Status of the Yellowtail Rockfish in 2004

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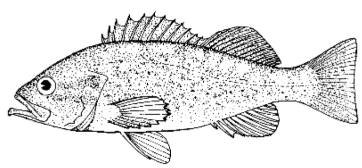

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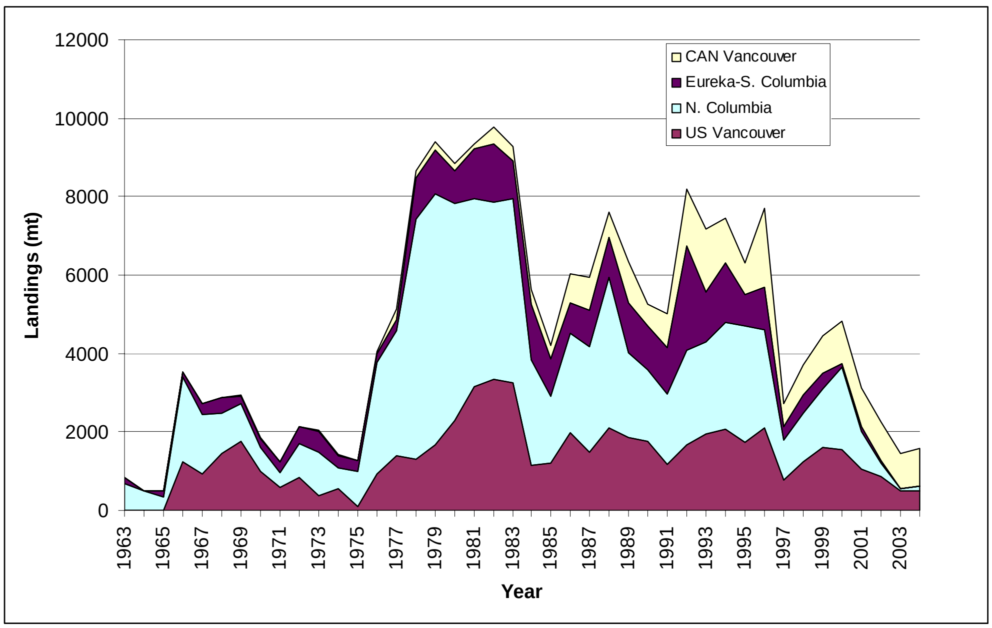
Version: Final

Executive Summary

Stock: The Pacific Fishery Management Council (PFMC) manages the U.S. fishery as two stocks separated at Cape Mendocino, California (40^{o} 30'N). As in past stock assessments, this assessment includes only the population between Cape Mendocino and 49^{o} N. lat. (Northern stock). The northern stock is divided into three assessment areas: Southern Vancouver from Cape Elizabeth (47^{o} 20'N) to approximately 49^{o}N, Northern Columbia from Cape Falcon (45^{o} 46'N) to Cape Elizabeth (47^{o} 20'N), and Eureka/South Columbia from Cape Mendocino (40^{o} 30'N) to Cape Falcon (45^{o} 46'N).

Catches: The landings in the three assessment areas, as well as the Canadian portion of the Vancouver INPFC area, are depicted in the figure below. Since 2000, the U.S. landings have decreased to pre-1965 levels. U.S. landings in 2004 were 618 mt, down from 5,702 in 1996. However, the total landings in Canadian portion of S. Vancouver area remained at historically rather high levels (959 mt in 2004).



Data and assessment: Yellowtail rockfish was assessed in 2000 and updated in 2003. This report presents the scheduled update on the status of the yellowtail rockfish population north of Cape Mendocino. The following extended data series were included in the analysis: (i) 1977-2004 NMFS Triennial survey abundance indices and catch at age (sex-combined), (ii) 2004 NWFSC Shelf-Slope survey abundance indices and catch at age (sex-combined), (iii) the current time series of area landings available from PacFIN, (iv) current commercial catch-at-age data available from PacFIN, including updates from the Washington Department of Fish and Wildlife to eliminate the duplicate records, (v) commercial weight-at-age data, by sex, for 1999-2004. The domestic trawl CPUE index (1988-1999) and the whiting fishery bycatch index (1978-1999) were not updated from the 2000 assessment, because subsequent changes in fishery regulations and behavior have altered the statistical properties of these abundance indices. The area-specific maturity ogives and age transition matrices are also unchanged from the 2000 assessment. The stock assessment model is an age-structured model written with AD Model Builder software, as used in the 2000 and 2003 updated assessments. Following the recommendations of the SSC and 2003 STAR panel, the coast-wide estimates of biomass and ABC/OY are the summation of estimates from the three assessed areas.

Unresolved problems and major uncertainties: In the current and previous assessments, there were concerns regarding the usefulness of the trawl and whiting CPUE-series and their time-variant catchabilities. An evaluation of proportion of tows with yellowtail rockfish from the same set of selected vessels used in 2000 revealed that there were not sufficient data to carry out the GLM-analyses for 2000-2004, especially in the N. Columbia and Eureka/S. Columbia areas.

TBA

Reference Points: Assuming constant recruitment at 2004 level, the estimate of unfished age4+ biomass (B_0) is 120,024 mt and unfished spawning biomass (SB_0) is 31,016 mt.

	S. Vancouver	N. Columbia	Eureka-S. Columbia	Total
Unfished Spawning Stock Biomass	13,355	12,169	5,492	31,016
Unfished Summary Age Biomass	60,873	42,636	16,515	120,024
Unfished Recruitment		NOT CALCULATED		
Spawning Biomass at MSY (SB_{MSY})	5,342	4,868	2,197	12,407
Basis for SB_{MSY}	$SPB_{40\%}$	$SPB_{40\%}$	$SPB_{40\%}$	
F_{MSY}	0.095	0.079	0.073	
Basis for F_{MSY}	$F_{50\%}$	$F_{50\%}$	$F_{50\%}$	
MSY	2,465	1,624	591	4,680

Stock biomass: The estimated age4+ biomass in year 2004 was 72,152 mt with a 26% CV, an increase from 58,025 mt in 2003 (Executive Summary Table 1). The SB has remained above 40% of unfished SB_0 since 1995.

Recruitment: There is no obvious spawner-recruit relationship. The average annual recruitment of age 4 fish was 7.6 million fish during 1995-2001, but increased to an average of 12.9 million during 2002-2004.

Exploitation status: Annual fishing mortalities were less than F_{MSY} since 1997, due to more restrictive regulations put in place to rebuild other overfished rockfishes.

Management performance: Since 2001, US total catches have not exceeded the recommended ABC's. The ABC set by PFMC and total U.S. catches are given below:

<table>
<tr><th rowspan="2">Year</th><th colspan="5">ABC (mt)</th><th rowspan="2">U.S. Catches (mt)</th></tr>
<tr><th>U.S. Vancouver</th><th>Columbia</th><th>Eureka</th><th>Monterey</th><th>Conception</th></tr>
<tr><td>1983</td><td>1,400</td><td>1,500</td><td>300</td><td>*</td><td>*</td><td>8,906</td></tr>
<tr><td>1984</td><td>1,400</td><td>1,500</td><td>300</td><td>*</td><td>*</td><td>5,270</td></tr>
<tr><td>1985</td><td>600</td><td>2,100</td><td>300</td><td>*</td><td>*</td><td>3,854</td></tr>
<tr><td>1986</td><td>1,100</td><td>2,600</td><td>300</td><td>*</td><td>*</td><td>5,296</td></tr>
<tr><td>1987</td><td>1,100</td><td>2,600</td><td>300</td><td>*</td><td>*</td><td>5,100</td></tr>
<tr><td>1988</td><td>1,100</td><td>2,600</td><td>300</td><td>*</td><td>*</td><td>6,960</td></tr>
<tr><td>1989</td><td>1,100</td><td>2,900</td><td>300</td><td>*</td><td>*</td><td>5,303</td></tr>
<tr><td>1990</td><td>1,100</td><td>2,900</td><td>300</td><td>*</td><td>*</td><td>4,700</td></tr>
<tr><td>1991</td><td>1,200</td><td>3,100</td><td>300</td><td>*</td><td>*</td><td>4,150</td></tr>
<tr><td>1992</td><td>1,200</td><td>3,100</td><td>300</td><td>*</td><td>*</td><td>6,727</td></tr>
<tr><td>1993</td><td>1,300</td><td>3,100</td><td>300</td><td>*</td><td>*</td><td>5,576</td></tr>
<tr><td>1994</td><td>1,190</td><td>2,970</td><td>2,580</td><td>*</td><td>*</td><td>6,305</td></tr>
<tr><td>1995</td><td>1,190</td><td>2,970</td><td>2,580</td><td>*</td><td>*</td><td>5,516</td></tr>
<tr><td>1996</td><td>1,190</td><td>2,970</td><td>2,330</td><td>*</td><td>*</td><td>5,702</td></tr>
<tr><td>1997</td><td>454</td><td>984[a] | 335[b]</td><td>104</td><td colspan="2">155</td><td>2,125</td></tr>
<tr><td>1998</td><td colspan="2">4,657</td><td>74</td><td colspan="2">155</td><td>2,944</td></tr>
<tr><td>1999</td><td colspan="2">3,465</td><td>74</td><td colspan="2">155</td><td>3,487</td></tr>
<tr><td>2000</td><td colspan="3">3,539</td><td colspan="2">155</td><td>3,735</td></tr>
<tr><td>2001</td><td colspan="3">3,146</td><td colspan="2">116</td><td>2,142</td></tr>
<tr><td>2002</td><td colspan="3">3,146</td><td colspan="2">116</td><td>1,260</td></tr>
<tr><td>2003</td><td colspan="3">3,146</td><td colspan="2">116</td><td>551</td></tr>
<tr><td>2004</td><td colspan="3">4,320</td><td colspan="2">116</td><td>618</td></tr>
</table>

*: ABC of yellowtail rockfish is included in the ABC for "remaining rockfish".
a: Columbia Area north of Cape Falcon
b: Columbia Area south of Cape Falcon

Forecasts: Under the Council's $F_{50\%}$ policy and assuming constant recruitment (equal to the geometric mean of 1967-1997), the profile of 3-yr mean yield is 3,133 mt at 25-percentile, 3,971 mt at 50-percentile, and 5,034 mt at 75-percentile. The projected coast-wide 3-yr average yield for 2004-2006 is 3,966 mt. These projections are very conservative since the US harvests have recently been, and are expected to be, a small fraction of the F50% yields. Lastly, to determine the US ABC/OY that doesn't include Canada, note that the US percentage of catch from the Vancouver area for 2004 is 34% (Table 1).

Decision Table: To bracket the uncertainty in this assessment the Executive Summary Table 2 shows three future spawning biomass states-of-nature and three catch scenarios projected over 12 years. The 'status quo' fixes the fishing mortality rate that closely matches the 2005 catch to what was seen in 2004.

Recommendations:

A full assessment is recommended for the next assessment because the current model does not utilize all of the biological data.

Reconstruction of historical catch before 1963 should be attempted for the next assessment.

An increase in the sampling effort for age, length, weight, and maturity data would be valuable.

Executive Summary Table 1. Summary of catches, ABC, fishing mortality, biomass, and recruitment for yellowtail rockfish since 1995.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total Catch (mt)	5,516	5,702	2,125	2,944	3,487	3,735	2,142	1,260	551	618	TBA
Discards (mt)	743	781	264	375	369	484	304	184	74	82	TBA
ABC* (mt) Total	6,740	6,490	1,877	4,731	3,539	3,539	3,146	3,146	3,146	4,320	4,320
F Eureka-S. Columbi	0.1365	0.2162	0.0609	0.0930	0.0743	0.0146	0.0214	0.0087	0.0012	0.0010	0.0008
N. Columbia	0.1569	0.1360	0.0534	0.0643	0.0741	0.1069	0.0508	0.0181	0.0035	0.0057	0.0057
S. Vancouver	0.0777	0.1276	0.0394	0.0587	0.0755	0.0774	0.0599	0.0656	0.0558	0.0483	0.0503
Summary Age (4+) Biomass	92,272	88,302	83,276	77,496	72,569	73,027	71,371	61,969	58,025	72,152	74,217
Eureka-S. Columbia	8,789	7,754	7,438	6,806	6,697	6,779	6,681	7,403	10,017	11,283	12,331
N. Columbia	29,226	28,017	25,481	24,446	23,093	23,155	22,767	22,330	19,514	20,335	21,385
S. Vancouver	54,257	52,531	50,357	46,244	42,779	43,093	41,923	32,236	28,494	40,534	40,501
SPB (mt) Total	15,822	15,073	15,733	15,735	16,955	17,909	18,467	18,783	16,324	17,686	16,915
Eureka-S. Columbia	1,700	1,333	1,445	1,321	1,403	1,567	1,782	1,919	1,929	2,367	2,197
N. Columbia	6,097	5,871	5,943	6,003	6,474	6,875	6,788	7,096	5,780	5,868	5,884
S. Vancouver	8,025	7,870	8,344	8,410	9,078	9,466	9,897	9,768	8,615	9,451	8,834
Recruitment Total	8,758	7,608	7,283	8,137	7,032	6,415	7,875	12,631	15,972	10,888	12,143
Eureka-S. Columbia	1,258	1,155	1,170	586	772	951	877	3,361	7,139	1,796	1,695
N. Columbia	2,946	2,478	2,452	2,805	1,941	1,770	2,233	2,999	3,362	3,748	4,485
S. Vancouver	4,554	3,975	3,660	4,746	4,320	3,694	4,765	6,272	5,471	5,344	5,962
Depletion Level	51%	49%	51%	51%	55%	58%	60%	61%	53%	57%	55%

*: U.S. Vancouver, Columbia and Eureka INPFC areas.

Executive Summary Table 2. South Vancouver area. Decision table for three future spawning biomass states-of-nature and three catch scenarios. The 'status quo' fixes the fishing mortality rate that closely matches the 2005 catch to what was seen in 2004.

Decision Table South Vancouver				Low state (less likely)		Middle state (more likely)		High state (less likely)	
	Year	Catch	Landings	Sp. Bio	Depletion	Sp. Bio	Depletion	Sp. Bio	Depletion
Status Quo (F67%)	2005	1,611	1,353	7,430	0.822	9,251	1.024	11,520	1.275
	2006	1,592	1,337	7,229	0.824	8,979	1.023	11,152	1.271
	2007	1,598	1,342	7,167	0.856	8,911	1.065	11,080	1.324
	2008	1,615	1,357	7,180	0.911	8,963	1.137	11,188	1.419
	2009	1,637	1,375	7,238	0.941	9,076	1.179	11,379	1.479
	2010	1,663	1,397	7,349	0.958	9,231	1.203	11,595	1.511
	2011	1,690	1,420	7,525	0.990	9,408	1.237	11,762	1.547
	2012	1,714	1,440	7,743	1.004	9,578	1.243	11,849	1.537
	2013	1,733	1,456	7,953	1.023	9,728	1.252	11,898	1.531
	2014	1,749	1,469	8,126	1.018	9,851	1.234	11,942	1.496
	2015	1,762	1,480	8,259	1.045	9,951	1.259	11,991	1.517
	2016	1,772	1,489	8,355	1.090	10,030	1.308	12,041	1.571
F50% Moderate Catch (F50%)	2005	2,996	2,517	7,430	1.004	9,251	1.250	11,520	1.556
	2006	2,798	2,350	6,800	0.966	8,456	1.201	10,515	1.494
	2007	2,677	2,249	6,396	0.996	7,983	1.243	9,964	1.552
	2008	2,604	2,187	6,137	1.049	7,714	1.319	9,696	1.657
	2009	2,560	2,150	5,980	1.046	7,571	1.324	9,585	1.676
	2010	2,541	2,134	5,925	0.910	7,524	1.155	9,555	1.467
	2011	2,535	2,130	5,971	0.801	7,537	1.012	9,515	1.277
	2012	2,534	2,129	6,077	0.750	7,574	0.935	9,441	1.165
	2013	2,534	2,128	6,184	0.707	7,615	0.871	9,376	1.072
	2014	2,534	2,128	6,265	0.738	7,651	0.901	9,342	1.100
	2015	2,534	2,128	6,320	0.769	7,680	0.935	9,333	1.136
	2016	2,533	2,128	6,355	0.758	7,704	0.919	9,339	1.114
High Catch (F45%)	2005	3,544	2,977	7,430	0.931	9,251	1.160	11,520	1.444
	2006	3,234	2,716	6,629	0.868	8,250	1.080	10,266	1.344
	2007	3,036	2,550	6,103	0.761	7,634	0.951	9,549	1.190
	2008	2,909	2,443	5,755	0.731	7,262	0.923	9,163	1.164
	2009	2,829	2,376	5,537	0.664	7,046	0.844	8,966	1.074
	2010	2,785	2,340	5,439	0.647	6,946	0.826	8,871	1.055
	2011	2,764	2,322	5,456	0.601	6,921	0.762	8,780	0.967
	2012	2,751	2,311	5,536	0.585	6,928	0.732	8,670	0.916
	2013	2,743	2,304	5,619	0.568	6,945	0.702	8,584	0.867
	2014	2,736	2,298	5,679	0.581	6,963	0.713	8,539	0.874
	2015	2,732	2,295	5,716	0.663	6,979	0.810	8,522	0.989
	2016	2,728	2,292	5,738	0.607	6,992	0.740	8,520	0.902

Executive Summary Table 2. (cont.) North Columbia area. Decision table for three future spawning biomass states-of-nature and three catch scenarios. The 'status quo' fixes the fishing mortality rate that closely matches the 2005 catch to what was seen in 2004.

Decision Table North Columbia				Low state (less likely)		Middle state (more likely)		High state (less likely)	
	Year	Catch	Landings	Sp. Bio	Depletion	Sp. Bio	Depletion	Sp. Bio	Depletion
Status Quo (F94%)	2005	112	94	4,946	0.378	5,962	0.455	7,186	0.549
	2006	115	97	4,984	0.380	5,997	0.458	7,217	0.551
	2007	121	102	5,084	0.388	6,118	0.467	7,363	0.562
	2008	129	108	5,256	0.401	6,340	0.484	7,647	0.584
	2009	137	115	5,493	0.419	6,655	0.508	8,063	0.615
	2010	146	123	5,787	0.442	7,043	0.538	8,571	0.654
	2011	154	130	6,127	0.468	7,466	0.570	9,097	0.694
	2012	162	136	6,495	0.496	7,888	0.602	9,581	0.731
	2013	169	142	6,862	0.524	8,289	0.633	10,012	0.764
	2014	175	147	7,205	0.550	8,655	0.661	10,396	0.794
	2015	180	151	7,513	0.573	8,982	0.686	10,738	0.820
	2016	184	155	7,785	0.594	9,273	0.708	11,045	0.843
F50% Moderate Catch (F50%)	2005	1,404	1,179	4,946	0.378	5,962	0.455	7,186	0.549
	2006	1,345	1,129	4,562	0.348	5,500	0.420	6,631	0.506
	2007	1,322	1,110	4,289	0.327	5,186	0.396	6,270	0.479
	2008	1,329	1,117	4,126	0.315	5,019	0.383	6,104	0.466
	2009	1,356	1,139	4,058	0.310	4,976	0.380	6,103	0.466
	2010	1,388	1,166	4,068	0.311	5,026	0.384	6,209	0.474
	2011	1,418	1,191	4,142	0.316	5,125	0.391	6,341	0.484
	2012	1,444	1,213	4,252	0.325	5,238	0.400	6,453	0.493
	2013	1,466	1,232	4,368	0.333	5,348	0.408	6,547	0.500
	2014	1,485	1,247	4,472	0.341	5,446	0.416	6,631	0.506
	2015	1,499	1,259	4,558	0.348	5,530	0.422	6,710	0.512
	2016	1,511	1,269	4,627	0.353	5,602	0.428	6,782	0.518
High Catch (F45%)	2005	1,650	1,386	4,946	0.378	5,962	0.455	7,186	0.549
	2006	1,556	1,307	4,482	0.342	5,406	0.413	6,520	0.498
	2007	1,510	1,269	4,145	0.316	5,019	0.383	6,077	0.464
	2008	1,503	1,263	3,930	0.300	4,793	0.366	5,845	0.446
	2009	1,521	1,278	3,820	0.292	4,703	0.359	5,789	0.442
	2010	1,547	1,299	3,796	0.290	4,710	0.360	5,845	0.446
	2011	1,572	1,321	3,840	0.293	4,772	0.364	5,930	0.453
	2012	1,594	1,339	3,922	0.299	4,852	0.370	6,002	0.458
	2013	1,613	1,355	4,011	0.306	4,932	0.376	6,063	0.463
	2014	1,628	1,367	4,090	0.312	5,003	0.382	6,120	0.467
	2015	1,640	1,377	4,155	0.317	5,065	0.387	6,176	0.471
	2016	1,649	1,385	4,205	0.321	5,118	0.391	6,228	0.475

Executive Summary Table 2. (cont.) Eurkea/South Columbia area. Decision table for three future spawning biomass states-of-nature and three catch scenarios. The ‘status quo’ fixes the fishing mortality rate that closely matches the 2005 catch to what was seen in 2004.

Decision Table Eureka\ South Columbia				Low state (less likely)		Middle state (more likely)		High state (less likely)	
	Year	Catch	Landings	Sp. Bio	Depletion	Sp. Bio	Depletion	Sp. Bio	Depletion
Status Quo (F99.2%)	2005	5.4	4.6	1,722	0.274	2,019	0.321	2,366	0.377
	2006	6.4	5.4	2,011	0.320	2,384	0.380	2,827	0.450
	2007	7.2	6.0	2,420	0.385	2,933	0.467	3,554	0.566
	2008	7.7	6.5	2,862	0.456	3,547	0.565	4,395	0.700
	2009	8.2	6.9	3,216	0.512	4,035	0.642	5,061	0.806
	2010	8.5	7.1	3,447	0.549	4,328	0.689	5,434	0.865
	2011	8.6	7.2	3,589	0.572	4,480	0.713	5,591	0.890
	2012	8.7	7.3	3,683	0.586	4,556	0.725	5,635	0.897
	2013	8.8	7.4	3,749	0.597	4,593	0.731	5,626	0.896
	2014	8.8	7.4	3,796	0.604	4,609	0.734	5,596	0.891
	2015	8.8	7.4	3,828	0.610	4,613	0.735	5,559	0.885
	2016	8.9	7.5	3,849	0.613	4,610	0.734	5,522	0.879
F50% Moderate Catch (F50%)	2005	540.2	453.8	1,722	0.274	2,019	0.321	2,366	0.377
	2006	601.5	505.2	1,864	0.297	2,214	0.352	2,628	0.419
	2007	635.1	533.5	2,094	0.333	2,548	0.406	3,101	0.494
	2008	645.6	542.3	2,315	0.369	2,887	0.460	3,601	0.573
	2009	646.2	542.8	2,432	0.387	3,074	0.489	3,884	0.619
	2010	633.2	531.9	2,440	0.389	3,087	0.491	3,904	0.622
	2011	612.4	514.4	2,393	0.381	3,007	0.479	3,779	0.602
	2012	594.4	499.3	2,329	0.371	2,902	0.462	3,615	0.576
	2013	578.9	486.3	2,266	0.361	2,799	0.446	3,457	0.550
	2014	565.3	474.9	2,207	0.351	2,707	0.431	3,321	0.529
	2015	554.0	465.3	2,154	0.343	2,629	0.419	3,210	0.511
	2016	544.9	457.7	2,108	0.336	2,565	0.408	3,121	0.497
High Catch (F45%)	2005	636.0	534.2	1,722	0.274	2,019	0.321	2,366	0.377
	2006	700.3	588.3	1,838	0.293	2,183	0.348	2,593	0.413
	2007	731.5	614.5	2,038	0.324	2,483	0.395	3,024	0.482
	2008	735.7	618.0	2,225	0.354	2,780	0.443	3,473	0.553
	2009	728.9	612.3	2,308	0.368	2,924	0.466	3,703	0.590
	2010	707.9	594.7	2,288	0.364	2,902	0.462	3,679	0.586
	2011	679.5	570.8	2,219	0.353	2,797	0.445	3,526	0.561
	2012	655.6	550.7	2,141	0.341	2,676	0.426	3,345	0.533
	2013	635.5	533.8	2,067	0.329	2,564	0.408	3,179	0.506
	2014	618.3	519.4	2,002	0.319	2,467	0.393	3,040	0.484
	2015	604.2	507.6	1,945	0.310	2,386	0.380	2,928	0.466
	2016	593.1	498.2	1,896	0.302	2,321	0.370	2,841	0.452

Executive Summary Table 2. (cont.) All three areas combined. Decision table for three future spawning biomass states-of-nature and three catch scenarios. The 'status quo' fixes the fishing mortality rate (by area) that closely matches the 2005 catch to what was seen in 2004.

Decision Table Aggregate of All Three Areas				Low state (less likely)		Middle state (more likely)		High state (less likely)	
	Year	Catch	Landings	Sp. Bio	Depletion	Sp. Bio	Depletion	Sp. Bio	Depletion
Status Quo (F by Area)	2005	1,727	1,451	14,098	0.496	17,232	0.606	21,071	0.741
	2006	1,714	1,439	14,223	0.500	17,360	0.611	21,196	0.746
	2007	1,726	1,450	14,671	0.516	17,962	0.632	21,997	0.774
	2008	1,752	1,471	15,298	0.538	18,849	0.663	23,230	0.817
	2009	1,783	1,498	15,948	0.561	19,765	0.696	24,503	0.862
	2010	1,818	1,527	16,583	0.584	20,602	0.725	25,601	0.901
	2011	1,853	1,557	17,242	0.607	21,354	0.751	26,450	0.931
	2012	1,884	1,583	17,921	0.631	22,022	0.775	27,065	0.952
	2013	1,911	1,605	18,564	0.653	22,609	0.796	27,536	0.969
	2014	1,933	1,623	19,127	0.673	23,115	0.813	27,934	0.983
	2015	1,951	1,639	19,600	0.690	23,547	0.829	28,288	0.995
	2016	1,965	1,651	19,989	0.703	23,913	0.841	28,608	1.007
F50% Moderate Catch (F50%)	2005	4,940	4,150	14,098	0.496	17,232	0.606	21,071	0.741
	2006	4,743	3,985	13,226	0.465	16,169	0.569	19,774	0.696
	2007	4,634	3,893	12,779	0.450	15,717	0.553	19,335	0.680
	2008	4,578	3,846	12,578	0.443	15,620	0.550	19,402	0.683
	2009	4,562	3,832	12,470	0.439	15,621	0.550	19,573	0.689
	2010	4,562	3,832	12,433	0.438	15,637	0.550	19,668	0.692
	2011	4,566	3,835	12,505	0.440	15,669	0.551	19,635	0.691
	2012	4,573	3,841	12,659	0.445	15,714	0.553	19,508	0.686
	2013	4,579	3,847	12,819	0.451	15,761	0.555	19,379	0.682
	2014	4,584	3,850	12,945	0.456	15,804	0.556	19,294	0.679
	2015	4,587	3,853	13,032	0.459	15,839	0.557	19,252	0.677
	2016	4,589	3,855	13,089	0.461	15,870	0.558	19,241	0.677
High Catch (F45%)	2005	5,830	4,897	14,098	0.496	17,232	0.606	21,071	0.741
	2006	5,490	4,611	12,949	0.456	15,839	0.557	19,380	0.682
	2007	5,278	4,434	12,285	0.432	15,135	0.533	18,650	0.656
	2008	5,148	4,324	11,910	0.419	14,835	0.522	18,481	0.650
	2009	5,079	4,266	11,665	0.410	14,672	0.516	18,457	0.649
	2010	5,040	4,234	11,524	0.405	14,558	0.512	18,395	0.647
	2011	5,016	4,213	11,514	0.405	14,490	0.510	18,236	0.642
	2012	5,001	4,201	11,599	0.408	14,456	0.509	18,017	0.634
	2013	4,991	4,192	11,698	0.412	14,440	0.508	17,825	0.627
	2014	4,982	4,185	11,771	0.414	14,433	0.508	17,698	0.623
	2015	4,975	4,179	11,815	0.416	14,431	0.508	17,626	0.620
	2016	4,970	4,175	11,840	0.417	14,431	0.508	17,590	0.619

1.0 Introduction

Yellowtail rockfish (*Sebastes flavidus*) are found throughout the northeast Pacific Ocean. Their range reportedly extends from San Diego, California to Kodiak and Admiralty Island, Alaska (Hart, 1975), although Eschmeyer et al. (1983) report the species is rare south of Point Conception, California (approximately 34^{o} 25' N. latitude). Their center of abundance is from Oregon to British Columbia (Alverson et al., 1964, Westrheim, 1970; Gunderson and Sample, 1980). Yellowtail rockfish are reported to occur at depths of 0 to 549 m (0 to 300 fm) (Hart, 1975). Commercial fishermen typically harvest yellowtail rockfish with bottom and midwater trawls fished at depths of 110 to 201 m (60 to 110 fm) (Fraidenburg, 1980; Tagart and Kimura, 1982).

Yellowtail rockfish recruit to the commercial fishery at 4 years of age (Tagart, 1988). The oldest recorded yellowtail rockfish is a 64-year-old male (Shaw and Archibald, 1981). Yellowtail rockfish reach their maximum size at approximately 15 years of age. The largest recorded yellowtail rockfish was 70 cm female caught by bottom trawl from PMFC area 3A in 1996. Females begin to mature at 27 cm to 37 cm (4 to 6 years of age) with the size at 50% maturity ranging from 37 cm to 45 cm (6 to 11 years old) (Westrheim 1975; Gunderson et al. 1980; Echeverria 1987; Tagart 1991). Males mature at a slightly smaller size and younger age than females. First maturity for males occurs at 30 cm (4 years old), with 50% maturity at 34 cm to 41 cm (5 to 9 years of age).

Several studies have been conducted for stock identification for yellowtail rockfish in the range of their distribution. Wishard et al. (1980) and McGauley (1991) found no variability among the samples collected along the western coast of northern America and concluded that their findings were consistent with the homogenous stock hypothesis. Tagart, Phelps and Stanley (personal communication) found that there were significant differences between samples from Oregon and those taken elsewhere; in addition, northern Washington samples were different from southern Washington samples. However, samples from northern Washington were not different from Canadian samples, and there were no detectable differences among Canadian samples. Stanley et al. (1992) found a cline in the prevalence of a monogenean gill parasite (*Monogenea sebastis*) with decreasing prevalence from north (80-100%) to south (0-10%), which was interpreted by Tagart et al (2000) as implying that the coast-wide yellowtail rockfish population was probably composed of separate stocks.

During the early development period of the rockfish fishery there was little attention paid to quantifying the species composition of the landings. It wasn't until the early 1960s that coastal states began to report landings by species (Niska, 1976; Tagart and Kimura, 1982). Estimation of amount of yellowtail rockfish landed by the foreign fleets during 1960’s and 1970’s remains a problem (Rogers 2002). In 1977, the U.S. extended fisheries jurisdiction to 200 nautical miles offshore. Yellowtail rockfish off Oregon and Washington were an important target of the expanding fishery in the late 1970's and 1980’s. The development of the yellowtail rockfish fishery provoked improvements in fishing strategies and fishing gear, such as three-seam, triple-bridle trawls to increase the vertical opening of the net, and improvements in roller gear needed to access rockfish habitat.

The Pacific Fishery Management Council (PFMC) manages the U.S. fishery as two stocks separated at Cape Mendocino, California (40^{o} 30' N). Tagart (1991) suggested that the fishery north of Cape Mendocino could be divided into three stocks (Figure 1): the Eureka/South Columbia stock extending from 40^{o} 30' N (Cape Mendocino) to 45^{o} 46' N (Cape Falcon); the

Northern Columbia stock extending north from Cape Falcon to 47° 20' N (Cape Elizabeth); and, the Southern Vancouver stock reaching north from Cape Elizabeth to approximately 49° N (the southern boundary of PMFC area 3D). The Canadian Department of Fisheries and Oceans (DFO) manages their fishery as two unit stocks; a "boundary" stock equivalent to the Southern Vancouver stock mentioned above and a "coastal stock" from PMFC area 3D to the northern Canada/U.S. border (Stanley, 1993).

Yellowtail rockfish co-occur with canary, widow rockfish and several other rockfishes (Nagtegaal 1983; Tagart 1987; Rogers and Pikitch 1992). Association with these and other rockfish species has substantially altered fishing opportunity for yellowtail rockfish. Canary rockfish stocks are currently at very low levels of abundance and have been declared overfished by National Marine Fisheries service. In order to achieve the necessary reduction in the canary rockfish catch, the Council adopted stringent management measures in 2000. Harvest of canary rockfish and their co-occurring species was limited.

Beginning in 2000, shelf rockfish species (including yellowtail) could no longer be retained by vessels using bottom trawl footropes with a diameter of greater than 8 inches. The use of small footrope gear increases the risk of gear loss in rocky areas. This restriction was intended to provide an incentive for fishers to avoid high-relief, rocky habitat, thus reducing the exposure of many depleted species to trawling. This incentive was reinforced through reductions in landing limits for most shelf rockfish species.

Since September 2002, managers have employed closed areas, referred to as Rockfish Conservation Areas (RCA's), in addition to landings limits and gear restrictions. The boundaries of the northern trawl RCA, delineated by waypoints approximating depth contours, have varied between and within years. The seaward boundary of the trawl RCA has ranged from 150-250 fm, while the shoreward boundary has ranged from 100 fm to the shore. Following implementation of this closed area, only small footrope gear could be used shoreward of the RCA. Beginning in 2005, additional gear restrictions were imposed in the northern area. Based on several years of testing and evaluation, a more flatfish-selective net design is now required for use in waters shoreward of the RCA.

Since the end of 2002, there have been no landings limits that provide directed mid-water fishing opportunities for yellowtail rockfish. From 2001 through 2004, yellowtail rockfish could be landed in amounts up to one-third the weight of most flatfish onboard (not to exceed 7,500 lb/trip or 15,000 lb/2-months). With the requirement to use selective flatfish gear in 2005, the yellowtail allowance was reduced to 2,000 lb/2-month period.

2.0 Changes and Responses to 2003-STAR Panel Report

In this section, we use "the Panel" for the 2003-STAR Panel.

2.1 Commercial Landings

Due to redistribution of rockfish species composition and the updated logbook database, the catch data in the three stock areas were different from that reported in Lai et al. (2003). In order to compare the effects of these changes, three catch series were included in model runs: (i) YT2003N; which is the catch series used in Lai et al. (2003), (ii) YT2003R, which is YT2003N

(Lai et al. 2003) updated with catches in 1999-2004, and (iii) YT2005; that consists of the revised 2005 series from PacFIN and the 2005 revised Canadian catches in INPFC area 3C.

2.2 Reference Model

The configurations of the referenced model used in Tagart et al. (2000) and Lai et al. (2003) are unchanged. In this model, the survey, whiting bycatch, and domestic non-whiting CPUE indices are treated as relative abundance estimates. The survey-only and fishery-only models in the previous assessments have not been updated. Previously, STAR panels and the SSC have recommended the biomass and ABC for the northern stock be calculated as the sum of the three area estimates, as opposed to a single northern area estimate (called Coast-wide in the last assessment, Lai et al. 2003 and Tagart et al. 2000). The STAT Team adopts this recommendation in this assessment.

2.3 Whiting bycatch and Domestic Non-whiting Trawl CPUE indices

An effort was made in this assessment to update the whiting bycatch and domestic non-whiting trawl CPUE time-series indices, as recommended by previous STAR panels. However, the STAT found difficulties in updating these indices after 2000. The domestic non-whiting trawl CPUE index was not updated because the catch of yellowtail rockfish declined due to the harvest constraints on canary and other overfished rockfish. Therefore, there were not sufficient catches available for the analyses of CPUE, especially in N. Columbia and Eureka-S. Columbia areas. In both the whiting and non-whiting fleets, recent efforts to rebuild overfished species have led to behavioral responses to avoid rockfish generally. These changes in behavior undermine the value of CPUE measures as indices of abundance in recent years. A study by A. Hoffmann (Tagart et al. 1997) indicates these two abundance indices violated the critical assumption of constant yearly “catchability”.

The domestic trawl CPUE data for 2000-2004 may not be comparable to 1988-1999 because the harvest of yellowtail rockfish has been limited by regulations implemented to protect overfished canary rockfish. Therefore, the time-series of CPUE data from 1988 to 1999 was used without update in this analysis.

However, this abundance index was not updated in this analysis because of (i) the changing of the whiting season and fishing grounds, (ii) the conclusion of the evaluation (Tagart et al. 1997), (iii) the fleet has placed greater emphasis on avoiding rockfish generally in recent years, and (iv) the whiting stock assessment (Helser et al. 2005) does not produce the same whiting catch-per-effort necessary to be used for this computation (see Equation 1).

3.0 Data

3.1 Catch Data

There have been multiple revisions to the historical estimates of landed catch since the assessment was conducted in 2000. The Oregon State Department of Fish and Game (ODFG) and California State Department of Fish and Game (CDFG) have revised the catch data submitted to PacFIN database due to improvement of species composition estimates for rockfish and revision of their stratification schemes. A new algorithm was adopted to estimate the catches of yellowtail rockfish in Canada (R. Stanley, pers. Comm.). Rogers (2002) revised estimated catches for foreign trawl fisheries during the period of 1966-1976. The logbook database was updated by the three state agencies (W. Daspit, pers. Comm.). Consequently, the historic catch time series is different from that used in the 2000 and 2003 assessments. The revised catch series are provided in Tables 1 (South Vancouver), 2 (North Columbia), and 3 (Eureka/South Columbia).

Landed catches of yellowtail rockfish from Washington, Oregon, and California from 1981 to 2004 were obtained from the PacFIN database. In the model, the landed catch for 2005 is assumed to be equal to the 2004 landed catch. The retained and discarded catches of yellowtail rockfish from at-sea whiting fishery from 1997 to 1999 were provided by Martin Loefflad (NMFS/AFSC Observer Program) and from 1999 to 2004 by Becky Renko (NMFS/NWR). Rick Stanley and Kate Rutherford (Canadian Department of Fisheries and Oceans, DFO) provided the estimated catches from Canada.

Landings of yellowtail rockfish from the shrimp trawl fishery in 1981-2004 were taken from the PacFIN database. Prior to 1981, the landings from shrimp trawl fishery were taken from Tagart et al. (2000). Yellowtail rockfish catch taken by the shore-based whiting fishery was estimated from reported landings on fish tickets in the PacFIN database. Fish tickets were filtered for a whiting catch greater than or equal to 5000 pounds. All yellowtail rockfish landings on these fish tickets were assumed to be from the directed shore-based whiting fishery. The estimated shore-based whiting fishery catch was subtracted from the domestic trawl yellowtail rockfish catch.

Discarded catch from the domestic trawl fishery is assumed to represent 16% of the total catch, i.e., total domestic catch equals domestic landed catch divided by 0.84. This represents the PFMC assumed discard rate in this fishery based on a study by Pikitch (1988). As in Tagart et al. (2000), we assume no discard prior to 1985 because there was no trip limit imposed by the PFMC. The report of the first year West Coast Groundfish Observer Program indicated little change on the assumed 16% discard rate (NWFSC 2003).

Based on the revised catch data, U.S. yellowtail rockfish total catch reached a plateau at around 9,000 mt in 1978-1983 (Fig. 2). When yellowtail rockfish trip limits were imposed in 1985, catch declined remarkably. Annual U.S. landings decreased to 618 mt in 2004. Since 2000, the proportion of annual catch from the N. Columbia and Eureka/S. Columbia areas decreased, while the proportion in S. Vancouver area increased, especially in the Canadian section of S. Vancouver area. The proportion of coast-wide catches (excluding recreational catches and catches taken in the south of Cape Mendocino) taken by the U.S. fishery has decreased over the years and has been less than 80% since 2000.

In Eureka/S. Columbia and N. Columbia areas, yellowtail rockfish were also taken by hook and line, pot, net, and trolls (Tables 2 and 3). These catches represent small amounts and were not factored into the past or the current analysis. Recreational catches of yellowtail rockfish are recorded in the RecFIN database. However, the recreational catches cannot be split among the three stock areas and the precision of these estimates requires further evaluation. As with non-trawl commercial gears, reported recreational removals represent a small fraction of annual amounts caught by commercial trawlers. Therefore, they were not included in this analysis.

3.2 Abundance Indices

Three types of abundance indices--NMFS triennial trawl survey index, domestic trawl CPUE, and whiting bycatch index--were used in the past three stock assessments (Tagart et al. 1997; Tagart et al. 2000, Lai et al. 2003). Tagart et al. (1997) included a critical evaluation carried out by A.

Hoffmann on the assumptions associated with the uses of abundance indices. The necessary assumptions for these indices are: (1) the indices are normally distributed, (2) the indices are independent of each other, (3) the indices are homogeneous, (4) the proportionality constant does not change from year to year, and (5) for an index of abundance-at-age, the proportionality constant does not change between ages within a year. That evaluation concludes that NMFS triennial trawl survey is the most credible among the three indices.

3.2.1 NMFS Triennial Trawl Survey

The NMFS trawl surveys took place at three-year intervals from 1977 to 2004 (Gunderson et al. 1980; Weinberg et al. 1984; Coleman 1986 and 1988; Zimmermann et al. 1994; Wilkins and Weinberg 2002). A post-stratification of the INPFC Columbia area, split at Cape Falcon, was conducted by Mark Wilkins (pers. comm.) to obtain estimates of biomass for the three stock areas (Table 4). Placement of the boundaries for the Columbia was discussed during previous assessments. Lai et al. (2003) further examined the issue with post-stratification based on the boundary at Cape Lookout. This resulted in less reliable density estimates than the boundary at Cape Falcon. The re-evaluation (Fig. 3) suggests that moving the stock boundary to Cape Falcon seems less important. Furthermore, such a split requires the redistribution of landings, which is difficult for the current data system. The survey does not extend into Canada every year, hence, biomass trends in the S. Vancouver area were assumed to follow the observed trend for estimates from the U.S. Vancouver area.

Following 1977, and in each successive survey through 1986, the NMFS increased the density of survey track lines in designated high density or rockfish sampling areas in an attempt to improve the precision of rockfish biomass estimates (Figure 3). In 1977, high-density sample areas had track lines 9.3 km (5 nm) apart; in 1980 and 1983 spacing was reduced to 5.6 km (3 nm); and in 1986 high-density track lines were placed at intervals of 3.7 km (2 nm). Despite higher density sampling in 1980 and 1983, the precision of estimates did not increase as expected. The high-density track-line sampling design was abandoned after 1986.

The survey-to-survey fluctuation of estimated biomass suggests that the vulnerability of yellowtail rockfish to the survey may vary over time. During the 1980 survey, 43 stations were sampled twice two weeks apart and the CPUE changed from 1.0 to 16.8 kg/km. This may be indicative of a schooling mobile species that can change distribution (and availability to trawl gear) in a relatively short period of time (Dark et al. 1982).

Historically, the highest survey yellowtail rockfish catch rates were in the S. Vancouver area (Figure 4, Table 4). Survey catch in these areas in 1989 and 1998 resulted in above average biomass estimates for the entire coast. There was no obvious trend for the coast-wide estimate of yellowtail rockfish biomass due to declines in the Eureka/S. Columbia and increase in the S. Vancouver areas in recent years. These trends should be interpreted cautiously because the variability associated with the biomass estimates is high (average CV ranges from 0.34 to 0.60, with year specific CVs as high as 0.90).

3.2.2 Whiting Bycatch Index

The whiting bycatch index (Table 5, Fig. 5) was computed from NMFS observer data from the at-sea whiting fishery (joint venture, domestic catcher processor and mothership), 1978-1999. However, the index is not updated as described in Sec. 2.3. Tow-by-tow yellowtail rockfish catches taken incidentally in the targeted whiting fishery were converted to index values using a ratio estimator of yellowtail rockfish catch to whiting catch (Rogers and Lenarz, 1993):

$$I = \left(\frac{C_h}{F_h}\right)\left(\frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} h_i}\right) \tag{1}$$

where, C_h is the annual whiting catch, F_h is the annual whiting fishing mortality, y_i is the catch of yellowtail rockfish on tow i and , h_i is the whiting catch on tow i. Qualified tows were those between 43.5 to 48 degrees N. latitude. The ratio estimator was scaled by annual estimates of whiting catch-per-effort as determined in the 1999 whiting stock assessment (Dorn, 1999). A single time series of coast-wide index was constructed for the period 1978 to 1999.

The variance for the index given the ratio of yellowtail to whiting catch (r) is estimated using the delta method assuming that the covariance between r and F_h is zero:

$$\hat{V}(I) = \hat{V}\left(\frac{rC_h}{F_h}\right) = \left(\frac{C_h}{F_h}\right)^2 \hat{V}(r) + \left(\frac{-rC_h}{F_h^2}\right)^2 \hat{V}(F_h) \tag{2}$$

The variance for F_h is estimated by Dorn (1999) and fixed at CV of 0.15. The variance of the ratio (r) is:

$$\hat{V}(r) = \frac{(N-n)}{(nN)}\left(\frac{1}{\bar{h}^2}\right)\left(\frac{\sum_{i=1}^{n}(w_i - rh_i)^2}{n-1}\right) \tag{3}$$

This index series fluctuated without apparent trend (Fig. 5, upper panel). However, the indices since 1994 were among the lowest of the entire series.

