Incorporating Age Information into SEAMAP Trawl Indexes for SEDAR9 Species

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SUMMARY

The recommendations from the SEDAR9 Data Workshop were used to infer age composition from the size composition data from the SEAMAP Summer and Fall trawl surveys. In the Summer Survey, size frequencies of both vermilion snapper and gray triggerfish show a component that is clearly young of the year. As recruitment would not be complete for the summer (June/July) survey, interannual variation of the new recruit CPUE in the summer probably tracks changes in recruitment timing much more than it indexes changes in year class strength, and therefore is probably not useful for most assessment purposes. The size ranges in the non-young of year component for each species include sizes expected for several age classes, and the CPUE indexes are interpreted as 'age 1+' for both species. For the fall survey, recruitment for both species was considered to be substantially complete. There are two obvious size components for vermilion snapper, interpreted as age 0 and age 1+. Triggerfish do not show much modal separation, and the entire CPUE is interpreted as age 0+. However, when the triggerfish size frequencies are combined over years, probably 95% of distribution is consistent with sizes expected for young of the year, so the entire CPUE may be a reasonable index of year class strength, with sporadic error from inclusion of older ages in years of weak recruitment. Annual abundance indexes for 1987-2004, based on these interpretations of the size composition data, are reported here.

INTRODUCTION

Catch rates for greater triggerfish and vermilion snapper in the SEAMAP trawl surveys appeared sufficient to develop abundance indexes for the SEDAR9 assessments (SEDAR9-DW-27), but the indexes might be improved by incorporating age composition information. Rigorous sampling for size composition has been in place since 1987. The SEDAR9 DW examined the size distributions from that sampling as presented in SEDAR9-AW-18, and made recommendations on how to interpret the size compositions as age compositions. In summary, knife-edged cuts at 150 mm for vermilion snapper in the fall survey, 80 mm for vermilion snapper in the summer survey, and 140 mm for gray triggerfish in the summer survey were taken as the best estimates of separation of young of the year (age 0s, new recruits) from older fish. The data were considered insufficient to support boundaries that varied over years. In the absence of much direct ageing of the trawl survey fish, age length keys were not seen as a viable option. More elaborate approaches to extracting modes from overlapping distribution did not seem warranted. Gray triggerfish in the fall survey do not separate into obvious size modes, so that survey was left as a 0+ index. However, to look at sensitivity, I added consideration of a separation at 210 mm for this paper.

METHODS

This paper uses the results from SEDAR9-DW-27, and applies the index derivation portions of SEDAR7-AW-15 to produce trawl CPUE indexes with specified age ranges for both the fall and summer surveys, 1987-2004. The distributions of the indexes from the Bayesian models are approximated as lognormal distributions. The samples from each station are weighted by the catch and numbers, and the spatial area of each stratum, summed, and divided by the total to give age fraction estimates . The age composition fractions are then modeled by a multinomial distribution, inserting as a sample size the total number of fish measured, ignoring the weightings used in calculating the age fractions. A short BUGS program multiplies draws from the lognormal index distribution by draws from the age composition multinomial, and produces a distribution of the index at age for each year. As with the non-aged indexes, these distributions are then simplified to lognormal for input into the stock assessment.

RESULTS

The index and size distribution parameters that become input for generating age-specific indexes are collected in Tables 1-4. Tables of BUGS output for the indexes are presented in Table 5-9. Tabled versions for the lognormal parameters best describing the indexes discussed below are presented in Tables 10-14.

The vermilion snapper Fall Survey has CPUE indexes for age 0, and age 1+ (Figs. 1 & 2, respectively). The Summer Survey has a CPUE index for age 1+ (Fig 3).

For gray triggerfish, the lack of obvious separation in the size distribution led to the DW recommendation to treat the unaged Fall CPUE as 0+. However, it was noted that true age 0's probably dominate numerically most of the time, and thus the unaged CPUE might be a valid recruitment index. To evaluate the possible error of that interpretation, an index was calculated for fish <210mm (Fig. 4). A plot of CPUE values for fish<210 mm vs the unaged CPUE index values is presented in Fig 5. For Summer, a gray triggerfish index for age 1+ is available (Fig.6).

DISCUSSION

There were no special anomalies noted in the analytical work to derive age-specific CPUEs under the DW guidelines. The major limitations remain the inability of the SEAMAP surveys to cover the full range of the stocks, and the modest precisions of the unaged annual CPUEs. Small sample sizes for measured fish go hand in hand with the low CPUE precisions, and the small sample sizes aurgued against trying to establish different boundaries between ages in different years. This could easily limit accuracy of course, but the limitation was already well understood at the DW. Multiple index points for the same cohort generally do not 'line up' very convincingly – this strengthens the view that there is a lot of 'noise' present, as is quite evident in the confidence intervals for the individual points.

