

Pacific Whiting Assessment Update for 2000

Overview

Since the last Pacific whiting assessment in 1998, limited new data are available. Fishery age composition data are available for the 1998 and 1999 U.S. and Canadian fisheries, and indices of whiting recruitment are available from the 1999 and 2000 SWFSC larval rockfish survey. Although these data contain relatively little information concerning absolute abundance, they can provide an indication of the strength of recruiting year classes. A coastwide acoustic survey, the primary index of whiting abundance, is planned for summer of 2001. Recent fishery composition data and recruitment indices were evaluated for consistency with 1998 model projections in a preliminary assessment model run. This model used the same configuration as the 1998 assessment, but included the new fisheries age composition and recruit indices.

Fishery age composition and recruitment indices showed no indication strong recruiting year classes, and suggested a continuing pattern of weak to moderate year classes consistent with the 1998 assessment. Preliminary assessment model runs showed only minor differences in biomass and recruitment estimates. Yield projections for 2001 under the F40% 40-10 option were slightly lower, but within 5% of the projected yield for the 1998 model. Whiting catch in 2000 will be approximately 75% of the ABC due to the scarcity of fishable aggregations of whiting off northern Washington and southeast Vancouver Island. Although an unharvested quota would tend to increase to stock size, catches in 1999 exceeded the ABC by 46,000 tons, and estimates of 1995 and 1996 year class strength are slightly lower in the preliminary model runs.

Given the time constraints to schedule a U.S. and Canadian STAR panel review of a full stock assessment and the fact that available data were available are unlikely to significantly affect assessment results, it is recommended that allowable harvest in 2001 be set to the projections based on the 1998 assessment. Projected 2001 total yield from the 1998 assessment is 238,000 t coastwide (Table below).

Year	Coastwide yield projection (from Dorn et al. 1999, Table 14, F40%, 40-10 option)	Coastwide ABC (tons)	Catch (tons)
1999	301,000	290,000	335,924
2000	275,000	290,000	218,837
2001	238,000	---	---

Assessment Model and Data

The Pacific whiting stock was last assessed in 1998 (Dorn et al. 1998). In that assessment, the age-structured model, which formerly used stock synthesis (Dorn and Methot 1991) to model the

population dynamics and estimate abundance, was converted to AD model builder (Fournier 1996). The 1998 assessment provided model validation using a side-by-side comparison of model results between stock synthesis and ADMB, and then extended the approach to take advantage of ADMB's post-convergence routines to estimate likelihood profiles and explore alternative treatment of process errors. This document provides an update of that assessment using the same model structure and parameter specification. Differences are limited to updated fishery catch and age compositions for 1998 and 1999, and indices of young-of-year abundance from the SWFSC Tiburon laboratory larval rockfish surveys for 1999 and 2000. Therefore, data sources inclusive to this update include:

- Total catch from the U.S. and Canadian fisheries (1972-99).
- Catch at age from the U.S. fisheries (1973-99) and Canadian fisheries (1977-99).
- Biomass and age composition from AFSC acoustic/midwater trawl surveys (1977, 1980, 1983, 1986, 1989, 1992, 1995, 1998).
- Biomass and age composition from AFSC bottom trawl surveys (1977, 1980, 1983, 1986, 1989, 1992, 1995, 1998).
- Biomass and age composition from the DFO acoustic surveys (1990-97).
- Indices of young-of-the-year abundance from the SWFSC Tiburon laboratory larval rockfish surveys (1986-2000).

Projections were performed to estimate 2001 yield and compared to the 1998 assessment using the updated fishery catches and size composition information as well as the Tiburon larval rockfish indices of recruits to age two. Preliminary catch estimates for the 2000 fishing season, used in the projections, were set to 219,000 mt.

Total Catch

Total catches for 1998 and 1999 in this update were compiled from U.S. shore-based landings and at sea domestic catch data provided by Kate King (11 July, 2000; AFSC). Canadian joint-venture and shore-based catch data were provided by Mark Saunders (4 August, 2000; DFO). As in the earlier assessments, shore-based landings, which do not include discard, were taken from the Fishery Information Network (PacFIN) while all other catch data were from the North Pacific Groundfish Observer Program (NPGOP). Total catches of Pacific whiting were 342,568 and 335,924 t in 1998 and 1999, respectively (Table 1). Acceptable biological catch (ABC) was set at 290,000 t, which means the percent of the ABC harvested was 118% and 116% for 1998 and 1999, respectively. Pacific whiting catch data for 2000 are preliminary. U.S. shore-based landings and at sea domestic catch data were provided by Becky Renko (12 October, 2000; AFSC), while foreign and joint-venture catch data provided by Barry Ackerman (13 October, 2000; DFO). Although preliminary at this time, it appears that the 2000 TAC of 290,000 mt will not be realized. As of 13 October, 2000 only 219,000 mt were harvested (Table 1). While the U.S. shore-based and at sea domestic fisheries either met or slightly exceeded the quota, it is unlikely that the Canadian and tribal quota will be harvested.