3.2.3 Domestic Trawl CPUE

As mentioned above, the domestic trawl CPUE data violate the required assumptions for an abundance index. Nevertheless, we continue to employ the index as we did in the past three assessments.

Yellowtail rockfish CPUE indices were constructed from Washington, Oregon and California domestic trawl fishery logbook. Tow-by-tow hailed weight of retained catch was adjusted to fish ticket weight. The adjusted weight and skippers' estimate of tow duration was used to compute CPUE (lbs/hour). If skippers failed to hail catch and yellowtail rockfish were recorded on the landing receipt, the data were excluded from the analysis. The data were further restricted to those vessels which landed yellowtail in at least 9 of the 12 years between 1988 and 1999. Only non-whiting fishery roller and bottom trawl tows with greater than 50lbs of yellowtail catch were included in the analysis. Tow data from depth strata with limited yellowtail catch (<50 and > 125 fathoms) and tows south of Cape Mendocino, 40^o 30'N Latitude, were also excluded.

Four separate indices were computed, one for each of the three presumptive stocks and one for a coast-wide stock (Table 6, Fig. 5) (The coast-wide index was not used for this 2005 update). Data were treated similarly for each index. After filtering, approximately 20% of the tow-by-tow data was used in the analysis, resulting in 13,022 tows used to generate the coast-wide index, 5,260 tows for the Eureka/S. Columbia index, 5,218 tows for the N. Columbia index and 2,544 tows for the S. Vancouver index.

The CPUE data were analyzed with a General Factorial General Linear Model (GLM). Main effects included year, vessel, season (December-March, April-July, and August-November), depth (25 fathom intervals between 50 and 125 fathom) and latitude (20 minute intervals). Data were analyzed for the period 1988 to 1999 for all indices except for the S. Vancouver area. Limited sample size restricted the S. Vancouver index to 1989 to 1999.

Analysis was limited to main effects (i.e., no interaction terms). With the exception of depth interval, all main-effects were found to be highly significant (P<1%). Depth interval was significant at the P<5% level for all but the N. Columbia index. Index values were estimated from the marginal means for the Year factor. The N. Columbia and S. Vancouver indices are without apparent trend (Table 6).

3.3 Biological Data

3.3.1 Sample sizes for Ageing

Tables 7-10 summarize the number of biological samples and number of otoliths collected from market catches of yellowtail rockfish. All data are from the PacFIN biological database. As of May, 2005, PacFIN does not contain samples for 2003 and 2004 in the Eureka/S. Columbia area. Rick Stanley and Kate Rutherford (Canadian DFO/PBS) supplied updated Canadian biological data for the period 1980 to 1998. Table 11 summarizes the number of survey tows made in the stock areas, number of tows sampled for collecting otoliths and number of otoliths aged for each year.

3.3.2 Age Composition in Commercial Landings and Surveys

The method of computing catch-at-age for the Canadian, ODFW, and WDFW data was given in Tagart (1991). The estimates of catch-at-age in number of fish from 1974 to 2004 are summarized in Tables 12-14. In Eureka/S. Columbia area, age data were not available in 1978, 2003, and 2004 (Table 14). Tagart et al. (2000) claims that coast-wide catch-at-age data reflect a pattern of irregular occurrences of dominant year classes in the fishery. Apparently strong year classes can be observed for 1949, 1962, 1968, 1974 and 1984. An echo of some of these patterns is detectable in each of the sub-stocks.

Catch expanded estimates of the number of fish-at-age from the NMFS trawl survey were provided by Mark Wilkins (NMFS/AFSC) (Table 15). In 1977, ages were determined using the "surface age reading method". These data are therefore incompatible with the break-and-burn ageing method applied to samples from all subsequent surveys. While we display the age distribution, it is not used in fitting our model. The assessment area age distribution is reasonably consistent, but the area-specific data are noisier. Fish are recruited to the trawl survey as young as age 1, but typically aren't caught with regularity until age 4. The modal age appears to be between 5 and 12 years old. The 1998 survey showed a bimodal age distribution with peaks at age 9 (1989 year class) and ages 11 and 12 (the 1986-1987 year classes). The 2001 survey age distributions continue to reflect the dominant 1989 and 1990 year classes that were first detected during the 1995 survey; however, the current survey age distributions suggest that recruitment has been much reduced in recent years.

3.3.3 von Bertalanffy Equation and Length-Weight Relationships

The parameters of von Bertallanffy equation were estimated from ageing data collected from commercial landings. Table 16 lists the estimates of L_∞, K, and t_0 by sex and year (pre-1987 and 1987-2004). Estimated length/weight parameters (*a* and *b*), where Weight = *a* (length) ^{b} are unchanged from the prior assessment. Tagart et al. (1997) found no year and season effects on the parameter estimates. The parameter values are *a* = 0.0214 and *b*= 2.920. The length/weight relationship is the same for both sexes.

3.3.4 Weight-at-age

The predicted weights at age were derived from the estimated von Bertalanffy equation (Table 16) and the length-weight relationship described above. Tables 17-19 list the predicted weights-at-age respectively for S. Vancouver, N. Columbia, and Eureka/S. Columbia areas by sex and year.

3.3.5 Maturity-at-age

We estimated the proportion mature-at-age for female yellowtail rockfish based on logistic functions $p_t = 1/\left(1 + e^{at+b}\right)$ from (Tagart, 1991). The estimated parameters (*a, b*) were (-0.960, 9.273) for the N. Columbia and (-1.006, 10.990) for U.S. Vancouver area. The parameter values from the N. Columbia stock were used for the Eureka/S. Columbia area. The proportion of female that reached sexually maturity is given in Table 20.

3.3.6 Natural mortality

Fraidenburg (1981) made the first estimate of yellowtail rockfish natural mortality (M=0.25), using surface aged otolith for samples collected from PMFC area 3A (N. Columbia stock). Leaman and Nagtegall (1987) estimated a yellowtail rockfish natural mortality rate of M=0.07 for a lightly exploited stock from Northern British Columbia aged using the break-and-burn method. Tagart (1991) reprised Fraidenburg's estimate after re-aging Fraidenburg's specimens using the break-and-burn aging method. Tagart's estimated yellowtail rockfish natural mortality rate was M=0.11. Using the Stock Synthesis model, Tagart profiled the fit to fishery age data across a range of constant natural mortality rates, demonstrating that the best fit occurred when M=0.11. However, female yellowtail rockfish appeared to show an increasing mortality with age (senescent mortality hypothesis), while males did not.

Tagart (1991) evaluated the assumption that natural mortality was constant for all ages using the stock synthesis model. Male natural mortality was assumed to be constant for all ages at M=0.11. Female natural mortality was allowed to rise linearly from age 6 at M=0.11 to a model determined maximum at age 25+. Tagart concluded that the senescent mortality hypothesis fit the fishery age data well, and was a better biological explanation for the disappearance of older age females than the alternative hypothesis that the older females were not vulnerable to the fishery. Because the natural mortality rate is confounded in age-structured models with fishery selectivity, there has been an active debate on whether female natural mortality is actually increasing with age, or whether the apparent disappearance of older age females is related to fishery selectivity. In this analysis, we continue to use the senescent female mortality hypothesis the approach introduced in Tagart (1991) and used in all subsequent yellowtail rockfish assessments.

3.3.7 Ageing Error

Since 1991, the WDFW age reader has routinely provided replicate age assignments for every fourth fish in a sample. These data were used to estimate age reading error. The mean difference and its standard deviation (s) between the first and second age assignment for each fish aged were calculated (Table 21, Figure 6). We then regressed ($s=\alpha Age+\beta$) the standard deviation of the difference against the first assigned age (*Age*) ($R^2=0.80$, N=22, $\alpha=0.055$, $\beta=0.429$). We used the predicted standard deviation at age from the regression (Table 21) and an assumed normal probability distribution to calculate the probability of recording an assigned age for a given "true age". The matrix of probabilities is known as the ageing error matrix. A more detailed description of the method is given in Tagart et al. (2000).

4.0 Model

This stock assessment was defined to be an update from the last assessment (Tagart et al. 2000 and Lai et al. 2003). According to the STAR-Update process, the model and its features were not to be changed. Therefore, this analysis concentrated on the reference models (Tagart et al. 2000) for each of the three sub-areas: S. Vancouver (RefVan), N. Columbia (RefCol), and Eureka/S. Columbia (RefEur). The three catch series, "YT2005", "YT2003N", and "YT2003R", as defined above, were fit into each of the three sub-areas.

4.1 General Description of Model

A detailed model description is given in Appendix A. The program was coded in AD Model Builder, which is given Appendix B. The important features of the model are provided in Sec. II (Input Control Variables) of the Appendix A. To summarize:

(1) Catchability - proportion between index and exploitable biomass

- (i) Fishery catchabilities are dependent on previous year with the random deviation from previous year being log-normally distributed.
- (ii) Survey catchability is constant over years.
- (iii) Catchabilities of whiting bycatch index and logbook CPUE vary over years by specifying $\lambda_{14} = \lambda_{15} \approx 20$.

(2) Dome-shaped selectivity

- (i) Fishery selectivity is sex-specific. Survey selectivity is not sex-specific.
- (ii) Curvature penalty (second difference) is imposed to ensure a smooth curve (λ_5, λ_6, λ_7).
- (iii) Dome-shaped constraints for selectivity should be increasing for fish $\leq$ age-5 (λ_2, λ_8) and be constant for fish $\geq$ age-16.
- (iv) Impose penalty to minimize difference between male and female selectivity (λ_4).

(3) Natural mortality

(i) Natural mortality (M) of male is 0.11 and is constant over ages.

(ii) Natural mortality of female is 0.11 for ages 4-6, and then, increases linearly to the estimated maximum M at age 25.

(4) Variance for trawl CPUE is to be estimated (λ_2).

(5) An ageing error matrix is postulated to be used for both fishery and survey age compositions (versus using identity matrix, i.e., no ageing error).

(6) Historical (i.e., pre-1967) fishing mortality (F) is assumed to be 10% of F at 1967.

Other important features and interpretation of model fits were summarized by the weighting factors in the component likelihoods (Sec. VII, Appendix A). Ageing error for both the survey and fishery age composition data was incorporated by use of an ageing error matrix. The age data were modeled as multinomial random variables. The sample size used for the multinomial component of the likelihood (which effectively scales the variance for the age-composition data) was set to the number of age samples taken in each year rather than to the number of fish aged. Similarly, the sample size used for the multinomial component of the likelihood for the survey age composition data was set to the number of hauls from which age data were collected.

5.0 Results

5.1 Model Area Fits

Model fits to the whiting bycatch index and domestic non-whiting trawl CPUE (Fig. 7) should be read with caution because time-varying catchability was assumed and the predicted biomass and their catchability demonstrated similar trends. The survey catchability was assumed to be constant over years with an estimate of 0.22, 0.11, and 0.27 respectively for YT2005 catch-series in the model areas, S. Vancouver, N. Columbia, and Eureka/S. Columbia areas (Table 22). The estimated survey abundance index trend is flat for 1977-2004 in the two northern areas, but for Eureka/S. Columbia there are two plateaus with the drop between the plateaus starting around 1989. Because the model was configured to treat survey index as the most scientifically creditable index, the two predicted fishery dependent indices might be misleading.

Standardized residuals, $\sqrt{n}(p_j - \hat{p}_j)/(\hat{p}_j(1-\hat{p}_j))$, where n = sample size, between observed and fitted age proportions (p_j and $\hat{p}_j$ respectively) for the fishery and survey are shown in Figures 8-10. The scatter plots of residuals from three catch-series (YT2005, YT2003R, and YT2003N) all showed similar patterns. Likelihoods from abundance indices and age compositions contributed the majority of the total likelihood (71 out of a total of 81, Table 22).

5.2 Biomass

Based on YT2005 catch-series, the population biomass (and number) has decreased continuously since 1994 with a small up-tick in the most recent years (Fig. 11). Coast-wide total biomass in 2004 was at 96%, 48%, and 66% of the biomass in 1967 for S. Vancouver, N. Columbia, and

Eureka/S. Columbia, respectively (Table 22). For the Eureka/S. Columbia areas, female spawning biomass (SPB) has seen a recent increase corresponding with the recent increase in total biomass. For the N. Columbia area while total biomass decreased and age-4 recruitments were low since 1995, female spawning biomass (SPB) has been flat after 1990. This is probably due to stronger recruitments observed in late 1980s and early 1990s remaining in the current population (Fig. 11). In S. Vancouver there has been a generally increasing trend in the spawner biomass since '94, despite a steady decline in total biomass through 2003. This is sensible given the recent low recruitment and small exploitation rate. Note that while the spawning biomass is near all-time highs around 2000-2001, the total biomass is at all-time lows. The 2005 SPB is slightly smaller than the last 5-yr average SPB for areas S. Vancouver and N. Columbia, but slightly higher for Eureka/S. Columbia (Table 22). The 95% confidence intervals for total biomass are, as to be expected, smaller in the middle range of years with an increase at the extremes. The S. Vancouver area appears to have some increased variability from 1990 to 2004 with the confidence band reaching a maximum of around 40,000 metric tons (Fig. 11).

5.3 Recruitment

Total recruitment (age-4 females and males) in 1995-2004 was almost at historical low levels (Fig. 11). Unlike the other two areas, the Eureka/S. Columbia area's average female recruitment for the period 2000-2004 was greater than both the historical average recruitment (1967-2004) and the median recruitment (Table 22). However, the CV of estimated age-4 recruitment for the Eureka/S. Columbia area is around 25% greater than in either of the other two areas.

5.4 Selectivity and mortality rates

The standardized fishery and survey ogives peaked or leveled out starting at age 11. However, the survey ogive leveled out at age 16 in the N. Columbia area (Fig. 12). Instantaneous natural mortality rate (M) was 0.11 for male and ages 4-6 female. The M for age-25 females ranges from 0.16 to 0.28 (Table 22). Fully vulnerable fishing mortality rate (F) at age 12 has decreased since 2000 (Fig. 12). The 2004 fishing mortality is lower than the historical average for all areas, with N. Columbia and Eureka/S. Columbia currently at very low levels (Table 22). Because of the uncertainty due to estimation of population parameters in 2004 (especially recruitment), caution should be paid to interpreting the estimated F in 2004.

5.5 Harvest Projection

Based on the recruitment and spawning biomass estimates from our models, we could not estimate a significant spawner/recruit relationship for yellowtail rockfish (Fig. 11). Therefore, we cannot estimate yellowtail rockfish F_{MSY}, and thus, we utilize the proxy yield-per-recruit fishing mortality rates for yield projections. In 2000, the PFMC adopted revised target exploitation rates based on an $F_{50\%}$ spawner-per-recruit (SPR) fishing mortality rate. The $F_{50\%}$ is a proxy for the unknown F_{MSY} and is the equilibrium fishing mortality rate that drives the spawning biomass-per-recruit to 50% of the unfished spawning biomass-per-recruit. In conducting their review, the Council's advisors noted that the Pacific coast rockfishes were not as productive as previously believed. Rockfish are expected to show density dependence in recruitment such that, exploitation at the $F_{50\%}$ fishing mortality rate will actually drive spawning biomass to approximately 40% of the unfished spawning biomass-per-recruit. Thus, the target spawning biomass level is $SPB_{40\%}$ (Tagart et al. 2000).

In the projections (Sec. IX, Appendix A), the estimation of unfished total biomass (B_0) and unfished spawning biomass (SPB_0) were based on the following assumptions: (i) the age-4 recruitment in the projection years (2006-2015) is equal to the geometric mean of the estimated age-4 recruitment in 1967-2004; (ii) The weight-at-age and area specific proportion mature-at-age are equal to that estimated for 2004; (iii) The model estimated male and female fishery selectivities are used; and (iv) The 2005 landing is equal to 2004 landing, and thus, the estimated 2004 population number at age is projected accordingly to the beginning of 2006.

Yield is projected for 10 years (2006-2015) based on YT2005 at the Council's $F_{50\%}$ SPR rate. The cumulative probability profiles for the three areas' $F_{50\%}$ yield in 2006 and the projected 3-yr mean yield (2006-2008) are shown in Fig. 13. The aggregate projected 3-yr mean yields for S. Vancouver, N. Columbia, and Eureka/S. Columbia respectively are, (2,345; 1,051; 531) mt at the 25-percentile, (3,066; 1,341; 691) mt at the 50-percentile and (4,011; 1,713; 899) mt at 75-percentile (Fig. 13). In the last assessment (Lai et al. 2003), the 3-yr mean yield (2004-2006) for the coast-wide model was 3,133 mt, 3,971 mt, and 5,034 mt respectively for the three specified percentiles.

Table 23 also gives the estimates (YT2003N) obtained from Lai et al. (2003). However, a strict comparison between the last and current assessment is not meaningful because the historical data have changed. The 3-yr mean yield for 2004-2006 estimated from the last assessment is 3,966 mt (Lai et al. 2003). The Council adopted ABC/OY for 2004 was 4,320 mt. (Pacific Fishery Management Council 2004).

If harvests equaled the $F_{50\%}$ yields over the 2007-2016 timeframe, the projected total biomasses in each area would remain similar to those in 2004 (Fig. 14 and Table 22). At the same time, the projected SPB would decrease sharply from 2006 to 2008 for two northern areas. However, recent U.S. catches have represented rather small fractions of the U.S. OYs, due to the restrictions discussed above. With the new requirement for selective flatfish gear to be used shoreward of the RCA in the U.S. portion of the northern area, there is a strong likelihood that U.S. landings will continue to be far below the $F_{50\%}$ yields throughout the projection period.

Plausibly, the projected $SPB_{50\%}$ becomes stable after 2011 considering that the combined mean recruitment in 2000-2004 is 80% of the combined assumed recruitment, i.e. the arithmetic means summed over the three areas from 1967 to 2004 (6,721 mt; Table 22).

6.0 Discussion

For two of the three areas, spawning biomass is increasing and the total biomass may be showing an upturn (Fig. 11). The number of males and females in the population is no longer declining. These positive trends may continue with continued reduction in fishing pressure due to the canary rockfish limits. If recruitment returns to the long-term average, this upward trend would likely improve.

The estimated 2004 total northern area biomass (72,152 mt) has a relatively reasonable CV of 19%. However, there is low precision in estimated recruitment (CV from 19 to 100%). The effect of these imprecise estimates on population projection and on ABC/OY determination should be evaluated. Further research is needed to determine whether the decision based on the projection is risk-prone or risk-averse.

There has been a decline in the collection of age data for yellowtail rockfish in 2001 and 2002. Of particular concern is the lack of age data for 1978, 2003, and 2004 from the Eureka/S. Columbia area. Growth of yellowtail rockfish in the south is slower than in the north (Tables 16-

19) and therefore borrowing data from the northern stocks for the Eureka/S. Columbia stock is not a good option. Additionally, the three state agencies use different designs to collect biological samples. The CDFG does not list yellowtail rockfish as a high priority for biological sampling, listing it as a shelf rockfish complex species, to be sampled subject to available resources. It is recommended that the three state agencies develop a uniform sampling protocol.

There are a substantial number of zero-tows in the triennial survey. Further research is needed to explore alternative methods for estimating survey indices, such as delta-GLM and other zero-inflated linear models. The length-weight relationship and maturity-at-age used in this analysis are dated. It is desired to update the information with new data; especially maturity information using a histological method.

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Table 1. Estimated catches of yellowtail rockfish, 1963-2002, for S. Vancouver stock. US total includes discard but does not include Hook & line, misc., net, pot, and trolls.

	Hook&					US Domestic Trawl		US Shrimp Trawl		US At-Sea Whiting		US Shoreside Whiting		US DomesticTrawl Disc.		US TOTAL	
Year	Line[b]	Misc.[b]	Net[b]	Pot[b]	Trolls[b]	2003[a]	2005	2003[a]	2005	2003[a]	2005	2003[a]	2005	2003[a]	2005	2003[a]	2005
1963																	
1964																	
1965																	
1966										1248.0	1248.0 e						1248.0
1967						34.7	34.7 a			892.0	892.0 e					926.7	926.7
1968						951.5	951.5 a			497.0	497.0 e					1448.5	1448.5
1969						1372.6	1372.6 a	3.5	3.5 a	400.0	400.0 e					1776.1	1776.1
1970						466.8	466.8 a			521.0	521.0 e					987.8	987.8
1971						365.1	365.1 a			223.0	223.0 e					588.1	588.1
1972						456.8	456.8 a			380.0	380.0 e					836.8	836.8
1973						276.4	276.4 a	5.4	5.4 a	94.0	94.0 e					375.8	375.8
1974						50.2	50.2 a	36.8	36.8 a	485.0	485.0 e					572.0	572.0
1975						66.0	66.0 a	37.9	37.9 a	0.0	0.0 e					103.9	103.9
1976						883.2	883.2 a	54.9	54.9 a	0.0	0.0 e					938.1	938.1
1977						1340.2	1340.2 a	39.5	39.5 a							1379.7	1379.7
1978						1212.4	1212.4 a	94.9	94.9 a							1307.3	1307.3
1979						1361.3	1361.3 a	316.7	316.7 a							1678.0	1678.0
1980						2028.1	2028.1 a	229.7	229.7 a	37.9	37.9 a					2295.7	2295.7
1981	0	0	0	0	0	2847.3	2847.3 b'	236.8	236.8 a,b	56.7	56.7 a					3140.8	3140.8
1982	0	0	0	0	0	2886.8	2886.8 b'	84.9	84.9 a,b	381.2	381.2 a					3352.9	3352.9
1983	0	0	0	0	0	2735.8	2735.8 b'	255.5	255.5 a,b	267.6	267.6 a					3258.9	3258.9
1984	0	0	0	0	0	1013.2	1013.2 b'	59.6	59.6 a,b	70.2	70.2 a					1143.0	1143.0
1985	0	0	0	0	0	943.4	943.4 b'	46.4	46.4 a,b	48.9	48.9 a			179.7	179.7	1218.4	1218.4
1986	0	0	0	0	0	1544.0	1544.0 b'	42.8	42.8 a,b	94.6	94.6 a			294.1	294.1	1975.5	1975.5
1987	0	0	0	0	0	1192.8	1192.8 b'	14.6	14.6 a,b	61.0	61.0 a			227.2	227.2	1495.6	1495.6
1988	26.2	0	0	0	2.2	1680.4	1679.9 b'			96.8	96.8 a			320.1	320.0	2097.3	2096.7
1989	1.4	0	0	0	0.1	1520.9	1520.9 b'			49.5	49.5 a			289.7	289.7	1860.0	1860.0
1990	9.6	0	0	0	4.9	1447.6	1447.6 b'			39.1	39.1 a			275.7	275.7	1762.5	1762.5
1991	1.4	0	0	0	8.2	945.2	945.2 b'	4.0	4.0 b	42.8	40.0 c	2.0	2.0 d	180.0	180.0	1172.0	1169.3
1992	9.9	0	0	0	9.2	1222.7	1222.7 b'		0.0	208.7	208.0 c			232.9	232.9	1664.3	1663.6
1993	18.3	0	0	0	9.8	1611.8	1611.8 b'	14.3	14.3 b	14.1	14.1 c			307.0	307.0	1947.2	1947.2
1994	7.7	0	0	0	4.8	1580.2	1580.2 b'	18.2	18.2 b	177.9	180.5 c			301.0	301.0	2077.2	2079.9
1995	8.7	0	0	0	0.2	1340.3	1322.7 b'	24.6	24.6 b	136.8	136.7 c	0.1	0.1 d	255.3	251.9	1756.9	1735.9
1996	7.6	0	0	0	0.4	1288.7	1268.3 b'	61.0	61.0 b	433.7	529.3 c			245.5	241.6	2028.9	2100.2
1997	6.5	0	0	0	3.6	507.9	500.8 b'	1.6	1.6 b	180.6	180.6 c	3.9	3.9 d	96.7	95.4	786.8	778.4
1998	12.6	0	0	0	7.4	717.3	720.9 b'	2.8	2.8 b	365.5	372.3 c	25.0	28.0 d	136.6	137.3	1222.2	1233.4
1999	7.7	0	0	0	16.1	604.1	588.1 b'	0.9	0.9 b	467.7	918.7 c	21.6	28.6 d	115.1	112.0	1187.8	1619.7
2000	0.9	0	0	0	4.9	889.3	891.1 b'		0.0	393.9	493.9 c	47.2	90.1 d	169.4	169.7	1452.5	1554.7
2001	0.9	0	0	0	4.6	765.6	765.6 b'	1.3	1.3 b	41.7	128.7 c	15.1	30.0 d	145.8	145.8	954.4	1041.4
2002	0.8	0	0	0	3.8	715.6	642.1 b'	0.8	0.8 b	180.7	91.3 c	2.1	4.0 d	136.3	122.3	1033.4	856.5
2003	0.5	0	0	0	9.6		331.2 b'		0.0		88.3 c		11.3 d		63.1		482.6
2004	2.4	0	0	0	14.3		350.9 b'		0.0		91.6 c		36.6 d		66.8		509.4

Data retrieved from PacFIN database, using ann_arid_woc_grg.sql.
a: Yellowtail Stock Assessment 2000, Jack Tagart et al.
b: Retrived from PacFIN on Mar. 15, 2003.
b': include shoreside bycatch
c: Provided by Becky Renko, based on NORPAC database
c': Provided by Martin Loefflad, based on NORPAC database
d: Estimated from fish tickets for whiting catch equal or greater than 5000 lbs.
e: Foreign Catches: Jean Roger (2003)
f: Provided by Rick Stanley, updated by new estimation algorithm
g: Assume 16% discard
h: Exclude Hook&line, Misc.,Net, and Trolls

Table 1. Continued.

Year	Canada Domestic Traw 2003[a]	2005	Canada Shrimp Trawl 2003[a]	2005	Canada At-Sea Whiting 2003[a]	2005	CANADA TOTAL 2003[a]	2005	US+CAN TOTAL 2003[a]	2005
1963										
1964										
1965										
1966										1248.0
1967	1.4	1.4 f					1.4	1.4	928.1	928.1
1968		f							1448.5	1448.5
1969	21.7	21.7 f					21.7	21.7	1797.8	1797.8
1970	10.2	10.2 f					10.2	10.2	998.0	998.0
1971	9.7	9.7 f					9.7	9.7	597.8	597.8
1972	11.3	11.3 f					11.3	11.3	848.1	848.1
1973	20.5	20.5 f					20.5	20.5	396.3	396.3
1974	16.9	16.9 f					16.9	16.9	588.9	588.9
1975	5.6	5.6 f					5.6	5.6	109.5	109.5
1976	50.2	50.2 f	13.5	13.5 a			63.7	63.7	1001.8	1001.8
1977	236.7	236.7 f	32.8	32.8 a			269.5	269.5	1649.2	1649.2
1978	48.1	48.1 f	16.8	16.8 a	120.0	120.0 a	184.9	184.9	1492.2	1492.2
1979	48.6	48.6 f	1.4	1.4 a	187.0	187.0 a	237.0	237.0	1915.0	1915.0
1980	38.2	38.2 f	1.1	1.1 a	142.0	142.0 a	181.3	181.3	2477.0	2477.0
1981	20.7	20.7 f	0.9	0.9 a	120.0	120.0 a	141.6	141.6	3282.4	3282.4
1982	114.8	114.8 f			320.0	320.0 a	434.8	434.8	3787.7	3787.7
1983	16.6	16.6 f			347.0	347.0 a	363.6	363.6	3622.5	3622.5
1984	19.8	19.8 f			350.0	350.0 a	369.8	369.8	1512.8	1512.8
1985	94.7	94.7 f			264.0	264.0 a	358.7	358.7	1577.1	1577.1
1986	429.9	429.9 f			311.0	311.0 a	740.9	740.9	2716.4	2716.4
1987	500.7	500.7 f			330.0	330.0 a	830.7	830.7	2326.3	2326.3
1988	280.1	280.1 f			383.8	383.8 f	663.9	663.9	2761.2	2760.6
1989	260.0	260.0 f			790.0	790.0 f	1050.0	1050.0	2910.1	2910.1
1990	228.6	228.6 f			338.0	338.0 f	566.6	566.6	2329.0	2329.0
1991	349.5	349.5 f		0.5 f	513.4	513.4 f	862.9	863.4	2037.0	2034.7
1992	504.1	504.1 f			958.9	958.9 f	1463.0	1463.0	3127.3	3126.6
1993	834.9	834.9 f		1.6 f	776.0	776.0 f	1610.9	1612.5	3558.1	3559.8
1994	319.9	319.9 f			822.9	822.9 f	1142.8	1142.8	3220.1	3222.8
1995	623.0	623.0 f			158.0	158.0 f	781.0	781.0	2538.1	2517.1
1996	1033.0	1033.0 f			980.3	980.3 f	2013.4	2013.4	4042.2	4113.6
1997	377.6	377.6 f		0.0 f	206.0	206.0 f	583.7	583.7	1374.4	1366.0
1998	554.1	554.1 f			209.8	209.8 f	763.9	763.9	2011.1	2025.3
1999	912.5	912.5 f			64.5	64.5 f	977.0	977.0	2186.5	2625.4
2000	1044.2	1044.2 f			37.9	37.9 f	1082.1	1082.1	2581.9	2726.9
2001	806.5	808.6 f			167.8	167.8 f	974.3	976.4	1943.8	2047.8
2002	904.4	1007.7 f				0.0 f	904.4	1007.7	1940.0	1868.2
2003		887.9 f				0.0 f		887.9		1381.7
2004		883.0 f				75.485 f		958.5		1504.5

Table 2. Estimated catches of yellowtail rockfish, 1963-2002, for N. Columbia (PSFMC Area 3A) stock. US total include discard but does not include Hook & line, pot and trolls.

Year	Hook& Line[b]	Misc.[b]	Net[b]	Pot[b]	Trolls[b]	US Domestic Trawl 2003[a]	US Domestic Trawl 2005	Shrimp Trawl 2003[a]	Shrimp Trawl 2005	At-Sea Whiting 2003[a]	At-Sea Whiting 2005	Shoreside Whiting 2003[a]	Shoreside Whiting 2005	US DomesticTrawl Disc. 2003[a]	US DomesticTrawl Disc. 2005	US TOTAL 2003[a]	US TOTAL 2005
1963						678.9	678.9 a	14.0	14.0 a							692.9	692.9
1964						493.0	493.0 a	3.8	3.8 a							496.8	496.8
1965						338.2	338.2 a	6.9	6.9 a							345.1	345.1
1966						563.1	563.1 a	3.4	3.4 a	1597.0	1597.0 e					2163.5	2163.5
1967						457.4	457.4 a	10.7	10.7 a	1063.0	1063.0 e					1531.1	1531.1
1968						490.9	490.9 a	16.5	16.5 a	522.0	522.0 e					1029.4	1029.4
1969						519.1	519.1 a	28.0	28.0 a	383.0	383.0 e					930.1	930.1
1970						115.1	115.1 a	3.4	3.4 a	510.0	510.0 e					628.5	628.5
1971						132.8	132.8 a	13.4	13.4 a	211.0	211.0 e					357.2	357.2
1972						521.7	521.7 a	15.6	15.6 a	320.0	320.0 e					857.3	857.3
1973						470.3	470.3 a	123.6	123.6 a	508.0	508.0 e					1101.9	1101.9
1974						247.2	247.2 a	163.1	163.1 a	103.0	103.0 e					513.3	513.3
1975						582.3	582.3 a	150.9	150.9 a	156.0	156.0 e					889.2	889.2
1976						2411.6	2411.6 a	232.4	232.4 a	186.0	186.0 e					2830.0	2830.0
1977						2817.0	2817.0 a	361.3	361.3 a	4.6	4.6 a					3182.9	3182.9
1978						5681.3	5681.3 a	314.5	314.5 a	117.2	117.2 a					6113.0	6113.0
1979						5726.4	5726.4 a	573.4	573.4 a	97.0	97.0 a					6396.8	6396.8
1980						4623.2	4623.2 a	657.8	657.8 a	232.7	232.7 a					5513.7	5513.7
1981	0.0			0.0	0.0	4304.0	4304.0 b'	366.0	366.0 a,b	130.4	130.4 a					4800.4	4800.4
1982	0.0			0.0	0.0	4033.2	4033.2 b'	300.1	300.1 a,b	161.0	161.0 a					4494.3	4494.3
1983	0.0			0.0	0.0	4410.1	4410.1 b'	88.3	88.3 a,b	196.2	196.2 a					4694.6	4694.6
1984	0.0			0.0	0.0	2433.1	2433.1 b'	68.3	68.3 a,b	185.9	185.9 a					2687.3	2687.3
1985	0.0			0.0	0.0	1316.5	1316.5 b'	20.8	20.8 a,b	106.9	106.9 a	2.7	2.7 d	250.8	250.8	1694.9	1694.9
1986	0.0			0.0	0.0	1642.3	1642.3 b'	180.9	180.9 a,b	410.7	410.7 a			312.8	312.8	2546.7	2546.7
1987	0.0			0.0	0.0	1914.3	1913.1 b'	35.1	35.1 a,b	368.4	368.4 a			364.6	364.4	2682.4	2681.0
1988	0.0			0.0	0.0	2884.5	2854.6 b'	171.5	170.6 b	285.0	285.0 a	14.9	4.2 d	549.4	543.7	3890.4	3853.9
1989	0.0			0.0	0.0	1484.6	1467.8 b'	324.4	322.7 b	87.0	87.0 a	3.5	d	282.8	279.6	2178.8	2157.1
1990	0.0			0.0	0.0	1321.7	1321.2 b'	231.1	222.2 b	22.8	22.8 a	10.2	7.5 d	251.8	251.7	1827.4	1817.9
1991	0.9			0.0	0.0	1152.1	1151.1 b'	164.1	160.3 b	173.2	274.6 c	27.6	29.0 d	219.4	219.3	1708.8	1805.2
1992	0.0			0.0	0.0	1568.8	1559.0 b'	130.1	122.6 b	410.8	430.0 c	38.6	37.2 d	298.8	297.0	2408.5	2408.6
1993	0.2			0.0	0.1	1462.4	1460.8 b'	318.1	317.8 b	227.7	293.5 c	76.2	76.3 d	278.6	278.2	2286.7	2350.3
1994	0.6			0.1	0.0	1798.9	1798.9 b'	122.4	118.3 b	381.3	439.3 c	144.2	169.5 d	342.6	342.6	2645.2	2699.1
1995	0.1			0.0	0.0	1986.6	1897.5 b'	65.9	45.5 b	651.4	656.2 c	194.1	234.6 d	378.4	361.4	3082.3	2960.6
1996	1.1			0.0	0.1	1932.9	1932.9 b'	2.3	0.0 b	197.3	197.3 c	271.7	384.6 d	368.2	368.2	2500.7	2498.3
1997	0.5			0.0	0.0	674.3	635.2 b'	75.9	47.3 b	220.3	220.3 c	69.6	90.7 d	128.4	121.0	1098.9	1023.8
1998	1.0			0.0	0.0	1128.3	875.8 b'	85.0	39.2 b	163.6	163.6 c	81.9	127.0 d	214.9	166.8	1591.8	1245.5
1999	0.1			0.0	0.0	1234.5	1042.2 b'	51.9	25.2 b	216.4	216.4 c	213.6	335.9 d	235.1	198.5	1738.0	1482.3
2000	0.1			0.0	0.0	1663.1	1591.1 b'	47.4	44.8 b	161.7	161.7 c	114.9	163.4 d	316.8	303.1	2189.0	2100.7
2001	0.3			0.0	0.0	784.8	735.6 b'	25.8	24.6 b	83.2	83.2 c	22.6	39.5 d	149.5	140.1	1043.3	983.6
2002	0.1			0.0	0.1	179.3	287.9 b'	6.6	5.8 b	6.0	6.0 c	8.5	12.0 d	34.2	54.8	226.1	354.6
2003	0.0			0.0	0.0		50.6 b'		0.0		1.0 c		17.7		9.6		61.2
2004	0.2			0.0	0.1		74.8 b'		0.0		13.8 c		18.7		14.2		102.8

a: Yellowtail Stock Assessment 2000, Jack Tagart et al.
b: Retrived from PacFIN on Mar. 15, 2003.
b': include shoreside bycatch
c: Provided by Becky Renko, based on NORPAC database
c': Provided by Martin Loefflad, based on NORPAC database
d: Estimated from fish tickets for whiting catch equal or greater than 5000 lbs.
e: Foreign Catches: Jean Roger (2003)
g: Assume 16% discard
h: Exclude Hook&line, Misc.,Net, and Trolls

Table 3. Estimated catches of yellowtail rockfish, 1963-2002, for Eurika-S. Columbia (PSFMC Areas 1C, 2A, 2B, 2C) stock. US total include discard but does not include Hook & line, misc., net, pot and trolls.

	Hook&					US Domestic Trawl		Shrimp Trawl		At-Sea Whiting		Shoreside Whiting		US DomesticTrawl Disc.		US TOTAL	
Year	Line[b]	Misc.[b]	Net[b]	Pot[b]	Trolls[b]	2003[a]	2005	2003[a]	2005	2003[a]	2005	2003[a]	2005	2003[a]	2005	2003[a]	2005
1963						149.0	149.0 a	0.0	0.0 a							149.0	149.0
1964						4.0	4.0 a	0.0	0.0 a							4.0	4.0
1965						144.0	144.0 a	0.0	0.0 a							144.0	144.0
1966						26.0	26.0 a	85.0	85.0 a							111.0	111.0
1967						134.0	134.0 a	136.2	136.2 a	1.0	1.0 e					271.2	271.2
1968						100.0	100.0 a	127.9	127.9 a	168.0	168.0 e					395.9	395.9
1969						84.0	84.0 a	110.2	110.2 a	3.0	3.0 e					197.2	197.2
1970						81.0	81.0 a	137.3	137.3 a							218.3	218.3
1971						175.0	175.0 a	122.6	122.6 a							297.6	297.6
1972						159.0	159.0 a	265.7	265.7 a	16.0	16.0 e					440.7	440.7
1973						98.0	98.0 a	272.5	272.5 a	168.0	168.0 e					538.5	538.5
1974						37.0	37.0 a	213.3	213.3 a	66.0	66.0 e					316.3	316.3
1975						79.0	79.0 a	118.1	118.1 a	66.0	66.0 e					263.1	263.1
1976						1.0	1.0 a	175.6	175.6 a	49.0	49.0 e					225.6	225.6
1977						85.0	85.0 a	197.7	197.7 a	19.7	19.7 a					302.4	302.4
1978						440.3	440.3 a	498.4	498.4 a	103.7	103.7 a					1042.4	1042.4
1979						568.2	568.2 a	413.8	413.8 a	117.0	117.0 a					1099.0	1099.0
1980						427.7	427.7 a	399.2	399.2 a	27.8	27.8 a					854.7	854.7
1981	0.0	0.0	0.0	0.0	0.0	943.9	943.9 b'	261.6	261.6 a,b	60.3	60.3 a					1265.8	1265.8
1982	189.6	0.0	0.0	0.0	0.0	1260.5	1260.4 b'	228.2	228.2 a,b	13.1	13.1 a	13.8	13.8 d			1501.8	1501.7
1983	0.5	0.0	0.0	0.0	0.0	964.8	854.4 b'	51.7	52.5 a,b	45.8	45.8 a	15.8	15.8 d			1062.3	952.7
1984	0.0	0.0	0.0	0.0	0.0	1305.9	1306.1 b'	45.6	45.6 a,b	87.7	87.7 a					1439.2	1439.4
1985	4.1	0.2	0.0	0.0	0.1	736.8	736.3 b'	15.7	15.7 a,b	48.1	48.1 a	3.6	3.6 d	140.3	140.2	941.0	940.4
1986	123.9	0.0	0.0	0.0	0.5	414.7	414.6 b'	197.8	197.8 a,b	82.7	82.7 a	1.2	1.2 d	79.0	79.0	774.2	774.0
1987	114.6	0.0	0.0	0.0	0.4	481.3	480.6 b'	214.3	214.9 a,b	136.4	136.4 a	0.0	0.0 d	91.7	91.5	923.7	923.4
1988	134.2	0.0	0.0	0.0	0.1	668.0	677.6 b'	115.8	116.8 b	85.4	85.4 a	1.3	12.0 d	127.2	129.1	996.4	1008.9
1989	194.1	0.0	0.0	0.0	0.1	862.4	859.0 b'	217.0	218.7 b	44.1	44.1 a		3.5 d	164.3	163.6	1287.8	1285.4
1990	231.3	0.0	0.0	0.0	0.1	779.9	770.2 b'	135.4	144.3 b	58.8	58.8 a	1.8	6.4 d	148.6	146.7	1122.7	1120.0
1991	193.6	0.0	0.0	0.0	0.4	878.7	877.7 b'	123.0	126.8 b	124.8	3.6 c	6.0	8.6 d	167.4	167.2	1293.9	1175.3
1992	204.7	0.0	0.0	0.0	0.6	2071.9	2071.8 b'	181.2	188.7 b	19.0	0.0 c	15.0	26.4 d	394.6	394.6	2666.7	2655.1
1993	177.3	0.0	0.0	0.0	8.6	998.8	998.9 b'	88.7	89.2 b	66.8	0.0 c	17.5	44.1 d	190.2	190.3	1344.6	1278.4
1994	143.5	0.0	0.0	0.0	3.8	1237.5	1240.2 b'	45.4	49.5 b	58.0	0.0 c	51.2	53.2 d	235.7	236.2	1576.6	1525.9
1995	52.2	0.0	0.1	0.5	0.8	1467.5	680.2 b'	70.8	9.4 b	2.0	0.0 c	76.7	89.4 d	279.5	129.6	1819.8	819.2
1996	82.9	0.0	0.0	0.4	8.4	1410.8	901.2 b'	351.1	30.2 b	0.0	0.0 c	115.8	239.4 d	268.7	171.7	2030.6	1103.1
1997	115.1	0.0	0.0	0.2	8.2	530.2	252.6 b'	45.2	20.0 b	2.1	2.1 c	14.3	23.5 d	101.0	48.1	678.5	322.8
1998	141.4	0.0	0.0	2.2	8.1	714.0	371.0 b'	148.0	23.8 b	0.0	0.0 c	16.1	27.4 d	136.0	70.7	998.0	465.5
1999	59.9	0.0	0.0	0.0	0.6	598.1	308.4 b'	38.5	17.8 b	0.0	0.0 c	29.9	56.5 d	113.9	58.7	750.5	384.9
2000	4.4	0.0	0.0	0.0	0.7	365.5	59.4 b'	28.6	8.8 b	0.0	0.0 c	15.6	28.9 d	69.6	11.3	463.7	79.5
2001	3.6	0.0	0.0	0.0	1.3	222.8	93.6 b'	34.6	6.0 b	0.0	0.0 c	9.8	16.1 d	42.4	17.8	299.9	117.5
2002	0.7	0.0	0.0	0.0	0.4	145.9	36.1 b'	5.3	1.7 b	4.0	4.0 c	1.5	2.7 d	27.8	6.9	183.0	48.7
2003	0.6	0.0	0.0	0.0	1.2		5.9 b'				0.0 c		2.6 d		1.1		7.0
2004	0.7	0.0	0.0	0.0	2.6		5.2 b'				0.1 c		2.9 d		1.0		6.2

Data retrieved from PacFIN database using ann_arid_woc_grg.sql.
a: Yellowtail Stock Assessment 2000, Jack Tagart et al.
b: Retrived from PacFIN on 06/07/2005.
b': include shoreside bycatch
c: Provided by Becky Renko, based on NORPAC database
c': Provided by Martin Loefflad, based on NORPAC database
d: Estimated from fish tickets for whiting catch equal or greater than 5000 lbs.
e: Foreign Catches: Jean Roger (2003)
f:Assume 16% discard
h: Exclude Hook&line, Misc.,Net, and Trolls

Table 4. Estimated yellowtail rockfish biomass (t) and its coefficient of variation (CV) for NMFS triennial trawl surveys, 1977-2001.