The product of the unaged CPUE with lognormal error and the multinomial age composition has a skewed distribution on the arithmetic scale (particularly so for vermilion snapper), but appears very symmetrical on a log scale. Lognormal error appears to be a very good approximation for use in the assessment models, and parameters for a lognormal distribution for each index value are available in Tables 10-14. For these parameters, the median value from the BUGS results were taken as the mean parameter, and the standard error parameters were calculated as the interquartile range divided by 1.34898. It is possible to calculate a correlation matrix between age 0 and age 1+ indexes, but that was not done here. I did report correlation estiamtes for red snapper in SEDAR7, but there was no way to incorporate them in the assessment models at that time. There was actually very little information evident in the correlations for red snapper, so their omission here is probably of no consequence. The multinormial connection does create one wrinkle that the assessment models must deal with. An observed fraction of zero for an age class will remain zero in the simulation results, so the lognormal value will be undefined. This result occurred two years in the Fall Index for age 0 vermilion snapper.

In view of the close agreement (Fig 5) between the unaged index and an alternate age zero approximation for gray triggerfish in the Fall Survey, I recommend staying with the DW recommendation, and using the unaged index as the recruitment index. Lognormal parameters for that are presented in the first to columns of Table 3. Note that the spread parameter used in this table is tau, which is the reciprocal of variance, and not the standard error parameter used in Tables 10-14.

I did not attempt estimation of juvenile M via the procedures used for red snapper, as the data available here clearly won't support a meaningful analysis. Only vermilion snapper have indexes for the same cohort at 3 points in time, and the levels of CPUE don't differ much between them. It would appear noise overwhelms any exponential decline over time. For gray triggerfish, only Fall to Summer Z could be estimated, and that didn't have enough effort contrast to get anything useful even for the more abundant red snapper. Looking at the decline in central tendency from fall to summer would give an apparent Z of about 3 per year. This seems high but not implausible given the red snapper results (Z`~2). However, this higher value for triggerfish may reflect some exit from vulnerability by summer at age 1. This would be consistent with an age selection discussed at the DW, where the few fished aged from trawls were substantially smaller than sizes at age for hook and line caught fish.

LITERATURE CITED

All references are to SEDAR7 or SEDAR9 DW and AW papers

Table 1. Input parameters for the age-specific indexes, vermilion snapper, Fall. Median and tau are lognormal parameters describing the unaged cpue index. (Tau is the reciprocal of variance) The Fract's are the age group fractions determined by splitting the length frequency distribution at 150mm.. The n column is the number of fish actually measured during the survey. The rows are years, from 1987 to 2004.

Mean	Tau	Fract 0	Fract 1+	n
-0.5166	2.933591	0.229553	0.770447	20
-2.532	1.728687	0	1	10
-0.4187	4.024187	0.620415	0.379585	32
0.03351	5.696482	0.949933	0.050067	46
0.4368	5.458301	0.48941	0.51059	126
-0.9962	2.716938	0.361564	0.638436	43
0.4795	5.450746	0.142435	0.857565	108
0.01756	4.814413	0.456656	0.543344	145
-0.4483	3.798157	0.490672	0.509328	68
-0.5057	4.217086	0.359987	0.640013	40
-0.8459	3.360264	0.827575	0.172425	11
-1.899	2.221846	0.036136	0.963864	7
-0.506	3.880463	0.668202	0.331798	59
-0.04872	4.084214	0.883809	0.116191	46
-0.6458	3.766313	0.176041	0.823959	55
-0.2712	3.36749	0.7263	0.2737	46
-0.9139	3.808935	0.133686	0.866314	34
0.2196	4.200445	0.771047	0.228953	146

Table 2. Input parameters for the age-specific indexes, vermillion snapper, Summer. Length boundary was 80 mm.

Mean	Tau	Fract 0	Fract 1+	nnn[]
0.233	2.9433	0	1	32
-2.109	1.586471	0	1	9
-1.341	1.546649	0	1	9
-1.743	1.735446	0	1	9
0.06909	3.211938	0.274565	0.725435	98
-2.18	1.721967	0	1	10
-1.473	2.212058	0	1	18
-1.724	2.103997	0	1	39
-1.133	2.49164	0.810005	0.189995	24
-0.03205	3.257653	0	1	114
-0.4954	2.925637	0	1	58
-1.549	1.838082	0.04766	0.95234	8
-0.5599	2.443371	0.084516	0.915484	47
-0.501	2.621337	0.415228	0.584772	58
-0.6919	1.828147	0	1	3
-0.3647	2.991958	0.083156	0.916844	49
-2.162	1.35004	0	1	4
-1.813	1.574686	0	1	6

Table 3. Input parameters for the age-specific indexes, gray triggerfish, Fall. Length boundary was 210 mm. This breakdown was done for sensitivity – the original DW recommendation was to use the unaged index as an age 0+ index. However, age 0's tend to dominate numerically, so the unaged index may approximate a pure age 0 index. This breakdown should give an idea of the purity of the unaged index, assuming a 210 mm boundary is a passable approximation.