Fishery Age Composition

A stratified random sampling design was used to estimate the age composition of the landed catch. For both the at sea domestic and shore-based fisheries strata were designated on the basis of geographic area. No seasonal strata have been used since the at sea domestic catches are taken early in the year and biological samples in the shore-based fishery are distributed evenly throughout the year. In the 1998 at sea domestic fishery only two spatial strata were used; north and south of Cape Falcon (45°46' N. lat.). These two strata reflect different areas of harvest in the 1998 at sea domestic fishery as shown by a plot of the distribution of whiting catches within 10' squares (Figure 1a). For 1999, fishery age compositions were estimated on the basis of only one strata inclusive of the entire coastline since nearly all at sea domestic whiting activity was restricted to the region north of Cape Falcon (Figure 1b). For the 2000 fishing season, distribution of at sea catches were similar to that observed in 1998, although at sea harvesting also centered on the area of the Columbia River (Figure 1c).

For the shore-based fishery in 1998 and 1999, four strata were used: 1) northern California (Eureka and Crescent City), 2) southern Oregon (Newport and Coos Bay), 3) northern Oregon (Astoria and Warrenton), and 4) Washington coastal ports (Illwaco and Westport). Biological samples collected in these ports were used to convert landed weight into numbers which were then apportioned into numbers at age according to proportions at age based on otolith samples. Figure 2 shows the estimated age composition for the 1998 and 1999 shore-based fishery by port in the U.S. zone. Ages 3 through 5 comprise the majority of the catch in each port in 1998. In particular, age-5 fish representing the 1993 year class recruiting to the fishery are prevalent in each port. Age-2 fish not seen in 1997 were evident in the shore-based catches in 1998. In 1999, age-3 fish dominated the fishery catches in all each ports with age-4 and age-5 making secondary contributions to the catches. The size and age composition in Newport during 1992-99 show the recruitment of 1993 and 1994 year classes to the fishery (Figure 3). The catch at age for Pacific whiting in both the U.S. and Canadian fisheries from 1973-1999 are given in Table 2.

Preliminary Assessment Results

Updated assessment results were very similar to that of Dorn et al. (1998) from the last Pacific whiting stock assessment. In particular, estimated 3+ biomass and recruitment trajectories from 1972-1998 were nearly identical (Figure 4). Whiting 3+ biomass for 1999 and 2000 from the 1998 assessment represent projected biomasses while 3+ biomasses for 1999 and 2000 were estimated from the model for this update. Estimated biomasses for 1999 and 2000 did not differ by more than 10%. Biomass in 2001, projected for both the 1998 assessment and this update, were virtually identical at 1.21 million mt (Figure 4). In addition, total yield projected 2001 differed by no more than 5%. Figure 5 illustrates the comparison of the projected 2001 age compositions between the 2000 assessment update and 1998 assessment results. Here, the 2000 assessment update shows relatively lower numbers of ages 4-6 and higher numbers of ages 2-3 Pacific whiting compared to the 1998 assessment. Despite the slight differences in numbers of fish at age between the 2000 update and the 1998 assessment, the updated 2000 model results in

essentially the same projected yield for 2001. Since projections use Tiburon larval rockfish indices to forecast future recruitment, these were updated for this assessment (Figure 6). Recent estimates not included in the 1998 assessment show that recruitment indices in 1999 were slightly above the average, while in 2000 below the average. Though uncertain, these data suggest that the fishery is not expected to see recruitment of strong year classes in the near future.

References

- Dorn, M.W., M.W. Saunders, C.D. Wilson, M.A. Guttormson, K. Cooke, R. Kieser, and M.E. Wilkins. 1999. Status of the coastal Pacific whiting/whiting stock in U.S. and Canada in 1998.
- Dorn, M.W., and R.D. Methot. 1991. Status of the coastal Pacific whiting resource in 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-204, 97 p.
- Fournier, D. 1996. An introduction to AD model Builder for use in nonlinear modeling and statistics. Otter Research Ltd. PO Box 2040, Sidney, B.C. V8L 3S3 Canada.

Table 1. Annual catches of Pacific whiting (1,000 t) in U.S. and Canadian management zones by foreign, joint venture (JV), domestic at-sea, domestic shore-based, and tribal fisheries, 1966-2000. Catches in 2000 are preliminary.