	INPFC Area [a]															
Year	Monterey	CV	Eureka	CV	S. Col	CV	N. Col	CV	Columbia	CV	US Van	CV	CAN Van	CV	Total Van	CV
1977	683	0.58	661	0.66	1,467	0.59	10,218	0.47	11,800	0.42	11,451	0.58	No survey			
1980	205	0.62	522	0.57	4,842	0.35	411	0.68	5,284	0.56	4,979	0.68	8,625	0.80	13,604	0.56
1983	1,586	0.80	673	0.54	3,349	0.39	3,366	0.40	6,718	0.28	4,666	0.90	20,823	0.57	25,489	0.49
1986	2,222	0.56	1,086	0.50	2,841	0.54	2,642	0.31	5,415	0.32	2,592	0.36	No survey			
1989	880	0.67	387	0.70	5,172	0.63	1,824	0.80	7,031	0.51	9,443	0.80	3,574	0.57	13,017	0.65
1992	652	0.70	74	0.56	1,142	0.77	4,399	0.44	5,398	0.39	5,174	0.47	7,627	0.45	12,801	0.35
1995	408	0.67	31	0.55	870	0.89	497	0.33	1,384	0.57	1,519	0.63	627	0.53	2,146	0.51
1998	3,858	0.67	385	0.84	2,096	0.35	3,922	0.24	6,017	0.21	16,212	0.34	14,659	0.33	31,526	0.27
2001	75	0.78	24	0.71	925	0.66	182	0.35	1,107	0.42	5,830	0.38	12,084	0.58	17,914	0.49
2004	1,204	1.00	1,991	1.00	425	0.38	2,496	0.31	2,921	0.27	13,012	0.42	No Survey		19,129	0.31
Mean	1,177	0.71	583	0.66	2,313	0.56	2,996	0.43	5,573	0.40	7,488	0.56	9,717	0.55	16,642	0.45

	STOCK [b]							
Year	EUR/ S.COL	CV	N.COL	CV	S.VAN	CV	TOTAL US [c]	CV
1977	2,128	0.46	10,218	0.47	11,451	0.58	23,912	0.35
1980	5,364	0.32	411	0.68	4,979	0.68	10,785	0.42
1983	4,022	0.34	3,366	0.40	4,666	0.90	12,057	0.38
1986	3,927	0.41	2,642	0.31	2,592	0.36	9,093	0.22
1989	5,559	0.59	1,824	0.80	9,443	0.80	16,861	0.50
1992	1,216	0.72	4,399	0.44	5,174	0.47	10,646	0.30
1995	901	0.86	497	0.33	1,519	0.63	2,934	0.42
1998	2,481	0.32	3,922	0.24	16,212	0.34	22,614	0.25
2001	949	0.65	182	0.35	5,830	0.38	6,961	0.32
2004	2,416	0.83	2,496	0.31	13,012	0.42	17,924	0.33
Mean	2,950	0.52	3,410	0.46	7,004	0.60	13,613	0.36
Geometric mean	2,394	0.49	1,680	0.42	5,530	0.54	10,993	0.34

a. INPFC area : Eureka, Columbia, Vancouver; S.Col and N.Col are requested division of the Columbia area at Cape Falcon, US Vanand CN Van are the United States and Canadian portions of the Vancouver area. The Columbia area was divided by special request the estimated Columbia area biomass is not necessarily equal to the sum of the S.Col and N.Col.

b. Stock units: Eureka/S.Col is Cape Mendocino to Cape Falcon; N.Col is Cape Falcon to Cape Elizabeth; S. Van is Cape Elizabeth to 49^{o}N

c. Total US biomass is the sum of the Area biomass for Eureka, Columbia and US Van.

Table 5. By-catch indices for yellowtail rockfish from the Pacific whiting at-sea fishery, 1978-1999.

YEAR	2000 INDEX	1997 INDE
1978	0.587	2039.8
1979	0.554	1705.4
1980	1.301	4096.7
1981	1.012	4088.7
1982	0.759	2465.4
1983	1.156	4160.3
1984	1.349	4328.9
1985	1.443	4341.3
1986	1.870	9070.5
1987	1.292	4088.9
1988	1.447	5802.0
1989	0.666	2040.6
1990	1.024	3180.5
1991	0.925	5993.0
1992	1.953	5678.9
1993	1.187	2197.6
1994	0.340	1700.5
1995	0.313	3573.5
1996	0.709	
1997	0.501	
1998	0.760	
1999	0.851	

Table 6. US domestic trawl CPUE (mt per hour) for yellowtail rockfish, based on 1988-2004 returned logbooks.

	S. Vancouver		N. Columbia		Eureka/S. Columbia		Coastwide	
YEAR	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
1988			979.89	318.58	1997.34	363.79	977.89	187.05
1989	599.90	363.45	895.36	317.21	1871.47	346.50	820.44	181.29
1990	700.45	361.12	1142.77	317.80	1103.89	341.35	914.71	178.40
1991	748.13	344.13	1139.54	316.33	959.40	322.00	911.46	175.81
1992	827.33	335.14	1033.10	314.02	937.77	291.08	935.25	171.46
1993	291.84	338.39	873.38	315.04	483.21	293.11	586.73	171.08
1994	707.30	345.79	831.98	313.63	236.11	285.24	503.73	169.32
1995	1147.04	345.81	905.38	315.78	607.60	298.52	726.25	172.84
1996	986.05	353.84	1020.83	314.83	648.62	283.32	778.14	169.25
1997	519.19	364.47	786.41	319.44	51.25	300.44	280.61	176.38
1998	496.37	347.46	928.90	319.66	155.05	292.04	462.92	172.84
1999	313.04	371.71	1118.50	316.57	272.22	328.10	823.44	182.31

Table 7. Coast-wide sample sizes and number of otoliths for yellowtail rockfish.

Coast-wide

	Domestic Trawl		Shrimp		Whiting		Total	
Year	Samples	Fish	Samples	Fish	Samples	Fish	Samples	Fish
1972	14	994	-	-	-	-	14	994
1973	4	318	-	-	-	-	4	318
1974	4	384	-	-	-	-	4	384
1975	2	206	-	-	-	-	2	206
1976	15	1,377	-	-	-	-	15	1,377
1977	14	1,326	-	-	-	-	14	1,326
1978	11	972	-	-	-	-	11	972
1979	24	2,349	-	-	-	-	24	2,349
1980	44	4,258	2	255	-	-	46	4,513
1981	62	4,790	-	-	-	-	62	4,790
1982	91	5,054	2	103	-	-	93	5,157
1983	75	2,878	-	-	-	-	75	2,878
1984	91	5,069	-	-	-	-	91	5,069
1985	78	5,945	-	-	-	-	78	5,945
1986	64	4,530	-	-	-	-	64	4,530
1987	96	4,230	-	-	-	-	96	4,230
1988	72	3,351	-	-	-	-	72	3,351
1989	99	6,009	-	-	-	-	99	6,009
1990	89	3,825	-	-	-	-	89	3,825
1991	86	3,301	-	-	-	-	86	3,301
1992	112	4,273	-	-	-	-	112	4,273
1993	89	3,779	-	-	-	-	89	3,779
1994	109	4,523	-	-	-	-	109	4,523
1995	104	4,249	-	-	-	-	104	4,249
1996	99	4,139	-	-	-	-	99	4,139
1997	103	4,001	26	939	5	204	134	5,144
1998	92	3,698	19	764	10	500	121	4,962
1999	122	4,622	17	750	10	479	149	5,851
2000	106	4,010	21	883	8	381	135	5,274
2001	111	3,917	19	846	5	250	135	5,013
2002	65	2,657	5	221	6	268	76	3,146
2003	33	1,172	-	-	8	397	41	1,569
2004	27	1,054	-	-	14	698	41	1,752

Table 8. Sample sizes and number of otoliths for yellowtail rockfish from S. Vancouver.

S.Vancouver

	Domestic Trawl		Shrimp		Whiting		Total	
Year	Samples	Fish	Samples	Fish	Samples	Fish	Samples	Fish
1972							-	-
1973							-	-
1974	1	122					1	122
1975	1	106					1	106
1976	5	497					5	497
1977	1	97					1	97
1978	3	302					3	302
1979	7	680					7	680
1980	15	1,463					15	1,463
1981	23	2,266					23	2,266
1982	19	1,839					19	1,839
1983	14	1,290					14	1,290
1984	18	1,694					18	1,694
1985	16	1,598					16	1,598
1986	16	1,597					16	1,597
1987	24	1,249					24	1,249
1988	21	1,050					21	1,050
1989	21	1,910					21	1,910
1990	24	1,194					24	1,194
1991	20	961					20	961
1992	22	1,055					22	1,055
1993	21	1,029					21	1,029
1994	21	1,071					21	1,071
1995	29	1,362					29	1,362
1996	18	879					18	879
1997	24	1,119	2	70	2	100	28	1,289
1998	21	1,033			8	400	29	1,433
1999	27	1,176			5	229	32	1,405
2000	36	1,518	5	218	5	231	46	1,967
2001	28	1,154	3	116	4	200	35	1,470
2002	18	886	2	100	4	168	24	1,154
2003	31	1,072			2	98	33	1,170
2004	21	875			10	499	31	1,374

Table 9. Sample sizes and number of otoliths for yellowtail rockfish from N. Columbia.

N. Columbia

	Domestic Trawl		Shrimp		Whiting		Total	
Year	Samples	Fish	Samples	Fish	Samples	Fish	Samples	Fish
1972	7	435					7	435
1973	1	98					1	98
1974	1	99					1	99
1975	1	100					1	100
1976	10	880					10	880
1977	9	862					9	862
1978	8	670					8	670
1979	17	1,669					17	1,669
1980	28	2,758	2	255			30	3,013
1981	23	2,264					23	2,264
1982	26	2,573	1	99			27	2,672
1983	14	1,354					14	1,354
1984	22	2,196					22	2,196
1985	29	2,892					29	2,892
1986	23	2,284					23	2,284
1987	43	2,235					43	2,235
1988	33	1,634					33	1,634
1989	41	2,873					41	2,873
1990	35	1,751					35	1,751
1991	31	1,355					31	1,355
1992	34	1,469					34	1,469
1993	39	1,683					39	1,683
1994	52	2,138					52	2,138
1995	56	2,305					56	2,305
1996	54	2,224					54	2,224
1997	39	1,516	15	518	3	104	57	2,138
1998	35	1,355	16	644	2	100	53	2,099
1999	47	1,759	15	690	5	250	67	2,699
2000	36	1,382	14	596	3	150	53	2,128
2001	34	1,274	13	613	1	50	48	1,937
2002	36	1,454	3	121	2	100	41	1,675
2003	2	100			6	299	8	399
2004	6	179			4	199	10	378

Table 10. Sample sizes and number of otoliths for yellowtail rockfish from Eureka/S. Columbia.

Eureka/S.Columbia

	Domestic Trawl		Shrimp		Whiting		Total	
Year	Samples	Fish	Samples	Fish	Samples	Fish	Samples	Fish
1972	7	559					7	559
1973	3	220					3	220
1974	2	163					2	163
1975							-	-
1976							-	-
1977	4	367					4	367
1978							-	-
1979							-	-
1980	1	37					1	37
1981	16	260					16	260
1982	46	642	1	4			47	646
1983	47	234					47	234
1984	51	1,179					51	1,179
1985	33	1,455					33	1,455
1986	25	649					25	649
1987	29	746					29	746
1988	18	667					18	667
1989	37	1,226					37	1,226
1990	30	880					30	880
1991	35	985					35	985
1992	56	1,749					56	1,749
1993	29	1,067					29	1,067
1994	36	1,314					36	1,314
1995	19	582					19	582
1996	27	1,036					27	1,036
1997	40	1,366	9	351			49	1,717
1998	36	1,310	3	120			39	1,430
1999	48	1,687	2	60			50	1,747
2000	34	1,110	2	69			36	1,179
2001	49	1,489	3	117			52	1,606
2002	11	317					11	317
2003							-	-
2004							-	-

Table 11. Number of tows and otolith samples in NMFS triennial trawl surveys, 1977-2004.

YEAR	ALL TOWS TOTAL	ALL TOWS CATCH>0	TOWS WITH AGED FISH SAMPLED TOWS	TOWS WITH AGED FISH FISH
S. VANCOUVER				
1977	81	31	6	437
1980	97	37	6	315
1983	137	33	6	460
1986	248	54	9	135
1989	131	35	5	123
1992	130	45	7	334
1995	121	29	25	184
1998	88	61	30	600
2001	85	30	27	603
2004	35	20	20	235
N. COLUMBIA				
1977	84	39	10	626
1980	180	56	4	295
1983	127	65	7	639
1986	105	57	10	23
1989	81	16	4	121
1992	80	29	7	159
1995	57	19	15	88
1998	56	30	25	469
2001	57	6	6	34
2004	50	17	17	140
EUREKA/S. COLUMBIA				
1977	200	27	3	257
1980	229	61	9	529
1983	254	87	9	652
1986	143	37	9	174
1989	177	19	2	110
1992	181	16	1	17
1995	198	15	7	23
1998	196	34	34	351
2001	205	21	21	143
2004	168	16	16	70
COASTWIDE				
1977	365	97	19	1320
1980	506	154	19	1139
1983	518	185	22	1751
1986	496	148	28	332
1989	389	70	11	354
1992	391	90	15	510
1995	376	63	47	295
1998	340	125	89	1420
2001	347	57	54	780
2004	253	53	53	445

Table 12. South Vancouver area estimated yellowtail rockfish catch-at-age (numbers of fish).

Age	4	5	6	7	8	9	10	11	12	13	14	15
Year						MALES						
1974	0	665	997	1330	3989	2660	665	1662	2660	665	332	0
1975	396	3416	5934	8112	2726	1737	396	644	859	644	2146	644
1976	0	0	1122	9053	16779	15866	16718	12348	15773	23542	31897	30423
1977	0	0	0	26899	26899	71730	17933	26899	26899	26899	62764	53798
1978	0	6528	19277	31227	40761	43533	38403	15325	24695	15396	14046	42774
1979	0	9043	6733	49270	35112	85367	71650	64430	53868	29058	25002	16167
1980	0	7227	24345	57617	72929	61413	104796	89771	75855	66074	53740	74111
1981	2121	3076	7958	36719	67843	99680	101959	122846	134851	116739	100339	103736
1982	0	17860	46641	129956	206544	148353	103036	80799	120414	108903	69397	48153
1983	0	10383	88750	118698	206305	207115	126020	42798	33942	41471	54439	32686
1984	0	1725	10615	24778	34487	51383	59629	26394	15013	16267	13331	12077
1985	0	1579	13441	42352	90765	65591	63015	56522	32982	12406	4956	5649
1986	0	4551	26324	39090	56381	79169	88428	58912	93101	62063	23886	20884
1987	4721	5576	12694	8587	23088	48583	56241	32808	55518	45762	27914	14642
1988	0	5370	11151	45856	38003	55208	96663	85939	70815	72146	48810	36827
1989	0	1323	27240	42049	68908	52036	58469	78313	88457	45025	42633	40910
1990	0	0	8896	23812	34131	75021	54057	60703	61062	68010	58657	35659
1991	0	0	4272	21960	29586	32100	54018	54350	36508	41242	24713	15549
1992	0	1054	4054	17947	47061	50458	53506	45351	41211	21975	23638	24906
1993	0	1441	16980	30714	111881	123444	148584	192157	218196	127928	57584	77869
1994	0	1638	3624	30514	54926	85160	108185	75230	81062	48695	33120	26243
1995	0	2574	7035	12655	58491	66841	85910	75695	59419	34878	31636	24663
1996	0	2914	11515	32922	58513	168334	132586	144926	108618	61515	43865	23441
1997	0	311	9528	20658	34756	72999	87656	63962	57003	23173	13974	24644
1998	0	668	3355	18138	76857	98918	68670	117707	88299	58213	54941	27336
1999	0	0	0	36228	59162	138684	105537	90034	66744	64920	56237	24875
2000	0	7557	17824	35095	54017	89233	81818	100785	45321	35737	33553	29445
2001	821	0	2961	13027	8055	19498	19140	54454	49850	34538	17736	12799
2002	0	0	1598	5954	14008	14305	19820	40957	48967	46763	33472	21150
2003	141	2528	2506	3291	8172	11259	7877	16400	14413	18340	13013	10552
2004	220	220	4418	6226	4843	10353	15865	7969	12158	14679	15968	17388
						FEMALES						
1974	0	665	997	2992	2660	997	665	1662	1330	665	332	0
1975	0	5142	5992	6725	1187	948	215	429	429	589	825	859
1976	0	0	1056	5687	12571	11495	10998	2239	13306	17596	28909	16316
1977	0	0	0	0	17933	44832	8966	8966	8966	17933	17933	44832
1978	0	6528	25583	18337	75435	55384	51615	12314	16681	19001	8248	19673
1979	0	1809	18206	19743	24967	54082	65352	59938	39999	22619	22428	12721
1980	0	1809	11816	34124	62732	59342	60283	94042	75129	47830	36262	22964
1981	0	3182	13784	22318	50690	62343	61014	83200	84740	74537	46388	39529
1982	0	5943	35967	110024	173513	105523	83829	71919	94783	60509	57300	28036
1983	0	2285	63043	96680	173842	206381	113081	44919	19771	61782	45865	25818
1984	392	1329	8084	24970	37279	51501	63327	25491	17606	11012	12808	11673
1985	0	2046	9278	31234	61259	47338	52460	51539	27646	7764	6062	4918
1986	0	6315	21735	48207	45498	81517	75608	81643	117771	61368	22535	15325
1987	1961	12239	13014	20998	18039	37858	62678	33329	48322	37570	22146	9603
1988	0	6025	7794	31994	39395	43265	80422	83692	61660	58240	39373	25262
1989	0	3034	19435	39111	80935	45097	41832	49596	64401	40303	27942	32818
1990	0	0	4221	17187	23755	43923	44601	44131	76373	59020	44892	32405
1991	0	0	5383	13314	23878	26814	57903	43319	31546	38011	19191	13044
1992	0	1099	2701	13551	33883	38690	52049	62814	47814	32320	36304	33660
1993	0	0	9973	21166	79910	140326	137663	161082	242270	110413	42552	37363
1994	0	0	4045	18578	47552	88118	82659	73410	72662	74249	36204	25908
1995	0	876	9668	18267	50029	66322	69763	57661	39068	34376	28346	17157
1996	0	2101	5221	30342	55556	160372	141705	120776	99003	38321	50912	39082
1997	0	0	1924	22933	36965	32130	68013	57879	42366	44728	25853	13575
1998	0	0	4674	17289	74843	84188	70144	125091	89037	57749	56158	37966
1999	0	13292	22523	33777	49372	61106	81382	57341	57352	41261	34639	39073
2000	1150	1724	21709	13461	41052	55551	58181	105181	45773	34189	28053	25269
2001	0	818	1328	9513	8528	15384	19757	64042	58766	48374	29027	20147
2002	0	0	725	3300	6957	6575	14177	27137	31847	31785	20462	14090
2003	287	3538	2171	5788	10025	10382	2937	11955	14863	18721	19980	6356
2004	0	1494	5251	4219	5914	8542	7682	8602	10637	15032	19048	13249

Table 12. S.Vancouver area catch-at-age (numbers of fish). (Continued)

Age	16	17	18	19	20	21	22	23	24	25
Year						MALES				
1974	0	0	997	0	332	332	665	665	0	7314
1975	1288	429	429	215	859	429	0	429	859	6398
1976	16559	11273	9862	14473	8840	7725	12312	7884	7828	133708
1977	62764	17933	26899	17933	0	8966	0	8966	17933	143461
1978	45601	32232	18701	19252	4942	15625	5759	8305	9883	71525
1979	27886	16547	33799	8944	11965	1272	5377	7196	4497	38048
1980	46846	30639	34407	22050	15339	11382	7098	7255	7205	46980
1981	92991	69417	59665	42043	41373	26028	11843	10262	10984	46794
1982	36357	23838	24691	26351	36620	41129	25807	24483	17051	130961
1983	21452	14661	15226	11906	29707	16556	27251	21860	23747	113791
1984	15385	9036	6378	5013	7458	4756	8871	8410	4117	101719
1985	7514	7115	4036	4733	2142	4155	2650	2970	6161	16171
1986	21516	17416	13208	6258	6604	6024	4786	6888	7152	30743
1987	11473	13526	14189	9833	10118	2010	6609	1847	4720	53758
1988	18744	7724	3742	14888	9552	6511	2126	3098	3089	23313
1989	18002	8259	3395	8640	9698	6085	6400	955	1138	24538
1990	32539	15936	8025	5037	6982	6754	7343	1688	2546	23480
1991	17378	16062	5052	4959	3762	2353	1934	1230	0	13561
1992	22057	12176	13976	4691	2603	1803	1767	1278	3317	29011
1993	55090	35102	9090	43066	24654	7438	2057	5019	2512	44512
1994	18816	18260	11388	11708	7962	5916	1206	0	1192	13138
1995	14934	16707	15156	9547	6444	3859	3556	1835	1125	8492
1996	26996	20672	17393	14246	7592	6914	7011	2230	5129	16690
1997	15810	10037	13985	2050	13507	2187	10600	2131	1176	12173
1998	27596	22208	18645	5125	8831	8957	7620	4355	2420	15810
1999	12383	10966	14775	8509	5960	3679	4858	2332	1791	9785
2000	20848	11938	11572	5150	5785	6204	4807	6860	4336	7798
2001	11579	11592	7335	6242	5151	4391	4801	1963	2477	14121
2002	19869	12117	8704	2896	6573	5408	3674	3293	1953	8742
2003	7590	5862	3536	3024	2252	3229	865	1591	1297	7707
2004	7300	6506	3853	3475	3022	7310	1223	922	1646	16962
						FEMALES				
1974	0	0	332	332	0	0	0	0	0	997
1975	215	215	0	0	0	0	215	0	0	0
1976	12162	4413	0	3295	3233	1056	0	1056	1080	3192
1977	17933	8966	0	8966	8966	0	0	0	0	8966
1978	10961	8237	6528	6276	0	9792	0	0	0	6528
1979	10909	10588	4258	2943	0	0	0	3267	0	5648
1980	21176	17392	16292	4535	5920	4954	1706	447	0	4705
1981	31726	24131	18976	10453	13962	3261	1707	826	2327	2856
1982	32266	11299	12442	8603	6126	6434	2089	989	1974	5673
1983	19619	7644	16317	2646	2734	7090	9412	4017	2818	3821
1984	9124	2169	1883	1698	1292	1061	1987	783	0	3271
1985	6514	5243	2303	1780	1323	425	0	0	883	0
1986	13171	10262	5081	5759	2648	614	648	0	651	2598
1987	10036	3288	6116	7522	3668	1238	1193	593	609	1704
1988	6125	12056	4962	942	2142	894	2040	1103	1518	3696
1989	8258	5356	5547	3154	3965	3503	0	144	0	3196
1990	24894	7966	3753	792	1445	821	2388	0	0	753
1991	9356	4911	3830	1895	2496	0	749	0	0	671
1992	21117	7966	13111	4277	2557	1915	1728	2975	774	4155
1993	22838	13175	30776	13962	5402	2068	0	0	0	0
1994	19963	8498	4558	5514	1084	2817	2252	1194	1194	1080
1995	10508	10219	9019	7316	4978	1221	0	1571	1461	3061
1996	29043	11057	6189	5732	3980	975	3952	1021	0	0
1997	16869	5768	3815	10486	1556	9371	2492	1063	1140	1177
1998	19935	16150	11033	4281	3066	1481	725	1882	1275	4681
1999	19708	6556	8658	1794	2516	1566	1151	259	354	1361
2000	16717	12382	8403	3521	7847	5332	5731	1934	2711	2040
2001	11509	9024	8534	5153	1697	4952	2821	2237	924	6480
2002	7799	5821	3780	4618	3732	1873	563	1127	540	4914
2003	7176	7183	4026	3676	1815	2215	1744	548	959	3153
2004	6368	5837	2536	3165	2118	1199	1345	972	726	4382

Table 13. North Columbia area estimated yellowtail rockfish catch-at-age (numbers of fish).

Age	4	5	6	7	8	9	10	11	12	13	14	15
Year						MALES						
1975	0	3842	23052	34577	30735	11526	0	7684	7684	0	7684	19210
1976	5619	7085	31122	92742	189002	66820	38697	34650	39830	32130	55188	73318
1977	0	0	0	24462	57850	93123	88795	59587	79602	79427	112647	123379
1978	0	25561	100705	97630	219053	241927	231376	192730	148050	161246	110314	167004
1979	0	5725	38666	135899	169975	190818	281099	241799	177009	116102	136409	102634
1980	0	6919	34088	120629	179789	155763	206308	225977	194558	155785	131220	108325
1981	0	6524	57038	128233	245116	199107	125526	94472	139263	137400	108003	59374
1982	8087	15103	86439	179489	334224	255102	137488	67429	69574	98230	91378	82665
1983	0	2915	96259	241787	420426	399599	219954	77387	52683	36122	57539	57970
1984	0	15107	44724	142623	136323	194196	205620	104209	65170	33445	20201	28139
1985	1009	7883	27193	79508	89330	87241	81987	56789	36529	13098	9298	8642
1986	0	3573	14951	35983	74809	88079	77168	60444	62617	44979	27073	10572
1987	819	9621	55085	62338	59428	98385	130845	79978	77373	52975	34754	17991
1988	3637	34192	38677	89304	97973	97368	139076	163435	100837	58865	54100	27677
1989	114	8346	38769	27373	67841	50442	42873	76364	70742	40190	37179	33218
1990	0	9554	45070	56476	53364	57722	48311	40531	55337	47310	27980	26877
1991	0	1079	4256	48128	57746	39006	56773	36126	30556	48800	33974	20054
1992	1961	3536	18630	63272	108598	104410	60021	64332	56557	36243	34952	21929
1993	775	4575	27605	54937	109833	104868	91224	51345	47512	30204	18935	12394
1994	0	2077	24417	65483	112396	126597	115317	76829	57768	38482	17113	17424
1995	0	5019	39623	87513	147496	144742	111882	82694	49648	31391	23451	14124
1996	0	10883	32807	59944	93403	130660	109650	96364	76142	38374	26198	24744
1997	0	1697	10521	33177	38066	40104	44465	43470	33708	32373	17501	13925
1998	0	0	3802	15477	48905	58158	40640	59106	46230	36198	22324	24897
1999	923	3753	8303	27838	67216	96482	110879	58214	49842	34651	25139	19974
2000	0	834	14910	33124	84447	144731	116502	148473	54003	40781	28652	18148
2001	0	519	3809	14928	22290	30347	28433	63175	42998	21134	16902	16727
2002	0	2208	2557	8368	13448	11229	11931	14523	14026	13140	10328	4081
2003	0	0	2	7	14	645	649	1923	2600	1935	3227	1624
2004	0	0	57	104	115	858	792	2046	992	3680	1006	2660
						FEMALES						
1975	3842	3842	15368	23052	38419	15368	3842	15368	7684	7684	15368	11526
1976	2038	12047	18421	49890	155358	125189	34007	37182	31667	36486	35103	24072
1977	0	0	5927	19284	40003	61443	72575	68798	44004	43967	85057	79822
1978	5160	17728	99123	78732	140573	223810	294401	135027	169822	175352	102076	92336
1979	0	13975	50989	97491	94426	162302	233545	296472	180286	124572	113249	71006
1980	1557	0	40113	97030	146311	112370	170753	208488	219999	163540	102760	71956
1981	0	8931	38857	109134	221255	187078	118403	113879	139531	146831	119195	78673
1982	8087	7696	58990	112276	244597	188513	148557	82878	63342	84012	90126	39886
1983	0	12074	78829	232893	355084	437293	249517	105753	50149	25838	36038	32844
1984	2209	14104	61983	139324	109368	143755	174573	62112	58160	27754	19340	14042
1985	0	11157	31142	79339	96453	72484	72576	62922	34345	9677	7348	5267
1986	0	4841	9012	33780	58517	100035	64875	80357	90040	47972	22077	16434
1987	2406	6254	33194	41601	59006	100802	108159	87316	70556	53626	27536	13641
1988	13424	35218	23535	101299	115329	96311	155712	174482	143801	84524	47123	24341
1989	177	5332	27684	24309	55988	48842	33863	70954	84580	50476	38909	29400
1990	1568	5522	40123	65486	28644	58585	41459	30408	49845	45143	29371	21074
1991	0	2205	3188	29084	47481	54835	68967	46878	30442	30916	28441	17470
1992	0	4475	16173	51457	117204	100068	72355	55498	43312	26829	24046	24540
1993	0	3769	23704	41285	82171	120966	77570	55434	43600	31068	11837	14654
1994	707	2036	16543	64266	94431	144911	127956	68506	62414	43280	33735	12934
1995	650	6663	46472	77016	145833	131877	110520	91051	62675	39566	34904	18341
1996	1473	12153	40135	69011	69449	125818	104847	102818	79895	49588	32199	30824
1997	606	4700	6495	27354	33512	27053	42938	36445	31184	33070	20381	8937
1998	0	493	1141	11444	50008	58825	43874	74585	65331	44759	41903	26529
1999	0	4300	3188	28190	47693	101597	90518	52253	57622	39330	24151	17792
2000	0	0	7237	22040	73145	101779	124500	128936	69761	46959	32605	24950
2001	0	0	2588	18640	14612	23883	27924	52807	62603	36308	23611	13605
2002	0	321	2934	5785	13321	8944	9429	14783	14757	12752	8382	4230
2003	0	2	0	0	16	330	326	1628	1613	3558	4504	1604
2004	0	0	0	1061	202	566	2492	1643	5856	3840	2417	1855

Table 13. N.Columbia area catch-at-age (numbers of fish). (Continued)

Age	16	17	18	19	20	21	22	23	24	25
Year						MALES				
1975	0	0	7684	0	0	3842	3842	0	0	7684
1976	58759	16578	14994	8156	9311	18994	11018	15911	12018	124417
1977	99659	60935	41728	18205	26749	18697	11527	5784	15393	96279
1978	109537	115384	44787	20563	16099	36763	21092	4994	10321	106886
1979	95707	84181	100090	82088	25750	31644	18309	15107	10087	131853
1980	64925	68440	53931	39095	28710	14456	6925	12670	16663	75858
1981	64405	53244	54351	44969	45295	33249	16873	14890	11851	57420
1982	43898	39506	30734	41236	55206	67554	36444	23422	14470	115392
1983	41370	37032	9937	14162	19023	20352	16071	27576	5571	105568
1984	24591	15703	14504	15956	12039	7893	15776	14451	14890	38261
1985	9548	6165	10407	7073	4386	5092	4946	7244	7105	24737
1986	11120	10499	9384	9942	2879	4808	2745	6370	5786	32576
1987	13392	7934	5426	12848	1771	2141	5054	1514	3033	32117
1988	13928	14689	10810	8722	3711	1213	6240	1077	1183	23799
1989	17019	9015	1304	2640	847	4167	2701	627	1123	16951
1990	20383	11234	3460	4745	2631	3775	3480	2597	2597	10837
1991	11266	7703	5229	1967	2135	523	2888	1359	1389	8274
1992	19656	13462	8976	6379	4227	2365	1924	3327	1583	12495
1993	21861	17318	13023	6718	2855	2384	586	1890	1952	7308
1994	11068	14585	6050	8178	5632	3986	2187	1448	1912	6858
1995	9699	10443	9804	4495	5231	5942	2987	0	0	2976
1996	15940	12389	12086	6365	7290	5612	3426	2449	1701	8861
1997	3520	7212	4420	4006	5028	3939	3018	2007	2333	6342
1998	11859	10437	4820	6375	831	2178	895	2036	2466	2513
1999	10139	8724	8113	3472	5576	3443	4478	1909	2293	7899
2000	14274	13015	10482	3985	8537	7073	2089	2617	1324	14303
2001	7886	8754	6444	5242	2857	4120	1637	1391	898	5547
2002	3167	2004	2184	2522	1482	846	352	650	142	1516
2003	967	333	14	639	328	11	11	0	0	337
2004	2797	2383	1640	1090	268	737	143	0	47	1091
						FEMALES				
1975	7684	7684	7684	0	11526	0	7684	3842	0	7684
1976	23367	16160	8978	14280	6685	13382	5296	1553	3780	46906
1977	49853	18118	7624	9436	1976	1819	5747	1819	0	9752
1978	69625	33627	60448	16721	20736	0	5160	0	0	0
1979	45947	51985	35348	20152	14626	12331	17369	0	2300	12721
1980	74839	52278	39986	30667	37381	13001	3775	2304	2507	11667
1981	37517	31013	26222	20507	18569	10202	9006	7064	7786	12322
1982	35241	26879	27216	25256	28224	18591	16785	10086	4381	15802
1983	26801	10973	13694	9940	5277	2915	17762	16082	5324	7348
1984	12531	6723	6850	2646	838	805	4288	2603	3503	4536
1985	5626	5381	3510	2540	1289	1480	1318	1872	1895	1742
1986	8590	6707	7468	4642	2791	3268	2521	2281	2096	3468
1987	8796	7034	2146	5424	2136	525	1434	980	598	5670
1988	17444	7088	3509	3228	3257	2160	3362	2269	0	5668
1989	14302	5913	1107	1639	1167	2609	0	59	133	2585
1990	11251	8791	2979	1934	915	492	481	0	528	5346
1991	20410	7641	8128	1802	1309	443	1810	0	0	452
1992	19052	10490	5417	5194	2042	842	0	0	0	3285
1993	8744	10748	9412	2850	2090	586	579	0	774	1340
1994	19519	10916	10065	2866	2809	3006	701	754	0	2217
1995	6844	9846	14594	6525	3205	2133	4319	0	0	1504
1996	13609	9914	9406	10868	6224	5599	4057	3124	2304	3110
1997	15153	6369	9440	6292	10084	3735	2898	2081	363	1663
1998	15695	6810	3537	1083	1745	2227	2786	313	105	88
1999	14491	5628	6593	4654	3890	1505	2787	3656	2059	1984
2000	16159	9419	8469	2088	3191	2811	3226	350	156	6145
2001	9943	6284	6859	4099	4195	3070	2353	474	628	4927
2002	3853	2720	2384	1867	1351	1136	896	494	39	269
2003	968	1262	333	8	319	0	0	312	322	4
2004	1669	2127	239	860	1432	849	285	319	40	2584

Table 14. Eureka/S. Columbia area estimated yellowtail rockfish catch-at-age (numbers of fish).

Age	4	5	6	7	8	9	10	11	12	13	14	15
Year						MALES						
1977	0	0	0	135	269	1432	1022	1405	1283	2523	3712	3307
1978						NO AGE DATA						
1979	0	0	0	0	0	6430	16075	3215	9645	3215	0	6430
1980	0	0	0	1753	7048	2775	20321	10875	11473	13490	12656	14100
1981	0	4674	4155	8111	31414	7144	20059	34889	17899	35424	30173	6157
1982	0	247	20098	73116	127582	55287	5107	8975	18161	15217	18726	23422
1983	0	13959	393	19850	23310	28893	10883	1367	29301	7033	5576	15249
1984	825	9190	16198	57018	62852	62803	46645	16230	17774	22524	8289	11025
1985	0	8191	16305	36849	17186	30048	32869	30687	11023	13978	5910	4962
1986	0	2657	33302	4132	19437	9584	8088	12105	13827	7461	2108	667
1987	0	1401	3010	7643	8266	8652	15849	18185	15157	13243	13316	4310
1988	1781	6597	6875	11778	16225	19689	20052	20027	23395	22921	15079	10238
1989	18604	26333	16271	17678	15150	42327	18261	18438	16762	21293	21551	19823
1990	0	12141	57605	40613	5885	31674	42095	13767	18016	22959	21911	21917
1991	1880	4621	7474	65781	19742	15405	27237	19431	14017	23624	20969	21506
1992	0	821	5162	28435	139417	94004	57540	59146	31506	26673	39576	54667
1993	0	0	3489	19915	44033	60792	55101	32190	21465	14664	24403	21114
1994	0	757	6608	32222	40008	82101	76914	48579	30194	25272	14605	21398
1995	1148	3858	4789	31434	16106	25389	41392	38419	19763	16851	11863	13369
1996	851	20958	34964	49182	25914	27516	28456	34781	36175	14135	19884	5539
1997	718	3569	12049	12748	13813	10678	8583	8612	9761	11602	4781	3711
1998	451	3083	7310	25500	17900	31065	26699	13387	11057	21137	12020	10996
1999	0	760	17733	34487	14710	20635	16735	12614	12257	9568	7836	6502
2000	0	991	1577	2267	2550	3933	2145	5496	1892	1509	1187	571
2001	0	0	572	1324	3398	4041	2933	5054	5125	2652	1778	1029
2002	0	0	2958	2362	1216	2964	197	395	885	197	197	197
2003						NO AGE DATA						
2004						NO AGE DATA						
						FEMALES						
1977	0	0	0	0	135	0	843	1841	2284	1629	2157	2154
1978						NO AGE DATA						
1979	0	0	0	0	3215	9645	9645	19290	28935	19290	16075	16075
1980	0	0	0	3529	0	7961	8375	11755	19275	4788	877	3507
1981	519	4674	2077	101200	23936	2597	16070	17318	14329	56199	14677	31525
1982	353	3180	113109	22801	128895	108543	38524	17609	82974	7970	14748	9101
1983	0	60457	51654	25583	21796	72553	19281	26463	19046	9978	1875	7799
1984	2327	15025	26674	29645	78395	87363	76520	26836	35206	12460	11322	21199
1985	42760	14032	14729	39875	14716	55208	49282	36476	28289	7201	5315	5219
1986	0	4714	16793	4955	3224	8593	31907	11440	28806	6907	2741	790
1987	0	4733	25740	33343	32027	5839	18138	26003	12605	10970	6347	2514
1988	2154	6959	3241	20321	26323	34824	30615	27298	38219	38315	8848	8936
1989	22817	37541	23939	49162	17666	23756	21688	21996	38177	30193	24937	18462
1990	0	4054	19148	13476	20471	23242	19261	10747	35100	17423	20313	14762
1991	0	1149	5737	52118	23890	32452	40986	34177	18591	21367	31820	29369
1992	0	6049	8587	25680	166766	105402	71757	74991	46976	42965	64368	42423
1993	0	626	1311	23661	34239	86148	70546	29228	35366	15631	13776	10647
1994	0	1513	4307	21064	32037	50322	90740	55937	25321	30359	24027	13263
1995	0	3118	12306	5908	32559	20804	29039	39399	34764	17093	15211	8999
1996	956	23206	39929	26294	44715	50498	45892	39950	51500	37244	20675	12424
1997	815	1757	6306	10692	8924	11735	14858	13757	9705	9089	6932	3035
1998	0	1352	5069	34744	21455	20361	15995	16054	13327	13022	7939	5967
1999	0	2033	13873	8986	17036	15291	15594	11815	11468	10854	6507	5452
2000	113	675	1792	7405	3444	5957	1944	4886	2022	643	1006	329
2001	159	478	647	2384	4247	4292	2506	9069	4829	2492	1797	1882
2002	840	420	2388	3001	2178	7210	395	592	592	197	197	0
2003						NO AGE DATA						
2004						NO AGE DATA						

Table 14. Eureka/S. Columbia area catch-at-age (numbers of fish). (Continued)

Age	16	17	18	19	20	21	22	23	24	25
Year						MALES				
1977	3503	1644	1468	492	1009	129	182	182	129	5618
1978						NO AGE DATA				
1979	9645	19290	12860	16075	0	9645	3215	0	0	22505
1980	18554	9854	11947	18184	5044	5618	2349	4213	948	9930
1981	15119	1458	6654	1458	4739	1984	3788	729	365	8894
1982	6352	14387	6844	41539	52555	13696	2513	828	3029	9003
1983	1560	14591	1036	4333	7839	7738	4030	1560	8353	40057
1984	38079	8782	4447	7456	6852	24845	30210	3379	12768	47866
1985	2604	3168	1444	2009	2100	12796	3769	5495	4540	17257
1986	5191	15441	1777	118	3749	1575	2271	594	243	26356
1987	14973	3479	936	1823	717	868	472	3150	696	12774
1988	8436	2075	1728	6688	6143	1452	1065	996	2135	12821
1989	9295	6764	3880	15246	529	951	2203	1100	330	13444
1990	17495	9377	6248	1918	1439	1943	699	3035	679	17512
1991	13464	10923	3777	2824	527	6635	0	3016	2642	10565
1992	39765	26122	29589	13557	9026	5333	3987	3137	3797	48695
1993	18574	12331	14926	8861	5507	4752	1297	847	2627	15523
1994	17877	24511	18656	13813	14326	6982	5624	2045	2707	28733
1995	6651	14137	2897	5219	2458	1147	1171	4967	4939	7227
1996	9732	8669	9322	5891	12786	8867	3823	1609	6164	6604
1997	698	3342	1471	1977	1599	1601	2187	896	220	2391
1998	3224	3526	730	1265	1821	6509	1401	679	1529	3370
1999	4414	1852	2189	1205	1846	2075	1473	1072	1690	3410
2000	1117	558	549	497	605	162	74	74	0	1456
2001	1129	1080	1612	673	539	192	278	413	392	2793
2002	197	0	197	197	395	197	0	0	885	592
2003						NO AGE DATA				
2004						NO AGE DATA				
						FEMALES				
1977	2935	2283	1272	1046	646	182	0	258	388	1626
1978						NO AGE DATA				
1979	25720	9645	6430	3215	0	3215	0	3215	3215	3215
1980	1753	7157	877	2700	5690	0	0	3143	0	4699
1981	8414	31366	22257	1967	12006	365	9978	729	365	1458
1982	6932	12416	5804	1940	16373	30166	1219	759	0	15805
1983	11492	22508	10361	14545	9778	0	0	18081	0	11853
1984	14740	17365	5766	4235	700	6179	14791	2277	2081	10135
1985	4929	5093	3755	3672	561	343	916	760	1404	5422
1986	2376	1843	2033	0	2337	7964	0	2271	244	3520
1987	1204	638	4398	688	2749	0	4267	475	702	14620
1988	5058	1505	5416	0	1499	471	0	0	0	1949
1989	10107	5268	2613	627	1169	788	1428	1128	885	3437
1990	14180	6910	3428	2831	791	2448	0	338	0	12779
1991	16420	11386	16824	2071	2070	1283	1542	2013	0	6525
1992	38009	31417	27018	15262	3332	3029	4597	1700	2614	15427
1993	18181	10494	11715	7947	6024	2089	680	626	0	3581
1994	24183	17288	20108	14037	13612	6957	4841	1441	702	4959
1995	9081	6114	9115	4872	6244	2448	3678	0	0	1199
1996	8585	4752	6141	2517	0	8063	868	0	1820	3429
1997	2005	2358	798	2112	1371	1096	270	1764	251	729
1998	3317	2062	1094	820	351	907	0	373	769	747
1999	3019	1617	301	229	500	0	255	591	602	2753
2000	828	390	197	0	161	0	96	127	0	0
2001	822	1614	1212	1718	629	317	176	188	157	675
2002	0	0	885	197	197	0	0	0	0	0
2003						NO AGE DATA				
2004						NO AGE DATA				

Table 15. Age composition in number of yellowtail rockfish from NMFS triennial trawl surveys by stock area, 1977-2004. (sex combined, 25+: > age 25)

Year	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
S. Vancouver (INPFC Area 3E)																				
1977	0	3717	18828	132269	691174	1076260	835042	673772	523578	928435	954378	698805	461894	202639	117324	41773	13289	0	0	0
1980	0	36995	234374	448770	582712	963815	959533	1060993	848962	726672	755691	473739	260445	365259	306243	223085	253024	197886	92493	23323
1983	276786	980535	1002388	1695015	2166878	2222128	1466559	1089983	893301	613105	876745	723477	503408	532130	402058	304010	510060	417190	538201	456782
1986	1716	46953	62388	79960	138122	219833	248076	307338	174987	202506	62747	46549	16027	31343	19702	3748	13690	20055	6394	19928
1989	72017	67014	41712	156263	495242	482170	576362	545832	1043150	1016036	906485	1199757	767211	333220	194296	55190	141177	109089	43650	78701
1992	342109	164025	252712	584442	1004732	988636	779515	1111069	1211319	893880	716844	658272	418373	395710	132716	186172	145242	71810	25259	23143
1995	1113	7010	30765	55892	89326	83733	85651	60386	34584	23987	25782	10105	6129	5375	9920	8284	6858	6970	1474	0
1998	0	44951	282863	1311196	4196627	4868951	2061869	3733507	3719705	2396413	1756004	940376	814766	465290	956528	91951	175559	160340	157397	127021
2001	15530	13973	306605	709936	582498	1254415	659441	3752366	4204370	2901248	2322644	1742866	1535921	1116211	964616	612962	436083	402669	288398	206759
2004	2395	14419	124665	75180	123045	594909	380093	563661	476932	661414	914310	965436	464020	390121	331327	286895	300577	111958	85617	56315
N. Columbia																				
1977	0	0	0	0	11319	51777	121273	157903	193287	494927	615890	445577	326094	151483	112418	38169	6441	0	0	0
1980	4985	22824	36537	27722	17732	23696	21028	20949	17116	13558	14874	8306	6081	6612	5819	3668	4271	2785	1918	385
1983	78846	317618	414128	529426	388635	255052	136644	72063	53956	31310	43726	38550	35743	33828	23786	20088	35879	37099	26465	32189
1986	4254	80786	59686	82873	128878	233268	216996	304757	169069	177601	65426	42317	16104	36224	19046	5267	17456	20016	6434	14996
1989	0	9610	15014	67598	185941	134841	152757	122220	251082	267825	166060	265372	170889	99497	44592	12436	48387	26954	16355	22389
1992	9467	5446	45911	128607	317801	267786	252839	330306	354823	232987	210069	174894	122345	94657	27750	70851	25817	16951	3674	14904
1995	959	3377	17265	17377	34307	39635	43182	31844	22753	20166	25562	12417	13456	6635	12185	8483	7126	19232	2047	0
1998	0	0	63249	261781	515799	544177	226291	389989	281965	277192	250091	185296	94061	67740	55648	31462	13670	14720	10681	2359
2001	0	0	20401	34231	20164	27417	11224	54133	41236	21686	15598	9425	7183	6330	4994	3738	2478	981	1323	1507
2004	0	2632	31477	21066	20087	93430	65635	115034	102994	145875	235650	203532	106602	98673	77446	69366	61053	28728	18950	16219
Eurika/S.Columbia																				
1977	0	5182	23483	51647	127728	235857	202128	140934	95938	120647	134262	88552	48653	14962	11113	3345	0	0	0	0
1980	21006	108553	188208	178952	171387	291398	293243	382898	364131	359411	379722	237803	128963	196307	164504	101700	145924	117757	51539	12818
1983	36950	145730	264801	584595	531992	406953	237048	148767	113415	66499	97063	93458	68597	55185	42554	33033	75782	49522	53740	53683
1986	17779	1696827	1139260	306919	173692	272127	205285	260430	139158	149903	29753	26145	6509	20603	10317	4831	4108	16567	4731	10906
1989	8357	78559	82575	127425	272765	193660	237347	146119	287545	348491	203271	313132	212061	134533	58456	15953	58951	38539	25190	29437
1992	972	727	9438	48111	131391	126051	112989	153067	179471	103792	81513	80456	51634	33529	15445	23246	15108	4931	3119	8871
1995	9360	245789	336915	255744	89055	43680	16443	12159	13064	7891	8929	3841	2764	1220	962	3854	2231	759	0	0
1998	0	24359	77378	364990	294959	321428	190697	110303	156012	128175	136163	164807	79594	59668	55422	6760	12715	19673	4644	23713
2001	0	0	20859	51085	47232	109522	55726	278230	272076	170370	121117	73259	63544	52722	34859	19721	18129	14790	9062	6916
2004	229747	750517	519029	234690	269384	200301	65705	156357	40979	106179	45652	34545	10381	16000	12898	10452	11080	3906	2692	2199

Table 16. The estimates of von Bertalanffy growth parameters for Yellowtail rockfish.