Mean	Tau	Fract 0	Fract 1+	n
0.794	18.76609	1	0	45
0.643	25.52634	0.965779	0.034221	38
1.218	31.85776	0.976257	0.023743	138
-0.2494	15.48746	0.795113	0.204887	49
2.558	46.88982	0.957173	0.042827	533
-0.2774	15.96637	0.778233	0.221767	69
1.857	39.00349	0.751997	0.248003	375
1.814	36.59328	0.960197	0.039803	376
0.9447	27.06487	0.849101	0.150899	174
0.8169	29.39749	0.87105	0.12895	103
0.435	21.75777	0.892533	0.107467	111
-1.919	6.453896	0.816289	0.183711	7
1.242	32.67285	0.98578	0.01422	222
1.796	41.26411	0.969775	0.030225	389
2.411	52.03886	0.995936	0.004064	520
0.9479	29.75519	0.928605	0.071395	163
0.7829	28.05131	0.907397	0.092603	97
0.9617	23.78519	0.959152	0.040848	163

Table 4. Input parameters for the age-specific indexes, gray triggerfish, Summer. Length boundary was 140 mm.

Mean	Tau	Fract 0	Fract 1+	n
-0.5532	9.850952	0.086638	0.913362	20
-1.232	7.373061	0.139601	0.860399	14
-0.4497	8.852134	0.625403	0.374597	39
-0.03903	12.00105	0.27384	0.72616	37
0.32	13.86355	0.385988	0.614012	52
-0.5578	10.29151	0.081619	0.918381	61
-0.9561	8.739973	0.434325	0.565675	23
0.3921	14.52127	0.579782	0.420218	106
0.09473	13.25596	0.257557	0.742443	81
-1.019	8.793852	0.067001	0.932999	57
-0.1356	11.21975	0.463264	0.536736	46
-1.323	7.221104	0.361882	0.638118	21
0.8421	16.77119	0.803943	0.196057	140
1.325	14.43957	0.949367	0.050633	197
1.423	11.03974	0.769667	0.230333	91
0.1052	12.71632	0.175107	0.824893	79
-1.077	5.817299	0.504333	0.495667	16
-0.9885	8.308437	0.101182	0.898818	24

Table 5. BUGS output of index for Age 0 vermilion snapper in the Fall SEAMAP Survey. The first subscript to cpue is year: 1 is 1987; 18 is 2004. The second subscript is age class: 1 is age 0; 2 is age 1+.

node	mean	sd	MC error	2.5%	25.0%	median	75.0%	97.5%	start	sample
cpue[1,1]	0.1632	0.1309	0.001019	0.02341	0.07732	0.129	0.209	0.504	501	20000
cpue[2,1]	0.0	0.0	5.0E-13	0.0	0.0	0.0	0.0	0.0	501	20000
cpue[3,1]	0.4605	0.254	0.001737	0.145	0.2838	0.4022	0.5719	1.102	501	20000
cpue[4,1]	1.075	0.4742	0.003326	0.4336	0.7399	0.9792	1.31	2.235	501	20000
cpue[5,1]	0.8345	0.3831	0.002594	0.326	0.5646	0.7559	1.019	1.786	501	20000
cpue[6,1]	0.1594	0.1148	8.043E-4	0.03581	0.08341	0.1291	0.2009	0.461	501	20000
cpue[7,1]	0.2526	0.13	9.507E-4	0.08475	0.1612	0.2253	0.3132	0.5755	501	20000
cpue[8,1]	0.5132	0.2517	0.001876	0.1841	0.338	0.4622	0.6308	1.138	501	20000
cpue[9,1]	0.3579	0.2029	0.001348	0.109	0.2197	0.312	0.444	0.87	501	20000
cpue[10,1]	0.2428	0.1392	0.001121	0.07254	0.1472	0.2117	0.3026	0.5948	501	20000
cpue[11,1]	0.4169	0.2531	0.001834	0.1154	0.2425	0.3549	0.5246	1.064	501	20000
cpue[12,1]	0.006774	0.01708	1.172E-4	0.0	0.0	0.0	0.0	0.05371	501	20000
cpue[13,1]	0.456	0.2505	0.001906	0.1475	0.2825	0.3985	0.5642	1.101	501	20000
cpue[14,1]	0.9514	0.5045	0.003531	0.31	0.601	0.8414	1.184	2.206	501	20000
cpue[15,1]	0.1053	0.06736	4.703E-4	0.02642	0.05888	0.08835	0.1327	0.2804	501	20000
cpue[16,1]	0.6432	0.3839	0.002647	0.1858	0.3805	0.5525	0.8001	1.617	501	20000
cpue[17,1]	0.06064	0.04461	3.242E-4	0.009417	0.03012	0.04976	0.07817	0.1765	501	20000
cpue[18,1]	1.08	0.5615	0.003995	0.3679	0.6922	0.9572	1.334	2.487	501	20000