Year	U.S.					Canada				U.S. and Canada total	
	Foreign	JV	Domestic			Foreign	JV	Shore	Total		
			At-sea	Shore	Tribal	Total					
1966	137.000	0.0	0.0	0.0	0.0	137.000	0.700	0.0	0.0	0.700	137.700
1967	168.699	0.0	0.0	8.963	0.0	177.662	36.713	0.0	0.0	36.713	214.375
1968	60.660	0.0	0.0	0.159	0.0	60.819	61.361	0.0	0.0	61.361	122.180
1969	86.187	0.0	0.0	0.093	0.0	86.280	93.851	0.0	0.0	93.851	180.131
1970	159.509	0.0	0.0	0.066	0.0	159.575	75.009	0.0	0.0	75.009	234.584
1971	126.485	0.0	0.0	1.428	0.0	127.913	26.699	0.0	0.0	26.699	154.612
1972	74.093	0.0	0.0	0.040	0.0	74.133	43.413	0.0	0.0	43.413	117.546
1973	147.441	0.0	0.0	0.072	0.0	147.513	15.125	0.0	0.001	15.126	162.639
1974	194.108	0.0	0.0	0.001	0.0	194.109	17.146	0.0	0.004	17.150	211.259
1975	205.654	0.0	0.0	0.002	0.0	205.656	15.704	0.0	0.0	15.704	221.360
1976	231.331	0.0	0.0	0.218	0.0	231.549	5.972	0.0	0.0	5.972	237.521
1977	127.013	0.0	0.0	0.489	0.0	127.502	5.191	0.0	0.0	5.191	132.693
1978	96.827	0.856	0.0	0.689	0.0	98.372	3.453	1.814	0.0	5.267	103.639
1979	114.909	8.834	0.0	0.937	0.0	124.680	7.900	4.233	0.302	12.435	137.115
1980	44.023	27.537	0.0	0.792	0.0	72.352	5.273	12.214	0.097	17.584	89.936
1981	70.365	43.556	0.0	0.839	0.0	114.760	3.919	17.159	3.283	24.361	139.121
1982	7.089	67.464	0.0	1.024	0.0	75.577	12.479	19.676	0.002	32.157	107.734
1983	0.0	72.100	0.0	1.050	0.0	73.150	13.117	27.657	0.0	40.774	113.924
1984	14.722	78.889	0.0	2.721	0.0	96.332	13.203	28.906	0.0	42.109	138.441
1985	49.853	31.692	0.0	3.894	0.0	85.439	10.533	13.237	1.192	24.962	110.401
1986	69.861	81.640	0.0	3.463	0.0	154.964	23.743	30.136	1.774	55.653	210.617
1987	49.656	105.997	0.0	4.795	0.0	160.448	21.453	48.076	4.170	73.699	234.147
1988	18.041	135.781	0.0	6.876	0.0	160.698	39.714	50.182	0.594	90.490	251.188
1989	0.0	203.578	0.0	7.418	0.0	210.996	31.589	66.256	1.687	99.532	310.528
1990	0.0	170.972	4.713	8.115	0.0	183.800	3.976	69.293	3.411	76.680	260.480
1991	0.0	0.0	196.905	20.600	0.0	217.505	6.043	76.254	22.225	104.522	322.027
1992	0.0	0.0	152.449	56.127	0.0	208.576	0.0	68.000	18.370	86.370	294.946
1993	0.0	0.0	99.103	42.119	0.0	141.222	0.0	47.172	11.611	58.783	200.005
1994	0.0	0.0	179.073	73.656	0.0	252.729	0.0	84.154	22.018	106.172	358.901
1995	0.0	0.0	102.624	74.965	0.0	177.589	0.0	26.580	43.838	70.418	248.007
1996	0.0	0.0	112.776	85.127	14.999	212.902	0.0	65.596	22.644	88.240	301.142
1997	0.0	0.0	121.173	87.410	24.840	233.423	0.0	42.565	48.065	90.630	324.053
1998	0.0	0.0	143.243	87.856	24.509	255.608	0.0	33.099	53.861	86.960	342.568
1999	0.00	0.00	140.024	83.419	25.844	249.287	0.0	17.915	68.722	86.637	335.924
2000	0.00	0.00	107.477	85.565	6.500	199.542	0.0	13.900	5.395	19.295	218.837
Average 1966-98						156.847				51.161	208.008

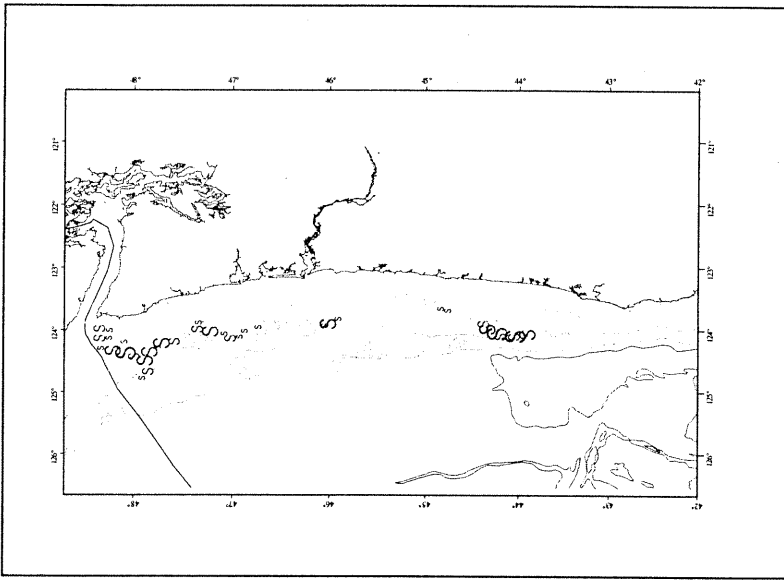
Table 2. Catch at age (millions of fish) for the Pacific whiting fisheries, 1973-99. Separate tables are given for U.S. and Canadian fisheries. The aggregate catch from all foreign, joint venture, domestic fisheries is included in these estimates.