	S. Vancouver							
	Male				Female			
Year	N	Linf	K	t0	N	Linf	K	t0
PRE 198	6965	48.1547	0.1716	-2.2017	4604	53.6603	0.1583	-1.2230
1987	677	48.6970	0.1712	-2.4991	522	55.1158	0.1411	-1.7835
1988	589	48.5984	0.1751	-1.9457	461	56.5024	0.1367	-1.3878
1989	586	48.6225	0.1669	-2.6011	369	53.2499	0.1697	-0.6465
1990	677	47.4511	0.1767	-2.2154	517	53.6374	0.1588	-0.8704
1991	542	48.7655	0.1424	-4.0618	419	56.6586	0.1166	-2.8797
1992	788	48.7211	0.1386	-4.1212	863	52.5533	0.1842	0.0820
1993	940	48.2401	0.1695	-1.5827	764	53.5064	0.1451	-1.2533
1994	922	47.5288	0.1647	-2.1581	882	53.8604	0.1450	-0.8724
1995	719	48.0801	0.1684	-2.1933	585	55.4054	0.1368	-1.3443
1996	443	47.6674	0.1812	-1.4453	436	53.6469	0.1300	-2.5486
1997	727	48.6824	0.1591	-2.1253	705	54.5531	0.1388	-1.8246
1998	679	48.2265	0.1366	-3.5098	754	53.1663	0.1365	-1.7673
1999	1175	50.1637	0.0956	-6.4364	1051	53.9922	0.1441	-0.5042
2000	1445	50.6679	0.0805	-9.6355	1289	52.2197	0.1392	-2.4950
2001	454	48.1232	0.1068	-7.5052	546	55.8225	0.1009	-4.7478
2002	699	47.9485	0.1302	-0.6918	448	53.2000	0.1592	-0.1144
2003	568	48.6600	0.1163	-0.7295	576	53.5431	0.1417	-0.3168
2004	667	47.0621	0.2286	-0.0192	686	52.3137	0.2043	0.0357

	N.Columbia							
	Male				Female			
Year	N	Linf	K	t0	N	Linf	K	t0
PRE 198	8120	47.3819	0.1989	-1.2573	6558	53.0126	0.1779	-0.4407
1987	1121	47.1137	0.2191	-0.8411	963	53.4385	0.1634	-1.6147
1988	774	48.1398	0.2046	-0.8717	860	54.6578	0.1649	-0.9348
1989	1028	48.1074	0.2004	-0.7087	880	52.7113	0.1918	-0.2128
1990	911	47.7733	0.1955	-1.3672	790	56.9283	0.1203	-2.9605
1991	688	48.3811	0.1594	-3.1562	667	55.3390	0.1338	-2.5188
1992	769	45.8315	0.2093	-1.4586	700	50.7430	0.2141	0.1204
1993	884	47.0248	0.1913	-1.2265	763	53.4957	0.1653	-0.7265
1994	1074	47.3998	0.1655	-2.4605	1068	54.4084	0.1345	-2.2189
1995	1125	48.2003	0.1508	-2.7647	1171	52.6433	0.1594	-0.9789
1996	1054	46.7047	0.1758	-2.2525	1083	53.7842	0.1264	-2.9172
1997	1137	47.2876	0.1852	-1.1476	974	52.9116	0.1622	-0.6575
1998	1144	47.2293	0.1423	-3.3135	1146	52.2322	0.1335	-2.5667
1999	1397	48.0144	0.1359	-3.1690	1304	51.8022	0.1560	-1.0327
2000	1061	46.3679	0.1322	-5.6962	1067	51.7154	0.1462	-2.3757
2001	449	47.1010	0.1382	-5.3091	427	53.4324	0.1124	-5.4290
2002	858	49.5178	0.0953	-0.7261	813	52.6185	0.1532	-0.2189
2003*	206	48.108	0.0799	-1.379	246	53.0695	0.1332	-0.6616
2004	177	48.1612	0.1189	-0.7854	201	59.5589	0.0652	-0.7560

	Eureka/S.Columbia							
	Male				Female			
Year	N	Linf	K	t0	N	Linf	K	t0
PRE 198	2197	46.2246	0.2058	-1.3580	2208	53.1179	0.1708	-0.8557
1987	418	45.2585	0.2165	-2.1634	328	51.0767	0.1919	-1.1438
1988	340	45.5001	0.2437	-0.9018	327	51.6137	0.2233	0.2018
1989	735	47.2928	0.1191	-8.0864	800	50.1521	0.2049	-1.2852
1990	501	45.8759	0.2060	-1.5792	379	51.7215	0.1962	-0.3827
1991	423	45.5824	0.2492	0.2013	497	55.3166	0.1169	-3.7570
1992	828	46.7730	0.1597	-3.5900	887	52.1340	0.1809	-0.4476
1993	553	46.6414	0.1696	-2.6486	549	54.8923	0.1079	-4.5197
1994	699	46.3773	0.1602	-2.7878	650	52.8679	0.1214	-3.5657
1995	339	45.4908	0.2084	-1.3543	346	51.1799	0.1608	-1.6080
1996	431	45.3580	0.1592	-3.0608	449	50.4355	0.1624	-1.2162
1997	843	44.9719	0.2353	-0.2343	823	50.8428	0.1751	-0.9949
1998	611	45.3293	0.1500	-3.5286	581	51.1669	0.1385	-2.1679
1999	894	45.7045	0.1436	-3.9658	843	47.8303	0.2300	0.2266
2000	609	43.7661	0.2512	-0.3296	570	47.3313	0.2124	-1.1132
2001	163	43.5776	0.2234	-0.9012	237	48.7583	0.1762	-1.6254
2002	214	43.4097	0.2466	-0.0760	171	46.8300	0.2296	-0.0871
2003		No Data				No Data		
2004		No Data				No Data		

Table 17. Predicted weight (kg) at age for yellowtail rockfish in S. Vancouver area.

S. Vancouver

Age	Pre 1987	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Males																			
1	0.142	0.176	0.126	0.177	0.146	0.259	0.251	0.085	0.121	0.134	0.085	0.117	0.182	0.274	0.404	0.386	0.015	0.012	0.017
2	0.250	0.294	0.236	0.291	0.256	0.366	0.354	0.177	0.217	0.239	0.181	0.213	0.273	0.350	0.475	0.469	0.049	0.040	0.090
3	0.375	0.427	0.365	0.419	0.381	0.480	0.464	0.291	0.330	0.360	0.301	0.328	0.375	0.431	0.547	0.552	0.104	0.085	0.214
4	0.508	0.564	0.504	0.553	0.512	0.595	0.576	0.419	0.452	0.490	0.435	0.453	0.480	0.514	0.620	0.635	0.176	0.146	0.370
5	0.642	0.701	0.644	0.686	0.643	0.709	0.687	0.552	0.575	0.620	0.572	0.581	0.588	0.598	0.693	0.716	0.261	0.220	0.536
6	0.770	0.832	0.779	0.813	0.769	0.818	0.794	0.683	0.696	0.747	0.706	0.708	0.693	0.682	0.765	0.794	0.355	0.303	0.699
7	0.891	0.953	0.907	0.933	0.885	0.922	0.896	0.809	0.811	0.866	0.833	0.829	0.794	0.765	0.835	0.869	0.454	0.392	0.850
8	1.002	1.065	1.023	1.042	0.991	1.018	0.991	0.926	0.917	0.976	0.949	0.942	0.890	0.845	0.904	0.940	0.554	0.485	0.984
9	1.102	1.165	1.129	1.141	1.086	1.107	1.079	1.033	1.015	1.076	1.054	1.047	0.980	0.923	0.971	1.007	0.653	0.578	1.099
10	1.191	1.254	1.222	1.230	1.171	1.188	1.160	1.130	1.102	1.166	1.147	1.142	1.063	0.998	1.035	1.070	0.750	0.671	1.198
11	1.270	1.332	1.305	1.308	1.244	1.261	1.234	1.216	1.180	1.245	1.229	1.227	1.139	1.069	1.097	1.129	0.842	0.761	1.280
12	1.339	1.401	1.377	1.377	1.309	1.327	1.300	1.292	1.249	1.315	1.300	1.303	1.209	1.137	1.156	1.183	0.928	0.848	1.348
13	1.399	1.460	1.440	1.437	1.364	1.386	1.360	1.359	1.310	1.376	1.361	1.370	1.271	1.201	1.212	1.234	1.009	0.931	1.404
14	1.451	1.511	1.493	1.489	1.412	1.439	1.413	1.417	1.362	1.429	1.413	1.430	1.327	1.261	1.266	1.280	1.083	1.009	1.449
15	1.495	1.556	1.540	1.534	1.452	1.485	1.461	1.467	1.408	1.475	1.458	1.481	1.378	1.317	1.317	1.323	1.151	1.082	1.486
16	1.533	1.594	1.579	1.573	1.487	1.526	1.503	1.510	1.448	1.514	1.496	1.526	1.423	1.369	1.365	1.362	1.214	1.149	1.516
17	1.566	1.626	1.613	1.607	1.516	1.563	1.541	1.547	1.482	1.548	1.528	1.565	1.463	1.418	1.410	1.398	1.270	1.212	1.540
18	1.594	1.654	1.641	1.635	1.541	1.595	1.574	1.579	1.512	1.577	1.556	1.599	1.498	1.464	1.453	1.431	1.321	1.269	1.559
19	1.618	1.677	1.666	1.660	1.563	1.623	1.603	1.606	1.537	1.601	1.579	1.629	1.530	1.506	1.493	1.461	1.367	1.322	1.574
20	1.638	1.697	1.686	1.681	1.581	1.647	1.629	1.629	1.559	1.623	1.598	1.654	1.558	1.545	1.530	1.489	1.408	1.370	1.587
21	1.655	1.714	1.704	1.699	1.596	1.669	1.652	1.648	1.577	1.641	1.614	1.676	1.582	1.581	1.566	1.513	1.444	1.414	1.597
22	1.670	1.728	1.718	1.714	1.608	1.688	1.672	1.665	1.593	1.656	1.628	1.694	1.604	1.614	1.599	1.536	1.477	1.453	1.605
23	1.682	1.741	1.731	1.727	1.619	1.704	1.689	1.679	1.606	1.669	1.639	1.710	1.623	1.645	1.630	1.556	1.506	1.489	1.611
24	1.692	1.751	1.741	1.738	1.628	1.719	1.704	1.692	1.618	1.680	1.649	1.724	1.639	1.673	1.658	1.575	1.532	1.522	1.616
25	1.701	1.760	1.750	1.747	1.636	1.731	1.718	1.702	1.628	1.689	1.657	1.736	1.654	1.699	1.685	1.592	1.555	1.551	1.620
Female																			
1	0.069	0.097	0.067	0.038	0.045	0.147	0.010	0.057	0.037	0.060	0.131	0.094	0.080	0.021	0.137	0.245	0.012	0.014	0.015
2	0.165	0.197	0.154	0.121	0.127	0.246	0.066	0.137	0.104	0.141	0.227	0.189	0.163	0.075	0.237	0.343	0.060	0.058	0.088
3	0.294	0.325	0.273	0.245	0.247	0.363	0.174	0.247	0.206	0.253	0.343	0.310	0.271	0.164	0.356	0.451	0.151	0.136	0.222
4	0.447	0.472	0.416	0.400	0.393	0.495	0.323	0.380	0.333	0.387	0.472	0.450	0.397	0.282	0.487	0.566	0.275	0.243	0.399
5	0.613	0.630	0.575	0.571	0.556	0.636	0.498	0.526	0.478	0.537	0.608	0.601	0.533	0.421	0.623	0.686	0.424	0.372	0.598
6	0.782	0.794	0.743	0.749	0.725	0.781	0.682	0.679	0.632	0.696	0.747	0.756	0.675	0.572	0.761	0.807	0.585	0.514	0.800
7	0.949	0.956	0.913	0.924	0.894	0.928	0.866	0.833	0.789	0.857	0.885	0.912	0.817	0.728	0.896	0.928	0.752	0.664	0.996
8	1.109	1.113	1.081	1.091	1.057	1.072	1.042	0.983	0.944	1.015	1.019	1.063	0.955	0.885	1.025	1.047	0.916	0.815	1.176
9	1.258	1.263	1.243	1.247	1.210	1.212	1.205	1.126	1.093	1.169	1.148	1.207	1.088	1.037	1.147	1.163	1.073	0.962	1.338
10	1.396	1.404	1.397	1.389	1.352	1.347	1.352	1.261	1.233	1.314	1.269	1.342	1.214	1.181	1.261	1.275	1.220	1.104	1.480
11	1.521	1.534	1.541	1.518	1.481	1.475	1.484	1.386	1.364	1.451	1.382	1.468	1.331	1.317	1.365	1.382	1.356	1.237	1.603
12	1.634	1.653	1.674	1.631	1.598	1.595	1.599	1.500	1.485	1.577	1.487	1.584	1.439	1.442	1.461	1.484	1.479	1.361	1.709
13	1.734	1.761	1.796	1.732	1.702	1.708	1.700	1.603	1.594	1.693	1.583	1.689	1.538	1.557	1.547	1.580	1.590	1.475	1.798
14	1.822	1.859	1.907	1.820	1.794	1.812	1.786	1.696	1.693	1.798	1.670	1.784	1.628	1.661	1.625	1.670	1.688	1.579	1.873
15	1.900	1.947	2.008	1.896	1.876	1.908	1.860	1.780	1.782	1.893	1.750	1.870	1.709	1.754	1.695	1.755	1.775	1.673	1.935
16	1.969	2.025	2.098	1.962	1.947	1.996	1.924	1.854	1.862	1.979	1.822	1.947	1.782	1.838	1.758	1.833	1.852	1.758	1.987
17	2.028	2.094	2.180	2.019	2.009	2.077	1.977	1.920	1.932	2.056	1.886	2.015	1.847	1.913	1.814	1.907	1.919	1.834	2.030
18	2.080	2.156	2.252	2.068	2.063	2.151	2.023	1.978	1.994	2.125	1.944	2.076	1.905	1.979	1.863	1.974	1.978	1.901	2.066
19	2.125	2.211	2.316	2.110	2.110	2.218	2.061	2.030	2.049	2.186	1.996	2.130	1.957	2.037	1.906	2.037	2.028	1.961	2.095
20	2.164	2.259	2.374	2.146	2.150	2.279	2.093	2.075	2.098	2.240	2.042	2.178	2.002	2.089	1.945	2.095	2.072	2.013	2.119
21	2.197	2.301	2.424	2.176	2.185	2.334	2.120	2.114	2.140	2.288	2.084	2.220	2.043	2.134	1.979	2.148	2.110	2.060	2.139
22	2.226	2.338	2.469	2.202	2.215	2.384	2.143	2.149	2.177	2.331	2.120	2.257	2.079	2.174	2.009	2.197	2.143	2.101	2.155
23	2.251	2.371	2.509	2.224	2.241	2.429	2.162	2.179	2.210	2.368	2.153	2.290	2.110	2.209	2.035	2.241	2.171	2.137	2.168
24	2.272	2.400	2.543	2.243	2.264	2.469	2.178	2.205	2.238	2.401	2.182	2.319	2.138	2.239	2.058	2.282	2.195	2.169	2.179
25	2.290	2.425	2.574	2.259	2.283	2.505	2.191	2.228	2.263	2.430	2.207	2.344	2.163	2.266	2.078	2.320	2.216	2.196	2.188

Table 18. Predicted weight (kg) at age for yellowtail rockfish in N. Columbia area.

N.Columbia

Age	Pre 1987	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003*	2004*
Males																			
1	0.086	0.066	0.062	0.047	0.094	0.214	0.106	0.074	0.148	0.152	0.141	0.064	0.170	0.150	0.331	0.337	0.194	0.105	0.017
2	0.192	0.174	0.164	0.137	0.203	0.327	0.218	0.170	0.250	0.249	0.246	0.153	0.260	0.235	0.423	0.437	0.291	0.190	0.090
3	0.325	0.316	0.300	0.265	0.338	0.450	0.352	0.292	0.367	0.359	0.365	0.269	0.359	0.332	0.515	0.538	0.398	0.306	0.214
4	0.471	0.474	0.455	0.413	0.485	0.576	0.493	0.427	0.489	0.475	0.490	0.400	0.463	0.434	0.606	0.638	0.509	0.439	0.370
5	0.619	0.634	0.615	0.569	0.634	0.700	0.631	0.567	0.612	0.593	0.614	0.537	0.568	0.540	0.694	0.734	0.621	0.578	0.536
6	0.760	0.784	0.769	0.722	0.776	0.819	0.761	0.702	0.731	0.709	0.733	0.672	0.671	0.644	0.778	0.825	0.730	0.714	0.699
7	0.890	0.921	0.911	0.865	0.908	0.930	0.878	0.828	0.842	0.820	0.844	0.799	0.769	0.745	0.857	0.910	0.834	0.842	0.850
8	1.007	1.042	1.040	0.996	1.026	1.033	0.981	0.943	0.945	0.923	0.945	0.917	0.862	0.842	0.930	0.989	0.932	0.958	0.984
9	1.111	1.146	1.153	1.112	1.131	1.126	1.070	1.046	1.039	1.019	1.036	1.022	0.948	0.933	0.997	1.061	1.024	1.061	1.099
10	1.200	1.234	1.251	1.213	1.222	1.209	1.146	1.135	1.123	1.107	1.116	1.116	1.027	1.017	1.058	1.127	1.107	1.153	1.198
11	1.277	1.308	1.335	1.300	1.301	1.284	1.210	1.214	1.197	1.186	1.186	1.198	1.099	1.094	1.114	1.186	1.184	1.232	1.280
12	1.343	1.370	1.405	1.374	1.368	1.349	1.264	1.281	1.263	1.256	1.247	1.269	1.164	1.165	1.165	1.239	1.253	1.300	1.348
13	1.398	1.420	1.465	1.437	1.425	1.407	1.309	1.338	1.320	1.320	1.300	1.330	1.223	1.229	1.210	1.287	1.315	1.359	1.404
14	1.445	1.462	1.515	1.490	1.473	1.457	1.346	1.386	1.370	1.376	1.346	1.382	1.275	1.287	1.251	1.329	1.370	1.410	1.449
15	1.483	1.496	1.556	1.534	1.513	1.501	1.377	1.427	1.413	1.425	1.385	1.427	1.321	1.339	1.288	1.367	1.420	1.453	1.486
16	1.516	1.524	1.590	1.571	1.547	1.540	1.402	1.461	1.450	1.468	1.418	1.464	1.362	1.386	1.320	1.400	1.463	1.490	1.516
17	1.542	1.546	1.619	1.601	1.575	1.573	1.423	1.490	1.483	1.506	1.446	1.496	1.399	1.427	1.349	1.430	1.502	1.521	1.540
18	1.565	1.565	1.642	1.627	1.598	1.601	1.440	1.514	1.510	1.539	1.470	1.523	1.431	1.464	1.375	1.456	1.536	1.548	1.559
19	1.583	1.579	1.661	1.648	1.617	1.626	1.453	1.534	1.534	1.568	1.491	1.545	1.459	1.497	1.398	1.479	1.566	1.570	1.574
20	1.598	1.591	1.677	1.665	1.633	1.647	1.465	1.551	1.554	1.593	1.508	1.564	1.484	1.525	1.418	1.499	1.593	1.590	1.587
21	1.611	1.601	1.690	1.679	1.646	1.665	1.474	1.565	1.571	1.615	1.522	1.580	1.505	1.551	1.436	1.516	1.616	1.606	1.597
22	1.621	1.609	1.700	1.691	1.657	1.681	1.481	1.576	1.586	1.634	1.535	1.593	1.524	1.574	1.451	1.532	1.636	1.620	1.605
23	1.629	1.615	1.709	1.700	1.666	1.694	1.487	1.586	1.599	1.651	1.545	1.604	1.541	1.593	1.465	1.545	1.654	1.633	1.611
24	1.636	1.620	1.716	1.708	1.674	1.706	1.492	1.594	1.610	1.665	1.554	1.613	1.556	1.611	1.478	1.557	1.670	1.643	1.616
25	1.642	1.624	1.722	1.714	1.680	1.715	1.496	1.600	1.619	1.677	1.561	1.620	1.568	1.626	1.488	1.568	1.683	1.652	1.620
Females																			
1	0.030	0.108	0.057	0.023	0.168	0.150	0.012	0.041	0.118	0.050	0.155	0.034	0.130	0.048	0.137	0.340	0.129	0.021	0.021
2	0.110	0.224	0.154	0.103	0.276	0.261	0.081	0.123	0.217	0.132	0.255	0.108	0.225	0.125	0.242	0.450	0.245	0.068	0.068
3	0.236	0.370	0.292	0.236	0.403	0.394	0.211	0.246	0.339	0.250	0.372	0.220	0.337	0.234	0.365	0.565	0.386	0.144	0.144
4	0.396	0.535	0.458	0.406	0.544	0.540	0.383	0.398	0.476	0.391	0.500	0.361	0.461	0.366	0.500	0.684	0.541	0.245	0.245
5	0.574	0.707	0.639	0.596	0.693	0.695	0.575	0.567	0.622	0.547	0.634	0.520	0.591	0.511	0.640	0.803	0.703	0.363	0.363
6	0.757	0.878	0.826	0.791	0.846	0.852	0.768	0.742	0.772	0.708	0.770	0.685	0.723	0.661	0.780	0.920	0.863	0.493	0.493
7	0.938	1.044	1.009	0.980	0.999	1.007	0.953	0.915	0.921	0.868	0.905	0.851	0.854	0.811	0.916	1.033	1.018	0.630	0.630
8	1.109	1.200	1.184	1.157	1.149	1.156	1.121	1.082	1.066	1.022	1.037	1.011	0.980	0.955	1.045	1.142	1.164	0.768	0.768
9	1.267	1.344	1.347	1.318	1.293	1.299	1.270	1.238	1.204	1.166	1.162	1.162	1.100	1.091	1.166	1.246	1.299	0.904	0.904
10	1.411	1.475	1.496	1.461	1.431	1.432	1.400	1.381	1.334	1.299	1.281	1.301	1.212	1.217	1.278	1.343	1.422	1.036	1.036
11	1.538	1.593	1.631	1.587	1.561	1.557	1.511	1.510	1.455	1.420	1.391	1.428	1.317	1.333	1.380	1.435	1.532	1.160	1.160
12	1.651	1.697	1.752	1.695	1.682	1.671	1.604	1.626	1.566	1.529	1.494	1.542	1.413	1.437	1.472	1.520	1.631	1.277	1.277
13	1.749	1.789	1.858	1.789	1.795	1.775	1.683	1.729	1.668	1.626	1.589	1.643	1.500	1.530	1.555	1.599	1.719	1.386	1.386
14	1.835	1.870	1.952	1.869	1.898	1.870	1.748	1.819	1.761	1.712	1.675	1.733	1.580	1.613	1.629	1.671	1.796	1.486	1.486
15	1.908	1.940	2.034	1.936	1.994	1.955	1.801	1.898	1.844	1.788	1.754	1.811	1.652	1.686	1.695	1.738	1.864	1.577	1.577
16	1.971	2.002	2.105	1.993	2.081	2.032	1.845	1.966	1.919	1.854	1.825	1.880	1.717	1.750	1.753	1.799	1.923	1.660	1.660
17	2.025	2.055	2.166	2.041	2.160	2.101	1.881	2.026	1.987	1.912	1.890	1.940	1.775	1.807	1.805	1.855	1.975	1.735	1.735
18	2.070	2.100	2.219	2.081	2.232	2.162	1.911	2.077	2.047	1.962	1.948	1.991	1.827	1.856	1.850	1.906	2.020	1.802	1.802
19	2.109	2.140	2.265	2.114	2.298	2.217	1.935	2.121	2.100	2.005	2.000	2.036	1.873	1.898	1.889	1.952	2.058	1.862	1.862
20	2.142	2.173	2.304	2.142	2.356	2.266	1.954	2.159	2.148	2.043	2.046	2.075	1.914	1.935	1.924	1.994	2.092	1.916	1.916
21	2.169	2.202	2.338	2.165	2.409	2.309	1.970	2.191	2.190	2.075	2.088	2.108	1.950	1.967	1.954	2.032	2.121	1.964	1.964
22	2.193	2.227	2.367	2.185	2.457	2.347	1.983	2.219	2.227	2.103	2.125	2.136	1.982	1.995	1.981	2.066	2.145	2.007	2.007
23	2.212	2.248	2.391	2.201	2.500	2.380	1.994	2.243	2.260	2.127	2.158	2.161	2.011	2.019	2.004	2.097	2.167	2.044	2.044
24	2.229	2.266	2.412	2.214	2.538	2.410	2.002	2.263	2.289	2.147	2.188	2.181	2.036	2.040	2.024	2.125	2.185	2.078	2.078
25	2.243	2.282	2.430	2.225	2.572	2.436	2.009	2.280	2.315	2.165	2.214	2.199	2.058	2.057	2.041	2.150	2.201	2.107	2.107

Table 19. Predicted weight (kg) at age for yellowtail rockfish in Eureka/S. Columbia area.

Eureka/S.Columbia																			
Males																			
Age	Pre 1987	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.095	0.188	0.082	0.496	0.114	0.010	0.237	0.167	0.157	0.093	0.168	0.026	0.186	0.210	0.034	0.059	0.018		
2	0.204	0.319	0.204	0.584	0.227	0.076	0.345	0.271	0.253	0.199	0.261	0.105	0.275	0.299	0.123	0.150	0.089		
3	0.336	0.459	0.356	0.670	0.360	0.199	0.458	0.388	0.360	0.328	0.362	0.228	0.370	0.393	0.252	0.268	0.204	N	N
4	0.478	0.598	0.517	0.753	0.499	0.355	0.573	0.508	0.472	0.465	0.466	0.373	0.469	0.490	0.398	0.398	0.341	O	O
5	0.619	0.728	0.672	0.832	0.635	0.520	0.684	0.627	0.583	0.600	0.569	0.523	0.566	0.585	0.545	0.526	0.483		
6	0.751	0.845	0.813	0.907	0.763	0.680	0.789	0.741	0.691	0.728	0.668	0.666	0.659	0.676	0.680	0.647	0.617	D	D
7	0.872	0.947	0.935	0.977	0.879	0.824	0.886	0.847	0.792	0.844	0.761	0.796	0.747	0.762	0.799	0.755	0.737	A	A
8	0.980	1.036	1.040	1.042	0.981	0.949	0.975	0.943	0.885	0.946	0.847	0.909	0.829	0.843	0.901	0.850	0.841	T	T
9	1.073	1.111	1.127	1.102	1.069	1.054	1.056	1.030	0.971	1.035	0.924	1.006	0.903	0.917	0.985	0.931	0.929	A	A
10	1.154	1.174	1.198	1.157	1.145	1.142	1.128	1.108	1.047	1.111	0.994	1.087	0.971	0.984	1.055	1.000	1.002		
11	1.222	1.226	1.256	1.208	1.209	1.214	1.191	1.176	1.116	1.175	1.057	1.155	1.032	1.045	1.111	1.057	1.061		
12	1.279	1.269	1.303	1.254	1.263	1.271	1.247	1.236	1.176	1.229	1.112	1.210	1.087	1.100	1.156	1.104	1.109		
13	1.327	1.305	1.340	1.296	1.308	1.318	1.297	1.287	1.229	1.274	1.160	1.254	1.135	1.149	1.192	1.143	1.147		
14	1.368	1.334	1.370	1.334	1.346	1.354	1.340	1.332	1.276	1.312	1.203	1.290	1.178	1.193	1.220	1.174	1.178		
15	1.401	1.358	1.394	1.368	1.377	1.384	1.377	1.371	1.317	1.342	1.240	1.319	1.215	1.231	1.243	1.200	1.202		
16	1.428	1.377	1.413	1.399	1.402	1.407	1.409	1.404	1.352	1.368	1.272	1.342	1.249	1.265	1.260	1.221	1.221		
17	1.451	1.393	1.427	1.426	1.423	1.425	1.437	1.433	1.382	1.389	1.299	1.361	1.277	1.295	1.274	1.238	1.237		
18	1.469	1.406	1.439	1.451	1.441	1.439	1.462	1.457	1.409	1.406	1.323	1.376	1.303	1.322	1.285	1.251	1.249		
19	1.484	1.416	1.448	1.474	1.455	1.450	1.482	1.478	1.431	1.420	1.344	1.387	1.325	1.345	1.293	1.262	1.258		
20	1.497	1.424	1.456	1.494	1.467	1.459	1.500	1.495	1.451	1.431	1.362	1.397	1.344	1.365	1.300	1.271	1.265		
21	1.507	1.431	1.461	1.512	1.476	1.466	1.516	1.510	1.468	1.440	1.377	1.404	1.360	1.383	1.305	1.278	1.271		
22	1.515	1.436	1.466	1.528	1.484	1.471	1.529	1.523	1.482	1.448	1.391	1.410	1.375	1.398	1.309	1.284	1.276		
23	1.522	1.441	1.469	1.542	1.490	1.475	1.540	1.534	1.495	1.454	1.402	1.415	1.387	1.412	1.312	1.288	1.279		
24	1.527	1.444	1.472	1.555	1.495	1.478	1.550	1.543	1.505	1.459	1.412	1.418	1.398	1.424	1.314	1.292	1.282		
25	1.532	1.447	1.474	1.567	1.499	1.481	1.558	1.551	1.514	1.463	1.420	1.421	1.407	1.434	1.316	1.295	1.284		
Female																			
1	0.052	0.087	0.011	0.111	0.032	0.218	0.030	0.247	0.189	0.091	0.061	0.058	0.102	0.009	0.085	0.100	0.020		
2	0.145	0.206	0.085	0.245	0.121	0.326	0.110	0.349	0.288	0.190	0.145	0.150	0.188	0.070	0.200	0.203	0.096	N	N
3	0.277	0.360	0.228	0.410	0.261	0.448	0.234	0.461	0.400	0.315	0.258	0.276	0.294	0.191	0.343	0.329	0.223	O	O
4	0.437	0.532	0.419	0.589	0.432	0.579	0.390	0.580	0.519	0.457	0.391	0.424	0.414	0.350	0.500	0.468	0.378		
5	0.610	0.710	0.629	0.767	0.618	0.715	0.564	0.703	0.643	0.606	0.533	0.582	0.540	0.524	0.656	0.611	0.543	D	D
6	0.788	0.883	0.841	0.936	0.806	0.852	0.742	0.826	0.767	0.755	0.678	0.742	0.669	0.698	0.803	0.750	0.704	A	A
7	0.961	1.045	1.040	1.091	0.986	0.987	0.916	0.949	0.890	0.900	0.820	0.896	0.797	0.860	0.937	0.882	0.851	T	T
8	1.126	1.193	1.220	1.229	1.152	1.119	1.080	1.068	1.009	1.037	0.955	1.041	0.921	1.005	1.055	1.004	0.982	A	A
9	1.278	1.325	1.378	1.349	1.301	1.245	1.231	1.184	1.122	1.164	1.081	1.174	1.038	1.131	1.158	1.114	1.095		
10	1.416	1.440	1.513	1.452	1.433	1.365	1.367	1.294	1.230	1.279	1.196	1.293	1.147	1.238	1.245	1.212	1.190		
11	1.540	1.541	1.627	1.540	1.547	1.478	1.488	1.399	1.330	1.383	1.300	1.400	1.249	1.328	1.319	1.299	1.270		
12	1.650	1.627	1.723	1.615	1.646	1.584	1.594	1.497	1.424	1.476	1.392	1.493	1.342	1.402	1.381	1.374	1.336		
13	1.747	1.700	1.802	1.677	1.730	1.682	1.686	1.589	1.510	1.559	1.475	1.575	1.426	1.463	1.432	1.440	1.390		
14	1.831	1.762	1.867	1.729	1.801	1.772	1.766	1.675	1.589	1.631	1.547	1.645	1.503	1.512	1.475	1.496	1.434		
15	1.904	1.815	1.920	1.772	1.861	1.856	1.834	1.755	1.661	1.695	1.610	1.706	1.571	1.553	1.509	1.545	1.469		
16	1.967	1.859	1.963	1.807	1.911	1.932	1.892	1.828	1.727	1.750	1.665	1.759	1.633	1.585	1.538	1.586	1.498		
17	2.021	1.896	1.998	1.837	1.953	2.001	1.942	1.896	1.787	1.798	1.713	1.803	1.687	1.611	1.561	1.622	1.521		
18	2.068	1.927	2.026	1.861	1.988	2.064	1.984	1.958	1.841	1.839	1.755	1.842	1.736	1.632	1.581	1.652	1.539		
19	2.107	1.953	2.049	1.880	2.017	2.121	2.020	2.016	1.890	1.875	1.790	1.874	1.779	1.649	1.596	1.677	1.554		
20	2.141	1.974	2.067	1.897	2.041	2.173	2.049	2.068	1.934	1.906	1.821	1.901	1.817	1.662	1.609	1.699	1.566		
21	2.170	1.992	2.082	1.910	2.061	2.220	2.075	2.115	1.973	1.932	1.847	1.925	1.851	1.673	1.619	1.717	1.575		
22	2.194	2.006	2.094	1.921	2.078	2.262	2.096	2.158	2.009	1.955	1.870	1.944	1.880	1.681	1.627	1.732	1.583		
23	2.215	2.019	2.103	1.930	2.091	2.300	2.114	2.198	2.040	1.975	1.889	1.961	1.906	1.688	1.634	1.745	1.589		
24	2.233	2.029	2.111	1.937	2.102	2.334	2.129	2.233	2.069	1.992	1.906	1.975	1.929	1.694	1.640	1.756	1.593		
25	2.248	2.037	2.117	1.943	2.112	2.365	2.141	2.266	2.094	2.006	1.920	1.987	1.949	1.698	1.644	1.765	1.597		

Table 20. Fraction of maturity at age for female yellowtail rockfish (from Tagart et al. 2000).

Age	Coast-wide	S. Vancouver	N. Columbia	Eureka/S.Columbia
1	0.000	0.000	0.000	0.000
2	0.001	0.000	0.001	0.001
3	0.002	0.000	0.002	0.002
4	0.004	0.001	0.004	0.004
5	0.011	0.003	0.011	0.011
6	0.029	0.007	0.029	0.029
7	0.072	0.019	0.072	0.072
8	0.169	0.050	0.169	0.169
9	0.347	0.126	0.347	0.347
10	0.581	0.283	0.581	0.581
11	0.784	0.519	0.784	0.784
12	0.904	0.746	0.904	0.904
13	0.961	0.890	0.961	0.961
14	0.985	0.957	0.985	0.985
15	0.994	0.984	0.994	0.994
16	0.998	0.994	0.998	0.998
17	0.999	0.998	0.999	0.999
18	1.000	0.999	1.000	1.000
19	1.000	1.000	1.000	1.000
20	1.000	1.000	1.000	1.000
21	1.000	1.000	1.000	1.000
22	1.000	1.000	1.000	1.000
23	1.000	1.000	1.000	1.000
24	1.000	1.000	1.000	1.000
25	1.000	1.000	1.000	1.000
Parameters				
a	-0.96	-1.0058	-0.96	-0.96
b	9.273	10.9896	9.273	9.273

Table 21. Mean difference and standard deviation of the mean difference between replicate age assignments for yellowtail rockfish.

AGE	N	MEAN DEV	STD	PREDICTED
4	2	0.500	0.707	0.651
5	26	0.308	0.679	0.706
6	131	0.199	0.574	0.762
7	305	0.216	0.895	0.817
8	507	0.073	0.765	0.873
9	695	0.006	0.826	0.928
10	668	-0.153	0.923	0.983
11	495	-0.297	0.960	1.039
12	384	-0.372	1.105	1.094
13	266	-0.323	1.179	1.150
14	197	-0.508	1.354	1.205
15	144	-0.417	1.298	1.261
16	104	-0.433	1.519	1.316
17	88	-0.489	1.788	1.372
18	76	-0.250	1.256	1.427
19	58	-0.379	1.576	1.483
20	42	-0.429	1.434	1.538
21	35	-1.229	1.800	1.594
22	21	-0.571	1.859	1.649
23	13	-0.385	1.387	1.705
24	9	-0.556	1.424	1.760
25+	48	-0.583	1.820	1.816
TOTAL	4314			

Table 22. Summary of estimates from model fitted to the yellowtail rockfish data of S. Vancourver, N. Columbia, and Eureka/S. Columbia areas.

	S. Vancouver		N. Columbia		Eureka/S. Columbia	
Output Indicator	**YT2005**	**YT2003R**	**YT2005**	**YT2003R**	**YT2005**	**YT2003R**
2005 Total Biomass	40,501	40,878	21,385	20,214	12,331	12,712
CV 2005 Total Biomass	31%	31%	28%	28%	32%	30%
2005 Biomass / 1967 Biomass	96%	97%	48%	38%	66%	70%
CV Biomass ratio	32%	32%	32%	32%	36%	32%
5-yr Average Total Biomass (2001-2005)	36,738	37,094	21,266	20,097	9543	10,099
2005 SPB	8,834	8,938	5,884	5,448	2,197	2,338
5-yr Average SPB (2001-2005)	9,313	9,420	6,283	5,807	1,999	2,357
Equilibrium SPB(F=0)	13,355	13,632	12,169	12,111	5,492	6,643
Equil SPB(40%)	5,342	5,453	4,868	4,844	2,197	2,657
2005 SPB/Equil SPB (40%)	165%	164%	121%	112%	100%	88%
5-yr Average SPB/Equil SPB(40%)	174%	173%	129%	120%	91%	89%
Female M at age 25	0.28	0.28	0.21	0.22	0.16	0.19
2004 Fully Vulnerable F (Female Age 12)	0.07	0.07	0.01	0.01	0.00	0.00
2004 Fully Vulnerable F (Male Age 12)	0.07	0.07	0.01	0.01	0.00	0.00
Average Fully Vulnerable F (Female, Age 12, 1967-20(	0.09	0.09	0.13	0.13	0.10	0.10
Average Fully Vulnerable F (Male, Age 12, 1967-2004)	0.09	0.09	0.13	0.13	0.08	0.09
Average Female Recruitment (1967-2004)	3,231	3,252	2,479	2,456	1,011	1,208
CV Average Female Recruitment	44%	44%	45%	50%	71%	75%
5-yr Average Female Recruitment (2000-2004)	2,555	2,569	1,411	1,312	1,412	1,401
Median Female Recruitment (1967-2004)	2,663	2,680	2,367	2,344	850	954
Constant Survey Catchability	0.22	0.22	0.11	0.10	0.27	0.23
Survey Abundance	7.61	6.97	21.31	20.37	3.89	4.59
Whiting bycatch	17.53	17.52	19.83	19.87	18.98	19.44
Logbook CPUE	-4.26	-4.26	-12.73	-12.70	1.64	2.64
Fishery Age Comp Fit	40.50	40.52	46.88	40.60	116.95	206.09
Survey Age Comp fit	9.79	9.79	9.83	30.28	26.35	63.79
Fishery Selectivity Curvature, Female	1.76	1.76	2.83	2.78	1.20	1.29
Fishery Selectivity Curvature, Male	2.42	2.42	3.59	3.39	2.01	1.93
Survey Selectivity Curvature	1.00	1.00	0.73	1.56	0.55	3.13
Fishery Selectivity Fit	0.26	0.26	0.52	0.57	0.23	0.30
Survey Selectivity Fit	0.00	0.00	0.00	0.01	0.03	0.11
Selectivity Fit Between Female and Male	0.00	0.00	0.00	0.00	0.00	0.00
Recruitment	2.83	2.84	3.89	4.46	5.80	9.23
Catch Biomass	0.01	0.01	0.06	0.06	0.04	0.05
Penalty for Low F	1.97	1.94	4.98	5.21	7.61	7.72
Total -lnL	81.41	80.77	101.73	116.47	185.27	320.33
Effective N	322	322	432	407	117	107
$RMSE = \left(\sqrt{\frac{\sum \ln(Obs / \Pr ed)^2}{n}} \right)$						
Triennial Survey fit	4.604	4.219	12.892	12.322	2.354	2.778
Whiting bycatch	1.406	1.405	1.591	1.594	1.523	1.560
Logbook CPUE	1.584	1.584	0.122	0.122	5.608	5.993

Table 23. Yellowtail rockfish projected yield (mt), biomass (mt), and stock benchmarks for S. Vancouver, N. Columbia, and Eureka/S. Col. areas.