Table 6. BUGS output of index for Age 1+ vermilion snapper in the Fall SEAMAP Survey.

node	mean	sd	MC error	2.5%	25.0%	median	75.0%	97.5%	start	sample
cpue[1,2]	0.5472	0.3573	0.002527	0.1432	0.3047	0.4602	0.6856	1.481	501	20000
cpue[2,2]	0.1051	0.09134	6.781E-4	0.01777	0.04744	0.07981	0.1314	0.3449	501	20000
cpue[3,2,]	0.2813	0.1649	0.001083	0.08023	0.1676	0.2434	0.3519	0.6986	501	20000
cpue[4,2]	0.05687	0.04649	3.18E-4	0.0	0.02508	0.04657	0.07693	0.1772	501	20000
cpue[5,2]	0.868	0.3955	0.002785	0.3405	0.5877	0.791	1.059	1.847	501	20000
cpue[6,2]	0.2821	0.1929	0.001419	0.0694	0.1525	0.2342	0.3535	0.781	501	20000
cpue[7,2]	1.521	0.6812	0.004993	0.5965	1.036	1.389	1.856	3.231	501	20000
cpue[8,2]	0.6113	0.298	0.00213	0.2221	0.4027	0.5495	0.7515	1.354	501	20000
cpue[9,2]	0.3718	0.2111	0.001438	0.116	0.2268	0.3238	0.4626	0.9061	501	20000
cpue[10,2]	0.4316	0.2307	0.001778	0.1418	0.2717	0.3807	0.5343	1.012	501	20000
cpue[11,2]	0.08571	0.08253	5.927E-4	0.0	0.03237	0.06466	0.1162	0.3017	501	20000
cpue[12,2]	0.1805	0.1368	0.001011	0.03801	0.0908	0.1431	0.2283	0.5411	501	20000
cpue[13,2]	0.2268	0.1323	9.266E-4	0.06866	0.1371	0.1964	0.2804	0.5729	501	20000
cpue[14,2]	0.1249	0.08747	6.537E-4	0.02268	0.06562	0.104	0.1601	0.3533	501	20000
cpue[15,2]	0.4927	0.2694	0.001821	0.1579	0.3044	0.4306	0.6106	1.189	501	20000
cpue[16,2]	0.2415	0.1571	0.001066	0.05986	0.1353	0.2024	0.303	0.6539	501	20000
cpue[17,2]	0.3958	0.2185	0.001725	0.1242	0.2447	0.3477	0.4902	0.9511	501	20000
cpue[18,2]	0.3212	0.1754	0.001273	0.1036	0.2005	0.2825	0.3979	0.7668	501	20000

Table 7. BUGS output of index for Age 1+ vermilion snapper in the Summer SEAMAP Survey

node	mean	sd	MC error	2.5%	25.0%	median	75.0%	97.5%	start	sample
cpue[1,2]	1.494	0.9482	0.00698	0.3984	0.8554	1.265	1.865	3.914	501	20000
cpue[2,2]	0.1656	0.1548	0.001073	0.02518	0.07126	0.1214	0.2061	0.5665	501	20000
cpue[3,2]	0.3631	0.3517	0.002426	0.05386	0.1513	0.2612	0.4575	1.26	501	20000
cpue[4,2]	0.2319	0.2069	0.001363	0.03992	0.1047	0.1748	0.2891	0.7614	501	20000
cpue[5,2]	0.912	0.5511	0.003732	0.2661	0.5336	0.7814	1.137	2.333	501	20000
cpue[6,2]	0.1505	0.1315	9.367E-4	0.0252	0.06811	0.1134	0.1897	0.5007	501	20000
cpue[7,2]	0.2868	0.2186	0.001569	0.06288	0.1452	0.229	0.3593	0.8598	501	20000
cpue[8,2]	0.2248	0.1734	0.001166	0.0477	0.1119	0.1779	0.2832	0.6776	501	20000
cpue[9,2]	0.07389	0.06347	4.294E-4	0.009275	0.03269	0.05675	0.09427	0.2416	501	20000
cpue[10,2]	1.131	0.665	0.004498	0.3302	0.6721	0.9738	1.416	2.841	501	20000
cpue[11,2]	0.7234	0.463	0.003308	0.1918	0.41	0.6087	0.9041	1.929	501	20000
cpue[12,2]	0.2669	0.2283	0.001601	0.04617	0.1222	0.203	0.3343	0.8689	501	20000
cpue[13,2]	0.6454	0.4612	0.00327	0.1489	0.3399	0.5239	0.8092	1.864	501	20000
cpue[14,2]	0.4295	0.298	0.002318	0.103	0.2308	0.353	0.5341	1.218	501	20000
cpue[15,2]	0.6586	0.5527	0.003471	0.116	0.3062	0.5016	0.8325	2.132	501	20000
cpue[16,2]	0.7577	0.4891	0.00357	0.2013	0.4298	0.6372	0.9431	2.032	501	20000
cpue[17,2]	0.167	0.181	0.001388	0.02214	0.06469	0.115	0.2046	0.624	501	20000
cpue[18,2]	0.2254	0.2119	0.001452	0.03458	0.096	0.1642	0.2819	0.7755	501	20000