Year	Age															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	U.S. fisheries															
1973	0.00	0.00	55.92	9.67	21.72	40.22	25.16	23.01	21.51	10.33	4.51	1.94	1.08	0.00	0.00	215.07
1974	29.31	1.30	0.98	150.14	20.52	35.50	44.29	25.73	11.40	3.58	1.63	0.98	0.33	0.00	0.00	325.69
1975	0.00	88.43	2.69	3.70	128.11	21.86	23.54	38.00	17.15	7.40	3.70	1.35	0.34	0.00	0.00	336.27
1976	0.00	0.33	36.85	29.29	29.62	185.27	27.65	13.82	4.93	0.99	0.33	0.00	0.00	0.00	0.00	329.09
1977	0.00	1.81	3.80	54.35	11.23	19.93	68.11	11.05	5.80	2.72	1.45	0.73	0.18	0.00	0.00	181.16
1978	0.01	0.02	4.56	8.58	51.87	9.48	20.32	38.57	5.74	2.48	1.28	0.52	0.20	0.05	0.01	143.69
1979	0.00	4.34	8.74	17.41	10.15	48.01	15.47	29.48	20.82	4.25	1.70	0.50	0.22	0.05	0.03	161.17
1980	0.00	0.13	24.67	2.16	6.90	7.16	20.11	9.57	11.99	9.92	1.74	1.35	1.01	0.59	0.14	97.44
1981	13.38	1.25	2.30	97.62	6.89	9.64	6.77	23.33	6.26	7.24	7.05	0.95	0.48	0.12	0.13	183.41
1982	0.00	27.51	1.93	1.57	57.88	5.02	5.78	5.02	11.96	2.43	2.53	4.64	0.34	0.13	0.03	126.77
1983	0.00	0.00	86.60	7.22	3.63	36.79	4.68	3.72	3.32	5.24	1.62	1.00	1.00	0.16	0.14	155.12
1984	0.00	0.00	2.59	164.97	7.18	5.18	17.54	2.17	1.24	0.82	1.34	0.21	0.20	0.31	0.03	203.78
1985	2.27	0.55	1.32	12.36	113.50	9.74	4.30	6.75	0.61	0.34	0.24	0.36	0.00	0.00	0.00	152.34
1986	0.00	62.92	12.88	1.85	9.34	171.79	21.55	10.76	12.45	1.53	1.05	0.38	0.79	0.15	0.05	307.49
1987	0.00	0.00	124.20	6.58	1.68	2.72	151.56	7.89	3.09	14.87	0.57	0.15	0.15	1.25	0.00	314.71
1988	0.00	1.22	1.31	172.76	8.02	1.40	2.60	96.93	5.16	0.72	8.32	0.15	0.24	0.00	0.65	299.48
1989	0.00	8.65	9.57	3.88	257.20	7.80	2.46	2.74	106.63	6.62	0.87	5.37	0.03	0.12	0.57	412.51
1990	0.00	0.00	1.31	10.97	1.92	152.02	2.56	1.14	0.71	95.97	0.47	0.00	6.07	0.00	0.41	363.27
1991	0.00	5.69	85.34	98.32	19.35	6.00	151.49	6.63	1.31	0.93	60.10	2.11	0.00	9.74	0.65	401.54
1992	0.97	18.53	43.96	51.95	109.58	10.27	5.09	131.94	4.84	2.38	0.79	42.06	0.63	0.20	1.88	391.05
1993	0.00	1.90	70.49	9.07	42.90	59.65	3.75	3.06	81.86	1.81	0.43	0.20	20.95	0.12	2.47	298.66
1994	0.00	0.23	16.48	121.89	4.82	76.93	104.64	3.29	2.04	115.38	0.46	2.06	0.22	29.13	3.65	476.31
1995	0.20	1.02	0.41	19.96	114.38	3.32	27.40	66.22	3.09	0.53	58.19	1.09	0.91	0.10	18.55	315.36
1996	0.00	102.26	71.90	6.75	34.60	97.87	1.81	17.17	46.84	0.90	0.17	50.38	0.00	0.49	14.81	445.94
1997	0.00	2.00	173.73	163.98	3.01	27.17	48.41	3.05	10.71	18.59	0.39	0.77	17.33	0.47	8.38	477.97
1998	0.00	26.97	117.63	103.21	133.25	16.56	20.27	41.66	4.83	2.35	17.29	1.52	0.48	11.85	3.32	501.20
1999	0.00	47.58	112.329	100.72	91.74	54.50	16.20	19.69	19.86	3.94	6.16	9.99	1.34	1.68	9.92	495.66

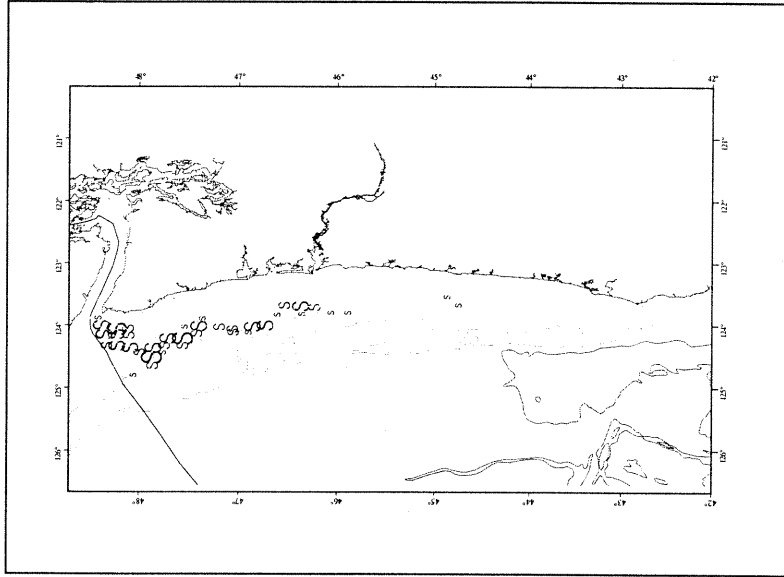
Table 2. Continued. Canadian catch at age.

