes. Five methods for estimating M (Hoenig 1983; Chen and Watanabe 1989; Jensen 1996) were therefore applied to data for each sex, and the results averaged to obtain sex-specific natural mortality rates (Table 2). The mean of these approaches imply, for Oregon and California respectively, natural mortality rate of approximately 0.34 and 0.28 yr^{-1} for females and 0.45 and 0.39 yr^{-1} for males, but these methods may produce highly uncertain values of M (Pascual and Iribarne 1993). Exploratory model runs estimating M internal to the model resulted in a value of 0.26yr^{-1} for both sexes. Discussion with the STAR panel supported the use of this single natural mortality rate which forms part of the base case model. Sensitivity to the assumed values of M is explored when applying the assessment model.

Fisheries History

Historically, the recreational sector has been the main source of kelp greenling removals. Kelp greenling were a minor component of the catch in California commercial fisheries back to 1916 (Walford 1931; Roedel 1948) and incidental to the lingcod and nearshore rockfish fisheries (Howard and Silberberg 2001). No information regarding kelp greenling commercial removals in Oregon waters is available prior to 1980, but it was not until the 1990s that a truly directed commercial fishery for kelp greenling was established in the waters of California and Oregon.

The most significant change in the fishery for kelp greenling has been the development of the live-fish commercial fishery that, in addition to kelp greenling, targets several other nearshore fishes (CDF&G 2002). This fishery started in southern California in the late 1980s and spread northward during the late 1990s to Oregon (Starr *et al.* 2002). Fishermen routinely obtain much higher prices for fish brought back to markets alive. Kelp greenlings are not subject to barotrauma because they lack a swim bladder and are usually found in shallow nearshore waters accessible to many fishers. These traits make kelp greenling an ideal target for both the live-fish and recreational fisheries. Gears that take kelp greenling include hook and line and pot/trap type gears, as they are successful at bringing up fish with relatively little damage. Kelp greenling continues to be an important component of the live-fish fishery, even with increased restrictions on the live-fish catch, especially as the allowable catches of other marketable groundfish species have been reduced.

Fisheries Management

The Pacific Fishery Management Council (PFMC) and NOAA Fisheries have management responsibility for the groundfish species included in the Groundfish Fishery Management Plan (FMP) out to the boundary of the 200-mile Exclusive Economic Zone (EEZ). Many nearshore species, such as kelp greenling, that fall primarily within the 3-mile limit of states' waters are also included in state-specific Nearshore Fishery Management Plans (NFMP). NFMPs are currently being developed and implemented in California and Oregon in response to the increased commercial take of the live-fish fishery (CDF&G 2002).

No management regulations existed specifically for recreationally caught kelp greenling before 1999 in California when a size limit (12-inches) was set (see Appendix A for a complete list of regulations). A California recreational bag limit of 10fish/day was also implemented in 1999. Kelp greenling is currently included in the California recreational regulatory complex Rockfish, Cabezon, and Greenlings (the RCG complex) and subject to seasonal closures for recreational fishers. In Oregon, recreational kelp greenling removal was limited to a 15 fish cabezon/kelp greenling bag limit, but no size limitation was implemented until 2003 when a 15 inch limit was established. Catch limits for recreationally caught kelp greenling in Oregon were first set in 2003.

Historically, commercial landings of kelp greenling were monitored as part of a mixed group called "Other Fish". This group of species includes sharks, skates, rays, grenadiers and other groundfish. This group has been defined historically as groundfish species that do not have directed or economically important fisheries. The coastwise ABC for this entire group of species was 14,700mt during 1999–2002 (5,200mt for the Eureka, Monterey and Conception INPFC areas and 9,500mt for the Columbia and Vancouver INPFC areas). Since 2000, California have managed kelp greenling on a state-wide basis, setting yearly state-based allowable catches. In California, the kelp greenling fishery is independently monitored and regulated by analyzing two-month cumulative trip limits. From 2001-2004, the kelp greenling season closed on or earlier than September 1 when the annual commercial allocations were reached before ends year. Commercial catch limits were first implemented in Oregon in 2003.

Assessment Data Sources

Data for species managed by NOAA Fisheries and the Pacific Fishery Management Council are collected by both federal (and/or quasi-federal) and state agencies. This can complicate analysis because several agencies may collect the same types of data. Where this occurs, the analyses below are based on those data that are most likely to be informative regarding changes in population size.

Removals
This assessment uses a reconstructed catch history back to 1916 for California, and back to 1981 for Oregon. The initial year for the California model was selected because of the availability of commercial catches back to 1916. For the Oregon model, recreational catches were available back to 1981, and this determines the start year for the model. Whenever possible, removals are characterized as landed catch plus fish released and presumed dead.

Commercial Catches
<u>California</u>
Several sources of California commercial landings are available to reconstruct commercial kelp greenling landings back to 1916 (the first year of required reporting in the commercial fishery):

- **Years 1978–2004**: The CalCOM database provides annual landings (in pounds) by gear (extracted 30 June 2005).
- **Years 1928–77**: The Pacific Fisheries Environmental Laboratory (PFEL) live access server (<u>http://las.pfeg.noaa.gov:8080/las_fish1/servlets/dataset</u>) and the California Explores the Ocean (<u>http://ceo.ucsd.edu/fishcatchtables/fish-catch-download.html</u>) website provide electronic summaries of CDF&G fish ticket receipts originally reported in the Fish Bulletin series (available electronically at: <u>http://ceo.ucsd.edu/fishbull/</u>). These sources were compared with landings in the Fish Bulletin publications and found not to be different for these years. All landings are reported in pounds and were extracted on 30 June, 2005.
- **Years 1916–27:** The publication *California Fish and Game* (vols 1–16) are the original source of landing reports before the Fish Bulletin series and are used for this time period. During 1916–26, kelp greenling was included in the category “sea trout” which also included small white seabass (*Atractoscion nobilis*). Given

the limited southern range of kelp greenling (Fitch 1953), 100% of the "sea trout" catch from Monterey north was assumed to be kelp greenling. In the San Luis Obispo to Ventura port complex, only two recorded catches of "sea trout" were made and both were in the hundreds of fish, i.e. indicative of white seabass rather than kelp greenling. Those catches were therefore not included in the kelp greenling removals. Commercial "sea trout" removals are not available for the year last 9 months of 1926 and all of 1927, and these catches were assumed to be 0 (as was recorded for 1928).

Finally, total kelp greenling landings in pounds were converted into metric tons. Two fleets are distinguished for assessment purposes: 1) non-live, and 2) live. California kelp greenling commercial landings are given in Table 3 and Figure 3. Landings of kelp greenling were low until the early- to mid-1990s when the live-fish/premium finfish fishery began targeting kelp greenling (Fig. 4). This fishery removes 'plate-sized' fish, avoiding the very small and large individuals, and obtains high prices per pound. Commercial kelp greenling landings reached a peak of over 23mt in 2000 and averaged almost 10mt since the mid-1990's (Fig. 4). Although the overall removal weight of the commercial fishery is relatively low, kelp greenling are relatively small, and thus ten of thousands a year are now removed by the commercial fleets.

<u>Oregon</u>

Information on the catch histories of the Oregon fisheries are limited compared to the situation for California. The longest time series of catches for Oregon is for the recreational sector and goes back to 1981. Therefore, the commercial catch history for Oregon was also constructed back to 1981 (see Table 3 and Figure 3):

- **Years 1988–2004**: ODF&G provided annual landings (in pounds) by gear and port for the non-live and live-fish fleets. Data extractions were made on 1 July, 2004.
- **Years 1981-87**: For the non-live fishery, catches were fairly constant from 1988 to 1995. The yearly average over this time period was therefore used as the annual catch for 1981-87. There were no live-fish catches from 1988 to 1991, so no catches for 1981-87 were assumed.
- **Equilibrium catch**: An equilibrium catch for the non-live fishery was assumed because of the short time series of catches. This equilibrium catch was assumed to be the same as the yearly catch used for 1981-87.

All catches were converted to metric tons for use in the stock assessment model.

<u>Gear Types</u>

Kelp greenling are caught commercially using a variety of gears-types in both states, but have been taken almost exclusively by hook-and-line and pots recently (Fig. 5). All catches are assumed to be taken using a single gear-type for the purposes of this assessment.

Spatial and Temporal Catch

There have been temporal and spatial patterns to the kelp greenling commercial landings. Spatially, much of the historical catch has come from central California ports, but removals from northern Californian ports have increased and contributed greatly to the overall reported removals in recent years (Fig. 6). In Oregon, the ports of Gold Beach and Port Orford comprise over 95% of the commercial catch (Fig. 7), with only minor contributions from eight other ports.

Temporally, the California historical landings were reported during the late winter/early spring months, but increasing catch was taken during the summer and fall months with the onset of the live-fish fishery (Fig. 8). In 2005, no commercial fishing for kelp greenling was allowed in March and April. All catch is assumed to be taken in the middle of the year for the purposes of the assessments.

Commercial Discards

The West Coast Groundfish Observer Program performed a pilot study during 2003-4 on discards in the nearshore open access fixed-gear fishery (in waters < 50 fathoms). Greenlings were found to be discarded in rates >60% in this report. However, the authors caution that this report is preliminary and should not be applied. Given that kelp greenling, even when discarded, have a high chance of survival because they lack an air bladder (and thus the effects of barotraumas), discard mortality is assumed to be negligible for the purposes of this assessment.

Recreational Fishing History in California

Recreational fishing in California became popular in the late 1890s, but was limited to mostly big game fishes (tuna, marlin, and swordfish) and wealthy participants (Holder 1914). There remained in California limited recreational fishing opportunities to most people before 1920. Private boat access to nearshore fishes increased after 1920 (Croaker 1939), but it was not until Commercial Passenger Fishing Vessels (CPFVs) began operating in earnest off southern California in 1928 that the general public gained major accessibility to many nearshore fishes (Scofield 1928; Young 1969). Both barges – large, flat, opens-spaced ships – and more traditional CPFV boats comprised the fleet. There were 15 barges and 20–30 boats off southern California in 1928 (Scofield 1928). The period 1929–39 saw a rapid increase in the popularity of CPFVs (Fig. 9; Croaker 1939), which also spread northward to central and northern California. By 1932, sportfishing in Monterey was very popular (Classic 1932). Pier and shore fishing modes also provided major recreational fishing outlets during this time of increased CPFV activity (Scofield 1928; Croaker 1938; Baxter & Young 1953; Young 1969), with kelp greenling being one of the major targets from Pismo Beach to the Oregon border. In all modes, most fishing occurred during the summer and autumn months, with some fishing extending into spring (Fry 1932; Baxter & Young 1953). CPFV captains have been required to submit logbooks detailing catches since 1936 (Croaker 1939; Baxter & Young 1953; Young 1969), although compliance rates were and are not 100%. In 1937, the sportfishing catch exceeded the commercial catch for many species (Conner 1937).

The popularity of CPFV fishing continued to increase until the war years of 1942–46 when CPFV activity was considerably reduced (Fig. 9; Calhoun 1950). The CPFV fleet underwent a period of rapid re-establishment, reinvention, and growth after 1946 (Young 1969). Fleets, boat size, and passenger interest all increased throughout California. This expansion continued into the 1970s, where the fleet peaked in 1973 (Baxter & Young 1953; Young 1969; Hill & Schneider 1999). A concomitant increase in private boat, and shorefishing from piers, jettys, and the beaches also occurred during this time, particularly in northern and central California (especially in Monterey and Morro Bay), where kelp greenling remained important components of the catch. Spearfishing meets also increased in popularity from the late 1950s in California.

Reconstructing Recreational Removals

Four recreational fishing modes are distinguished for California: 1) Shore (beach/bank and piers/jetties), 2) Private Boat and Rental (PBR), 3) CPFV, and 4) Spearfishing. Four recreational fishing modes are recognized for Oregon: 1) Man-made (piers/jetties), 2) Beach/Bank, 3) CPFV, and 4) Private Boat and Rental (PBR). These modes were distinguished for analysis and modeling purposes because of differences in selectivities and the size-frequency of the catch: shore-based modes generally catch smaller individuals than the PBR and CPFV modes, while the spearfishing modes strictly target larger individuals.

Information on the activities of recreational fishermen is collected by both state (CDF&G and ODF&W) and federal (Marine Recreational Fishery Statistical Survey or MRFSS) programs. Since 1980 (excluding the years 1990–92), the MRFSS program (available via the RecFIN database: **http://www.psmfc.org/recfin/**) provides effort information from a random-digit dialing protocol and catch/trip information from intercept interviews. These data can be used to calculate total catches by mode. In 2004, the CDF&G, in cooperation with the PSFMC, started the California Recreational Fisheries Survey (CRFS) program to replace the MRFSS sampling program in California for all modes. This program aims to increase sampling effort for better catch and effort estimation, to increase spatial resolution of catches, and to identify targeted species. Before the CRFS was implemented, CDF&G only collected logbook catches from the CPFV fishery. Very few estimates of the removals by the man-made, beach/bank, and PBR modes are available for the years before 1980.

The Recreational Fisheries Information Network (RecFIN) contains estimates of total removals for most recreational fishery modes for 1980-9 and 1993-2004 and comprises the main data source of recreational removals for each state. Karpov et al. (1995) state that total estimates of removals for 1980 should not be used because of survey quality problems, so RecFIN estimates were only considered from 1981. Historical catches (prior to 1981) for California are reconstructed from historical documents .

California Recreational Removals

1) CPFV

The CPFV fleet provides the longest time series of recreational removals for California, although it was recognized early in the CPFV reporting process (Croaker 1938; Baxter & Young 1953) that logbook records may be inaccurate for two main reasons: 1) mis-reporting of catches (either over- or under-reporting; Karpov et al. 1995), and 2) less than

100% compliance rates (Hill & Barnes 1998). A study by Miller & Gotshall (1965) demonstrated that CPFV reporting of kelp greenling is inaccurate and unreliable. Reported CPFV removals therefore must be adjusted for mis-reporting. In addition, compliance rates have always been less than 100% and also necessitate the adjustment of CPFV removals. Given the need for these adjustments, the historical CPFV catch (1916–2004) was reconstructed as follows (Table 4 and 5):

- **Year 2004**: CRFS database (Extracted 14, June 2005).
- **Years 1981-1989, 1993, 1996-2003**: RecFIN database of total landing estimates for kelp greenling (based on fish examined or reported by the angler as dead). Extracted 14, June 2005.
- **Year 1960**: Estimate of total CPFV removals by Gotshall and Miller (1965).
- **Years 1957–1959, 1961-78, 1980, 1990-1992, 1994-1995**: Hill and Schneider (1999, extracted 24 January, 2005) performed a data recovery exercise to extract catch, effort, block (CDF&G designated 10 x 10 nautical mile statistical areas), and month information from the California CPFV logbooks. This information provides area-specific catches (in numbers) for kelp greenling for 1957–2003, excluding 1979 (the data for this year are lost). This data suffers from under-reporting of greenling, so a ratio between total estimated removals (C_{total}) and logbook reported removals ($C_{logbook}$) was calculated to correct the reported logbook removals. These empirically-derived ratios were then used to develop predictive linear relationships between numbers reported in the logbooks and the expected C_{total}:$C_{logbook}$ ratio (Fig. 10). It is apparent that there were two different relationships based on the amount of kelp greenling reported in the logbook, so two different linear relationships were developed based on a break at 500 reported kelp greenling. From these relationships, C_{total}:$C_{logbook}$ ratios were estimated and used to expand the reported logbook removals.
- **Year 1979:** No information on kelp greenling removals by the CPFV fishery is available for this year, so the catch during this year was assumed to be the average of those for 1978 and 1980.
- **Years 1947–56**: Young (1969) provided logbook reports of kelp greenling catch (C_{Young}) for the years 1947-67 from three central Californian ports complexes: Bodega Bay, Santa Cruz, and Avila. For the overlapping years (1957-67), these values were compared to the total logbook reported catch of kelp greenling and found to be smaller, indicating that the values provided by Young were not representative of the state-wide CPFV fishery. Therefore, the geometric mean of the ratios of $C_{logbook}$: C_{Young} in the overlapping years was used to expand the 1947-56 numbers to represent estimated logbook reported removals. These values were then expanded by the predicted C_{total}:$C_{logbook}$ ratios as described above.
- **Years 1936–46:** No CPFV removal information is available for these years. Information on the number of CPFV permits and licenses is available, and it was assumed that the change in registered participants was proportional to the change in kelp greenling catch (Fig. 9). The proportional relationship of registered boats during 1936-46 was standardized to 1947. This year-specific proportion was then multiplied by the estimated CPFV removals in 1947 to obtain estimated removals of the CPFV fishery for 1936-46.

- **Years 1929–35:** No data on catches are available for these years. The start of the CPFV fleet in central and northern California was around 1929 (Young 1969) and thus reflects the start year of the CPFV time series. Based on the information provided in Young (1969), it was estimated that around 20 CPFVs operated in 1929 in central and northern California waters. A linear increase in boat participants from 1929 through 1935 is assumed because the CPFV fleet is known to have increased rapidly during these years (Fry 1932; Young 1969). The boat numbers were then converted to catch using the proportional relationship to 1947 as described above.
- **Years 1916–1928:** The catches by the CPFV fleet were assumed to be zero for these years.

The above estimated numbers of removed kelp greenling in the California CPFV fleet do not account for non-reporting CPFVs (Fig. 11A). Compliance rates (as reported from several sources and compiled in Cope and Punt [2005]) are provided in Table 4 and were used to expand the CPFV removals to account for non-compliance in the logbook program (Fig. 11B).

2) Historical spearfishing removals in California
Competitive and non-competitive spearfishing has been a significant source of removals of kelp greenling and so a time series of these removals was constructed. Totals for competitive diving were available from the CenCAL spearfishing database (California Department of Fish and Game. 2005). The removals for any years with missing data were set to the average of the removals for the year pervious to and following the year with missing data. Gotshall & Miller (1965) provided an estimate of total kelp greenling removals in competitive freediving meets for 1960. The CenCAL database underestimates the total California kelp greenling competitive spearfishing removals because reported CenCAL meets are limited to those between Cape Mendocino and Point Conception. The ratio between the 1960 total estimate and the 1960 CenCAL estimate was therefore used to expand all CenCAL-derived estimates to total competitive dive removals. Karpov et al. (1995) found that average spearfishing removals were similar between 1958-61 and 1981-86, supporting the use of a constant ratio expansion. Gotshall and Miller (1965) also show that competitive dives comprised roughly 50% of the total diving removals (which also include non-competitive freediving and SCUBA diving). The competitive diving removals were therefore doubled to estimate total spearfishing removals. Spearfishing in central and northern California was uncommon before the mid-1950s, so an exponential relationship was used to describe the catches from 1946 through 1958. No spearfishing removals were assumed prior to 1946. The full spearfishing removal time series is found in Table 5 and Figure 12B.

3) Historical Shore and PBR removals
Removals (in numbers) for the remaining two recreational modes (Shore and PBR) were determined as follows:

- **Years 1981-89, 1993-2003**: the RecFIN database contains estimates of removals for these years for both modes. Extracted 14 June, 2005.

- **Years 1990-92:** The values for these years were set to the averages of those for 1989 and 1993.
- **Years 1958-61**: Miller & Gotshall (1965) provide estimated annual removals for both modes.
- **Years 1962-80**: No information was available for these years; values therefore had to be interpolated using assumed relationships. For the Shore mode, a linear increase from 1961 to 1981 was assumed to interpolate removals as pier, jetty, and beach/bank use increased during this period. For the PBR mode, a power function was used to interpolate removals because of the greater than linear increase of private boat use off California during this period (Young 1969).
- **Years 1916-40, 1947-57:** No information was available for these years, so values again had to be interpolated. The removals for the Shore mode were again based on a linear relationship starting in 1916, while the removals for the PBR mode were again based on an exponential relationship, this time starting in 1929 (the same year as the CPFV fleet). No catch was assumed for the PBR mode prior to 1929.
- **Years 1941-46:** No information was available for these modes for these years. As was seen in the CPFV fishery, the war years were assumed to depress fishery growth in the shore mode. An annual value of 30,000 fish was assumed for these years in the Shore mode, a value slightly higher than the catch for 1940, but much less than that for 1947. For the PBR mode, the exponential relationship assumed previously was maintained because the values did not change much and were small over this time period.

There was almost certainly very little recreational catch before 1916 in California so the fishing mortalities before 1916 for the four recreational modes were set to zero when conducting the assessment. The time-series of removals for both modes are found in Table 5 and Figure 12B.

DISCARDS: Because kelp greenlings do not suffer from barotrauma, discarded kelp greenling have a high probability of survival. Even though a size limit has been imposed in recent years (see Appendix A), the analyses of this document assume that there is no discard mortality by the recreational sector.

<u>Oregon Recreational Removals</u>

- **Years 1993-2003:** There are two sources of information about recreational removals off Oregon from the early 1980s: 1) the MRFSS database and 2) the Ocean Recreational Boat Sampling (ORBS) Program (Voorhess et al. 2000). While MRFSS samples all four modes year round, ORBS only samples the CPFV and PBR modes from late spring to early fall. In the early phases of the ORBS program, sampling targeted salmon trips and was therefore not an appropriate estimator of catch for groundfishes. From 1993 onwards, ORBS changed its emphasis from salmon to groundfish because groundfish had become increasingly important to the Oregon recreational fishery. A study, Voorhees et al. (2000), was conducted to compare the estimates from the two programs for the overlapping years (1993-99) and months (May-August). The evaluation uncovered inadequacies in both programs, but also demonstrated that MRFFS estimates were consistently higher than ORBS estimates. A considerable difference between the two programs remained even after adjustments to the estimates from both programs were made, and no identifiable reason for the discrepancy could be found. It was suggested that from 1993 to present, catch estimates be based on ORBS-adjusted estimates for May-June, and on MRFFS-adjusted estimates for the remaining months. This data stream is provided by RecFIN and was used for each Oregon recreational fishery mode for 1993-2004. The data were extracted 14 June, 2005.

- **Years 1981-85:** MRFSS estimates were used for all four modes (as extracted from RecFIN on 14 June, 2005).
- **Years 1986-89:** Only a combined Shore mode estimate was available for these years. Removal estimates were allocated 45:55 to the man-made and beach/bank modes. This ratio was obtained by taking the geometric average of the proportions of man-made and beach/bank mode removals to the total removals for 1981-85. For the CPFV and PBR modes, RecFIN provided estimates of removals for 1986-89.
- **Years 1990-92:** No estimates were available for these years for any modes. Removals were set at the mode-specific annual removal averages calculated for 1989 and 1993.
- **Equilibrium catch:** The lack of removal information prior to 1981 made it necessary to assume equilibrium catches for each mode. The mode-specific equilibrium catch was set to the annual average over 1981-89.

Total removals for the Oregon recreational fleets are provided in Table 5 and Figure 12A.

Correction factors were considered for the months May-August to account for the potential overestimation of MRFSS data in the CPFV and PBR modes for 1981-89. Given the large amount of uncertainty as to what those correction factors should be, model sensitivity to the full recreational data set was explored by halving and double the recreational removals for each mode.

Total Removals
The bulk of the historical kelp greenling recreational removals (in numbers) has and continues to be from central and northern California, although the reported removals for California in recent years are similar to those for Oregon (Figure 13). Historical commercial removals have been relatively small compared to those for recent years. Most of the commercial catch in the mid- and late-1990s was reported from California, but Oregon now reports the largest commercial landings (Fig. 13). The live-fish fishery is currently the primary component of commercial fisheries in both states.

Size and Age Compositions
Kelp greenling otoliths and other ageing structures have not been collected routinely during port sampling, except in the Oregon CPFV recreational mode during 2003 and 2004 (Table 6). Therefore, most of the information on the biological structure of the catch is from length and weight measurements. Gender has not been consistently recorded when sampling for length or weight in California, but was available for the Oregon

commercial fisheries. When gender was not-specified, catch length-compositions considered in this assessment were gender-aggregated. Catch length and age compositions were developed for each substock, fishery sector, and fleet and are presented in Tables 7 and 8 and Figures 14-28.

The use of the Oregon age compositions in exploratory model runs lead to difficulties in the internal estimation of growth parameters. After discussions with the STAR panel, the use of sex-specific ages conditional on length bins was implemented in SS2. This approach allows one to extend the use of lengths by specifying age distributions for each length bin. Such an approach explicitly links the age and length data and provides information to estimate growth by sex within the model. The conditional age at length information is provided in Table 8.

The catch length-compositions for each state and year for the recreational fisheries were obtained from the RecFIN website. RecFIN expands the sampled length proportions by port, fishing fleet (mode), and wave (bi-monthly period) to estimate the proportions-at-length for the entire year. Not all lengths retrieved from RecFIN were true lengths; many were weighed fish converted to lengths. Instead of using these data as lengths (as reported in RecFIN), these weighed fish were used to calculate mean body weights (in kg) for each year (Table 9).

The commercial length-compositions for California were extracted from the CALCOM database (30 June, 2005). Oregon length and ages were provided by the Oregon Department of Fish and Wildlife on 1 July, 2005. Commercial length samples are expanded using the standard routine at the port-gear-month level and then aggregated for the state. No additional body weights are available for either commercial fleet for either state.

The sample sizes for each year and fleet used in the assessment were determined from a zero-intercept regression of effective sample size on initial sample size (Ralston and Dick 2003). The initial sample sizes for the commercial fishery were set to the numbers of clusters from which the raw length samples were obtained. The initial recreational sample sizes were set to the number of unique sampling opportunities (as identified by the ID_CODE field in the RecFIN output). Sensitivity of the model results to the use of the initial sample sizes was investigated.

Indices of Abundance

There is no standardized survey designed to provide biomass indices for kelp greenling along the U.S. west coast. All surveys presently used to provide biomass indices for groundfish populations are conducted at depths that are largely outside the depth preference of kelp greenling. Kelp greenling are caught so infrequently in the standardized trawl surveys that those data sources are not considered further in this assessment. Therefore, in common with the assessments of cabezon (Cope et al. 2004, Cope and Punt 2005), yelloweye rockfish (Methot *et al*. 2002), cowcod (Butler et al. 1999), and bocaccio (MacCall 2003), this assessment is based on recreational CPUE data. All data extractions were made during the last week of June 2005

RecFIN CPUE indices

Kelp greenling is caught by four recreational fishing modes sampled by MRFSS, and the data are available by year and two-month wave from the RecFIN data base. These fishing modes can be grouped as two boat modes (CPFV and PBR) and two shore modes (man-made and beach/bank). Length frequencies indicate that the combined shore modes take smaller fish relative to the boat modes. A separate multispecies extract of northern California RecFIN CPFV data summarized by individual trips (Wade VanBuskirk, pers. comm.) was analyzed using the logistic regression method of Stephens and MacCall (2004) to define a subset of the trips that would be appropriate for the calculation of kelp greenling CPUE. The species coefficients that predict presence/absence of kelp greenling catch on northern California CPFV are shown in Figure 29.

Individual trip records for other regions and modes were not conveniently available. Year effects were estimated from lognormal or delta-lognormal GLM models of the year-wave summary data from RecFIN (gamma distributions would not converge). All shore mode trips were assumed to be relevant to kelp greening CPUE. Boat mode records were filtered, retaining only ocean trips within three miles of shore that caught kelp greenling or any of the top five species in Figure 29 (lingcod, treefish, black rockfish, rosethorn rockfish and grass rockfish). Sample sizes are not known, but estimated variances of the year-wave summary values are given by RecFIN and provide a basis for an appropriately weighted GLM. Weights were inversely proportional to estimated variances, but apply only to positive observations. Jackknife estimates of standard errors were based on deleting individual year-wave summary values. Model selection used a stepwise procedure, and considered both Akaike's Information Criterion (AIC) and the Bayesian Information Criterion (BIC). BIC tends to select for simpler models (Schwarz, 1978), but AIC is often considered to be appropriate for models with a large number of parameters relative to the number of observations (Nishii, 1984), as is the case here.

<u>California</u>

RecFIN data supported development of CPUE indexes for shore modes, but not for boat modes:

- *CPFV mode:* Although individual trip records were available, kelp greenling are sampled too infrequently from northern California CPFV trips (113 positive records out of 3722 trips sampled between 1980 and 2003) to support a CPFV-based abundance index for northern California.
- *PBR mode:* Development of a RecFIN summary-based CPUE index for the PBR mode was attempted, but there were too few positive year-wave values. Of 21 sampled years between 1980 and 2003, three years had no positive observations, and four years had only one positive observation, preventing jackknife estimation of standard errors for those years. Jackknife estimates of CVs for the remaining years tended to exceed 1.
- *Shore mode:* Shore mode queries produce no values with CPUE=0, which is puzzling. However, this allows use of a simple lognormal GLM with no binomial component. The two shore modes (man-made and shore-based) were considered simultaneously in the GLM, with estimation of fixed year, wave and mode

effects. Stepwise consideration of AIC and BIC rejected the interaction terms, but retained all three fixed effects. Temporal coverage is shown in Table 10, and an analysis of deviance table is shown in Table 11. Year effects with jackknifed estimates of standard errors are shown in Figure 30. Year 2003 was poorly sampled (Table 10) and the index for that year is not considered further in this assessment.

<u>Oregon</u>

Attempts to combine fishing modes encountered various statistically significant (AIC or BIC) interaction terms. In the case of boat modes, a strong interaction exists between mode and wave, apparently reflecting a summer CPFV fishery and a winter private boat fishery (Table 12). Although this interaction did not explicitly involve year effects, estimated year effects from combined boat mode models with and without the interaction term were substantially different. Consequently, four separate RecFIN CPUE series were developed for Oregon's recreational fisheries, one for each fishing mode.

- *CPFV mode*: Temporal coverage is shown in Table 13, and an analysis of deviance table is shown in Table 14. Year effects with jackknifed estimates of standard errors are shown in Figure 31. Year 2003 was poorly sampled (Table 13) and the index for that year is not considered further in this assessment.
- *PBR mode*: Temporal coverage is shown in Table 15, and an analysis of deviance table is shown in Table 16. Year effects with jackknifed estimates of standard errors are shown in Figure 32. Year 2003 was poorly sampled (Table 15) and the index for that year is not considered further in this assessment.
- *Beach/Bank mode*: Temporal coverage is shown in Table 17, and an analysis of deviance table is shown in Table 18. Year effects with jackknifed estimates of standard errors are shown in Figure 33. Years 1989 and 1998 were poorly sampled and are not considered further in this assessment.
- *Man-made mode*: Temporal coverage is shown in Table 19, and an analysis of deviance table is shown in Table 20. Year effects with jackknifed estimates of standard errors are shown in Figure 34.

CDF&G CPFV Monitoring

The California Department of Fish and Game conducted an independent CPFV monitoring program during 1987-98 in waters north of Pt. Conception. This data set (supplied by Deb Wilson-Vandenberg, CDF&G, pers. comm.) is unique in that it recorded catch, effort and other information at individual fishing locations within CPFV trips that primarily targeted rockfish. Kelp greenling were taken relatively infrequently on these trips, but there were 21 different fishing locations at which greenling were caught during at least three different years, for a total of 297 separate records (including visits to those locations that did not catch kelp greenling). The 21 locations fell into four general regions: Pt. Sal-Piedras Blancas (4 sites), Año Nuevo (7 sites), Farallons-Pt. Reyes (5 sites), and Ft. Ross-Noyo (5 sites). An initial delta-lognormal GLM with year effects (12), month effects (11), depth bin effects (7), region effects (4) and location effects (21) was fit to the data set. Note that the region effects are aliased with the location effects, and are included for exploratory purposes. The patterns of estimated values allowed some collapsing of levels, so that month effect were reduced to four "seasonal" levels (Jan-Feb, Mar-Apr, May-July, Aug-Dec), and depths were collapsed to three levels (0-20m, 20-30m, over 30m). A delta-lognormal GLM was then run on the collapsed data. Only the lognormal distribution was used for the positive component of the delta-GLM model; a gamma distribution was considered, but encountered convergence problems.

The factors to include in the positive and binomial (presence-absence) components of the delta GLM were evaluated using a stepwise process, considering values of both AIC and BIC. In all models, the depth effect was consistently strong, and may contribute to a reduction in significance of location effects (each location has a characteristic depth, with relatively little within-location depth variability). The stepwise process tended to drop location and/or region effects in the lognormal portion of the model, whereas year effects tended to be dropped in the binomial portion. A reasonable interpretation of this would be that presence/absence of kelp greenling is primarily associated with location, whereas if kelp greenling are present, variability in catch rate is associated primarily with year. Both AIC and BIC favored collapsing the 21 location effects into 4 regional effects. Interactions between region and year were not significant in the lognormal portion of the model, but were substantial in the binomial portion of the model. Nonetheless, a main effects model was used for the final model because there is no basis for interpreting an interaction term including year. Including the regional effect was weakly justified, but it was retained partially because that was one of the motivating reasons for using this data source. Too few observations were made during 1987 to support an estimated CPUE index for that year. The analysis of deviance tables are shown in Table 21, estimated values of non-year effects in Table 22, and sample sizes in Table 23. The year effects with jackknifed estimates of standard error are shown in Figure 35. All CPUE values with CVs for each model are provided in Table 24.

Data Input File
The SS2 input files for Oregon are provided in Appendix B-1.

Assessment

Assessment Model
This is the first assessment of the kelp greenling resource off the west coast. The present assessment is based on Stock Synthesis 2 (SS2; Methot 2005), a flexible length- and age-based population dynamics modeling environment, though the models for both substocks are essentially length-based. Only two years of age-specific data were available for the Oregon assessment. No year-specific age information was available for use in the California assessment.

The choice of two assessment substocks rather than one was predicated on several factors. The ecology of nearshore reef fishes leads to the expectation of low rates of movement among reefs and thus potential substock differentiation. Based on previous growth studies, their may also be significant latitudinal growth differentiation in kelp greenling warranting separate substock modeling (Table 1). Additionally, exploration of recruitment variation in these models indicated substantial differences between Oregon and California. Beyond biological reasons, fishing histories off Oregon and California are dissimilar, implying different time-trajectories of population size in these two broad regions if movement is indeed low. Finally, kelp greenling is a state-managed and any management advice would be best served on a state by state basis. Although even finer scale assessments would be desirable, the current two-substock approach is the only one that can be supported by the currently available data.

The population dynamics model

The base case assessment for each substock is based on the following assumptions:

1. There are two fishery sectors (commercial and recreational). The commercial sector consists of two fleets and the recreational sector consists of four fleets.
   - Fleet 1: Commercial non-live-fish fishery
   - Fleet 2: Commercial live-fish fishery
   - Fleet 3: Recreational mode: Man-made (OR); A combined shore mode consisting of the man-made and beach/bank modes (CA).
   - Fleet 4: Recreational mode: Beach/Bank (OR); CPFV (CA)
   - Fleet 5: Recreational mode: CPFV (OR): PBR (CA);
   - Fleet 6: Recreational mode: PBR (OR); Spearfishing (CA)

   Fleet distinctions imply different length-specific selectivity patterns.
2. Selectivity is assumed to be dome-shaped for the commercial live-fish fishery for both substocks and the man-made and beach/bank fleets in the Oregon recreational fishery because each of these fleets tends not to land the larger -ized fishes. The possibility of dome-shaped selectivity was considered for the California shore mode (fleet 3), but the estimated double-logistic parameters resulted in an asymptotic selectivity curve. Selectivity is assumed to be asymptotic and related to length by a logistic function for the remaining fleets. All selectivities are assumed to be constant over time. Length compositions for the California spearfishing mode (fleet 6) showed a long-term stepwise decrease in the frequency of smaller fish, suggesting a possible evolution of spearfishers' attitudes toward minimum acceptable size. Consequently, the lower tails of length compositions for Fleet 6 were truncated at 34 cm FL. The sensitivity of the results of the assessment to alternative specifications related to selectivity is examined in the tests of sensitivity.
3. There is one fishing season each year and the removals are taken instantaneously in the middle of the year after half of the natural mortality.
4. The estimates of removals-in-mass are known with negligible error.
5. Recruitment is related to reproductive output by means of a Beverton-Holt stock-recruitment relationship with log-normally distributed process error.
6. Length-at-age is normally distributed about its expected value.
7. There is no connection between the two substocks of kelp greenling, either through recruitment or migration.

Parameter estimation

The population dynamics model has many parameters. The values for some of these parameters are based on auxiliary information, while others are estimated by fitting the model to the data (Table 25; Oregon only). The base models assume a Beverton-Holt stock-recruitment relationship (BHSRR), with a Mace-Doonan steepness of h = 0.7, the same value used in another hexagrammid assessment (lingcod; Jagielo et al. 2004) and similar to the steepnesses estimated for other west coast groundfishes (Dorn 2002). The sensitivity of the results to the choice of a value for steepness is evaluated using likelihood profiles. Recruitment variation, σ_R, is set equal to 1 for Oregon and 0.4 for California. The California value is considerably lower than is used for the Oregon model, but a low value of σ_R was necessary to prevent estimated recruitment strengths from oscillating on a two- to three-year cycle.

Recruitment estimation for the Oregon model was made from the beginning of the time series (1981) until one year before the end of the model time period (2003) because no information was available to indicate recruitment strength in 2004. No attempt is made to estimate recruitment residuals for the first year of the assessment period (1916), nor those for some of the subsequent years, in the California model because the data are completely uninformative regarding the values for some of the early (and most recent) recruitment residuals. Recruitment estimates in the California model were obtained for1975 to 2001. The estimates for 1975 to 1990 are based more on fluctuations in average fish weight than on length compositions (which may contribute to a regime-like change in estimated mean recruitment levels after the mid 1980s). Model uncertainty to the starting and ending year of recruitment estimation was explored to quantify the effect the years for which recruitment is chosen to be estimated has on model outputs.

The base-case values for the instantaneous rate of natural mortality are set to 0.26yr^{-1} for both sexes, as internally estimated for the Oregon model. Given the considerable uncertainty associated with the (assumed) base-case values for σ_R, and *M*, sensitivity tests examine the consequences of changing the values for these parameters.

The inclusion of the conditional age-at-length data (Table 8) in the Oregon model made it possible to estimate sex-specific growth parameters. Growth parameters were estimated within both models instead of being fixed to the empirically derived values because the available growth curve for Oregon was based on samples from the most recent years only (mainly 2004), whereas the California values were derived from a small-scale study in the early 1980s. The differences in the values for the VBGF parameters between the two substocks may represent real biological differences, fishing-induced growth patterns, or both. There was no gender-specific size data available in the California fishery to differentiate growth between genders, so the male offset was set to equal the female for initial model exploration. There is an indication that the CV of length-at-age decreases linearly with age for many marine fishes (Erzini 1994). The base model assumed that the CV of length-at-age for a 2-year-old is 0.1 and that for a 10-year-old is 0.09 as they are approximately in the middle of the range of values that produce positive definite Hessian matrices. The sensitivity of the results to this assumption, as well as to different assumed CVs, was explored. Finally, weight and fecundity relationships were empirically-derived (Table 1).

Likelihood components
The following five components comprised the objective function that was minimized to find the estimates for the free parameters of the model:

1. Abundance Index (the indices are assumed to be log-normally distributed).
2. Mean Weight (assumed to be normally distributed).
3. Length Composition (assumed to multinomially distributed).
4. Recruitment Deviations.
5. Parameter Priors (penalties on deviations from the prior distribution; generally very small for these model parameterizations)

Coefficients of variation about the abundance indices derived from bootstrapping or jackknifing techniques may greatly underestimate the true uncertainty regarding the relationship between these indices and biomass so the pre-specified coefficients of variation for the abundance indices were adjusted iteratively until the model-calculated R.M.S.E. matched the pre-specified coefficient of variation for each index. The sensitivity of the results to setting the coefficients of variation to those obtained from the jackknife procedure (Tables 24) is explored in the tests of sensitivity.

The mean weight data (Table 8) were assumed to be normally distributed with coefficients of variation based on the raw data when these data were included in the objective function.

The length composition data were binned by 2-cm intervals beginning at 6cm and ending at 50cm+. Approximate observed sample sizes (N_{obs}) for fleets 1 to 5 were based on the number of sample clusters taken from the corresponding year (i) and fleet(j). Weighting of the length composition data was based on the "effective sample size" (N_{eff}) calculated using the approach of McAllister and Ianelli (1997). The slope (*s*) of a zero-intercept regression of N_{eff} on N_{obs} was used to produce smoothed effective sample sizes (N_{ij}), $N_{ij}=s*N_{obsij}$. A maximum sample size constraint of $N\leq200$ was placed on all sample sizes. As a check on the tuned values, the zero-intercept regressions slopes of N_{eff} on N were all near unity, except for fleet 2 for which several values were capped at the maximum. Observed sample sizes for the California fleet 6 (spearfishing mode) were in numbers of fish. Presumably because of the predictability of the truncated length compositions for fleet 6, values of N_{eff} were generally larger than the actual number of fish measured, so for fleet 6, $N_{ij}=N_{obsij}$.

Parameter Input File (Control)
The SS2 files for the Oregon assessment are provided in Appendix B-2.

California model diagnostics
Extensive exploration of the California model before and during the STAR Panel made it clear that, given the current knowledge of kelp greenling life history in California (specifically the paucity of information on age and growth and natural mortality) and major inconsistencies in the available data streams, there is no suitable model structure for this substock at present.

The formulation of the original base case model, which assumed logistic selectivity for the shore fleet, led to extremely high and unreasonable exploitation rates (Fig. 36). When attempts were made to estimate a double-logistic selectivity curve for the shore fleet, the model would always return an asymptotic relationship, even though this seems unreasonable for the fishery (larger fish are not fully selected). When the dome-shaped selectivity pattern for the Oregon beach/bank mode was assumed for the California shore mode, exploitation rates dropped considerably (Fig. 36), but fits to the length data were poor (Fig. 37). This internal trade-off between reasonable exploitation rates/selectivities and good fits to the shore mode length data indicated contradictory data in the shore mode that needs resolution before an adequate assessment for California is possible.

Estimating growth and natural mortality rates is another major difficulty for the California model. The only study of kelp greenling growth in California is a small-scale (Monterey Bay area) study conducted during the 1970s. The results of this study provided questionable VBGF estimates and also affected the empirically-derived estimates of natural mortality (Table 2). When estimating growth within the model, the best behaved model implied that males grow at the same rate as females even though this is clearly not the case. Age and growth of kelp greenling in California needs further research before it is feasible to conduct an assessment for California using SS2.

The exercise of attempting to develop an assessment for this region did identify the major shortcomings of the data and the model that need to be addressed in future assessments of the kelp greenling in California waters. It also provided a summary and reconstruction of the historical catch information that can also be used in future assessments.

Oregon model diagnostics (base model)

Abundance Indices

Figure 38 shows the fits to the base-case indices of abundance. The model tracks the changes in the indices qualitatively, but the CVs for the indices are generally large, and there are considerable differences between the model-estimates and the data for some years.

Mean Weights

Figure 39 shows the fits to the mean weight data. The confidence intervals for the mean weights are wide (as expected given the CVs in Table 8), which implies that the model is not constrained to a substantial extent by these data. The fit of the model to the data for the man-made mode (fleet 3) is poor; the model consistently over-estimates the mean weight of the catch. Of the four modes, the model fits the mean weight data for the PBR mode best.

Length and Age Composition Data

The base case fits to the length-composition data are given in Figures 40–47 and for the age-composition data in Figure 48. The corresponding Pearson residuals are summarized in Figures 49-51. When interpreting these figures, it should be noted that the observed and model-predicted lengths are collapsed (*i.e.* bins contain more than one 2-cm interval) at low and high sizes. The fits to the length frequency data for the Oregon recreational fleets (Figures 44-47) are better than those to the data for the Oregon commercial fleets (Figures 40–43) and consequently have the higher effective sample sizes. Of the recreational fleets, the fits to the observer data for Oregon beach/bank mode (Figure 45) are better than those to the data for the remaining modes. The fits to the age-composition data for 2004 are better than to those for 2003 and the fits to the data for females and males are equally good (Fig 48).

Results

Base-case results: Oregon

Figure 52 shows the MPD estimates of the time-trajectories of reproductive output (in absolute terms) and recruitment, along with their asymptotic standard errors. There are two major recruitment events during the mid-1980s, with all other years demonstrating low recruitment, indicating σ_R for the Oregon population is relatively high. Comparison of the inputted σ_R (1) to the model-calculated R.M.S.E of the deviations about the stock-recruit relationship (1.00) demonstrates consistency. The estimates of recruitment are generally imprecise, with most precision seen during the early 1980s (Figure 52B). The estimates of reproductive output are also very imprecise (Figure 52A). The Oregon substock is estimated to have been at 48.8% of its virgin level (321 mt) at the start of 2005 (157 mt), though the true scale of the reproductive output is uncertain. Figure 53 shows the estimated spawner-recruit relationship. Appendix C lists the MPD estimates of the numbers-at-age matrix for each gender.

Figures 54 and 55 show the length- and age-specific selectivity patterns for each fleet. The live-fish fishery (fleet 2) is dome-shaped with respect to length. Selectivity for the man-made and beach/bank fleets (fleets 3 and 4) also decline with size, though maintain elevated selectivities for the largest/oldest individuals. Males are more selected than females for a given age in the commercial live-fish fleet and recreational man-made and beach/bank modes because females are larger at age and these fisheries target smaller individuals. Females are more selected in the commercial non-live and recreational CPFV fisheries because these fisheries capture larger individuals. Selectivity based on age and length suggests that immature fish are not completely excluded from the current and historical catch, especially in the man-made and shore-based fisheries.

Harvest rates for each fleet are given in Figure 56. The onset of the live-fish fishery in the late 1990s is dramatic and the peak harvest rate by this fleet is greater than that for any other fleet. The removals by the beach/bank fleet during the 1980s and by the man-made during the 1990s also lead to the highest harvest rates.

Sensitivity analyses

The first set sensitivity tests for the Oregon assessment relate to data set choices. The selectivity pattern for a fleet is fixed to that for the base-case analysis if removal of a data source causes selectivity for that fleet to be inestimable.

- Trial 1: Ignore the length-composition data for the commercial non-live-fish fleet (fleet 1).
- Trial 2: Ignore the length-composition data for the commercial live-fish fleet (fleet 2).
- Trial 3: Ignore the length-composition and mean weight data for the recreational man-made fleet (fleet 3).

Trial 4: Ignore the length-composition and mean weight data for the recreational beach/bank fleet (fleet 4).
Trial 5: Ignore the mean weight, length-composition, and age-composition data for the recreational CPFV fleet (fleet 5).
Trial 6: Ignore the mean weight data for the recreational CPFV fleet (fleet 5).
Trial 7: Ignore the length-composition data for the recreational CPFV fleet (fleet 5).
Trial 8: Ignore the age-composition data for the recreational CPFV fleet (fleet 5).
Trial 9: Ignore the length-composition and mean weight data for the recreational PBR fleet (fleet 6).
Trial 10: Ignore the catch-rate index for the man-made fleet (fleet 3).
Trial 11: Ignore the catch-rate index for the Beach/Bank fleet (fleet 4) survey index.
Trial 12: Ignore the catch-rate index for the CPFV fleet (fleet 5) survey index.
Trial 13: Ignore the catch-rate index for the PBR fleet (fleet 6) survey index.
Trial 14: Assumed that CPUE is related non-linearly (power=0.5) to abundance.

The results of these sensitivity analyses are provided in Table 26. Table 27 examines the sensitivity of the results to changing the values for M and σ_R and Table 28 explores the sensitivity of the results to a) the years for which recruitment residuals are estimated, b) the specifications for length-specific selectivity, c) the coefficients of variation assumed for the abundance indices and the effective sample sizes assumed for the length-composition data, d) the historical catches, and e) the coefficients of variation assumed for length-at-age.

Overall, the results in Table 26 indicate that the assessment for Oregon is not particularly sensitive to adding or removing data sources. Ignoring the CPFV catch-rate index (trial 12) led to least optimistic estimate of depletion (0.402). Ignoring the length-composition data for the CPFV and PBR fleets (trials 5 and 9) or assuming a non-linear relationship between CPUE and abundance (trial 14) leads to more optimistic estimates of depletion.

The results in Table 27 indicate that the Oregon assessment is sensitive to the values assumed for M and σ_R. The lowest value of σ_R generally led to the most optimistic depletion rates, except when M was set to 0.225yr^{-1}. Decreasing M from its base-case value led to a more depleted resource and *vice versa*. The fit of the model to the data improves when σ_R is set to 1. The model would not converge when M was set to 0.2yr^{-1}. The model also had trouble converging when M was higher than 0.3yr^{-1}.