	S. Vancouver			N. Columbia			Eureka/S. Columbia			Sum of Eur, Col, and Van		
Projections	**2005**	**2003R**	**2003N**	**2005**	**2003R**	**2003N**	**2005**	**2003R**	**2003N**	**2005**	**2003R**	**2003N**
Unfished Biomass: B(0)	60,873	57,166	52,181	42,636	41,973	42,668	16,515	19,247	18,725	120,023	118,386	113,574
Unfished Spawning Biomass: SPB(0)	13,355	12,823	11,826	12,169	12,111	12,418	5,492	6,643	6,439	31,016	31,577	30,683
SPB(50%)	6,678	6,411	5,913	6,084	6,055	6,209	2,746	3,322	3,220	15,508	15,789	15,342
SPB(40%)	5,342	5,129	4,730	4,868	4,844	4,967	2,197	2,657	2,576	12,406	12,631	12,273
SPB(25%)	3,339	3,206	2,956	3,042	3,028	3,105	1,373	1,661	1,610	7,754	7,894	7,671
Equilibrium Yield 50%	2,465	2,318	2,117	1,624	1,600	1,627	591	690	671	4,681	4,608	4,415
F(50%)	0.095	0.095	0.095	0.079	0.079	0.079	0.073	0.073	0.073			
F(40%)	0.132	0.132	0.132	0.111	0.111	0.111	0.102	0.102	0.102			
F(25%)	0.227	0.227	0.227	0.193	0.193	0.193	0.175	0.175	0.175			
F(20%)	0.281	0.281	0.281	0.240	0.240	0.240	0.216	0.216	0.216			
Projected Recriuitment 2006-2015	5,962	5,483	4,954	4,485	4,377	4,418	1,695	1,884	1,842	12,143	11,743	11,214
Yield 50%										-	-	-
2006	2,693	2,462	2,093	1,386	1,305	1,258	637	662	536	4,716	4,429	3,886
2007	2,555	2,338	1,952	1,328	1,251	1,225	702	723	506	4,585	4,312	3,682
2008	2,470	2,267	1,873	1,305	1,235	1,224	735	756	494	4,510	4,258	3,592
2009	2,415	2,222	1,847	1,309	1,247	1,256	739	763	495	4,464	4,233	3,598
2010	2,378	2,192	1,854	1,332	1,277	1,298	730	758	503	4,441	4,226	3,656
2011	2,359	2,175	1,876	1,363	1,312	1,339	710	741	513	4,432	4,229	3,728
2012	2,354	2,170	1,897	1,394	1,347	1,375	684	720	523	4,432	4,236	3,796
2013	2,355	2,170	1,914	1,423	1,378	1,405	660	700	533	4,438	4,248	3,852
2014	2,359	2,172	1,927	1,448	1,404	1,430	639	682	541	4,445	4,258	3,898
2015	2,362	2,174	1,938	1,468	1,426	1,449	621	667	548	4,450	4,267	3,935
Total Biomass 50%										-	-	-
2006	40,469	37,255	31,455	22,429	21,290	20,889	13,197	13,634	9,300	76,095	72,180	61,644
2007	39,535	36,409	30,975	22,368	21,330	21,205	13,207	13,684	9,286	75,109	71,423	61,465
2008	38,940	35,873	30,811	22,500	21,551	21,627	13,023	13,560	9,363	74,463	70,983	61,800
2009	38,578	35,544	30,840	22,751	21,876	22,090	12,722	13,328	9,490	74,051	70,747	62,420
2010	38,376	35,354	30,963	23,059	22,242	22,538	12,372	13,046	9,636	73,808	70,642	63,136
2011	38,283	35,260	31,112	23,379	22,608	22,943	12,013	12,751	9,783	73,675	70,619	63,839
2012	38,252	35,222	31,255	23,685	22,948	23,298	11,675	12,471	9,919	73,612	70,641	64,472
2013	38,254	35,214	31,379	23,962	23,252	23,602	11,372	12,219	10,043	73,587	70,685	65,024
2014	38,268	35,218	31,483	24,206	23,518	23,859	11,108	11,998	10,149	73,582	70,734	65,492
2015	38,284	35,227	31,568	24,416	23,745	24,074	10,882	11,809	10,242	73,583	70,781	65,884
Spawning Biomass 50%										-	-	-
2006	8,310	7,667	6,805	5,883	5,471	4,964	2,415	2,507	2,816	16,608	15,645	14,584
2007	7,518	6,897	6,027	5,428	5,055	4,794	2,608	2,673	2,520	15,554	14,625	13,341
2008	6,991	6,401	5,477	5,114	4,774	4,663	2,957	3,014	2,298	15,062	14,188	12,438
2009	6,687	6,129	5,135	4,935	4,632	4,616	3,311	3,363	2,175	14,933	14,124	11,925
2010	6,507	5,981	4,978	4,868	4,603	4,672	3,494	3,552	2,150	14,869	14,137	11,800
2011	6,392	5,890	4,966	4,888	4,658	4,800	3,485	3,567	2,188	14,764	14,115	11,953
2012	6,335	5,847	5,034	4,971	4,768	4,950	3,372	3,485	2,249	14,678	14,100	12,233
2013	6,336	5,850	5,126	5,087	4,903	5,094	3,231	3,372	2,313	14,655	14,126	12,533
2014	6,376	5,884	5,213	5,211	5,039	5,221	3,095	3,260	2,371	14,681	14,183	12,805
2015	6,426	5,927	5,286	5,326	5,162	5,330	2,974	3,159	2,421	14,726	14,249	13,037
3-Year average												
Mean Yield 2006-2008	2,573	2,356	1,973	1,340	1,264	1,236	691	713	512	4,604	4,333	3,720
Total Biomass 2008	38,940	35,873	30,811	22,500	21,551	21,627	13,023	13,560	9,363	74,463	70,983	61,800
Spawning Biomass 2008	6,991	6,401	5,477	5,114	4,774	4,663	2,957	3,014	2,298	15,062	14,188	12,438
SPB(2008)/SPB(40%)	131%	125%	116%	105%	99%	94%	135%	113%	89%	121%	112%	101%
10-Year average												
Mean Yield 2006-2015	2,430	2,234	1,917	1,376	1,318	1,326	686	717	519	4,491	4,270	3,762
Total Biomass 2015	38,284	35,227	31,568	24,416	23,745	24,074	10,882	11,809	10,242	73,583	70,781	65,884
Spawning Biomass 2015	6,426	5,927	5,286	5,326	5,162	5,330	2,974	3,159	2,421	14,726	14,249	13,037
SPB(2015/SPB(40%)	120%	116%	112%	109%	107%	107%	135%	119%	94%	119%	113%	106%

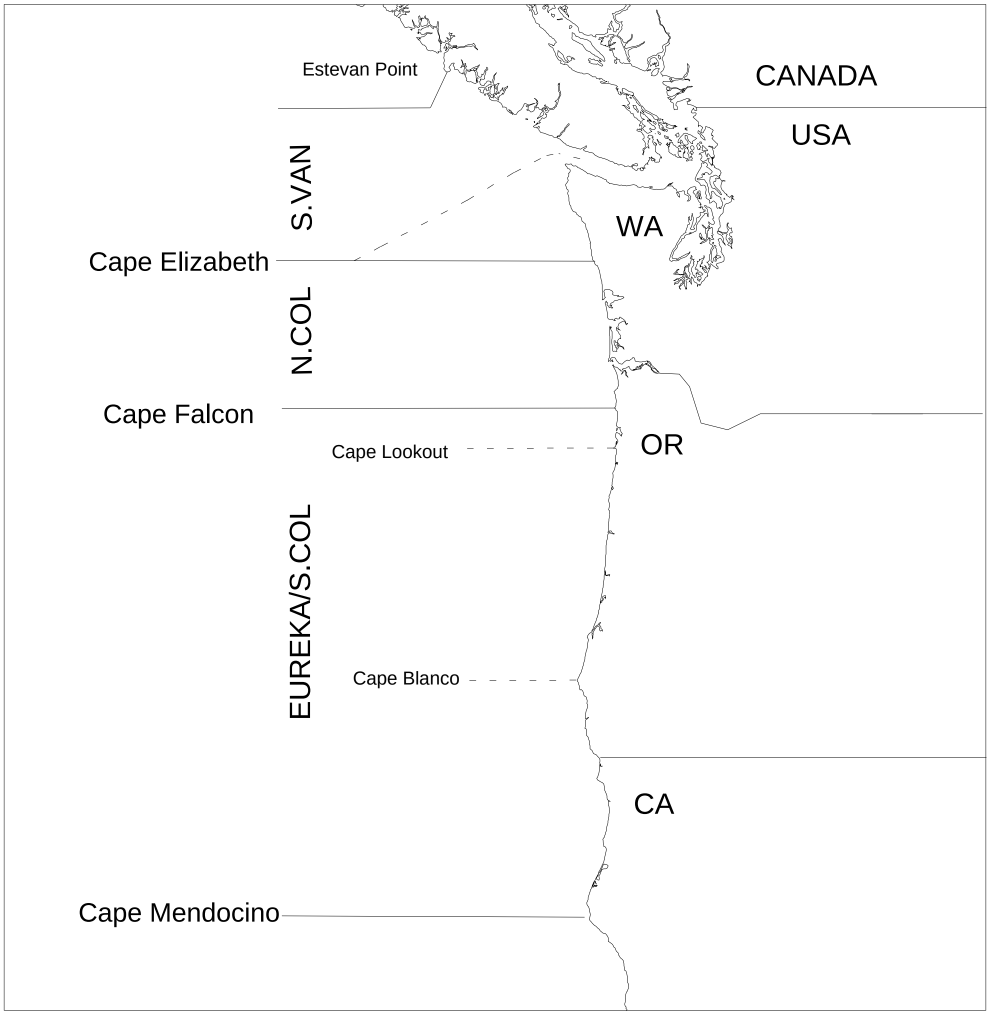


Figure 1. Yellowtail rockfish stock boundaries.

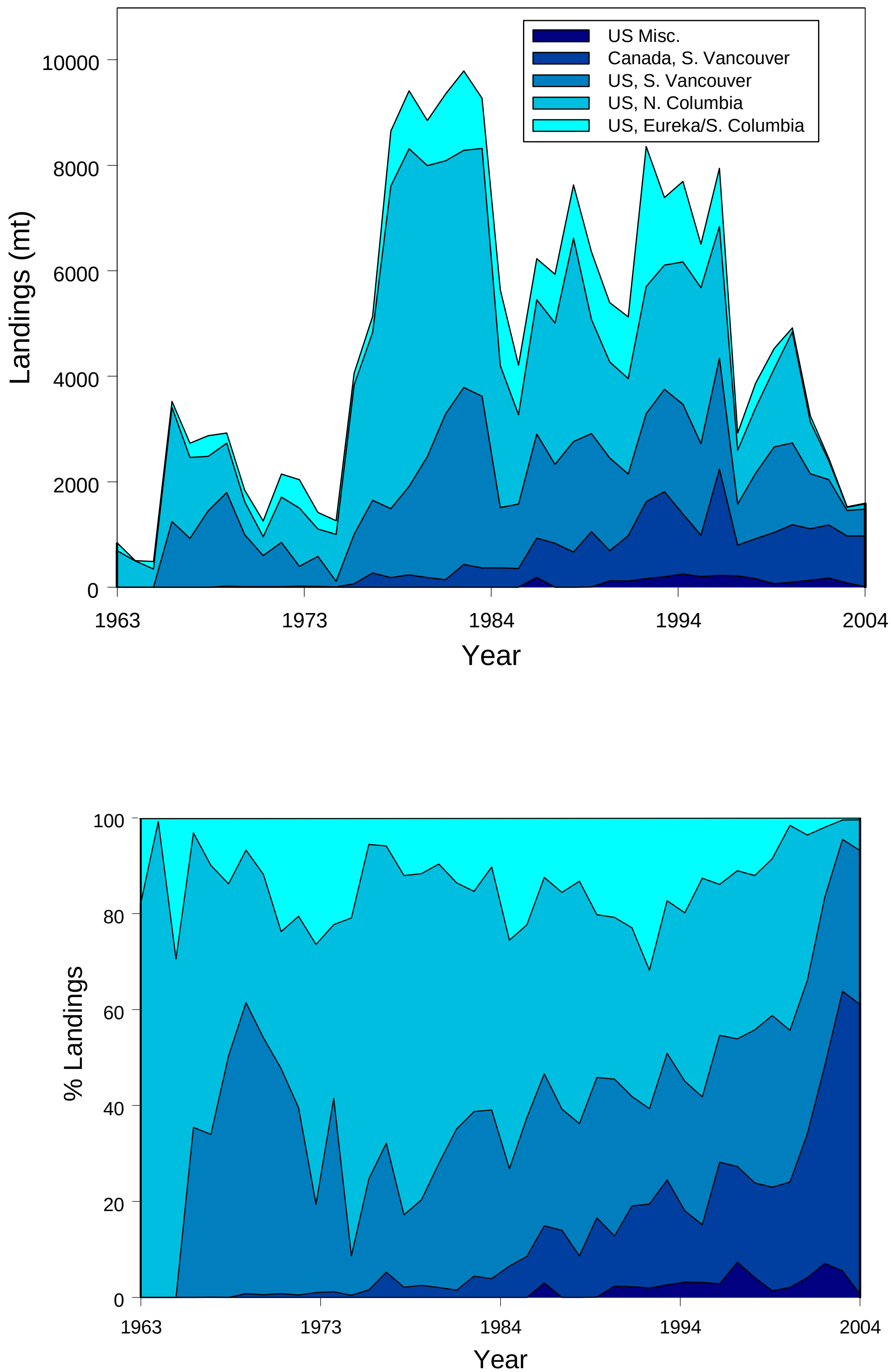


Figure 2. Distribution of annual landings for yellowtail rockfish. Misc.: Includes hook & line, net, pot, trolls, and miscellaneous gears. Based on YT2005N catch series.

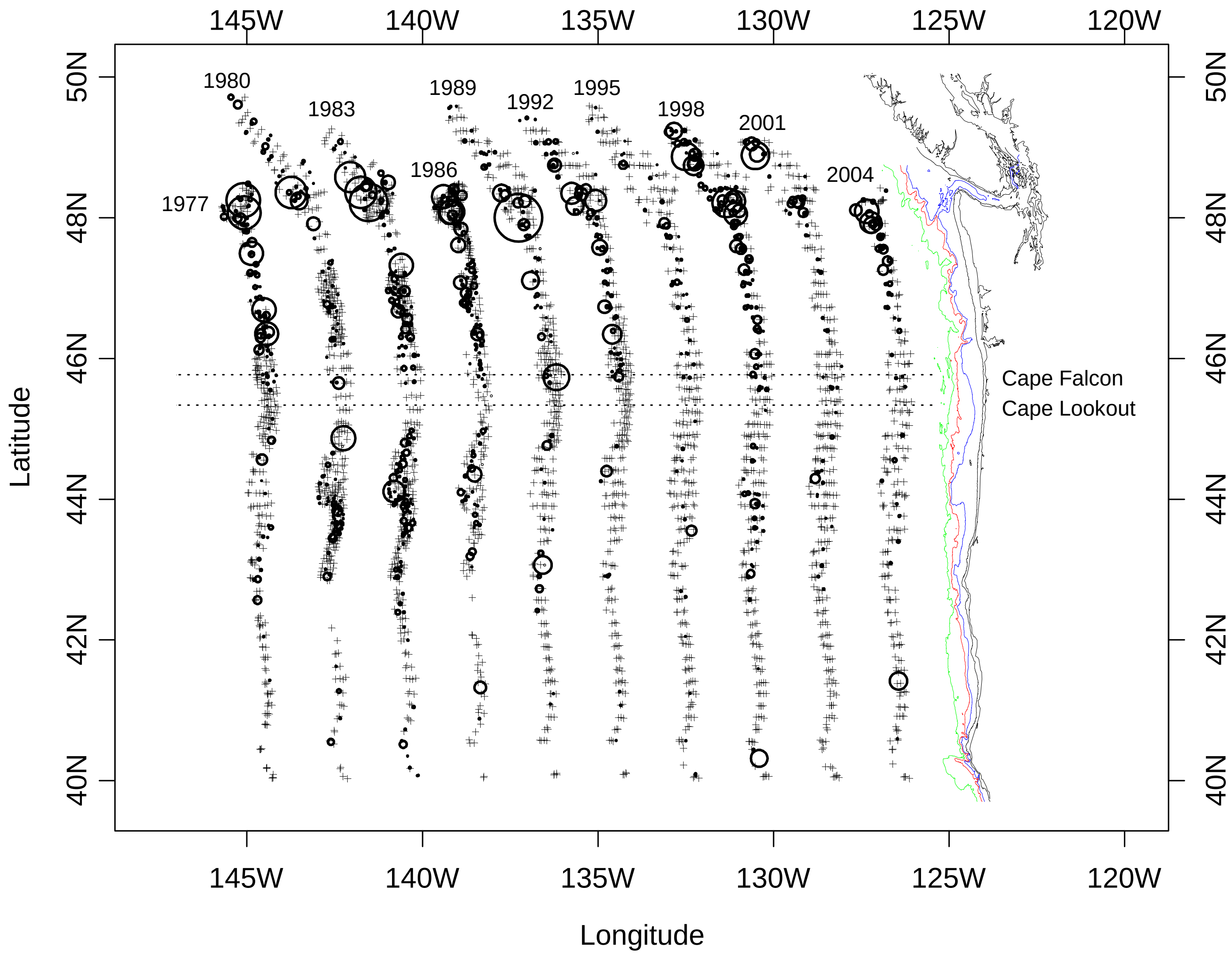


Figure 3. Tow locations and estimated CPUE (kg per hectare) of NMFS triennial surveys, 1977-2004. The circles show positive CPUE, with the area of the circle proportional to the size of the catch. Tows with zero yellowtail rockfish catch are represented by a cross (+).

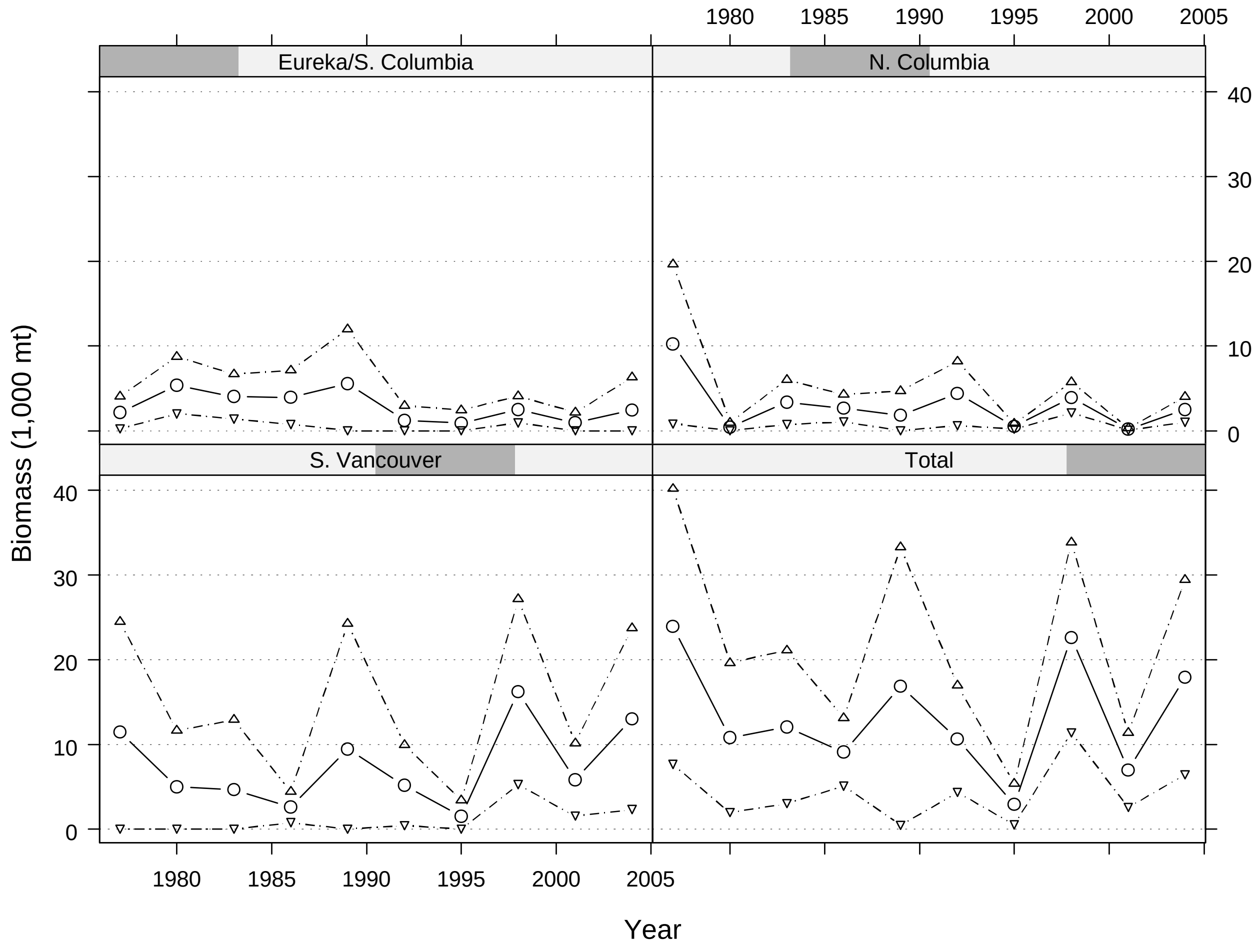
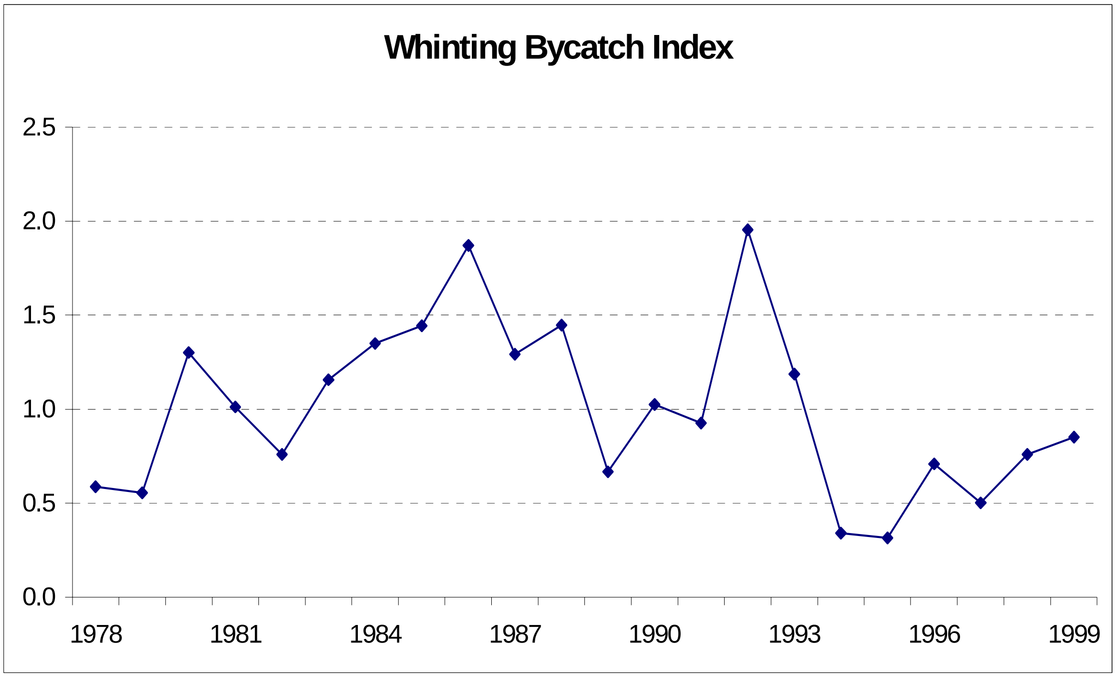


Figure 4. Estimates of NMFS triennial survey biomass for yellowtail rockfish, 1977-2001. S. Vancouver includes only the US portion of S. Vancouver. The dash-dotted line is the 95% confidence interval.



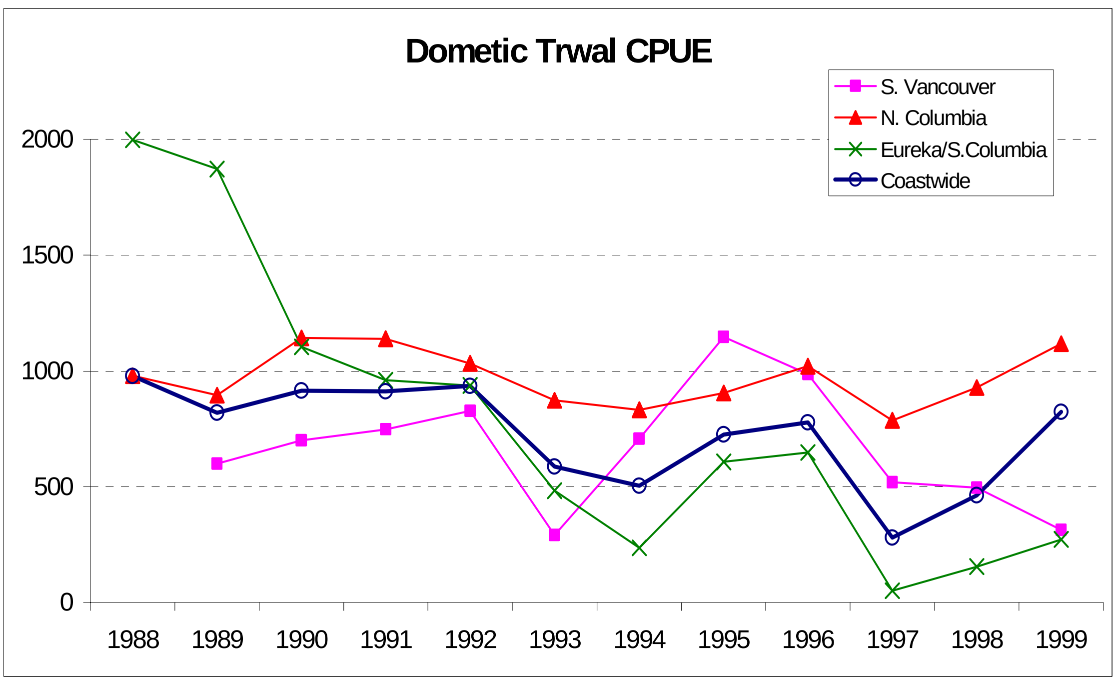


Figure 5. Pacific hake bycatch index and domestic trawl CPUE.

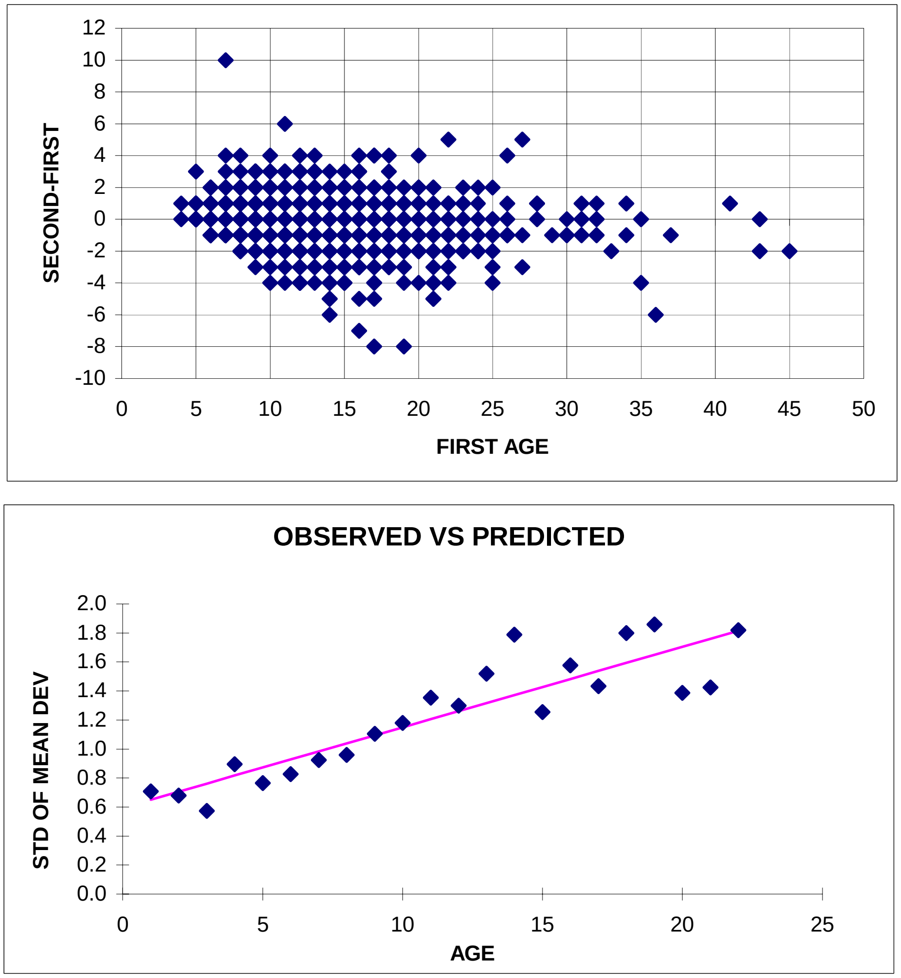


Figure 6. Variability in the replicate age assignment of Yellowtail rockfish. (Ageing error) Panel A represents the deviations between the first and second age assignment for the same age structure. Panel B shows the estimated standard deviation for the mean deviation between first and second age, and a predicted line through the standard deviations.

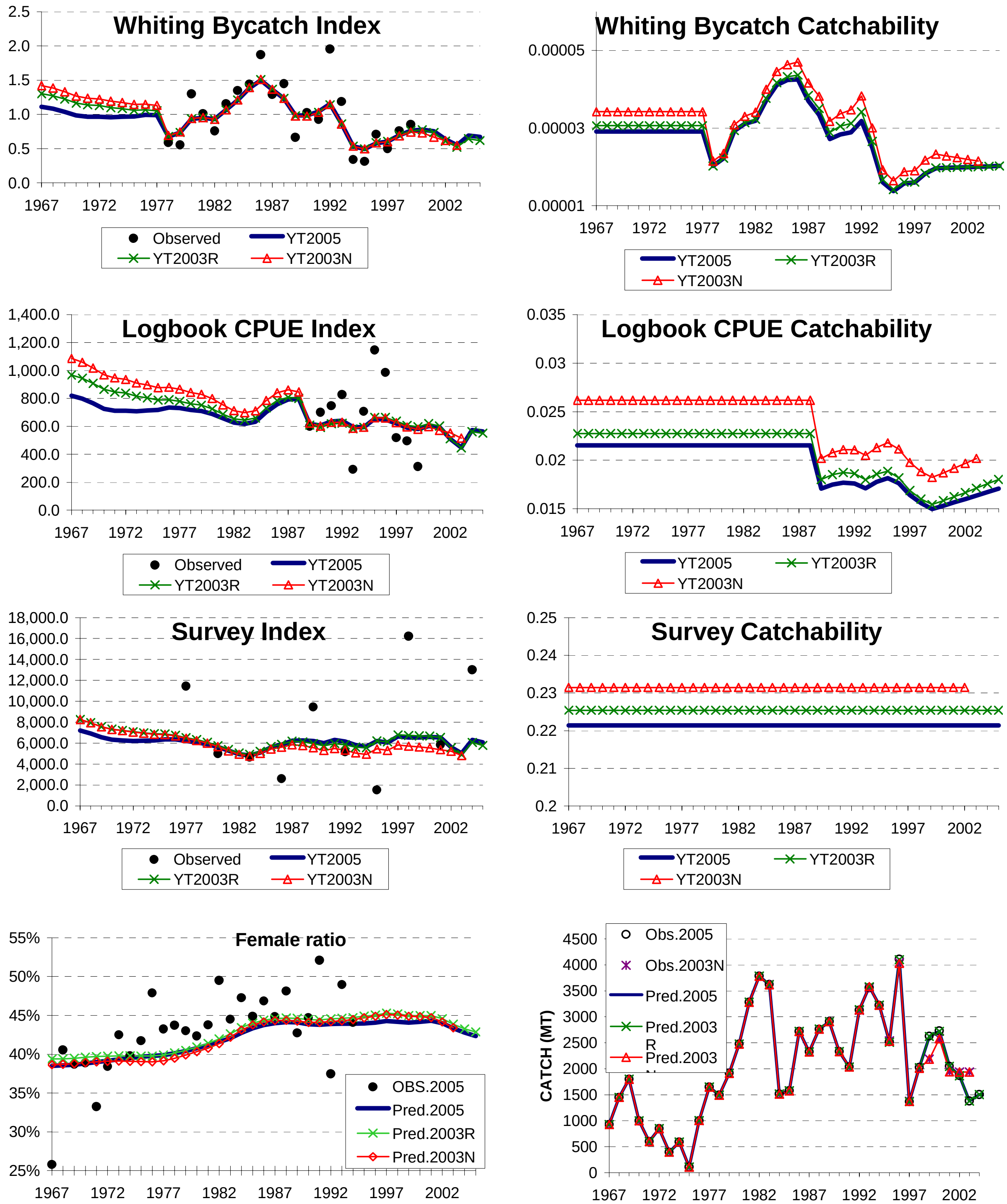


Figure 7. South Vancouver area. The model fits of three abundance indices, female ratio, and catch series. Also shown is the catchability for the three indices.

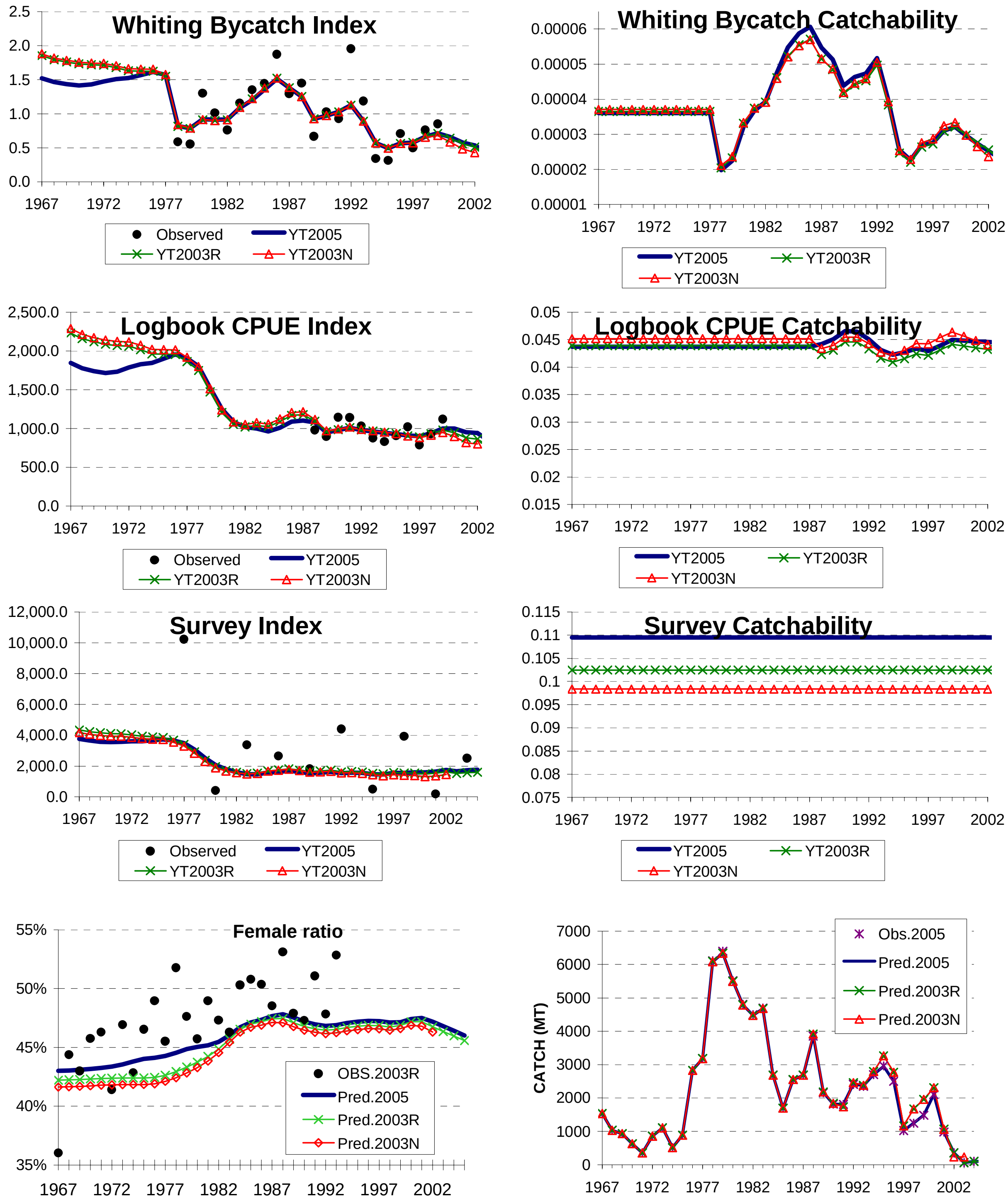


Figure 7. (cont.) North Columbia area. The model fits of three abundance indices, female ratio, and catch series. Also shown is the catchability for the three indices.

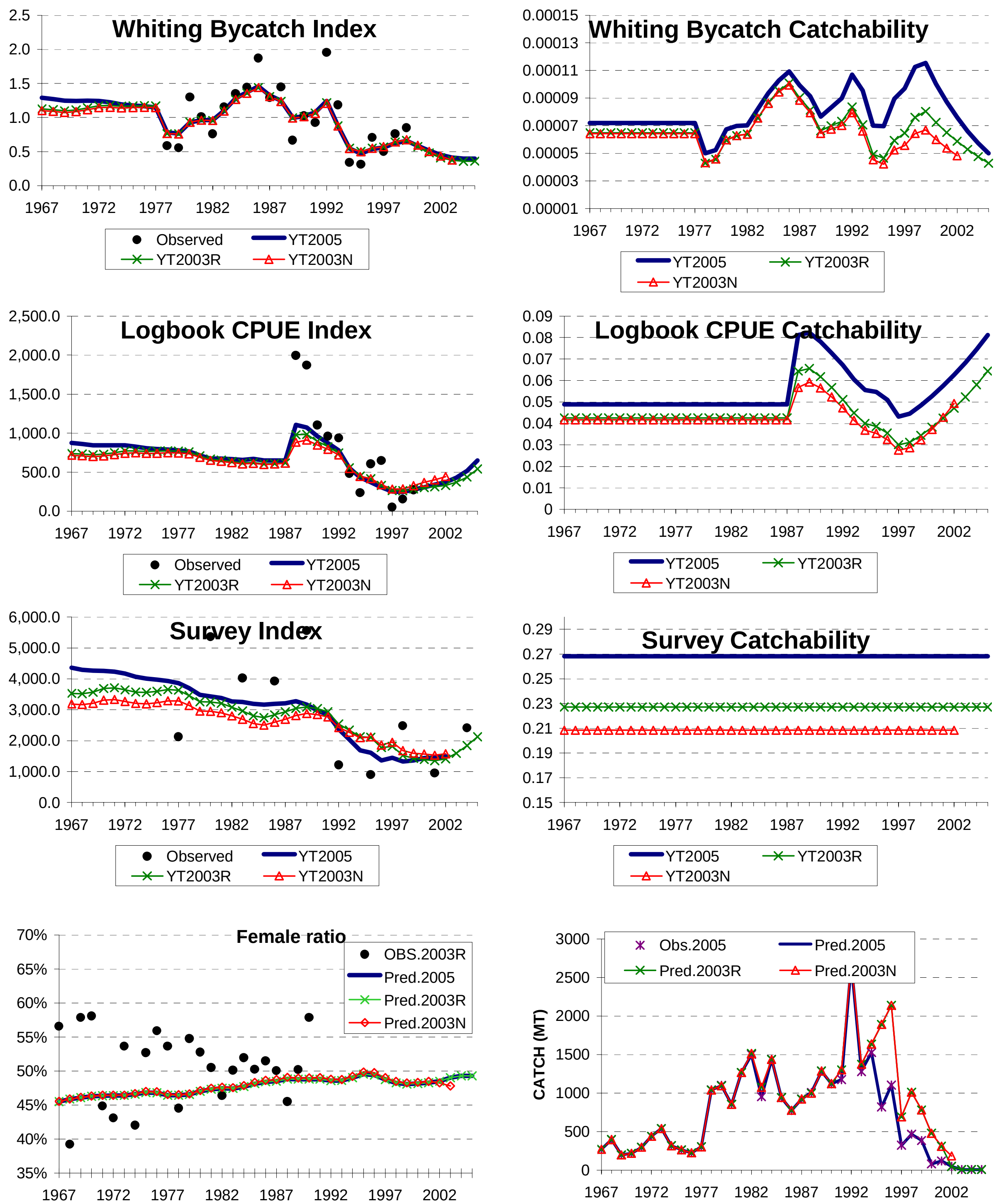
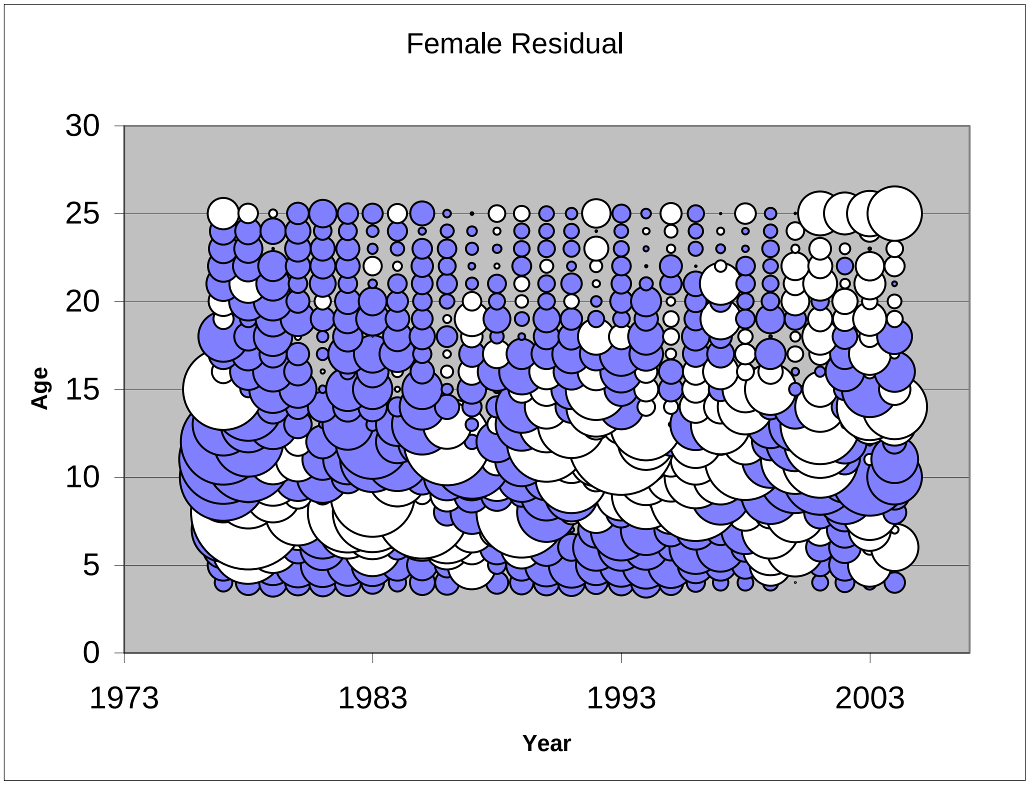


Figure 7. (cont.) Eurkea/South Columbia area. The model fits of three abundance indices, female ratio, and catch series. Also shown is the catchability for the three indices.



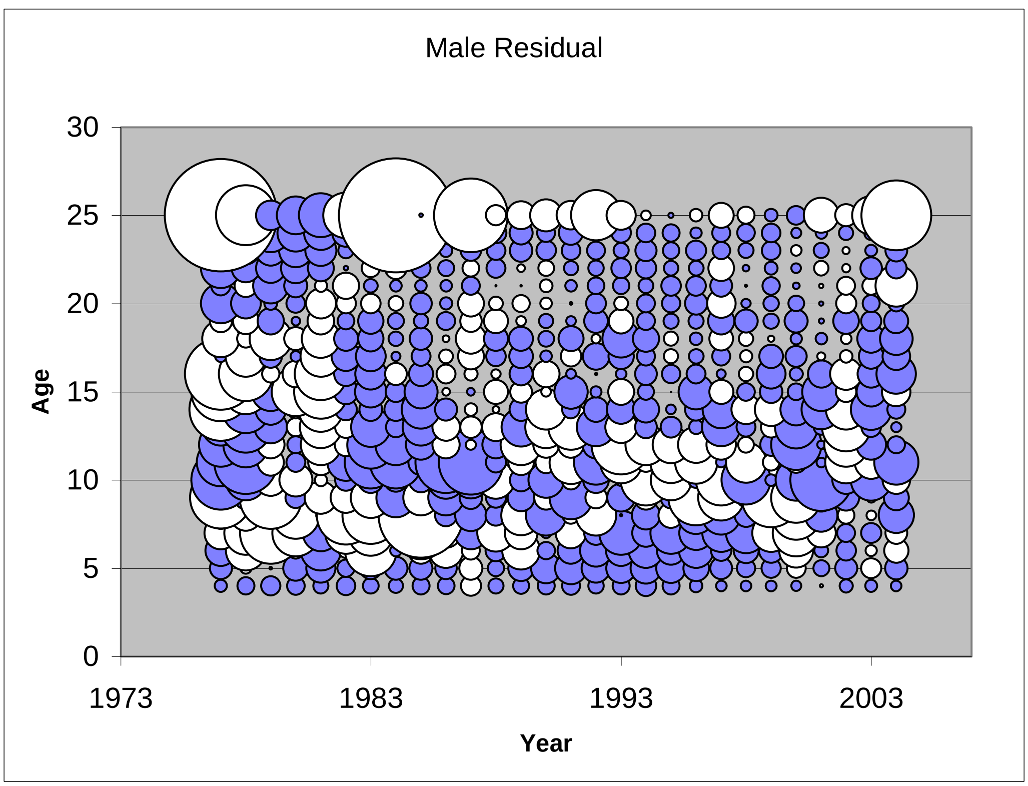
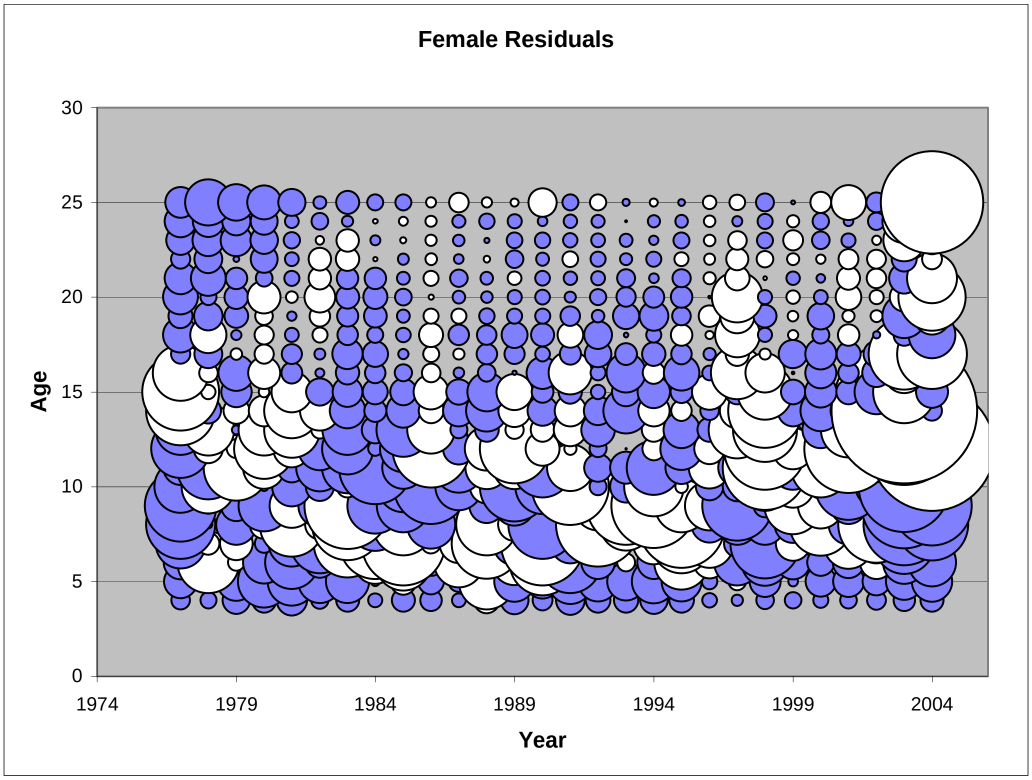


Figure 8 (Female) & Figure 9 (Male). South Vancouver area. YT2005 residual plots for proportions of catch at age. The filled circles have positive values and the open circles have negative values.