Year	Age															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1977	0.00	0.01	0.01	0.25	0.09	0.30	1.83	0.53	0.50	0.42	0.40	0.35	0.16	0.00	0.00	4.85
1978	0.00	0.00	0.00	0.20	0.35	0.28	1.06	1.31	1.12	0.62	0.48	0.21	0.18	0.09	0.00	5.90
1979	0.00	0.00	0.00	0.21	0.62	1.30	1.14	2.10	3.02	1.10	0.79	0.37	0.25	0.17	0.12	11.19
1980	0.00	0.00	0.00	0.00	0.47	0.62	2.46	0.92	1.18	6.74	1.27	0.62	0.62	0.20	0.00	15.10
1981	0.00	0.00	0.00	1.01	0.27	1.41	1.38	4.28	0.85	2.36	6.18	1.49	0.60	0.85	0.00	20.68
1982	0.00	0.00	0.00	0.69	13.35	1.10	1.44	1.41	4.41	1.00	0.78	6.04	0.59	0.47	0.00	31.28
1983	0.00	0.06	14.02	1.03	1.80	32.15	1.29	1.87	1.67	5.59	0.77	0.26	3.41	0.26	0.13	64.31
1984	0.00	0.00	1.11	13.27	1.73	9.26	20.86	2.04	2.35	1.54	4.81	0.93	0.80	2.65	0.37	61.72
1985	0.00	0.06	0.06	2.45	8.03	1.65	3.25	9.62	0.49	0.55	0.55	1.65	0.37	0.00	1.59	30.32
1986	0.00	0.14	0.14	0.28	3.97	38.41	2.41	2.41	11.48	1.28	0.57	0.99	1.42	0.43	1.42	65.35
1987	0.00	0.00	0.90	0.60	0.15	2.56	70.71	2.86	2.86	10.38	0.60	0.45	1.20	0.90	1.20	95.37
1988	0.00	0.00	0.31	15.28	0.62	1.13	2.36	66.66	2.26	1.44	7.90	0.51	0.21	0.21	0.62	99.51
1989	0.00	0.00	0.20	0.59	35.55	0.20	0.39	0.59	69.34	1.76	1.37	8.59	0.39	0.20	1.17	120.34
1990	0.00	0.00	2.80	2.08	0.21	48.67	0.73	0.21	0.00	27.50	0.42	0.00	1.25	1.04	2.08	86.99
1991	0.00	0.00	0.11	6.11	2.46	0.43	70.60	0.54	0.00	0.21	47.47	0.21	0.11	2.25	0.11	130.61
1992	0.00	0.00	0.67	7.63	17.81	3.55	0.40	56.83	0.27	0.00	0.13	30.79	0.07	0.13	1.21	119.49
1993	0.00	0.07	0.77	2.52	12.91	17.54	1.89	0.21	40.62	0.21	0.14	0.14	12.49	0.21	0.21	89.93
1994	0.00	0.00	0.70	2.87	3.07	15.20	26.86	4.20	0.80	67.45	0.87	0.27	0.13	22.73	1.33	146.48
1995	4.88	0.04	0.53	6.31	5.03	3.21	10.72	15.96	3.25	0.67	33.81	0.68	0.04	0.15	9.41	94.70
1996	0.00	12.46	2.89	1.44	12.03	16.06	4.31	14.28	17.05	2.84	1.10	34.27	0.06	0.00	10.01	128.80
1997	0.00	0.81	22.17	19.19	2.52	17.21	16.22	2.25	11.08	14.42	3.24	0.54	18.65	1.35	4.06	133.73
1998	0.14	0.14	9.15	39.39	38.25	3.56	13.74	14.27	1.64	7.74	7.17	0.99	0.67	5.50	1.91	144.26
1999	1.45	26.28	9.65	18.35	40.74	25.71	1.94	8.39	8.47	2.65	3.66	4.26	0.56	0.19	4.05	156.36

1998



1999



2000

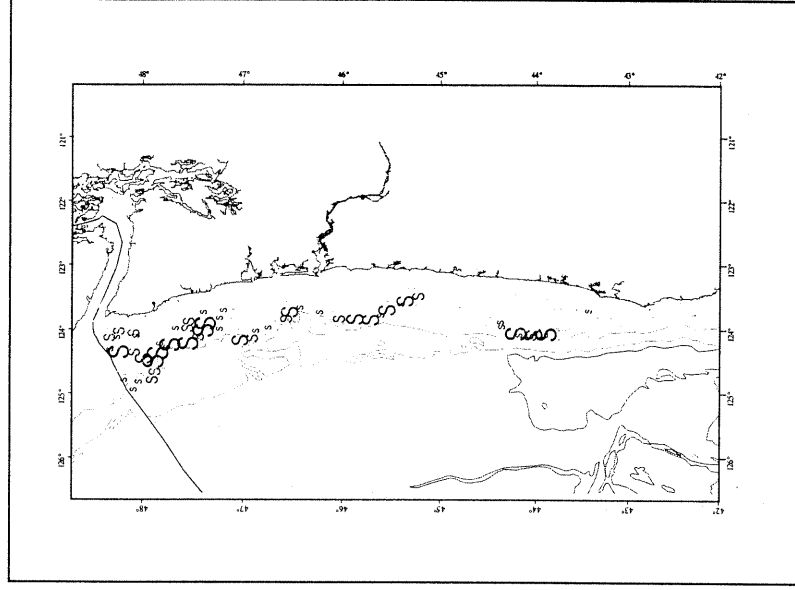


Figure 1. Distribution plots showing Pacific whiting at sea domestic catches within a 10'x10' grid. Catches within each grid are summed and symbol size illustrates the magnitude of catches.