The factors considered in Table 28 generally had less impact on the outcomes from the assessment than those examined in Tables 26 and 27. The factors that changed the depletion for Oregon the most were ending recruitment estimates in 2002 (more optimistic depletion), assuming logistic selectivity for the live-fish fleet and/or the man-made and beach/bank modes (less optimistic), doubling the catch history (less optimistic), and the values assumed for variation in length-at-age (less optimistic). Specifically, the results for Oregon are sensitive to the assumption that length-at-age CVs change linearly and decrease with age, although this assumption seems biologically realistic. The assumption of dome-shaped selectivities for the man-made and shore modes in Oregon also seems realistic and is supported by the data. Ending recruitment estimation in 2002 is also not appropriate considering the available data. The estimates of absolute spawning biomass are more sensitive than those of depletion.

Figure 57 shows a likelihood profile for steepness and Figure 58 provides the resultant estimates of unfished spawning and current biomass and current depletion. The data are uninformative for steepness values above about 0.5. Higher steepness values lead to less optimistic depletion levels. The absolute scale of abundance is very sensitive to the value assumed for steepness.

Projection and decision analysis

Twelve-year projections are conducted for Oregon under the standard PFMC OY control rule for groundfish of $F_{45\%}$ with a 40-10 adjustment for stocks below the target level of 40% of the unfished reproductive output. The ABC control rule is based only on the F_{MSY} proxy of $F_{45\%}$. The relative proportion of the six fleets in future harvests is assumed to be the same as in the last year in the model (2004). The first two years of projected catches are set to the current (2004) OY values because management based on this assessment would not be implemented until 2007.

The results in Table 29 suggest that a reduction in population size will occur over the projection period, although there will be an upturn in biomass towards the end of this period. These results are, however, highly dependent on the recruitment patterns inferred from the stock-recruitment relationship and should be interpreted given this caveat.

Projections based on alternative states of nature for initial recruitment (R_0) were explored to capture uncertainty in current (2005) absolute spawning biomass. The probability assigned to the low and high states of nature by the STAR Panel was 0.25 while that assigned to the base-case model was 0.5. The values of $\ln R_0$ for the low and high states of nature were calculated by assuming a normal probability density function parameterized by the maximum likelihood estimate for R_0 and its asymptotic standard deviation from the base-case model. The high and low states of nature were determined as the top and bottom 0.125 density values of the pdf for R_0. For the low scenario $\ln R_0 = 6.56$ while for the high scenario $\ln R_0 = 7.33$ (Figure 59).

Decision analysis population projections are provided in Table 30 for each state of nature and several state-dependent future catch series. The Oregon substock will drop below 0.25 B_0 if catch levels are based on the high R_0 scenario, but the true state of nature is either the base case or the low R_0 scenario. This also occurs if catches are based on the base case model, but the low R_0 state of nature is correct. All other scenarios lead to depletion levels above 0.25 B_0 in 2016.

Response To STAR Panel Review

The STAR Panel, during its review of the assessment, made several recommendations for model exploration. The following is a list of these recommendations and the STAT team responses:

1. Consistency among trends in the abundance indices: Fit a linear regression to the CPUE abundance indices to determine the recent trends: The STAR Panel requested a linear regression fit to the CPUE abundance indices to explore trends in the survey data. The analysis demonstrated that the trend for the Oregon sub-stock was slightly declining. All trends were consistent with outcomes from the assessment model.

2. Determine the sampling design of the catch-at-age data and conduct a catch-curve analysis to compare with empirically-derived estimates of *Z*: A catch curve analysis was requested because there were age data for Oregon. The samples sizes were low and the estimated total mortality (*Z*) was $0.1yr^{-1}$, much lower than what is expected by the biology of this species and what was estimated internally by the model and though empirical methods. The STAR Panel agreed the catch curve analysis was probably inappropriate because it does not account for selectivity and variation in year-class strength, factors explicitly included in the stock assessment model.

3. Determine the sensitivity of the assessment results to sex-specific estimates of *M*: In early formulations of the base model, sex-specific natural mortality rates were used. When the conditional age-at-length data were used, internal estimation of *M* was possible The data support a sex-independent value for *M* of $0.26yr^{-1}$ and the STAR Panel agreed that this should be included in the base case model.

4. Explore the behavior of both substock models at different values of R_0: A profile over R_0 was most informative for California because it showed that additional data are providing information that reduces a predicted increase in biomass (as was expected given the catch history). Removal of the length-frequency data led to more pessimistic results while removal of the catch-rate indices led to more optimistic results. This exercise highlighted the inherent contradictions in the data for California.

5.Perform a stock reduction analysis for both substocks: A stock reduction analysis was performed for both substocks and resulted in greatly optimistic depletion rates.

6. One area model: The STAR Panel suggested exploring a one area model. This model was developed and presented to the STAR Panel, but, given the differing time series of data between Oregon and California, reconciling the different model parameterizations between areas (e.g. specifying the value of σ_R), the contradictory data for California, and the need for more spatial management in nearshore fisheries, the one area model was not considered further.

Research Recommendations

1. Collection of sex-specific data: Given the ease of outward sexual identification of gender in kelp greenling, gender-specific information should be collected. This is especially the case for California as there are currently no sex-specific data for this area.

2 Accurate accounting of removals, especially from the recreational and live-fish fisheries: Fisheries exploited primarily by recreational and live-fish commercial fisheries are traditionally hard to monitor. More effort to monitor these fishery sectors may be necessary to accurately monitor fishing mortality.

3. A fishery-independent survey of kelp greenling population abundance: A current fishery-independent survey being developed for cabezon in Morro Bay may also provide information for kelp greenling. The development of surveys like this will become an important input into future assessments of kelp greenling. Expansion of this survey will increase its usefulness as an index of abundance for central and northern California.

4. A study of the stock structure of kelp greenling: Kelp greenling stock structure needs to be studied and the results accounted for in future assessments.

5. Age validation/ age determination: Catch age-composition data were limited in this assessment. Accurate ageing is crucial to understand the population dynamics of a species, especially those for which there is limited information on trends in abundance. Information on the age-structure of the catches for each fishery sector would substantially improve some aspects of the assessment. This is especially true for California. Even one year of catch-at-age data may be able to reconcile growth, mortality, and other issues currently effecting development of an assessment for this area.

6. Documentation on the historical Oregon recreational fishery: Extending the catch time series for the Oregon substock back in time should be a priority for the next assessment. Accomplishing this will require collaboration with scientists from Oregon to reconstruct recreational fishing activity prior to the MRFSS program.

7. Alternative substock designations: In additional to further identifying spatial sub-units for assessment purposes, consideration should be given to assessing the combination of California north of Cape Mendocino and Oregon, particularly if a coastwide California assessment remains difficult.

8. Alternative assessment procedures: The need for greater spatial resolution in the management of nearshore fisheries also increases the amount of data required to perform traditional stock assessments. Alternative assessment procedures that are less data-hungry, but still provide relevant management outputs should be developed to address this need. In addition, the nest-guarding behavior of males indicates males in the kelp greenling population should be incorporated into the depletion rates. A metric other than spawning biomass may be needed to help account for the male portion of the population in reference points.

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Table 1. Biological parameters for cabezon used in the 2005 assessment.

A. Age and growth (VBGF) parameters. Length in cm.

	Parameter		
	$L\infty$	k	t0
OR			
Female	38.98	0.30	-2.46
Male	37.05	0.40	-1.21
CA			
Female	43.00	0.20	-2.50
Male	39.50	0.29	-1.40

B. Length maturity function parameters (combined sex and area)

	a	b
OR	-1.24813869	35.19458842
CA	-1.196014056	37.03781892

C. Weight (kg)-length (cm) relationship

	a	b
OR		
Female	0.00000445	3.3194
Male	0.00000828	3.1442
CA		
Female	0.00000445	3.3194
Male	0.00000828	3.1442

Table 2. Natural mortality calculations used to obtain gender-specific estimates of *M*.

Method	Equation	Input values (per sex)	Estimated *M*: OR Female	OR Male	CA Female	CA Male
Hoenig (1983)	ln(*Z*) = 1.46 - 1.01ln(ω)	ω = 25 (both sexes)	-0.17	-0.17	-0.17	-0.17
Chen and Watanabe (1989)	$M(t)=\begin{cases}\dfrac{k}{1-e^{-k(t-t_0)}}, & t \le t_M \\ \dfrac{k}{a_0+a_1(t-t_M)+a_2(t-t_M)^2}, & t \ge t_M\end{cases}$ *where* $a_0 = 1-e^{-k(t_M-t_0)}$ $a_1 = ke^{-k(t_M-t_0)}$ $a_2 = -0.5k^2e^{-k(t_M-t_0)}$ $t_M = -\frac{1}{k}\ln(1-e^{kt_0})+t_0$	OR values: k = 0.30 (F);0.40 (M) t_0 = -2.46 (F); - 1.21 (M) CA values: k = 0.20 (F);0.29 (M) t_0 = - 2.50(F); -1.40 (M)	-0.33	-0.45	-0.23	-0.38
Jensen (1996)	*M*= 1.65/a_M	a_M = 4(F); 3(M)	-0.41	-0.55	-0.41	-0.55
Jensen (1996)	*M*= 1.5*k*	OR: k = 0.22(F);0.37 (M)	-0.45	-0.60	-0.30	-0.43
Jensen (1996)	*M*= 1.6*k*	CA: k = 0.20(F);0.29 (M)	-0.48	-0.65	-0.32	-0.46
			OR		CA	
		Average *M* estimate=	-0.34	-0.45	-0.28	-0.39

Table 3. Commerical landings (mt) of kelp greenling by assessment substock

	OREGON		CALIFORNIA			OREGON		CALIFORNIA	
Year	Non-live	Live	Non-live	Live	Year	Non-live	Live	Non-live	Live
1916			0	0	1961			0.3996	0
1917			0	0	1962			0.2635	0
1918			0	0	1963			0.0000	0
1919			0.0213	0	1964			0	0
1920			0.2935	0	1965			0	0
1921			0.0136	0	1966			0	0
1922			0.0458	0	1967			0	0
1923			0.0172	0	1968			0	0
1924			0	0	1969			0.1905	0
1925			0.0340	0	1970			0.0662	0
1926			0	0	1971			0	0
1927			0	0	1972			0	0
1928			0	0	1973			0	0
1929			0	0	1974			0	0
1930			0	0	1975			0	0
1931			0	0	1976			0	0
1932			0	0	1977			0.0200	0
1933			0	0	1978			0.5910	0
1934			0	0	1979			0.1334	0
1935			0.0136	0	1980			1.4261	0
1936			0.0268	0	1981	0.0362	0	0.0984	0
1937			0.0259	0	1982	0.0362	0	0.6700	0
1938			0.2567	0	1983	0.0362	0	0.1433	0
1939			0.0109	0	1984	0.0362	0	0.0721	0
1940			0	0	1985	0.0362	0	0.0358	0
1941			0.0649	0	1986	0.0362	0	0.2762	0
1942			0	0	1987	0.0362	0	0.7158	0
1943			0	0	1988	0.0803	0	1.8969	0
1944			0	0	1989	0.0767	0	2.6562	0
1945			0	0	1990	0.0032	0	1.5572	0
1946			0	0	1991	0.0227	0	0.8228	0
1947			0.0522	0	1992	0.0132	0.0027	2.5075	0
1948			0.3289	0	1993	0.0236	0.0594	1.1952	0.0576
1949			0.3338	0	1994	0.0390	0.1420	0.8246	0.6563
1950			0.1864	0	1995	0.0308	0.0073	4.6992	0.8419
1951			0.2644	0	1996	0.6400	0.0249	1.9736	2.0339
1952			0.2191	0	1997	1.7695	8.8015	6.3675	7.3083
1953			0.0630	0	1998	0.7643	9.0700	1.0628	6.8973
1954			0	0	1999	1.3227	23.2979	1.6456	13.6041
1955			0.3411	0	2000	1.2864	18.1278	1.3163	22.0813
1956			0.5384	0	2001	1.3268	27.5870	0.8106	10.0620
1957			0.8283	0	2002	1.5948	51.8955	0.9430	7.1736
1958			2.1546	0	2003	0.3556	19.7340	0.6187	4.3631
1959			0	0	2004	0.5302	22.7477	0.3475	1.6896
1960			0	0					

Table 4. Reconstruction of the CPFV removals (in numbers) for California.

	CPFV Removals						
	Logbook (#s)						
Year	Historical database[a]	Young (1969) Expanded	Reported Est. Total (#s)	C_{total}:$C_{logbook}$	Expanded Logbook (#s)	Compliance rates[e]	Total Estimate (#s)
1916							0
1917							0
1918							0
1919							0
1920							0
1921							0
1922							0
1923							0
1924							0
1925							0
1926							0
1927							0
1928							0
1929					77	1.00	77
1930					213	1.00	213
1931					349	1.00	349
1932					485	1.00	485
1933					621	1.00	621
1934					757	1.00	757
1935					893	1.00	893
1936					1030	0.80	1287
1937					1614	0.90	1794
1938					2222	0.95	2339
1939					2199	0.90	2443
1940					2170	0.90	2411
1941					2141	0.90	2379
1942					1131	0.90	1256
1943					1088	0.90	1209
1944					910	0.90	1011
1945					1115	0.90	1239
1946					1696	0.90	1884
1947		173		13.92	2446	0.83	2947
1948		821		3.01	2503	0.93	2691
1949		1010		2.91	2976	0.93	3200
1950		1967		2.41	4799	0.98	4897
1951		4386		1.14	5078	0.96	5289
1952		2291		2.24	5196	0.95	5469
1953		934		2.95	2791	0.95	2938
1954		1055		2.88	3084	0.95	3246
1955		2072		2.35	4940	0.95	5200
1956		2222		2.29	5087	0.95	5354
1957	1522			2.65	4034	0.95	4246
1958	884			2.98	2634	0.95	2772
1959	200			12.97	2594	0.95	2730

Table 4 (continued).

	CPFV Removals						
	Logbook (#s)						
Year	Historical database[a]	Young (1969) Expanded	Reported Est. Total (#s)	$C_{total}:C_{logbook}$	Expanded Logbook (#s)	Compliance rates[e]	Total Estimate (#s)
1960	31		521[b]	16.81	521	0.95	548
1961	20			20.03	401	0.95	422
1962	334			7.71	2576	0.85	3030
1963	919			2.96	2721	0.85	3202
1964	302			8.97	2708	0.85	3186
1965	124			15.95	1978	0.85	2327
1966	98			16.97	1663	0.85	1956
1967	152			14.85	2257	0.85	2656
1968	92			17.20	1583	0.85	1862
1969	108			16.58	1790	0.85	2106
1970	108			16.58	1790	0.80	2238
1971	63			18.34	1155	0.80	1444
1972	185			13.56	2508	0.80	3135
1973	92			17.20	1583	0.80	1978
1974	86			17.44	1500	0.80	1875
1975	50			18.85	943	0.80	1178
1976	46			19.01	874	0.80	1093
1977	40			19.24	770	0.80	962
1978	40			19.24	770	0.80	962
1979						0.80	1232[f]
1980	52			18.77	976	0.65	1502
1981	380		2424[c]	6.38	2424	0.65	3729
1982	85		1700[c]	20.00	1700	0.65	2616
1983	95		2667[c]	28.07	2667	0.65	4103
1984	76		1034[c]	13.60	1034	0.65	1591
1985	68		944[c]	13.88	944	0.65	1452
1986	62		2061[c]	33.24	2061	0.65	3170
1987	183		1950[c]	10.66	1950	0.71	2742
1988	893		1912[c]	2.14	1912	0.76	2513
1989	566		3825[c]	6.76	3825	0.80	4781
1990	167			14.26	2382	0.91	2627
1991	281			9.79	2751	0.63	4360
1992	1012			2.91	2948	0.62	4763
1993	923		1159[c]	1.26	1159	0.68	1711
1994	576			3.14	1808	0.62	2914
1995	438			3.63	1591	0.56	2866
1996	275		2442[c]	8.88	2442	0.54	4547
1997	409		3532[c]	8.64	3532	0.65	5413
1998	184		200[c]	1.09	200	0.48	417
1999	521		1071[c]	2.06	1071	0.65	1648
2000	381		3712c	9.74	3712	0.65	5711
2001	3110		10763[c]	3.46	10763	0.65	16558
2002	880		550c	0.63	550	0.65	847
2003	5052		8280[c]	1.64	8280	0.65	12739
2004			5076[d]		5076	0.65	7809

[a]*source* :K. Hill (pers. comm.)
[b]*source* :Gotshall and Miller (1965)
[c]*source* : RecFIN
[d]*source* : CRFS
[e]*source* : Cope and Punt 2005
[f]average of the 1978 and 1980 values

Table 5. Expanded removals (numbers) by year for each mode in the recreational fleet for each assessment substock.

	OREGON				CALIFORNIA			
Year	Man-made	Beach/Bank	CPFV	PBR	Shore Combined	CPFV	PBR	Spearfishing
1916					1	0	0	0
1917					1202	0	0	0
1918					2404	0	0	0
1919					3605	0	0	0
1920					4807	0	0	0
1921					6008	0	0	0
1922					7209	0	0	0
1923					8411	0	0	0
1924					9612	0	0	0
1925					10814	0	0	0
1926					12015	0	0	0
1927					13216	0	0	0
1928					14418	0	0	0
1929					15619	77	1	0
1930					16821	213	2	0
1931					18022	349	2	0
1932					19223	485	3	0
1933					20425	621	4	0
1934					21626	757	5	0
1935					22828	893	7	0
1936					24029	1287	9	0
1937					25231	1794	12	0
1938					26432	2339	15	0
1939					27633	2443	20	0
1940					28835	2411	26	0
1941					30000	2379	35	0
1942					30000	1256	46	0
1943					30000	1209	60	0
1944					30000	1011	79	0
1945					30000	1239	103	0
1946					30000	1884	136	1
1947					37245	2947	178	2
1948					38446	2691	234	3
1949					39647	3200	308	6
1950					40849	4897	404	11
1951					42050	5289	531	20
1952					43252	5469	697	37
1953					44453	2938	916	68
1954					45654	3246	1203	125
1955					46856	5200	1581	229
1956					48057	5354	2077	418
1957					49259	4246	2728	765
1958					50460	2772	3579	1401
1959					50460	2730	3579	1751
1960					50460	548	3579	3308
1961					50460	422	3579	2867
1962					52334	3030	5277	4891
1963					54208	3202	6623	4501
1964					56081	3186	7781	1557
1965					57955	2327	8817	6408
1966					59828	1956	9765	3230
1967					61702	2656	10646	1479
1968					63575	1862	11473	3100
1969					65449	2106	12255	1855
1970					67322	2238	13001	4359
1971					69196	1444	13714	4359
1972					71069	3135	14399	6862
1973					72943	1978	15059	2685
1974					74816	1875	15697	1972
1975					76690	1178	16316	1258
1976					78563	1093	16916	2543
1977					80437	962	17501	1505
1978					82310	962	18070	337
1979					84184	1232	18626	1660
1980					86057	1502	19169	2750
1981	7213	16761	18561	13502	87929	3729	19702	778
1982	5711	4147	7598	7061	77790	2616	48354	1699
1983	3272	8640	589	13301	114412	4103	17499	1427
1984	2182	3306	1481	11901	90047	1591	25261	1972
1985	5713	3744	1209	7421	88377	1452	23868	1881
1986	5702	6969	2825	7860	97604	3170	48201	934
1987	7827	9566	2408	24277	148107	2742	38139	1414
1988	4265	5212	1618	14920	126273	2513	41012	739
1989	4731	5782	2625	2460	87161	4781	38727	1583
1990	12240	8026	2950	6364	59030	2627	38261	1712
1991	12240	8026	2950	6364	59030	4360	38261	1258
1992	12240	8026	2950	6364	59030	4763	38261	713
1993	19750	10269	3275	10268	30899	1711	37796	597
1994	4845	1282	3397	7600	29019	2914	29872	389
1995	5040	2058	1272	4365	36387	2866	21240	389
1996	4924	3776	2470	6157	71196	4547	22110	402
1997	6319	2904	3119	7832	22863	5413	10397	746
1998	1940	1198	2385	2989	17795	417	5612	1090
1999	1643	2668	3980	5266	6381	1648	10872	350
2000	6583	7617	3605	4598	8930	5711	8705	2037
2001	14561	3818	2143	7615	17355	16558	12721	259
2002	20015	4719	2235	16282	29638	847	39248	65
2003	10944	1098	2670	13783	12636	12739	49265	78
2004	10944	1098	2670	13783	15505	7809	6795	78

Table 6. Summary of the A) length-composition, B) mean body weight, and C) age composition data by substock and fleet available for the assessment.

A) Length Compositions

Sunstock	Sector	Fleet	Years Used	Source
Oregon	Commerical	Non-Live	2000-2003	ODF&W
		Live	1998-2004	ODF&W
	Recreational	Man-made	1993-2004	RecFIN
		Beach/Bank	1993-2004	RecFIN
		CPFV	1993-2003	RecFIN
		PBR	1993-2004	RecFIN
California	Commerical	Non-Live	1993-1997, 1999-2001	CalCOM
		Live	1997-2002	CalCOM
	Recreational	Combined Shore	1993-2004	RecFIN
		CPFV	1987-1998	CDF&G CPFV Observer Program
		CPFV	1999-2004	RecFIN
		PBR	1993-2004	RecFIN
		Spearfishing	1959-1969,1972-1973,1976-1978,1980-1996,1998-2001	CenCAL databsae

B) Mean Body Weights (kg)

Area	Sector	Fleet	Years Used	Source
Oregon	Recreational	Man made	1980-1989	RecFIN
		Beach/Bank	1980-1989	RecFIN
		PBR	1980-1989	RecFIN
		CPFV	1980-1989	RecFIN
California		Combined Shore	1980-1989	RecFIN
		CPFV	1960	Baxter & Young 1953
		CPFV	1980-1983, 1985-1989, 1997-1998	RecFIN
		PBR	1980-1989	RecFIN

C) Age Compositions

Area	Sector	Fleet	Years Used	Source
Oregon	Recreational	CPFV	2003-2004	ODF&W

Table 7. Catch length-compositions for the Oregon commercial fleets. F= Female; M=Male; C= Combined genders. N = original length-composition sample sizes before iterative re-weighting. N_{eff} = base-case sample sizes after iterative re-weighting.

					Length bin																						
Sector	Year	Gender	N	N_{eff}	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50+
Commercial																											
Non-live	2000	F	6	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0.20833	0.41667	0.20833	0.08333	0.04167	0.04167	0	0	0	0
	2001	F	10	22	0	0	0	0	0	0	0	0	0	0	0	0	0.20588	0.08824	0.11765	0.14706	0.20588	0.17647	0.02941	0.02941	0	0	0
	2002	F	4	12	0	0	0	0	0	0	0	0	0	0	0	0	0.11111	0.38889	0.16667	0.22222	0.11111	0	0	0	0	0	0
	2003	F	6	16	0	0	0	0	0	0	0	0	0	0	0	0	0.15385	0.26923	0.26923	0.23077	0.07692	0	0	0	0	0	0
	2000	M	6	16	0	0	0	0	0	0	0	0	0	0	0	0	0.08824	0.14706	0.35294	0.20588	0.17647	0.02941	0	0	0	0	0
	2001	M	6	22	0	0	0	0	0	0	0	0	0	0	0	0	0.11111	0	0.18519	0.2963	0.33333	0.07407	0	0	0	0	0
	2002	M	5	12	0	0	0	0	0	0	0	0	0	0	0	0	0.13793	0.13793	0.31034	0.34483	0.03448	0.03448	0	0	0	0	0
	2003	M	5	16	0	0	0	0	0	0	0	0	0	0	0	0	0.16216	0.16216	0.18919	0.18919	0.21622	0.08108	0	0	0	0	0
Live	1998	F	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0.07595	0.08861	0.16456	0.21519	0.27848	0.11392	0.05063	0	0.01266	0	0
	1999	F	7	2	0	0	0	0	0	0	0	0	0	0	0	0	0.31081	0.28378	0.16216	0.17568	0.06757	0	0	0	0	0	0
	2000	F	80	19	0	0	0	0	0	0	0	0	0	0	0	0.00694	0.09722	0.20833	0.26736	0.21875	0.12847	0.06424	0.00521	0.00174	0	0	0.00174
	2001	F	135	31	0	0	0	0	0	0	0	0	0	0	0	0.0008	0.09783	0.13633	0.24379	0.25341	0.17482	0.07137	0.02085	0.0008	0	0	0
	2002	F	189	43	0	0	0	0	0	0	0	0	0	0	0	0.00581	0.16649	0.23414	0.18446	0.17178	0.14641	0.074	0.01586	0.00106	0	0	0
	2003	F	73	17	0	0	0	0	0	0	0	0	0	0	0	0.00134	0.1028	0.23632	0.22296	0.16689	0.16155	0.08011	0.0267	0.00134	0	0	0
	2004	F	131	30	0	0	0	0	0	0	0	0	0	0	0	0.00084	0.06812	0.15223	0.27586	0.24979	0.15896	0.07233	0.01766	0.00336	0.00084	0	0
	1998	M	5	1	0	0	0	0	0	0	0	0	0	0	0	0.02326	0.10465	0.10465	0.15116	0.27907	0.22093	0.10465	0.01163	0	0	0	0
	1999	M	7	2	0	0	0	0	0	0	0	0	0	0	0	0.01724	0.26724	0.22414	0.21552	0.21552	0.0431	0.01724	0	0	0	0	0
	2000	M	84	19	0	0	0	0	0	0	0	0	0	0	0.00124	0.00495	0.07426	0.20792	0.2896	0.26238	0.1349	0.02475	0	0	0	0	0
	2001	M	135	31	0	0	0	0	0	0	0	0	0	0	0.00063	0.0025	0.06324	0.16281	0.31183	0.27426	0.14778	0.03444	0.00188	0.00063	0	0	0
	2002	M	181	43	0	0	0	0	0	0	0	0	0	0	0	0.00358	0.15763	0.21904	0.18577	0.25333	0.1392	0.03787	0.00256	0.00102	0	0	0
	2003	M	70	17	0	0	0	0	0	0	0	0	0	0	0	0	0.11811	0.2126	0.26434	0.2216	0.15636	0.02362	0.00337	0	0	0	0
	2004	M	120	30	0	0	0	0	0	0	0	0	0	0	0	0.00146	0.0744	0.16484	0.28738	0.30708	0.14442	0.01969	0.00073	0	0	0	0

Table 7 (continued). Catch length-compositions of the Oregon recreational modes. F= Female; M=Male; C= Combined genders. N = original length-composition sample sizes before iterative re-weighting. N_{eff} = base-case sample sizes after iterative re-weighting.

					Length bin																						
Sector	Year	Gender	N	N_{eff}	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50+
Man-made	1993	C	132	137	0	0	0	0	0.00889	0.01778	0.04667	0.06222	0.08	0.11111	0.26444	0.16444	0.08889	0.06444	0.04889	0.02222	0.00889	0.00889	0	0	0	0.00222	0
	1994	C	85	88	0	0	0	0	0.01702	0.03404	0.02553	0.02128	0.13617	0.19149	0.16596	0.09787	0.10213	0.08511	0.0383	0.04681	0.01277	0.01702	0.00851	0	0	0	0
	1995	C	56	58	0	0	0.01429	0	0.01429	0.03571	0.04286	0.05	0.09286	0.14286	0.12857	0.04286	0.12143	0.09286	0.09286	0.07143	0.03571	0.00714	0.01429	0	0	0	0
	1996	C	52	54	0	0	0	0	0	0.00595	0.04762	0.07143	0.05357	0.1131	0.11905	0.09524	0.14286	0.09524	0.06548	0.07143	0.05357	0.03571	0.01786	0.00595	0	0.00595	0
	1997	C	63	65	0	0	0	0	0	0.00481	0.01923	0.03365	0.08654	0.14423	0.23077	0.12981	0.09615	0.12019	0.04327	0.03846	0.02885	0.00962	0.01442	0	0	0	0
	1998	C	18	19	0	0	0	0	0	0.01923	0	0.07692	0.03846	0.11538	0.13462	0.23077	0.03846	0.13462	0.03846	0.09615	0.07692	0	0	0	0	0	0
	1999	C	32	33	0	0	0	0	0	0	0.03571	0.08333	0.05952	0.09524	0.09524	0.09524	0.21429	0.07143	0.15476	0.03571	0.02381	0.03571	0	0	0	0	0
	2000	C	29	30	0	0	0	0	0	0.00862	0.01724	0.07759	0.06034	0.09483	0.18966	0.19828	0.18103	0.03448	0.07759	0.05172	0.00862	0	0	0	0	0	0
	2001	C	23	24	0	0	0	0	0.01333	0.05333	0.01333	0.04	0.06667	0.10667	0.20000	0.14667	0.08000	0.08000	0.08000	0.02667	0.06667	0.01333	0	0.01333	0	0	0
	2002	C	46	48	0	0	0	0	0	0.03846	0.02747	0.04396	0.09341	0.02747	0.14835	0.0989	0.10989	0.12088	0.15934	0.08242	0.02747	0.01648	0	0	0.00549	0	0
	2003	C	37	38	0	0	0	0	0.00633	0	0.00633	0.00633	0.10759	0.15823	0.18354	0.12658	0.09494	0.09494	0.10127	0.0443	0.05063	0.01899	0	0	0	0	0
	2004	C	38	39	0	0	0	0	0	0	0	0.01905	0.05714	0.08571	0.20000	0.19048	0.12381	0.07619	0.13333	0.0381	0.05714	0.00952	0	0.00952	0	0	0
Beach/Bank	1993	C	21	63	0	0	0	0	0	0.01613	0.06452	0.09677	0.06452	0.17742	0.16129	0.12903	0.08065	0.08065	0.03226	0.03226	0.01613	0.01613	0.03226	0	0	0	0
	1994	C	27	80	0	0	0	0	0	0.01852	0.01852	0.03704	0.05556	0.12963	0.14815	0.09259	0.22222	0.12963	0.11111	0	0.01852	0	0.01852	0	0	0	0
	1995	C	35	104	0	0	0	0.01961	0.01961	0.05882	0.08824	0.05882	0.13725	0.12745	0.17647	0.11765	0.10784	0.03922	0.00980	0.00980	0.01961	0	0	0.00980	0	0	0
	1996	C	51	152	0	0	0	0	0	0.00769	0.03846	0.04615	0.06154	0.11538	0.27692	0.10000	0.14615	0.10769	0.05385	0.01538	0.01538	0.00769	0.00769	0	0	0	0
	1997	C	41	122	0	0	0	0	0.02151	0.04301	0.03226	0.05376	0.04301	0.13978	0.25806	0.1828	0.08602	0.04301	0.01075	0.01075	0.05376	0.01075	0.01075	0	0.00000	0	0
	1998	C	21	63	0	0	0	0	0	0.02941	0.05882	0.14706	0.11765	0.17647	0.05882	0.05882	0.17647	0.08824	0.02941	0.05882	0	0	0	0	0	0	0
	1999	C	26	77	0	0	0	0	0	0	0.05769	0.01923	0.13462	0.19231	0.13462	0.09615	0.05769	0.09615	0.13462	0.03846	0.01923	0.01923	0	0	0	0	0
	2000	C	40	119	0	0	0	0	0	0.02817	0.08451	0.07042	0.0493	0.14789	0.14085	0.11268	0.09155	0.12676	0.10563	0.01408	0.02113	0	0	0	0.00704	0	0
	2001	C	21	63	0	0	0.01449	0	0	0	0.01449	0.07246	0.02899	0.18841	0.17391	0.17391	0.07246	0.02899	0.11594	0.07246	0.04348	0	0	0	0	0	0
	2002	C	36	107	0	0	0	0	0	0	0.01818	0.03636	0.18182	0.11818	0.09091	0.14545	0.10000	0.17273	0.08182	0.01818	0.01818	0.01818	0	0	0	0	0
	2003	C	46	137	0	0	0	0	0	0.02817	0.0493	0.08451	0.11268	0.1338	0.17606	0.16197	0.11972	0.06338	0.03521	0.01408	0	0.02113	0	0	0	0	0
	2004	C	34	101	0	0	0	0	0	0	0.00962	0.04808	0.08654	0.14423	0.25962	0.13462	0.125	0.09615	0.06731	0	0.01923	0.00962	0	0	0	0	0
CPFV	1993	C	36	36	0	0	0	0	0	0	0	0	0	0	0.01493	0.02985	0.0597	0.07463	0.26866	0.28358	0.20896	0.04478	0	0.01493	0	0	0
	1994	C	36	36	0	0	0	0	0	0	0	0	0	0	0.01299	0.02597	0.09091	0.07792	0.22078	0.16883	0.27273	0.10390	0.01299	0	0	0	0.01299
	1995	C	23	23	0	0	0	0	0	0	0	0	0	0	0.02778	0	0.08333	0.16667	0.16667	0.33333	0.16667	0.02778	0.02778	0	0	0	0
	1996	C	36	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0.14815	0.25926	0.25926	0.22222	0.07407	0.03704	0	0	0	0
	1997	C	43	43	0	0	0	0	0	0	0	0	0	0.02128	0.02128	0.06383	0.06383	0.07447	0.19149	0.2766	0.21277	0.05319	0	0.02128	0	0	0
	1998	C	50	50	0	0	0	0	0	0	0	0	0.01042	0	0	0.05208	0.08333	0.16667	0.1875	0.21875	0.22917	0.05208	0	0	0	0	0
	1999	C	86	85	0	0	0	0	0	0	0	0	0	0	0.01064	0.05319	0.06915	0.20745	0.24468	0.25532	0.10638	0.04255	0.01064	0	0	0	0
	2000	C	42	42	0	0	0	0	0	0	0	0	0	0	0	0.02198	0.07692	0.23077	0.34066	0.14286	0.12088	0.06593	0	0	0	0	0
	2001	C	31	31	0	0	0	0	0	0	0	0	0	0.03704	0.01852	0.03704	0.16667	0.14815	0.2037	0.16667	0.16667	0.05556	0	0	0	0	0
	2002	C	34	34	0	0	0	0	0	0	0	0	0	0.01515	0.01515	0.01515	0.10606	0.16667	0.28788	0.15152	0.21212	0.01515	0	0	0	0	0.01515
	2003	C	7	7	0	0	0	0	0	0	0	0	0	0	0	0.09091	0.18182	0.09091	0.18182	0.27273	0.09091	0.09091	0	0	0	0	0
PBR	1993	C	41	60	0	0	0	0	0	0	0.01538	0.02308	0.06923	0.07692	0.09231	0.12308	0.09231	0.09231	0.06923	0.13077	0.11538	0.05385	0.03077	0.00769	0	0	0.00769
	1994	C	51	75	0	0	0	0	0	0	0	0	0.03053	0.00763	0.07634	0.0458	0.13740	0.16031	0.24427	0.0916	0.16031	0.03817	0	0	0	0	0.00763
	1995	C	32	47	0	0	0	0.01053	0.01053	0.01053	0.01053	0.03158	0.11579	0.04211	0.07368	0.09474	0.09474	0.15789	0.11579	0.14737	0.05263	0.03158	0	0	0	0	0
	1996	C	41	60	0	0	0	0	0	0	0.00709	0.01418	0.08511	0.14184	0.12057	0.0922	0.13475	0.04965	0.12057	0.13475	0.05674	0.02837	0.01418	0	0	0	0
	1997	C	58	85	0	0	0	0	0	0	0.00658	0.00658	0.03289	0.07895	0.06579	0.09211	0.08553	0.13158	0.13816	0.21053	0.11184	0.02632	0.00658	0.00658	0	0	0
	1998	C	50	73	0	0	0	0	0	0	0.00826	0.00826	0.02479	0.01653	0.12397	0.1157	0.17355	0.14876	0.12397	0.15702	0.06612	0.01653	0.01653	0	0	0	0
	1999	C	82	120	0	0	0	0	0	0	0	0.01042	0.02604	0.04167	0.11458	0.10938	0.13542	0.20313	0.15104	0.11458	0.0625	0.01042	0.01563	0.00521	0	0	0
	2000	C	36	53	0	0	0	0	0	0	0	0	0.01905	0.03810	0.07619	0.06667	0.10476	0.25714	0.21905	0.17143	0.02857	0.01905	0	0	0	0	0
	2001	C	52	76	0	0	0	0	0	0	0.02190	0.06569	0.05109	0.06569	0.18248	0.16788	0.10219	0.14599	0.09489	0.04380	0.03650	0.02190	0	0	0	0	0
	2002	C	59	86	0	0	0	0	0	0	0	0.00515	0.06701	0.1134	0.06701	0.09278	0.13918	0.16495	0.1701	0.08247	0.07216	0.02062	0.00515	0	0	0	0
	2003	C	32	47	0	0	0	0	0	0	0.00704	0.0493	0.08451	0.11972	0.1338	0.15493	0.07746	0.11972	0.11972	0.07746	0.02817	0.02113	0	0	0.00704	0	0
	2004	C	15	22	0	0	0	0	0	0	0	0	0	0.15584	0.25974	0.14286	0.1039	0.11688	0.14286	0.03896	0.01299	0	0.01299	0.01299	0	0	0

Table 7 (continued). Catch length-compositions of the California commercial fleets. F= Female; M=Male; C= Combined genders. N = original length-composition sample sizes before iterative re-weighting. N_{eff} = base-case sample sizes after iterative re-weighting.

					Length bin																						
Sector	Year	Gender	N	N_{eff}	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50+
Commercial																											
Non-live	1993	C	11	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0833	0.0833	0.4167	0.0833	0.25000	0.0833	0	0	0	0
	1994	C	9	5	0	0	0	0	0	0	0	0	0	0	0.1333	0	0	0.4	0.3333	0	0.1333	0	0	0	0	0	0
	1995	C	28	15	0	0	0	0	0	0	0	0	0	0	0	0.0115	0.0651	0.1456	0.1877	0.2759	0.2644	0.0421	0.0077	0	0	0	0
	1996	C	79	41	0	0	0	0	0	0	0	0	0	0	0	0.0222	0.1778	0.0444	0.3111	0.2667	0.1556	0.0222	0	0	0	0	0
	1997	C	39	20	0	0	0	0	0	0	0	0	0	0	0.0177	0.0088	0.1504	0.2301	0.1239	0.1858	0.0796	0.1239	0.0796	0	0	0	0
	1999	C	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0.0395	0.1711	0.1974	0.25	0.1447	0.1316	0.0658	0	0	0	0
	2000	C	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1887	0.283	0.3019	0.1698	0.0566	0	0	0	0	0
	2001	C	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0.1897	0.1379	0.2931	0.2069	0.0862	0.069	0.0172	0	0	0	0
Live	1997	C	11	30	0	0	0	0	0	0	0	0	0	0	0	0.0274	0.0822	0.1644	0.3425	0.274	0.1096	0	0	0	0	0	0
	1998	C	35	96	0	0	0	0	0	0	0	0	0	0	0	0.0042	0.1447	0.2449	0.3148	0.2194	0.0692	0.0027	0	0	0	0	0
	1999	C	88	200	0	0	0	0	0	0	0	0	0	0	0.0003	0.0141	0.1066	0.1847	0.2841	0.2457	0.1109	0.0481	0.0056	0	0	0	0
	2000	C	160	200	0	0	0	0	0	0	0	0	0	0	0	0.0042	0.0704	0.1711	0.2619	0.2557	0.1592	0.067	0.0083	0.001	0.0006	0.0006	0
	2001	C	67	184	0	0	0	0	0	0	0	0	0	0	0.0014	0.0071	0.0671	0.1869	0.2383	0.2676	0.1594	0.0667	0.0042	0.0014	0	0	0
	2004	C	16	44	0	0	0	0	0	0	0	0	0	0	0	0	0.2165	0.1772	0.2607	0.2029	0.0977	0.0449	0	0	0	0	0
	2003	C	6	16	0	0	0	0	0	0	0	0	0	0	0	3	12	10	8	3	4	0	0	0	0	0	0
	2004	C	14	38	0	0	0	0	0	0	0	0	0	0	0	0	1	6	17	10	28	0	0	0	0	0	0

Table 7 (continued). Catch length-compositions of the California recreational modes. F= Female; M=Male; C= Combined genders. N = original length-composition sample sizes before iterative re-weighting. N_{eff} = base-case sample sizes after iterative re-weighting.

					Length bin																						
Sector	Year	Gender	N	N_{eff}	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50+
Recreational																											
Shore Combined	1993	C	48	55	0	0	0	0	0	0.00909	0	0	0.01818	0.05455	0.19091	0.12727	0.17273	0.09091	0.11818	0.14545	0.03636	0.02727	0.00909	0	0	0	0
	1994	C	29	33	0	0	0	0	0	0	0	0.05000	0.025	0.025	0.075	0.10000	0.10000	0.30000	0.05000	0.15000	0.07500	0.05000	0	0	0	0	0
	1995	C	26	30	0	0	0	0	0	0.03279	0	0	0.04918	0.11475	0.22951	0.03279	0.11475	0.09836	0.13115	0.09836	0.06557	0.03279	0	0	0	0	0
	1996	C	48	55	0	0	0	0	0.00746	0.01493	0.01493	0.01493	0.06716	0.12687	0.18657	0.14925	0.04478	0.08209	0.07463	0.08955	0.06716	0.05224	0.00746	0	0	0	0
	1997	C	23	27	0	0	0	0	0	0	0.04878	0.07317	0.07317	0.04878	0.31707	0.07317	0.12195	0.09756	0.02439	0.02439	0.07317	0	0	0	0.02439	0	0
	1998	C	30	35	0	0	0	0	0	0	0	0.01333	0.06667	0.06667	0.17333	0.13333	0.18667	0.22667	0.05333	0.04	0.01333	0.01333	0.01333	0	0	0	0
	1999	C	14	16	0	0	0	0	0	0.02381	0	0	0.09524	0.07143	0.02381	0.21429	0.33333	0.09524	0.09524	0.02381	0	0.02381	0	0	0	0	0
	2000	C	10	12	0	0	0	0	0.07143	0.07143	0	0.07143	0	0	0	0.07143	0.21429	0.28571	0.14286	0	0.07143	0	0	0	0	0	0
	2001	C	14	16	0	0	0	0	0	0	0	0	0.04000	0.04000	0.04000	0.20000	0.24000	0.04000	0.08000	0.16000	0.16000	0	0	0	0	0	0
	2002	C	20	23	0	0	0	0	0	0.01961	0	0.01961	0.05882	0.07843	0.05882	0.15686	0.19608	0.09804	0.19608	0.05882	0.05882	0	0	0	0	0	0
	2003	C	7	8	0	0	0	0	0	0	0	0	0	0.08333	0.16667	0.25	0.16667	0.16667	0.16667	0	0	0	0	0	0	0	0
	2004	C	21	24	0	0	0.01923	0.07692	0.01923	0	0.05769	0.11538	0.09615	0.03846	0.09615	0.09615	0.11538	0.07692	0.05769	0.09615	0.01923	0	0.01923	0	0	0	0
CPFV (Observer)	1988	C	58	9	0	0	0	0	0	0	0	0	0	0	0	0.40000	0.20000	0	0.20000	0	0.20000	0	0	0	0	0	0
	1989	C	90	6	0	0	0	0	0	0	0	0	0	0.01724	0.10345	0.10345	0.06897	0.25862	0.13793	0.12069	0.10345	0.05172	0.03448	0	0	0	0
	1990	C	14	26	0	0	0	0	0	0	0	0	0	0.01111	0.02222	0.05556	0.10000	0.16667	0.24444	0.22222	0.13333	0.01111	0.02222	0	0	0.01111	0
	1991	C	15	3	0	0	0	0	0	0	0	0	0	0	0	0.07143	0.28571	0.07143	0.14286	0.28571	0.14286	0	0	0	0	0	0
	1992	C	32	52	0	0	0	0	0	0	0	0	0	0	0	0	0.26667	0.20000	0.26667	0.26667	0	0	0	0	0	0	0
	1993	C	61	51	0	0	0	0	0	0	0	0	0	0	0	0	0.0625	0.1875	0.50000	0.15625	0.09375	0	0	0	0	0	0
	1994	C	34	79	0	0	0	0	0	0	0	0.01639	0.03279	0.04918	0.03279	0.06557	0.19672	0.22951	0.18033	0.13115	0.04918	0.01639	0	0	0.00000	0	0
	1995	C	56	12	0	0	0	0	0	0	0	0	0	0	0.08824	0.08824	0.23529	0.14706	0.17647	0.08824	0.17647	0	0	0	0	0	0
	1996	C	101	13	0	0	0	0	0	0	0	0	0	0	0.07143	0.14286	0.21429	0.19643	0.16071	0.07143	0.08929	0.03571	0.01786	0	0	0	0
	1997	C	87	28	0	0	0	0	0	0	0	0.0099	0	0.0396	0.06931	0.13861	0.13861	0.17822	0.17822	0.18812	0.0396	0.0198	0	0	0	0	0
	1998	C	19	53	0	0	0	0	0	0	0	0	0	0.02299	0.11494	0.13793	0.24138	0.16092	0.1954	0.09195	0.01149	0.02299	0	0	0	0	0
CPFV (RecFIN)	1999	C	10	61	0	0	0	0	0	0	0	0	0	0	0	0.25000	0.33333	0.16667	0.08333	0.08333	0.08333	0	0	0.00000	0	0	0
	2000	C	7	30	0	0	0	0	0	0	0	0	0	0	0	0	0.20000	0	0	0.40000	0.10000	0.20000	0.10000	0	0	0	0
	2001	C	30	49	0	0	0	0	0	0	0	0	0	0	0.01818	0.09091	0.20000	0.41818	0.18182	0.01818	0.03636	0.00000	0.01818	0	0.00000	0.01818	0
	2002	C	4	88	0	0	0	0	0	0	0	0	0	0	0.25000	0	0	0	0.5	0	0.25	0	0	0	0	0	0
	2003	C	60	76	0	0	0	0	0	0	0	0.00781	0	0	0.03125	0.03125	0.14063	0.3125	0.25781	0.10938	0.05469	0.02344	0.01563	0.00781	0.00781	0	0
	2004	C	71	17	0	0	0	0	0	0	0	0	0.00671	0.00671	0.02013	0.28188	0.2953	0.26846	0.08054	0.02013	0.01342	0.00671	0	0	0	0	0
PBR	1993	C	91	110	0	0	0	0	0	0	0	0	0	0.00645	0.02581	0.06452	0.09032	0.25161	0.23871	0.2	0.07097	0.04516	0.00645	0	0	0	0
	1994	C	44	53	0	0	0	0	0	0	0	0	0	0	0.05319	0.06383	0.07447	0.21277	0.25532	0.2234	0.06383	0.03191	0.01064	0	0	0	0.01064
	1995	C	42	51	0	0	0	0	0	0	0	0	0.01389	0.02778	0.04167	0.09722	0.11111	0.23611	0.26389	0.11111	0.04167	0.02778	0	0.01389	0.01389	0	0
	1996	C	53	64	0	0	0	0	0	0	0	0.00909	0.00909	0.03636	0.04545	0.07273	0.14545	0.18182	0.18182	0.20000	0.06364	0.03636	0.00909	0.00909	0	0	0
	1997	C	23	28	0	0	0	0	0	0	0	0	0.02564	0.07692	0.05128	0.12821	0.12821	0.10256	0.20513	0.17949	0.02564	0.07692	0	0	0	0	0
	1998	C	16	19	0	0	0	0	0	0	0	0	0	0.14286	0.09524	0.09524	0.04762	0.33333	0.14286	0.14286	0	0	0	0	0	0	0
	1999	C	36	44	0	0	0	0	0	0	0	0	0.02083	0	0.125	0.0625	0.375	0.14583	0.10417	0.04167	0.10417	0.02083	0	0	0	0	0
	2000	C	26	31	0	0	0	0	0	0	0	0.02778	0	0	0	0	0.13889	0.33333	0.27778	0.11111	0.05556	0.05556	0	0	0	0	0
	2001	C	16	19	0	0	0	0	0	0	0	0	0.04545	0.04545	0.04545	0	0.18182	0.13636	0.22727	0.18182	0.13636	0	0	0	0	0	0
	2002	C	26	31	0	0	0	0	0	0	0	0	0	0	0.0625	0.09375	0.1875	0.09375	0.21875	0.125	0.15625	0.0625	0	0	0	0	0
	2003	C	40	48	0	0	0	0	0	0	0	0	0	0.01538	0.01538	0.06154	0.29231	0.27692	0.23077	0.06154	0.04615	0	0	0	0	0	0
	2004	C	159	192	0	0	0	0	0	0	0	0	0.00338	0.00338	0.00338	0.02703	0.13176	0.24662	0.23986	0.19257	0.08784	0.04054	0.01689	0.00338	0	0	0.00338
Spearfishing	1959	C	39	39	0	0	0	0	0	0	0	0	0	0	0.05128	0.10256	0.17949	0.15385	0.15385	0.10256	0.10256	0.07692	0.05128	0.02564	0	0	0
	1960	C	54	54	0	0	0	0	0	0	0	0	0	0	0.05556	0.11111	0.12963	0.12963	0.14815	0.14815	0.14815	0.09259	0.03704	0	0	0	0
	1961	C	53	53	0	0	0	0	0	0	0	0	0	0.01887	0.0566	0.07547	0.13208	0.15094	0.15094	0.15094	0.13208	0.09434	0.03774	0	0	0	0
	1962	C	56	56	0	0	0	0	0	0	0	0	0	0.03571	0.05357	0.10714	0.125	0.14286	0.14286	0.14286	0.14286	0.07143	0.01786	0.01786	0	0	0
	1963	C	44	44	0	0	0	0	0	0	0	0	0	0	0	0.09091	0.18182	0.15909	0.18182	0.18182	0.09091	0.06818	0	0	0	0	0
	1964	C	21	21	0	0	0	0	0	0	0	0	0	0	0	0	0.09524	0.19048	0.19048	0.19048	0.14286	0.19048	0	0	0	0	0
	1965	C	51	51	0	0	0	0	0	0	0	0	0	0	0.03922	0.01961	0.15686	0.13725	0.15686	0.15686	0.15686	0.11765	0.05882	0	0	0	0
	1966	C	49	49	0	0	0	0	0	0	0	0	0	0	0.02041	0.10204	0.14286	0.16327	0.16327	0.16327	0.14286	0.08163	0.02041	0	0	0	0
	1967	C	45	45	0	0	0	0	0	0	0	0	0	0	0.02222	0.04444	0.13333	0.15556	0.17778	0.17778	0.15556	0.08889	0.04444	0	0	0	0
	1968	C	48	48	0	0	0	0	0	0	0	0	0	0	0.02083	0.02083	0.0625	0.14583	0.16667	0.16667	0.16667	0.125	0.08333	0.04167	0	0	0
	1969	C	49	49	0	0	0	0	0	0	0	0	0	0	0.02041	0.08163	0.16327	0.16327	0.16327	0.16327	0.12245	0.08163	0	0	0	0	0
	1972	C	48	48	0	0	0	0	0	0	0	0	0	0	0.02083	0.06250	0.10417	0.20833	0.25000	0.16667	0.10417	0.04167	0.02083	0.02083	0	0	0
	1973	C	28	28	0	0	0	0	0	0	0	0	0	0	0.03571	0.03571	0.10714	0.14286	0.14286	0.14286	0.14286	0.14286	0.10714	0	0	0	0
	1976	C	43	43	0	0	0	0	0	0	0	0	0	0	0	0.02326	0.06977	0.16279	0.18605	0.18605	0.18605	0.16279	0.02326	0	0	0	0
	1977	C	18	18	0	0	0	0	0	0	0	0	0	0	0	0	0.05556	0.16667	0.22222	0.22222	0.11111	0.16667	0.05556	0	0	0	0
	1978	C	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0.16667	0.25	0.33333	0.16667	0.08333	0	0	0	0	0
	1980	C	36	36	0	0	0	0	0	0	0	0	0	0	0.02778	0	0.05556	0.13889	0.22222	0.22222	0.22222	0.05556	0.02778	0	0	0	0.02778
	1981	C	26	26	0	0	0	0	0	0	0	0	0	0	0	0	0.03846	0.11538	0.26923	0.23077	0.30769	0.03846	0	0	0	0	0
	1982	C	38	38	0	0	0	0	0	0	0	0	0	0	0	0.02632	0.05263	0.21053	0.21053	0.21053	0.18421	0.05263	0.02632	0.02632	0	0	0
	1983	C	22	22	0	0	0	0	0	0	0	0	0	0	0	0.04545	0.18182	0.18182	0.18182	0.18182	0.18182	0.04545	0	0	0	0	0
	1984	C	22	22	0	0	0	0	0	0	0	0	0	0	0	0	0.09091	0.09091	0.36364	0.27273	0.13636	0.04545	0	0	0	0	0
	1985	C	37	37	0	0	0	0	0	0	0	0	0	0	0.02703	0	0.05405	0.21622	0.21622	0.18919	0.18919	0.08108	0.02703	0	0	0	0
	1986	C	18	18	0	0	0	0	0	0	0	0	0	0	0.05556	0.05556	0	0.16667	0.22222	0.22222	0.22222	0.05556	0	0	0	0	0
	1987	C	44	44	0	0	0	0	0	0	0	0	0	0	0	0	0.06818	0.20455	0.22727	0.22727	0.20455	0.06818	0	0	0	0	0
	1988	C	49	49	0	0	0	0	0	0	0	0	0	0	0	0.06122	0.06122	0.18367	0.22449	0.20408	0.16327	0.08163	0.02041	0	0	0	0
	1989	C	48	48	0	0	0	0	0	0	0	0	0	0	0	0.02083	0.08333	0.20833	0.20833	0.20833	0.14583	0.08333	0.04167	0	0	0	0
	1990	C	51	51	0	0	0	0	0	0	0	0	0	0	0	0	0.09804	0.17647	0.21569	0.21569	0.17647	0.09804	0.01961	0	0	0	0
	1991	C	31	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0.09677	0.22581	0.25806	0.22581	0.12903	0.06452	0	0	0	0
	1992	C	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0.08333	0.33333	0.33333	0.16667	0.08333	0	0	0	0	0
	1993	C	26	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03846	0.23077	0.30769	0.26923	0.11538	0.03846	0	0	0	0
	1994	C	18	18	0	0	0	0	0	0	0	0	0	0	0	0.05556	0.05556	0.16667	0.22222	0.27778	0.22222	0	0	0	0	0	0
	1995	C	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0.23077	0.30769	0.30769	0.15385	0	0	0	0	0	0
	1996	C	18	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0.11111	0.27778	0.27778	0.22222	0.11111	0	0	0	0	0
	1998	C	32	32	0	0	0	0	0	0	0	0	0	0	0	0	0.03125	0.125	0.21875	0.3125	0.1875	0.0625	0	0.0625	0	0	0
	1999	C	18	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.27778	0.38889	0.22222	0.05556	0.05556	0	0	0	0
	2000	C	34	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0.20588	0.23529	0.20588	0.20588	0.11765	0.02941	0	0	0	0
	2001	C	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.30769	0.38462	0.23077	0.07692	0	0	0	0	0

Table 8. A) Age and B) conditional age-at-length-compositions for the Oregon CPFV recreational mode. F= Female; M=Male. N = original sample sizes before iterative re-weighting. N_{eff} = base-case sample sizes after iterative re-weighting.