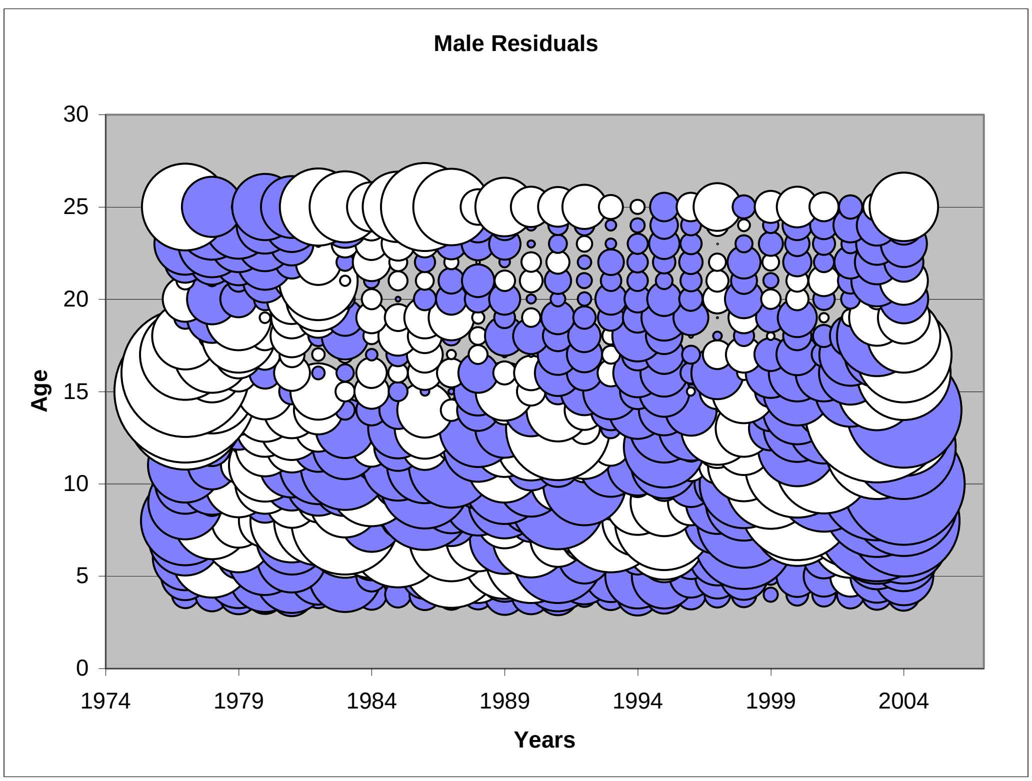
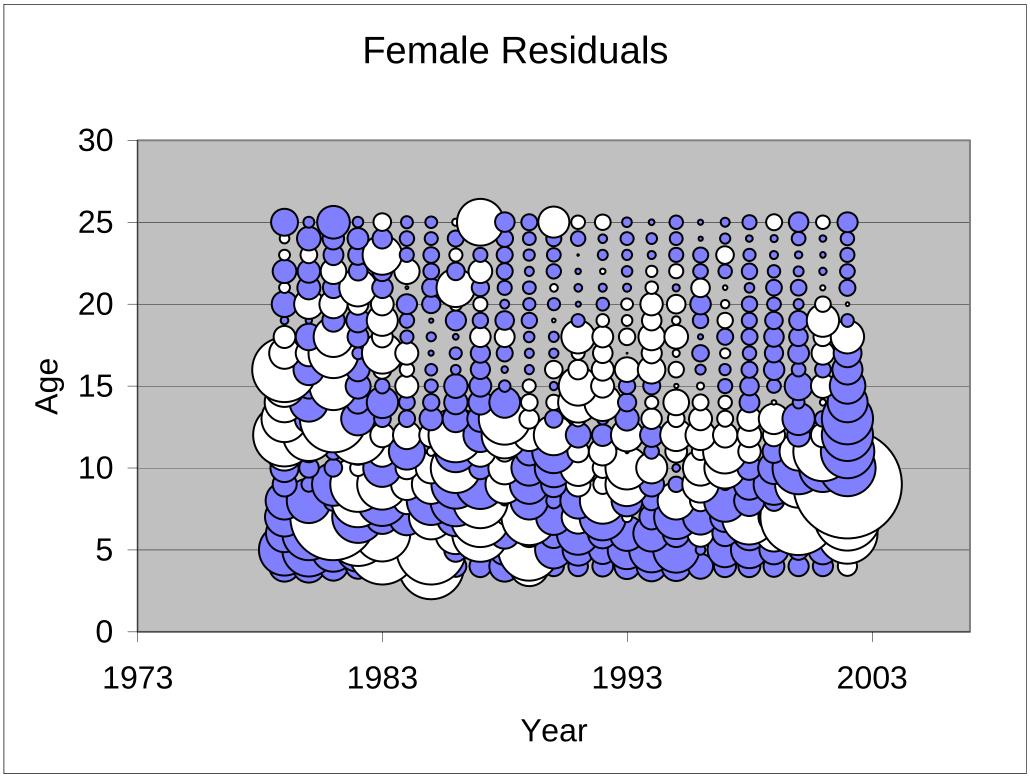


Figure 8 (Female) & Figure 9 (Male). (cont.) North Columbia area. YT2005 residual plots for proportions of catch at age. The filled circles have positive values and the open circles have negative values.



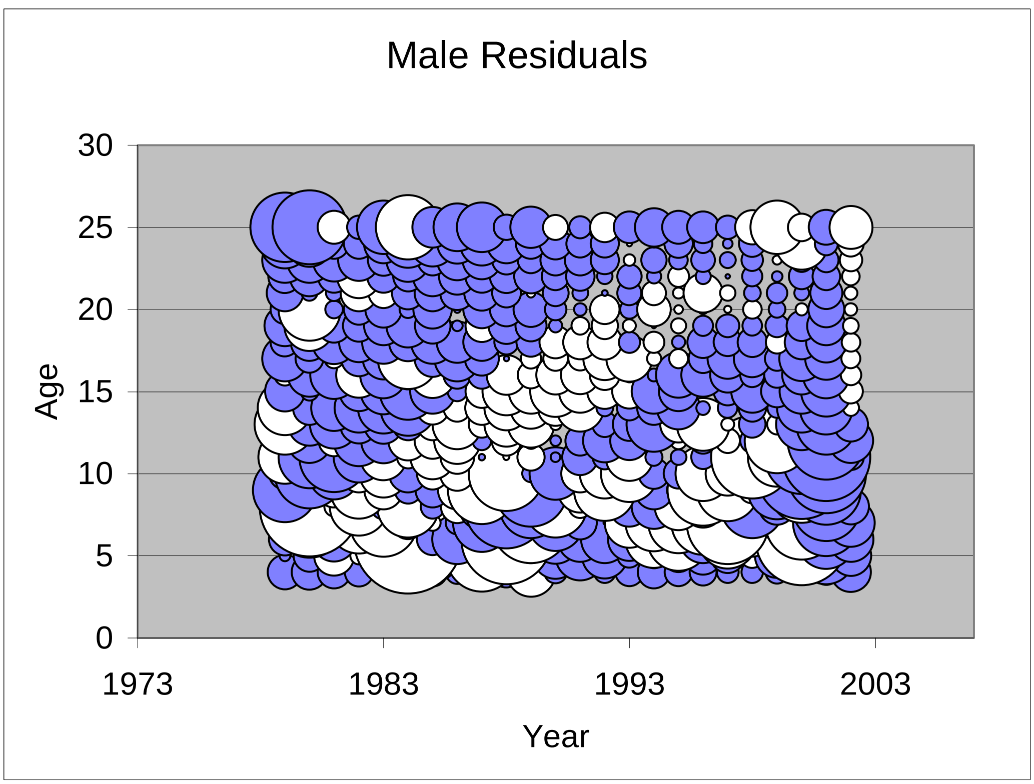


Figure 8 (Female) & Figure 9 (Male). (cont.) Eurkea/South Columbia area. YT2005 residual plots for proportions of catch at age. The filled circles have positive values and the open circles have negative values.

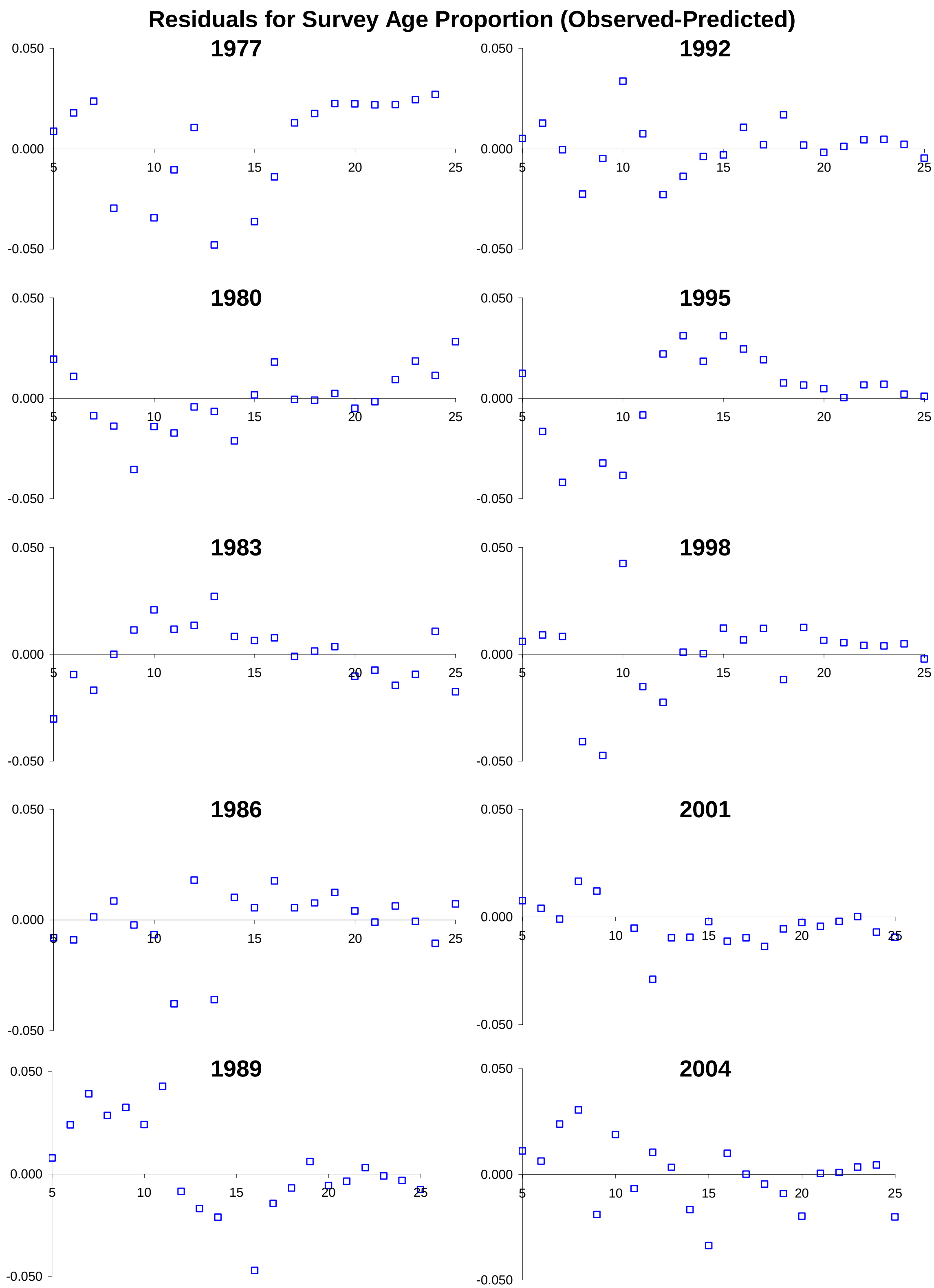


Figure 10. South Vancouver area. Residual plots for proportions of survey catch at age.

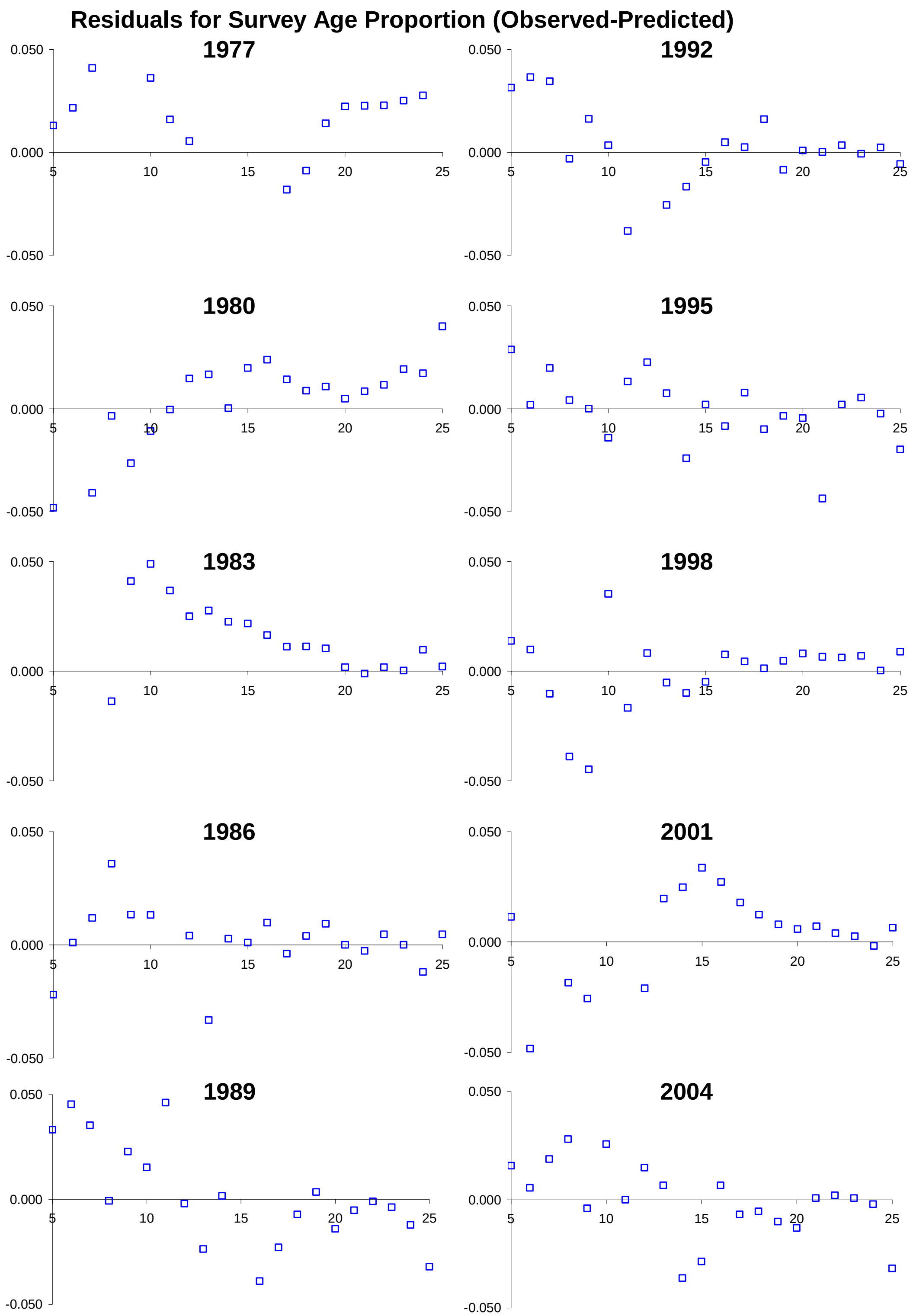


Figure 10. (cont.) North Columbia area. Residual plots for proportions of survey catch at age.

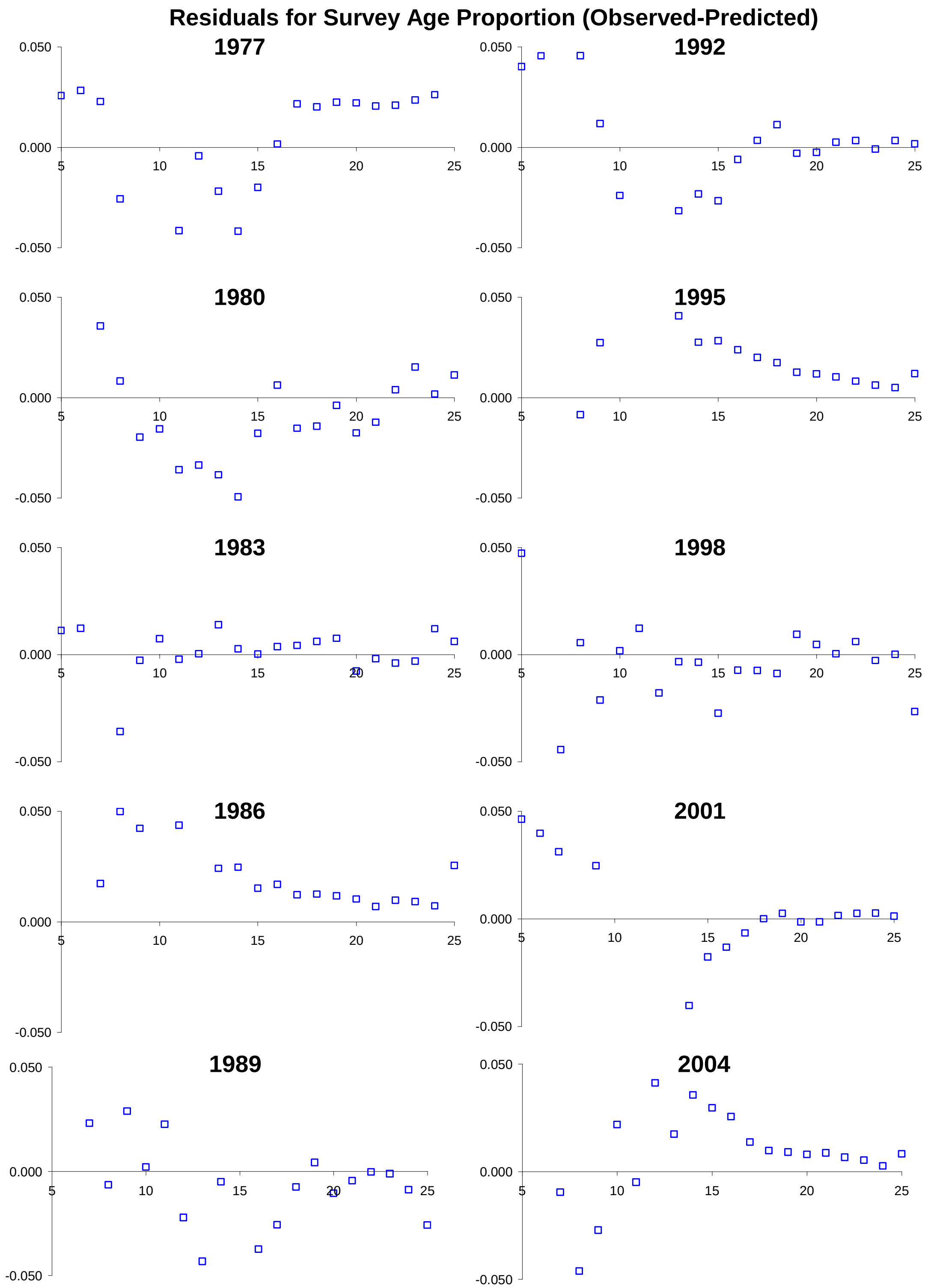


Figure 10. (cont.) Eurkea/South Columbia area. Residual plots for proportions of survey catch at age.

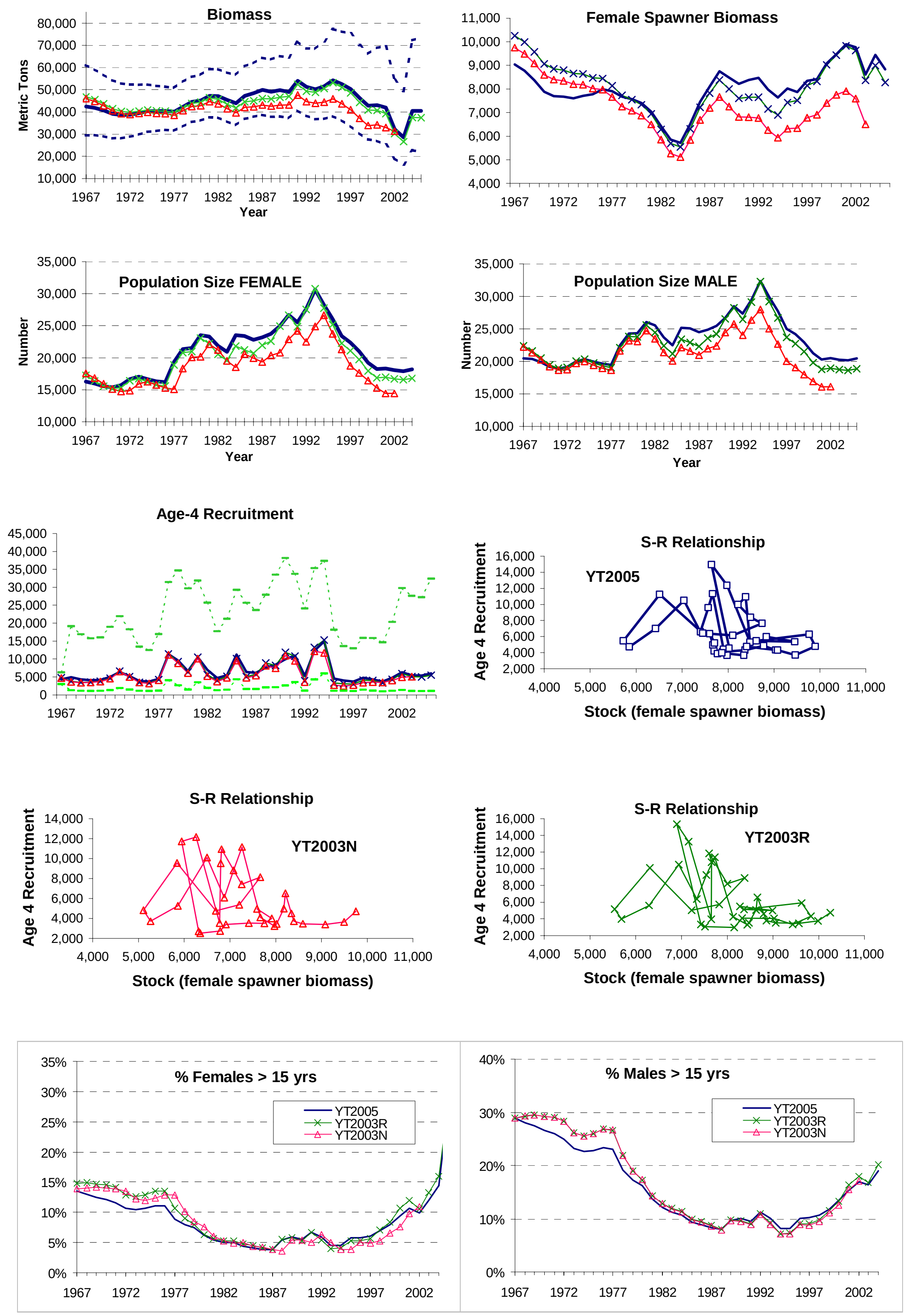


Figure 11. South Vancouver area. Estimated coast-wide biomass, population sizes, recruitment, stock-recruit relationship, and fraction of female and male older than 15 yrs using catch series YT5000, YT2003R, and YT2003N (See text for the definitions of these three catch series). The 95% confidence intervals for biomass and age-4 recruitment, estimated by using YT2005, are also provided.

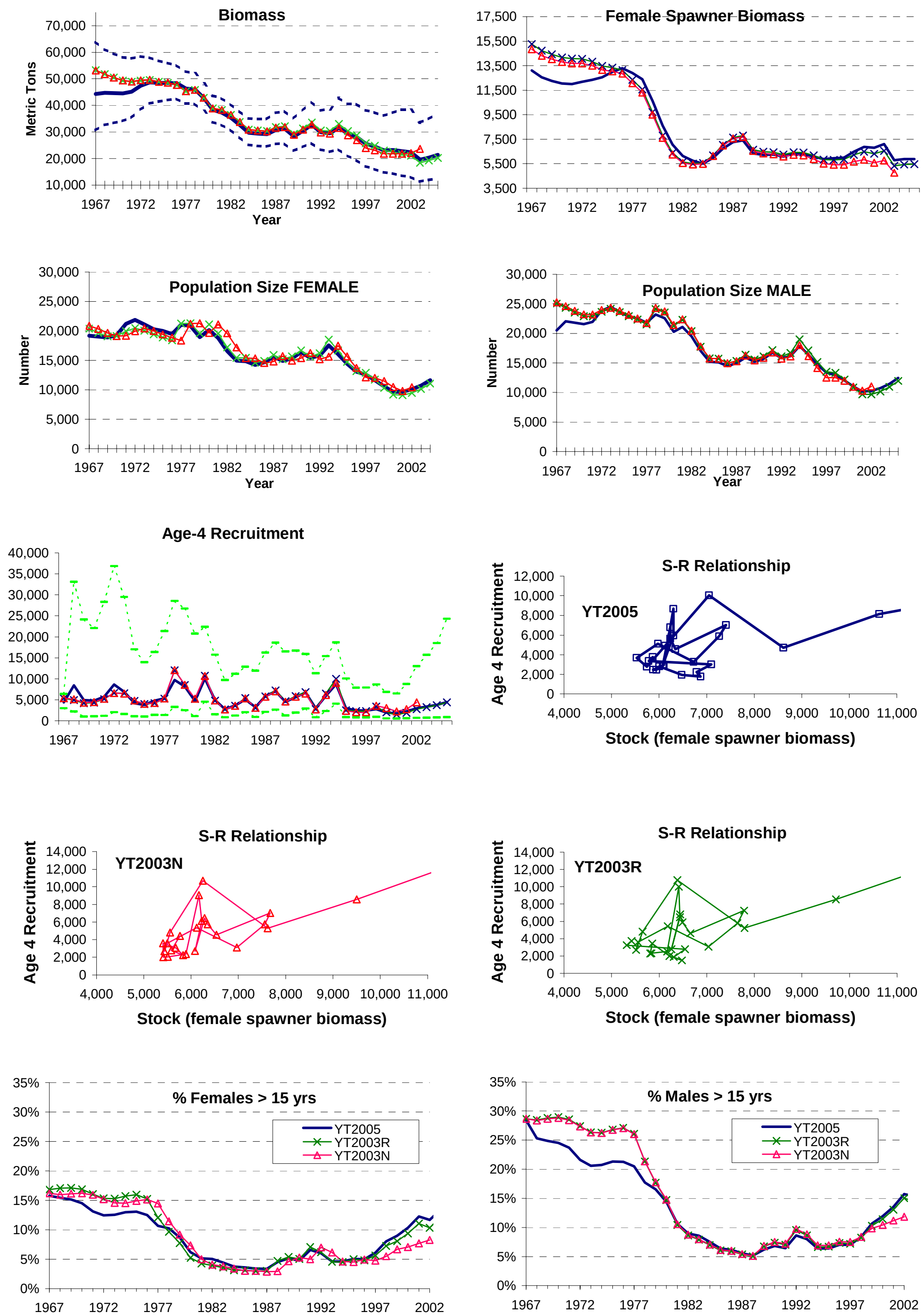


Figure 11. (cont.) North Columbia area. Estimated coast-wide biomass, population sizes, recruitment, stock-recruit relationship, and fraction of female and male older than 15 yrs using catch series YT5000, YT2003R, and YT2003N (See text for the definitions of these three catch series). The 95% confidence intervals for biomass and age-4 recruitment, estimated by using YT2005, are also provided.

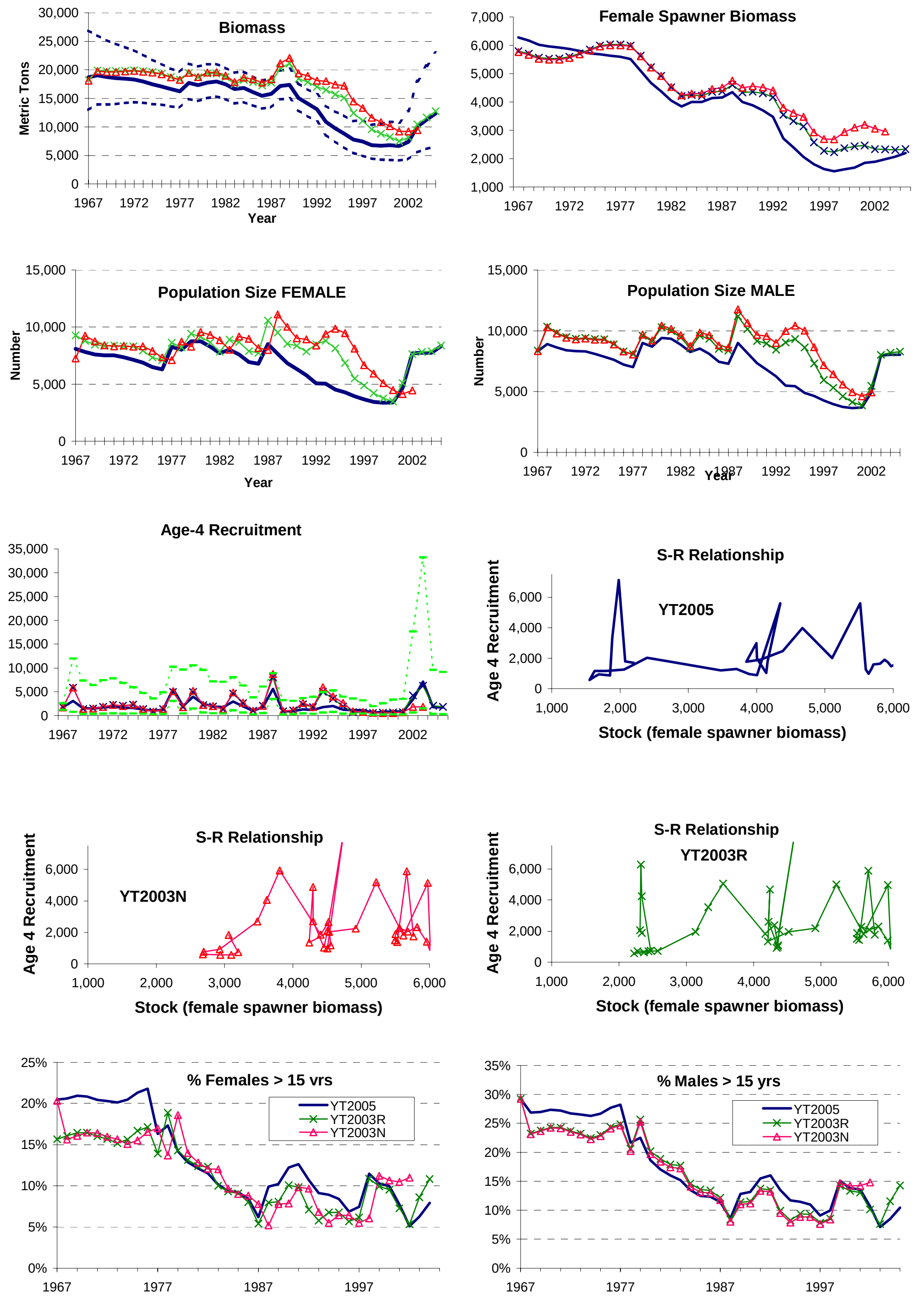


Figure 11. (cont.) Eurkea/South Columbia area. Estimated coast-wide biomass, population sizes, recruitment, stock-recruit relationship, and fraction of female and male older than 15 yrs using catch series YT5000, YT2003R, and YT2003N (See text for the definitions of these three catch series). The 95% confidence intervals for biomass and age-4 recruitment, estimated by using YT2005, are also provided.

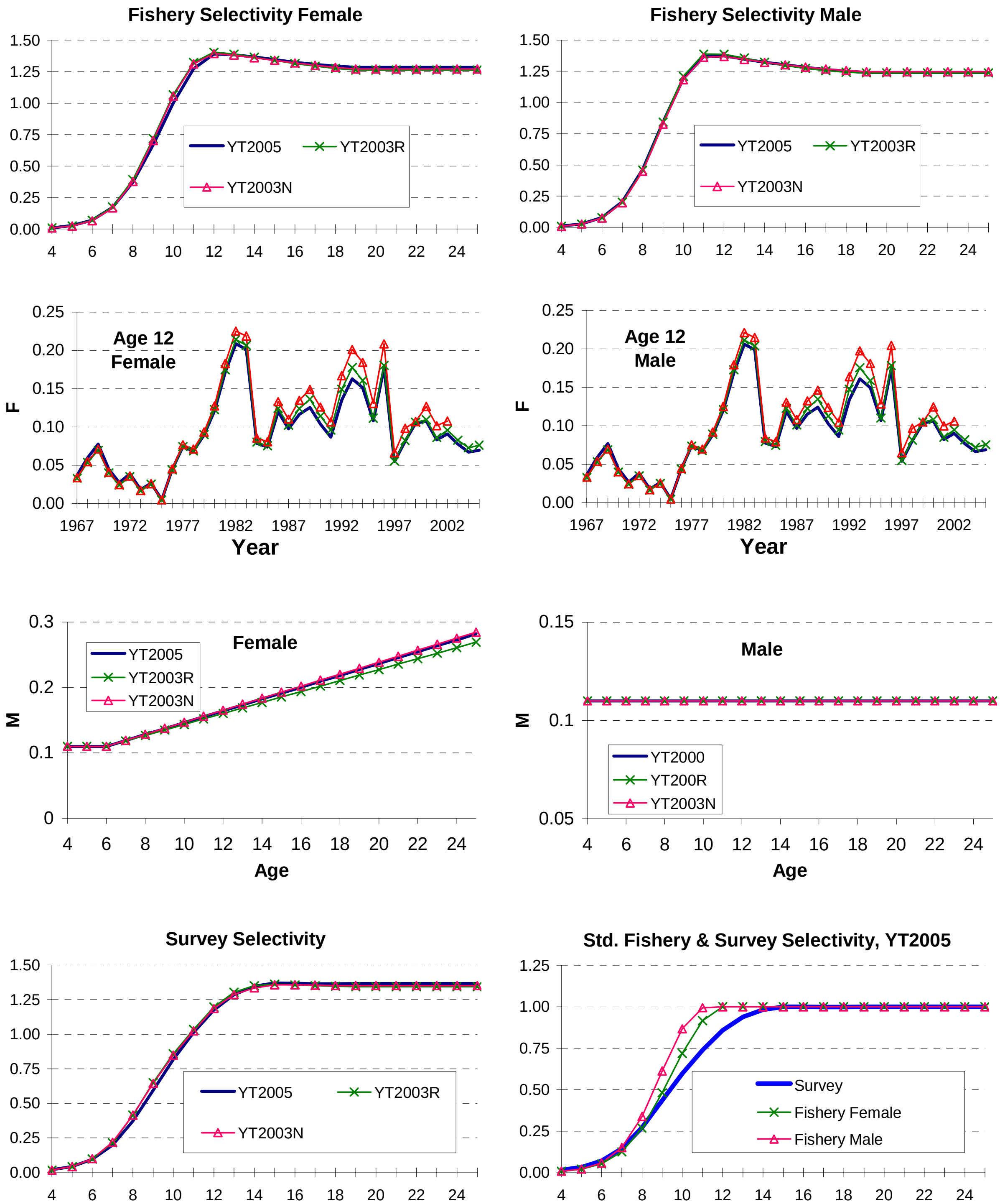
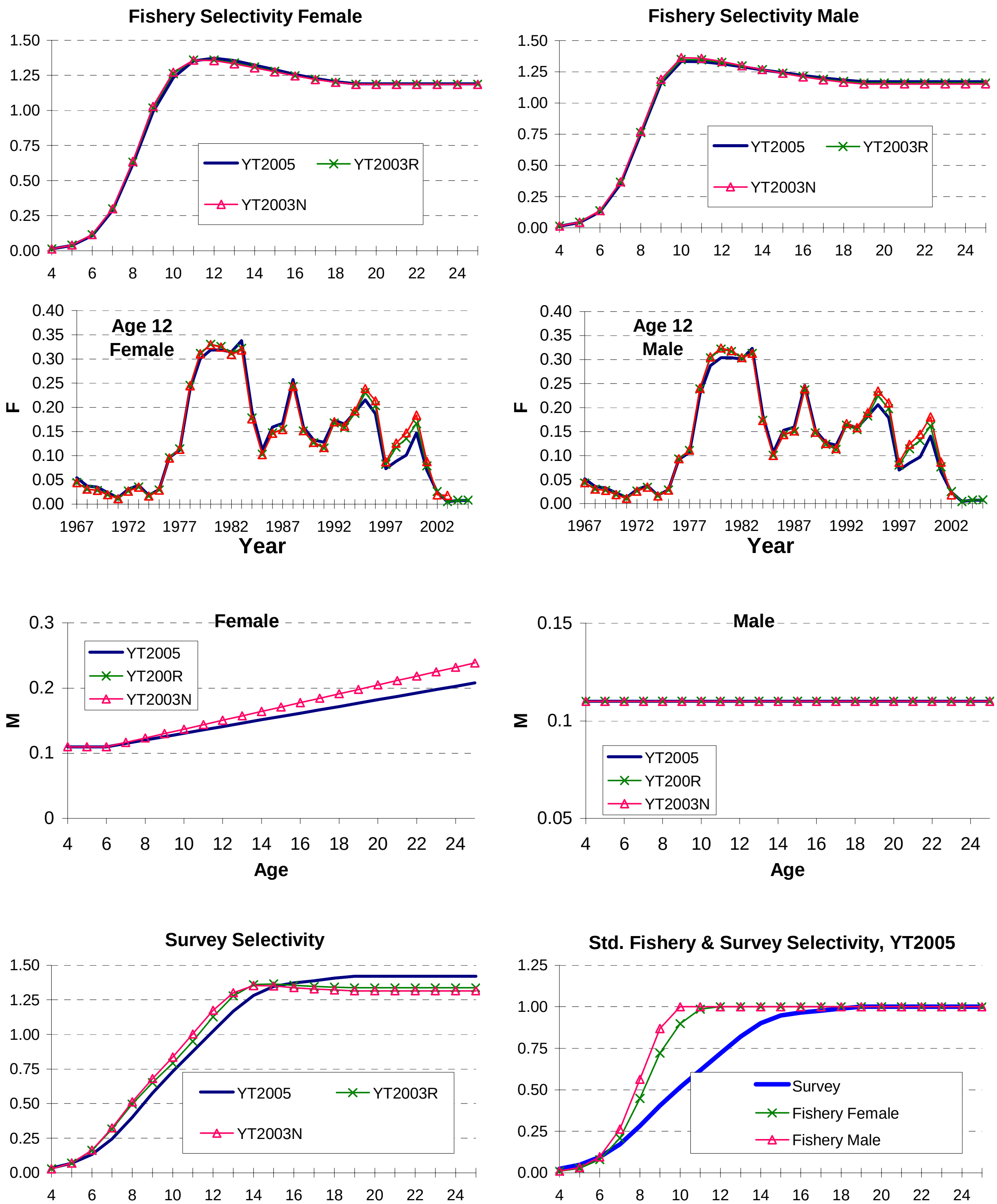


Figure 12. South Vancouver area. Estimated fishery selectivity, fishing mortality, natural mortality, survey selectivity, and the comparison of standardized (std.) fishery and survey selectivities for yellowtail rockfish using the three catch sereies YT2005, YT2003R, and YT2003N.



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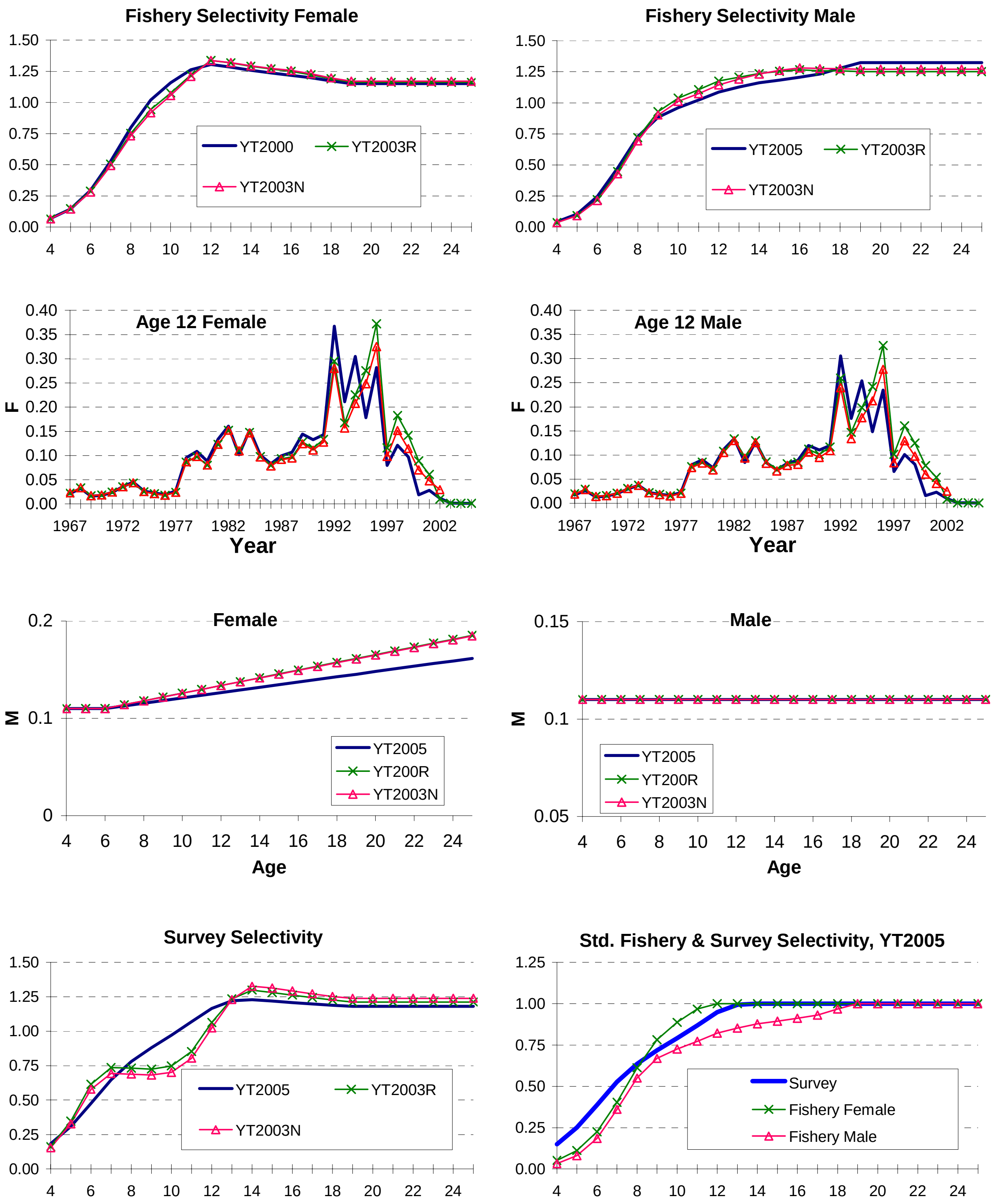


Figure 12. (cont.) Eurkea/South Columbia area. Estimated fishery selectivity, fishing mortality, natural mortality, survey selectivity, and the comparison of standardized (std.) fishery and survey selectivities for yellowtail rockfish using the three catch sereies YT2005, YT2003R, and YT2003N.