Table 8. BUGS output of index for an alternativeAge 0 gray triggerfish in the Fall SEAMAP Survey. This aged index was created to examine sensitivity to assuming the original (unaged) index was essentially an age 0 index, even though occasionally contaminated by older fish.

node	mean	sd	MC error	2.5%	25.0%	median	75.0%	97.5%	start	sample
cpue[1,1]	2.273	0.5337	0.003949	1.404	1.895	2.208	2.589	3.498	501	20000
cpue[2,1]	1.871	0.3782	0.002588	1.24	1.601	1.832	2.104	2.721	501	20000
cpue[3,1]	3.354	0.5997	0.00403	2.337	2.928	3.297	3.724	4.664	501	20000
cpue[4,1]	0.6394	0.1707	0.001177	0.367	0.5172	0.6199	0.7393	1.03	501	20000
cpue[5,1]	12.5	1.828	0.01213	9.306	11.21	12.37	13.68	16.38	501	20000
cpue[6,1]	0.6083	0.1602	0.001083	0.3542	0.4923	0.5896	0.7024	0.9713	501	20000
cpue[7,1]	4.874	0.7936	0.005486	3.493	4.317	4.813	5.363	6.604	501	20000
cpue[8,1]	5.968	0.9909	0.006831	4.26	5.271	5.88	6.576	8.144	501	20000
cpue[9,1]	2.223	0.433	0.003055	1.484	1.918	2.187	2.488	3.178	501	20000
cpue[10,1]	2.006	0.3797	0.002739	1.364	1.738	1.973	2.235	2.859	501	20000
cpue[11,1]	1.411	0.3075	0.002247	0.9015	1.191	1.379	1.594	2.109	501	20000
cpue[12,1]	0.1299	0.05894	4.627E-4	0.04877	0.08841	0.1191	0.1591	0.2764	501	20000
cpue[13,1]	3.474	0.6116	0.004311	2.433	3.043	3.414	3.845	4.827	501	20000
cpue[14,1]	5.9	0.934	0.006732	4.289	5.239	5.823	6.486	7.933	501	20000
cpue[15,1]	11.2	1.551	0.0106	8.436	10.12	11.11	12.17	14.53	501	20000
cpue[16,1]	2.435	0.4571	0.003088	1.666	2.112	2.394	2.711	3.463	501	20000
cpue[17,1]	2.018	0.3915	0.002906	1.361	1.738	1.98	2.257	2.89	501	20000
cpue[18,1]	2.561	0.5291	0.003813	1.682	2.179	2.508	2.882	3.749	501	20000

Table 9. BUGS output of index for Age 1+ gray triggerfish in the Summer SEAMAP Survey.