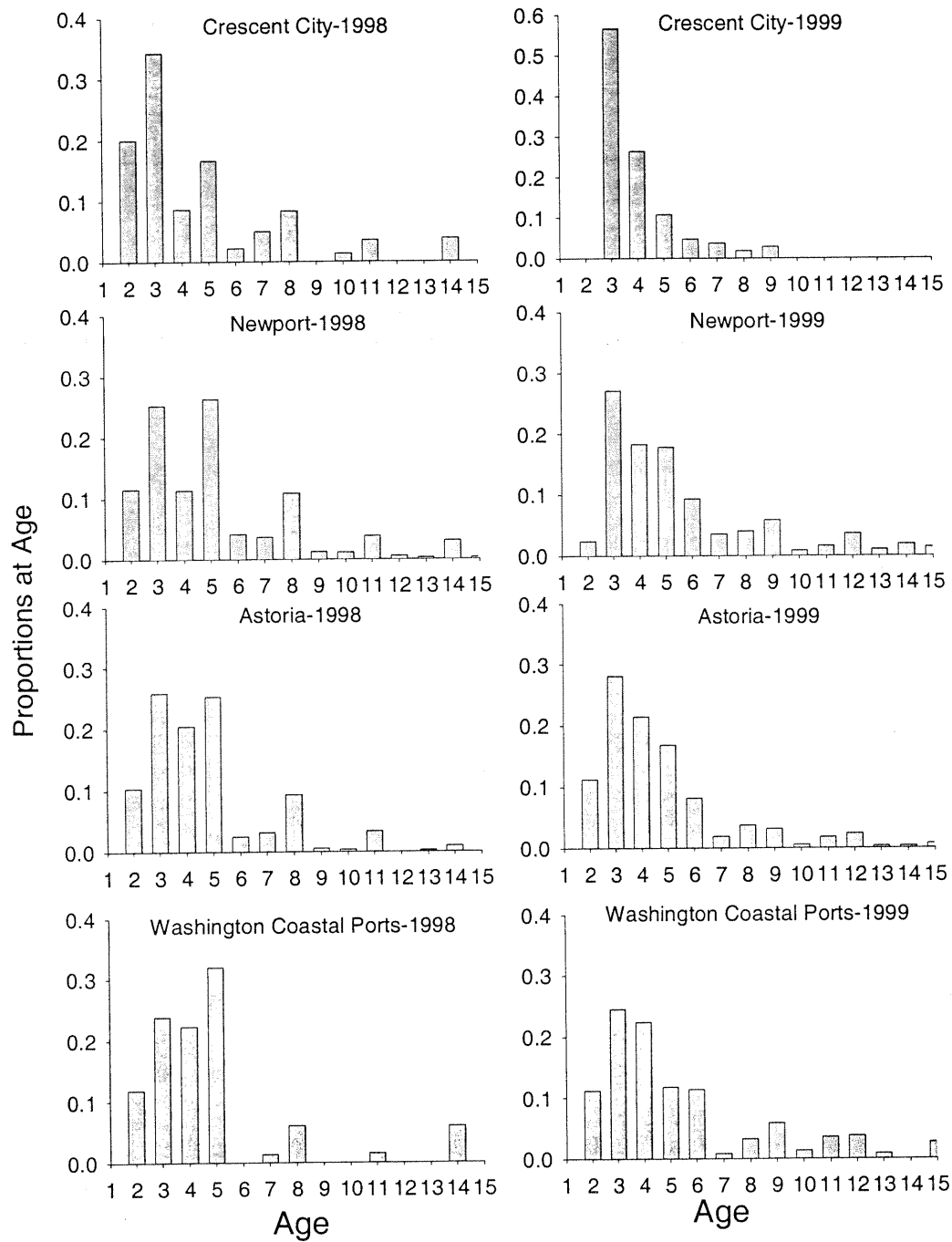


Figure 2. Pacific whiting proportion by age from shore-based landings in the U.S. zone, 1998-1999.