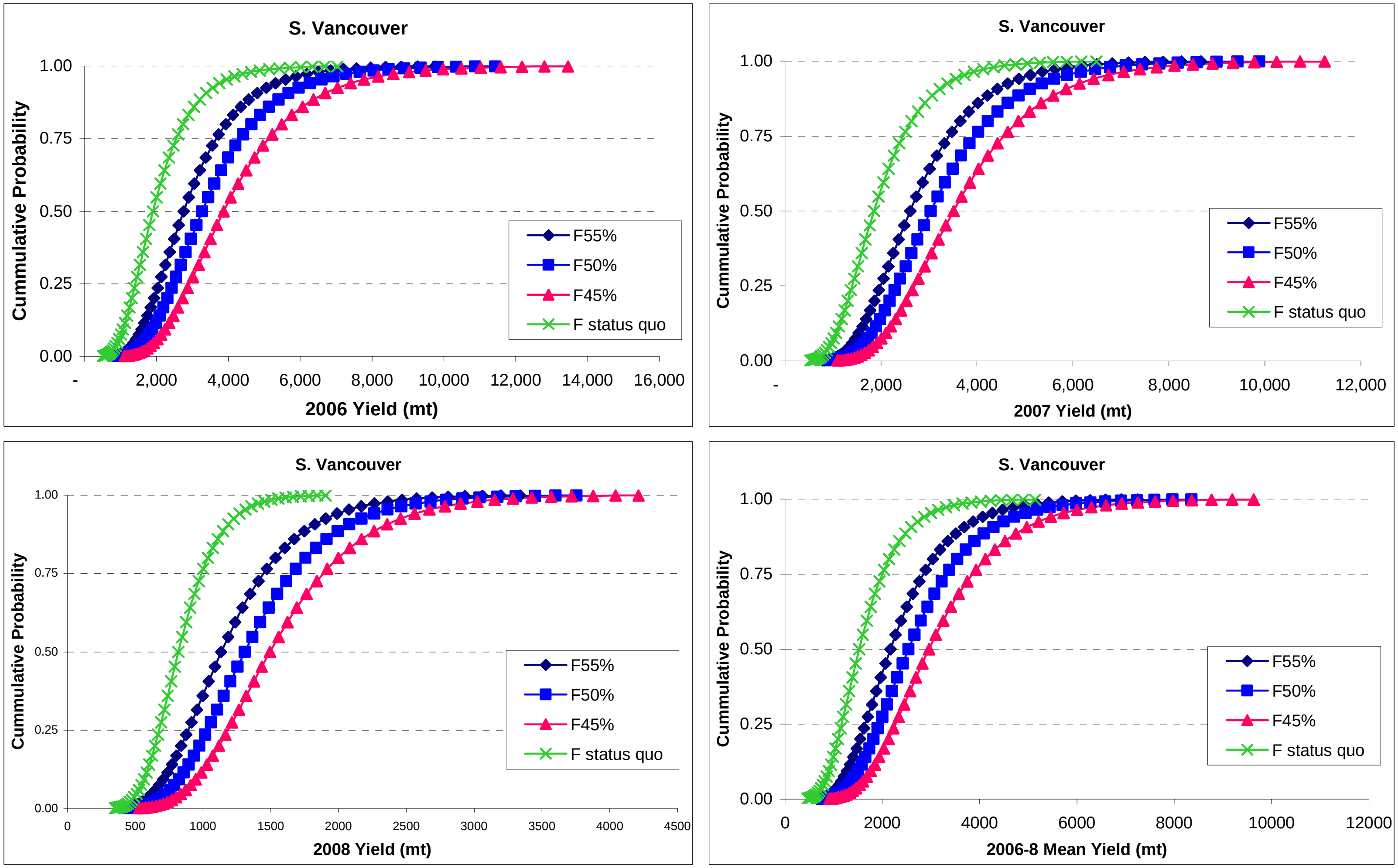


Figure 13. South Vancouver area. Cumulative probability distribution for the estimated yield at three selected levels of fishing mortality rate and at the 'status quo' which continues the actual yield seen in 2004. [Yield estimates based on the catch series YT2005. Point estimates for yield from the model are at the 50-percentile level.]

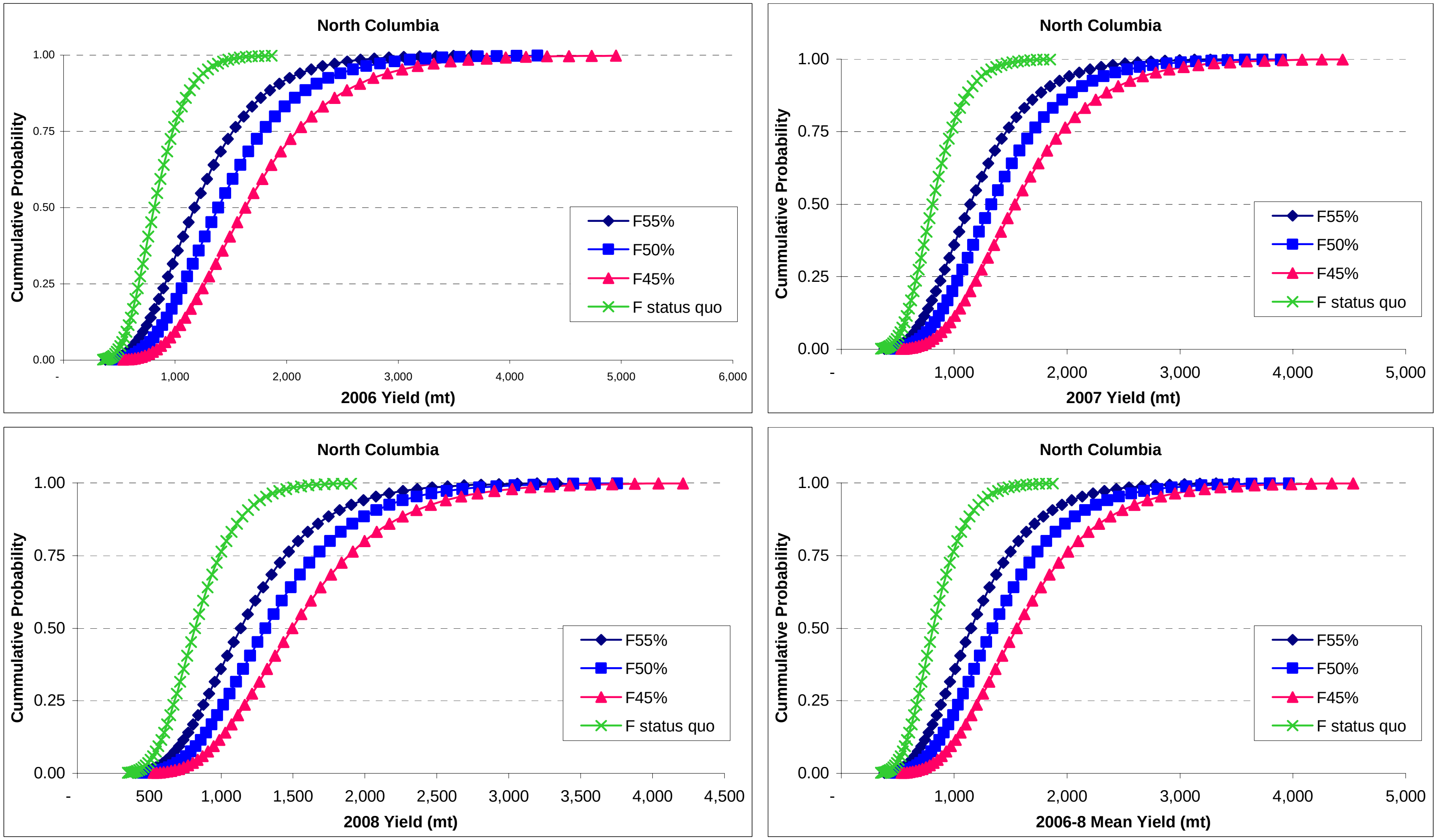


Figure 13. (cont.) North Columbia area. Cumulative probability distribution for the estimated yield at three selected levels of fishing mortality rate and at the 'status quo' which continues the actual yield seen in 2004. [Yield estimates based on the catch series YT2005. Point estimates for yield from the model are at the 50-percentile level.]

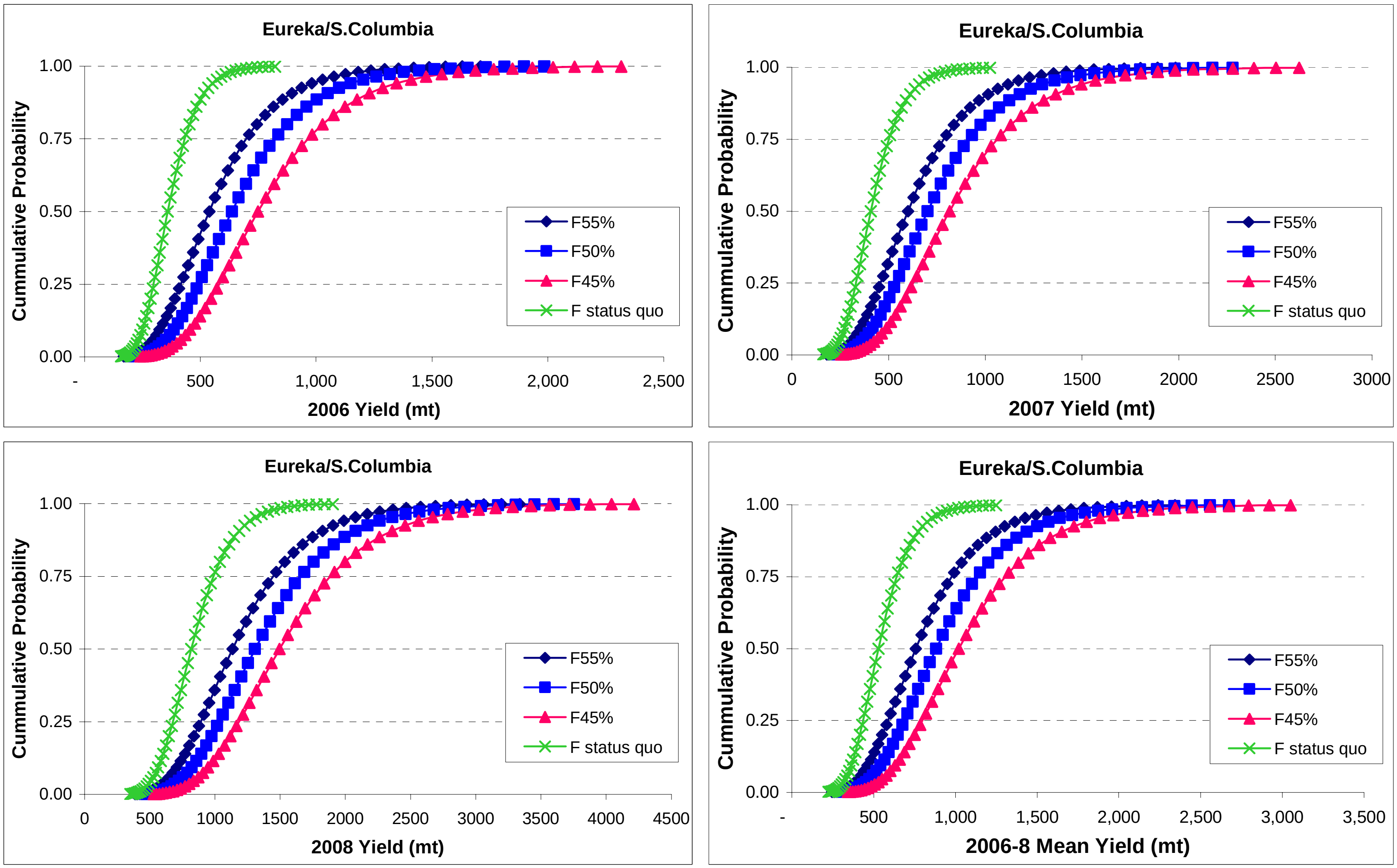


Figure 13. (cont.) Eurkea/South Columbia area. Cumulative probability distribution for the estimated yield at three selected levels of fishing mortality rate and at the 'status quo' which continues the actual yield seen in 2004. [Yield estimates based on the catch series YT2005. Point estimates for yield from the model are at the 50-percentile level.]

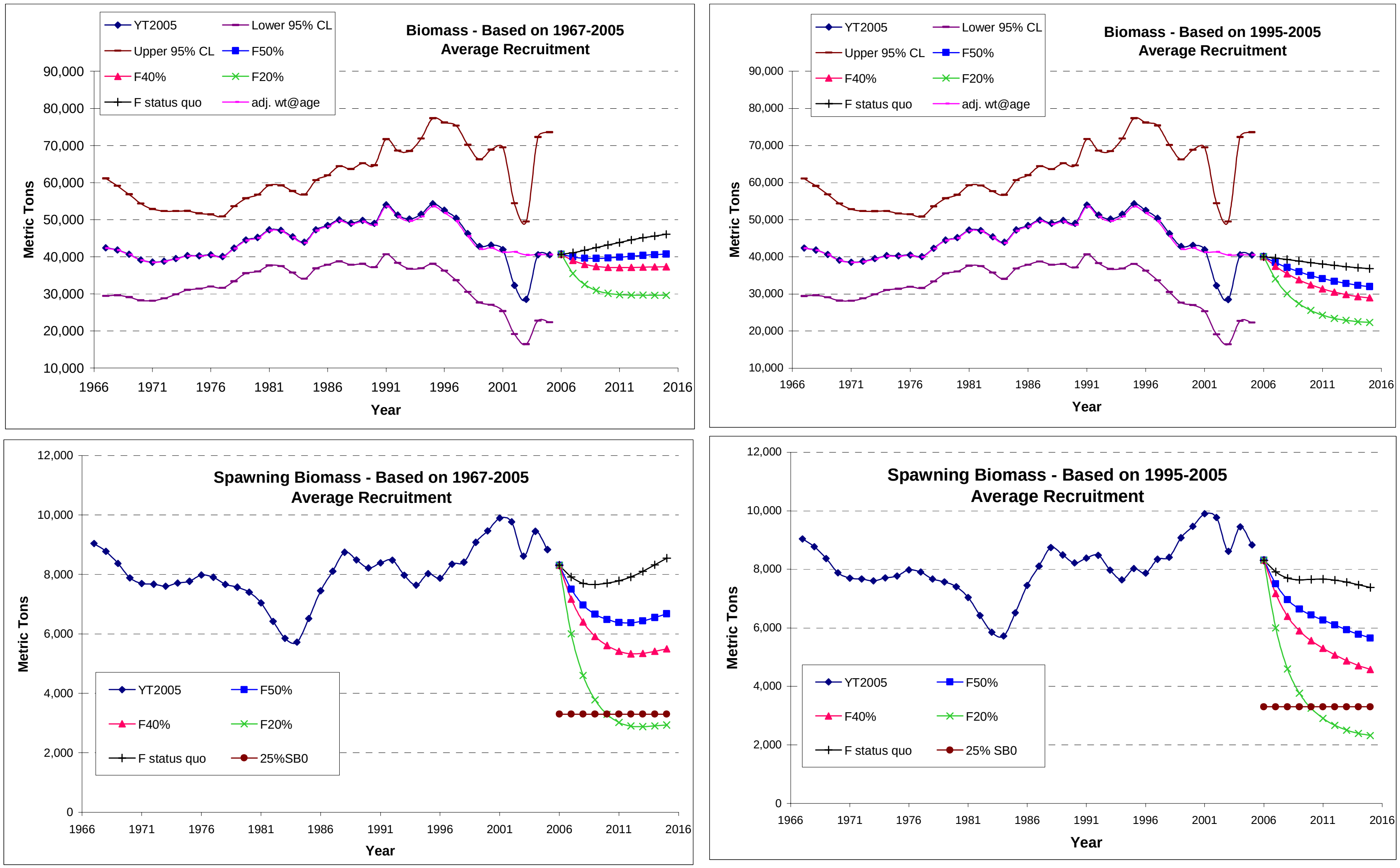


Figure 14. Vancouver area. The estimated total biomass and spawning biomass using YT2005. The 2005 values are estimated by assuming that 2005 landing and catch-at age is equal to 2004. The projections from 2006-2015 are based on the arithmetic mean age-4 recruitment in 1967-2005 (left-hand side) and 1995-2005 (right-hand side).

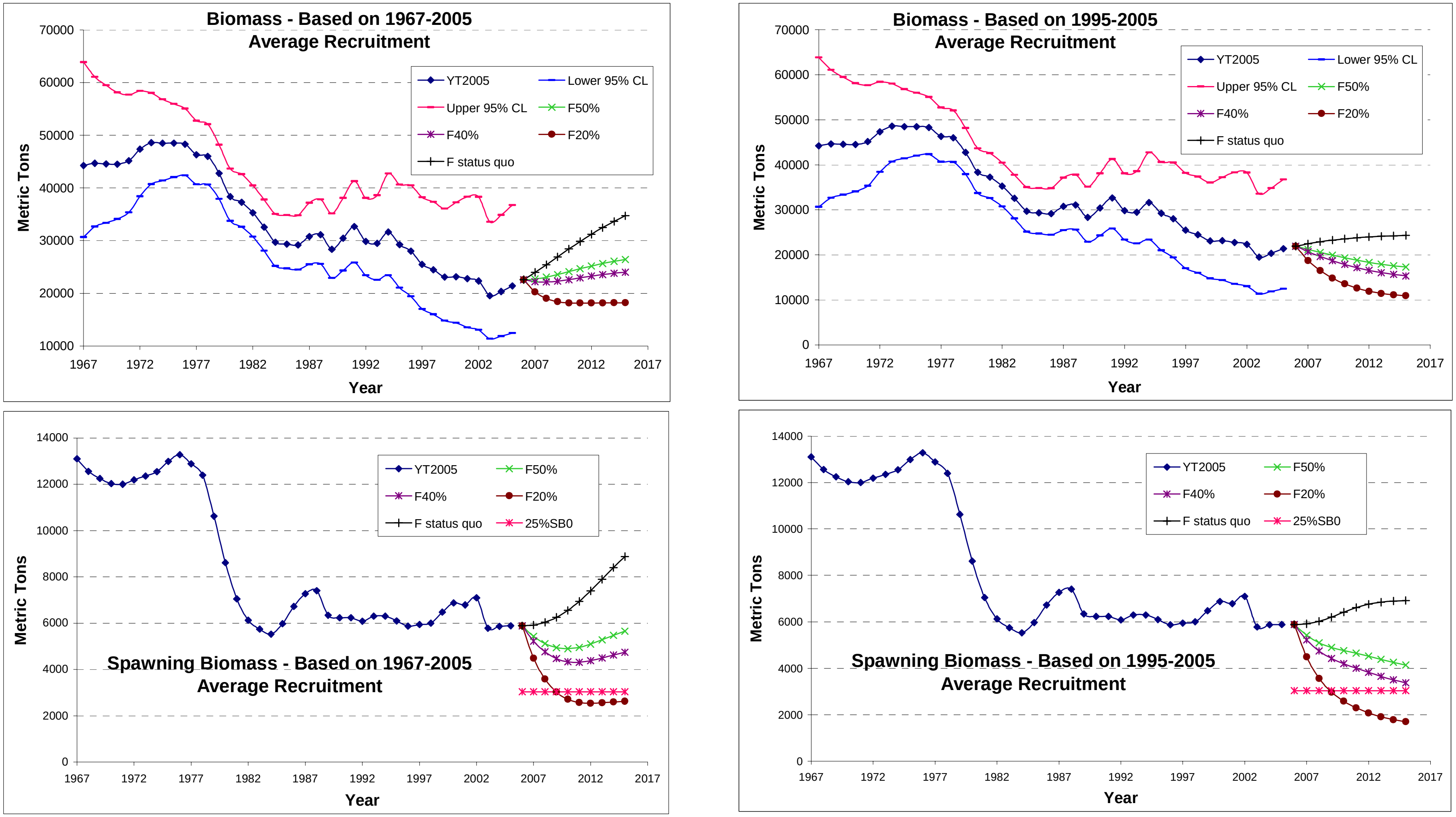
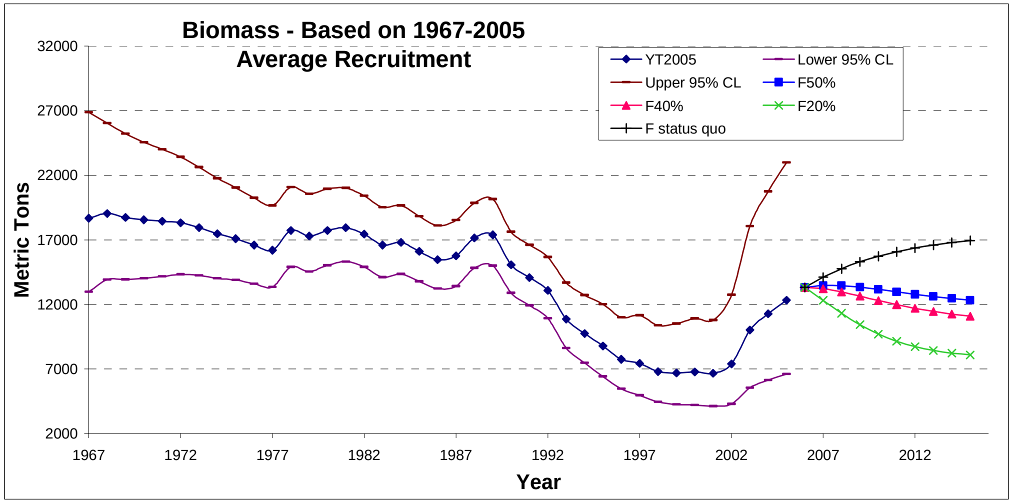


Figure 14. (cont.) North Columbia area. The estimated total biomass and spawning biomass using YT2005. The 2005 values are estimated by assuming that 2005 landing and catch-at age is equal to 2004. The projections from 2006-2015 are based on the arithmetic mean age-4 recruitment in 1967-2005 (left-hand side) and 1995-2005 (right-hand side).



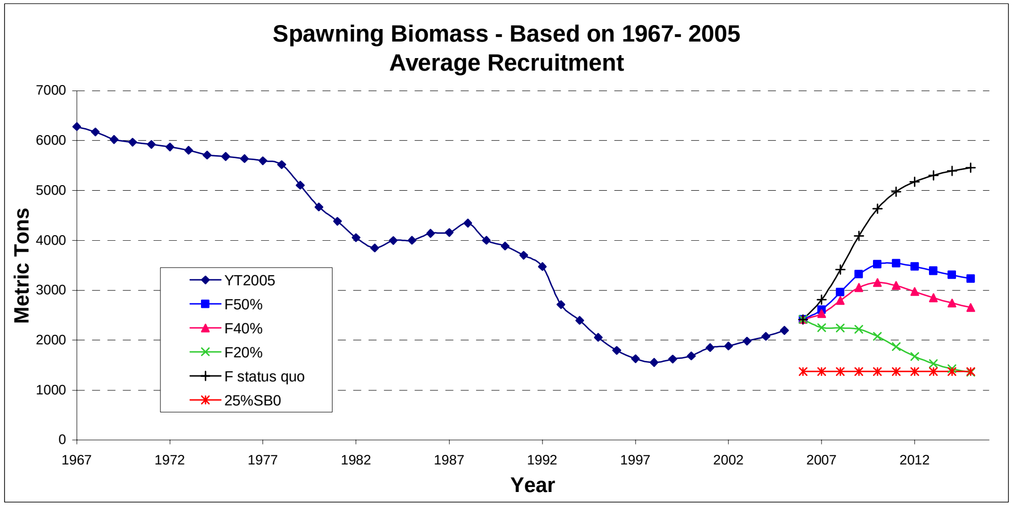
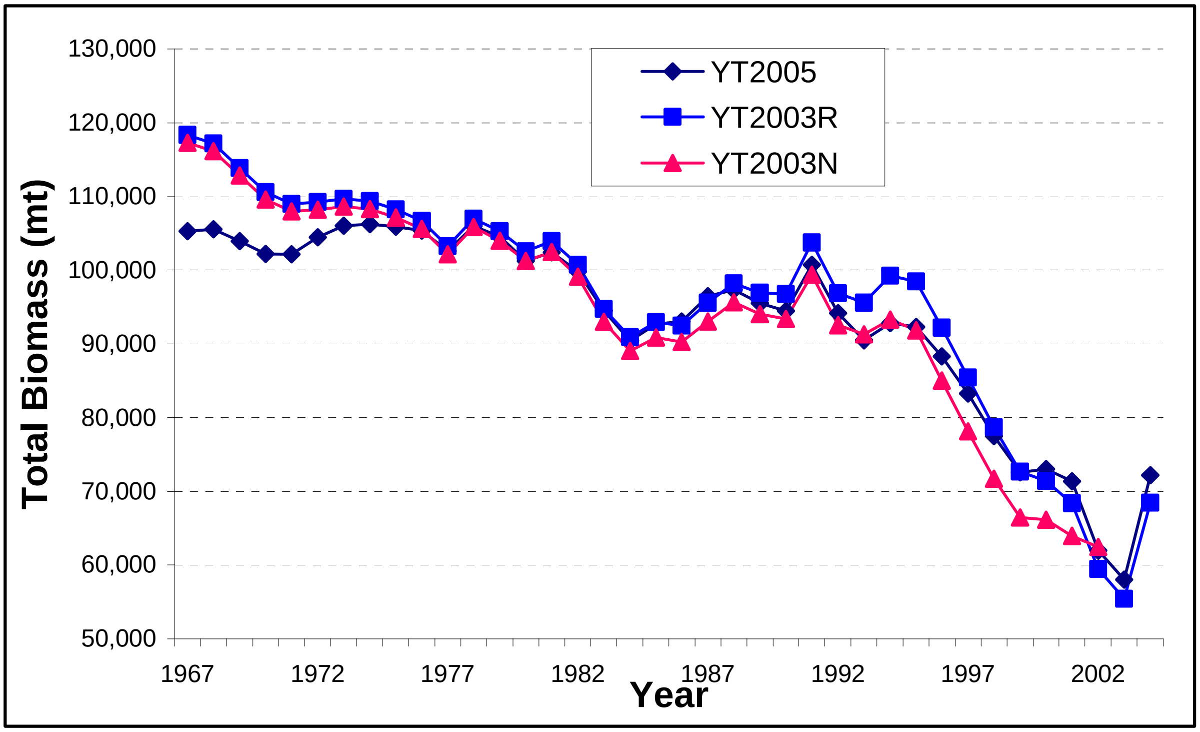


Figure 14. (cont.) Eurkea/South Columbia area. The estimated total biomass and spawning biomass using YT2005. The 2005 values are estimated by assuming that 2005 landing and catch-at age is equal to 2004. The projections for 2006-2015 are based on the arithmetic mean age-4 recruitment in 1967-2005. (The Star Panel recommended not showing the 1995-2005 estimates for the Eurkea/South Columbia area given the lack of data in this area for 2003 and 2004.)



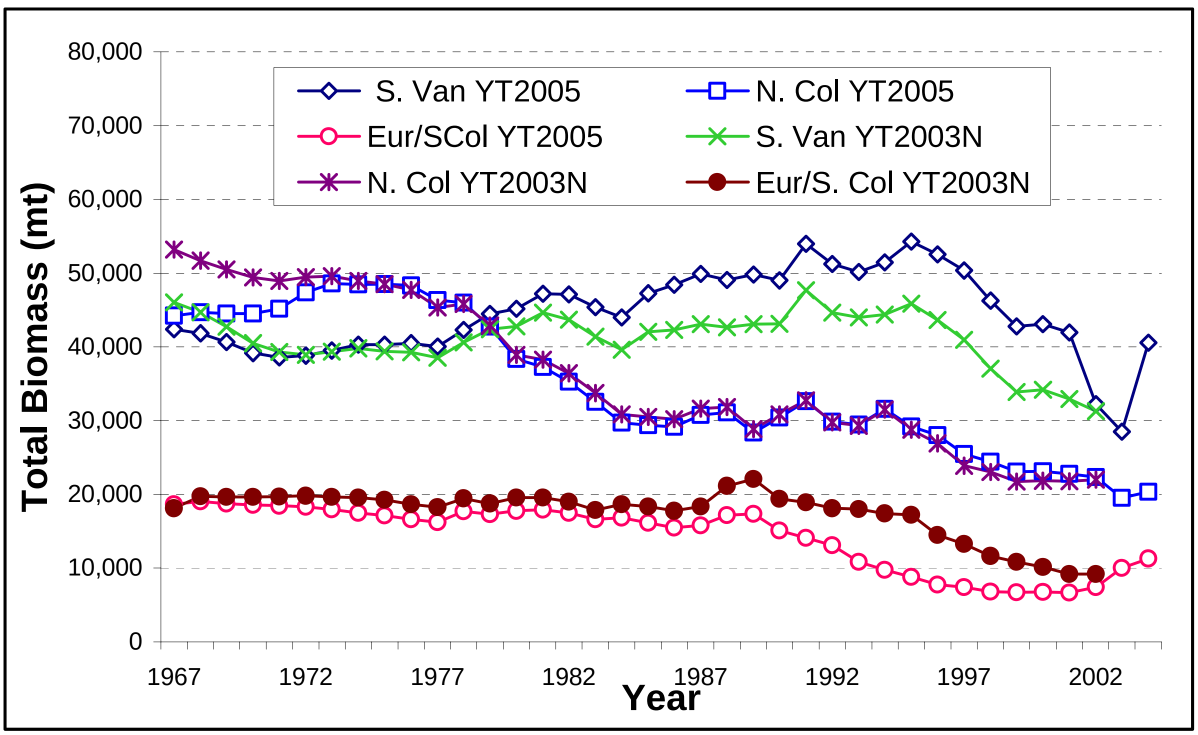
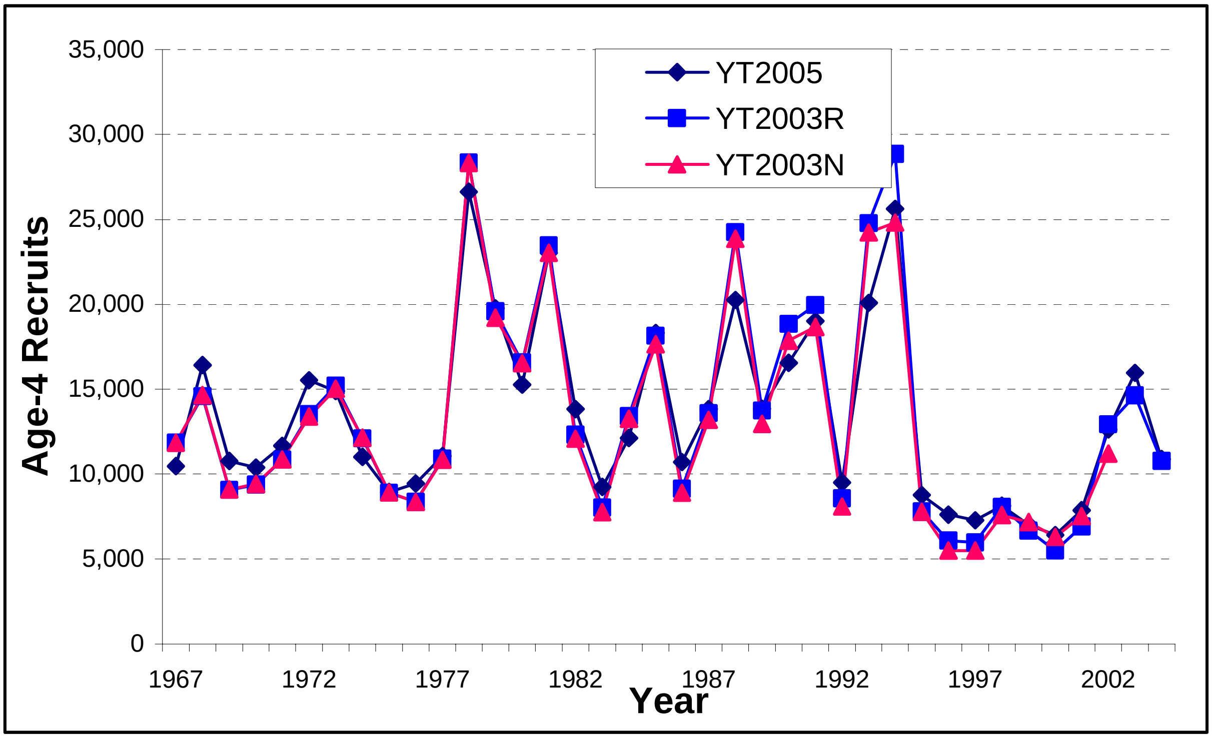


Figure 15. Comparisons of trends in total biomass for the three stocks combined biomass (upper panel) and of the three individual stock areas (lower panel) for the YT2005 and YT2003N catch series.



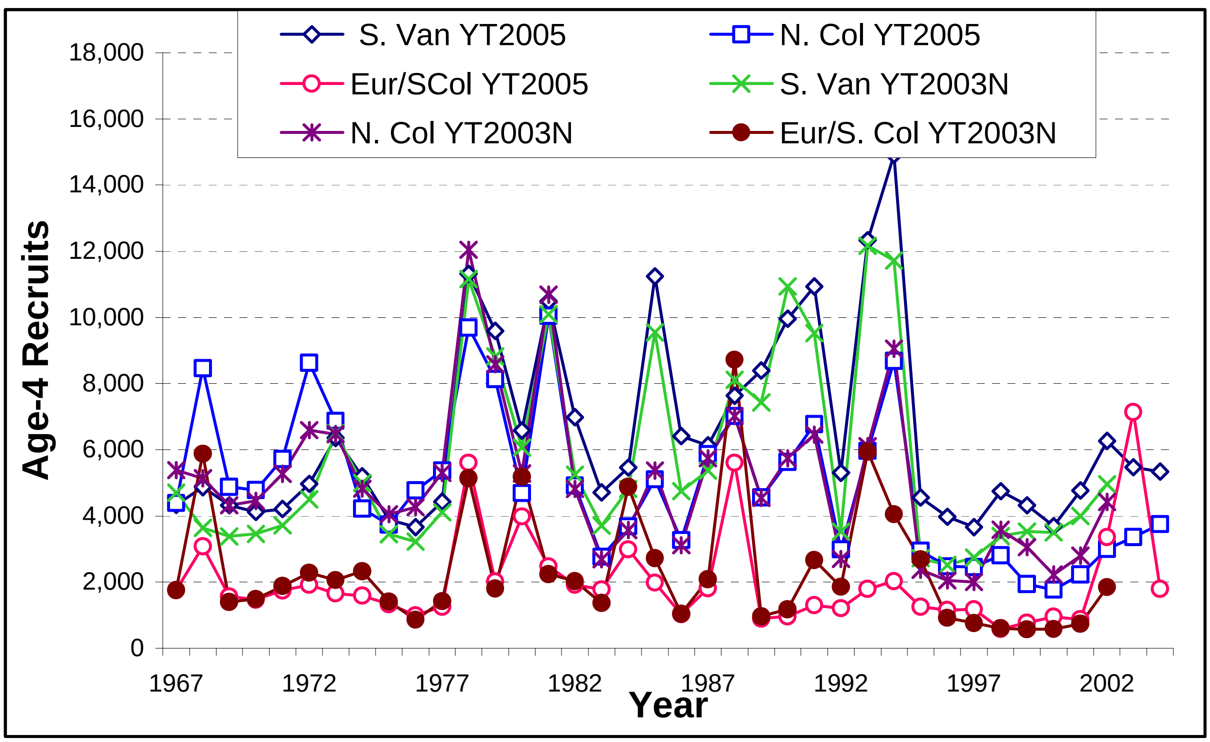


Figure 16. Comparisons of trends in age-4 recruits for the three stocks combined biomass (upper panel) and of the three individual stock areas (lower panel) for the YT2005 and YT2003N catch series.

Appendix A. Description of Model.

I. INPUT DATA

Items	Symbols/Values in Model	Variable Name in Program	Descriptions
Total Commercial Landings	$T_0 = 1967$	styr	Beginning year of catch data
	$T = 2003$	endyr	End year of catch data, assume equal catches in 2002 and 2003
	$A = 22$ (ages 4-25+)	nages	Number of age classes
	Y_i, for $i \in t^{com}$={1967,…,2002}	obs_catch_bio(styr,endyr)	Total commercial landings mt
NMFS Shelf Survey Indices	η^{srv} =9 survey years	nobs_srv	Number of survey years
	T^{srv}={1977, 1980, 1983, 1986, 1989, 1992 1995, 1998, 2001}	yrs_srv(1, nobs_srv)	Calendar years of survey
	I_i^{srv}	obs_srv(1, nobs_srv)	Survey indices
NMFS Shelf Survey Age Comp	a_i^{srv}	nsamples_srv(1, nobs_srv)	Hypothetic number of shelf survey age samples by year
	n_{ij}	obs_ac_srv(1, nobs_srv, 1,nages)	Number at age of the survey
Whiting Bycatch Indices	η^{whi} =22 years	nobs_whi	Number of years for whiting bycatch indices
	t^{whi}={1978,…,1999}	yrs_whi(1, nobs_whi)	Calendar year of whiting bycatch indices
	I_i^{whi}	obs_ac_whi(1, nobs_whi)	Whiting bycatch indices by year

Trawl Fishery CPUE	$\eta^{\log}$=12 years	nobs_log	Number of years for trawl CPUE
	T^{log}={1988-1999}	yrs_log(1,nobs_log)	Calendar year of trawl CPUE
	$I_i^{\log}$	obs_log(1,nobs_log)	Observed trawl CPUE
		obs_log_se(1,nobs_log)	Standard errors of trawl cpue
Fishery Catch at Age	T_o^{fish} =1977 (1979 for Eureka/ S. Columbia)	styr_fish	Beginning year of fishery catch at age data
	T^{fish} =2002 (2001 for Eureka/ S. Columbia)	endyr_fish	End year of fishery catch at age data
	a_i^{cat}, i $\in$ t^{fish}={1977,…,2002}	nsamples_fish(1, nobs_srv)	Hypothetic number of fishery age samples by year
	C_{kij}	obs_ac_fish(1,2,styr_fish, endyr_fish,1,nages)	Sex-specific (1:F, 2:M) catch at age data by year. All fisheries
Ageing Error Matrix	$E_{jj'}$	age_err(1,nages,1,nages)	Ageing error matrix: General matrix $E_{jj'}$ if use_age_err=1; $E_{jj'}=\boldsymbol{I}$ otherwise
Weight at age	W_{kij}	wt(1,2,styr,endyr,1,nages)	Sex- and year-specific weight at age (kg.)
Female Maturity at age	φ_j	maturity(styr_fish,endyr_fish)	Female maturity at age.

II. INPUT CONTROL VARIABLES FOR MODEL

Items	Symbols/Values in Model	Variable Name in Program	Descriptions
Catchability for Indices	-5	ph_q_dev_srv	Constant survey q
	5	ph_q_dev_whi	whiting bycatch q changes are estimated
	5	ph_q_dev_log	trawl CPUE q changes are estimated
Selectivity for Fishery and Survey	4	ph_sel_coffs	Fishery selectivity changes over ages but smoothed
	-2	ph_sel_log	Fishery selectivity is not a logistic curve
	2	ph_sel_srv	survey selectivity is estimated at 2nd stage of model fitting
Absolute Survey Catchability	4	ph_q	Absolute survey q means q can be > 1.
Natural Mortality for Old Ages	6	ph_M_old	M for old ages is estimated
Variance for Trawl Indices	4	ph_sigmau	Variance for trawl CPUE is estimated
Ageing Errors	1	use_age_err	use real ageing error (not **I**)
Age for Dome-shape selectivity	$a^{dec} = 5$	age_decrease	Age beyond which to panelized dome-shape selectivity
Age for Asymptotic selectivty	$a^{max} =16$	sel_max_age	Age beyond which selectivity is constant

Adjusted Ratio of Historical F	F^{hist}=0.1	Hist_F	Ratio between pre-T_o F and F at T_o
Weighting Factors	λg; $1 \leq g \leq 20$	lambda(1,20)	See belows and likelihoods. Note: λg; $17 \leq g \leq 20$ were not used
Lambda 1 rec regularity (how much rec tends to mean (log) value)	0.5	s.d. ≈ 1.00	under normality assumptions.
Lambda 2, Fishery non-decreasing selectivity (Higher->more asymptotic)	100	s.d. ≈ 0.07	s.d. ≈ sqrt(1/2lambda)
Lambda 3 Penalty on fitting observed catch biomass	200	s.d. ≈ 0.05	
Lambda 4 Between sex difference in selectivity	0.001	s.d. ≈ 22.36	
Lambda 5 Selectivity curvature females	12.5	s.d. ≈ 0.20	
Lambda 6 Selectivity curvature males	12.5	s.d. ≈ 0.20	
Lambda 7 Survey Selectivity curvature survey combined sexes	12	s.d. ≈ 0.20	
Lambda 8 Survey non-decreasing selectivity (Higher->more asymptotic)	100	s.d. ≈ 0.07	
Lambda 9 Survey index	1.653	s.d. ≈ 0.55	
Lambda 10 Whiting Index	12.5	s.d. ≈ 0.20	
Lambda 11 Logbook CPUE (defunct, estimated internally)	1	s.d. ≈ 0.71	
Lambda 12 Penalty on Fmort deviations	0.1	s.d. ≈ 2.24	
Lambda 13 Prior variance on change in survey catchability	100	s.d. ≈ 0.16	**never used, because ph_q_dev_srv = -5.**

Lambda 14 Prior variance on change in Whiting Bycatch catchability	19.531	s.d. ≈ 0.40	
Lambda 15 Prior variance on change in Logbook CPUE catchability	19.531	s.d. ≈ 0.40	
Lambda 16 weight on Survey Age Comp (small if no survey)	1	s.d. ≈ 0.71	
Lambda 17, not used	1	s.d. ≈ 0.71	
Lambda 18, not used	1	s.d. ≈ 0.71	
Lambda 19, not used	1	s.d. ≈ 0.71	
Lambda 20, not used	1	s.d. ≈ 0.71	

III. ASSIGNED OR CALCULATED VARIABLES

Items	Symbols/Values	Variable Name in Program	Descriptions
Year Starts to Change q	$t_2^{srv} = t_1^{srv} + 1 = 1978$	styr_q	Surveys, if (ph_q_dev_srv)
	$t_2^{whi} = t_1^{whi} + 1 = 1979$	styr_q_whi	Whiting bycatch, if (ph_q_dev_whi)
	$t_2^{\log} = t_1^{\log} + 1 = 1988$	styr_q_log	Trawl CPUE, if(ph_q_dev_log)
Projection beyond endyr	$\eta^{fut} = 12$	nyrs_future	project 12 yrs beyond endyr
	$T^{fut} = T + \eta^{fut} = 2015$	endyr_fut	The last year of projection

	$t_1^{fut} = T + 1 = 2004$	styr_future	The first year of projection, assume equal catch in 2003 and 2003
	3	nFs	3 F-levels in projection (F55%, F50%, F45%)
Variance for Trawl Indices	$\sigma^2 = 0.27$	sigmau	0.27 is default. estimated σ^2 because ph_sigmau > 0,
Time of survey in the year	=8.5/12	yr_fraction	Fraction of date in a year when NMFS Shelf survey occurs
Annual Sex Ratios (female) of Landings	$r_i = \sum_j C_{1ij} \Big/ \sum_{k,j} C_{kij}$, for i ∈ t^{fish}	obs_sexr(styr_fish,endyr_fish)	sex: k = 1, 2 yr: i = styr_fish, ... , endyr_fish age: j = 1, nages
Proportion of Survey Age Composition	$\pi_{ij} = n_{ij} \Big/ \sum_j n_{ij}$, for i ∈ t^{srv}	obs_p_srv(1,nobs_srv,1,nages)	
Sex-specific Proportion of Catch at Age in entire (both sex) catch	$p_{kij} = C_{kij} \Big/ \sum_{k,j} C_{kij}$, for i ∈ t^{fish}	obs_p(1,2, styr_fish,endyr_fish, 1,nages)	

IV. SELECTIVITY

Items	Symbols/Values	Variable Name in Program	Descriptions
Dome-shaped Fishery Selectivity if(ph_sel_coffs)	s_{kj}	sel(1,2,1,nages)	Sex and age specific. It has mean value of 1 (NOT max.=1) because $\overline{F}_i$ is read as the year-specific average F across ages, which is NOT fully recruited F. There are 2 constraints imposed inside of LIKELIHOODs to penalize curvature and smoothness over consecutive ages.
	$\tilde{s}_{kj}$, j=1,...,sel_max_age	sel_coffs(1,sel_max_age, ph_sel_coffs)	
	$\ln(s_{kj}) = \tilde{s}_{kj}$, if $j <$ sel_max_age $\ln(s_{kj}) = \tilde{s}_{k\text{sel\_max\_age}}$, if $j \geq$ sel_max_age $\ln(s_{kj}) = \ln(s_{kj}) - \ln\left(\sum_j s_{kj} \Big/ nages\right)$	log_sel(k,j)	
Logistic Fishery Selectivity if ph_sel_coffs ≤ 0 and ph_sel_coffs_log > 0	$s_{kj} = 1/\left(1+\exp\left(-\alpha_k\,(j-\beta_k)\right)\right)$	sel(1,2,1,nages)	sex-specific logistic curve α_k: slope of ascending lobe β_k: age at 50% selectivity
Dome-shaped Survey selectivity when model fistting is at the stage of ph_sel_srv	v_j	sel_srv(1,nages)	Similar to Dome-shaped Fishery Selectivity if ph_sel_coffs > 0
	$\tilde{v}_j$, j=1,...,sel_max_age	sel_coffs_srv(1,sel_max_age, ph_sel_srv)	