node	mean	sd	MC error	2.5%	25.0%	median	75.0%	97.5%	start	sample
cpue[1,2]	0.5536	0.186	0.001273	0.2732	0.4209	0.5245	0.6532	0.9972	501	20000
cpue[2,2]	0.2673	0.1064	7.072E-4	0.1163	0.1925	0.2486	0.3214	0.5266	501	20000
cpue[3,2]	0.2536	0.1041	7.081E-4	0.1047	0.1787	0.2357	0.3081	0.5043	501	20000
cpue[4,2]	0.7285	0.227	0.001495	0.3792	0.5672	0.6959	0.8536	1.26	501	20000
cpue[5,2]	0.8784	0.2596	0.001796	0.4771	0.6926	0.8446	1.026	1.478	501	20000
cpue[6,2]	0.5528	0.1786	0.001246	0.2848	0.4255	0.5258	0.65	0.9762	501	20000
cpue[7,2]	0.2298	0.09256	7.178E-4	0.09878	0.1634	0.2134	0.2782	0.4526	501	20000
cpue[8,2]	0.6419	0.1882	0.001347	0.3481	0.5046	0.6178	0.7499	1.074	501	20000
cpue[9,2]	0.8477	0.2457	0.001749	0.4654	0.6726	0.8135	0.9857	1.425	501	20000
cpue[10,2]	0.3551	0.1228	9.234E-4	0.1747	0.2671	0.3358	0.4217	0.6483	501	20000
cpue[11,2]	0.4903	0.1639	0.00118	0.2419	0.3744	0.4672	0.5795	0.8737	501	20000
cpue[12,2]	0.1829	0.07855	5.094E-4	0.07383	0.1275	0.1682	0.2221	0.376	501	20000
cpue[13,2]	0.4676	0.1424	0.001007	0.2439	0.3661	0.4493	0.5488	0.7971	501	20000
cpue[14,2]	0.1982	0.08258	6.019E-4	0.07271	0.1396	0.1855	0.2437	0.3921	501	20000
cpue[15,2]	1.0	0.3673	0.00276	0.4604	0.7371	0.9418	1.198	1.892	501	20000
cpue[16,2]	0.9581	0.2798	0.002164	0.5258	0.7586	0.9199	1.116	1.612	501	20000
cpue[17,2]	0.1844	0.0935	6.164E-4	0.05922	0.1177	0.1656	0.2312	0.4188	501	20000
cpue[18,2]	0.3555	0.1307	9.355E-4	0.1663	0.2631	0.3336	0.4247	0.6688	501	20000

Table 10. Lognormal parameters approximating the age 0 index for vermilion snapper, Fall.. The undefined entries indicate a value for the index of zero on the arithmetic scale. Values are base e.

Year	Mean	Std Err
1987	-2.048	0.737594
1988	undefined	undefined
1989	-0.9107	0.519059
1990	-0.02097	0.423505
1991	-0.2798	0.437998
1992	-2.047	0.651603
1993	-1.49	0.492224
1994	-0.7717	0.46272
1995	-1.165	0.521876
1996	-1.552	0.534478
1997	-1.036	0.572136
1998	undefined	undefined
1999	-0.92	0.512758
2000	-0.1727	0.502528
2001	-2.426	0.602678
2002	-0.5934	0.550935
2003	-3.001	0.70646
2004	-0.04376	0.486293

Table 11. Lognormal parameters approximating the age 1+ index for vermilion snapper, Fall. Values are base e.

Year	Mean	Std Err
1987	-0.776	0.600824
1988	-2.528	0.754644
1989	-1.413	0.550045
1990	-3.067	0.830998
1991	-0.2345	0.436433
1992	-1.452	0.622693
1993	0.3287	0.432015
1994	-0.5987	0.462572
1995	-1.128	0.528622
1996	-0.9658	0.501342
1997	-2.739	0.947382
1998	-1.944	0.683479
1999	-1.627	0.530771
2000	-2.263	0.66124
2001	-0.8425	0.515797
2002	-1.597	0.59823
2003	-1.056	0.515278
2004	-1.264	0.508088

Table 12. Lognormal parameters approximating the age 1+ index for vermilion snapper, Summer. Values are base e.

Year	Mean	Std Err
1987	0.2351	0.577844
1988	-2.108	0.78652
1989	-1.343	0.819879
1990	-1.744	0.753162
1991	-0.2466	0.560572
1992	-2.177	0.759092
1993	-1.474	0.671619
1994	-1.726	0.687927
1995	-2.869	0.785038
1996	-0.02652	0.55264
1997	-0.4964	0.586221
1998	-1.595	0.745749
1999	-0.6465	0.64293
2000	-1.041	0.621803
2001	-0.69	0.741078
2002	-0.4507	0.582566
2003	-2.163	0.853237
2004	-1.806	0.798381

Table 13. Lognormal parameters approximating an age 0 index for gray triggerfish, Fall. This is the sensitivity case based on a size boundary at 210 mm. (The DW recommendation was the unaged index; parameters in Table 3.) Values are base e.

Year	Mean	Std Err
1987	0.792	0.231286
1988	0.6052	0.202449
1989	1.193	0.178654
1990	-0.4782	0.264867
1991	2.515	0.147519
1992	-0.5284	0.263458
1993	1.571	0.160121
1994	1.772	0.163827
1995	0.7824	0.192738
1996	0.6796	0.186511
1997	0.3212	0.215719
1998	-2.128	0.435885
1999	1.228	0.173464
2000	1.762	0.158638
2001	2.408	0.137141
2002	0.8731	0.185251
2003	0.6831	0.193554
2004	0.9196	0.207045

Table 14. Lognormal parameters approximating the age 1+ distribution for gray triggerfish, Summer. Values are base e.