						Age bin																								
Year	Gender	Low age bin	Hi age bin	N	N_{eff}	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
2003	F	-1	-1	67	29.8674	0	0.04478	0.10448	0.07463	0.22388	0.08955	0.04478	0.02985	0.02985	0.04478	0.04478	0.01493	0	0.01493	0	0	0.01493	0.02985	0	0	0	0	0	0	0
2004	F	-1	-1	316	81.3057	0	0.04430	0.06013	0.09810	0.10759	0.04114	0.00949	0.01582	0.03481	0.01266	0.00949	0.00316	0.00949	0	0.00316	0.00633	0	0.00316	0.00316	0	0	0	0	0	0.00316
2003	M	-1	-1	67	29.8674	0	0	0	0.04478	0.01493	0.02985	0.02985	0.01493	0	0.01493	0.01493	0	0.01493	0	0	0	0	0	0.01493	0	0	0	0	0	0
2004	M	-1	-1	316	81.3057	0	0.03481	0.05696	0.06329	0.09494	0.05380	0.03481	0.02848	0.02215	0.02532	0.02532	0.02215	0.01582	0.02215	0.00316	0.00316	0.00316	0.00633	0.00633	0.00633	0	0.00633	0	0	0

B) Conditional age-length compositions

						Age bin																								
Year	Gender	Low length bin	Hi length bin	N	Neff	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
2003	F	9	9	1	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
2003	F	10	10	2	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
2003	F	12	12	2	2	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
2003	F	13	13	1	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
2003	F	14	14	9	9	0	0	0.22222	0.22222	0.33333	0.11111	0.11111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	F	15	15	6	6	0	0	0	0.16667	0.66667	0.16667	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	F	16	16	15	15	0	0	0.20000	0	0.33333	0.06667	0	0.13333	0.06667	0	0.13333	0	0	0	0	0	0	0.06667	0	0	0	0	0	0	0
2003	F	17	17	9	9	0	0	0	0.11111	0.22222	0.22222	0	0	0	0.33333	0.11111	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	F	18	18	9	9	0	0	0	0	0.11111	0.11111	0.22222	0	0.11111	0	0	0.11111	0	0.11111	0	0	0.11111	0.11111	0	0	0	0	0	0	0
2004	F	9	9	1	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
2004	F	11	11	6	6	0	0.50000	0.33333	0	0.16667	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	F	12	12	10	10	0	0.40000	0	0.30000	0.20000	0	0.10000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	F	13	13	21	21	0	0.23810	0.28571	0.19048	0.19048	0.04762	0.04762	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	F	14	14	26	26	0	0.03846	0.19231	0.34615	0.19231	0.11538	0.03846	0	0.03846	0	0	0	0.03846	0	0	0	0	0	0	0	0	0	0	0	0
2004	F	15	15	19	19	0	0	0.10526	0.31579	0.36842	0.21053	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	F	16	16	21	21	0	0	0.14286	0.23810	0.33333	0.19048	0	0.04762	0.04762	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	F	17	17	18	18	0	0	0.05556	0.11111	0.27778	0	0	0.11111	0.22222	0.11111	0	0.05556	0	0	0	0	0	0.05556	0	0	0	0	0	0	0
2004	F	18	18	19	19	0	0	0	0.10526	0.15789	0.05263	0	0.05263	0.26316	0.10526	0.05263	0	0.10526	0	0.05263	0.05263	0	0	0	0	0	0	0	0	0
2004	F	19	19	5	5	0	0	0	0	0	0	0	0.20000	0	0	0.20000	0	0	0	0	0.20000	0	0	0.20000	0	0	0	0	0	0.20000
2004	F	20	20	1	1	0	0	0	0	0	0	0	0	0	0	1.00000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	M	10	10	1	1	0	0	0	1.00000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	M	14	14	5	5	0	0	0	0.40000	0	0.20000	0.20000	0.20000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	M	15	15	4	4	0	0	0	0	0	0.25000	0.25000	0	0	0	0.25000	0	0.25000	0	0	0	0	0	0	0	0	0	0	0	0
2003	M	16	16	2	2	0	0	0	0	0.50000	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50000	0	0	0	0	0	0
2003	M	17	17	1	1	0	0	0	0	0	0	0	0	0	1.00000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	M	5	5	1	1	0	1.00000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	M	8	8	1	1	0	1.00000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	M	10	10	4	4	0	0.75000	0	0	0	0.25000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	M	11	11	5	5	0	0.20000	0.20000	0.20000	0	0.20000	0.20000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	M	12	12	8	8	0	0.37500	0.37500	0.12500	0	0	0	0.12500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	M	13	13	15	15	0	0.13333	0.26667	0.33333	0.26667	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	M	14	14	26	26	0	0	0.15385	0.23077	0.26923	0.15385	0.03846	0	0	0	0.07692	0.03846	0	0.03846	0	0	0	0	0	0	0	0	0	0	0
2004	M	15	15	35	35	0	0	0.17143	0.08571	0.28571	0.14286	0.11429	0.02857	0.02857	0.02857	0.05714	0	0	0.02857	0	0	0	0	0	0	0	0.02857	0	0	0
2004	M	16	16	36	36	0	0	0	0.08333	0.16667	0.11111	0.02778	0.11111	0.08333	0.08333	0.02778	0.11111	0	0.02778	0	0.02778	0.02778	0.05556	0.02778	0.02778	0	0	0	0	0
2004	M	17	17	25	25	0	0	0	0.04000	0.12000	0.08000	0.12000	0.08000	0.04000	0.08000	0.08000	0.08000	0.08000	0.04000	0.04000	0	0	0	0.04000	0.04000	0	0.04000	0	0	0
2004	M	18	18	13	13	0	0	0	0	0	0	0.07692	0.07692	0.15385	0.15385	0.07692	0.00000	0.23077	0.23077	0	0	0	0	0	0	0	0	0	0	0

Table 9. Annual mean body weights of kelp greenling by substock and fleet.

A) OREGON

Fleet	Year	Mean weight (kg)	CV
Man-Made	1980	0.27	0.56
	1981	0.29	0.50
	1982	0.27	0.52
	1983	0.31	0.65
	1984	0.25	0.58
	1985	0.24	0.56
	1986	0.23	0.70
	1987	0.32	0.69
	1988	0.30	0.60
	1989	0.30	0.43
Beach/Bank	1980	0.35	0.65
	1981	0.31	0.54
	1982	0.30	0.55
	1983	0.27	0.61
	1984	0.25	0.69
	1985	0.29	0.52
	1986	0.39	0.64
	1987	0.35	0.46
	1988	0.30	0.94
	1989	0.36	0.58
CPFV	1980	0.70	0.26
	1981	0.69	0.25
	1982	0.75	0.30
	1983	0.59	0.33
	1984	0.58	0.26
	1985	0.50	0.45
	1986	0.63	0.33
	1987	0.61	0.30
	1988	0.62	0.30
	1989	0.62	0.28
PBR	1980	0.50	0.52
	1981	0.50	0.46
	1982	0.56	0.44
	1983	0.50	0.30
	1984	0.41	0.57
	1985	0.38	0.50
	1986	0.33	0.59
	1987	0.36	0.53
	1988	0.44	0.50
	1989	0.39	0.57

B) CALIFORNIA

Fleet	Year	Mean weight (kg)	CV
Combined Shore	1980	0.31	0.64
	1981	0.32	0.61
	1982	0.40	0.52
	1983	0.42	0.52
	1984	0.34	0.54
	1985	0.32	0.69
	1986	0.33	0.57
	1987	0.31	0.62
	1988	0.37	0.61
	1989	0.39	0.52
CPFV	1980	0.68	0.48
	1981	0.60	0.37
	1982	0.56	0.08
	1983	0.56	0.15
	1985	0.48	0.48
	1986	0.81	0.46
	1987	0.52	0.34
	1988	0.44	0.33
	1989	0.58	0.22
	1997	0.44	0.31
	1998	0.49	0.24
PBR	1980	0.60	0.43
	1981	0.64	0.37
	1982	0.61	0.26
	1983	0.56	0.45
	1984	0.56	0.30
	1985	0.46	0.44
	1986	0.52	0.40
	1987	0.55	0.32
	1988	0.53	0.41
	1989	0.54	0.32

Table 10. Temporal coverage for CPUE from northern California shore modes (Values are the number of modes for which CPUE values are available.)

	WAVE						
YEAR	1	2	3	4	5	6	Total
1980	2	2	2	2	2	2	12
1981	2	2	2	2	2	2	12
1982	2	2	2	2	2	2	12
1983	2	2	2	2	1	2	11
1984	2	2	2	2	2	2	12
1985	2	2	2	2	2	2	12
1986		2	2	2	2	2	10
1987	2	2	2	2	2	1	11
1988	2	2	2	2	2		10
1989		2	2	2	2	2	10
1993	2	2	2	2	2	2	12
1994		2	2	2	2		8
1995		2	2	2	2	2	10
1996	2	2	2	2	1	2	11
1997	1	2	2	2	2	1	10
1998		2	2	2	2		8
1999	1	2	2	2	2	1	10
2000	2	2	1	1	2	2	10
2001	1	2	2	1	2		8
2002	2	2	2	2	2	2	12
2003	2	2					4
Total	29	42	39	38	38	29	215

Table 11. Analysis of deviance for the lognormal GLM model for the northern California combined shore mode CPUE.

	Df	Deviance Resid.	Df	Resid. Dev	F	Pr(>F)
NULL	214	213.261				
YEAR	20	80.309	194	132.951	10.481	<2.20E-16
WAVE	5	14.893	189	118.058	7.775	1.14E-06
MODE	1	46.034	188	72.024	120.158	<2.20E-16

Table 12. Wave effects from independent GLM analyses of Oregon RecFIN CPUE.

WAVE	Man-made	Shore-based	CPFV	PBR
1	0.08	0.061	0.029	0.194
2	0.039	0.042	0.044	0.144
3	0.019	0.026	0.042	0.071
4	0.047	0.025	0.091	0.068
5	0.033	0.023	0.031	0.084
6	0.095	0.033	0.025	0.117

Table 13. Temporal coverage for the RecFIN CPUE data from the Oregon partyboats. (A zero value indicates estimated CPUE = 0, a blank indicates no estimate available.)

	WAVE							
YEAR	1	2	3	4	5	6	POS	OBS
1980	1	1			1	1	4	4
1981	0	1			1	1	3	4
1982	0	1	1		1	1	4	5
1983	0	1	1			0	2	4
1984	0	1	1		1	1	4	5
1985	1	1	1		1	1	5	5
1986	1	1	1		1	0	4	5
1987	1	1	1		1	1	5	5
1988	1	1	1		1	1	5	5
1989	1	1	1		1	1	5	5
1993	1	1	1		1	1	5	5
1994		1	1		1		3	3
1995		1	1		1	0	3	4
1996	1	1	1		1	0	4	5
1997	1	1	1	1	1	1	6	6
1998	1	1	1	1	1	0	5	6
1999	1	1	1	1	1	1	6	6
2000	1	1	1	1	1	1	6	6
2001	1	1	1	1	1	1	6	6
2002	1	1	1	1	1	1	6	6
2003	1	1					2	2
Total	15	21	18	6	19	14	93	102

Table 14. Analysis of deviance for the delta-lognormal GLM model of RecFIN-monitored Oregon partyboat CPUE.

Lognormal GLM of positive records							Binomial model of presence/absence						
	Df	Deviance Resid.	Df	Resid. Dev	F	Pr(>F)		Df	Deviance Resid.	Df	Resid. Dev	P(>|Chi|)	Joint Probability
NULL	92	63.121					NULL	101	60.881				
YEAR	20	43.776	72	19.345	9.3996	1.28E-12	YEAR	20	20.916	81	39.965	0.402	5.13E-13
WAVE	5	3.743	67	15.602	3.2147	0.01162	WAVE	5	23.33	76	16.636	0.00029	3.39E-06

Table 15. Temporal coverage for RecFIN CPUE from the Oregon private boats. (A zero value indicates estimated CPUE = 0, a blank indicates no estimate available.)

	WAVE							
YEAR	1	2	3	4	5	6	POS	OBS
1980		1			0	1	2	3
1981		0		0	1	1	2	4
1982		1	1		1	1	4	4
1983	0	1	1				2	3
1984		1	1		1		3	3
1985	1	1	1		1	1	5	5
1986		1	1		1	0	3	4
1987	1	1	1		1	0	4	5
1988	1	1	1		1	1	5	5
1989	1	0	1		1		3	4
1993	1	1	1		1	1	5	5
1994		1	1		1		3	4
1995		1	1		1	0	3	4
1996	1	1	1		1	1	5	5
1997	1	1	1	1	1	0	5	6
1998		1	1	1	1	0	4	5
1999	1	1	1	1	1	1	6	6
2000	1	1	1	1	1	1	6	6
2001	0	1	1	1	1	1	5	6
2002	1	1	1	1	1	1	6	6
2003	1	1					2	2
Total	11	19	18	6	18	11	83	95

Table 16. Analysis of deviance for the delta-lognormal GLM model of RecFIN-monitored Oregon private boat CPUE.

	Lognormal GLM of positive records							Binomial model of presence/absence					
	Df	Deviance Resid.	Df	Resid. Dev	F	Pr(>F)		Df	Deviance Resid.	Df	Resid. Dev	P(>|Chi|)	Joint Probability
NULL	82	55.491					NULL	93	67.858				
YEAR	20	25.513	62	29.978	3.4205	0.00014	YEAR	20	20.357	73	47.501	0.436	0.000061
WAVE	5	8.719	57	21.258	4.6758	0.0012	WAVE	5	11.957	68	35.544	0.035	0.000042

Table 17. Temporal coverage for the RecFIN CPUE from the Oregon beach mode.

	WAVE						
YEAR	1	2	3	4	5	6	Total
1980	1	1	1	1	1		5
1981	1	1	1	1	1	1	6
1982		1	1	1	1	1	5
1983		1	1	1		1	4
1984	1	1	1	1	1	1	6
1985	1	1	1	1	1	1	6
1986		1	1	1	1	1	5
1987	1	1		1			3
1988			1	1			2
1989				1			1
1993			1	1	1	1	4
1994		1	1	1	1		4
1995		1		1	1	1	4
1996		1	1	1			3
1997		1	1	1	1		4
1998			1				1
1999	1	1		1			3
2000	1	1		1			3
2001	1	1			1		3
2002	1	1	1		1	1	5
2003	1	1	1		1		4
Total	10	17	15	17	13	9	81

Table 18. Analysis of deviance for thelognormal GLM model of RecFIN-monitored Oregon beach mode CPUE.

	Df	Deviance Resid.	Df	Resid. Dev	F	Pr(>F)
NULL	78	63.601				
YEAR	18	52.446	60	11.155	19.8566	<2.20E-16
WAVE	5	3.085	55	8.07	4.2046	0.002625

Table 19. Temporal coverage for the RecFIN CPUE from the Oregon pier mode.

	WAVE						
YEAR	1	2	3	4	5	6	Total
1980	1		1	1	1		4
1981	1	1	1	1	1	1	6
1982	1	1	1	1	1	1	6
1983	1	1	1	1			4
1984	1	1	1	1	1		5
1985	1	1	1	1	1	1	6
1986		1	1	1			3
1987	1	1	1	1	1		5
1988	1		1	1	1		4
1989		1		1			2
1993	1	1	1	1	1	1	6
1994		1	1	1	1		4
1995		1	1	1	1	1	5
1996		1	1	1			3
1997	1	1	1	1	1		5
1998			1	1			2
1999		1	1	1	1		4
2000	1	1			1	1	4
2001		1	1	1			3
2002		1	1	1	1		4
2003	1	1	1	1	1		5
Total	12	18	19	20	15	6	90

Table 20. Analysis of deviance for the lognormal GLM model of RecFIN-monitored Oregon pier mode CPUE.

	Df	Deviance Resid.	Df	Resid. Dev	F	Pr(>F)
NULL	89	61.392				
YEAR	20	40.238	69	21.154	10.0505	5.71E-13
WAVE	5	8.342	64	12.811	8.3349	4.11E-06

Table 21. Analysis of deviance for the delta-GLM model of CDFG-monitored CPFV CPUE.

	Lognormal GLM of positive records							Binomial model of presence/absence					
	Df	Deviance Resid.	Df	Resid. Dev	F	Pr(>F)		Df	Deviance Resid.	Df	Resid. Dev	P(>|Chi|)	Joint Probability
NULL	98	93.794					NULL	290	373.16				
YEAR	11	26.287	87	67.508	4.327	0.000048	YEAR	11	15.04	279	358.12	0.18	0.000009
MONTH	3	6.691	84	60.817	4.0384	0.010020	MONTH	3	8.34	276	349.78	0.04	0.000401
region	3	3.706	81	57.111	2.2371	0.090390	region	3	1.73	273	348.04	0.63	0.056900
DepBIN	2	13.481	79	43.629	12.2053	0.000024	DepBIN	2	43.8	271	304.24	3.08E-10	7.41E-15

Table 22. Estimated values of the effects in the delta-lognormal GLM model of CDFG-monitored CPFV CPUE.

Season		Region		Depth	
fall	0.048	Pt. Buchon	0.037	deep	0.013
spring	0.104	Ano Nuevo	0.039	mid	0.048
summer	0.041	Farallones	0.049	shallow	0.127
winter	0.023	Ft. Ross	0.068		

Table 23 Sample sizes for the delta-lognormal GLM model of CDFG-monitored partyboat CPUE.

	Region				
YEAR	Pt. Buchon	Ano Nuevo	Farallones	Ft. Ross	Total
1987		2			2
1988	8	15	10	3	36
1989	10	23	14	1	48
1990	2	9	8		19
1991	5	3	2	2	12
1992	7	14	4	11	36
1993	8	16	5	3	32
1994	1	19	5	2	27
1995	2	15	9		26
1996	9	8	6	5	28
1997	3	5	4	3	15
1998	5	8	3		16
Total	60	137	70	30	297

Table 24 Summary of the abundance indices considered in the assessment.

	OREGON								CALIFORNIA			
	Man-Made		Beach/Bank		CPFV		PBR		Shore		CPFV	
Year	Index	CV	Index	CV	Index	CV	Index	CV	Index	CV	Index	CV
1980									0.0094769	0.50743		
1981	0.02453	0.86186	0.03311	0.36072	0.10858	0.59666	0.08138	0.31447	0.0043782	0.49491		
1982	0.01654	1.59603	0.03672	0.34784	0.04073	0.32752	0.11777	0.54613	0.0040698	0.82839		
1983	0.05122	0.61647	0.01755	1.43075	0.03156	0.17138	0.14567	1.05022	0.0058507	0.48887		
1984	0.01128	0.50096	0.01582	0.33582	0.03663	0.55115	0.08612	0.59014	0.0017677	0.94776		
1985	0.07682	0.30522	0.05454	0.44457	0.03179	0.63555	0.06727	0.47379	0.0068945	0.26662		
1986	0.10738	0.60916	0.04883	2.18693	0.07022	0.22457	0.07397	0.47702	0.012448	0.20722		
1987	0.09229	0.36581	0.06208	0.60677	0.01757	0.71394	0.08036	0.73626	0.0048255	2.33999	0.06697	1.22044
1988	0.1067	0.47973	0.03577	3.51986	0.08	0.33927	0.13487	0.76245	0.001605	2.01748	0.00751	0.48046
1989	0.01835	1.30771			0.01878	3.36849	0.13745	0.67766	0.0021923	1.01778	0.02283	0.40578
1990											0.03524	0.53324
1991											0.01972	0.44664
1992											0.01446	0.48251
1993	0.06111	0.94331	0.09952	0.52365	0.07856	0.25892	0.27938	0.20474	0.0030156	1.74343	0.03271	0.45922
1994	0.04282	0.84941	0.04384	0.31564	0.05267	0.45293	0.1346	0.35529	0.0075992	0.17822	0.01816	0.60519
1995	0.07987	0.40277	0.04264	0.56758	0.03958	0.15168	0.09195	0.35807	0.0027871	0.99228	0.08786	0.46596
1996	0.03689	4.18034	0.01848	0.75403	0.03622	0.36654	0.10549	0.37048	0.0056315	0.27003	0.02311	0.5829
1997	0.11372	0.54504	0.03161	0.4735	0.04555	0.73393	0.2386	0.64494	0.0062956	0.34983	0.02037	0.76711
1998	0.03302	2.4886			0.02853	0.58055	0.05367	0.13674	0.0022907	0.50004	0.01139	0.86602
1999	0.01392	0.5245	0.00571	2.01785	0.07532	0.19227	0.09506	0.21916	0.0028004	0.25846		
2000	0.06385	0.62274	0.10944	0.31035	0.06077	0.21571	0.09783	0.33319	0.0027746	0.42681		
2001	0.04682	0.54936	0.01737	0.28819	0.01946	1.65522	0.06058	0.3462	0.0013751	0.9489		
2002	0.02772	1.02202	0.02997	0.36722	0.04197	0.22703	0.08186	0.16079	0.0032437	0.29701		
2003	0.05168	1.03677	0.01678	0.9528	0.0328	4.60706	0.09089	0.77311	0.0021027	3.23046		

Table 25 Input variables and parameters of the Oregon population dynamics model. The base-case values are given for those parameters that are pre-specified. An X indicates that the parameter is estimated. All catch-rate-based indices of abundance are mirrored to their respective fleets and are not included in this table.

Parameter	Pre-specified in Base Case	Estimated in Base Case
Age at minimum length (L_{min})	2	
Age at maximum length (L_{max})	10	
Natural Mortality (M)	0.26 (both sexes)	
Minimum Length (L_{min})		X (both sexes)
Maximum Length (L_{max})		X (both sexes)
Growth rate (k)		X (both sexes)
Length at age 2 CV	0.1	
Length at age 10 CV	0.09	
lnR_0		X
steepness (h)	0.7	
σ_R	1	
Recruitment (years)		(1981-2003)
Selectivities		
Commercial non-live		
parameter 1		X
parameter 2		X
Commericial live		
parameter 1		X
parameter 2	0	
parameter 3		X
parameter 4		X
parameter 5		X
parameter 6		X
parameter 7		X
parameter 8	3	
Recreational Man-made		
parameter 1		X
parameter 2	0	
parameter 3		X
parameter 4		X
parameter 5		X
parameter 6		X
parameter 7	0.5	
parameter 8	4	
Recreational Beach/Bank		
parameter 1		X
parameter 2	0	
parameter 3		X
parameter 4	0.3	
parameter 5		X
parameter 6		X
parameter 7		X
parameter 8	2	
Recreational PBR		
parameter 1		X
parameter 2		X
Recreational CPFV		
parameter 1		X
parameter 2		X

Table 26 Values for the likelihood components and summary statistics related to the current status of the resource for the sensitivity tests that involve changing the data sources included in the assessment (- data source is ignored)

		Trial								
Likelihood Components	Base Case	1	2	3	4	5	6	7	8	9
Abundance Index										
RecFIN Man-Made	19.20	19.34	19.34	19.14	18.65	18.04	19.2093	19.1404	18.1135	19.15
RecFIN Shore	32.73	32.54	32.55	33.55	32.73	31.80	32.714	32.5261	31.7803	31.06
RecFIN CPFV	45.11	45.06	45.30	45.54	45.82	40.63	45.1899	45.2371	40.1103	46.01
RecFIN PBR	52.62	52.61	52.09	52.26	51.07	53.25	52.5062	52.5301	53.5277	49.44
Mean Body Weight	3.77	3.74	3.62	2.48	2.61	3.22	3.04674	3.91639	4.02989	3.37
Length Comps.										
Commerical: Non-live	38.04	-	40.64	38.23	37.77	36.36	38.7106	37.842	36.7426	37.24
Commerical: Live	45.07	46.94	-	46.16	45.17	38.19	45.4187	42.0181	41.1978	37.30
Recreational: Man-Made	57.83	57.92	59.13	-	56.08	57.85	59.1434	57.4318	59.1665	54.26
Recreational: Shore	124.66	124.46	125.61	123.98	-	120.38	125.018	124.211	120.545	126.91
Recreational: CPFV	66.50	65.97	63.42	65.96	65.70	-	67.2786	-	63.94	72.14
Recrational: PBR	98.78	98.14	94.99	95.12	101.24	101.49	99.1328	102.923	98.5051	-
CPFV Age Comps.	202.40	201.53	198.77	202.36	200.49	-	202.985	200.537	-	204.99
Recruitment penalty	11.50	11.55	12.08	11.61	11.88	10.51	11.5662	11.339	10.7535	10.11
Parameter priors	16.30	14.95	15.32	12.33	12.94	12.94	16.217	12.5475	12.9201	13.50
TOTAL LIKELIHOOD	814.51	774.77	762.86	748.71	682.15	524.67	818.14	742.20	591.34	705.48
1979 reproductive output	321 (101)	315 (96)	272 (76)	312 (97)	335 (109)	301 (91)	327 (91)	326 (102)	258 (106)	760 (436)
2005 reproductive output	157 (76)	152 (73)	126 (58)	151 (74)	171 (85)	168 (70)	164 (70)	158 (79)	131 (88)	465 (306)
%Depletion	48.8 (9)%	48.2 (9)%	46.4 (0.09)%	48.2 (10)%	51.0 (10)%	55.7 (8)%	50.0 (8)%	48.3 (10)%	51.0 (14)%	61.2 (6)%

	Trial				
Likelihood Components	10	11	12	13	14
Abundance Index					
RecFIN Man-Made	-	21.39	20.76	18.41	18.69
RecFIN Shore	34.67	-	33.05	33.20	32.77
RecFIN CPFV	46.21	44.54	-	40.05	48.30
RecFIN PBR	51.20	52.81	48.14	-	48.71
Mean Body Weight	3.25	3.02	3.73	4.11	3.24
Length Comps.					
Commerical: Non-live	38.18	37.85	38.00	38.11	38.14
Commerical: Live	45.21	44.87	45.51	44.71	45.01
Recreational: Man-Made	57.90	58.64	58.51	57.50	57.32
Recreational: Shore	124.41	124.81	125.67	123.68	125.14
Recreational: CPFV	66.22	66.16	66.48	66.39	67.33
Recrational: PBR	98.76	97.49	99.36	98.36	100.30
CPFV Age Comps.	200.48	200.81	202.10	204.26	202.83
Recruitment penalty	11.20	11.72	8.36	12.12	12.62
Parameter priors	16.27	16.27	16.28	16.23	16.31
TOTAL LIKELIHOOD	793.97	780.39	765.94	757.13	816.71
1979 reproductive output	336 (99)	366 (125)	311 (88)	246 (109)	546 (371)
2005 reproductive output	161 (73)	186 (94)	125 (60)	107 (89)	368 (604)
%Depletion	47.9 (9)%	50.9 (9)%	40.2 (8)%	43.5 (17)%	64.6 (11)%

Table 27 Results of the sensitivity tests in which the (pre-specified) values for (sex-independent) M and σ_R are varied. The results in bold typeface pertain to the base-case analysis.

M	σ_R	SB_{1979}	SB_{2005}	Depletion	Negative Log Likelihood
0.26	**1**	**321**	**157**	**48.8%**	**814.51**
0.2	1		Does Not Converge		
0.225	0.5	209	90	43.0%	822.42
	1	213	73	34.1%	815.40
	1.5	274	122	44.3%	814.67
0.25	0.5	224	110	49.3%	848.23
	1	274	122	44.3%	814.67
	1.5	224	86	38.1%	848.31
0.275	0.5	484	334	68.9%	816.61
	1	454	253	55.7%	814.26
	1.5	471	248	52.7%	828.36
0.3	0.5	1623	1276	78.6%	817.47
	1	1521	997	65.6%	814.81
	1.5	1221	738	60.5%	828.35
0.325	0.5	818	574	70.2%	825.61
	1	2857	1847	64.6%	817.28
	1.5	3049	1858	60.9%	831.03
0.35	0.5	1519	1107	72.9%	827.44
	1	901	512	56.8%	824.59
	1.5	3885	2278	58.6%	835.97
0.375	0.5	1267	885	69.9%	838.70
	1	4471	2670	59.7%	829.80
	1.5	6869	3899	56.8%	842.84
0.4	0.5	4719	3364	71.3%	846.52
	1	7500	4339	57.9%	838.95
	1.5	1319	694	52.6%	857.51

Table 28 Results of the sensitivity tests in which changes are made to: a) the years for which recruitment residuals are estimated, b) the specifications for length-specific selectivity, c) the coefficients of variation assumed for the abundance indices and the effective sample sizes assumed for the length-composition data, d) the historical catches, and e) the coefficients of variation assumed for length-at-age.

	SB_{1979}	SB_{2005}	Depletion	NLL
Base Case	321	157	48.8%	814.51
Recruitment Year				
start:1990	246	107	43.49%	818.14
end: 2002	606	397	65.49%	845.82
end: 2004	366	186	50.88%	780.39
Logisitic Selectivity				
all fleets	108	31	28.62%	889.36
fleets 3 & 4	111	29	25.99%	904.55
2004 Size Limits	302	142	47.09%	810.96
Original CV/N_{eff}	319	146	45.67%	327.40
Catch history				
Halved	254	134	52.72%	815.19
Double	285	107	37.66%	815.59
Length at age CV (both sexes)				
0.05	336	150	44.60%	939.04
0.15	83	33	39.18%	884.52

Table 29. Projections (2006–16) of harvest levels, age 2+ biomass, spawning biomass and depletion for Oregon under the 40-10 control rule with an F_{MSY} proxy of $F_{45\%}$.

	40-10/$F_{45\%}$				
Year	OY	ABC	SB_{2+}	SB	Depletion
2005	29	69	569	150	48%
2006	29	60	527	141	45%
2007	63	55	509	126	41%
2008	60	57	506	107	34%
2009	61	61	532	98	31%
2010	64	65	563	98	31%
2011	68	68	586	103	33%
2012	71	70	601	108	35%
2013	73	71	610	112	36%
2014	75	72	616	114	37%
2015	76	74	622	115	37%
2016	76	75	627	116	37%

Table 30. Decision analyses of different states of nature under different catch histories for Oregon under the 40-10 control rule with an FMSY proxy of $F_{45\%}$. p denotes the probability associated with each state of nature. The shaded areas indicate when depletion is less than 0.25.

			State of Nature					
			Low R_0 p = 0.25		Base Case R_0 p = 0.50		High R_0 p = 0.25	
	Year	OY	Spawning Biomass	Depletion	Spawning Biomass	Depletion	Spawning Biomass	Depletion
	2005	29	72	35%	156	49%	244	56%
	2006	29	65	31%	147	46%	233	53%
	2007	26	55	27%	133	41%	213	49%
	2008	26	50	24%	122	38%	197	45%
	2009	29	50	24%	120	37%	191	44%
Catch based on	2010	34	54	26%	126	39%	199	46%
Low R_0 model	2011	38	60	29%	138	43%	216	49%
	2012	41	65	31%	150	47%	234	53%
	2013	44	68	33%	160	50%	249	57%
	2014	45	70	34%	168	52%	262	60%
	2015	47	72	35%	174	54%	272	62%
	2016	48	73	36%	179	56%	280	64%
	2005	29	72	35%	156	49%	244	56%
	2006	29	65	31%	147	46%	233	53%
	2007	63	55	27%	133	41%	213	49%
	2008	60	41	20%	113	35%	187	43%
	2009	61	34	17%	104	32%	175	40%
Catch based on	2010	64	32	16%	104	32%	176	40%
Base Case R_0	2011	68	32	15%	109	34%	186	43%
	2012	71	30	15%	115	36%	198	45%
	2013	73	27	13%	119	37%	208	48%
	2014	75	23	11%	122	38%	216	49%
	2015	76	18	9%	124	38%	222	51%
	2016	76	14	7%	125	39%	227	52%
	2005	29	72	35%	156	49%	244	56%
	2006	29	65	31%	147	46%	233	53%
	2007	100	55	27%	133	41%	213	49%
	2008	98	32	16%	104	32%	178	41%
	2009	97	19	9%	86	27%	157	36%
Catch based on	2010	99	11	5%	79	25%	151	35%
High R_0 Catch	2011	103	5	3%	78	24%	154	35%
	2012	106	0	0%	77	24%	159	36%
	2013	107	0	0%	74	23%	163	37%
	2014	108	0	0%	71	22%	165	38%
	2015	109	0	0%	66	21%	166	38%
	2016	109	0	0%	62	19%	166	38%

Figure 1. A map of the assessment area showing state and INPFC boundaries.

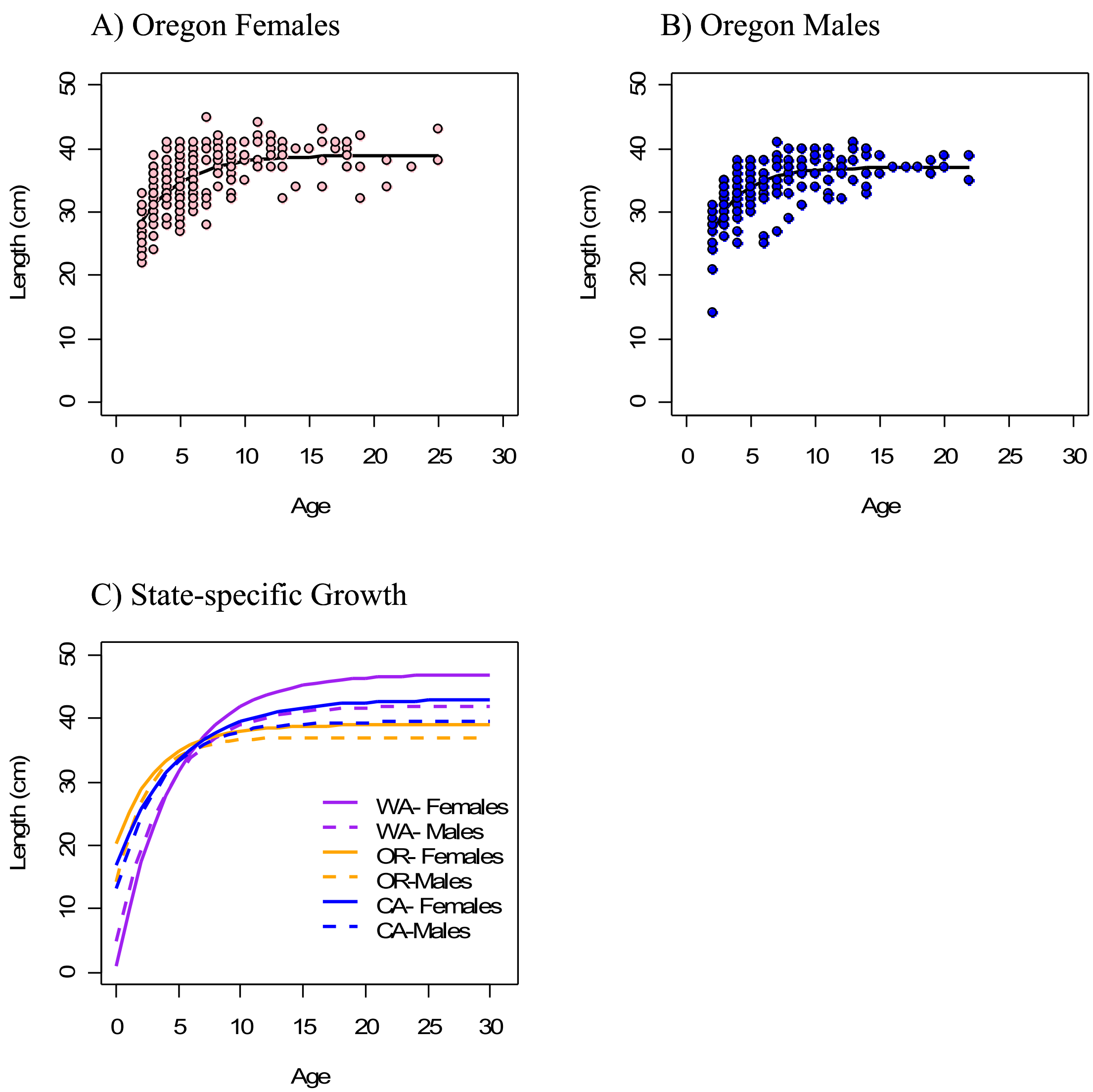


Figure 2. Estimated growth curves for kelp greenling: A) Oregon females, B) Oregon males, and C) each state by sex. The solid lines in (A) and (B) are the expected growth curves and the solid circles are the observed age and length values.

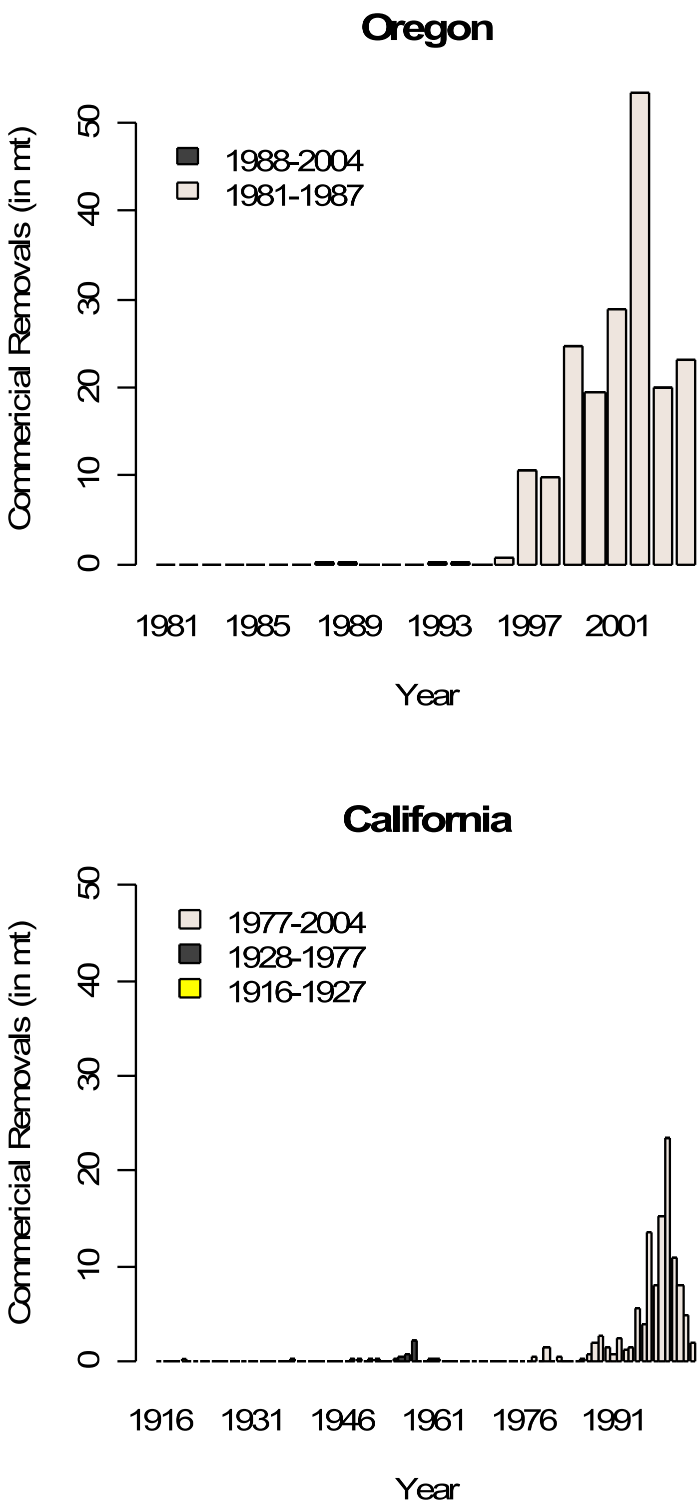


Figure 3. Reconstructed catch history (in mt) of kelp greenling in Oregon and California.

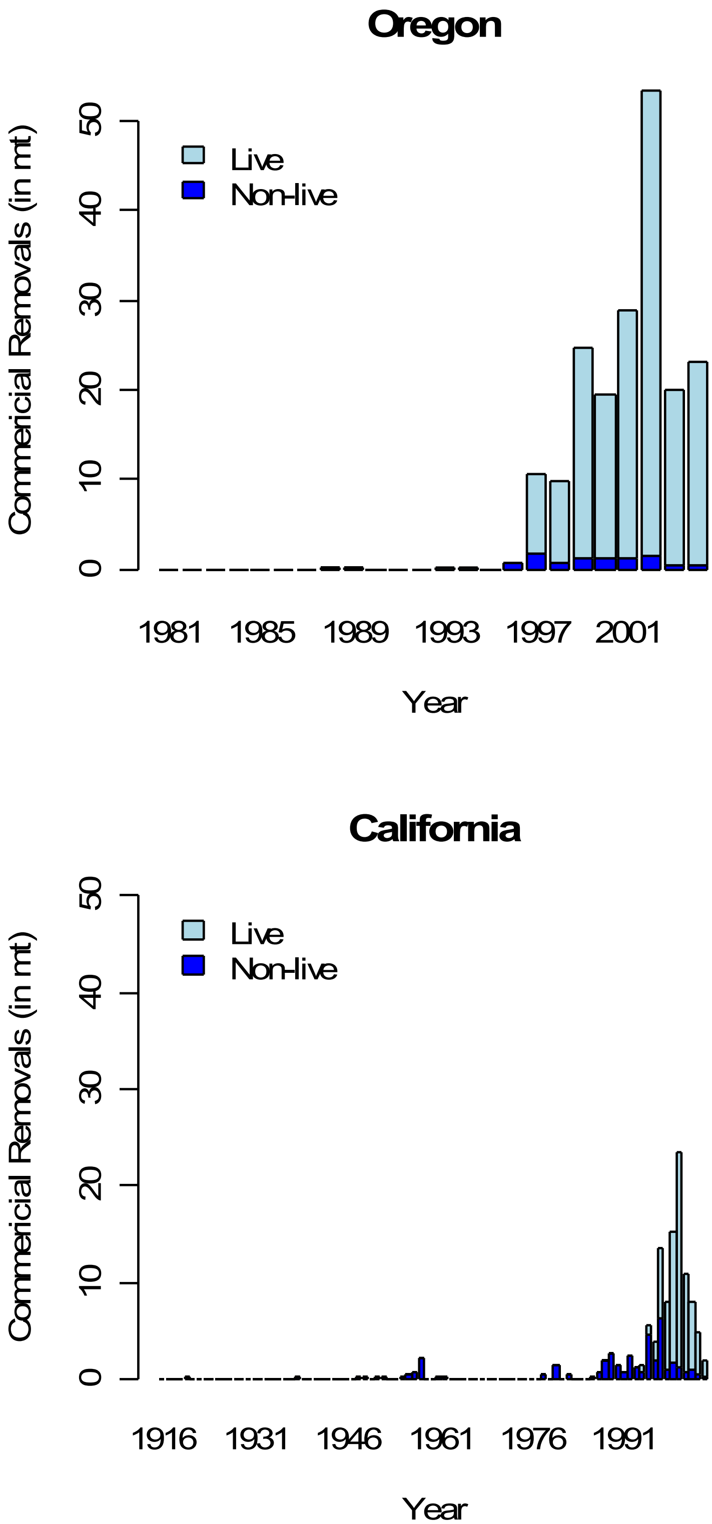


Figure 4. Commercial landings of kelp greenling (in mt) by fleet.