	$\ln(v_j) = \tilde{v}_j$, if $j <$ sel_max_age $\ln(v_j) = \tilde{v}_{\text{sel\_max\_age}}$, if $j \geq$ sel_max_age $\ln(v_j) = \ln(v_j) - \ln\left(\sum_j v_j \Big/ nages\right)$	log_sel_srv(j)	

V. MORTALITY

Items	Symbols/Values	Variable Name in Program	Descriptions
Natural Mortality	$M_k = 0.11$ (default)	M(k)	If NOT(ph_M_old), constant M
	$\tilde{M}$	M_old(ph_M_old)	M for age 25+ female
	Male: $m_{2j} = M_2$=0.11 for all ages **Female:** if NOT(ph_M_old), $m_{1j} = M_1$ if ACTIVE(ph_M_old), $m_{1j} = M_1$, for j=ages 4, 5, 6 $m_{1j} = m_{1j-1} + (\tilde{M} - M_1)/19$, for j $\geq$ age 7	nat_mort(1,2,1,nages)	Male: age-invariant Female: If NOT(ph_M_old), constant for all ages Otherwise, constant for ages 4,5,6 and then increased by the amount of $(\tilde{M} - M_1)/19$ per age
Fully selective Fishing Mortality	$F_i = \exp(\overline{F} + dF_i)$	fmort(styr,endyr)	$\overline{F}, dF_i$ to be estimated. $\overline{F}_i$ is year-specific average F across ages (This is NOT fully

		avg_F fmort_dev(styr,endyr)	recruited F)
Age-specific F, Z, S	$F_{kij} = s_{kj} F_i$	F(1,2, styr,endyr,1,nages)	Fishing mortality
	$Z_{kij} = F_{kij} + m_{kj}$	Z(1,2, styr,endyr,1,nages)	Total mortality
	$S_{kij} = \exp(-Z_{kij})$	S(1,2, styr,endyr,1,nages)	Survival rate

VI. CATCHABILITY

Items	Symbols/Values	Variable Name in Program	Descriptions
Mean q's for three types of indices	q^{srv}	log_q_srv	Mean survey q, To be estimated
	q^{whi}	log_q_whi	Mean whiting bycatch q, To be estimated
	$q^{\log}$	log_q_log	Mean trawl CPUE q, To be estimated
Constant q	$q_i^{srv} = \exp(q^{srv})$	catchab_srv(yrs_srv(1))	survey q in year i
	$q_i^{whi} = \exp(q^{whi})$	catchab_whi(yrs_whi(1))	Whiting bycatch q in year i
	$q_i^{\log} = \exp(q^{\log})$	catchab_log(yrs_log(1))	Trawl cpue q in year i
Year-specific q	$q_i^{srv} = q_{i-1}^{srv} * \exp(\Delta q_i^{srv})$	catchab_srv(yrs_srv(i)) q_dev_srv(i)	Δq_i^{srv} to be estimated

	$q_i^{whi} = q_{i-1}^{whi} * \exp(\Delta q_i^{whi})$	catchab_whi(yrs_whi(i)) q_dev_whi(i)	Δq_i^{whi} to be estimated
	$q_i^{\log} = q_{i-1}^{\log} * \exp(\Delta q_i^{\log})$	catchab_log(yrs_log(i)) q_dev_log(i)	$\Delta q_i^{\log}$ to be estimated

VII. RECRUITMENT

Items	Symbols/Values	Variable Name in Program	Descriptions
Mean log-scaled Recruits	$\overline{R}$	Mean_log_rec	To be estimated
Annual deviation on log-scaled Recruit, styr $\leq$ t $\leq$ endyr	ΔR_i	rec_dev(i)	To be estimated
Recruits	$N_{1,i,1} = \exp(\overline{R} + \Delta R_i)$	natage(1,i,1)	Females
	$N_{2,i,1} = N_{2,i,1}$	natage(2,i,1)	Males, assume sex ratio 1:1

VIII. POPULATION DYNAMICS

Items	Symbols/Values	Variable Name in Program	Descriptions
Initial year (styr)	$N_{k,T_0,j} = N_{k,T_0,j-1} \exp(-F_{k,T_0,j-1} F^{hist} - m_{k,j-1})$	natage(k,styr,j), j<A	Number at age Assume steady state at T_0

	$N_{k,T_0,A} = \dfrac{N_{k,T_0,A-1}\exp(-F_{k,T_0,j-1}F^{hist} - m_{k,A})}{1-\exp(-F_{k,T_0,j-1}F^{hist} - m_{k,A})}$	natage(k,styr,A)	Last age is plus
The following years	$N_{ktj} = N_{k,t-1,j-1}S_{k,t-1,j-1}$	natage(k,t,j), 2≤j<A	Number at age
	$N_{kiA} = N_{k,i-1,A-1}S_{k,i-1,A-1} + N_{k,i-1,A}S_{k,i-1,A}$	natage(k,i,A)	Last age is plus
Exploitable stock	$n_{k,i,j} = N_{kij}s_{kj}$	popn(k,i,j)	s_{kj} fishery selectivity
Predicted catch_at_age	$\hat{C}_{k,i,j} = \dfrac{N_{kij}F_{kij}(1-S_{kij})}{Z_{kij}}$	catage(k,i,j)	Baranov catch equation
Predicted annual catch in weight	$\hat{Y}_i = \sum_{k,j}\hat{C}_{kij}W_{kij}$	Pred_catch_bio(i)	
Predicted Sex-specific Proportion of Catch at Age in entire (both sex) catch	$\hat{p}_{kij} = \dfrac{s_{kj}N_{kij}}{n_{1ij}+n_{2ij}}E_{jj}$	pred_p(k,i,j)	
Available stock at survey time	$n_{kij}^{srv} = v_j S_{kij}^{8.5/12}N_{kij}$	eac_srv(k,i,j)	
Predicted NMFS shelf survey indices	$\hat{I}_{kij}^{srv} = q_i^{srv}\hat{n}_{kij}^{srv}W_{kij}$	pred_srv(k,i,j)	
Predicted whiting bycatch indices	$\hat{I}_{kij}^{whi} = q_i^{whi}W_{kij}s_{kj}N_{kij}$	pred_whi(k,i,j)	
Predicted NMFS shelf survey indices	$\hat{I}_{kij}^{\log} = q_i^{\log}W_{kij}s_{kj}N_{kij}$	pred_log(k,i,j)	

Predicted proportion of survey age comp	$\hat{\pi}_{ij} = \frac{n_{1ij}^{srv} + n_{2ij}^{srv}}{\sum_j (n_{1ij}^{srv} + n_{2ij}^{srv})} E_{jj}$	Pred_p_srv(i,j)	
Total biomass	$B_i = \sum_{k,j} N_{kij} W_{kij}$	totbio(i)	
Total recruitment	$R_i = \sum_k N_{ki1}$	rec(i)	
depletion	$=B_T/B_{To}$	depletion	
Stock01	$= \sum_{k,j} \left(N_{kTj} W_{kTj} S_{kTj} \right)$	stock01	

IX. PROJECTIONS for F55, F50, and F45 if ACTIVE(last_phase)

Items	**Symbols/Values**	**Variable Name in Program**	**Descriptions**
Levels of harvesting	f_l = F0, F55, F50, F45	ftmp, *l*=1: F0, *l*=2: F55, *l*=3: F50, *l*=4: F45	F55, F50 and F45 are to be estimated. The levels of F that will reduce equilibrium SSB/R to 55%, 50% and 45% of equilibrium $SSB_{F=0}$.
Future Mortality and Survival rate	$F_{kij}^{fut} = s_{kj} f_l$ $Z_{kij}^{fut} = F_{kij}^{fut} + m_{kj}$ $S_{kij}^{fut} = \exp(-Z_{kij}^{fut})$	F_future(k,i,j) Z_future(k,i,j) S_future(k,i,j)	endyr+1 $\leq$ i $\leq$ endyr+nyrs_future
Future Recruitment	$N_{ki1}^{fut} = \exp(\overline{R} + dR_i)$	mean_log_rec rec_dev_future(i)	geometric mean and random walk

Future N at age	$N_{kij}^{fut} = N_{k,i-1,j-1}^{fut} S_{k,i-1,j-1}^{fut}$	nage_future(k,it,j), 2≤j<A	Number at age
	$N_{kiA}^{fut} = N_{k,i-1,A-1}^{fut} S_{k,i-1,A-1}^{fut} + N_{k,i-1A}^{fut} S_{k,i-1,A}^{fut}$	nage_future(k,i,A)	Last age is plus
Future catch_at_age	$\hat{C}_{kij}^{fut} = \dfrac{N_{kij}^{fut} F_{kij}^{fut} (1 - S_{kij}^{fut})}{Z_{kij}^{fut}}$	catage_future(k,i,j)	
Future annual catch in weight	$\hat{Y}_{ki}^{fut} = \sum_j \hat{C}_{kij}^{fut} W_{kTj}$	catch_future(k,i)	
Future annual total biomass	$B_{ki}^{fut} = \sum_j N_{ktj}^{fut} W_{kTj}$	future_biomass(k,i)	
Future number of spawners per R	$N_{l1}^{spr} = 1$ for j=1 $N_{lj}^{spr} = N_{l,j-1}^{spr} \exp\left(-m_{1,j-1} - s_{1,j-1} f_l\right)$ for 2≤j≤A-1 $N_{lA}^{spr} = \dfrac{N_{l,A-1}^{spr} \exp\left(-m_{1,A-1} - s_{1,A-1} f_l\right)}{1 - \exp\left(-m_{1,A-1} - s_{1,A-1} f_l\right)}$ for j=A	Nspr(*l*,j)	
Future spawner biomass per R	$SB_l = N_{lj}^{spr} \varphi_j W_{1Tj} \exp\left(-0.25(m_{1j} + s_{1j} f_l)\right)$	SB0, SBF55, SBF50, SBF45	

X. LIKELIHOODS

Items	Symbols/Values	Variable Name in Program	Descriptions
Small number	$\varepsilon = 0.001$		To prevent log(~0)
Catch biomass	$LC = \lambda_3 \sum_i (\log(Y_i) - \log(\hat{Y}_i))^2$	catch_like	Fishery landings
Indices	$L_1 = \lambda_9 \sum_{k,i,j} (\log(I_{kij}^{srv} + \varepsilon) - \log(\hat{I}_{kij}^{srv} + \varepsilon))^2$	index_like(1)	Survey
	$L_2 = \lambda_{11} \sum_{k,i,j} (\log(I_{kij}^{whi} + \varepsilon) - \log(\hat{I}_{kij}^{whi} + \varepsilon))^2$	index_like(2)	Whiting bycatch
	$L_3 = \lambda_{12} \left(\frac{\sum_{k,i,j} (\log(I_{kij}^{\log} + \varepsilon) - \log(\hat{I}_{kij}^{\log} + \varepsilon))^2}{2\sigma^2} + \eta^{\log} \log(\sigma) \right)$	index_like(3)	Trawl cpue $\eta^{\log}$ = size_count(obs_log)
Ageing	$\hat{p}_{ki2} = \hat{p}_{ki1} + \hat{p}_{ki2}$ $LA_1 = \sum_{k,i,j} \left(a_i^{cat} (p_{kij} + \varepsilon) \log(\hat{p}_{kij}^{srv} + \varepsilon) \right) - offset(1)$	age_like(1)	Catch at age Start at the 2nd age class (age 5)
	$LA_2 = \lambda_{16} \left(\sum_{k,i,j} \left(a_i^{srv} (\pi_{kij} + \varepsilon) \log(\hat{\pi}_{kij} + \varepsilon) \right) - offset(2) \right)$	age_like(2)	Survey index at age

Recruitment	$LR = \lambda_1 \sum_i (\Delta R_i)^2 + \dfrac{\sum_i (dR_i)^2}{2\sum_i (\Delta R_i)^2 \big/ \eta^{rec}}$	rec_like	ΔR_i: see RECRUITMENT dR_i: rec_dev_future η^{rec} =size_count(rec_dev)
Dome-shaped Fishery Selectivity if ACTIVE (ph_sel_coffs)	$x_{k,j} = \ln(s_{k,j+1}) - \ln(s_{k,j})$ $LSEL_1 = \lambda_5 \sum_{k,j} (x_{1,j+1} - x_{1,j})^2$ $LSEL_2 = \lambda_6 \sum_{k,j} (x_{2,j+1} - x_{2,j})^2$	sel_like(k), k=1,2 for sex	Fishery selectivity is fluctuating over ages but should be as smooth as possible. This likelihood is curvature-penalty to prevent sudden change of selectivity over the adjacent ages.
	$LSEL_4 = \lambda_2 \sum_{k,j=a^{dec}} (\ln(s_{k,j-1}) - \ln(s_{k,j}))^2$	sel_like(4)	This is dome-shape penalty to ensure that fishery selectivity tends to decrease beyond a^{dec}.
	$LSEL_7 = \lambda_4 \sum_j (\ln(s_{2,j}) - \ln(s_{1,j}))^2$	sel_like(7)	To ensure that fishery selectivity are equal at the same age between male and female
Dome-shaped NMFS Shelf survey Selectivity	$x_j = \ln(v_{j+1}) - \ln(v_j)$ $LSEL_3 = \lambda_7 \sum_j (x_{j+1} - x_j)^2$	sel_like(3)	Survey selectivity is year-invariant. This is the 2nd-difference for curvature penalty
	$LSEL_5 = \lambda_8 \sum_{j=a^{dec}} (\ln(v_{j-1}) - \ln(v_j))^2$	sel_like(5)	This is dome-shape penalty to ensure that survey selectivity tends to decrease beyond a^{dec}

Scale fishery and survey selectivity to have mean 0	$\bar{s}_k = average(\ln(s_{k,j}))$ $\bar{v} = average(\ln(\bar{v}_j))$ $LSEL_6 = \sum_k (\bar{s}_k - 0)^2 + (\bar{v} - 0)^2$	sel_like(6)	
Low F penalty if current_pase < 5	$fpen = 10\left(\exp(\bar{F}) - 0.1\right)^2$	fpen	Set $\exp(\bar{F}) \geq 0.1$
Catchability	$LQ = \lambda_{13} \sum_t \left(\Delta q_t^{srv}\right)^2 + \lambda_{14} \sum_t \left(\Delta q_t^{whi}\right)^2 + \lambda_{15} \sum_t \left(\Delta q_t^{\log}\right)^2$	q_like	Normalize $\Delta q_t^{srv}, \Delta q_t^{whi}, \Delta q_t^{\log}$ to have mean 0
Spawner Biomass per R	$sprpen = 100 \left(\left(\frac{SB_2}{SB_1} - 0.55\right)^2 + \left(\frac{SB_3}{SB_1} - 0.50\right)^2 + \left(\frac{SB_4}{SB_1} - 0.45\right)^2 \right)$	sprpen	
Objective Function	Sum all of the above		

Appendix B. List of program, in AD Model Builder code, for yellowtail rockfish stock assessment modeling.

```
//////////////////////////////////////////////////////////////////////////
// COASTWIDE YT2003
//////////////////////////////////////////////////////////////////////////
   ///////////////////////////////////////////////////////////////////////
  //  Template File for Yellowtail rockfish
 //   James Ianelli, July 1997 (jianelli@afsc.noaa.gov)
///////////////////////////////////////////////////////////////////////
   // Data notes: 1977 survey age comps based on surface ages and therefore
  //             not used in estimating selectivity
///////////////////////////////////////////////////////////////////
DATA_SECTION
  init_int styr                            // Begin year of data
  init_int endyr                           // End year of data
  init_int nages                           // Number of age classes
  init_vector obs_catch_bio(styr,endyr)    // Observed catch Biomass

  init_int nobs_srv                        // Number of observations in survey
  init_ivector yrs_srv(1,nobs_srv)         // Actual years of survey occurrence
  init_vector obs_srv(1,nobs_srv)          // Biomass index values from survey

  init_vector nsamples_srv(1,nobs_srv)     // Number of age-samples assumed by yr
  init_matrix obs_ac_srv(1,nobs_srv,1,nages)// Observed numbers at age from survey

  init_int nobs_whi                        // Number of observations in Whiting Bycatch index
  init_ivector yrs_whi(1,nobs_whi)         // Actual years of whiting bycatch index
  init_vector obs_whi(1,nobs_whi)          // Biomass index values from whiting bycatch

  init_int nobs_log                        // Number of observations in logbook CPUE index
  init_ivector yrs_log(1,nobs_log)         // Actual years of logbook CPUE index
  init_vector obs_log(1,nobs_log)          // Biomass index values from logbook CPUE
  init_vector obs_log_se(1,nobs_log)       // Biomass index std errors from logbook CPUE
  !! cout << obs_log<<endl<<obs_log_se<<endl;
  init_int styr_fish                       // Year fishery age comps begin
  init_int endyr_fish                      // Year fishery age comps end
  init_vector nsamples_fish(styr_fish,endyr_fish) // Number of samples for fishery age comps
  init_3darray obs_ac_fish(1,2,styr_fish,endyr_fish,1,nages) // obs. fishery age comps
  init_matrix age_err(1,nages,1,nages)     // Transition matrix of ageing errors
  init_3darray wt(1,2,styr,endyr,1,nages)  // Wt at sex, yr, and age
  init_vector maturity(1,nages)            // Maturity at age
```

```
  vector obs_sexr(styr_fish,endyr_fish)     // sex ratio in fishery (from obs. age comp)
  int i                                     // Index for year
  int j                                     // Index for age
  int k                                     // Index for sex
  int styr_q                                // start q-dev vector for fshry
  int styr_q_whi                            // start q-dev vector for whiting bycatch
  int styr_q_log                            // start q-dev vector for logbook cpue
 LOCAL_CALCS
   ad_comm::change_datafile_name("ref.ctl");
   styr_q=yrs_srv(1)+1;
   styr_q_whi=yrs_whi(1)+1;
   styr_q_log=yrs_log(1)+1;
 END_CALCS

  init_int ph_q_dev_srv   //Phase when survey catchability changes are estimated
  init_int ph_q_dev_whi   //Phase when whiting index catchability changes are estimated
  init_int ph_q_dev_log   //Phase when logbook index catchability changes are estimated
  init_int ph_sel_coffs   //Phase when smoothed selectivity parameters are estimated
  init_int ph_sel_log     //Phase when logistic sel parameters are estimated
  init_int ph_sel_srv     //Phase when survey selectivity parameters are est.
  init_int ph_q           //Phase when absolute survey catchability is estimated
  init_int ph_M_old       //Phase when M old age is estimated
  init_number ph_sigmau   //Phase to estimate sigmau (Logbook CPUE variance)
  init_number use_age_err //Flag to use (=1; or not use =0) ageing error trans. matrix
  init_int age_decrease   //Age beyond which to penalized dome-shapedness
  init_int sel_max_age    //Age behond which selectivity is held constant
  init_number Hist_F      //Historical F relative to styr F
  init_vector lambda(1,20)//Vector of wts etc (see .ctl file)

  int endyr_fut;
  int styr_fut;
  int nFs;
 LOCAL_CALCS
    int nyrs_future=12;
    endyr_fut=endyr+nyrs_future;
    styr_fut=endyr+1;
    nFs=3;
 END_CALCS

INITIALIZATION_SECTION
```

```
  M .11
  mean_log_rec 6.0
  avg_F -1.6
  log_q_srv -1.609437912 // Q = 0.2 as a default....
  log_q_log -2.9
  log_q_whi -11.9
  sel_coffs_srv -.01
  //sigmau .20
  F55 .1
  F50 .13
  F45 .23


PARAMETER_SECTION
  init_number mean_log_rec(1)
  //init_number prist_log_rec(1)
  init_number avg_F(1)
  init_bounded_vector rec_dev(styr,endyr,-8,8,3)
  init_bounded_dev_vector fmort_dev(styr,endyr,-6.,6.,2)
  init_bounded_dev_vector q_dev_srv(styr_q,endyr,-6.,6.,ph_q_dev_srv)
  init_bounded_dev_vector q_dev_whi(styr_q_whi,endyr,-6.,6.,ph_q_dev_whi)
  init_bounded_dev_vector q_dev_log(styr_q_log,endyr,-6.,6.,ph_q_dev_log)

  init_bounded_vector M(1,2,.1,.45,-1)
  init_bounded_number M_old(.02,.5,ph_M_old)
  init_matrix sel_coffs(1,2,1,sel_max_age,ph_sel_coffs)
  init_bounded_vector fish_sel50(1,2,1.,10.,ph_sel_log)
  init_bounded_vector fish_slope(1,2,0.001,10.,ph_sel_log)
  init_vector sel_coffs_srv(1,sel_max_age,ph_sel_srv)
  init_number log_q_srv(ph_q)
  init_number log_q_whi(1)
  init_number log_q_log(2)
  //init_bounded_number sigmau(0.05,2.,ph_sigmau)
  number sigmau
  !!sigmau=.22;

  init_bounded_number F55(0.05,1.,ph_sigmau)
  init_bounded_number F50(0.05,1.,ph_sigmau)
  init_bounded_number F45(0.05,1.,ph_sigmau)

  number sigmar
```

```
number ftmp
number SB0
number SBF55
number SBF50
number SBF45
number sprpen
matrix Nspr(1,4,1,nages)

3darray nage_future(1,2,styr_fut,endyr_fut,1,nages)
init_vector rec_dev_future(styr_fut,endyr_fut,8);
3darray F_future(1,2,styr_fut,endyr_fut,1,nages);
3darray Z_future(1,2,styr_fut,endyr_fut,1,nages);
3darray S_future(1,2,styr_fut,endyr_fut,1,nages);
3darray catage_future(1,2,styr_fut,endyr_fut,1,nages);
number avg_rec_dev_future


vector fmort(styr,endyr)
matrix log_sel(1,2,1,nages)
vector log_sel_srv(1,nages)
vector catchab_srv(styr,endyr)
vector catchab_whi(styr,endyr)
vector catchab_log(styr,endyr)
matrix nat_mort(1,2,1,nages)
matrix sel(1,2,1,nages)
vector sel_srv(1,nages)
vector avg_sel(1,2)
number avg_sel_srv
vector pred_srv(styr,endyr)
vector pred_whi(styr,endyr)
vector pred_log(styr,endyr)
matrix popn(1,2,styr,endyr)
number deltaM
number yr_fraction
3darray natage(1,2,styr,endyr,1,nages)
3darray pred_p(1,2,styr,endyr,1,nages)
3darray eac_srv(1,2,styr,endyr,1,nages)
matrix pred_p_srv(styr,endyr,1,nages)

//3darray u(1,2,styr,endyr,1,nages)
3darray Z(1,2,styr,endyr,1,nages)
```

```
  3darray F(1,2,styr,endyr,1,nages)
  3darray S(1,2,styr,endyr,1,nages)
  3darray catage(1,2,styr,endyr,1,nages)
  3darray obs_p(1,2,styr_fish,endyr_fish,1,nages)
  matrix obs_p_srv(1,nobs_srv,1,nages)
  vector pred_catch_bio(styr,endyr)
  vector pred_sexr(styr,endyr)
  number rbar
  vector offset(1,2)
  number rec_like
  number q_like
  number M_like
  number sex_like
  number catch_like
  vector sel_like(1,10)
  vector age_like(1,2)
  number fpen
  vector index_like(1,3)
  sdreport_vector totbiom(styr,endyr)
  sdreport_vector rec(styr,endyr)
  sdreport_number depletion
  sdreport_matrix catch_future(1,3,styr_fut,endyr_fut);
  sdreport_matrix future_biomass(1,3,styr_fut,endyr_fut)

  likeprof_number stock01
  objective_function_value f

RUNTIME_SECTION
  maximum_function_evaluations 4000
  convergence_criteria 1e-3 1e-4 1e-7

PRELIMINARY_CALCS_SECTION
  yr_fraction=(8.5)/12;
  for (i=styr_fish; i <= endyr_fish; i++)
    obs_sexr(i)=sum(obs_ac_fish(1,i))/(sum(obs_ac_fish(1,i))+sum(obs_ac_fish(2,i)));

  //cout<<" ObsP "<< endl<<obs_ac_srv<<endl;
  // Normalize the survey age compositions
  for (i=1;i<=nobs_srv;i++)
    obs_p_srv(i)=obs_ac_srv(i)/(sum(obs_ac_srv(i)));
```

```
  for (k=1;k<=2;k++)
    for (i=styr_fish;i<=endyr_fish;i++)
      obs_p(k,i)=obs_ac_fish(k,i)/(sum(obs_ac_fish(1,i))+sum(obs_ac_fish(2,i)));
  for (k=1; k <= 2; k++)
  {
    for (i=styr_fish; i <= endyr_fish; i++)
    {
      // this is to mimic accumulation from synthesis
      obs_p(k,i,2)+=obs_p(k,i,1);
      for (j=2; j<=nages; j++)
        offset(1)-=nsamples_fish(i)*(1e-3+obs_p(k,i,j))* log((1e-3+obs_p(k,i,j)));
     }
   }
   //Computing offset for survey (ignoring 77 data)
   for (i=2; i<=nobs_srv; i++)
     for (j=1; j<=nages; j++)
       offset(2)-=nsamples_srv(i)* (1e-3+obs_p_srv(i,j))*log((1e-3+obs_p_srv(i,j)));

   if(use_age_err==0)
     for (j=1; j<=nages; j++)
       for (int jj=1; jj<=nages; jj++)
         if(jj==j)
           age_err(j,jj)=1.;
         else
           age_err(j,jj)=0.;

  cout<<" samplesize "<<endl<<nsamples_fish<<endl<<endl;
  cout<<" Offset "<<offset<<endl<<endl;
  cout<<" HistF"<<endl<< Hist_F<<endl;
  cout<<" Lambda "<<endl<< lambda<<endl;
  //cout<<" agerr "<<endl<< age_err<<endl;
  //cout<<" ObsP "<< endl<<obs_p_srv<<endl;


PROCEDURE_SECTION
  get_selectivity();
  get_mortality();
  get_numbers_at_age();
  get_predicted_values();
  get_catch_at_age();
  evaluate_the_objective_function();
```

```
FUNCTION get_selectivity

  if (ph_sel_coffs>0)
  {
    for (k=1;k<=2;k++)
    {
      log_sel(k)(1,sel_max_age)=sel_coffs(k);
      log_sel(k)(sel_max_age+1,nages)=sel_coffs(k,sel_max_age);
      avg_sel(k)=log(mean(mfexp(log_sel(k))));
      log_sel(k)-=log(mean(exp(log_sel(k))));
      sel(k)=mfexp(log_sel(k));
    }
  }
  else
  {
    for (k=1;k<=2;k++)
      for (j=1; j<=nages; j++)
         sel(k,j)=1./(1.+mfexp(-1.*fish_slope(k)*(double(j)-fish_sel50(k))));

  }

  log_sel_srv(1,sel_max_age)=sel_coffs_srv;
  log_sel_srv(sel_max_age+1,nages)=sel_coffs_srv(sel_max_age);
  avg_sel_srv=log(mean(mfexp(log_sel_srv)));
  log_sel_srv-=log(mean(exp(log_sel_srv)));
  sel_srv=mfexp(log_sel_srv);

FUNCTION get_mortality
  fmort=mfexp(avg_F+fmort_dev);
  nat_mort(1)(1,3)=M(1);
  nat_mort(2)=M(2);
  deltaM=(M_old-M(1))/19.;
  for (j=4;j<=nages;j++)
    nat_mort(1,j)=nat_mort(1,j-1)+deltaM;

  for (k=1;k<=2;k++)
   {
    for (i=styr;i<=endyr;i++)
      {
        F(k,i) = sel(k) * fmort(i);
```

```
        Z(k,i) = F(k,i) + nat_mort(k);
      }
    }
  S=mfexp(-1.0*Z);

// Catchability in initial years
  catchab_srv(yrs_srv(1)) = exp(log_q_srv);
  catchab_whi(yrs_whi(1)) = exp(log_q_whi);
  catchab_log(yrs_log(1)) = exp(log_q_log);

  if (active(q_dev_srv))
     for (i=styr_q;i<=endyr;i++)
        catchab_srv(i) = catchab_srv(i-1)*exp(q_dev_srv(i));
  else
    catchab_srv = catchab_srv(yrs_srv(1));

  if (active(q_dev_whi))
    for (int i =styr_q_whi;i<=endyr;i++)
      catchab_whi(i) = catchab_whi(i-1)*exp(q_dev_whi(i));
  else
    catchab_whi = catchab_whi(yrs_whi(1)) ;

  if (active(q_dev_log))
    for (i=styr_q_log;i<=endyr;i++)
        catchab_log(i) = catchab_log(i-1)*exp(q_dev_log(i));
  else
    catchab_log = catchab_log(yrs_log(1)) ;


FUNCTION get_numbers_at_age
  // Initial Age composition here
  natage(1,styr,1)=mfexp(mean_log_rec+rec_dev(styr));
  natage(2,styr,1)=natage(1,styr,1);
  for (j=2;j<nages;j++)
    {
      natage(1,styr,j)=natage(1,styr,j-1)*mfexp(
                      -1.*(F(1,styr,j-1)*Hist_F+nat_mort(1,j-1)));
      natage(2,styr,j)=natage(2,styr,j-1)*mfexp(
                      -1.*(F(2,styr,j-1)*Hist_F+nat_mort(2,j-1)));
    }
  //Cumulative Plus group in initial age comp-------------------
```

```
    natage(1,styr,nages)=natage(1,styr,nages-1)*
                         mfexp(-1.*(F(1,styr,nages-1)*Hist_F+nat_mort(1,nages)))
               /(1.-exp(-1.*(F(1,styr,nages)*Hist_F+nat_mort(1,nages))));

    natage(2,styr,nages)=natage(2,styr,nages-1)*
                         mfexp(-1.*(F(2,styr,nages-1)*Hist_F+nat_mort(2,nages)))
                  /(1.-exp(-1.*(F(2,styr,nages)*Hist_F+nat_mort(2,nages))));

// Now do for next several years----------------------------------
  for (i=styr+1;i<=endyr;i++)
    {
      natage(1,i,1)=mfexp(mean_log_rec+rec_dev(i));
      natage(2,i,1)=natage(1,i,1);
    }

  for (k=1;k<=2;k++)
  {
    for (i=styr;i<endyr;i++)
    {
      natage(k,i+1)(2,nages) = ++elem_prod(natage(k,i)(1,nages-1),
                                    S(k,i)(1,nages-1));
       natage(k,i+1,nages)+=natage(k,i,nages)*S(k,i,nages);
       popn(k,i)=natage(k,i)*sel(k);
    }
    popn(k,endyr)=natage(k,endyr)*sel(k);
  }
  if (last_phase())
  {
   future_biomass=0.;
   catch_future=0.;
   for (int l=1;l<=3;l++)
   {
    switch (l)
   {
    case 1:
     ftmp=F55;
     break;
    case 2:
     ftmp=F50;
     break;
    case 3:
```

```
  ftmp=F45;
  break;
}

 for (k=1;k<=2;k++)
 {
 // Get future F's
   for (i=endyr+1;i<=endyr_fut;i++)
   {
   for (j=1;j<=nages;j++)
      {
       F_future(k,i,j) = sel(k,j)*ftmp;
       Z_future(k,i,j) = F_future(k,i,j)+nat_mort(k,j);
       S_future(k,i,j) = exp(-1.*Z_future(k,i,j));
      }
   }
   for (i=styr_fut;i<=endyr_fut;i++)
   {
     nage_future(k,i,1)=exp(mean_log_rec + rec_dev_future(i));
   }

   nage_future(k,styr_fut)(2,nages)=++elem_prod(natage(k,endyr)(1,nages-1),
                                             S(k,endyr)(1,nages-1));
   nage_future(k,styr_fut,nages)+=natage(k,endyr,nages)*S(k,endyr,nages);

   for (i=styr_fut;i<endyr_fut;i++)
   {
     nage_future(k,i+1)(2,nages)=++elem_prod(nage_future(k,i)(1,nages-1),
                                          S_future(k,i)(1,nages-1));
     nage_future(k,i+1,nages)+=nage_future(k,i,nages)*S_future(k,i,nages);
   }

 // Now get catch at future ages
   for (i=styr_fut; i<=endyr_fut; i++)
   {
     for (j = 1 ; j<= nages; j++)
     {
      catage_future(k,i,j) = nage_future(k,i,j) * F_future(k,i,j) *
                     (1.- S_future(k,i,j) ) / Z_future(k,i,j);
     }
  catch_future(l,i)    +=catage_future(k,i)*wt(k,endyr);
```

```
      future_biomass(l,i)  +=nage_future(k,i)*wt(k,endyr);
      }
    } // End of loop over Sex
   }   //End of loop over F's
  }   //End of Future_phase


FUNCTION get_predicted_values
  //Now get predictive parts-------------------------
   pred_srv=0.;
   pred_whi=0.;
   pred_log=0.;
   for (i=styr;i<=endyr;i++)
   {
     for (k=1;k<=2;k++)
     {
       pred_p(k,i)=(elem_prod(sel(k),natage(k,i))/ (popn(1,i)+popn(2,i)))*age_err;

       for (j = 1 ; j<= nages; j++)
       {
         eac_srv(k,i,j)=  sel_srv(j)* pow(S(k,i,j),yr_fraction)* natage(k,i,j);
         pred_srv(i)+=eac_srv(k,i,j)*wt(k,i,j);
         pred_whi(i)+=catchab_whi(i)*wt(k,i,j)*sel(k,j)*natage(k,i,j);
         pred_log(i)+=catchab_log(i)*wt(k,i,j)*sel(k,j)*natage(k,i,j);
       }
     }
     pred_p_srv(i)=(eac_srv(1,i)+eac_srv(2,i))/ sum((eac_srv(1,i)+eac_srv(2,i)))*age_err;
     pred_srv(i)*=catchab_srv(i);
   }

   if (sd_phase())
   {
     for (i=styr;i<=endyr;i++)
     {
       totbiom(i)=(natage(1,i)*wt(1,i)) + (natage(2,i)*wt(2,i));
       rec(i)=natage(1,i,1) + natage(2,i,1);
     }
     depletion=totbiom(endyr)/totbiom(styr);
   }
   stock01=elem_prod(natage(1,endyr),wt(1,endyr))*S(1,endyr) +
           elem_prod(natage(2,endyr),wt(2,endyr))*S(2,endyr);
```

```
FUNCTION get_catch_at_age
  pred_catch_bio.initialize();
  for (i=styr; i<=endyr; i++)
    for (k=1;k<=2;k++)
      for (j = 1 ; j<= nages; j++)
      {
        //--Baranov's equation here-----------------------------------
        catage(k,i,j)     = natage(k,i,j)*F(k,i,j)*(1.-S(k,i,j))/Z(k,i,j);
        pred_catch_bio(i)+=catage(k,i,j)*wt(k,i,j);
      }

FUNCTION evaluate_the_objective_function
  catch_like=lambda(3)*norm2(log(obs_catch_bio)-log(pred_catch_bio));

  index_like(1)= lambda(9) * norm2(log(obs_srv + .001)-log(pred_srv(yrs_srv)+.001));
  index_like(2)=lambda(10) * norm2(log(obs_whi + .001)-log(pred_whi(yrs_whi)+.001));
  //index_like(3)=0.;
  index_like(3)=lambda(11)*(norm2(log(obs_log+.001)-log(pred_log(yrs_log)+.001))/
              (2*sigmau*sigmau)+size_count(obs_log)*log(sigmau));

  //for (i=1;i<=nobs_log;i++)
  //{
    //index_like(3) += square(obs_log(i) - pred_log(yrs_log(i))) /
    //                 (2*obs_log_se(i)*obs_log_se(i));
  //}
  //index_like(3) *= lambda(11);

  //cout << index_like(3)<<" "<<lambda(11)<<endl;

  //index_like(3)=lambda(11)*norm2(log(obs_log+ .001)- log(pred_log(yrs_log)+.001));

  age_like=0.;

  for (k=1; k <= 2; k++)
    for (i=styr_fish; i <= endyr_fish; i++)
    {
     // this is to mimic accumulation from synthesis
      pred_p(k,i,2)+=pred_p(k,i,1);
      for (j=2; j<=nages; j++)
        age_like(1)-=nsamples_fish(i)*(1e-3+obs_p(k,i,j))*log(1e-3+pred_p(k,i,j));
```

```
    }

  //cout<<age_like(1)<<endl;
  // cout<<nsamples_fish <<endl;
  age_like(1)-=offset(1);
//Computing multinomial for survey age comp data (ignoring 1977 (first obs))
  for (i=2; i <= nobs_srv; i++)
    age_like(2)-=nsamples_srv(i)*(1e-3+obs_p_srv(i))*log(1e-3+pred_p_srv(yrs_srv(i)));

  //cout<<nsamples_srv <<endl;
  //cout<<age_like(1)<<endl;
  age_like(2)-=offset(2);
  age_like(2)*=lambda(16);  // This is to have the option to turn this part off

// Prior kind of stuff here--------------------------------------------------------
  rec_like=lambda(1)*norm2(rec_dev); //Regularity assumption on recruitment variability
  sigmar   =  norm2(rec_dev)/size_count(rec_dev);
  // This sets variability of future recruitment to same as in past....
  rec_like+= norm2(rec_dev_future)/(2.*sigmar+.001);

  sel_like=0.;
  if (ph_sel_coffs>0)
  {
    sel_like(1)=lambda(5)*norm2(first_difference(first_difference(log_sel(1))));
    sel_like(2)=lambda(6)*norm2(first_difference(first_difference(log_sel(2))));
    sel_like(7)=lambda(4)*norm2(log_sel(2)-log_sel(1));
    for (k=1; k <= 2; k++)
      for (j=age_decrease; j <= nages; j++)
          if (sel(k,j-1)>sel(k,j)) sel_like(4)+=lambda(2) *
                                                square(log_sel(k,j-1)-log_sel(k,j));
  }
  sel_like(3)=lambda(7)*norm2(first_difference(first_difference(log_sel_srv)));

  //For survey selectivity dome-shapedness
  for (j=age_decrease; j <= nages; j++)
    if (sel_srv(j-1)>sel_srv(j))
      sel_like(5)+=lambda(8) * square(log_sel_srv(j-1)-log_sel_srv(j));

  // Normalizing part of selectivity vector (to give it mean zero, log-scale)
  sel_like(6) = norm2(avg_sel) + square(avg_sel_srv);
```

```
// Phases less than 5, penalize low F's
if(current_phase() < 5)
  fpen=10.*square(mfexp(avg_F)-.1);

fpen=lambda(12)*norm2(fmort_dev);

q_like  = lambda(13)*norm2(q_dev_srv);
q_like += lambda(14)*norm2(q_dev_whi);
q_like += lambda(15)*norm2(q_dev_log);

if (active(F55))
{ //Compute SPR Rates and add them to the likelihood for Females
  SB0=0.;
  SBF55=0.;
  SBF50=0.;
  SBF45=0.;
  for (i=1;i<=4;i++)
    Nspr(i,1)=1.;

    for (j=2;j<nages;j++)
    {
        Nspr(1,j)=Nspr(1,j-1)*exp(-1.*nat_mort(1,j-1));
        Nspr(2,j)=Nspr(2,j-1)*exp(-1.*(nat_mort(1,j-1)+F55*sel(1,j-1)));
        Nspr(3,j)=Nspr(3,j-1)*exp(-1.*(nat_mort(1,j-1)+F50*sel(1,j-1)));
        Nspr(4,j)=Nspr(4,j-1)*exp(-1.*(nat_mort(1,j-1)+F45*sel(1,j-1)));
      }
      Nspr(1,nages)=Nspr(1,nages-1)*exp(-1.*nat_mort(1,nages-1))/
                    (1.-exp(-1.*nat_mort(1,nages)));
      Nspr(2,nages)=Nspr(2,nages-1)*
                    exp(-1.* (nat_mort(1,nages-1)+F55*sel(1,nages-1)))/
                  (1.-exp(-1.*(nat_mort(1,nages)+F55*sel(1,nages))));
      Nspr(3,nages)=Nspr(3,nages-1)*exp(-1.*
                   (nat_mort(1,nages-1)+F50*sel(1,nages-1)))/
                         (1.-exp(-1.*(nat_mort(1,nages)+F50*sel(1,nages))));
      Nspr(4,nages)=Nspr(4,nages-1)*exp(-1.*
                   (nat_mort(1,nages-1)+F45*sel(1,nages-1)))/
                         (1.-exp(-1.*(nat_mort(1,nages)+F45*sel(1,nages))));

     for (j=1;j<=nages;j++)
     {
       SB0  +=Nspr(1,j)*maturity(j)*wt(1,endyr,j)*exp(-0.25*nat_mort(1,j));
```

```
        SBF55  +=Nspr(2,j)*maturity(j)*wt(1,endyr,j)*exp(-0.25*(
                 nat_mort(1,j)+F55*sel(1,j)));
        SBF50 +=Nspr(3,j)*maturity(j)*wt(1,endyr,j)*exp(-0.25*(
                 nat_mort(1,j)+F50*sel(1,j)));
        SBF45  +=Nspr(4,j)*maturity(j)*wt(1,endyr,j)*exp(-0.25*(
                 nat_mort(1,j)+F45*sel(1,j)));
   }
   sprpen =100.*square(SBF55/SB0-0.55);
   sprpen+=100.*square(SBF50/SB0-0.50);
   sprpen+=100.*square(SBF45/SB0-0.45);
  }


  // Sum all components---------------------------
  f+=sum(index_like);
  f+=sum(sel_like);
  f+=rec_like;
  f+=catch_like;
  f+=sum(age_like);
  f+=q_like;
  f+=fpen;
  f+=sprpen;

REPORT_SECTION
  report << "Estimated numbers of fish " << endl;
  report << natage << endl;
  report << "Estimated catch numbers " << endl;
  report << catage << endl;
  report << "Estimated F mortality " << endl;
  report << F << endl;
  report << "Observed Survey 1 " << endl;
  report << obs_srv << endl;
  report << "Predicted Survey 1 " << endl;
  report << pred_srv << endl;
  report << "Observed Prop " << endl;
  for (k=1;k<=2;k++)
  {
    for (i=1974;i<=endyr_fish;i++)
    {
      if (i<styr_fish) report <<  endl;
      if (i>=styr_fish) report << obs_p(k,i) << endl;
```

```
  }
}
report << "Predicted prop  " << endl;
report << pred_p << endl;
report << "Observed catch biomass " << endl;
report << obs_catch_bio << endl;
report << "predicted catch biomass " << endl;
report << pred_catch_bio << endl;
report << "Estimated annual fishing mortality " << endl;
report << fmort << endl;
report << "Estimated Selectivity " << endl;
report << sel << endl;
report << "Observed, Predicted Sex Ratio " << endl;
report << (obs_sexr) << endl;
for (i=styr;i<=endyr;i++)
  pred_sexr(i)=popn(1,i)/(popn(1,i)+popn(2,i));
report << (pred_sexr) << endl;
report << "totbiom" << endl;
for (i=styr;i<=endyr;i++)
  report << (natage(1,i)*wt(1,i)) + (natage(2,i)*wt(2,i)) <<" ";
report <<endl;
report << "Natural Mortality (females, males)" << endl;
report << nat_mort << endl;
report << catchab_srv << endl;
report << "Observed Whiting  " << endl;
report << yrs_whi << endl;
report << obs_whi << endl;
report << "Predicted Whiting  " << endl;
report << pred_whi << endl;
report << "Observed logbook " << endl;
report << yrs_log << endl;
report << obs_log << endl;
report << "Predicted logbook " << endl;
report << pred_log << endl;
report << "catchabilities, Survey, Whiting, Logbook" << endl;
report << catchab_srv << endl;
report << catchab_whi  << endl;
report << catchab_log  << endl;

report << "Observed Prop Survey data" << endl;
report << obs_p_srv << endl;
```

```
  report << "Predicted prop survey" << endl;
  report << pred_p_srv << endl;
  report << "Survey Selectivity " << endl;
  report << sel_srv << endl;
  report << "Likelihoods: Survey, sel, rec, catch, age, q, Fpen"<<endl;
  report << "Survey: "<< index_like <<endl;
  report << "Selectivity: "<< sel_like  <<endl;
  report << "Recruitment: "<< rec_like  <<endl;
  report << "Catch_Biom: "<< catch_like<<endl;
  report << "AgeComp: "<< age_like  <<endl;
  report << "Catchability: "<< q_like    <<endl;
  report << "Fmort: "<< fpen      <<endl;
  report << "Sigma for Logbook CPUE data"      <<endl;
  report << sigmau      <<endl;
  report << "SBF50, F55, F50, F45  ok CPUE data"      <<endl;
  report << SBF50<< " " << F55<<" "<<F50<<" "<<F45<<" "<<endl;

TOP_OF_MAIN_SECTION
  gradient_structure::set_MAX_NVAR_OFFSET(1600);
  gradient_structure::set_GRADSTACK_BUFFER_SIZE(200000);
  gradient_structure::set_CMPDIF_BUFFER_SIZE(2000000);
  arrmblsize=500000;
```