Year	Mean	Std Err
1987	-0.6453	0.325802
1988	-1.392	0.380287
1989	-1.445	0.404009
1990	-0.3625	0.302896
1991	-0.1689	0.291161
1992	-0.6429	0.314237
1993	-1.544	0.395113
1994	-0.4816	0.293703
1995	-0.2065	0.283347
1996	-1.091	0.338404
1997	-0.761	0.323874
1998	-1.783	0.410681
1999	-0.8	0.300153
2000	-1.685	0.412905
2001	-0.05995	0.359902
2002	-0.08348	0.28629
2003	-1.798	0.501119
2004	-1.098	0.354861

Figure 1. BUGS box plot of Age 0 index for vermilion snapper, Fall, 1987-2004.

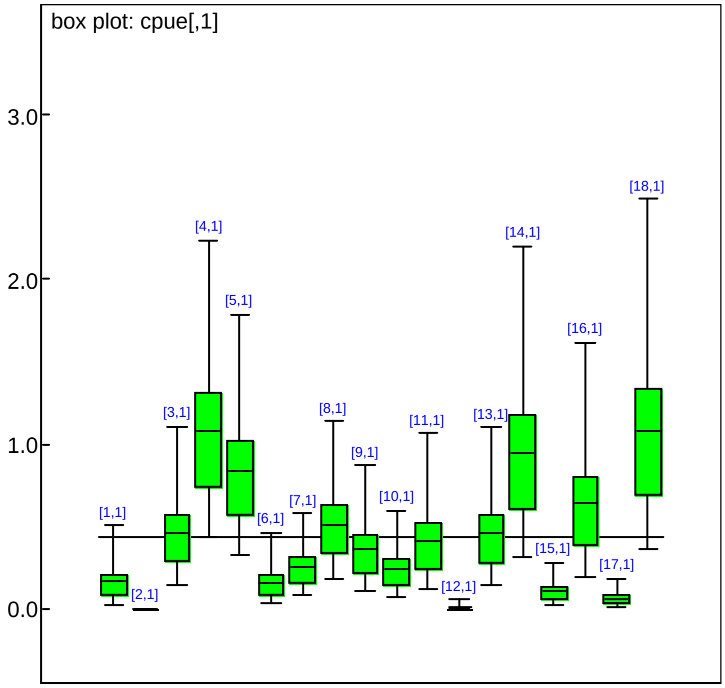

Figure 2. Bugs box plot for Age 1+ index for vermilion snapper, Fall, 1987-2004.

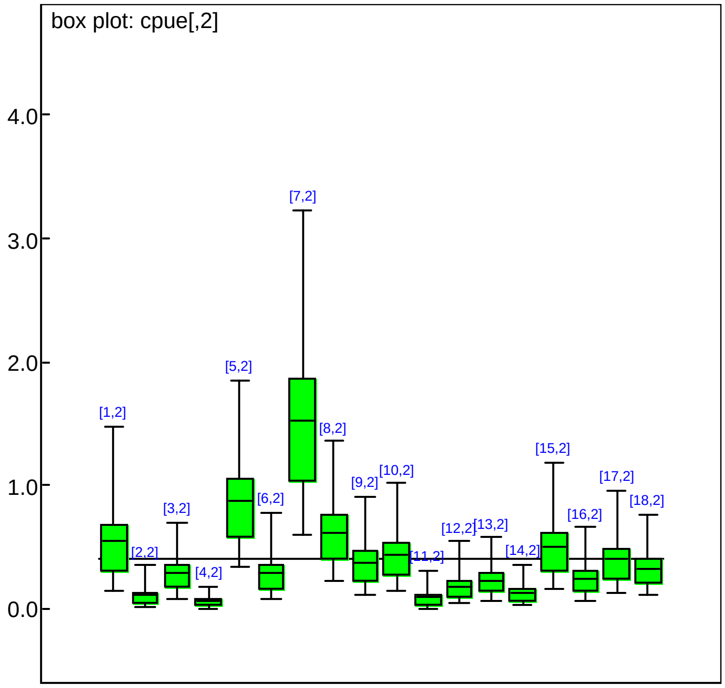

Figure 3. BUGS box plot of Age 1+ index for vermilion snapper, Summer, 1987-2004.