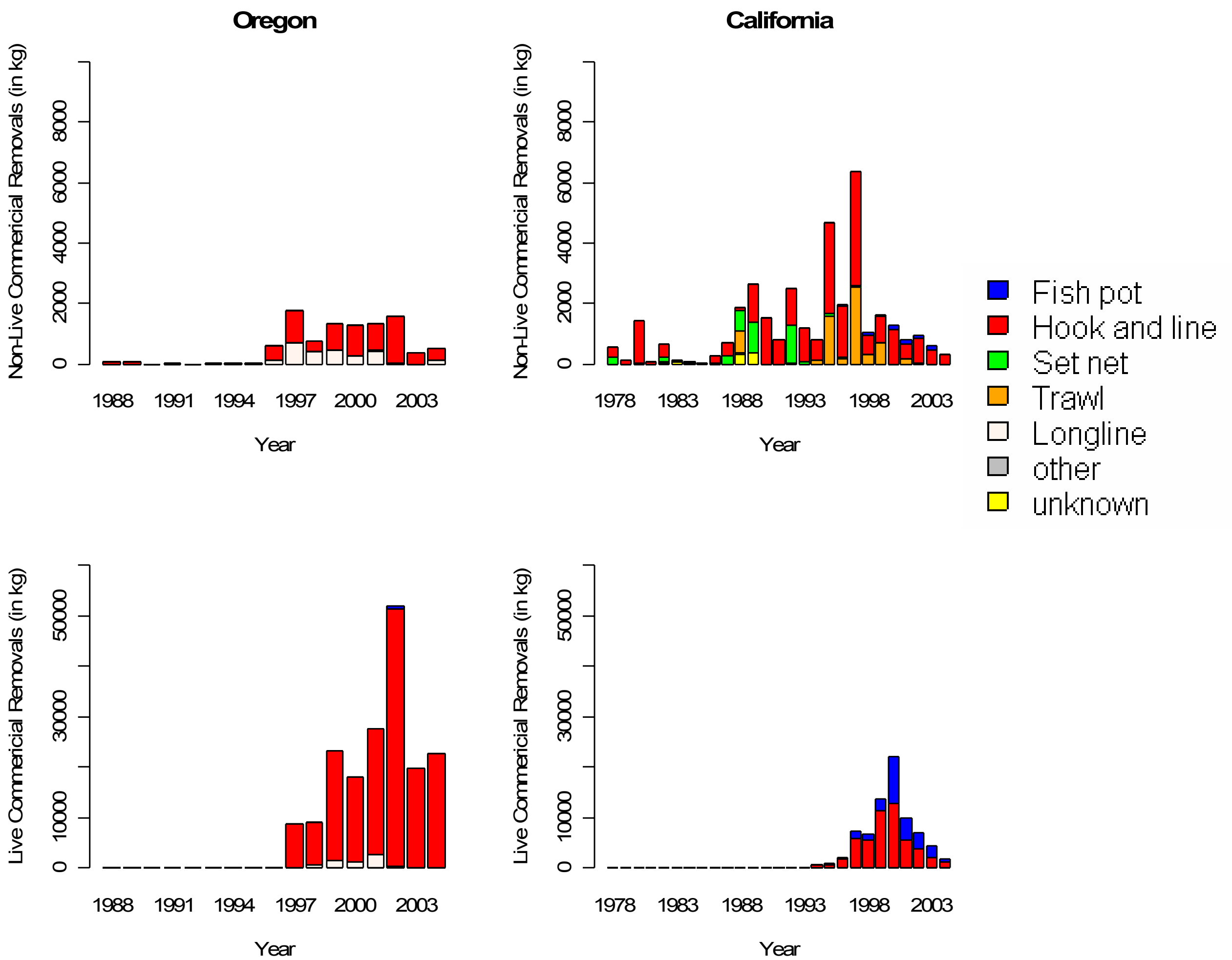


Figure 5. Commercial landings of kelp greenling by substock, fleet, and gear type. Top row: Non-live fishery. Bottom row: Live fish fishery. Fish pots include crab pots in the Oregon fishery.

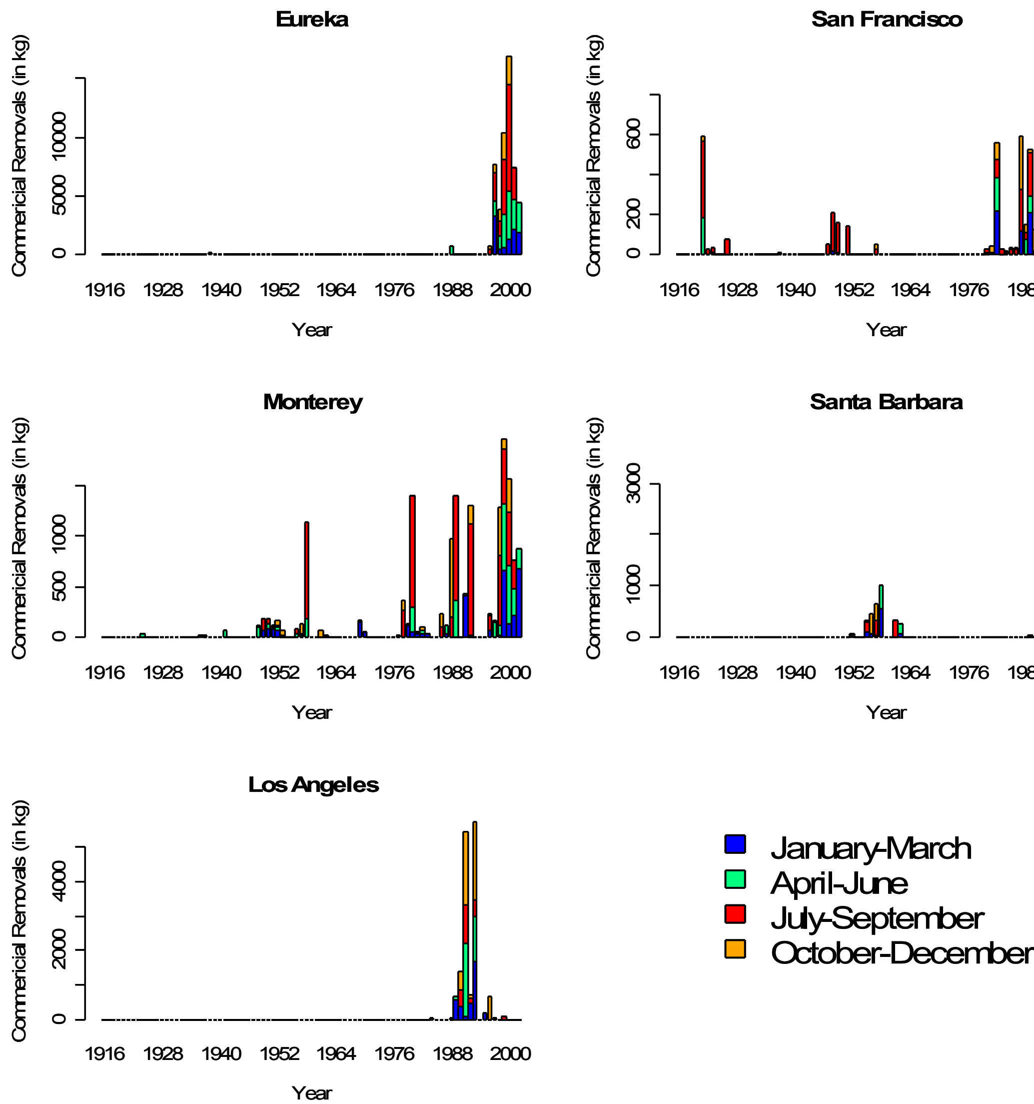


Figure 6. Commercial kelp greenling landings for California by three-month period and port complex. JFM: January, February, March; AMJ: April, May, June; JAS: July, August, September; OND: October, November, December.

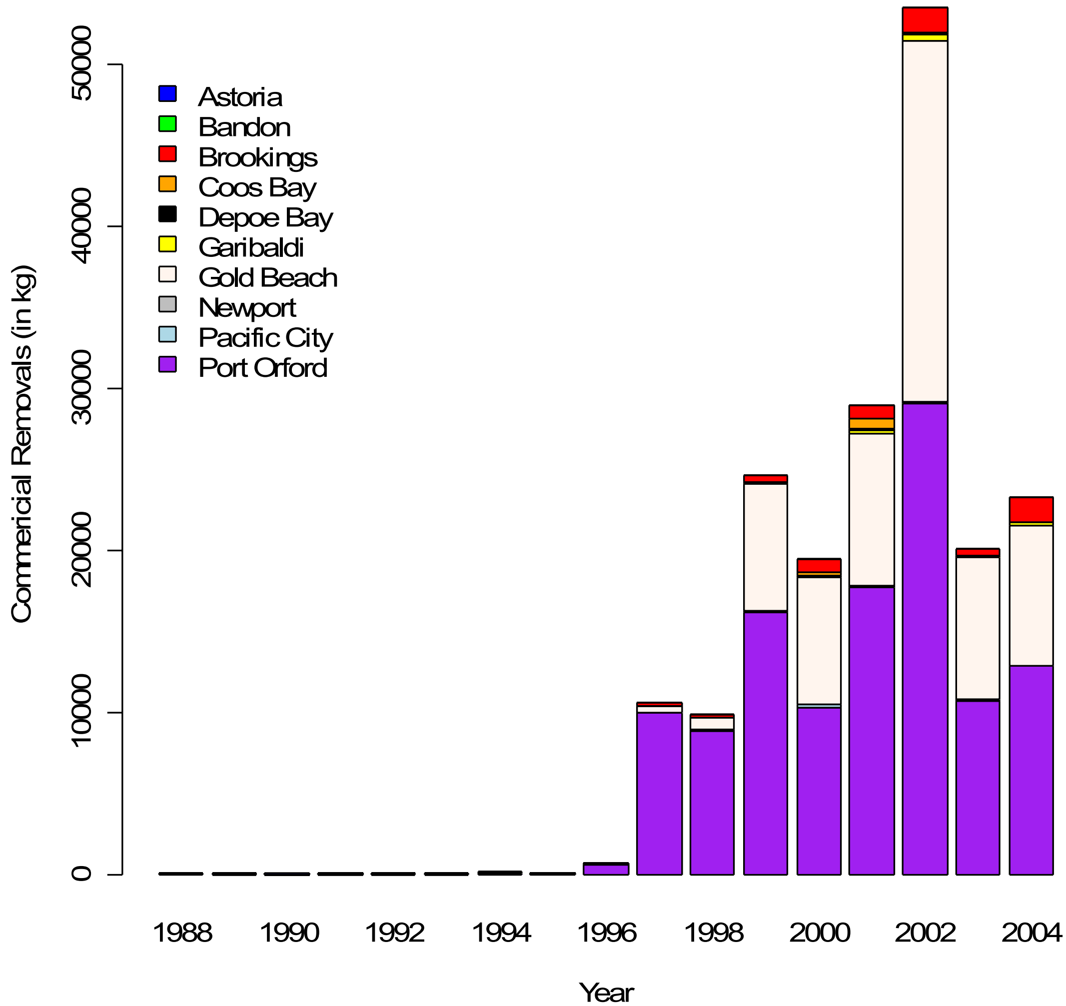


Figure 7. Commercial kelp greenling landings in Oregon by port.

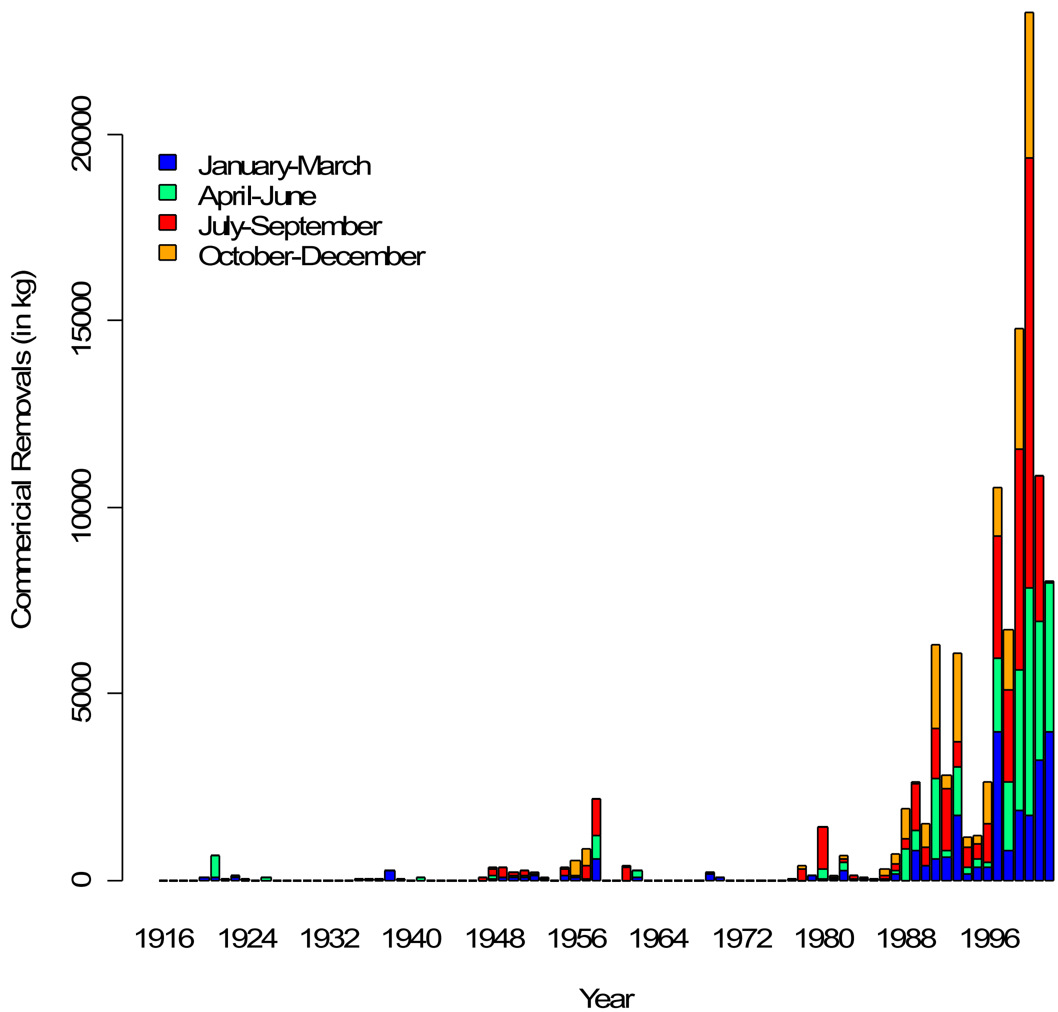


Figure 8. Commercial kelp greenling landings for California by three month period (1916-2002).

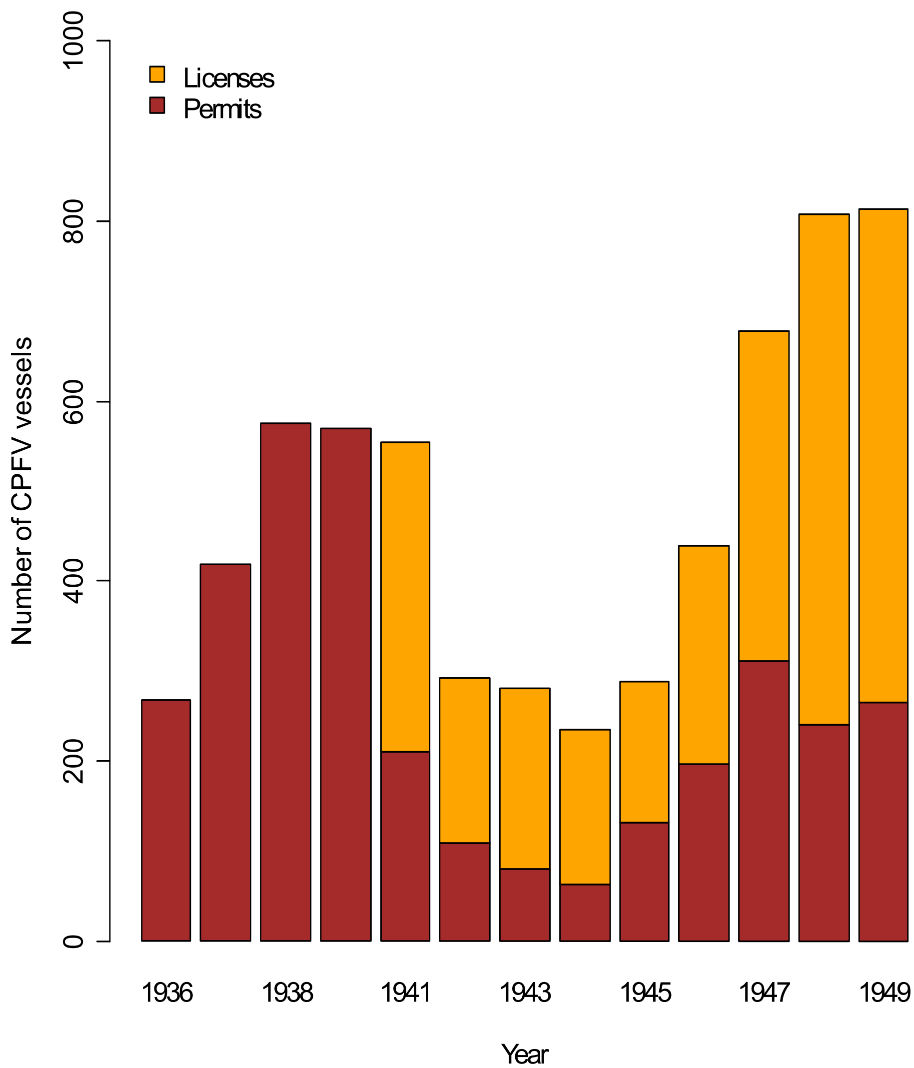


Figure 9. Registered Commercial Passenger Fishing Vessels (CPFVs) in California 1936–49 (*source*: Fishery Bulletins 57, 59, 63, 67, 74, 80).

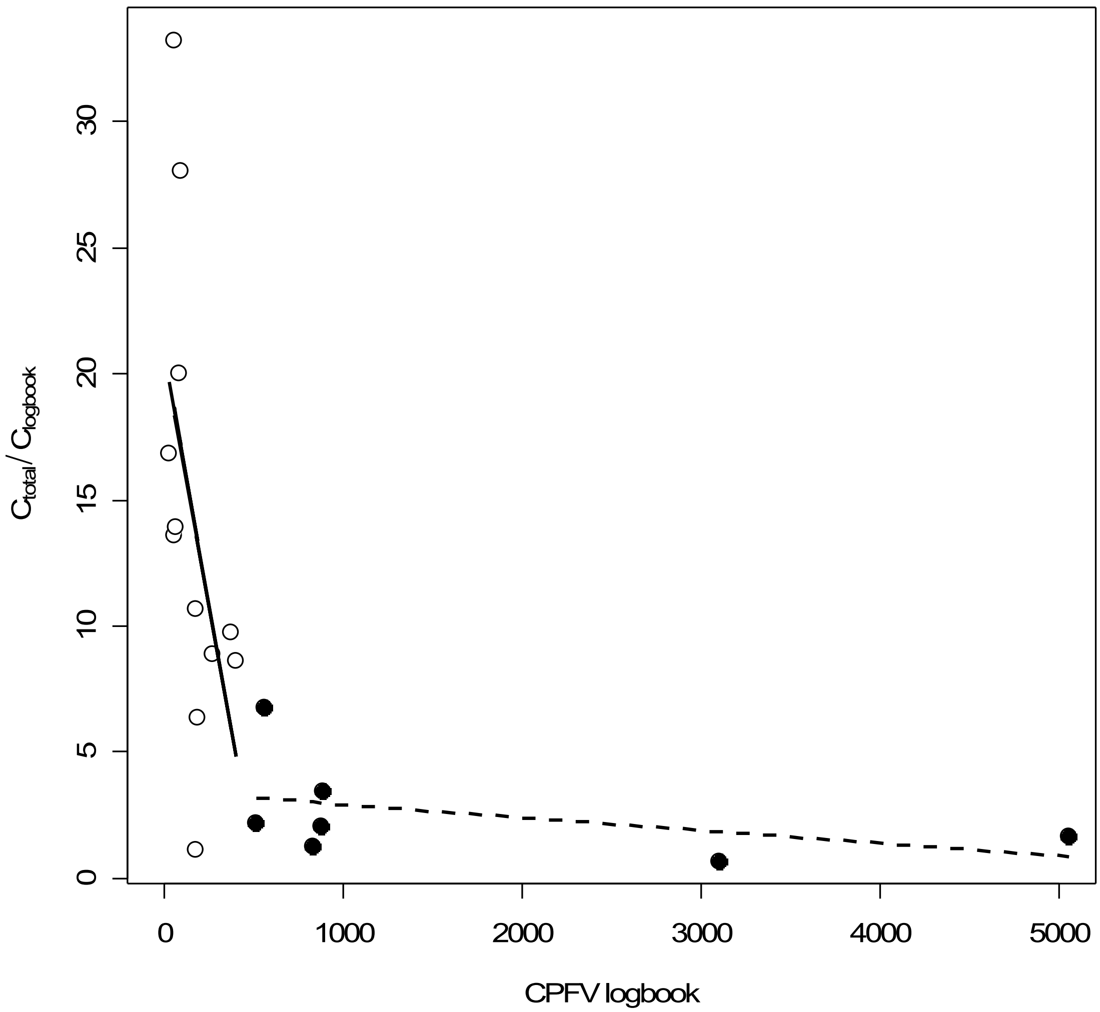
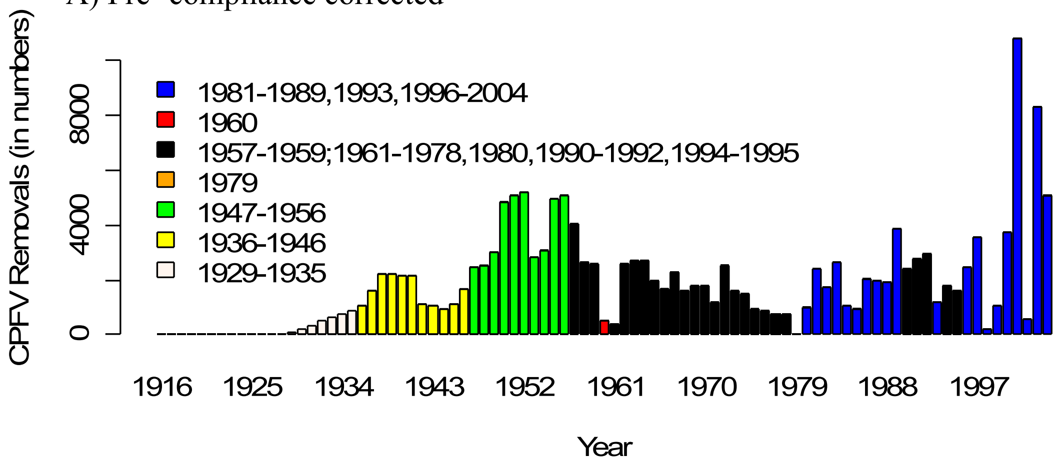


Figure 10. Linear relationships used to expand the under-reported kelp greenling removals from the Californian CPFV logbook records. Open circles and solid line: Reported catch <500 fish. Solid circles and broken line: Reported catch >500 fish.

A) Pre- compliance corrected



B) Compliance corrected

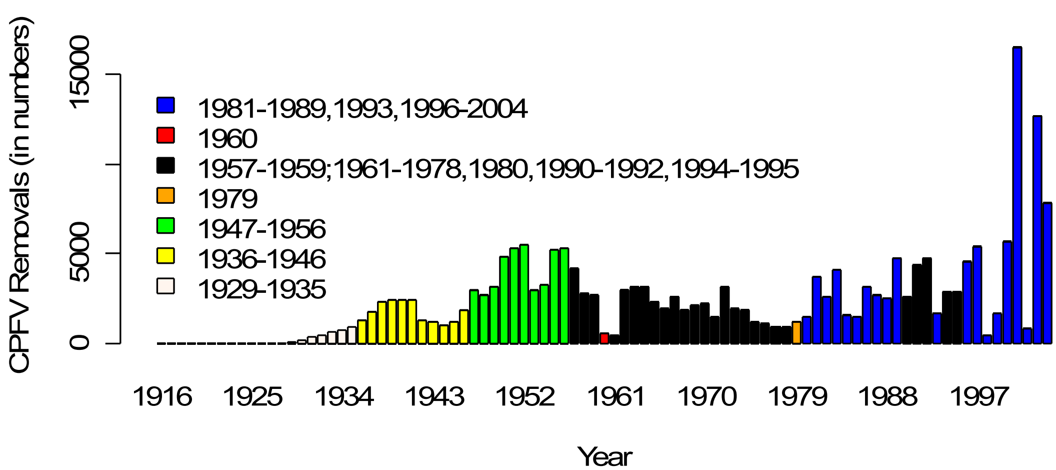
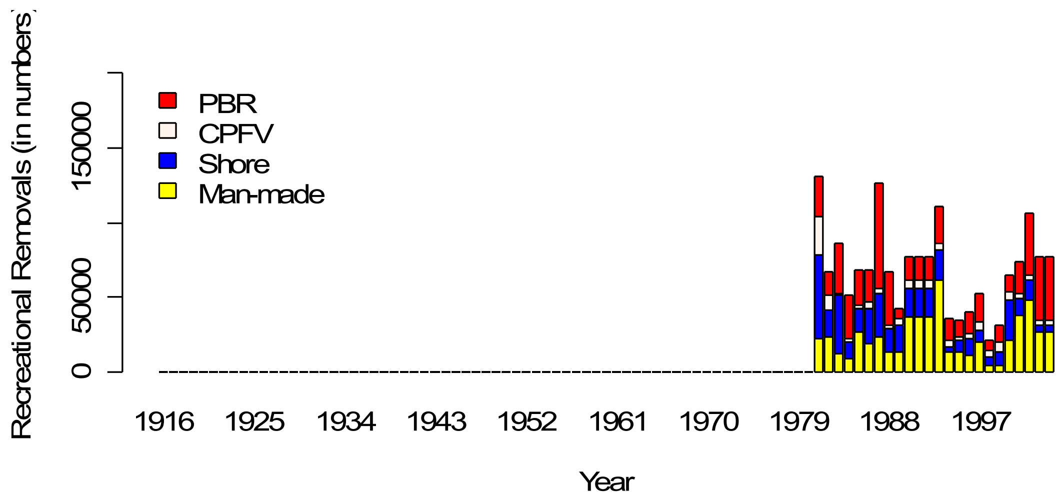


Figure 11. A) Pre-compliance-corrected recreational removals and B) compliance-corrected recreational removals by the California CPFV mode (1916–2004). Each color represents a different data source used when quantifying removals (see text for details).

A) Oregon



B) California

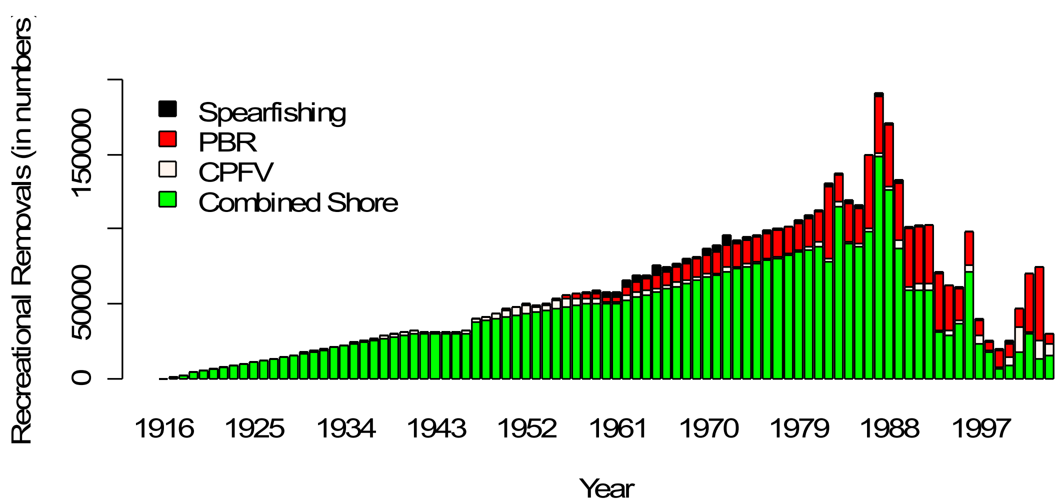


Figure 12. Total mode-specific recreational removals for A) Oregon and B) California.

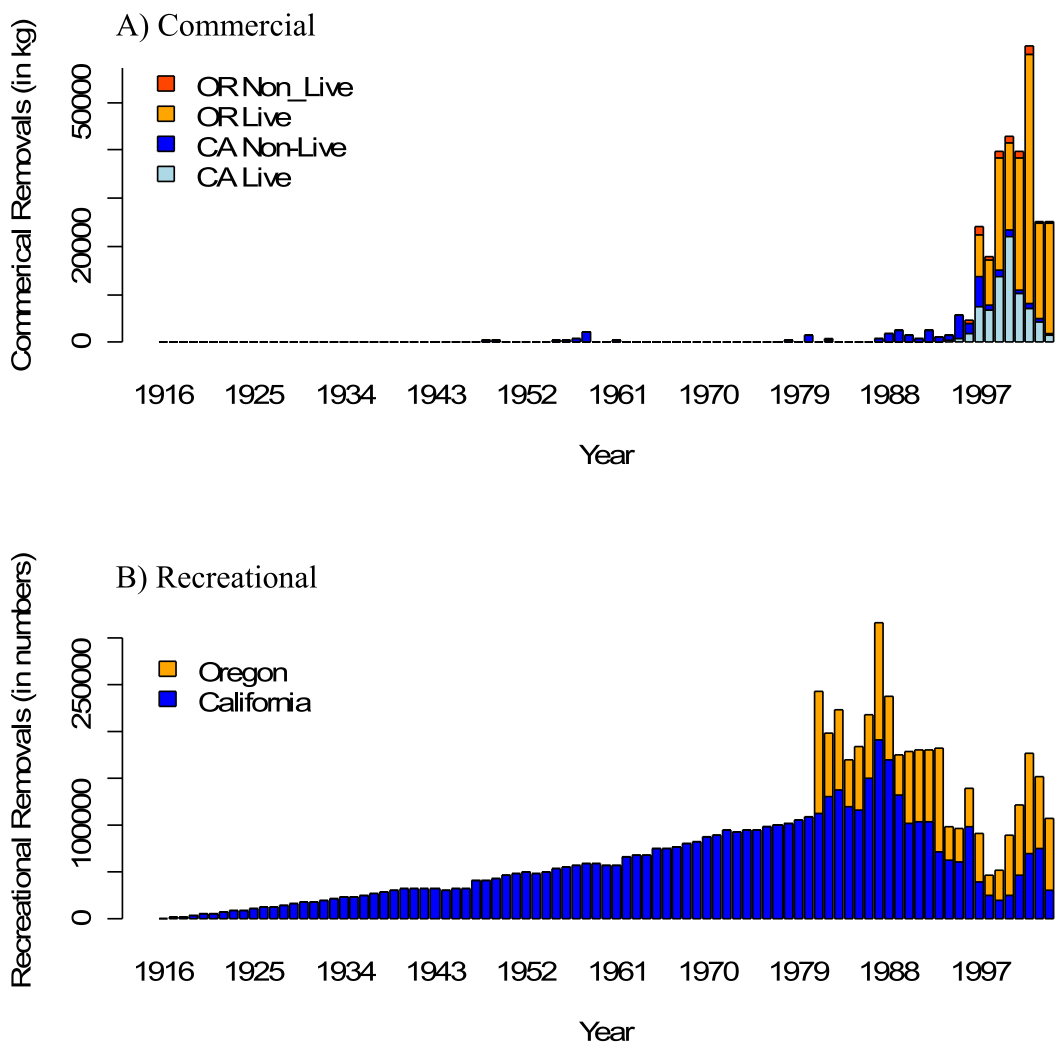


Figure 13. Total removals by the A) commercial and B) recreational fisheries for each substock.

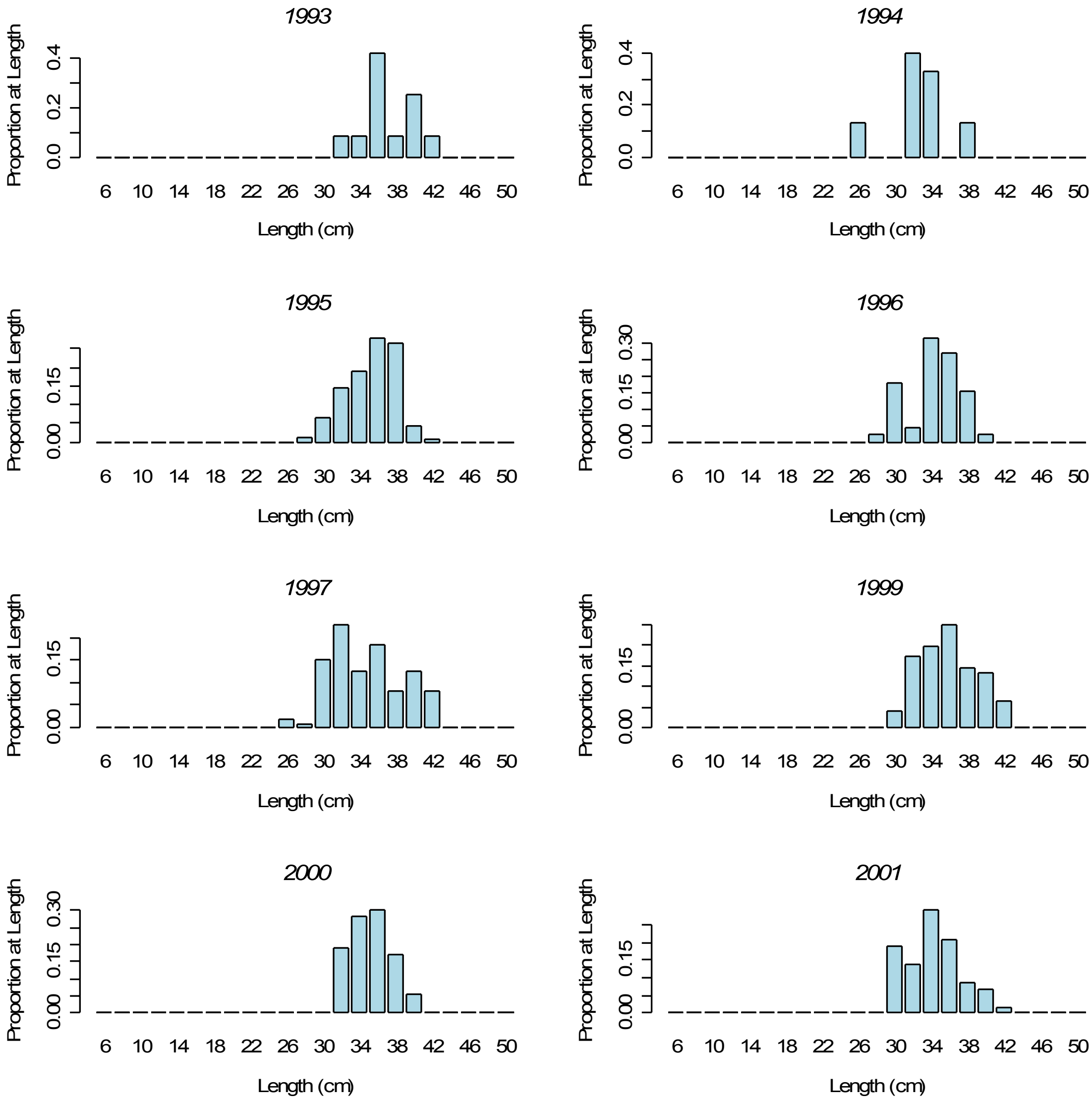


Figure 14. Length compositions for the commercial non-live fleet for California.

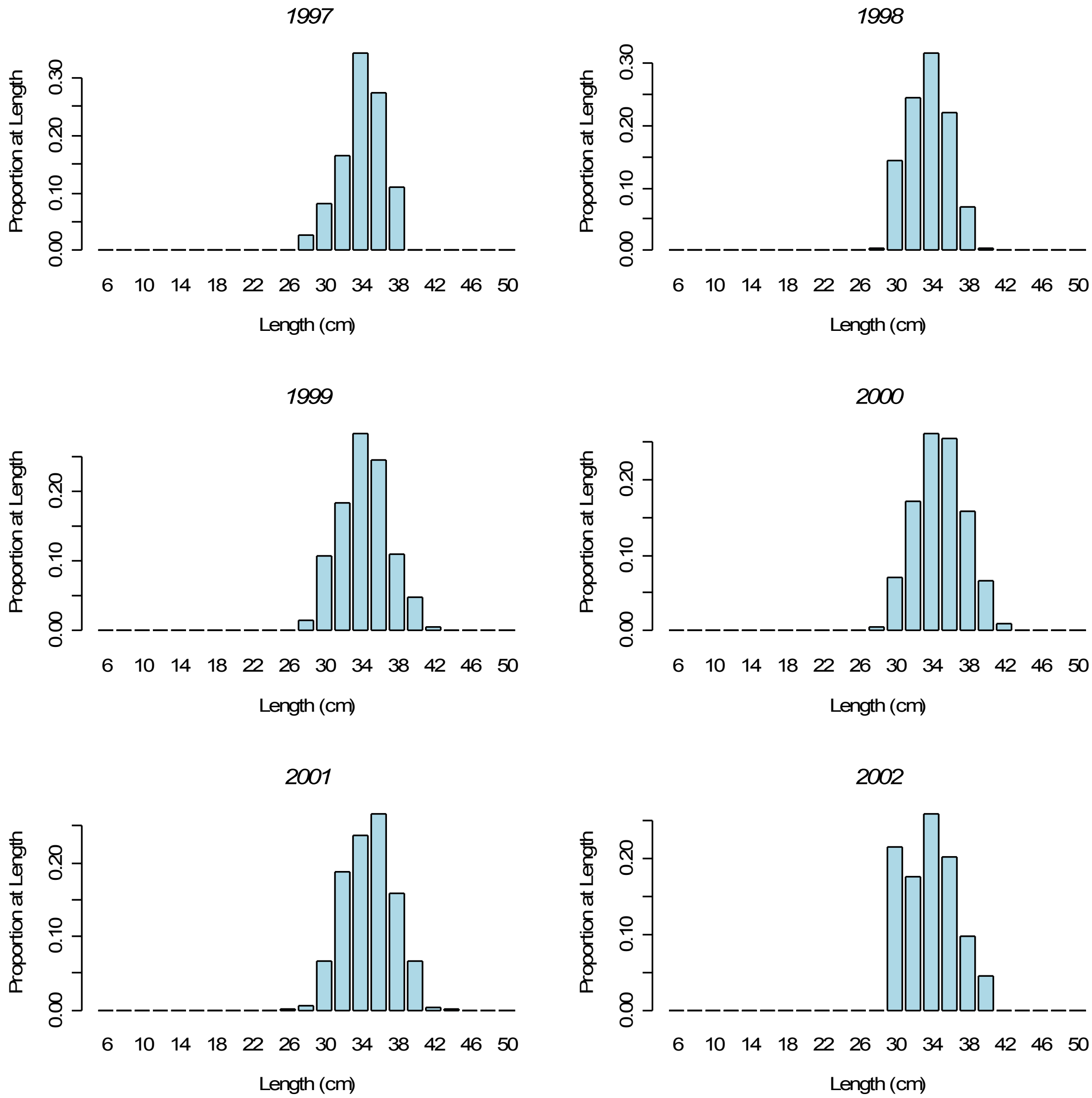


Figure 15. Length compositions for the commercial live-fish fleet for California.

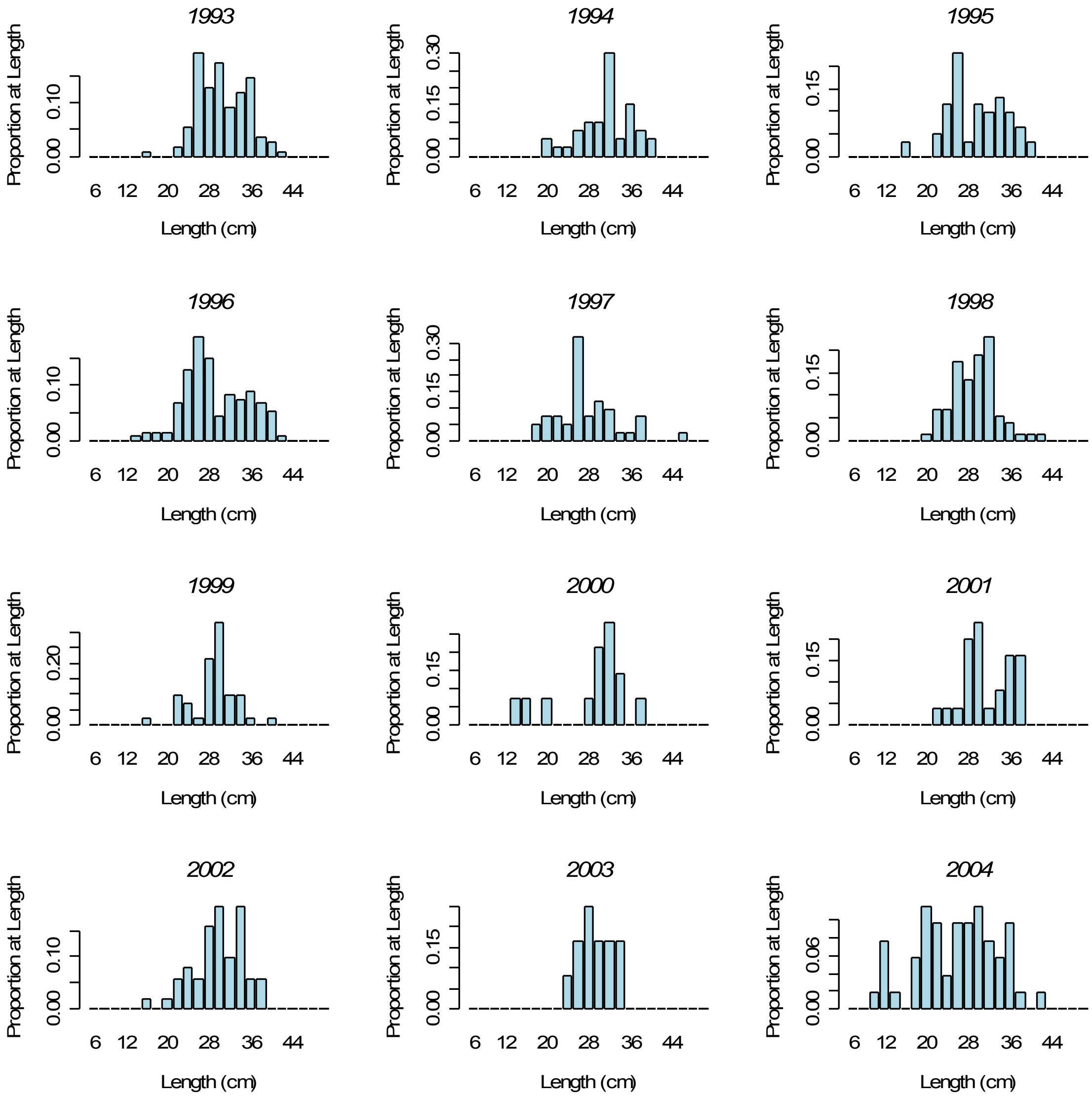
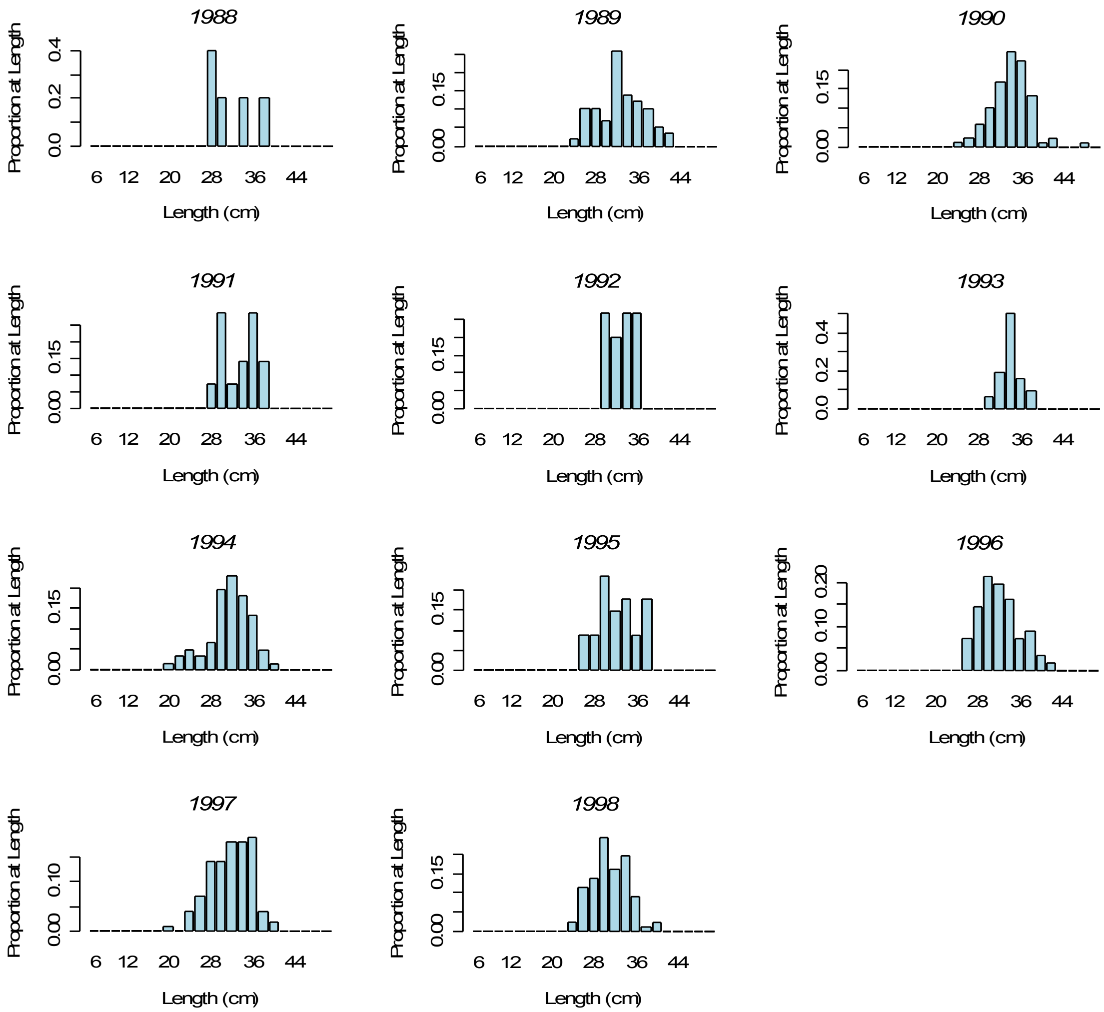


Figure 16. Length compositions for the recreational shore mode for California.