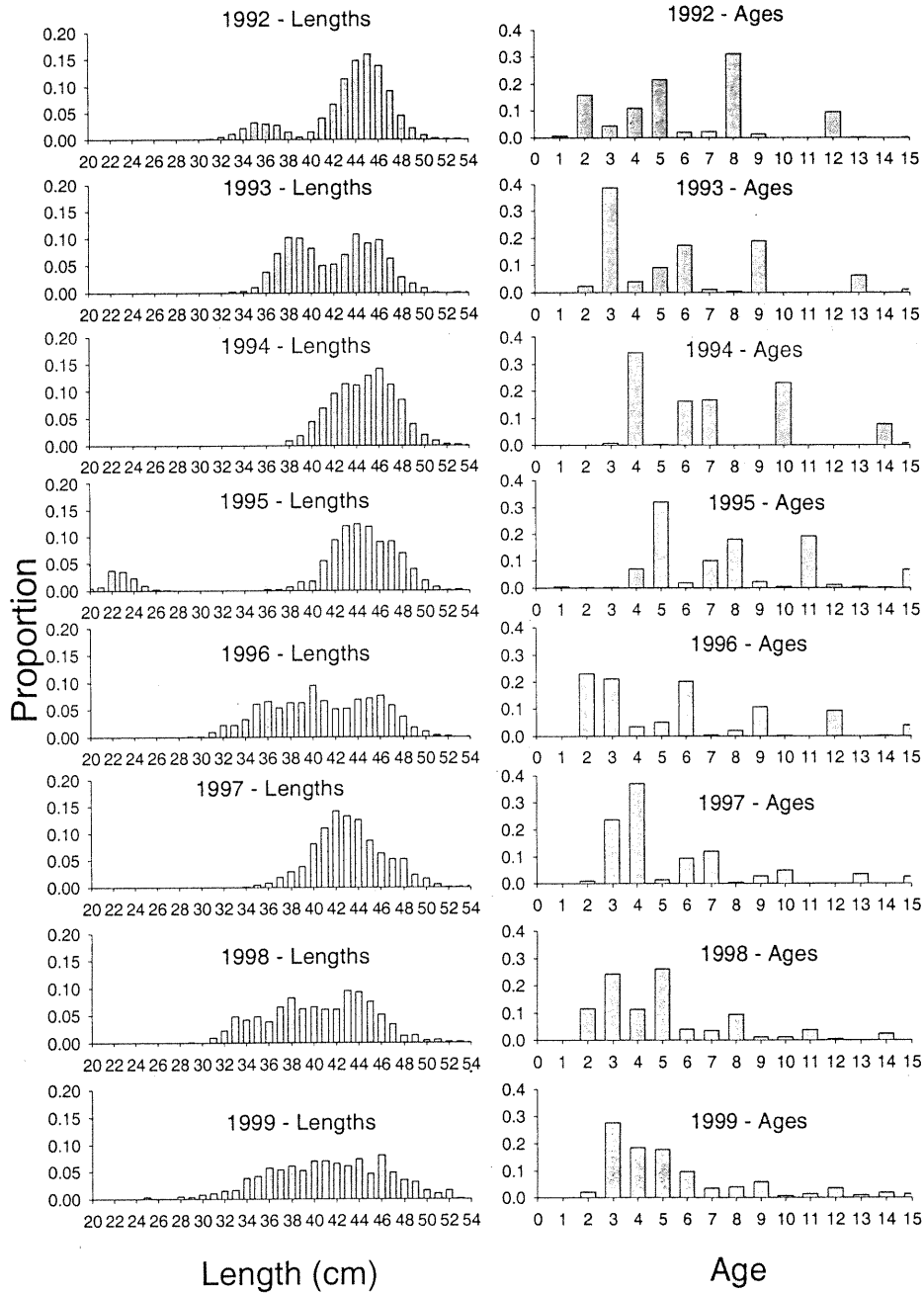


Figure 3. Pacific whiting length and age compositions from the shore-based whiting fishery sampled from Newport, 1992-1999.

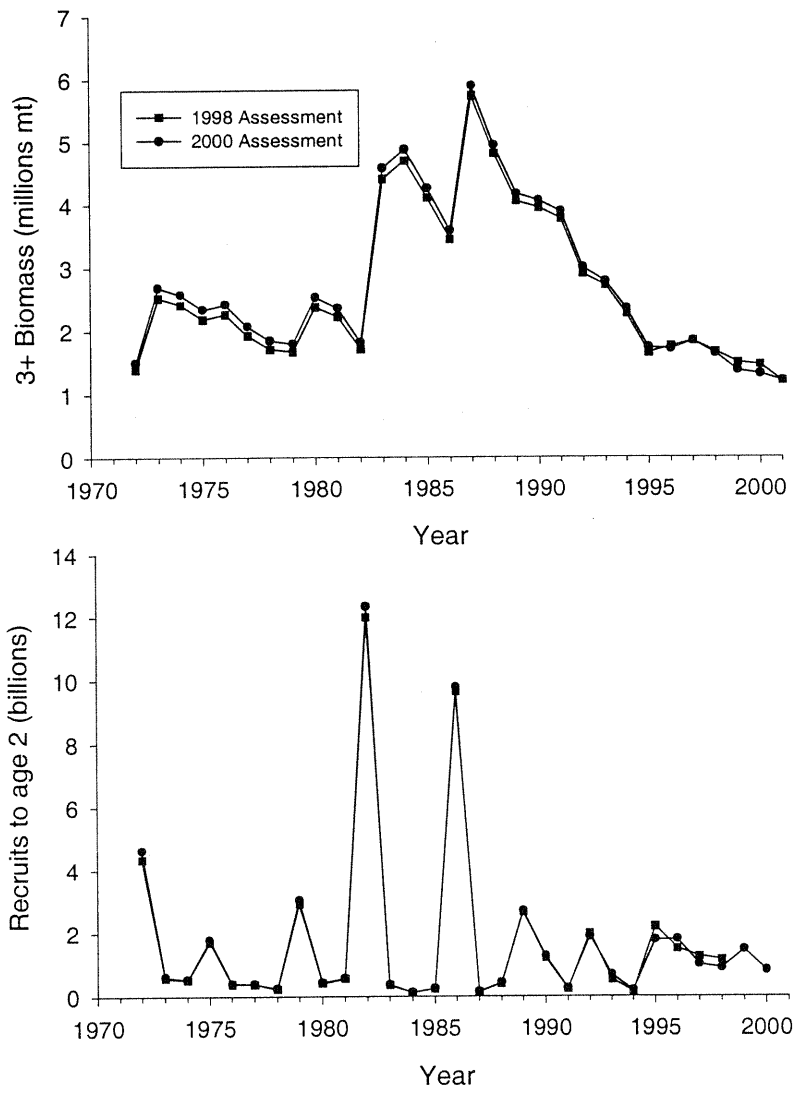


Figure 4. Pacific whiting 3+ biomass (millions mt) and recruits to age-2 (billions) comparing estimates from the 1998 assessment and 2000 assessment update. Biomasses from 1998-2001 are based on 1998 assessment projections while biomass in 2001 is based on projections from the 2000 assessment update.