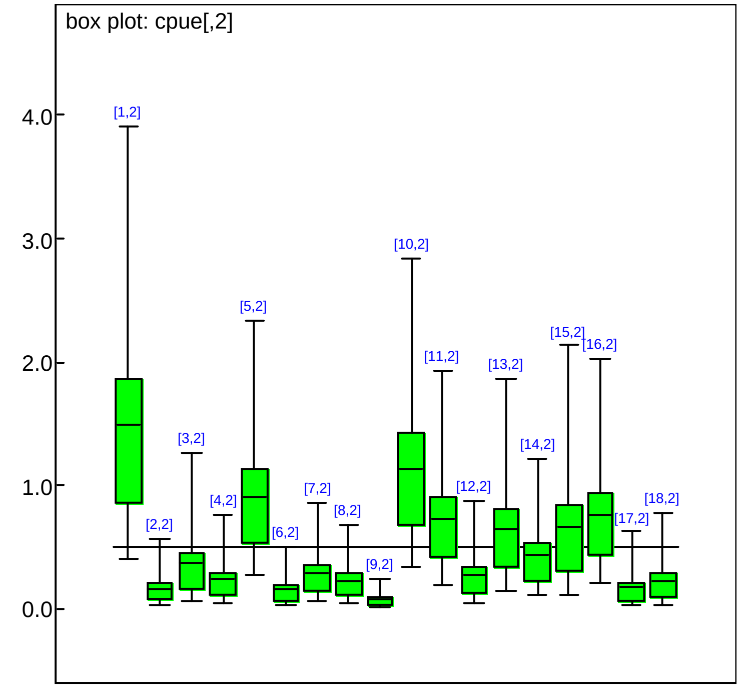

Figure 4. BUGS box plot of Age 0 sensitivity trial for gray triggerfish, Fall 1987-2004.

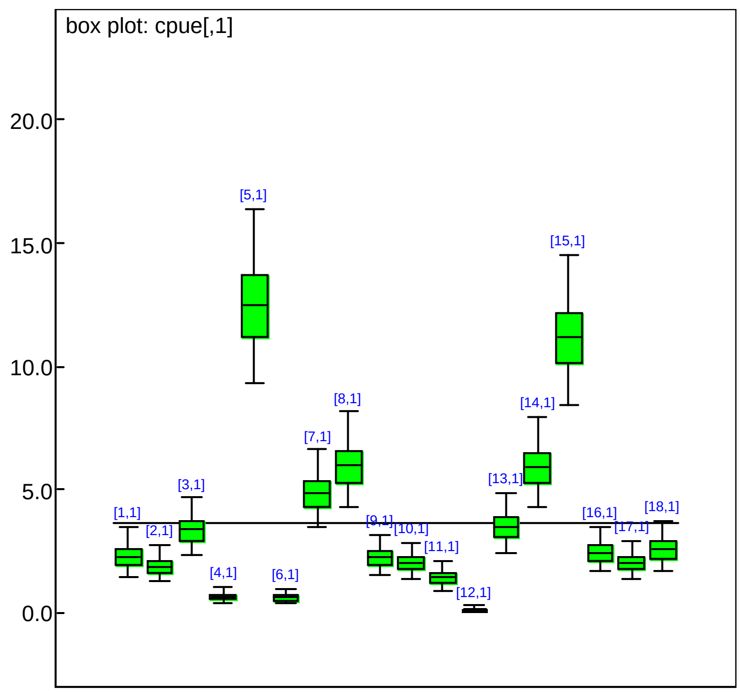

Figure 5. Comparison of the unaged Fall index for gray triggerfish with the sensitivity case eliminating fish >210 mm.

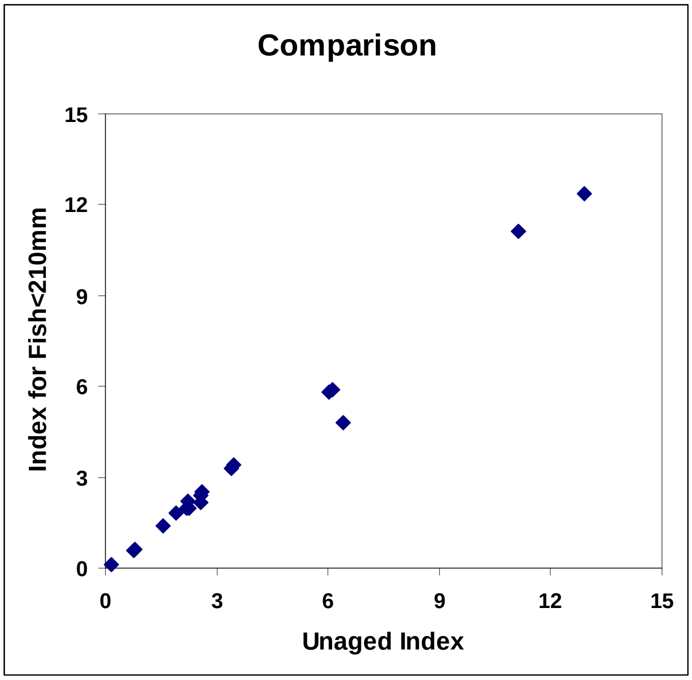

Figure 6. BUGS box plot of Age 1+ index for gray triggerfish, Summer 1987-2004.