A) CPFV CDF& G Observer



B) CPFV RecFIN

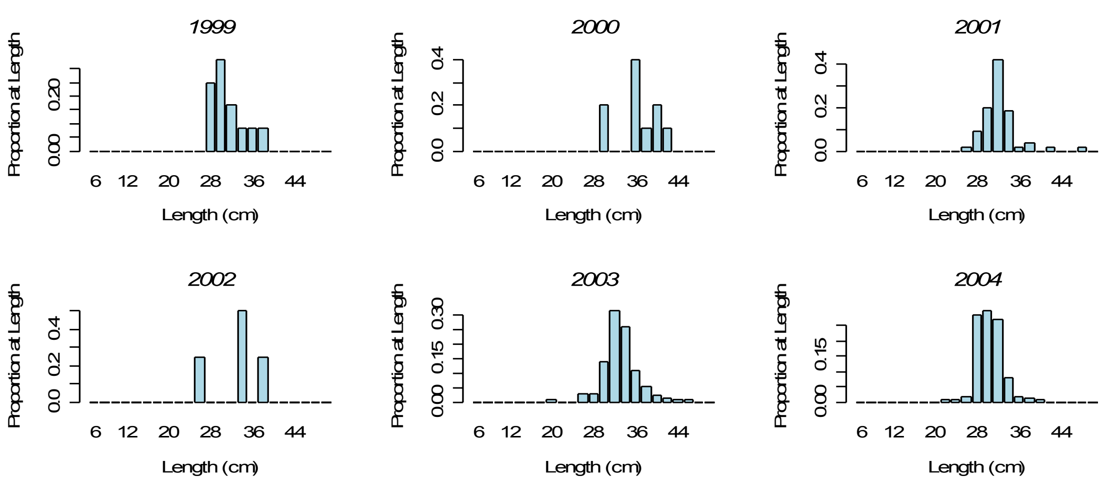


Figure 17. Length compositions for the recreational CPFV mode for California from A) the CDF&G Observer program and B) RecFIN.

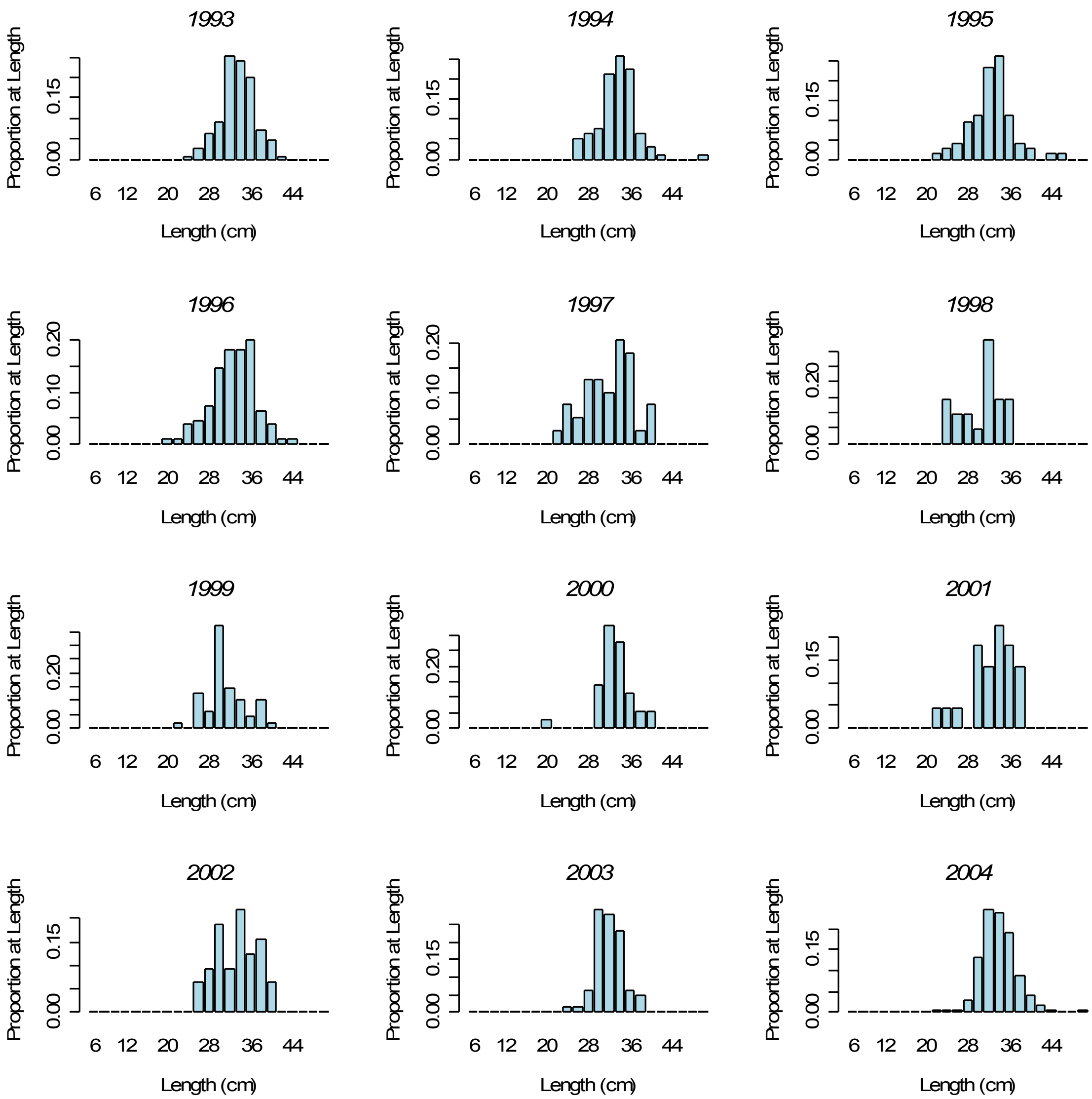


Figure 18. Length compositions for the recreational PBR mode for California.

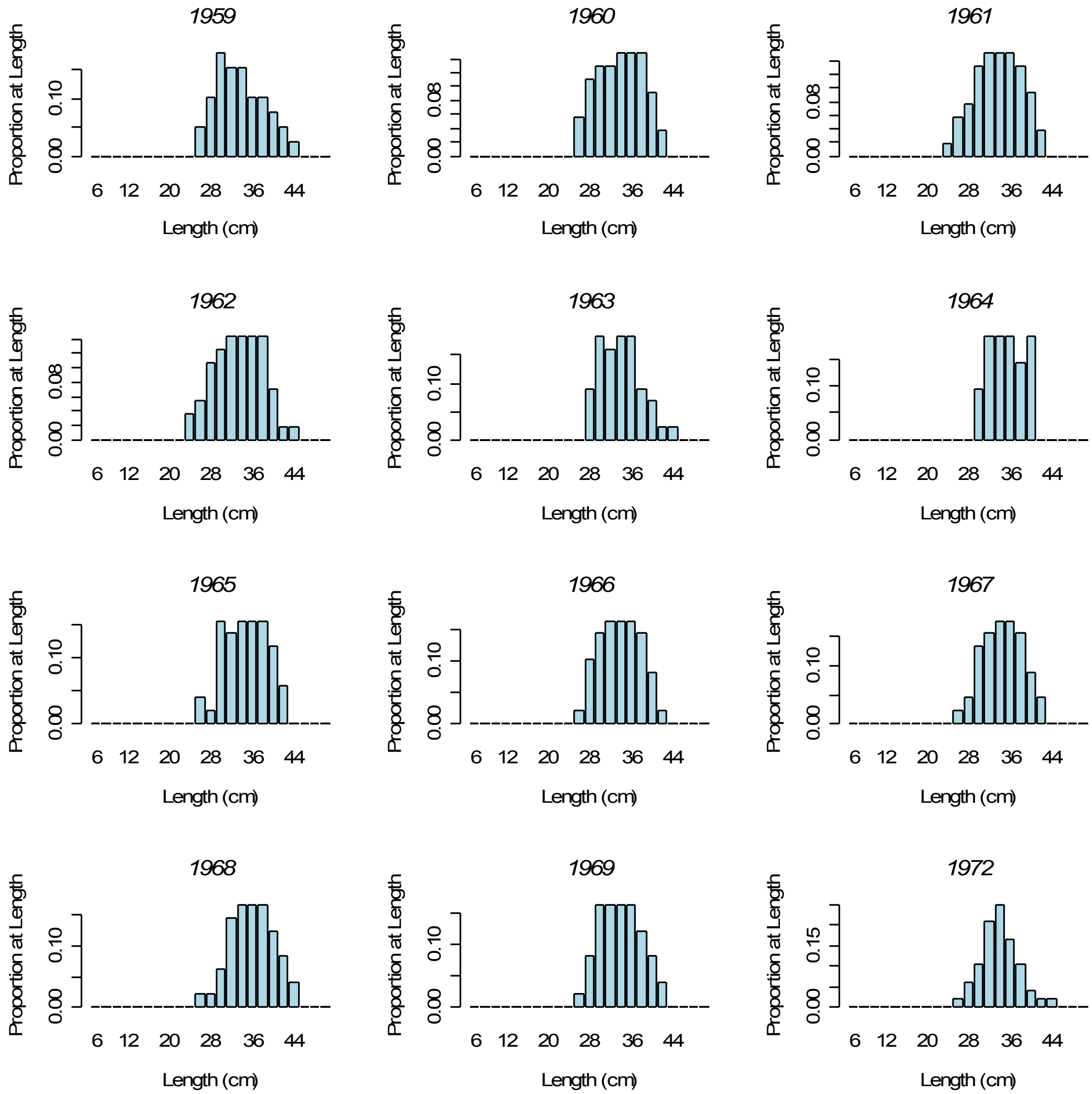


Figure 19. Length compositions for the recreational spearfishing mode for California, 1959-72.

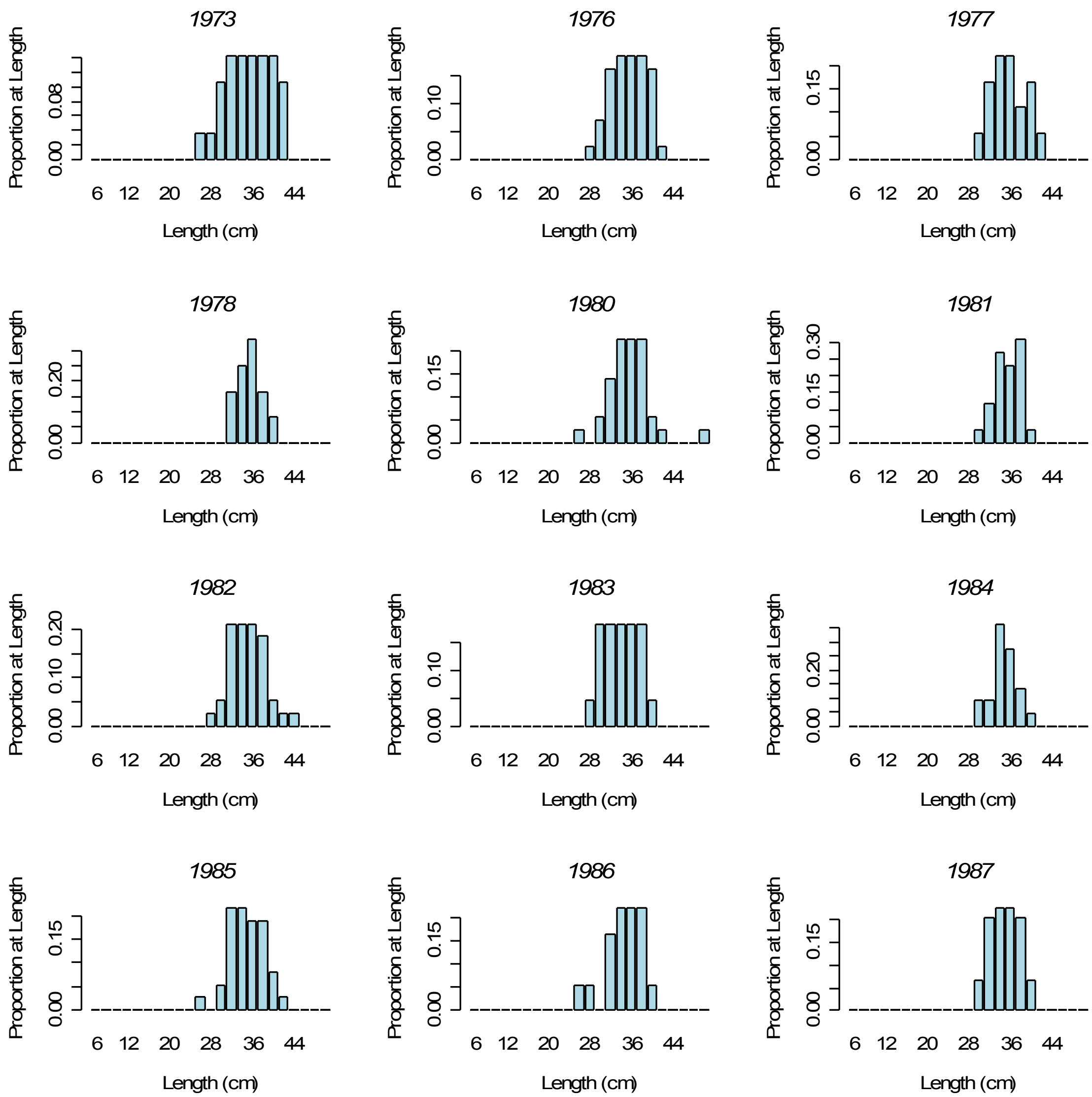


Figure 20. Length compositions for the recreational spearfishing mode for California, 1973-87.

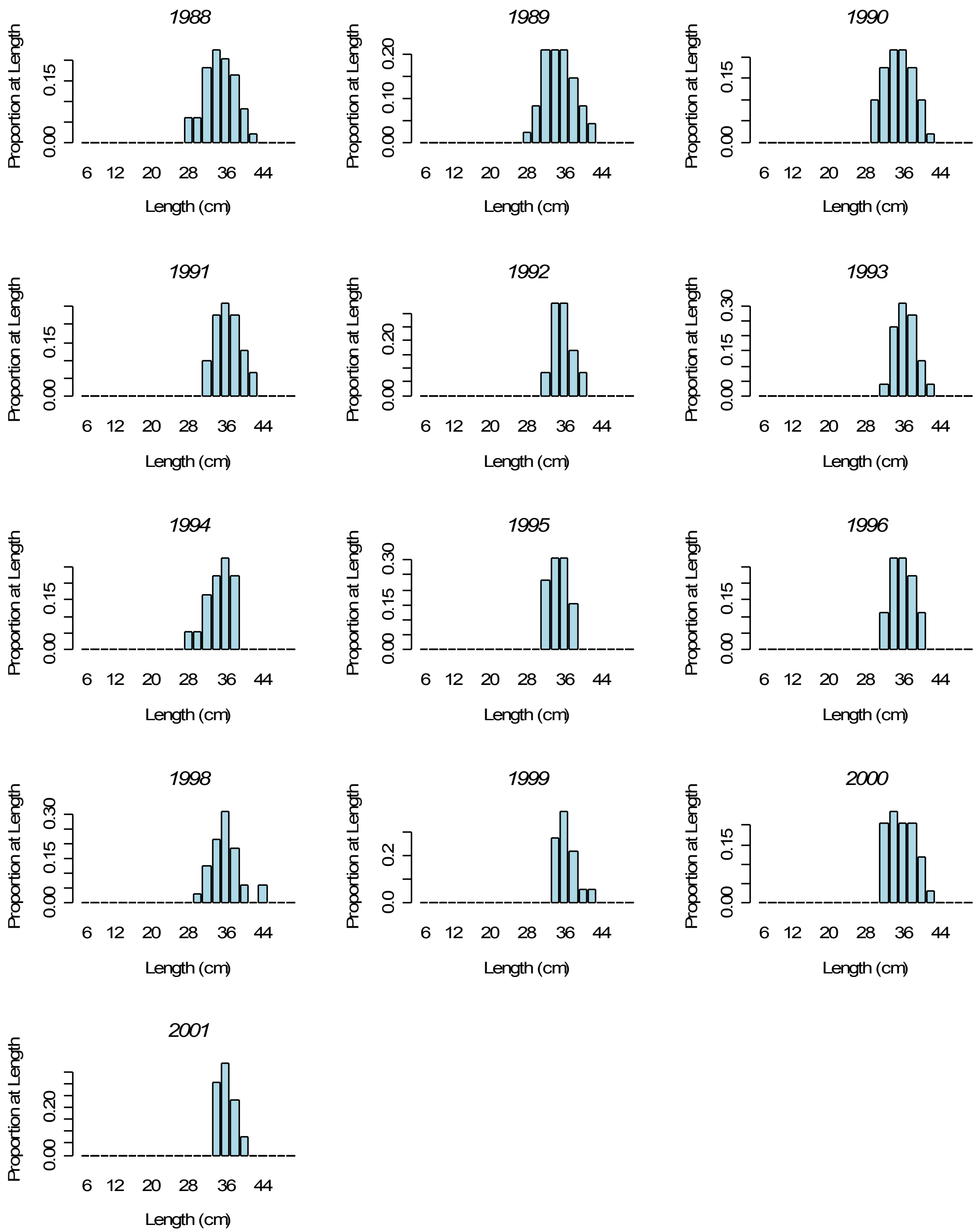
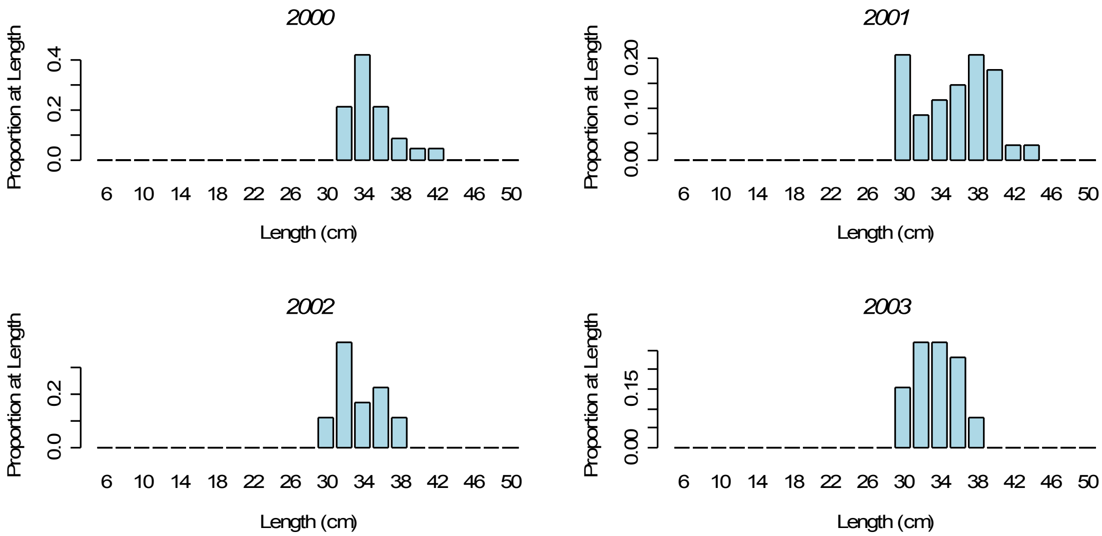


Figure 21. Length compositions for the recreational spearfishing mode for California, 1988-2001.

A) Females



B) Males

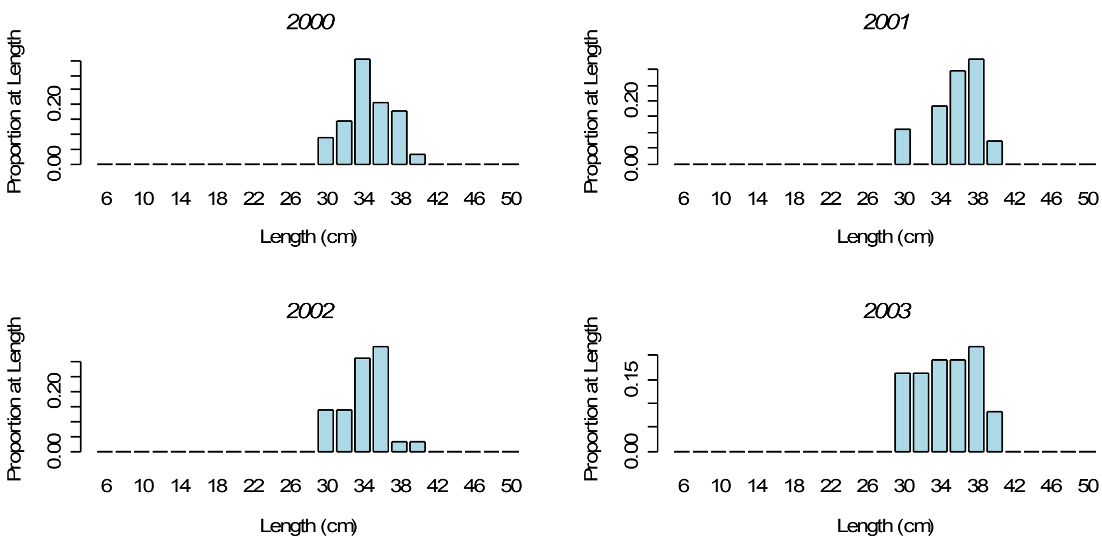
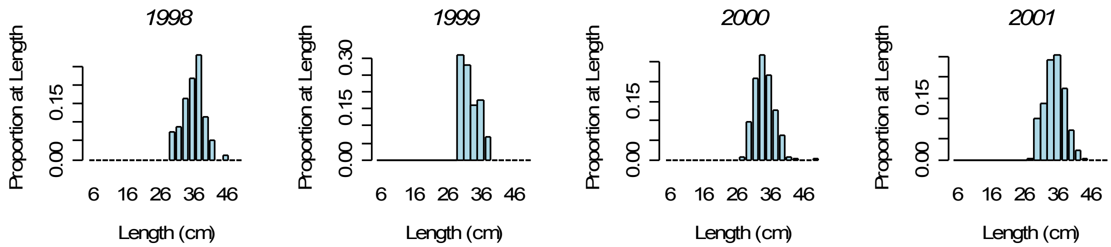


Figure 22. Length compositions for A) females and B) males from the commercial non-live fleet for Oregon.

A) Females



B) Males

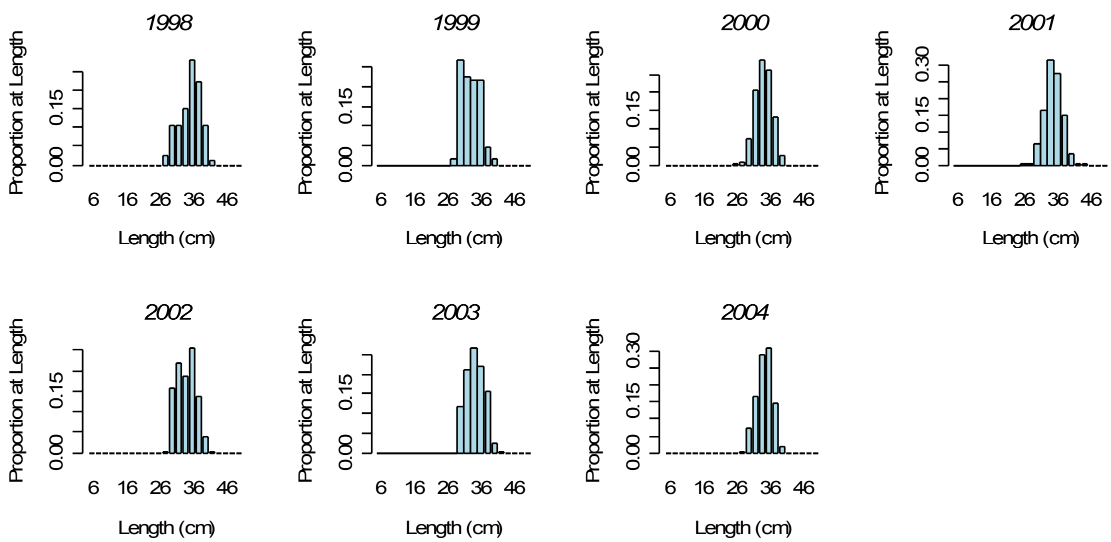


Figure 23. Length compositions for A) females and B) males from the commercial live-fish fleet for Oregon.

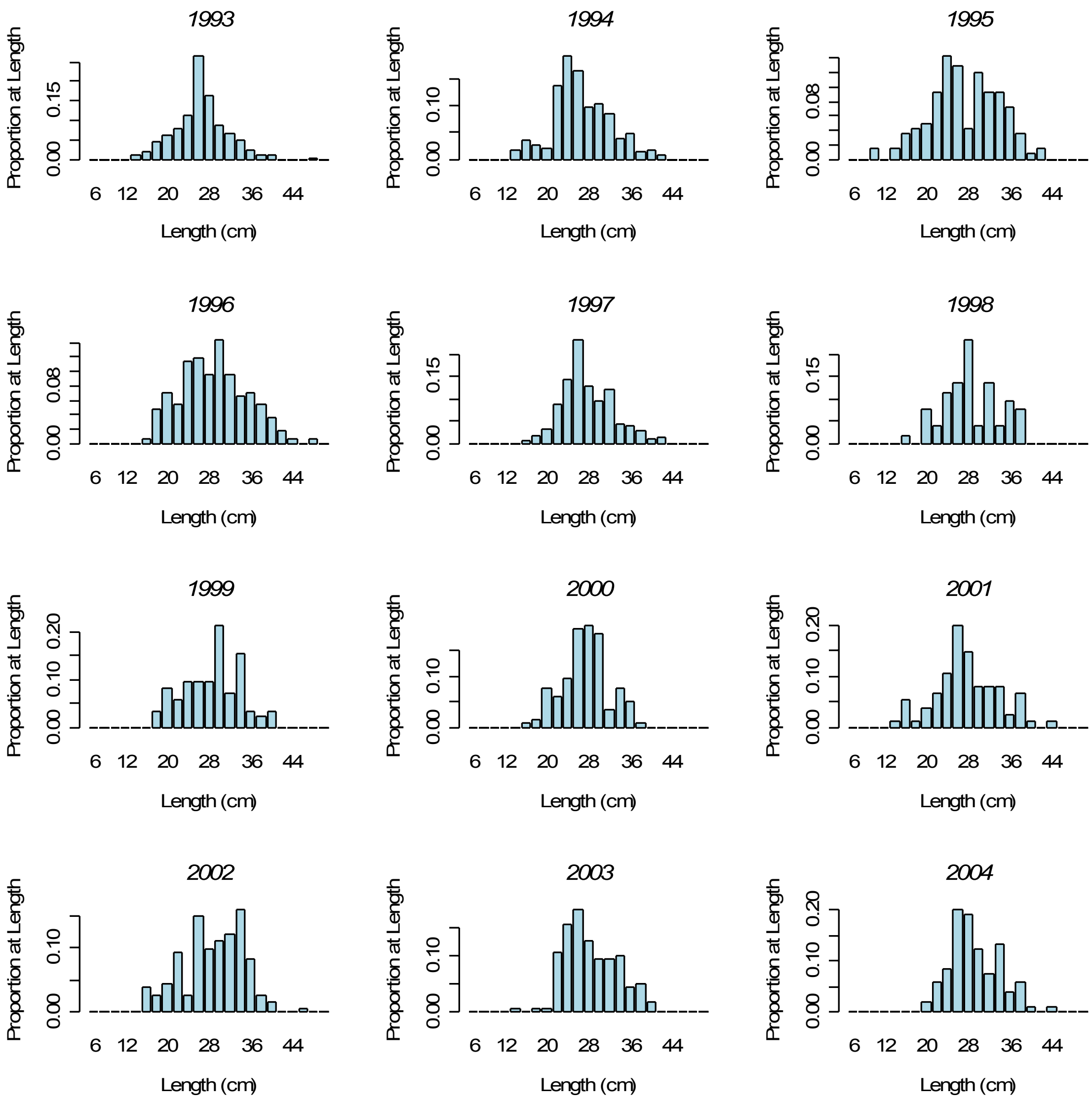


Figure 24. Length compositions for the recreational man-made mode for Oregon.

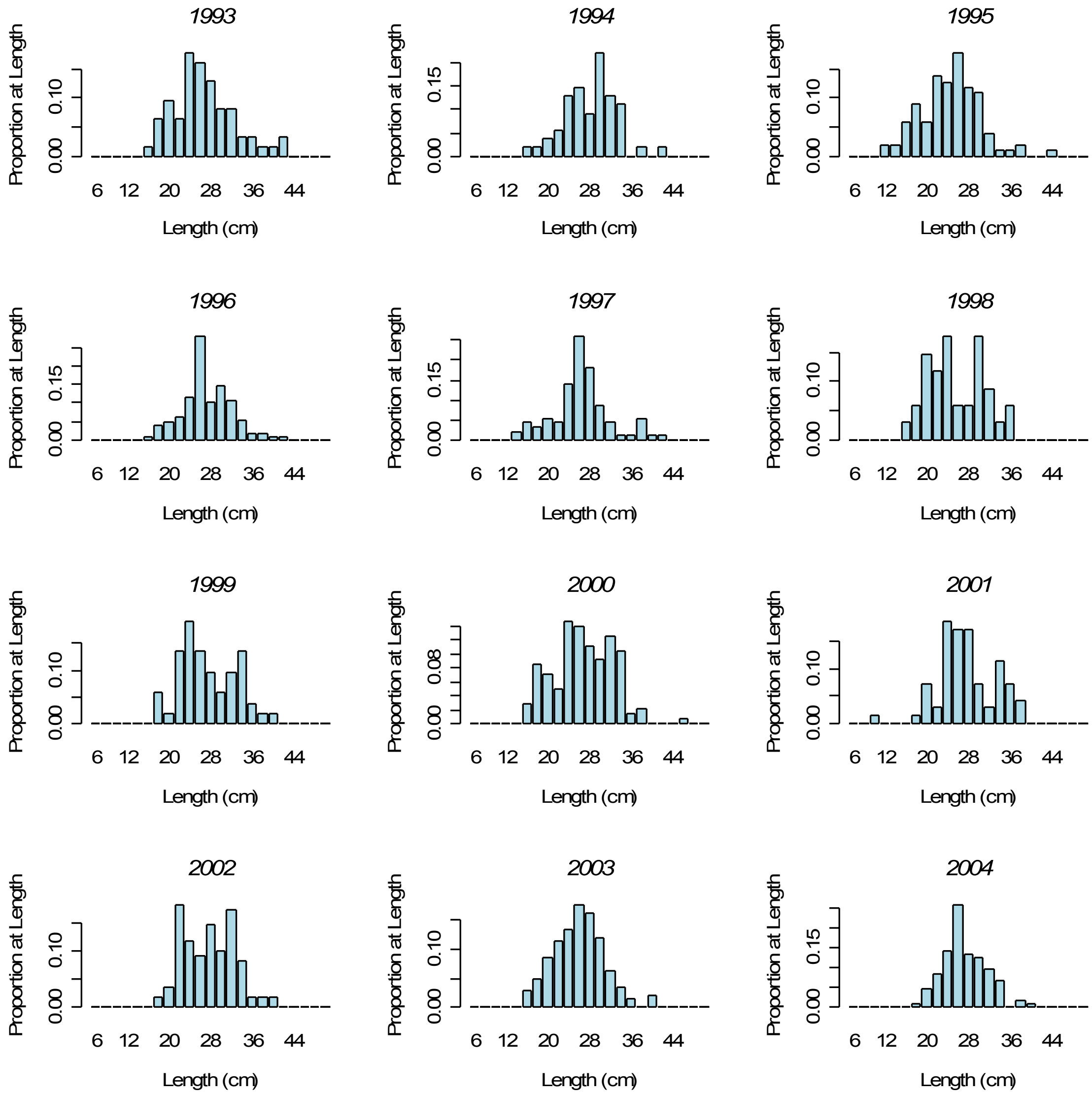


Figure 25. Length compositions for the recreational beach/bank mode for Oregon.

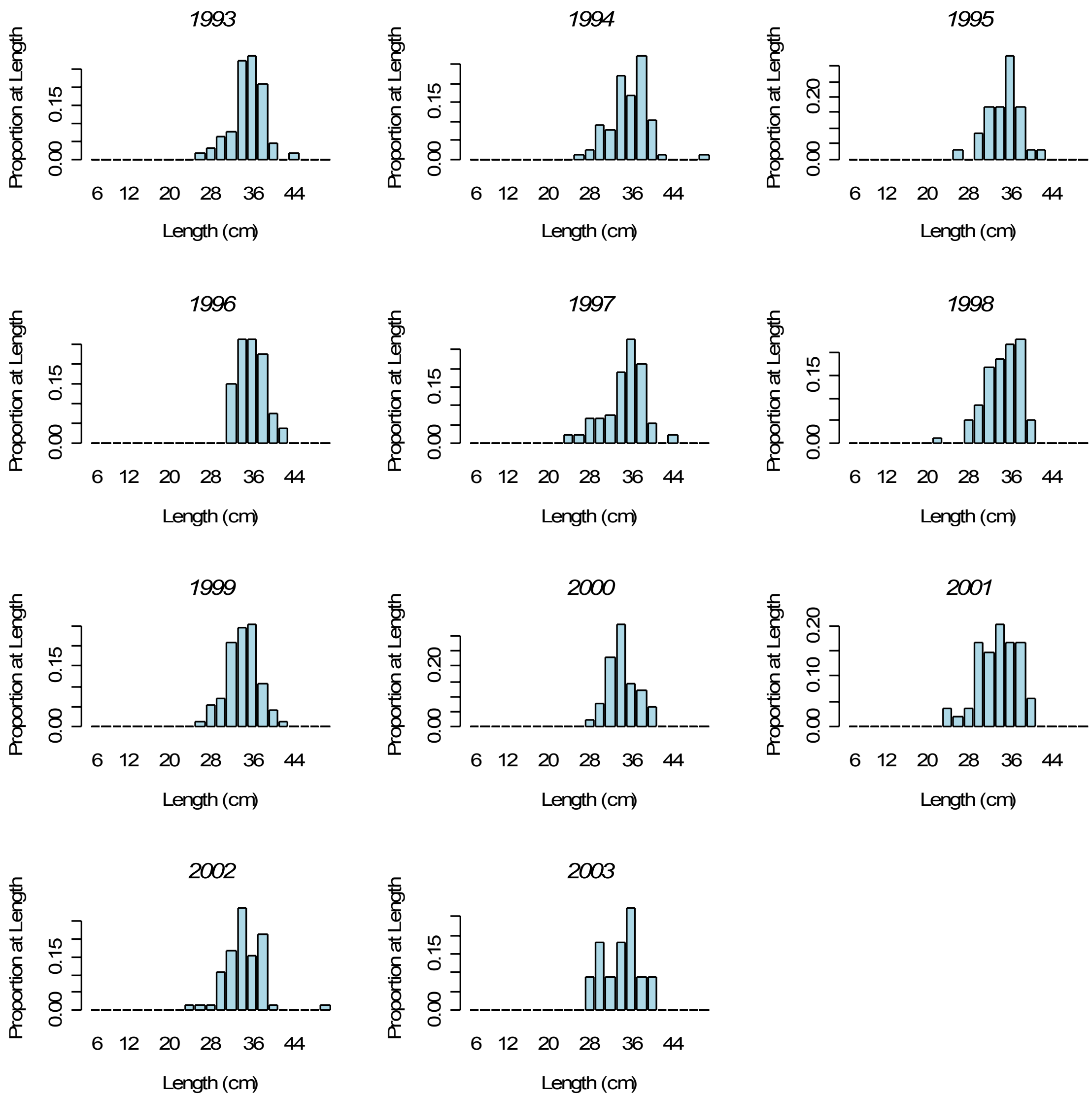


Figure 26. Length compositions for the recreational CPFV mode for Oregon.

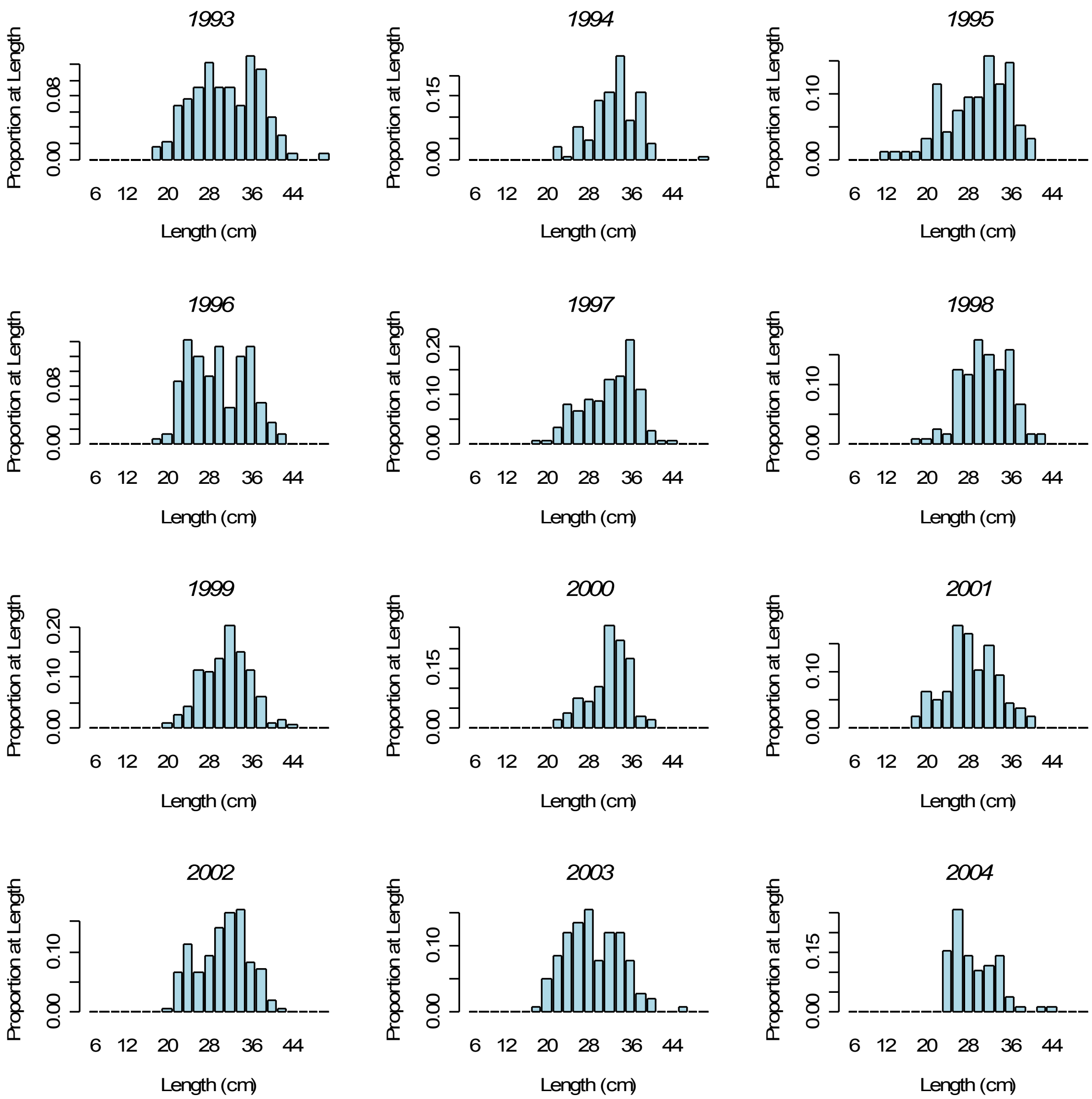
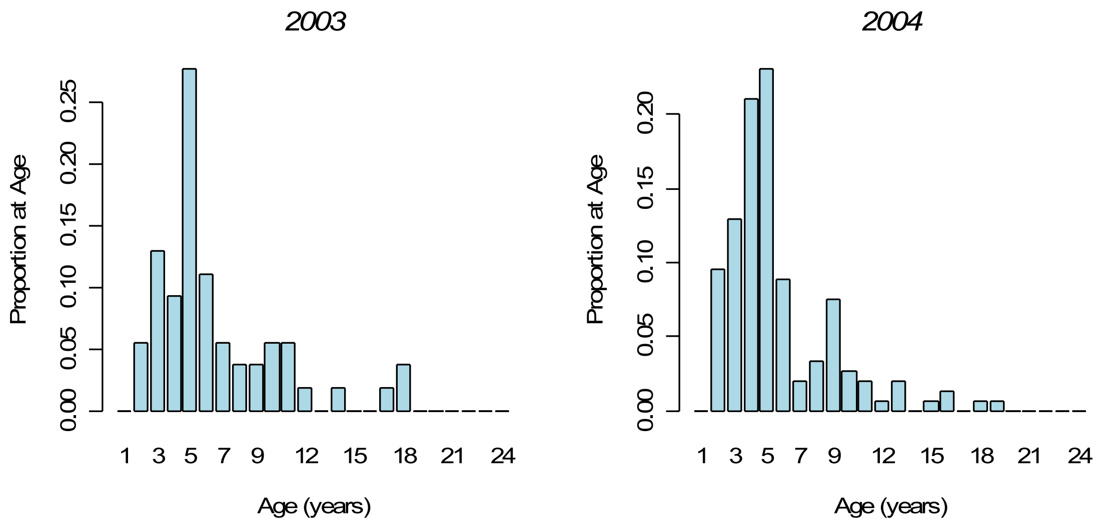


Figure 27. Length compositions for the recreational PBR mode for Oregon.

A) Females



B) Males

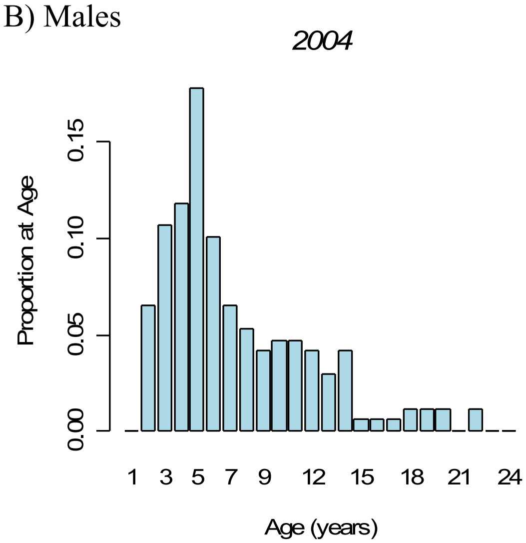


Figure 28. Age composition data for the Oregon CPFV mode for A) females and B) males.

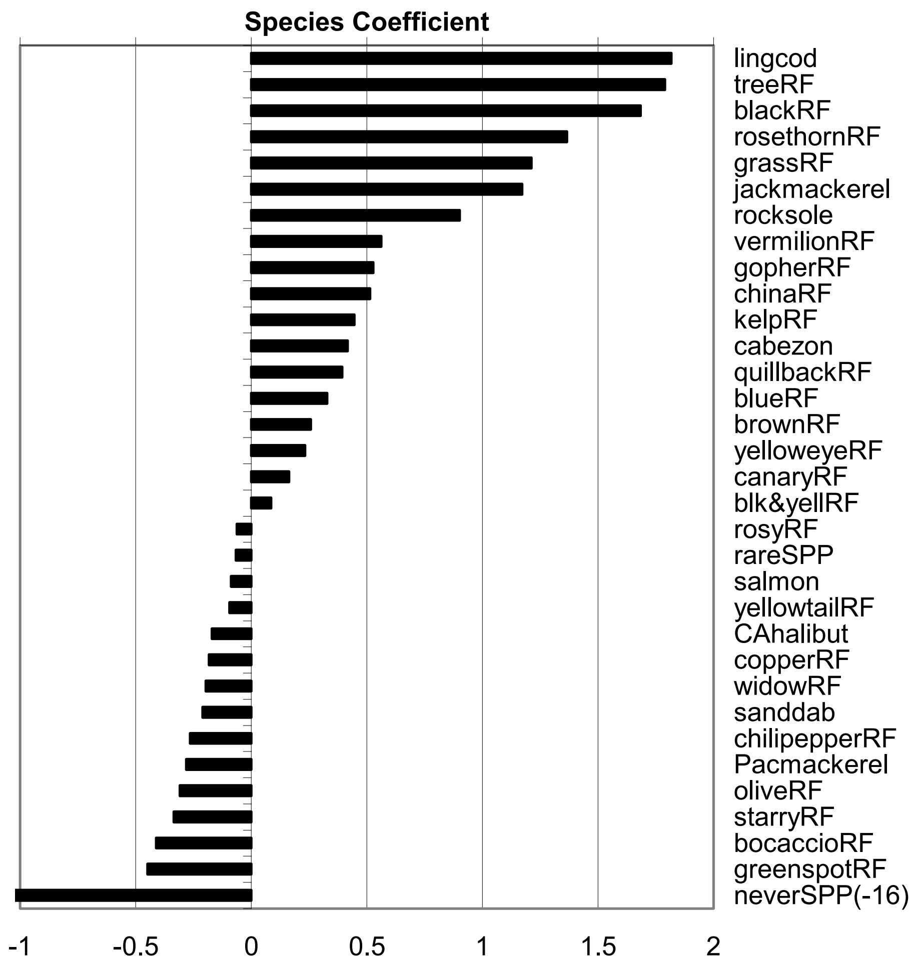


Figure 29. The association of species of fish with kelp greenling taken in the CPFV fishery (data provided the RecFIN).

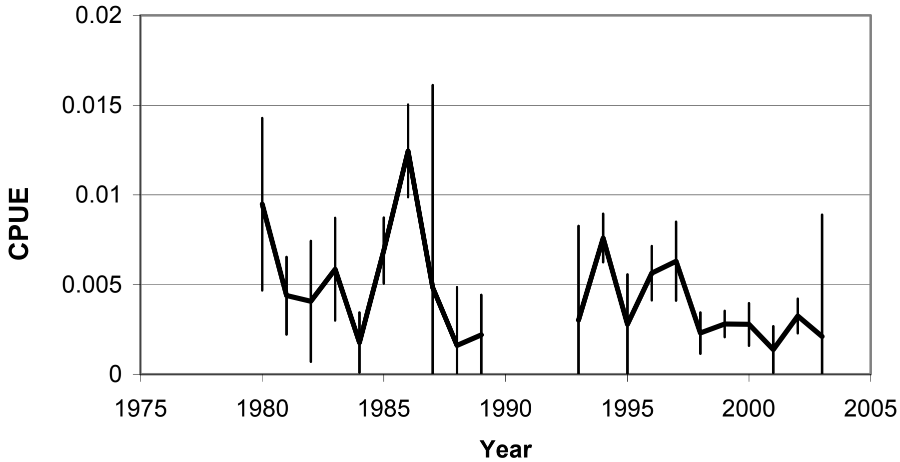


Figure 30. Index of kelp greenling abundance in California, based on a delta GLM of shore mode CPUE data. Error bars are +/- 1 SE.

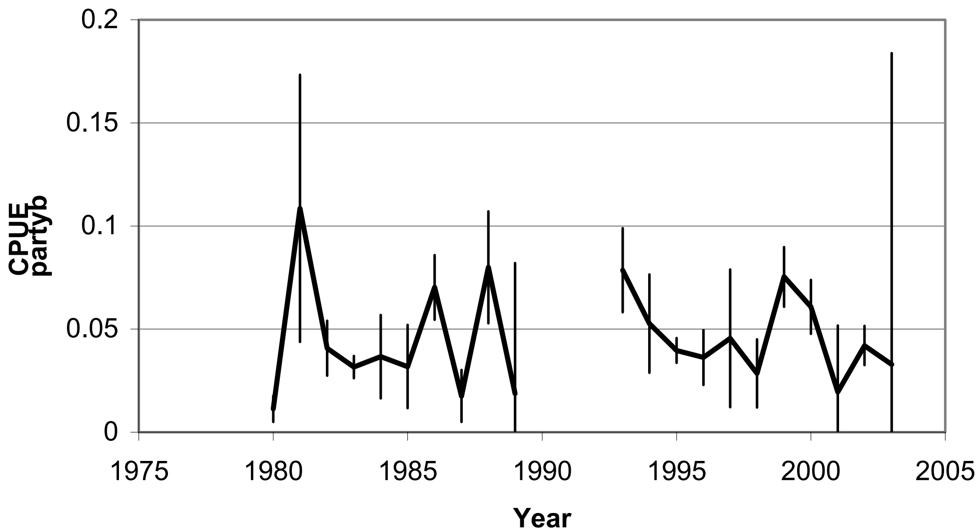


Figure 31. Index of kelp greenling abundance in Oregon, based on a delta GLM of the CPFV mode CPUE data. Error bars are +/- 1 SE.