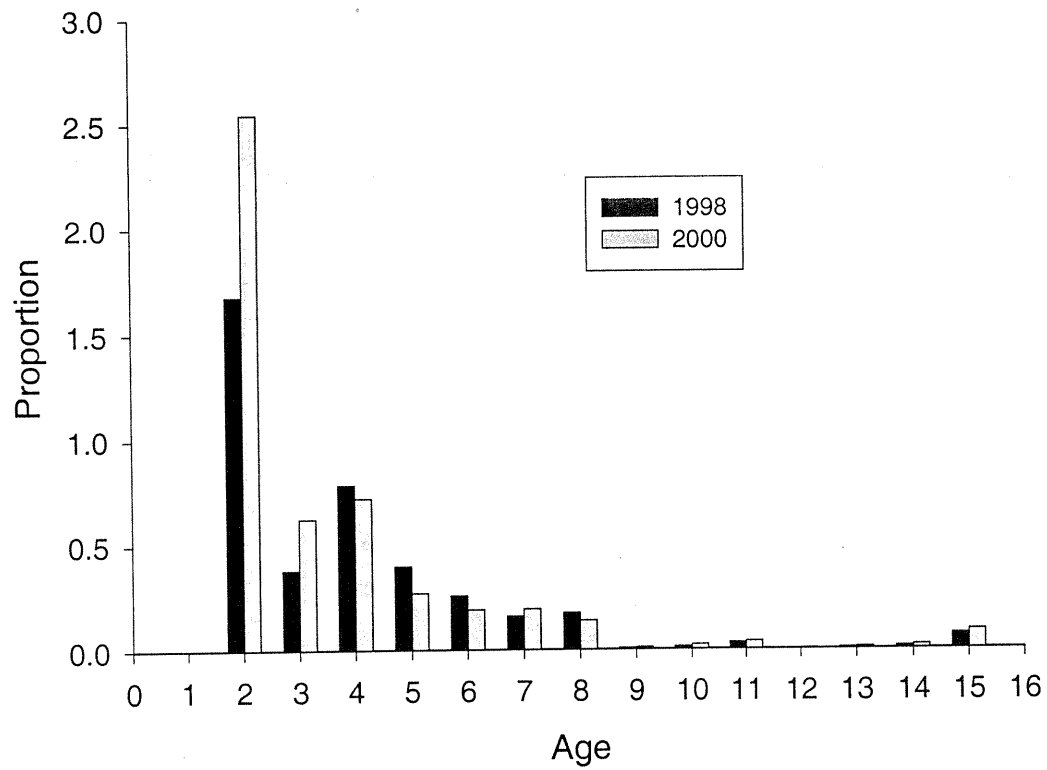


Figure 5. Comparison of projected age compositions for 2001 from 1998 assessment and from the 2000 assessment update.

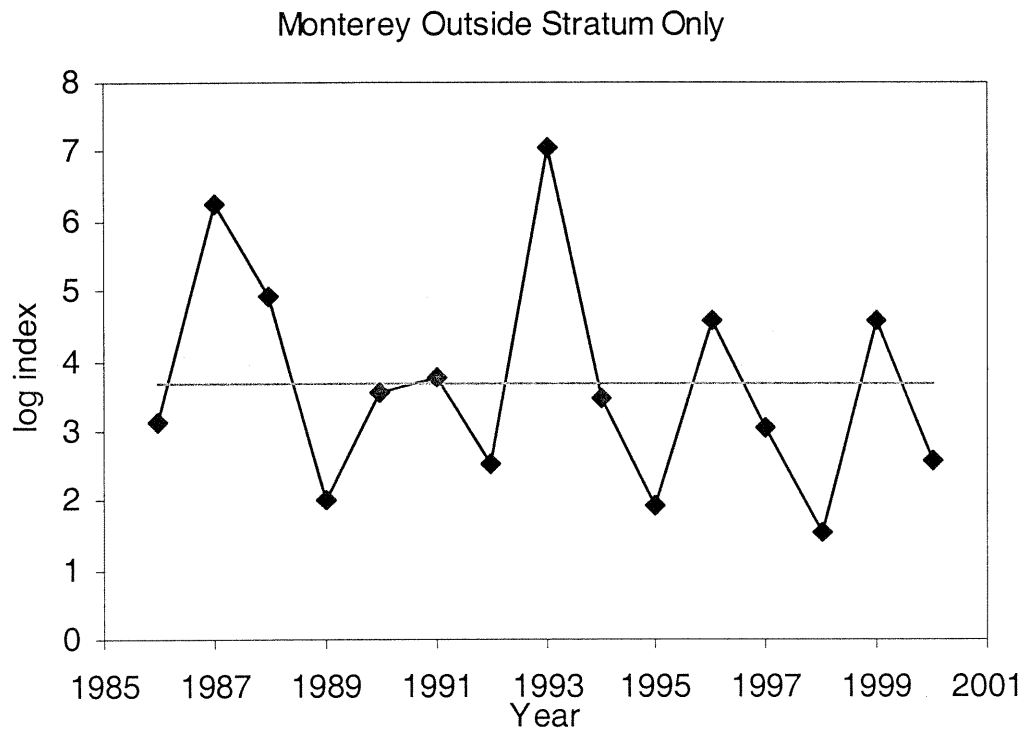


Figure 6. SWFSC Tiburon larval rockfish whiting abundance indices for Monterey outside strata only from 1986-2000.