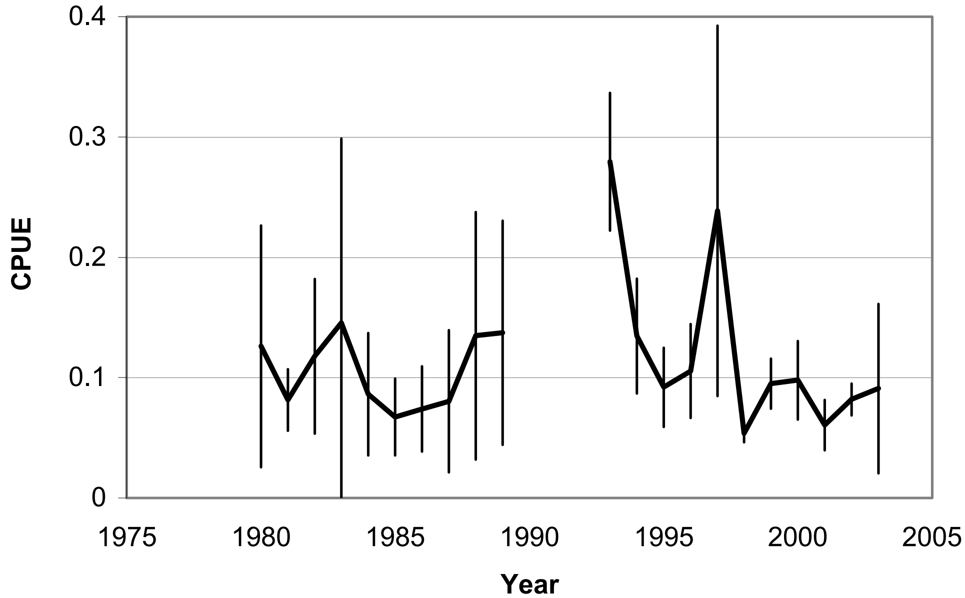


Figure 32. Index of kelp greenling abundance in Oregon, based on a delta GLM of the PBR mode CPUE data. Error bars are +/- 1 SE.

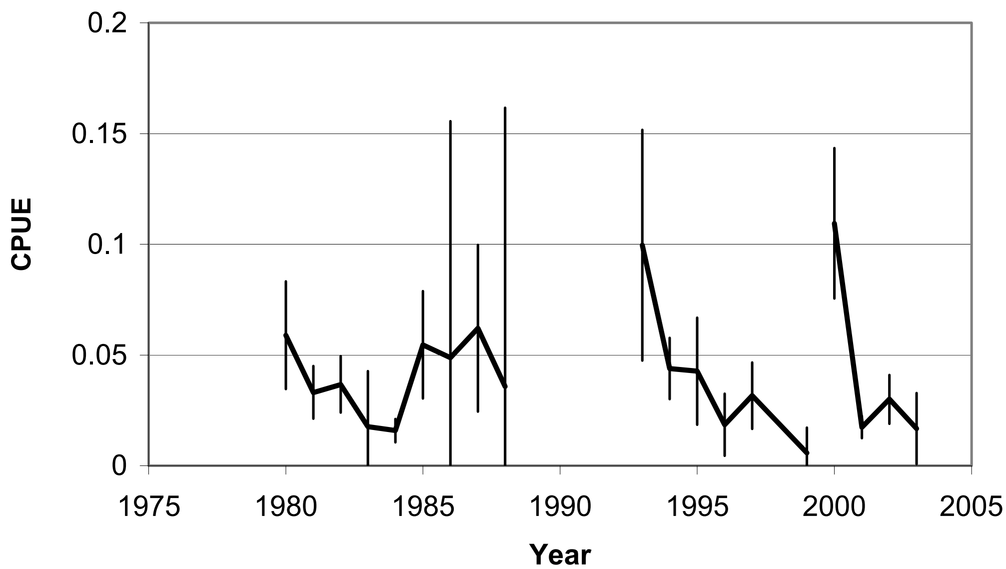


Figure 33. Index of kelp greenling abundance in Oregon, based on a delta GLM of the beach/bank mode CPUE data. Error bars are +/- 1 SE.

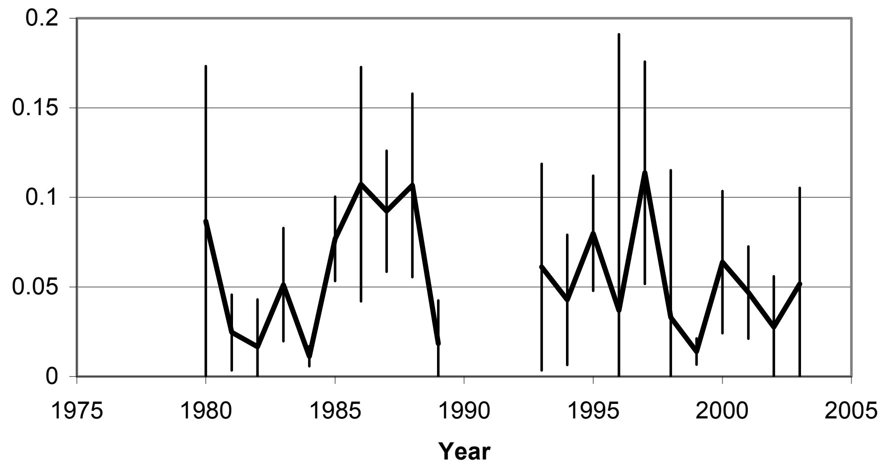


Figure 34. Index of kelp greenling abundance in Oregon, based on a delta GLM of the man-made mode CPUE data. Error bars are +/- 1 SE.

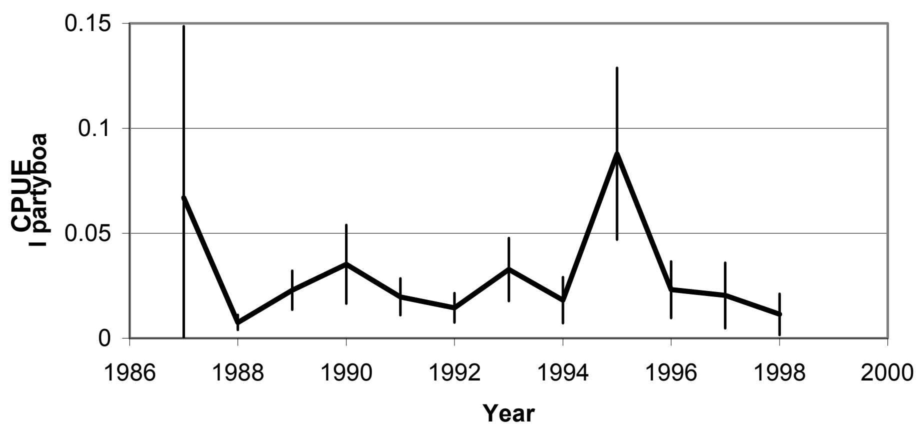


Figure 35. Index of kelp greenling abundance in California, based on a delta GLM of CPFV CPUE data. Error bars are +/- 1 SE.

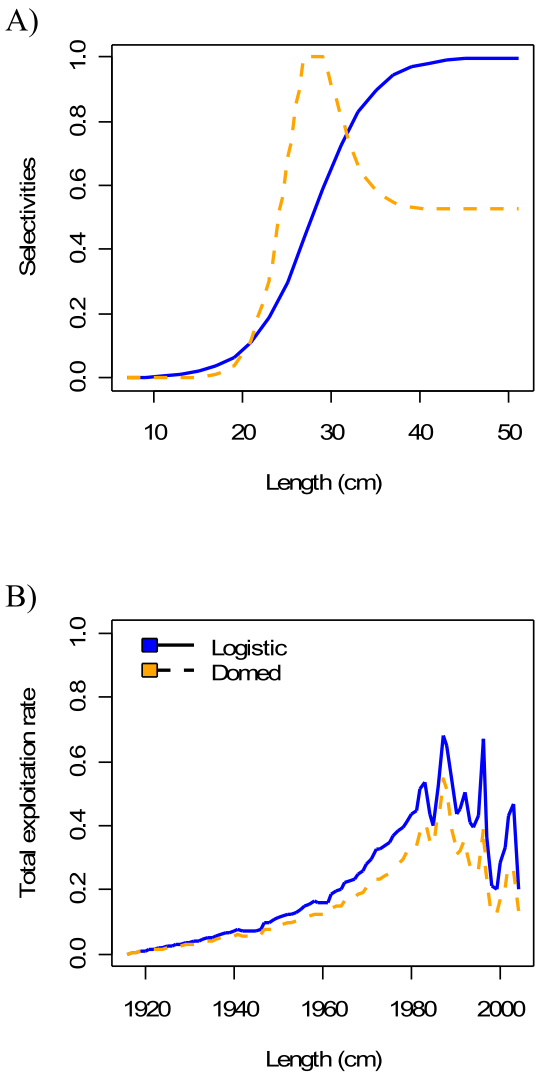


Figure 36. A) Shore (fleet 3) selectivities and B) total exploitation rates for California when the selectivities for the shore mode are either estimated as logistic or set to those for the Oregon beach/bank fleet (dome-shaped).

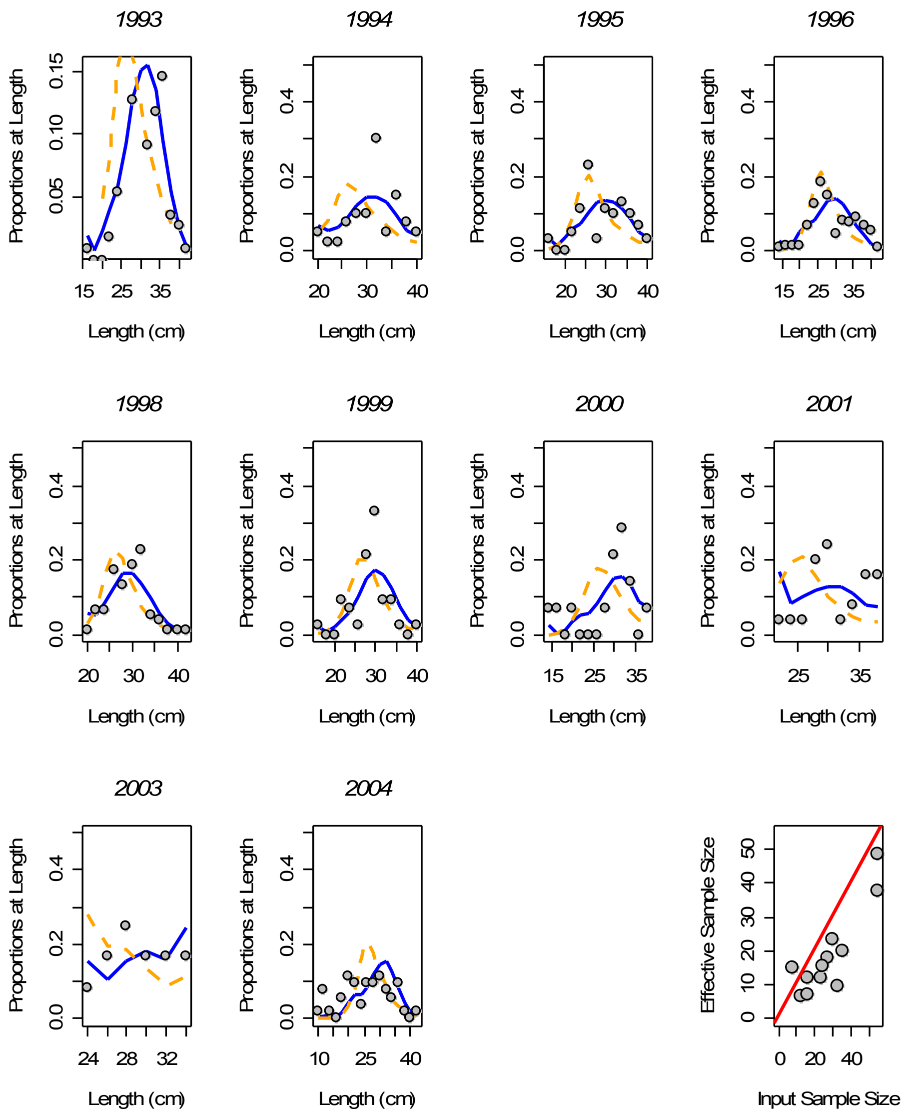


Figure 37. Fits to the California shore mode (fleet 3) length-composition data when selectivity is freely estimated (logistic) or set to the dome-shaped selectivity pattern for the Oregon beach/bank fleet.

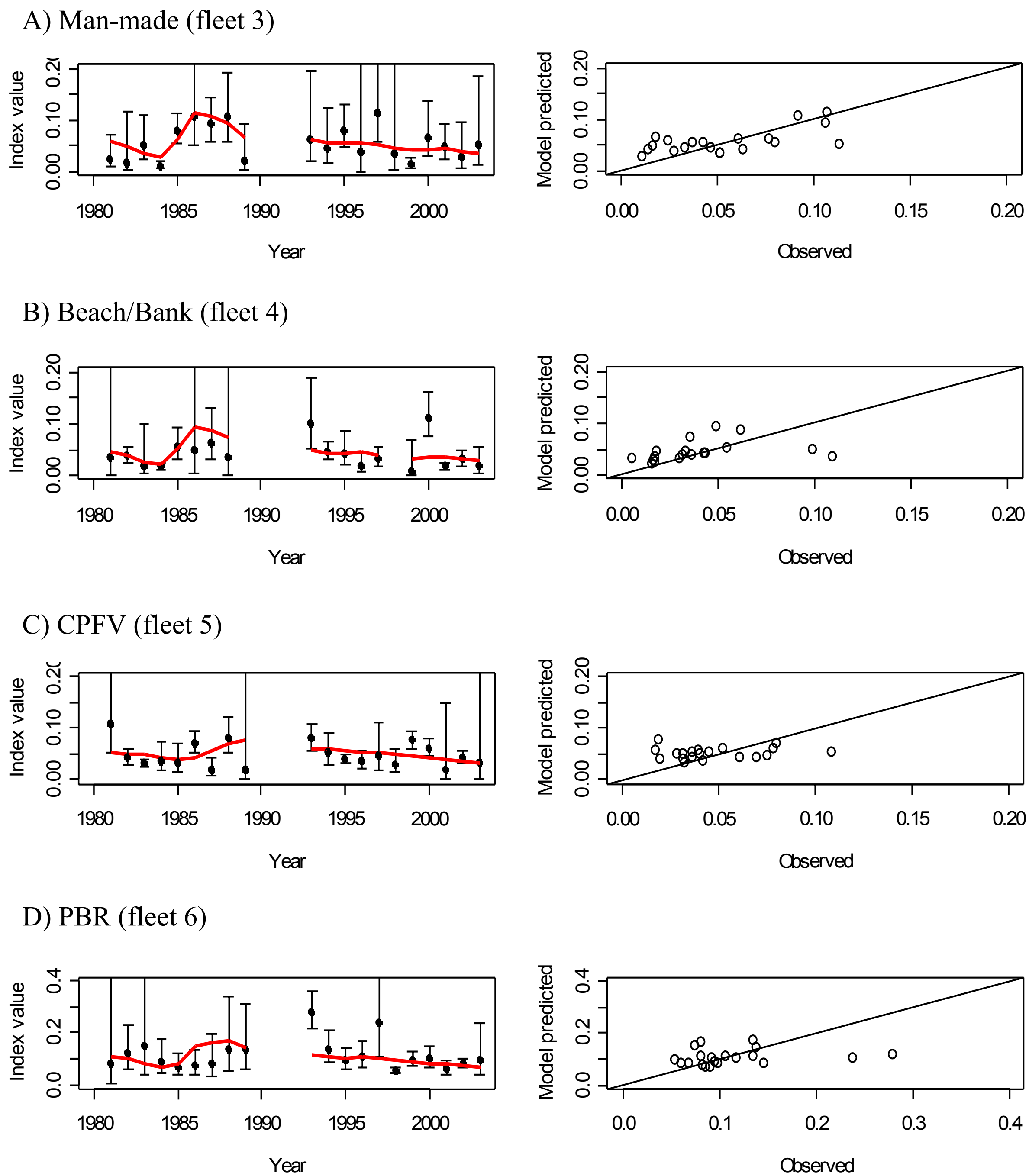


Figure 38. Fits to catch-rate indices for the Oregon recreational fleets. The left panel shows the fit of the model (solid red line) to the observed CPUE data (solid black dots). The vertical lines in the left panel are the 95% confidence intervals for the data (based on the assumed coefficients of variation). The panel on the right compares the observed and model-predicted indices, with the solid line indicating the 1:1 relationship.

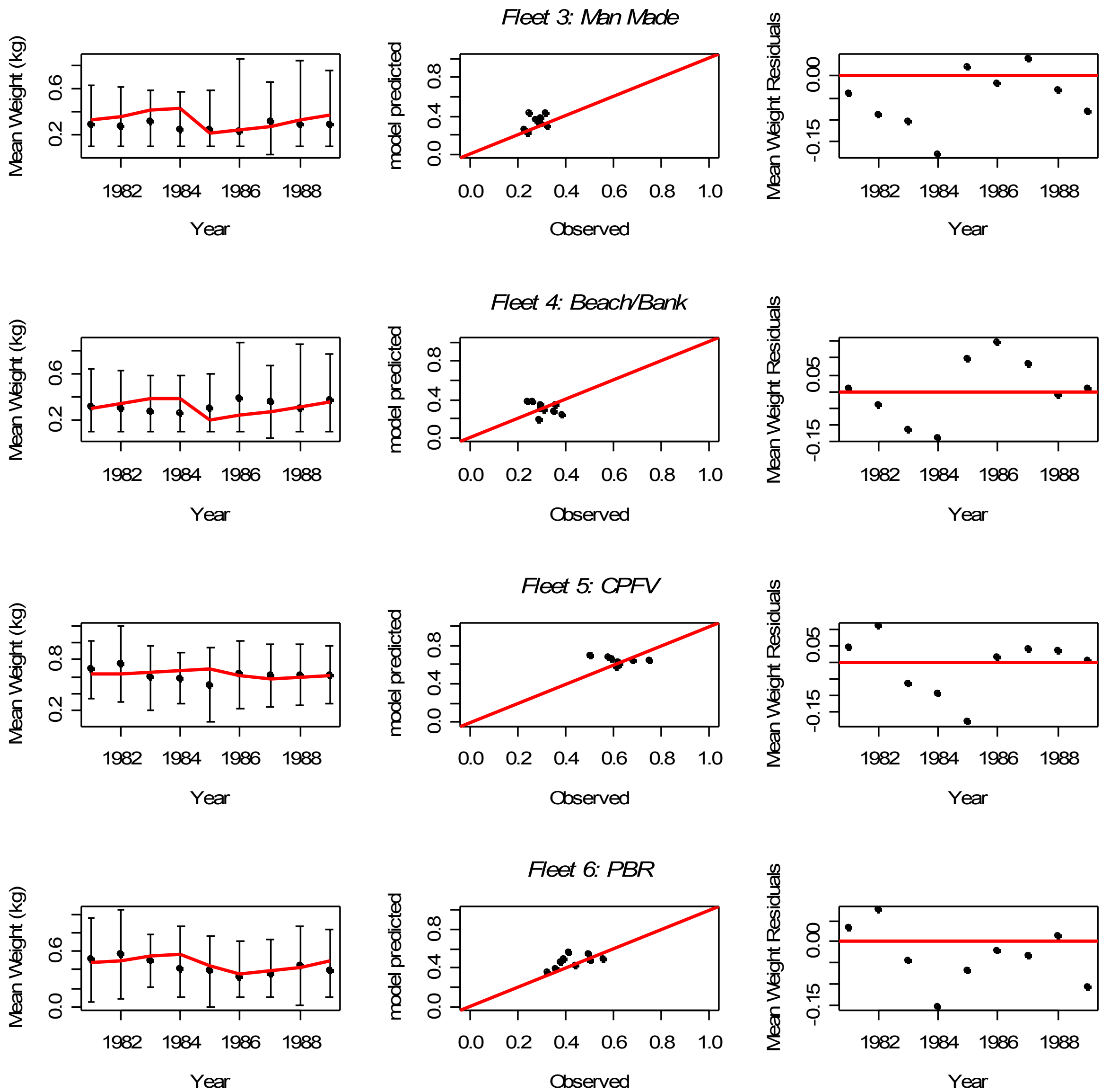


Figure 39. Base-case model fits to the mean weight data for Oregon. The left panels show the observed (solid dots with 95% confidence intervals) and model-predicted (solid red lines) mean weights. The center panels plot the observed *versus* model-predicted mean weights and the right panels show the time-sequence of residuals.

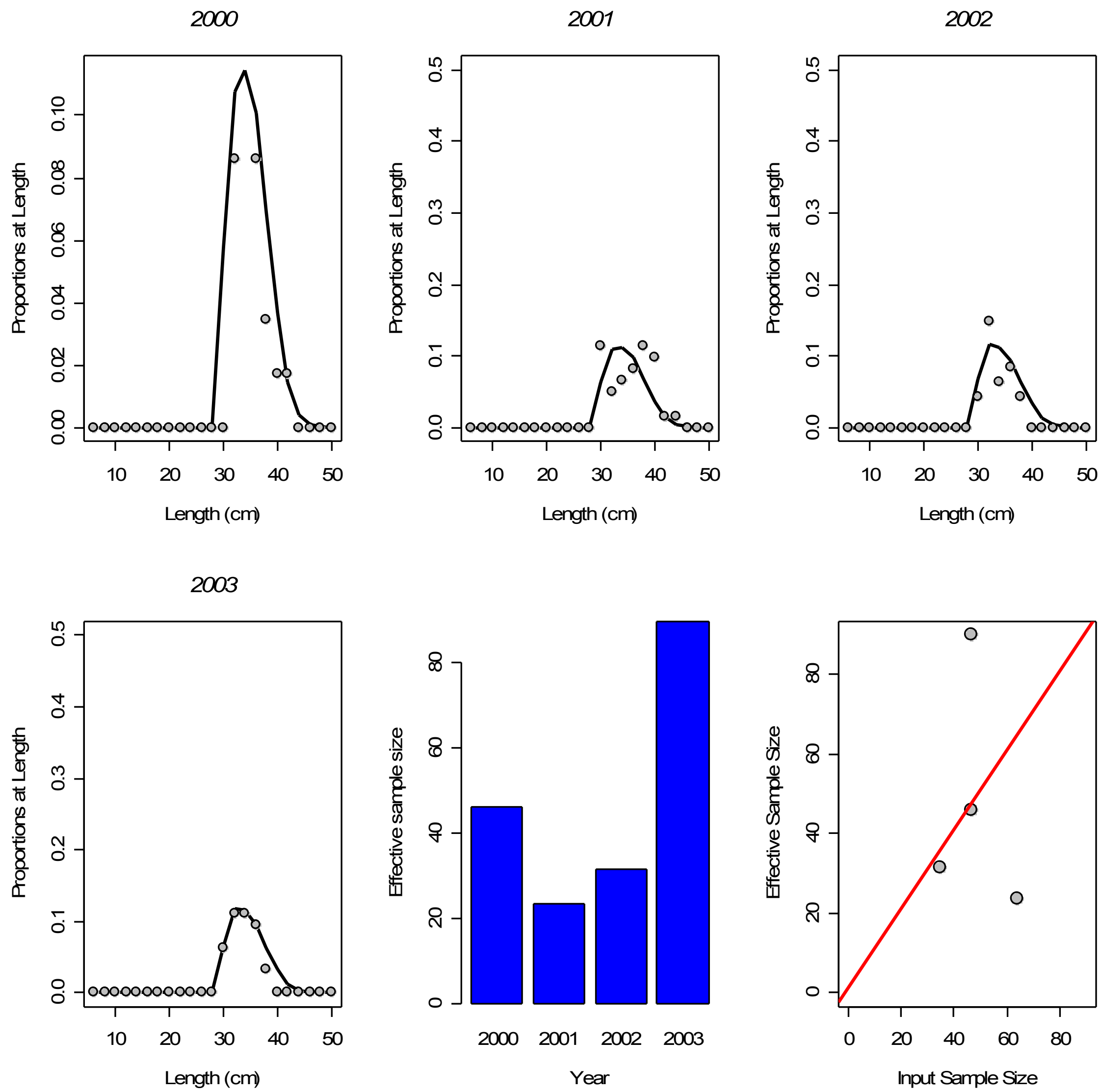


Figure 40. Observed (solid circles) and model-predicted (solid lines) female length-composition data for the Oregon commercial non-live-fish fleet (fleet 1). The annual effective sample sizes are summarized by the histogram and a comparison of inputted to effective sample sizes is given in the lower center panel (the solid red line in this panel is the 1:1 line).

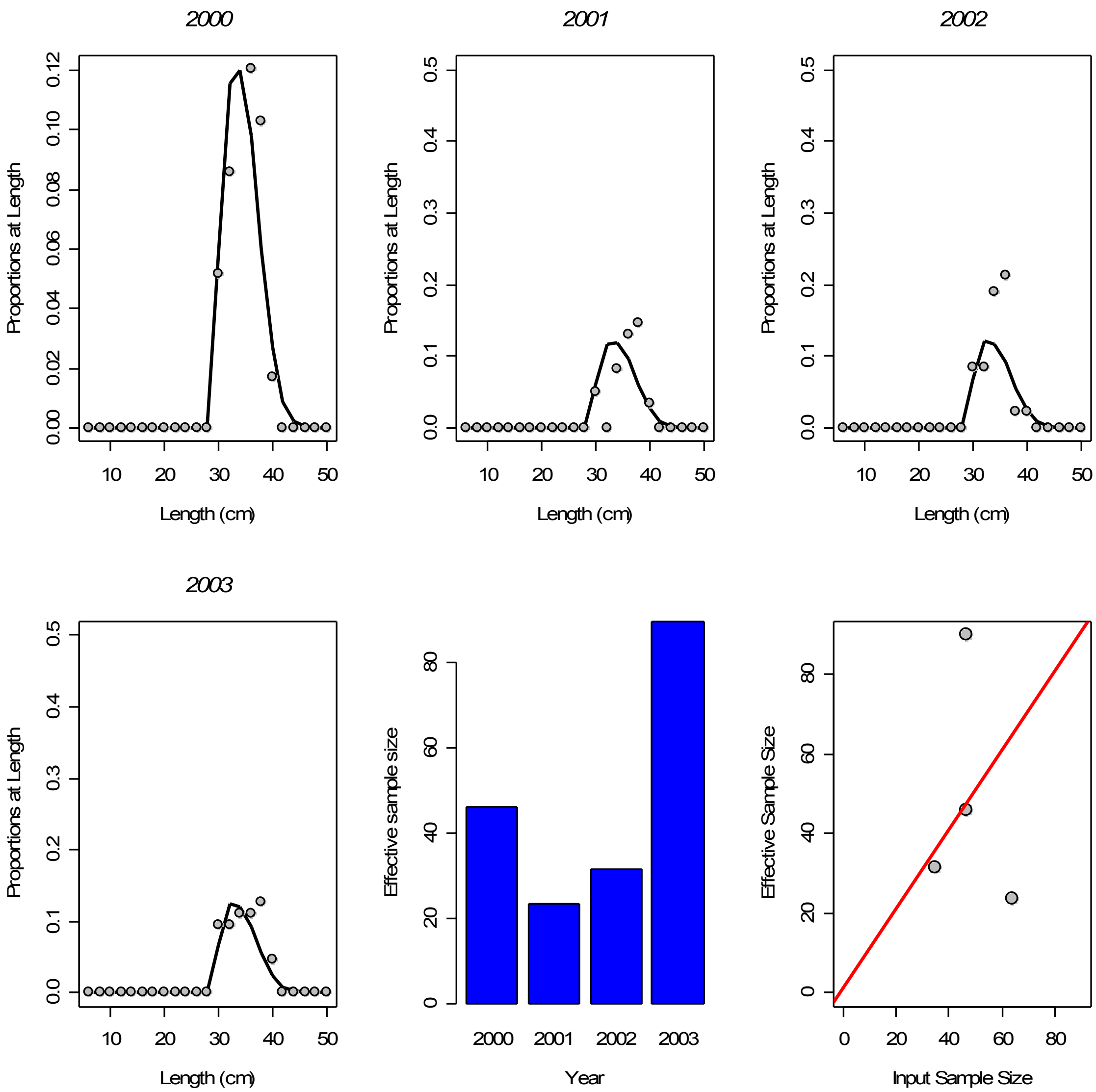


Figure 41. Observed (solid circles) and model-predicted (solid lines) male length-composition data for the Oregon commercial non-live-fish fleet (fleet 1). The annual effective sample sizes are summarized by the histogram and a comparison of inputted to effective sample sizes is given in the lower center panel (the solid red line in this panel is the 1:1 line).

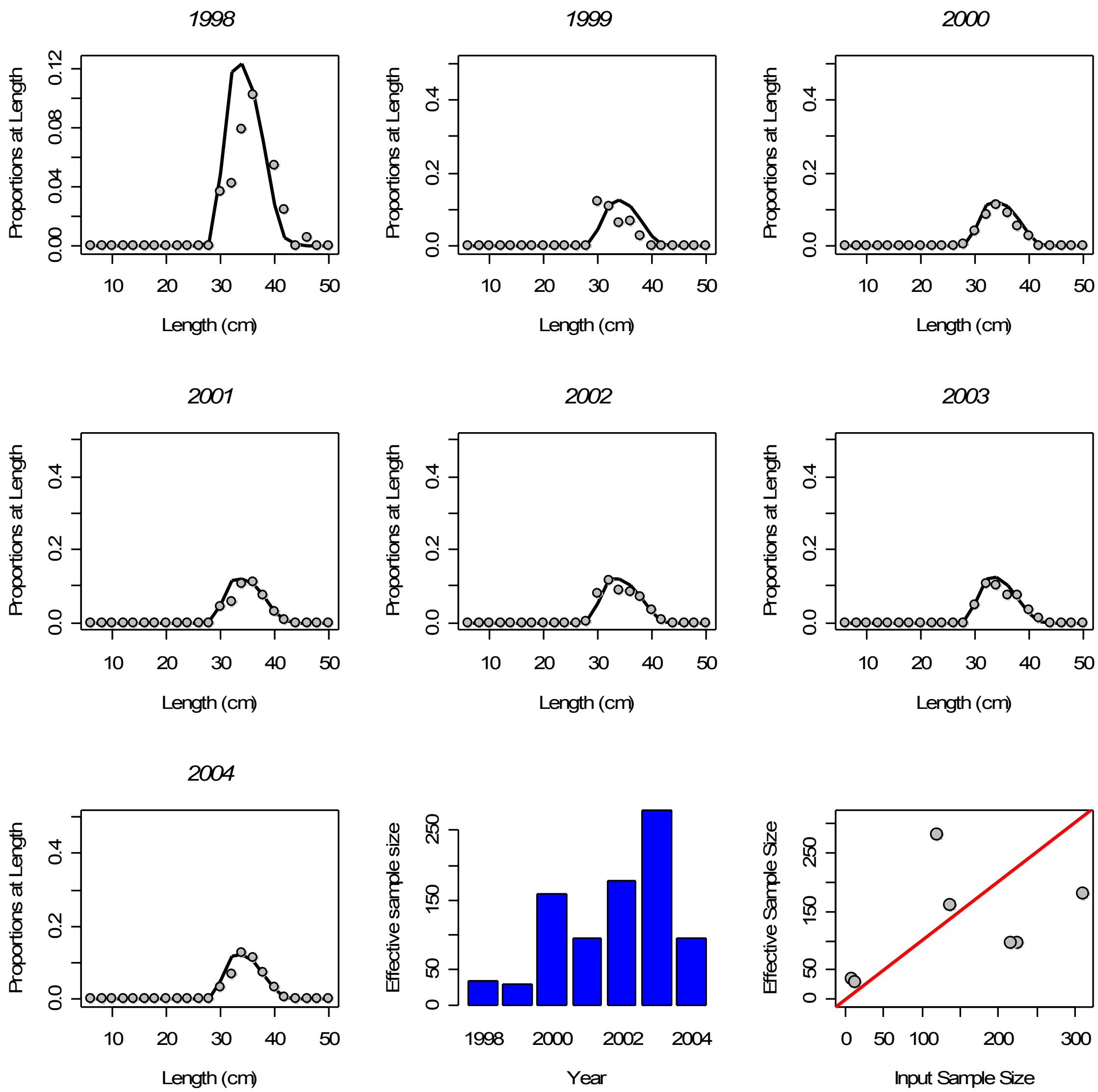


Figure 42. Observed (solid circles) and model-predicted (solid lines) female length-composition data for the Oregon commercial live-fish fleet (fleet 2). The annual effective sample sizes are summarized by the histogram and a comparison of inputted to effective sample sizes is given in the lower center panel (the solid red line in this panel is the 1:1 line).

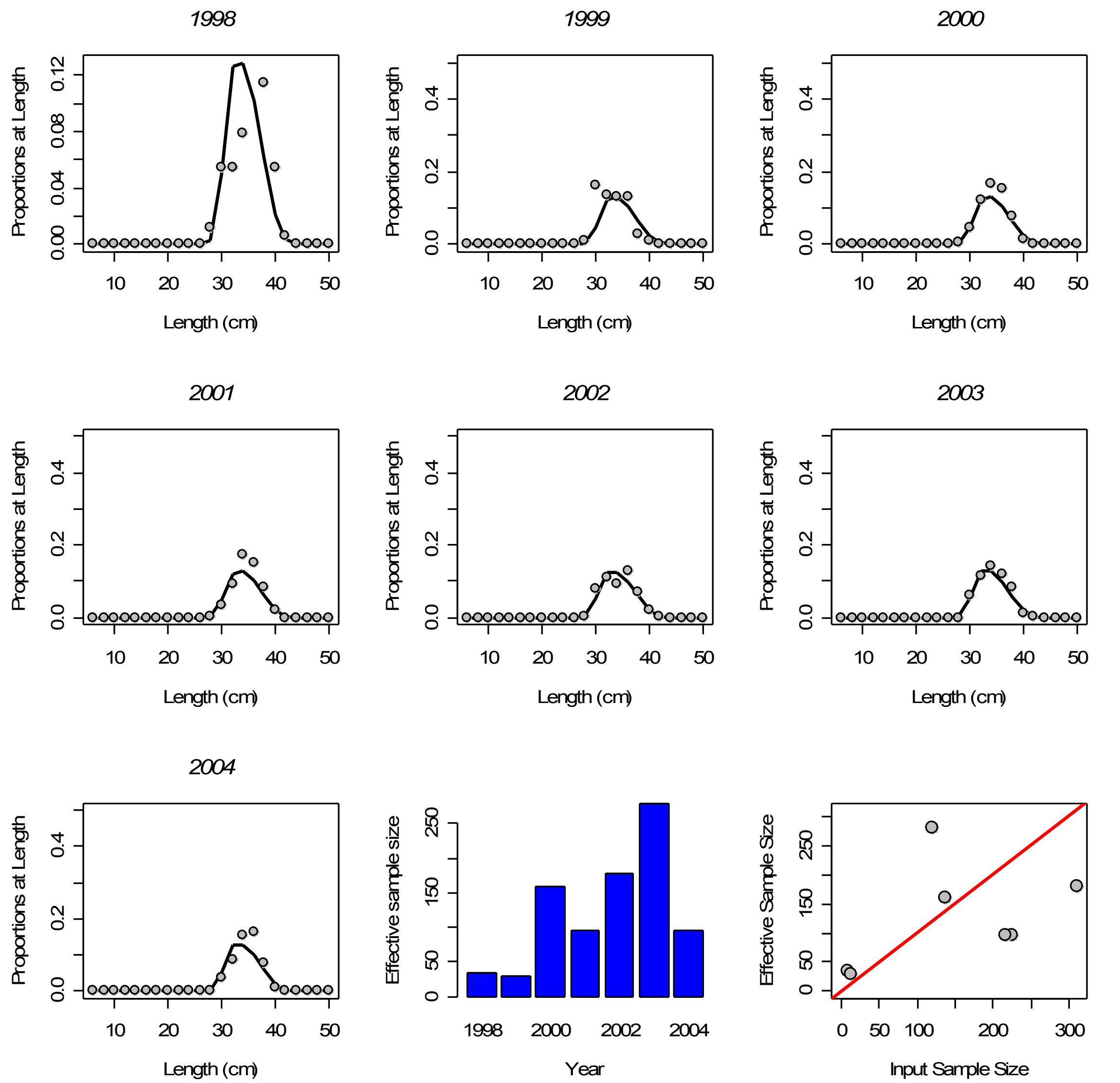


Figure 43. Observed (solid circles) and model-predicted (solid lines) male length-composition data for the Oregon commercial live-fish fleet (fleet 2). The annual effective sample sizes are summarized by the histogram and a comparison of inputted to effective sample sizes is given in the lower center panel (the solid red line in this panel is the 1:1 line).

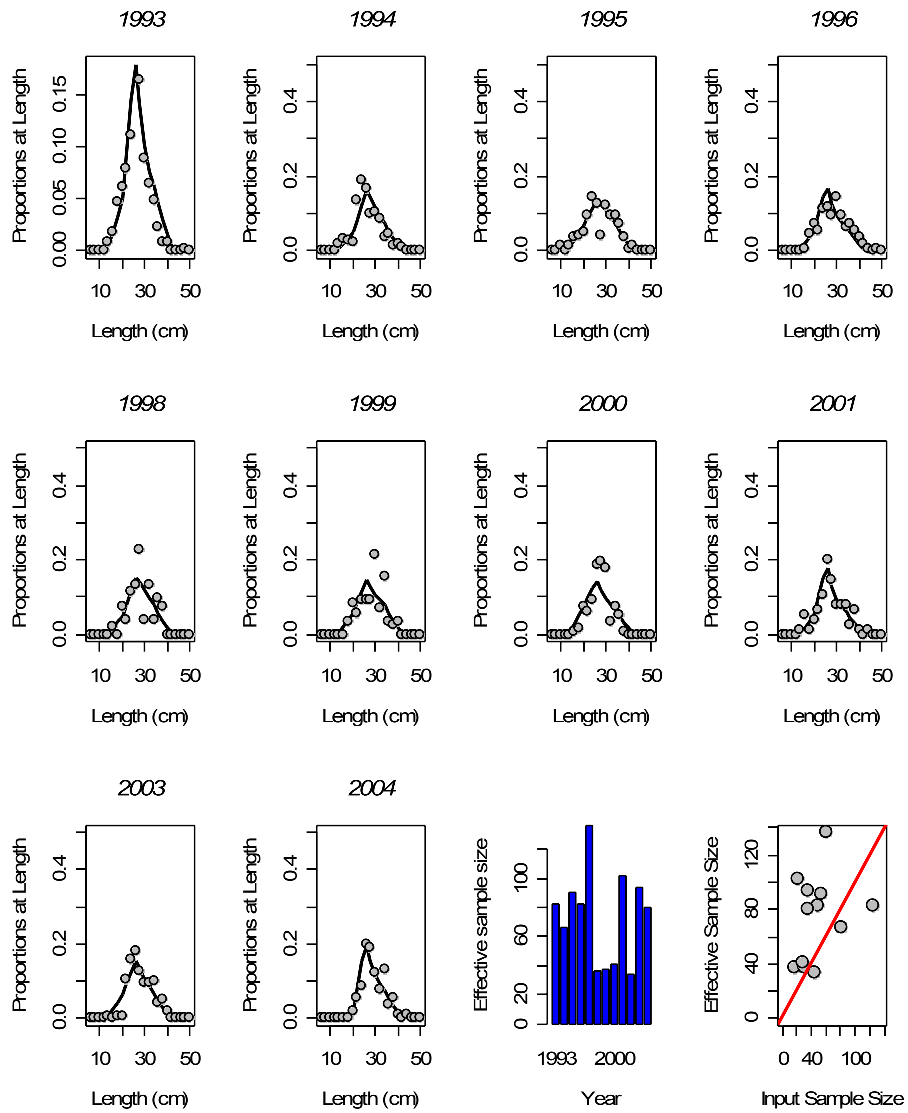


Figure 44. Observed (solid circles) and model-predicted (solid lines) length-composition data for the Oregon recreational man-made fish mode (fleet 3). The annual effective sample sizes are summarized by the histogram and a comparison of inputted to effective sample sizes is given in the lower center panel (the solid red line in this panel is the 1:1 line).

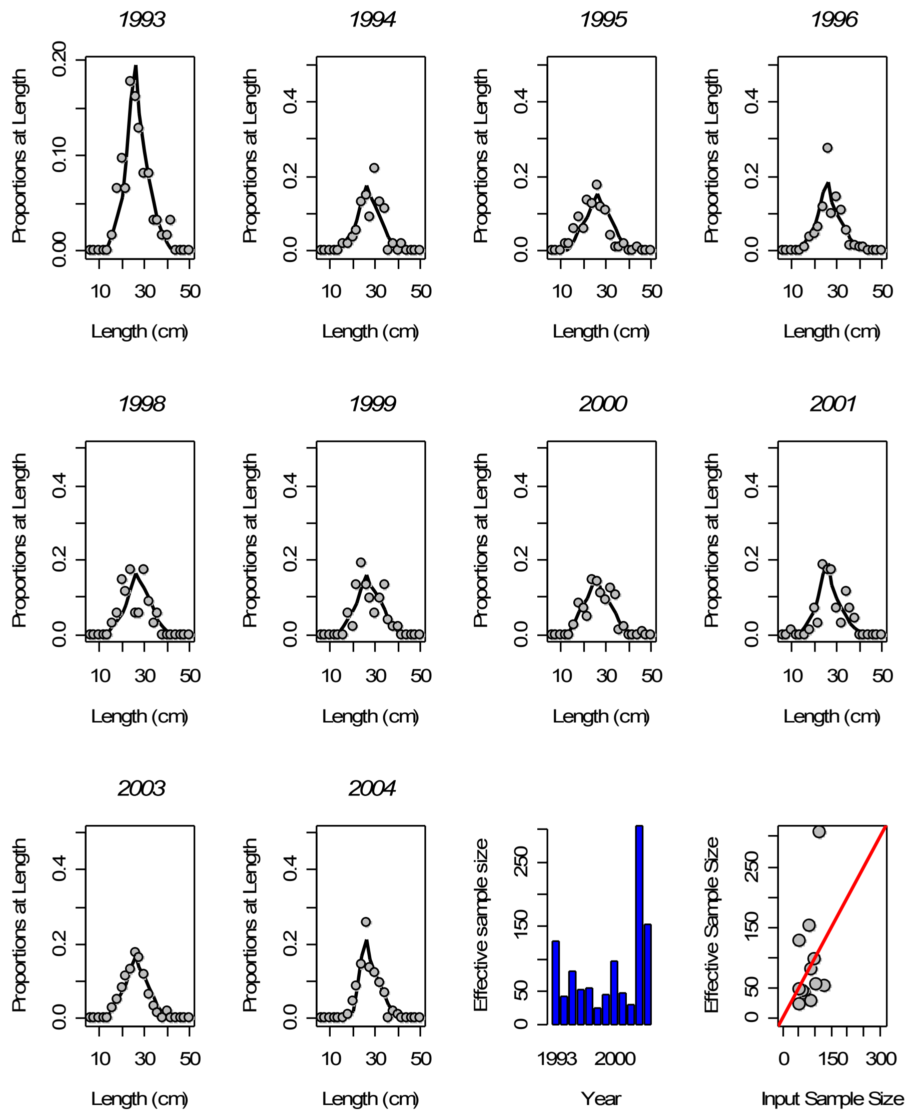


Figure 45. Observed (solid circles) and model-predicted (solid lines) length-composition data for the Oregon recreational beach/bank fish mode (fleet 4). The annual effective sample sizes are summarized by the histogram and a comparison of inputted to effective sample sizes is given in the lower center panel (the solid red line in this panel is the 1:1 line).

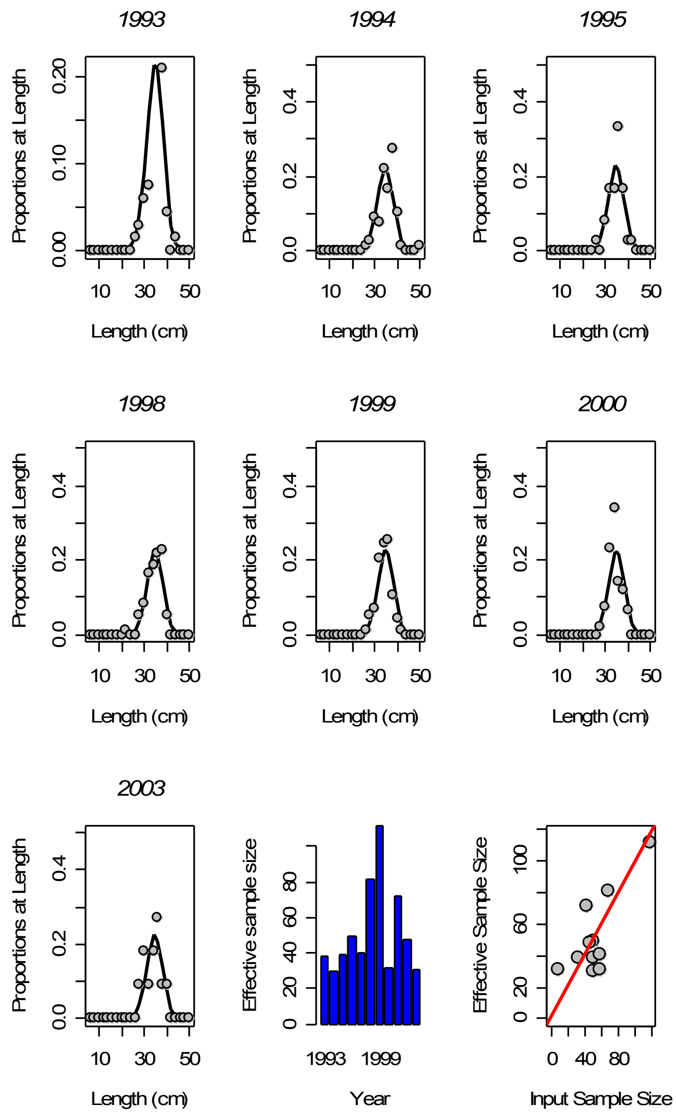


Figure 46. Observed (solid circles) and model-predicted (solid lines) length-composition data for the Oregon recreational CPFV fish mode (fleet 5). The annual effective sample sizes are summarized by the histogram and a comparison of inputted to effective sample sizes is given in the lower center panel (the solid red line in this panel is the 1:1 line).

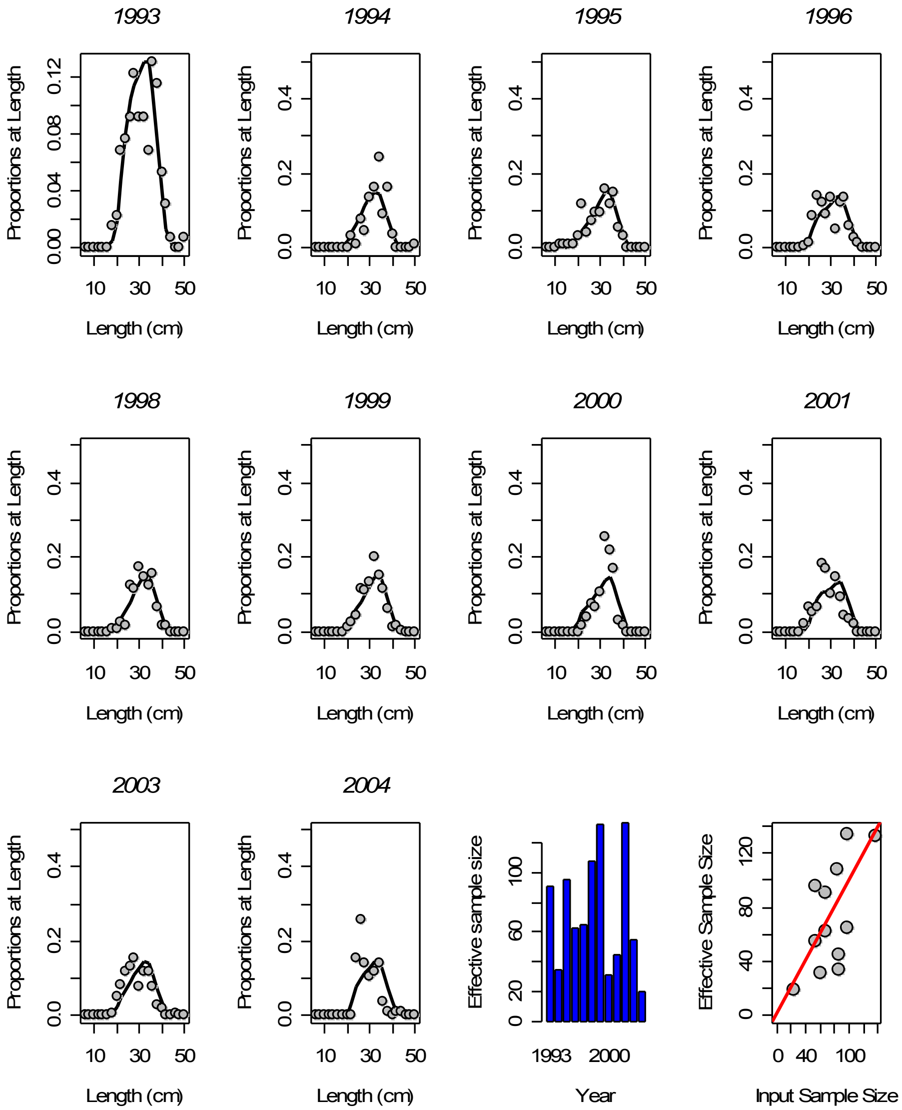
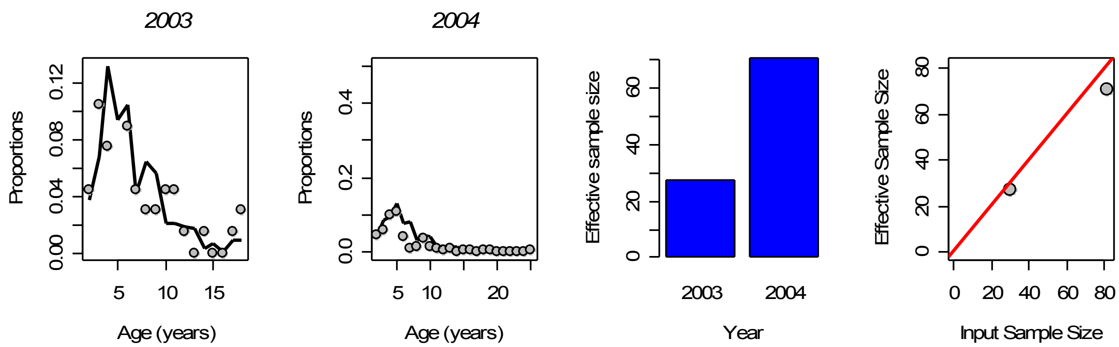


Figure 47. Observed (solid circles) and model-predicted (solid lines) length-composition data for the Oregon recreational PBR fish mode (fleet 6). The annual effective sample sizes are summarized by the histogram and a comparison of inputted to effective sample sizes is given in the lower center panel (the solid red line in this panel is the 1:1 line).

A) Female



B) Male

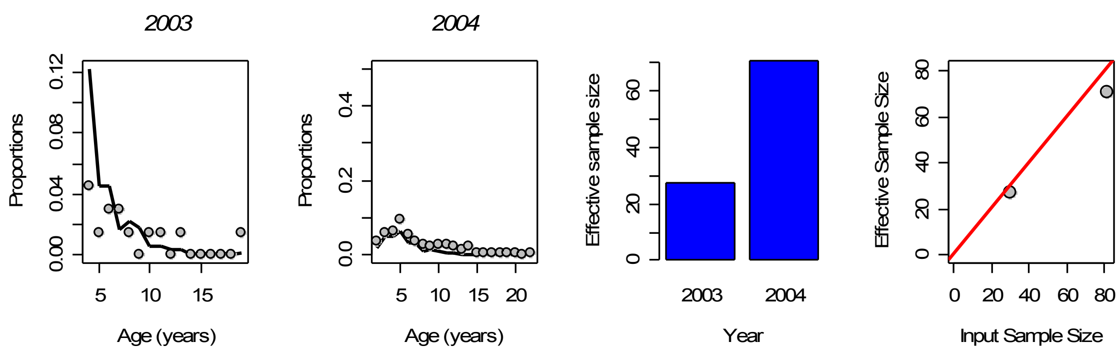
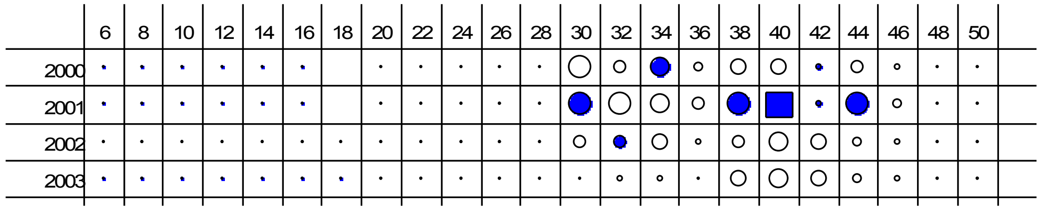
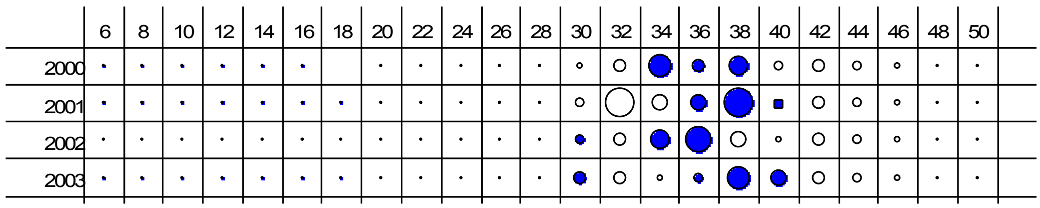


Figure 48. Observed (solid circles) and model-predicted (solid lines) gender-specific age-composition data for the Oregon recreational CPFV fish mode (fleet 5). The annual effective sample sizes are summarized by the histogram and a comparison of inputted to effective sample sizes is given in the lower center panel (the solid red line in this panel is the 1:1 line).

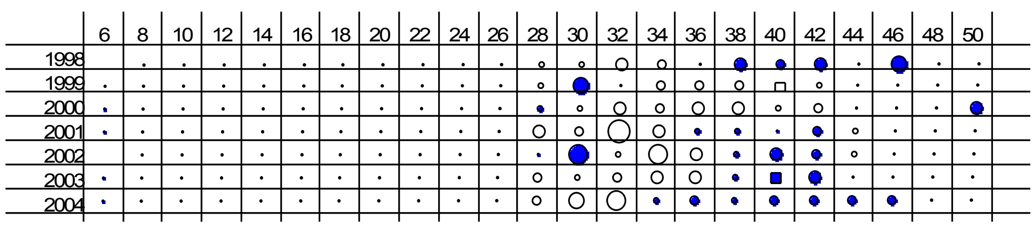
A) Oregon Commercial non-live (fleet 1) females



B) Oregon Commercial non-live (fleet 1) males



C) Oregon Commercial live-fish (fleet 2) females



D) Oregon Commercial live-fish (fleet 2) males

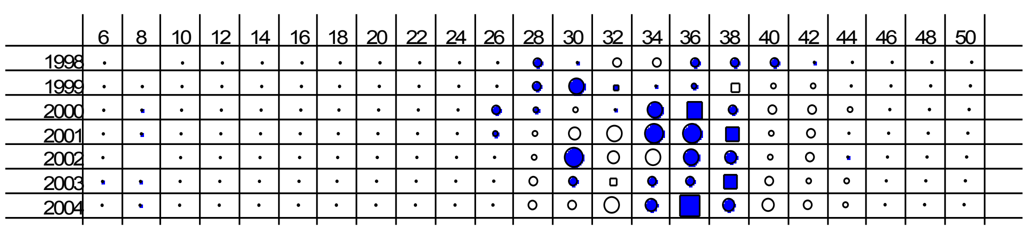
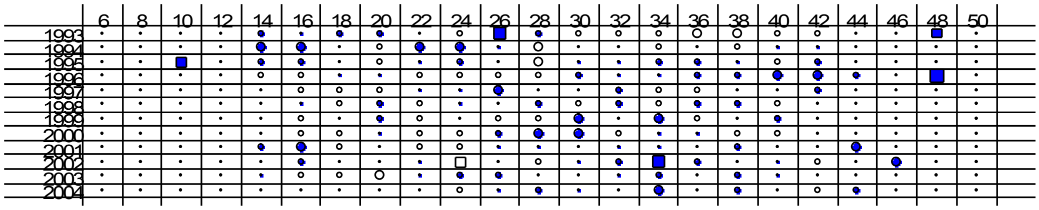
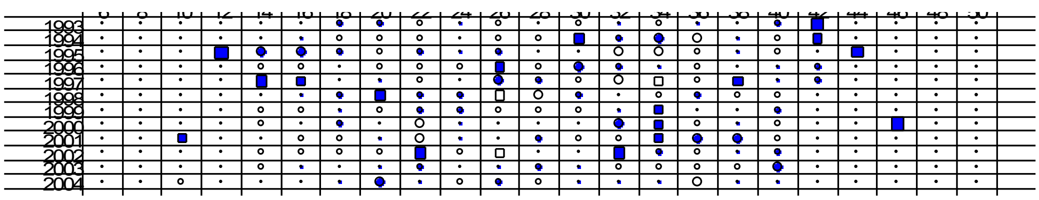


Figure 49. Pearson residual plots of fits to the length-composition data for the commercial fleets by gender. Solid symbols represent negative values; open symbols positive values; squares represent residuals <-2 and >2.

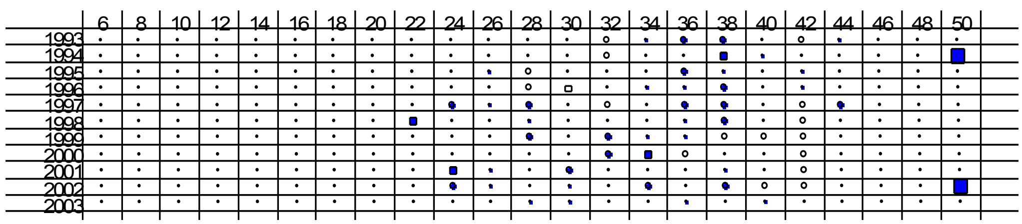
A) Oregon Recreational Man-made (fleet 3)



B) Oregon Recreational Beach/Bank (fleet 4)



C) Oregon Recreational CPFV (fleet 5)



D) Oregon Recreational PBR (fleet 6)

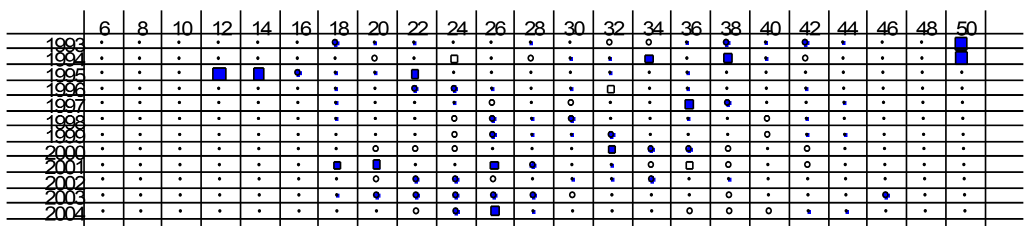
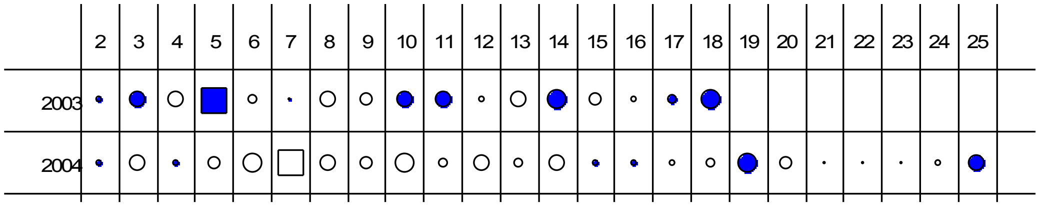


Figure 50. Pearson residual plots of fits to the length-composition data for the recreational modes. Solid symbols represent negative values; open symbols positive values; squares represent residuals <-2 and >2.

A) Oregon Recreational CPFV (fleet 6) females



B) Oregon Recreational CPFV (fleet 6) females

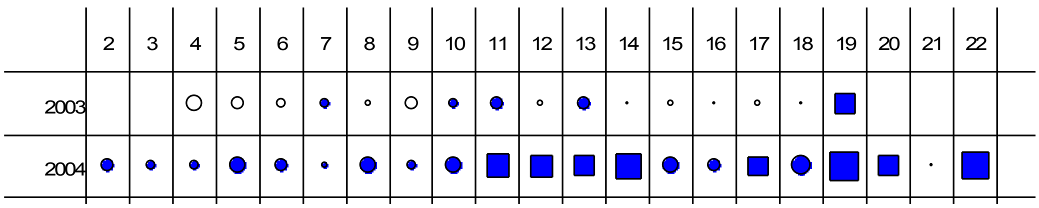
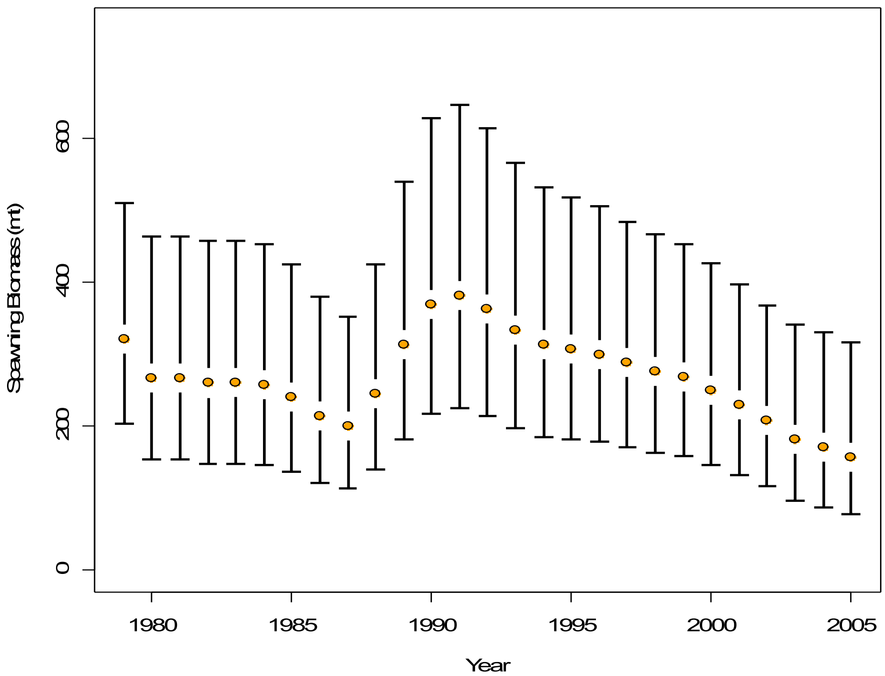


Figure 51. Pearson residual plots of fits to the age-composition data for the recreational CPFV mode. Solid symbols represent negative values; open symbols positive values; squares represent residuals <-2 and >2.

A) Spawning Biomass



B) Recruitment

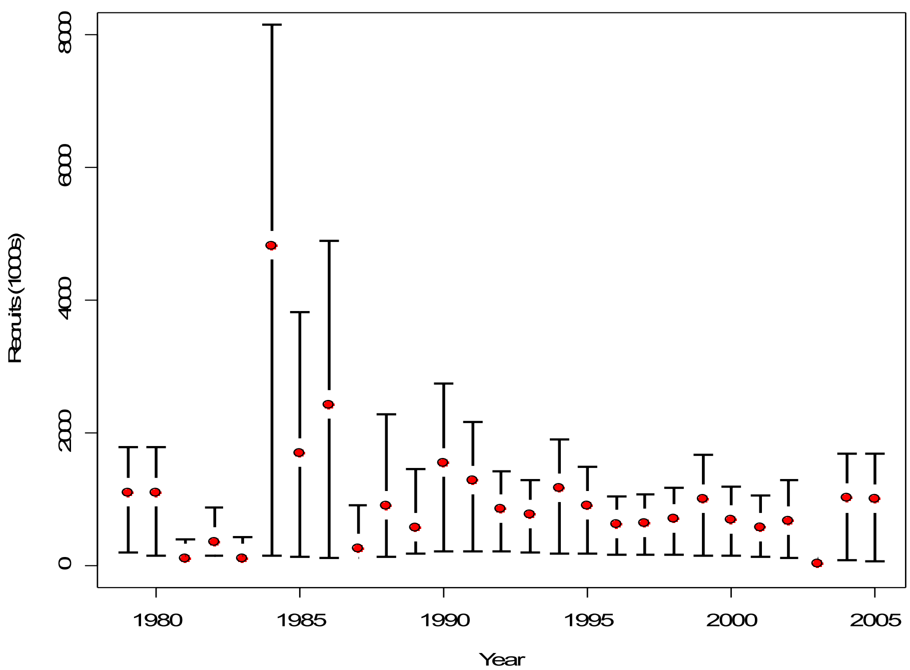


Figure 52. MPD time-trajectories of A) reproductive output (measured in spawning biomass) and B) recruitment for Oregon. The vertical bars represent 95% confidence intervals based on the asymptotic standard deviation.

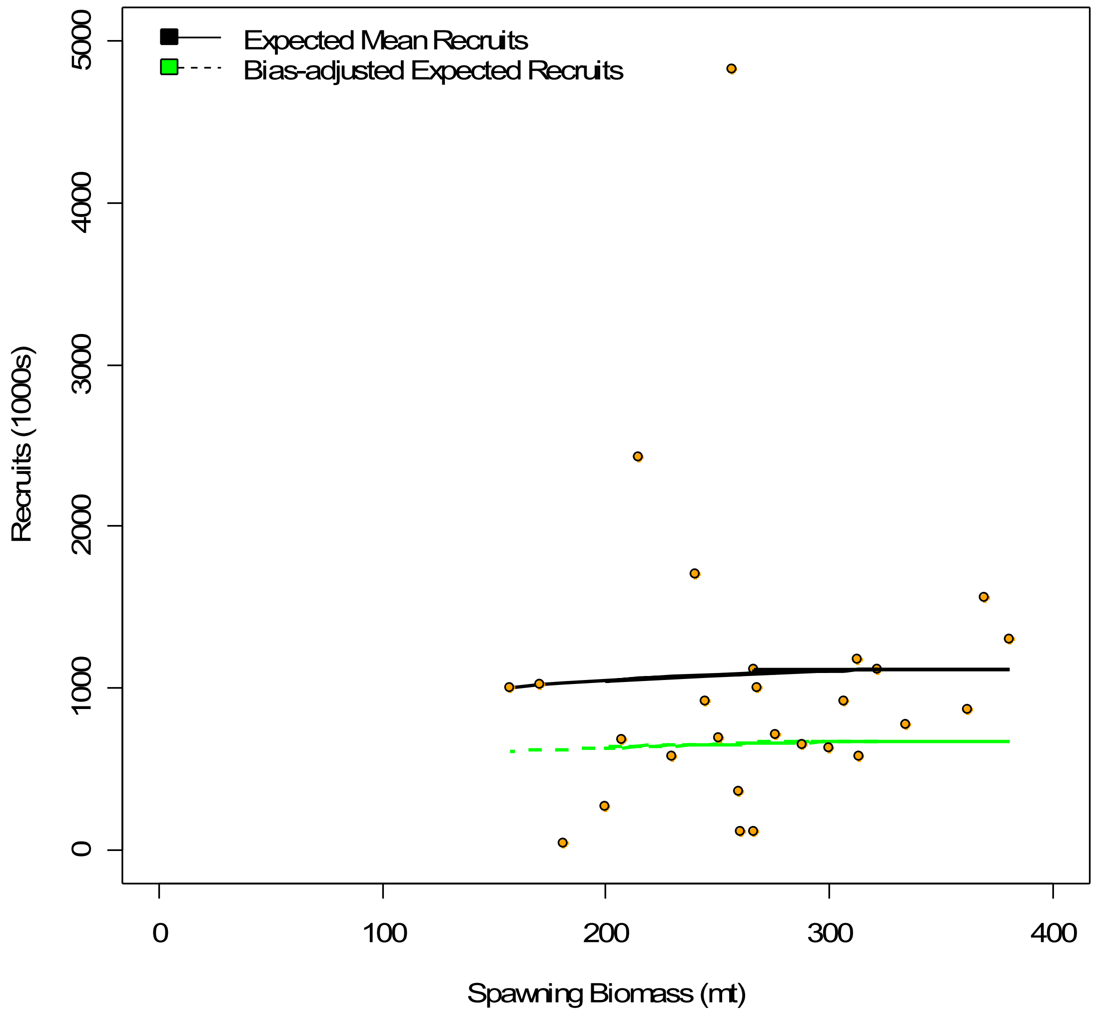


Figure 53. Relationship between spawners and recruits for Oregon.

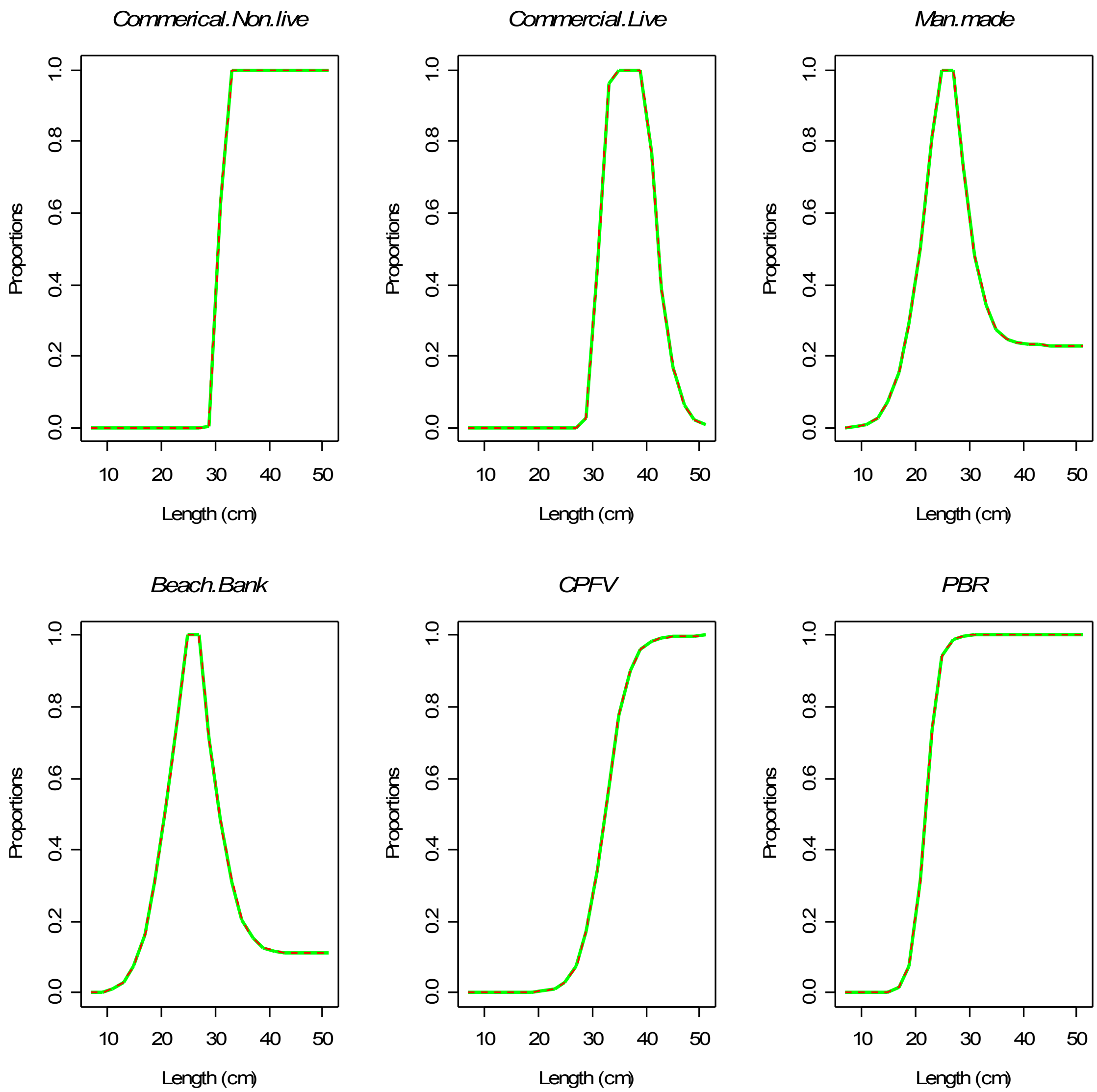


Figure 54. MPD estimates of selectivity as a function of length for Oregon.

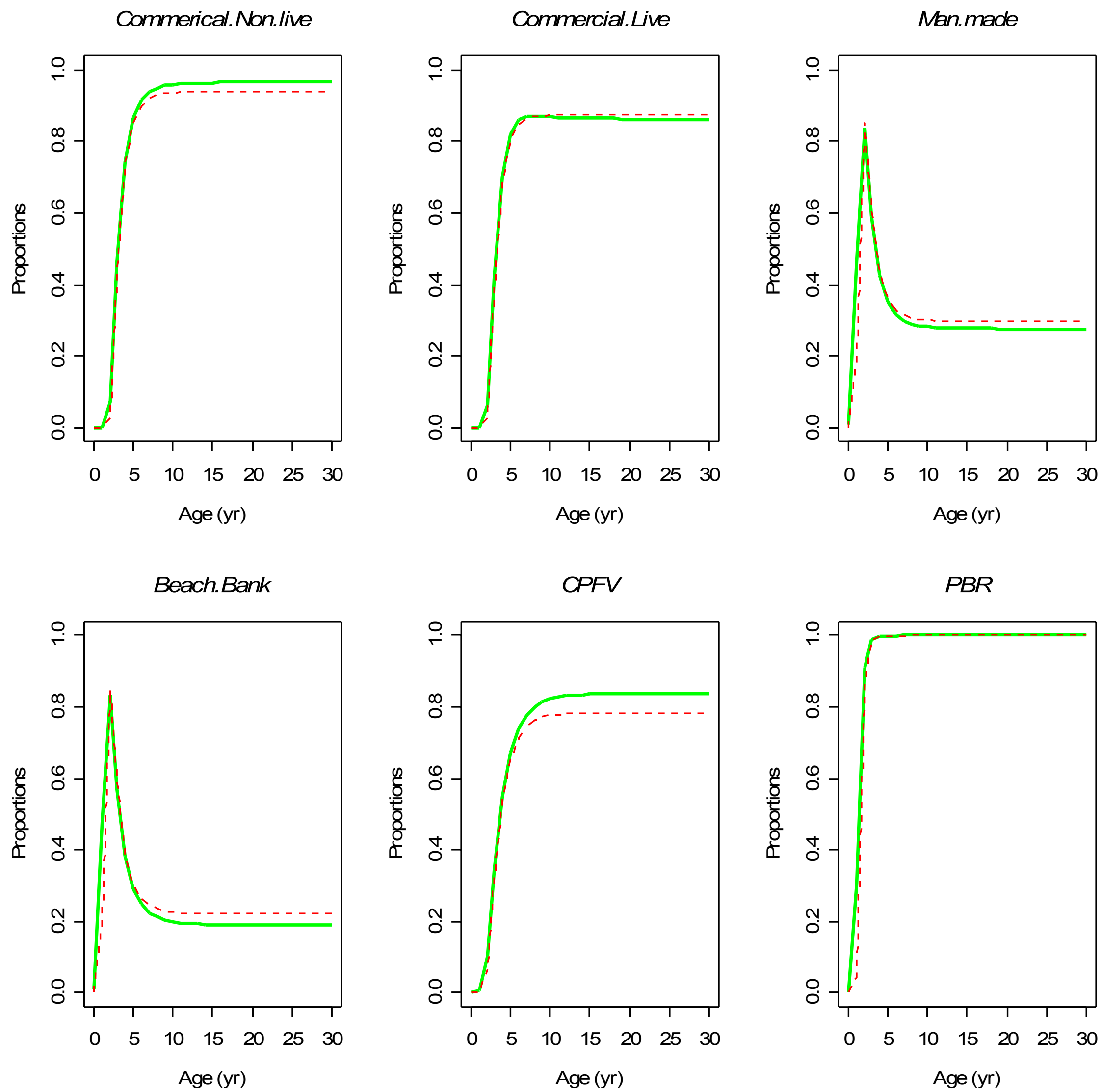


Figure 55. MPD estimates of selectivity as a function of age for Oregon (females: solid lines; males: dashed lines).

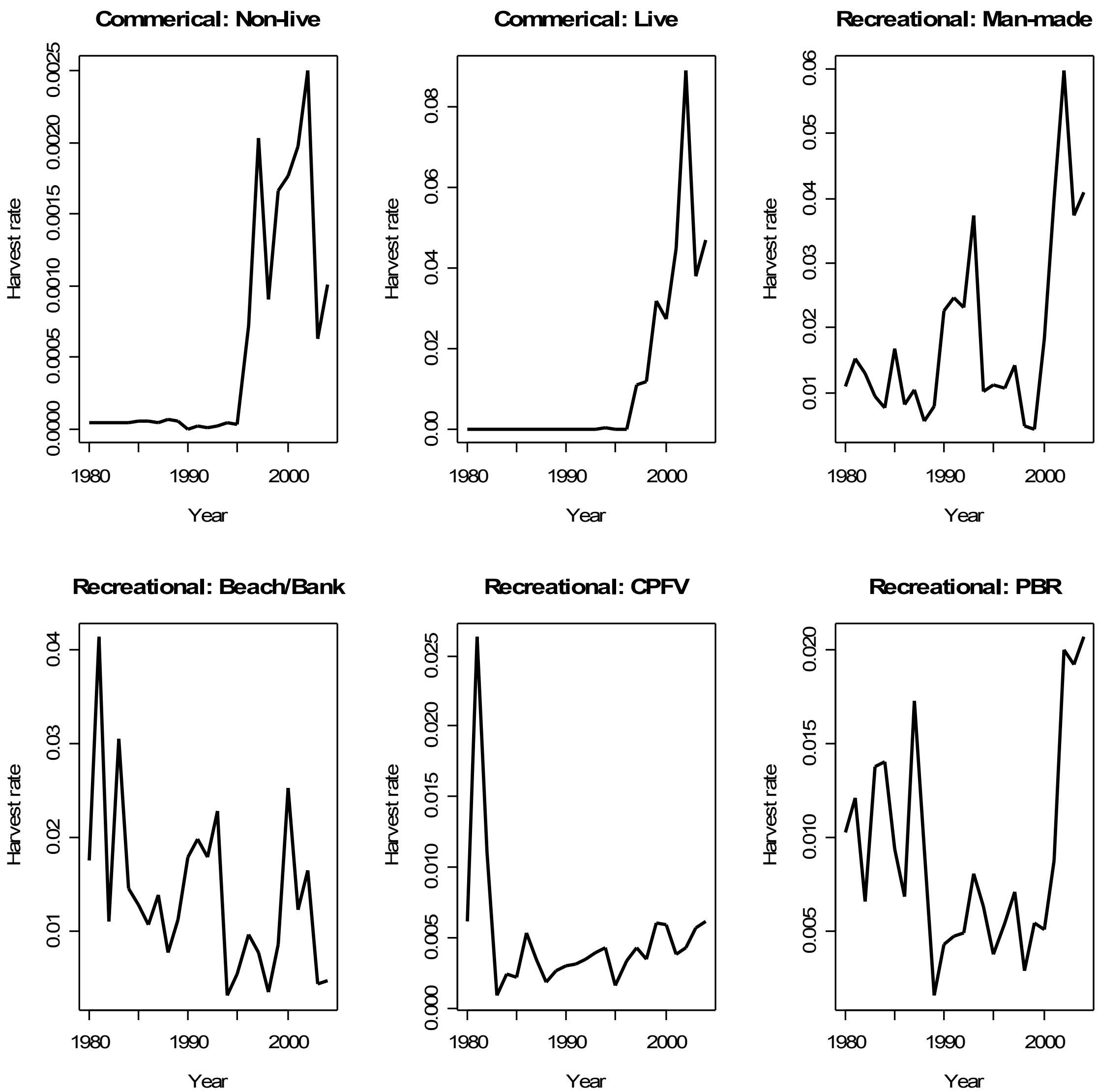


Figure 56. MPD estimates of harvest rate by fleet for Oregon.

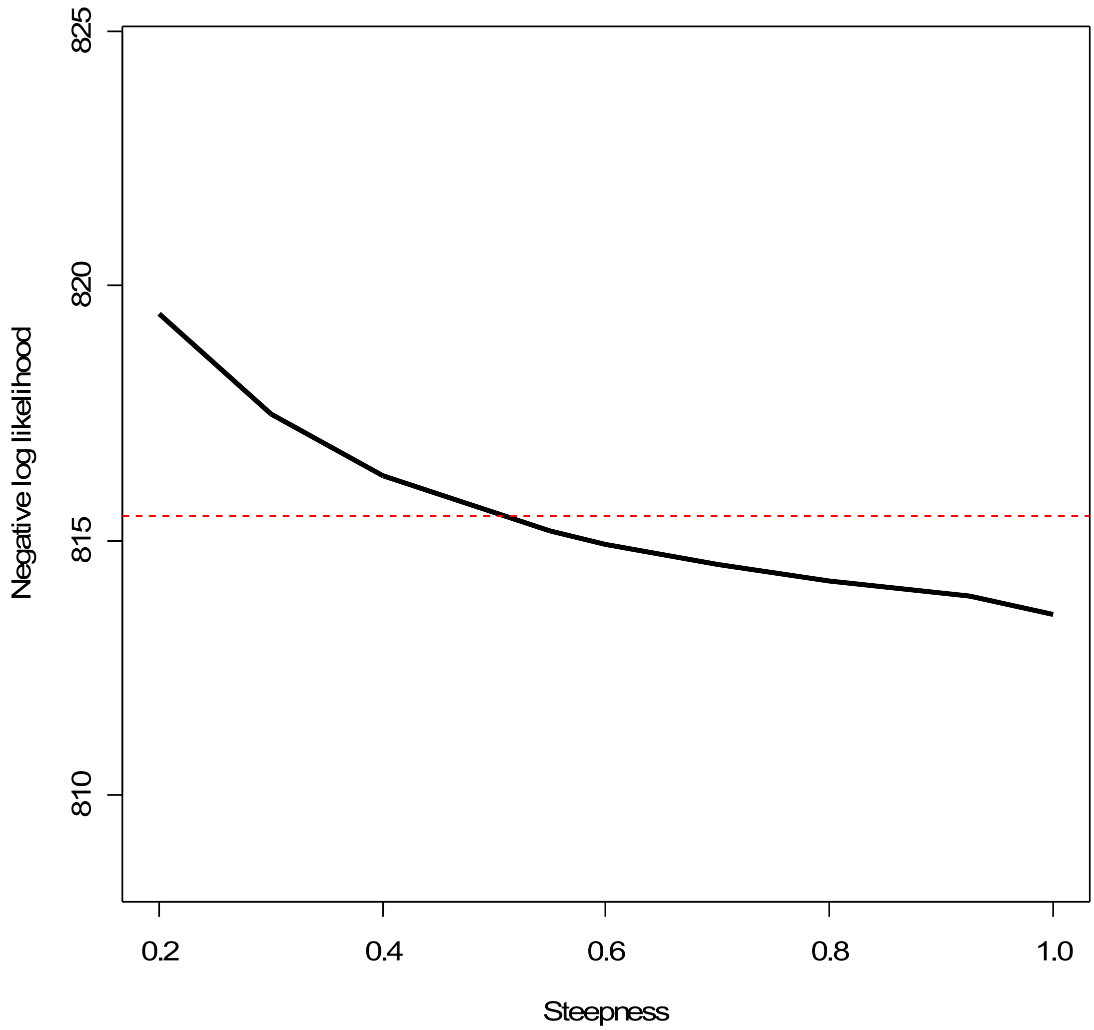


Figure 57. Likelihood profile for steepness for Oregon. The broken line represents the bound that defines a steepness that is significantly from the best estimate at α=0.05.

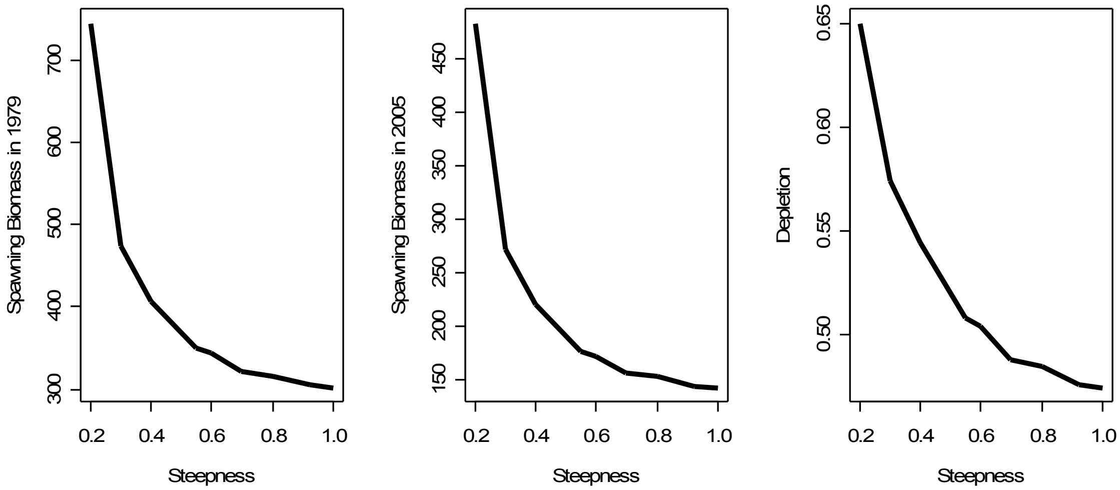


Figure 58. Beginning and ending spawning biomass and depletion for each steepness value in the likelihood profile for Oregon. Base case value: steepness = 0.7.

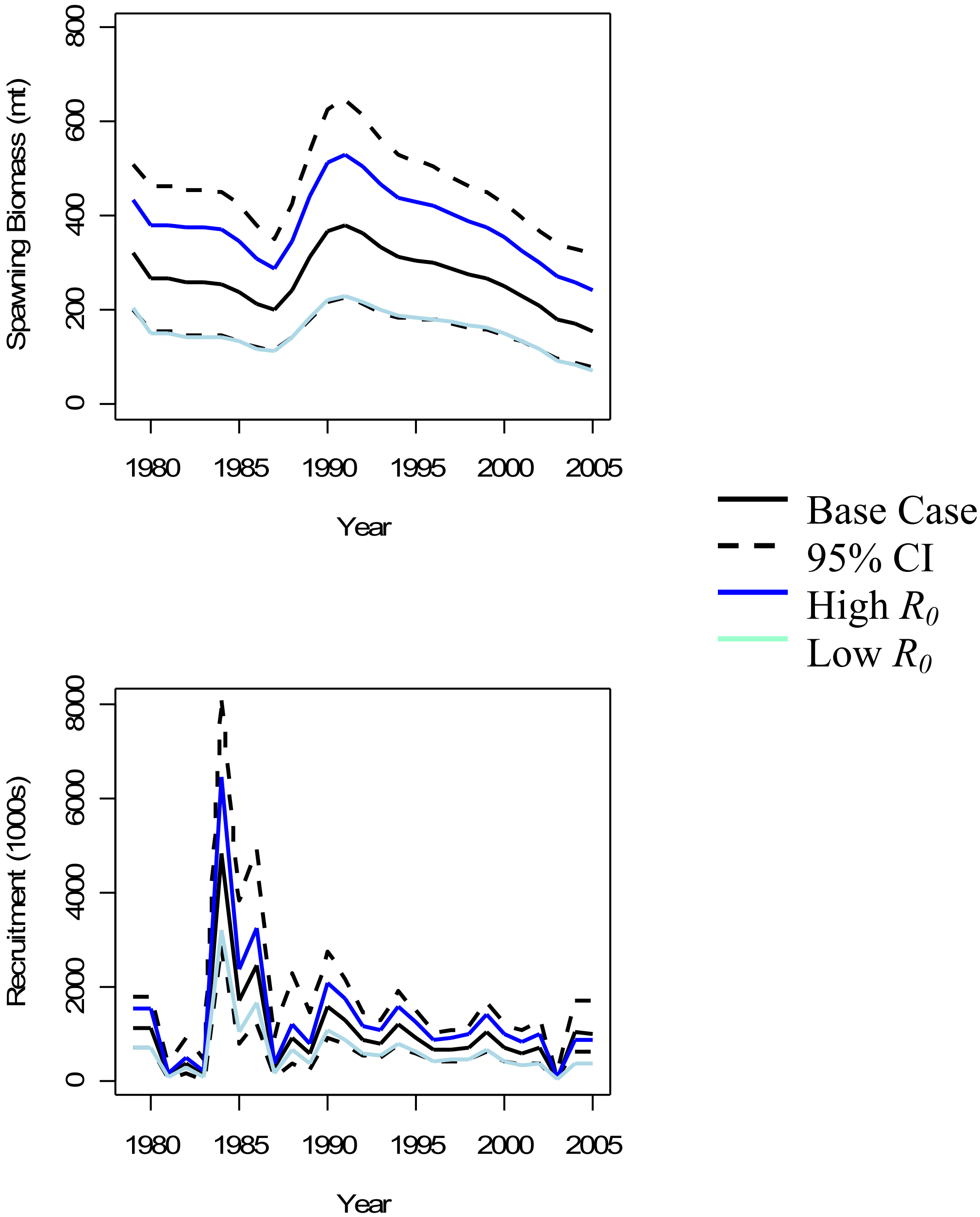


Figure 59. Time-trajectories of spawning biomass (upper panels) and recruitment (lower panels) for Oregon for the three different states of nature.

Appendix A. Summary of Management Measures Affecting Kelp Greenling

<u>OREGON</u>

Year	Description	Effective Date	Sector
1978	Aggregate bag limit: 15 kelp greenling, cabezon, or rockfish	3/17/78	Recreational
2003	Kelp greenling OY for Oregon set at 23.4 mt (commercial) and 5.2 mt (recreational)	2/22/03	Comm./Rec.
2003	Kelp greenling, cabezon, and rockfish bag-limit set at 10 fish/day	1/1/03	Recreational
2004	Kelp greenling size-limit set at 12 inches (Commercial); 10 inches (Recreational)	1/1/04	Comm./Rec.
2005	Kelp greenling, cabezon, and rockfish bag-limit set at 8 fish/day	1/1/05	Recreational

Appendix A continued.

CALIFORNIA

Year	Description	Effective Date	Sector
Pre-1999	Recreational Bag Limit of 10 fish w/in 20 fish aggregate	3/1/1984	Recreational
1999	Recreational size-limit set at 12 inches	1/1/1999	Recreational
1999	Recreational bag-limit set a 10 greenling/day	1/1/1999	Recreational
1999	Commercial size limit set at 13 inches	1/1/1999	Commercial
2000	State TAC set at 5,172 (commercial) and 34,651 (recreational).	1/1/2000	Comm./Rec.
2001	State TAC set at 13,420 (commercial) and 26,403 (recreational).	1/1/2001	Comm./Rec.
2001	New state TAC set at 19,420 (commercial) and 20,403 (recreational).	1/1/2001	Comm./Rec.
2001	Commerical fishery closed	9/1/2001	Commercial
2002	New state TAC set at 13,420 (commercial) and 26,403 (recreational).	1/1/2002	Comm./Rec.
2002	Commerical fishery closed	6/13/2002	Commercial
2003	New state TAC set at 13,420 (commercial) and 26,403 (recreational).	1/1/2003	Comm./Rec.
2003	Cumulative two-month trip limit of 50lb for January-February.	1/1/2003	Commercial
2003	Commerical fishery closed	6/19/2003	Commercial
2004	New state TAC set at 3,400 (commercial) and 36,423 (recreational).	1/1/2004	Comm./Rec.
2004	Cumulative two-month trip limit of 25lb for January-February.	1/1/2004	Commercial
2004	Commerical fishery closed	8/15/2004	Commercial
2005	New state TAC set at 3,400 (commercial) and 34,200 (recreational).	1/1/2004	Comm./Rec.
2005	Cumulative two-month trip limit of 25lb for January-February.	1/1/2005	Commercial

Appendix B-1. SS2 .DAT File for the OREGON model

#_Number_of_datafiles: 1
#_start_nudata: 1
1981 #_styr
2004 #_endyr
1 #N_seasons_per_year
12 #vector_with_N_months_in_each_season
1 #spawning_season_-_spawning_will_occur_at_beginning_of_this_season
6 #N_fishing_fleets
4 #N_surveys

fleet1%fleet2%fleet3%fleet4%fleet5%fleet6%survey1%survey2%survey3%survey4

0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5 #survey timing

2 #number_of_genders(1 / 2)
30 #accumulator_age;_model_always_starts_with_age_0

#Catch (mt)

#Fleet 1	#Fleet 2	#Fleet 3	#Fleet 4	#Fleet 5	#Fleet 6
#Non-Live	Live	Man-made	Shore	CPFV	PBR
0.036173987	0	5.179539182	7.125325929	4.32393478	11.41133039
0.036173987	0	7.213465179	16.76069341	18.56142155	13.50204735
0.036173987	0	5.711242252	4.147176702	7.598122028	7.061215034
0.036173987	0	3.27183404	8.639537554	0.589262088	13.30124578
0.036173987	0	2.181678104	3.306376362	1.481454758	11.90093954
0.036173987	0	5.712726423	3.743707881	1.208668775	7.420591749
0.036173987	0	5.702171843	6.969321142	2.825216152	7.859503839
0.036173987	0	7.827102128	9.566458156	2.408395426	24.27686492
0.080285839	0	4.264729764	5.21244749	1.617583507	14.91954083
0.0766571	0	4.730902907	5.782214664	2.625288731	2.460024495
0.003175146	0	12.24041845	8.025544334	2.950168438	6.363894905
0.022679615	0	12.24041845	8.025544334	2.950168438	6.363894905
0.013154177	0.002721554	12.24041845	8.025544334	2.950168438	6.363894905
0.0235868	0.059420593	19.74993399	10.268874	3.275048146	10.26776532
0.039008939	0.141974393	4.844984187	1.281529078	3.397348707	7.599783892
0.030844277	0.007257477	5.039634537	2.057838006	1.271824505	4.365165622
0.640018749	0.024947577	4.924113712	3.776293868	2.469846028	6.15657337
1.7694636	8.801505178	6.319485829	2.903729499	3.119121694	7.832290934
0.764303042	9.070031826	1.940220794	1.197581823	2.385024562	2.988727877
1.322675175	23.29786181	1.643191253	2.668128869	3.979512742	5.266398069
1.28638779	18.12781666	6.582833532	7.616575875	3.605155727	4.598014875
1.326757506	27.58703069	14.5607371	3.817871652	2.143074153	7.614754975
1.594830561	51.89549616	20.01491759	4.719081804	2.23513563	16.28232484
0.355616371	19.73398703	10.94447654	1.097907561	2.669661064	13.78328666
0.53024941	22.74765433	10.94447654	1.097907561	2.669661064	13.78328666

#Abundance_Indices
78 #_N_observations

#Year	Season	Type	Value	CV
1981	1	7	0.02453148	0.538665155
1982	1	7	0.01654244	0.997527824
1983	1	7	0.05122276	0.385297457
1984	1	7	0.01127527	0.313101751

1985	1	7	0.0768208	0.190764739
1986	1	7	0.1073843	0.380729773
1987	1	7	0.09228717	0.228630758
1988	1	7	0.10670248	0.299831626
1989	1	7	0.01834708	0.817329975
1993	1	7	0.06111463	0.589572406
1994	1	7	0.04282475	0.530887645
1995	1	7	0.07987446	0.251732654
1996	1	7	0.03689207	2.612739824
1997	1	7	0.11372035	0.340651975
1998	1	7	0.03301795	1.555391212
1999	1	7	0.01391737	0.327818812
2000	1	7	0.06385161	0.389215248
2001	1	7	0.04681632	0.34335576
2002	1	7	0.02771597	0.638765938
2003	1	7	0.05168103	0.647989467
1981	1	8	0.033114601	1.6273153
1982	1	8	0.036717939	0.217402325
1983	1	8	0.017553267	0.894225929
1984	1	8	0.015824294	0.209891413
1985	1	8	0.054535527	0.2778564
1986	1	8	0.048827546	1.366843573
1987	1	8	0.062079673	0.379235958
1988	1	8	0.035768465	2.199936087
1993	1	8	0.099521144	0.327281669
1994	1	8	0.043841571	0.197274942
1995	1	8	0.04264278	0.354741788
1996	1	8	0.01847757	0.471274428
1997	1	8	0.031606756	0.295942869
1999	1	8	0.005707516	1.261171335
2000	1	8	0.109439835	0.193972378
2001	1	8	0.017371119	0.180121859
2002	1	8	0.029969061	0.22951362
2003	1	8	0.01678272	0.595506024
1981	1	9	0.10857635	0.373789824
1982	1	9	0.0407259	0.204704301
1983	1	9	0.03156429	0.107110668
1984	1	9	0.03662877	0.34447237
1985	1	9	0.03178757	0.397221226
1986	1	9	0.07022042	0.140354575
1987	1	9	0.01756867	0.44621442
1988	1	9	0.07999877	0.212047689
1989	1	9	0.01878039	2.10532599
1993	1	9	0.07855615	0.161826484
1994	1	9	0.05267289	0.283083736
1995	1	9	0.03958429	0.094800854
1996	1	9	0.03622088	0.229089304
1997	1	9	0.04554504	0.458709486
1998	1	9	0.02852675	0.362847559
1999	1	9	0.07532451	0.120171179
2000	1	9	0.06076626	0.134822267
2001	1	9	0.01945723	1.03452087
2002	1	9	0.04196724	0.141893715
2003	1	9	0.03280411	2.879443546
1981	1	10	0.08138066	2.181107297
1982	1	10	0.11777498	0.341337213

1983	1	10	0.14566967	0.656394466
1984	1	10	0.0861227	0.368843684
1985	1	10	0.06727163	0.296120995
1986	1	10	0.07397353	0.298141266
1987	1	10	0.08036383	0.460170314
1988	1	10	0.13487156	0.476538295
1989	1	10	0.13745103	0.423539561
1993	1	10	0.27938491	0.127966759
1994	1	10	0.13460151	0.222059355
1995	1	10	0.09195162	0.223796311
1996	1	10	0.10548607	0.231550142
1997	1	10	0.23859854	0.403094099
1998	1	10	0.05366587	0.085465945
1999	1	10	0.09506455	0.136974665
2000	1	10	0.09782701	0.208248213
2001	1	10	0.06057748	0.216379484
2002	1	10	0.08186322	0.100493351
2003	1	10	0.09088812	0.483199364

#_Discard_Biomass
1 #_(1=biomass;_2=fraction)
0 #_N_observations
#Year Season Type Value CV

#_Mean_BodyWt
36 #N_observations

# Year	Seas	Type	Partition	Value	CV
1981	1	3	2	0.287685967	0.499614742
1982	1	3	2	0.274590042	0.516849595
1983	1	3	2	0.314759393	0.650590102
1984	1	3	2	0.252098806	0.58173905
1985	1	3	2	0.242240486	0.564214503
1986	1	3	2	0.230433292	0.702103069
1987	1	3	2	0.322203437	0.690827043
1988	1	3	2	0.295339352	0.595846023
1989	1	3	2	0.295836024	0.428839307
1981	1	4	2	0.308173117	0.53962702
1982	1	4	2	0.298321349	0.55244248
1983	1	4	2	0.265358191	0.613367732
1984	1	4	2	0.245071793	0.68554506
1985	1	4	2	0.291491	0.519959648
1986	1	4	2	0.385394939	0.64198619
1987	1	4	2	0.350552368	0.459196501
1988	1	4	2	0.297447653	0.944963105
1989	1	4	2	0.361052916	0.575366232
1981	1	5	2	0.685861592	0.248820793
1982	1	5	2	0.751928813	0.303088941
1983	1	5	2	0.591686379	0.328727466
1984	1	5	2	0.580619719	0.262898735
1985	1	5	2	0.502821511	0.446333058
1986	1	5	2	0.627034653	0.326607859
1987	1	5	2	0.6118572	0.304830738
1988	1	5	2	0.620449812	0.299211242
1989	1	5	2	0.621039973	0.278850592
1981	1	6	2	0.504575217	0.458659467
1982	1	6	2	0.560913883	0.436703667

```
1983	1	6	2	0.49522601	0.301033007
1984	1	6	2	0.412663972	0.569036935
1985	1	6	2	0.38141481	0.502618514
1986	1	6	2	0.326445209	0.59012959
1987	1	6	2	0.356985026	0.526162647
1988	1	6	2	0.441283035	0.498107417
1989	1	6	2	0.39201156	0.573992797

-1	#min_proportion_for_compressing_tails_of_observed_composition
0.0001	#_constant added to expected frequencies

23	#_N_length_bins
#_lower_edge_of_length_bins
6	8	10	12	14	16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50

58	#N_observations
#Year	Seas	Fleet	sexes	Mkt	Nsamp	6	8	10	12	14	16
	18	20	22	24	26	28	30	32	34	36	38
	40	42	44	46	48	50	6	8	10	12	14
	16	18	20	22	24	26	28	30	32	34	36
	38	40	42	44	46	48	50
2000	1	1	3	0	46.30600428	0	0	0	0	0
	0	0	0	0	0	0	0	0	0.086206897
	0.172413793	0.086206897	0.034482759	0.017241379	0.017241379	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0.051724138	0.086206897	0.206896552
	0.120689655	0.103448276	0.017241379	0	0	0	0	0
2001	1	1	3	0	63.67079128	0	0	0	0	0
	0	0	0	0	0	0	0	0.114754098	0.049180328
	0.06557377	0.081967213	0.114754098	0.098360656	0.016393443
	0.016393443	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.049180328	0	0.081967213
	0.131147541	0.147540984	0.032786885	0	0	0	0	0
2002	1	1	3	0	34.729574	0	0	0	0	0
	0	0	0	0	0	0	0	0.042553191	0.14893617
	0.063829787	0.085106383	0.042553191	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0.085106383	0.085106383	0.191489362	0.212765957
	0.021276596	0.021276596	0	0	0	0	0
2003	1	1	3	0	46.30600428	0	0	0	0	0
	0	0	0	0	0	0	0	0.063492063	0.111111111
	0.111111111	0.095238095	0.031746032	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0.095238095	0.095238095	0.111111111	0.111111111
	0.126984127	0.047619048	0	0	0	0	0
1998	1	2	3	0	9.352431352	0	0	0	0	0
	0	0	0	0	0	0	0	0.036363636	0.042424242
	0.078787879	0.103030303	0.133333333	0.054545455	0.024242424	0
	0.006060606	0	0	0	0	0	0	0	0	0
	0	0	0	0	0.012121212	0.054545455	0.054545455
	0.078787879	0.145454545	0.115151515	0.054545455	0.006060606	0
	0	0	0
1999	1	2	3	0	12.4698603	0	0	0	0	0
	0	0	0	0	0	0	0	0.121052632	0.110526316
	0.063157895	0.068421053	0.026315789	0	0	0	0	0
```

0 0 0 0 0 0 0 0 0 0 0
0 0.010526316 0.163157895 0.136842105 0.131578947 0.131578947
0.026315789 0.010526316 0 0 0 0 0
2000 1 2 3 0 137.1686078 0 0 0 0 0
0 0 0 0 0 0 0.002890173 0.040462428
0.086705202 0.111271676 0.091040462 0.053468208 0.026734104
0.00216763 0.000722543 0 0 0.000722543 0 0 0
0 0 0 0 0 0 0 0.000722543 0.002890173
0.043352601 0.121387283 0.169075145 0.153179191 0.078757225
0.014450867 0 0 0 0 0
2001 1 2 3 0 224.457919 0 0 0 0 0
0 0 0 0 0 0 0.000351617 0.042897328
0.059774965 0.106891702 0.111111111 0.076652602 0.031293952
0.009142053 0.000351617 0 0 0 0 0 0 0
0 0 0 0 0 0 0.000351617 0.00140647
0.035513361 0.091420534 0.175105485 0.154008439 0.082981716
0.019338959 0.001054852 0.000351617 0 0 0
2002 1 2 3 0 310.1881182 0 0 0 0 0
0 0 0 0 0 0 0.002860114 0.081903276
0.115184607 0.09074363 0.08450338 0.072022881 0.036401456
0.007800312 0.000520021 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0.001820073 0.080083203
0.111284451 0.094383775 0.128705148 0.070722829 0.01924077
0.001300052 0.000520021 0 0 0
2003 1 2 3 0 120.0227125 0 0 0 0 0
0 0 0 0 0 0 0.000610501 0.047008547
0.108058608 0.101953602 0.076312576 0.073870574 0.036630037
0.012210012 0.000610501 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0.064102564
0.115384615 0.143467643 0.12026862 0.084859585 0.012820513
0.001831502 0 0 0 0
2004 1 2 3 0 216.6638047 0 0 0 0 0
0 0 0 0 0 0 0.000390625 0.031640625
0.070703125 0.128125 0.116015625 0.073828125 0.03359375
0.008203125 0.0015625 0.000390625 0 0 0 0 0
0 0 0 0 0 0 0 0 0.00078125
0.03984375 0.08828125 0.15390625 0.164453125 0.07734375
0.010546875 0.000390625 0 0 0 0
1993 1 3 0 0 125.81496 0 0 0 0
0.008888889 0.017777778 0.046666667 0.062222222 0.08 0.111111111
0.264444444 0.164444444 0.088888889 0.064444444 0.048888889
0.022222222 0.008888889 0.008888889 0 0 0 0.002222222
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0
1994 1 3 0 0 81.01692482 0 0 0 0
0.017021277 0.034042553 0.025531915 0.021276596 0.136170213
0.191489362 0.165957447 0.09787234 0.10212766 0.085106383
0.038297872 0.046808511 0.012765957 0.017021277 0.008510638 0
0 0 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 3 0 0 53.37589314 0 0 0.014285714 0
0.014285714 0.035714286 0.042857143 0.05 0.092857143 0.142857143
0.128571429 0.042857143 0.121428571 0.092857143 0.092857143
0.071428571 0.035714286 0.007142857 0.014285714 0 0 0

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 3 0 0 49.56327679 0 0 0 0 0
0.005952381 0.047619048 0.071428571 0.053571429 0.113095238
0.119047619 0.095238095 0.142857143 0.095238095 0.06547619
0.071428571 0.053571429 0.035714286 0.017857143 0.005952381 0
0.005952381 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 3 0 0 60.04785679 0 0 0 0 0
0.004807692 0.019230769 0.033653846 0.086538462 0.144230769
0.230769231 0.129807692 0.096153846 0.120192308 0.043269231
0.038461538 0.028846154 0.009615385 0.014423077 0 0 0
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 3 0 0 17.15654365 0 0 0 0 0
0.019230769 0 0.076923077 0.038461538 0.115384615 0.134615385
0.230769231 0.038461538 0.134615385 0.038461538 0.096153846
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
1999 1 3 0 0 30.50047095 0 0 0 0 0
0 0.035714286 0.083333333 0.05952381 0.095238095 0.095238095
0.095238095 0.214285714 0.071428571 0.154761905 0.035714286
0.023809524 0.035714286 0 0 0 0 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 3 0 0 27.64103168 0 0 0 0 0
0.00862069 0.017241379 0.077586207 0.060344828 0.094827586
0.189655172 0.198275862 0.181034483 0.034482759 0.077586207
0.051724138 0.00862069 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
2001 1 3 0 0 21.92224511 0 0 0 0
0.013333333 0.053333333 0.013333333 0.04 0.066666667 0.106666667
0.2 0.146666667 0.08 0.08 0.08 0.026666667 0.066666667
0.013333333 0 0.013333333 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
2002 1 3 0 0 43.84449022 0 0 0 0 0
0.038461538 0.027472527 0.043956044 0.093406593 0.027472527
0.148351648 0.098901099 0.10989011 0.120879121 0.159340659
0.082417582 0.027472527 0.016483516 0 0 0.005494505 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0
2003 1 3 0 0 35.26617241 0 0 0 0
0.006329114 0 0.006329114 0.006329114 0.107594937 0.158227848
0.183544304 0.126582278 0.094936709 0.094936709 0.101265823
0.044303797 0.050632911 0.018987342 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0

2004 1 3 0 0 36.21934949 0 0 0 0 0
0 0 0.019047619 0.057142857 0.085714286 0.2 0.19047619
0.123809524 0.076190476 0.133333333 0.038095238 0.057142857
0.00952381 0 0.00952381 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
1993 1 4 0 0 53.01224238 0 0 0 0 0
0.016129032 0.064516129 0.096774194 0.064516129 0.177419355
0.161290323 0.129032258 0.080645161 0.080645161 0.032258065
0.032258065 0.016129032 0.016129032 0.032258065 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0
1994 1 4 0 0 68.15858524 0 0 0 0 0
0.018518519 0.018518519 0.037037037 0.055555556 0.12962963
0.148148148 0.092592593 0.222222222 0.12962963 0.111111111 0
0.018518519 0 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
1995 1 4 0 0 88.3533136 0 0 0 0.019607843
0.019607843 0.058823529 0.088235294 0.058823529 0.137254902
0.12745098 0.176470588 0.117647059 0.107843137 0.039215686
0.009803922 0.009803922 0.019607843 0 0 0.009803922 0
0 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 4 0 0 128.7446346 0 0 0 0 0
0.007692308 0.038461538 0.046153846 0.061538462 0.115384615
0.276923077 0.1 0.146153846 0.107692308 0.053846154 0.015384615
0.015384615 0.007692308 0.007692308 0 0 0 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 4 0 0 103.4997412 0 0 0 0
0.021505376 0.043010753 0.032258065 0.053763441 0.043010753
0.139784946 0.258064516 0.182795699 0.086021505 0.043010753
0.010752688 0.010752688 0.053763441 0.010752688 0.010752688 0
0 0 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 4 0 0 53.01224238 0 0 0 0 0
0.029411765 0.058823529 0.147058824 0.117647059 0.176470588
0.058823529 0.058823529 0.176470588 0.088235294 0.029411765
0.058823529 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
1999 1 4 0 0 65.63418064 0 0 0 0 0
0 0.057692308 0.019230769 0.134615385 0.192307692 0.134615385
0.096153846 0.057692308 0.096153846 0.134615385 0.038461538
0.019230769 0.019230769 0 0 0 0 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 4 0 0 100.9753366 0 0 0 0 0
0.028169014 0.084507042 0.070422535 0.049295775 0.147887324
0.14084507 0.112676056 0.091549296 0.126760563 0.105633803
0.014084507 0.021126761 0 0 0 0.007042254 0 0
0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0
0
2001 1 4 0 0 53.01224238 0 0 0.014492754 0
0 0 0.014492754 0.072463768 0.028985507 0.188405797
0.173913043 0.173913043 0.072463768 0.028985507 0.115942029
0.072463768 0.043478261 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
2002 1 4 0 0 90.8777182 0 0 0 0 0
0 0.018181818 0.036363636 0.181818182 0.118181818 0.090909091
0.145454545 0.1 0.172727273 0.081818182 0.018181818 0.018181818
0.018181818 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2003 1 4 0 0 116.1226116 0 0 0 0 0
0.028169014 0.049295775 0.084507042 0.112676056 0.133802817
0.176056338 0.161971831 0.11971831 0.063380282 0.035211268
0.014084507 0 0.021126761 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
2004 1 4 0 0 85.828909 0 0 0 0 0
0 0.009615385 0.048076923 0.086538462 0.144230769 0.259615385
0.134615385 0.125 0.096153846 0.067307692 0 0.019230769
0.009615385 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
1993 1 5 0 0 49.46358312 0 0 0 0 0
0 0 0 0 0 0.014925373 0.029850746 0.059701493
0.074626866 0.268656716 0.28358209 0.208955224 0.044776119 0
0.014925373 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
1994 1 5 0 0 49.46358312 0 0 0 0 0
0 0 0 0 0 0.012987013 0.025974026 0.090909091
0.077922078 0.220779221 0.168831169 0.272727273 0.103896104
0.012987013 0 0 0 0.012987013 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 5 0 0 31.60174905 0 0 0 0 0
0 0 0 0 0 0.027777778 0 0.083333333
0.166666667 0.166666667 0.333333333 0.166666667 0.027777778
0.027777778 0 0 0 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 5 0 0 49.46358312 0 0 0 0 0
0 0 0 0 0 0 0 0 0.148148148
0.259259259 0.259259259 0.222222222 0.074074074 0.037037037 0
0 0 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 5 0 0 59.0814405 0 0 0 0 0
0 0 0 0 0.021276596 0.021276596 0.063829787
0.063829787 0.074468085 0.191489362 0.276595745 0.212765957
0.053191489 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

1998 1 5 0 0 68.69929788 0 0 0 0 0
0 0 0 0.010416667 0 0 0.052083333 0.083333333
0.166666667 0.1875 0.21875 0.229166667 0.052083333 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0
1999 1 5 0 0 118.162881 0 0 0 0 0
0 0 0 0 0 0.010638298 0.053191489 0.069148936
0.207446809 0.244680851 0.255319149 0.106382979 0.042553191
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
2000 1 5 0 0 57.7074213 0 0 0 0 0
0 0 0 0 0 0 0.021978022 0.076923077
0.230769231 0.340659341 0.142857143 0.120879121 0.065934066 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
2001 1 5 0 0 42.59362563 0 0 0 0 0
0 0 0 0 0.037037037 0.018518519 0.037037037
0.166666667 0.148148148 0.203703704 0.166666667 0.166666667
0.055555556 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2002 1 5 0 0 46.71554472 0 0 0 0 0
0 0 0 0 0.015151515 0.015151515 0.015151515
0.106060606 0.166666667 0.287878788 0.151515152 0.212121212
0.015151515 0 0 0 0 0.015151515 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
2003 1 5 0 0 9.617912784 0 0 0 0 0
0 0 0 0 0 0 0.090909091 0.181818182
0.090909091 0.181818182 0.272727273 0.090909091 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
1993 1 6 0 0 68.7977568 0 0 0 0 0
0 0.015384615 0.023076923 0.069230769 0.076923077 0.092307692
0.123076923 0.092307692 0.092307692 0.069230769 0.130769231
0.115384615 0.053846154 0.030769231 0.007692308 0 0
0.007692308 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0
1994 1 6 0 0 85.5776136 0 0 0 0 0
0 0 0 0.030534351 0.007633588 0.076335878 0.045801527
0.13740458 0.160305344 0.244274809 0.091603053 0.160305344
0.038167939 0 0 0 0 0.007633588 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 6 0 0 53.69577104 0 0 0 0.010526316
0.010526316 0.010526316 0.010526316 0.031578947 0.115789474
0.042105263 0.073684211 0.094736842 0.094736842 0.157894737
0.115789474 0.147368421 0.052631579 0.031578947 0 0 0
0 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	6	0	0	68.7977568	0	0	0	0	0	
	0	0.007092199	0.014184397	0.085106383	0.141843972	0.120567376					
	0.092198582	0.134751773	0.04964539	0.120567376	0.134751773						
	0.056737589	0.028368794	0.014184397	0	0	0	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	6	0	0	97.323628	0	0	0	0	0	
	0	0.006578947	0.006578947	0.032894737	0.078947368	0.065789474					
	0.092105263	0.085526316	0.131578947	0.138157895	0.210526316						
	0.111842105	0.026315789	0.006578947	0.006578947	0	0	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	6	0	0	83.89962792	0	0	0	0	0	
	0	0.008264463	0.008264463	0.024793388	0.016528926	0.123966942					
	0.115702479	0.173553719	0.148760331	0.123966942	0.157024793						
	0.066115702	0.016528926	0.016528926	0	0	0	0	0			
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1999	1	6	0	0	137.5955136	0	0	0	0	0	
	0	0	0.010416667	0.026041667	0.041666667	0.114583333					
	0.109375	0.135416667	0.203125	0.151041667	0.114583333	0.0625					
	0.010416667	0.015625	0.005208333	0	0	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	6	0	0	60.40771376	0	0	0	0	0	
	0	0	0	0.019047619	0.038095238	0.076190476	0.066666667				
	0.104761905	0.257142857	0.219047619	0.171428571	0.028571429						
	0.019047619	0	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
2001	1	6	0	0	87.25559928	0	0	0	0	0	
	0	0.02189781	0.065693431	0.051094891	0.065693431	0.182481752					
	0.167883212	0.102189781	0.145985401	0.094890511	0.04379562						
	0.03649635	0.02189781	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
2002	1	6	0	0	99.00161368	0	0	0	0	0	
	0	0	0.005154639	0.067010309	0.113402062	0.067010309					
	0.092783505	0.139175258	0.164948454	0.170103093	0.082474227						
	0.072164948	0.020618557	0.005154639	0	0	0	0	0			
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
2003	1	6	0	0	53.69577104	0	0	0	0	0	
	0	0.007042254	0.049295775	0.084507042	0.11971831	0.133802817					
	0.154929577	0.077464789	0.11971831	0.11971831	0.077464789						
	0.028169014	0.021126761	0	0	0.007042254	0	0	0			
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
2004	1	6	0	0	25.16989984	0	0	0	0	0	
	0	0	0	0	0.155844156	0.25974026	0.142857143				
	0.103896104	0.116883117	0.142857143	0.038961039	0.012987013	0					
	0.012987013	0.012987013	0	0	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	#_N_age'_bins
#_lower_age_of_age'_bins
1	2	3	4	5	6	7	8	9	10	11	12
	13	14	15	16	17	18	19	20	21	22	23
	24	25

1	#_number_of_ageerr_types
#_vector_with_stddev_of ageing_precision_for_each_AGE_and_type
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	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

#2	#_N_age_observations
#Year	Season	Fleet	Gender	Mkt	ageerr	Lbin_lo	Lbin_hi	Nsamp
#2003	1	5	3	0	1	-1	-1	29.8674	0	0.044776119
	0.104477612	0.074626866	0.223880597	0.089552239	0.044776119
	0.029850746	0.029850746	0.044776119	0.044776119	0.014925373	0
	0.014925373	0	0	0.014925373	0.029850746	0	0	0
	0	0	0	0	0	0	0	0.044776119	0.014925373
	0.029850746	0.029850746	0.014925373	0	0.014925373	0.014925373
	0	0.014925373	0	0	0	0	0	0.014925373	0
	0	0	0	0	0
#2004	1	5	3	0	1	-1	-1	81.3057	0	0.044303797
	0.060126582	0.098101266	0.107594937	0.041139241	0.009493671
	0.015822785	0.034810127	0.012658228	0.009493671	0.003164557
	0.009493671	0	0.003164557	0.006329114	0	0.003164557
	0.003164557	0	0	0	0	0	0.003164557	0
	0.034810127	0.056962025	0.063291139	0.094936709	0.053797468
	0.034810127	0.028481013	0.022151899	0.025316456	0.025316456
	0.022151899	0.015822785	0.022151899	0.003164557	0.003164557
	0.003164557	0.006329114	0.006329114	0.006329114	0	0.006329114
	0	0	0

36	#_N_age_observations
#Year	Season	Fleet	Gender	Partition	ageerr	Ltbin_lo	Ltbin_hi	Nsamps	1	2	3
	4	5	6	7	8	9	10	11	12	13	14
	15	16	17	18	19	20	21	22	23	24	25
	1	2	3	4	5	6	7	8	9	10	11
	12	13	14	15	16	17	18	19	20	21	22
	23	24	25
2003	1	5	1	0	1	9	9	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	0	0	0	0	0	0	0
	0	0	0
2003	1	5	1	0	1	10	10	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	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0
```

2003	1	5	1	0	1	12	12	2	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	0	0	0	0	0	0	0
	0	0	0								
2003	1	5	1	0	1	13	13	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	0	0	0	0	0	0	0
	0	0	0								
2003	1	5	1	0	1	14	14	9	0	0	
	0.222222222		0.222222222		0.333333333		0.111111111		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
	0	0	0	0	0	0	0	0	0		
2003	1	5	1	0	1	15	15	6	0	0	0
	0.166666667		0.666666667		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	0	0	0	0
	0	0	0	0	0	0					
2003	1	5	1	0	1	16	16	15	0	0	0.2
	0	0.333333333		0.066666667		0	0.133333333		0.066666667		0
	0.133333333		0	0	0	0	0	0	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	0	0	0	0		
2003	1	5	1	0	1	17	17	9	0	0	0
	0.111111111		0.222222222		0.222222222		0	0	0	0.333333333	
	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	0	0	0	0	0			
2003	1	5	1	0	1	18	18	9	0	0	0
	0	0.111111111		0.111111111		0.222222222		0	0.111111111		0
	0	0.111111111		0	0.111111111		0	0	0.111111111		
	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										
2003	1	5	2	0	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	0	0	1	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
2003	1	5	2	0	1	14	14	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	0.4	0	0.2	0.2	0.2	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								

2003	1	5	2	0	1	15	15	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	0	0	0	0	0.25	0.25	0	0	0	0.25
	0	0.25	0	0	0	0	0	0	0	0	0
	0	0	0								
2003	1	5	2	0	1	16	16	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	0.5	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.5	0	0	0
	0	0	0								
2003	1	5	2	0	1	17	17	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	1	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
2004	1	5	1	0	1	9	9	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	0	0	0	0	0	0	0
	0	0	0								
2004	1	5	1	0	1	11	11	6	0	0.5	
	0.333333333		0	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	0	0	0	0	0
	0	0	0	0	0	0					
2004	1	5	1	0	1	12	12	10	0	0.4	0
	0.3	0.2	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	0	0	0
	0	0	0								
2004	1	5	1	0	1	13	13	21	0	0.238095238	
	0.285714286		0.19047619		0.19047619		0.047619048		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
	0	0	0	0	0	0	0	0	0		
2004	1	5	1	0	1	14	14	26	0	0.038461538	
	0.192307692		0.346153846		0.192307692		0.115384615		0.038461538		0
	0.038461538		0	0	0	0.038461538		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
2004	1	5	1	0	1	15	15	19	0	0	
	0.105263158		0.315789474		0.368421053		0.210526316		0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			
2004	1	5	1	0	1	16	16	21	0	0	
	0.142857143		0.238095238		0.333333333		0.19047619		0	0.047619048	

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 0 0 0 0 0 0 0
2004 1 5 1 0 1 17 17 18 0 0
0.055555556 0.111111111 0.277777778 0 0 0.111111111
0.222222222 0.111111111 0 0.055555556 0 0 0 0
0 0.055555556 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0
2004 1 5 1 0 1 18 18 19 0 0 0
0.105263158 0.157894737 0.052631579 0 0.052631579 0.263157895
0.105263158 0.052631579 0 0.105263158 0 0.052631579
0.052631579 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0
2004 1 5 1 0 1 19 19 5 0 0 0
0 0 0 0 0.2 0 0 0.2 0 0 0
0 0.2 0 0 0.2 0 0 0 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
2004 1 5 1 0 1 20 20 1 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 0 0 0 0 0 0 0 0
0 0 0
2004 1 5 2 0 1 5 5 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 0 0 0 0 0 0 0
0 0 0
2004 1 5 2 0 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 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
2004 1 5 2 0 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
0 0.75 0 0 0 0.25 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0
2004 1 5 2 0 1 11 11 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 0.2 0.2 0.2 0 0.2 0.2 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0
2004 1 5 2 0 1 12 12 8 0 0 0
0 0 0 0 0 0 0 0 0 0 0

```
        0       0       0       0       0       0       0       0       0       0       0
        0       0.375   0.375   0.125   0       0       0       0.125   0       0       0
        0       0       0       0       0       0       0       0       0       0       0
        0       0       0
2004    1       5       2       0       1       13      13      15      0       0       0
        0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0
        0       0.133333333     0.266666667     0.333333333     0.266666667     0       0
        0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0
2004    1       5       2       0       1       14      14      26      0       0       0
        0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0
        0       0       0.153846154     0.230769231     0.269230769     0.153846154
        0.038461538     0       0       0       0.076923077     0.038461538     0
        0.038461538     0       0       0       0       0       0       0       0       0
        0       0
2004    1       5       2       0       1       15      15      35      0       0       0
        0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0
        0       0       0.171428571     0.085714286     0.285714286     0.142857143
        0.114285714     0.028571429     0.028571429     0.028571429     0.057142857     0
        0       0.028571429     0       0       0       0       0       0       0
        0.028571429     0       0       0
2004    1       5       2       0       1       16      16      36      0       0       0
        0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0.083333333     0.166666667     0.111111111     0.027777778
        0.111111111     0.083333333     0.083333333     0.027777778     0.111111111     0
        0.027777778     0       0.027777778     0.027777778     0.055555556     0.027777778
        0.027777778     0       0       0       0       0
2004    1       5       2       0       1       17      17      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       0.04    0.12    0.08    0.12    0.08    0.04    0.08    0.08
        0.08    0.08    0.04    0.04    0       0       0       0.04    0.04    0       0.04
        0       0       0
2004    1       5       2       0       1       18      18      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       0
        0       0       0       0       0       0       0.076923077     0.076923077
        0.153846154     0.153846154     0.076923077     0       0.230769231     0.230769231
        0       0       0       0       0       0       0       0       0       0       0

0       #_N_size-at-age_observations;_values_on_row1;_N_on_row2

#Year   Season  Fleet   Gender  Mkt     ageerr  Nsamp
#_environmental_data
1       #       N_variables
0       #       N_observations
#_Year  Variable Value
999     #end    of      file
```

Appendix B-2. SS2 .CTL File for the Oregon model

```
2	#_N_growthmorphs
#_assign_sex_to  each_morph_(1=female;_2=male)
1	2
1	#_N_Areas_(populations)
#_each_fleet/survey_operates_in_just_one_area
#_but_different_fleets/surveys_can be assigned_to_share_same_selex(FUTURE_coding)
1	1	1	1	1	1	1	1	1	1
#area_for_each_fleet/survey

0	#do_migration_(0/1)

0	#_N_Block_Designs

#Natural_mortality_and_growth_parameters_for_each_morph
0	#_Last_age_for_natmort_young
0	#_First_age_for_natmort_old
2	#_age_for_growth_Lmin
10	#_age_for_growth_Lmax
-4	#_MGparm_dev_phase
#	LO	HI	INIT	PRIOR	PR_type	SD	PHASE	env-variable	use_dev
	dev_minyr	dev_maxyr	dev_stddev
	0.02	0.5	0.26	0.26	0	100	-2	0	0	0	0
	0.5	0	0	#M1_natM_young
	0	0.5	0	0	0	0.8	-3	0	0	0	0
	0.5	0	0	#M1_natM_old_as_exponential_offset(rel_young)
	1	40	23.67	28.75	0	100	2	0	0	0	0
	0.5	0	0	#M1_Lmin
	30	90	36.96	38.97	0	100	2	0	0	0	0
	0.5	0	0	#M1_Lmax
	0.05	0.5	0.45	0.3	0	100	2	0	0	0	0
	0.5	0	0	#M1_VBK
	0.14	0.14	0.10	0.139	0	100	-3	0	0	0	0
	0.5	0	0	#M1_CV-young
	-3	3	-0.1054	-0.2877	0	100	-3	0	0	0	0
	0.5	0	0	#M_CV old_as_exp_offset(rel_young)
	-3	3	0	-0.1	0	100	-3	0	0	0	0
	0.5	0	0	#M2_natM_young_as_exponential_offset(rel_morph_1)
	-3	3	0	0	0	0.8	-3	0	0	0	0
	0.5	0	0	#M2_natM_old_as_exponential_offset(rel_young)
	-3	3	-0.08	-0.0706	0	100	3	0	0	0	0
	0.5	0	0	#M2_Lmin_as_exponential_offset
	-3	3	-0.02	-0.0506	0	100	3	0	0	0	0
	0.5	0	0	#M2_Lmax_as_exponential_offset
	-3	3	0.26	0.2877	0	100	3	0	0	0	0
	0.5	0	0	#M2_VBK_as_exponential_offset
	-3	3	0.0	0	0	100	-3	0	0	0	0
	0.5	0	0	#M2_CV-young_as_exponential_offset
	-3	3	-0.1054	-0.049	0	100	-3	0	0	0	0
	0.5	0	0	#M2_CV-old_as_exponential_offset

# Add 2+2*gender lines to read the wt-Len and mat-Len parameters
```

```
-3	3	0.0000044467	0.00001	0	0.8	-3	0	0	0
0	0.5	0	0	#Female wt-len-1
-3	3	3.3194	3.187	0	0.8	-3	0	0	0	0
0.5	0	0	#Female wt-len-2
-3	3	35.1946	35	0	0.8	-3	0	0	0	0
0.5	0	0	#Female mat-len-1
-3	3	-1.2481	-0.7	0	0.8	-3	0	0	0	0
0.5	0	0	#Female mat-len-2
-3	3	1	1	0	0.8	-3	0	0	0	0
0.5	0	0	#Female eggs/gm intercept
-3	3	0	0	0	0.8	-3	0	0	0	0
0.5	0	0	#Female eggs/gm slope
-3	3	0.0000082833	0.0000089088	0	0.8	-3	0	0
0	0	0.5	0	0	#Male wt-len-1
-3	3	3.1442	3.190852	0	0.8	-3	0	0	0
0	0.5	0	0	#Male wt-len-2

# pop*gmorph lines For the proportion of each morph in each area

0	1	0.5	0.2	0	9.8	-3	0	0	0	0
0.5	0	0	#frac to morph 1 in area 1
0	1	0.5	0.2	0	9.8	-3	0	0	0	0
0.5	0	0	#frac to morph 2 in area 1

# pop lines For the proportion assigned to each area

0	1	1	1	0	0.8	-3	0	0	0	0
0.5	0	0	#frac to area 1

#_custom-env_read
0	#_ 0=read_one_setup_and_apply_to_all_env_fxns;
1=read_a_setup_line_for_each_MGparm_with_Env-var>0
#_custom-block_read
0	#_ 0=read_one_setup_and_apply_to_all_MG-blocks;  1=read_a_setup_line_for_each_block x
MGparm_with_block>0

#_Spawner-Recruitment_parameters
1	# SR_fxn:  1=Beverton-Holt
#LO	HI	INIT	PRIOR	PRIOR TYPE	SD	PHASE
3	30	7.26	12	0	10	1	#Ln(R0)
0.2	1	0.7	0.71	0	0.8	-3	#steepness
0	1	1	1.1	0	1	-1	#SD_recruitments
0	5	0	0	0	1	-3	#Env_link
0	5	0	0	0	1	-3	#r1: offset that allows use of recruitment
diff. than initial recruitment for virgin recruitment
0	#env-var_for_link
#	recruitment_residuals
#	start_rec_year	end_rec_year	Lower_limit	Upper_limit	phase
	1981	2003	-15	15	2

#init_F_setup,	for	each	fleet
#	LO	HI	INIT	PRIOR	PRIOR TYPE	SD	PHASE
	0	1	0.01	0.0001	0	99	2
	0	1	0	0.1	0	99	-2
	0	1	0.01	0.1	0	99	2
	0	1	0.01	0.1	0	99	2
```

```
        0       1       0.01    0.0001  0       99      2
        0       1       0.01    0.0001  0       99      2

#_Qsetup
#_add_parm_row_for_each_positive_entry_below(row_then_column)

#-Float(0/1)    #Do-power(0/1)  #Do-env(0/1)    #Do-dev(0/1-not implemented)    #Env-Var
        #Biomass(1)/Numbers(2)          for     each    fleet   and     survey
0       0       0       0       0       1
0       0       0       0       0       1
0       0       0       0       0       1
0       0       0       0       0       1
0       0       0       0       0       1
0       0       0       0       0       1
0       0       0       0       0       2
0       0       0       0       0       2
0       0       0       0       0       2
0       0       0       0       0       2

#LO     HI      INIT    PRIOR   PRIOR TYPE      SD      PHASE
#-30    30      0       0.1     20      2
#-30    30      0       0.1     20      2
#-30    30      0       0.1     20      2
#-30    30      0       0.1     20      2
#-30    30      -3      -2      10      1       #log(Q) (if     float   =       1)
#-30    30      0.01    -1      1       4       #Q-power
#-30    30      0.01    -1      1       4       #Q-env

#_SELEX_&_RETENTION_PARAMETERS

#Selex_type     Do_retention(0/1)       Do_male         Mirrored_selex_number

1       0       0       0       #_fleet_1
2       0       0       0       #_fleet_2
2       0       0       0       #_fleet_3
2       0       0       0       #_fleet_4
1       0       0       0       #_fleet_5
1       0       0       0       #_fleet_6
5       0       0       3       #_survey_1
5       0       0       4       #_survey_2
5       0       0       5       #_survey_3
5       0       0       6       #_survey_4
#_Age   selex

10      0       0       0       #_fleet_1

10      0       0       0       #_fleet_2

10      0       0       0       #_fleet_3

10      0       0       0       #_fleet_4

10      0       0       0       #_fleet_5

10      0       0       0       #_fleet_6
```

```
10	0	0	0	#_survey_1

10	0	0	0	#_survey_2

10	0	0	0	#_survey_3

10	0	0	0	#_survey_4


#	LO	HI	INIT	PRIOR	PR_type	SD	PHASE	env-variable		use_dev
	dev_minyr		dev_maxyr		dev_stddev		Block_Pattern
	19	70	30.4	45	0	10	3	0	0	0	0
	0.5	0	0	#infl_for_logistic FLT 1
	0.001	30	1	5	0	5	4	0	0	0	0
	0.5	0	0	#95%width_for_logistic

	10	60	37.49	50	0	10	3	0	0	0	0
	0.5	0	0	#peak FLEET 2 LIVE FISH
	0.0001	0.1	0.000	0	0	99	-2	0	0	0	0
	0.5	0	0	#init
	-10	5	1.37	0.0	0	3	3	0	0	0	0
	0.5	0	0	#infl
	0.001	5	1.172	0.3	0	99	3	0	0	0	0
	0.5	0	0	#slope
	-10	10	-5.04	9	0	99	4	0	0	0	0
	0.5	0	0	#final
	-10	5	-1.59	0.0	0	3	3	0	0	0	0
	0.5	0	0	#infl2
	0.001	50	0.52	.3	0	99	5	0	0	0	0
	0.5	0	0	#slope2
	0.1	10	3	4	0	99	-5	0	0	0	0
	0.5	0	0	#width of top


	10	60	23.61	50	0	10	3	0	0	0	0
	0.5	0	0	#peak FLEET 3 Man Made
	0.0001	0.1	0.000	0	0	99	-2	0	0	0	0
	0.5	0	0	#init
	-10	5	1.63	0.0	0	3	2	0	0	0	0
	0.5	0	0	#infl
	0.001	5	0.01	0.3	0	99	3	0	0	0	0
	0.5	0	0	#slope
	-10	10	-1.63	9	0	99	3	0	0	0	0
	0.5	0	0	#final
	-10	5	-2.04	0.0	0	3	4	0	0	0	0
	0.5	0	0	#infl2
	0	50	0.5	.3	0	99	-5	0	0	0	0
	0.5	0	0	#slope2
	0.1	10	4	4	0	99	-5	0	0	0	0
	0.5	0	0	#width of top

	10	60	32.37	50	0	10	3	0	0	0	0
	0.5	0	0	#peak FLEET 4 Beach/Bank
	0.0001	0.1	0.000	0	0	99	-2	0	0	0	0
	0.5	0	0	#init
```

```
    -10     5       1.2     0.0     0       3       2       0       0       0       0
    0.5     0       0       #infl
    0.001   5       0.3     0.3     0       99      -3      0       0       0       0
    0.5     0       0       #slope
    -10     10      -0.9783 9       0       99      3       0       0       0       0
    0.5     0       0       #final
    -10     5       -1.4155 0.0     0       3       4       0       0       0       0
    0.5     0       0       #infl2
    0.001   50      0.4376  .3      0       99      5       0       0       0       0
    0.5     0       0       #slope2
    0.1     10      2       4       0       99      -5      0       0       0       0
    0.5     0       0       #width of top

    10      70      32.37   5       0       10      3       0       0       0       0
    0.5     0       0       #infl_for_logistic FLT 5 CPFV
    0.001   30      6       5       0       5       4       0       0       0       0
    0.5     0       0       #95%width_for_logistic

    10      70      21.84   45      0       10      3       0       0       0       0
    0.5     0       0       #infl_for_logistic FLT 6 PBR
    0.001   30      3.3     5       0       5       4       0       0       0       0
    0.5     0       0       #95%width_for_logistic

    1       44      1       1       0       10      -3      0       0       0       0
    0.5     0       0       #min Len bin - fixed SURVEY 1
    0.001   100     33      50      0       5       -4      0       0       0       0
    0.5     0       0       #max Len bin fixed

    1       44      1       1       0       10      -3      0       0       0       0
    0.5     0       0       #min Len bin - fixed SURVEY 1
    0.001   100     33      50      0       5       -4      0       0       0       0
    0.5     0       0       #max Len bin fixed

    1       44      1       1       0       10      -3      0       0       0       0
    0.5     0       0       #min Len bin - fixed SURVEY 1
    0.001   100     33      50      0       5       -4      0       0       0       0
    0.5     0       0       #max Len bin fixed

    1       44      1       1       0       10      -3      0       0       0       0
    0.5     0       0       #min Len bin - fixed SURVEY 1
    0.001   100     33      50      0       5       -4      0       0       0       0
    0.5     0       0       #max Len bin fixed


#_custom-env_read
0
#_custom-block_read
0

-4      #_phase_for_selex_parm_devs
1 #_max_lambda_phases:_read_this_Number_of_values_for_each_component
0       #sd_offset
#_survey_lambdas
0       0       0       0       0       0       1       1       1       1
#_discard_lambdas
0       0       0       0       0       0       0       0       0       0
```

#_meanwtlambda(one_for_all_sources)
1
#_lenfreq_lambdas

1	1	1	1	1	1	0	0	0	0

#_age_freq_lambdas

0	0	0	0	1	0	0	0	0	0

#_size@age_lambdas

0	0	0	0	0	0	0	0	0	0

#_initial_equil_catch
1
#_recruitment_lambda
1
#_parm_prior_lambda
1
#_parm_dev_timeseries_lambda
1
crashpen lambda
100
#max F
0.9
999 #_end-of-file
#Q_setup:_add_parm_row_for_each_positive_entry_below(row_then_column)

Appendix C. Numbers (in 1000s)-at-age matrix for Oregon.

A) Females

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1979	559	431	332	256	198	152	117	91	70	54	42	32	25	19	15	11	9	7	5	4	13
1980	559	431	327	243	182	137	103	78	59	44	33	25	19	14	11	8	6	5	3	3	8
1981	59	431	327	243	182	137	103	78	59	44	33	25	19	14	11	8	6	5	3	3	8
1982	184	46	322	237	178	134	101	76	57	43	32	25	18	14	11	8	6	5	3	3	8
1983	60	142	35	242	178	134	101	76	57	43	33	25	18	14	11	8	6	5	3	3	8
1984	2411	47	107	25	179	133	100	76	57	43	32	24	18	14	11	8	6	5	3	3	8
1985	855	1859	35	80	19	135	100	76	57	43	33	25	18	14	11	8	6	5	3	3	8
1986	1215	659	1409	26	60	14	102	76	57	43	33	25	19	14	11	8	6	5	3	3	8
1987	134	936	502	1062	20	45	11	77	58	43	33	25	19	14	11	8	6	5	3	3	8
1988	460	103	710	373	792	15	34	8	58	43	33	25	19	14	11	8	6	5	3	3	8
1989	291	355	79	536	283	601	11	26	6	44	33	25	19	14	11	8	6	5	3	3	8
1990	779	224	271	60	408	216	459	9	20	5	34	25	19	14	11	8	6	5	3	3	8
1991	649	600	169	201	45	307	163	348	7	15	4	26	19	14	11	8	6	5	4	3	8
1992	433	500	452	125	150	34	232	123	263	5	11	3	19	14	11	8	6	5	4	3	8
1993	390	333	378	335	94	113	25	175	93	199	4	9	2	15	11	8	6	5	4	3	8
1994	589	301	249	274	247	70	84	19	132	70	149	3	6	2	11	8	6	5	4	3	8
1995	459	454	230	189	208	188	53	64	14	100	53	114	2	5	1	8	6	5	4	3	8
1996	317	354	347	174	144	159	143	40	49	11	76	41	87	2	4	1	6	5	4	3	8
1997	326	245	270	262	132	109	121	109	31	37	8	58	31	66	1	3	1	5	4	3	8
1998	357	251	186	203	196	99	82	90	82	23	28	6	44	23	49	1	2	1	4	3	8
1999	504	276	193	142	154	149	75	62	68	62	17	21	5	33	18	37	1	2	0	3	8
2000	347	389	211	146	106	114	110	55	46	50	46	13	16	4	24	13	28	1	1	0	8
2001	292	268	293	155	108	78	84	81	41	34	37	34	9	11	3	18	10	20	0	1	6
2002	340	225	201	213	113	78	56	60	58	29	24	27	24	7	8	2	13	7	15	0	5
2003	20	262	166	141	147	77	52	38	41	39	20	16	18	16	5	6	1	9	5	10	4
2004	510	16	197	121	102	106	55	38	27	29	28	14	12	13	12	3	4	1	6	3	10

B) Males

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1979	559	431	332	256	198	152	117	91	70	54	42	32	25	19	15	11	9	7	5	4	13
1980	559	431	330	246	184	139	104	79	59	45	34	25	19	14	11	8	6	5	4	3	8
1981	59	431	330	246	184	139	104	79	59	45	34	25	19	14	11	8	6	5	4	3	8
1982	184	46	329	239	180	135	102	77	58	44	33	25	19	14	11	8	6	5	3	3	8
1983	60	142	35	247	180	135	102	77	58	44	33	25	19	14	11	8	6	5	3	3	8
1984	2411	47	109	26	183	135	102	77	58	43	33	25	19	14	11	8	6	5	3	3	8
1985	855	1859	36	81	19	138	101	77	58	44	33	25	19	14	11	8	6	5	3	3	8
1986	1215	659	1425	27	61	15	104	77	58	44	33	25	19	14	11	8	6	5	3	3	8
1987	134	936	506	1074	20	46	11	79	58	44	33	25	19	14	11	8	6	5	3	3	8
1988	460	103	718	376	801	15	35	8	59	44	33	25	19	14	11	8	6	5	3	3	8
1989	291	355	79	543	285	608	11	26	6	45	33	25	19	14	11	8	6	5	3	3	8
1990	779	224	272	60	413	217	464	9	20	5	34	25	19	14	11	8	6	5	4	3	8
1991	649	600	172	202	45	311	164	351	7	15	4	26	19	15	11	8	6	5	4	3	8
1992	433	501	459	127	151	34	235	124	266	5	11	3	20	15	11	8	6	5	4	3	8
1993	390	333	383	340	95	113	25	177	94	201	4	9	2	15	11	8	6	5	4	3	8
1994	589	301	254	278	250	70	85	19	133	70	151	3	7	2	11	8	6	5	4	3	8
1995	459	454	231	193	211	190	54	64	15	101	53	115	2	5	1	8	6	5	4	3	8
1996	317	354	349	175	146	161	145	41	49	11	77	41	87	2	4	1	6	5	4	3	8
1997	326	245	272	263	133	111	122	110	31	37	8	59	31	66	1	3	1	5	4	3	8
1998	357	252	188	204	198	99	83	92	83	23	28	6	44	23	50	1	2	1	4	3	8
1999	504	276	194	143	155	150	75	63	69	62	18	21	5	33	18	38	1	2	0	3	8
2000	347	389	212	147	107	115	111	56	46	51	46	13	16	4	25	13	28	1	1	0	8
2001	292	268	297	156	108	79	85	81	41	34	38	34	10	11	3	18	10	20	0	1	6
2002	340	225	204	217	113	78	57	61	59	29	25	27	24	7	8	2	13	7	15	0	5
2003	20	262	171	144	150	77	53	38	41	39	20	17	18	16	5	6	1	9	5	10	4
2004	510	16	201	125	104	108	55	38	28	29	28	14	12	13	12	3	4	1	6	3	10