Separating Vermilion Snapper Trawl Indexes into East and West Components

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SUMMARY

Summations over appropriate strata in the SEAMAP trawl surveys were used to produce East and West indexes for vermilion snapper, separated at 89 degrees west (essentially, at the Mississippi river). The West Summer index is well determined, and can be extended back via calibration of Early SEAMAP and Texas Closure surveys to 1981. The West Fall survey is well determined during the full SEAMAP period (1987-2004), but extension back in time via calibration with the old Fall Groundfish surveys failed. Indexing the population east of the river is more problematic, mainly because the SEAMAP survey can cover only a small portion of the eastern range of vermilion snapper. Also, the eastern portion of the SEAMAP survey area is only about 1/5 the size of the western area, with proportionately fewer stations. In some years, no catches of vermilion occurred in the eastern survey area. The age partitioning described in SEDAR9-AW-1 was applied to the eastern and western indexes separately (1987-2004). The western aged indexes are well behaved, but the eastern indexes lack size compositions some years (those with little or no catch), and may or may not be useful.

INTRODUCTION AND METHODS

The modern SEAMAP trawl surveys (1987-2004) are stratified in an alongshore direction into 5 zones, based on the shrimp statistical areas: 21-20 in south Texas, 19-18 for the upper Texas coast, 17-16 for western Louisiana, 15-13 for central Louisiana west of the river, and 12-11 east of the river. Indexes for the areas east and west of the river were calculated by keeping the same (Bayesian) model used in SEDAR9-DW-27, and summing over the strata east and west of the river. (More details about the modeling are available in SEDAR7-DW-2; more about the designs of the surveys, and details about data are to be found in SEDAR7-DW-1.) A particular strength of the Bayesian modeling approach was that it allowed development of a method to extend the indexes of abundance back in time, by calibrating with earlier surveys. The calibrations follow the same basic procedures used in SEDAR9-DW-27, but the calibrations are calculated separately for the east and west portions, just as in SEDAR7-DW-2. For input to the stock assessments, the complete distributions of the index estimated by the BUGS program are simplified as lognormal distributions, using the median value of the log index as location parameter, and the interquartile range divided by 1.34898 as the standard error.

Age specific indexes are calculated by the same rules described in SEDAR9-AW-1, but using measurements from each side of the river separately. The samples from each station are weighted by the catch and numbers, and the spatial area of each stratum, and summed. The age composition fractions are then modeled by a multinomial distribution, inserting as a sample size the total number of fish actually 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 simplified to lognormal for input into the stock assessment.

RESULTS

The Fall SEAMAP index time series for 1987-2004 are shown in Figs. 1 & 2. On an arithmetic scale, the distributions are quite skewed, but on a log scale (Figs. 3 & 4), the distributions are nearly symmetrical, and a lognormal approximation appears sound. Note that the model structure will produce small positive index values in years with zero catch in an area, based on the fixed main effects and quasi-random local effects that essentially ‘borrow’ information from other cells. Lognormal parameters to communicate these results to the stock assessment models are include in Table 1. The indexes, which are (highly processed) catch per hour rates, are generally less than one fish per hour, but the precisions do suggest that some real signal relevant to abundance variations has been captured.

The age fractions and sample sizes for the age-specific indexes are also included in Table 1. For Fall West, the age-specific indexes (Figs. 5 & 6) could be calculated for at least one of the age groups every year, and parameters for entering the indexes into the stock assessment are shown in Table 2. In the Fall East, there were no fished measured in 1988, 1992, 1997, or 2004. (Catches were either zero, or the few fish caught could not be measured.) Thus, there is no age composition information for those years, and no age-specific index values. (For this reason, I have not plotted the East aged indexes, although Table 2 does have parameter values for the years available.) Sample sizes in the east were small in general – in addition to the 4 years with no samples, seven years had less than 10 fish each. Additionally, observed fractions of zero result in undefined log parameters, so the available index points for the East are missing several years. The West had only two years of less than 10 fish, and no years with zero fish. (The two missing sets of parameters in the West in Table 2 are due to observed fractions of zero.) Note that the weightings, the Bayesian modeling, and the use of a lognormal variance structure each mean that the area-specific and age-specific indexes are not going to be simple partitions of the total index or of the area-specific unaged indexes – the age-specific indexes scale noticeably higher than the unaged indexes in what are nominally “catch per hour” units.

The Fall West analysis to extend the time series back via a calibration with the old Fall Groundfish survey produced numerical nonsense. The cause was the very low catch rates of vermilion in the western section of the old Groundfish ‘Primary Area’ (89 to 91.5 degrees west) during the SEAMAP survey years, on the order of 0.01 fish per hour. The nominal ratio between the full SEAMAP western CPUE and the western primary area CPUE was over 30x, but estimated extremely imprecisely (interquartile range 2.6x -405x). The resulting index would have 95% confidence intervals ranging over about 7 powers of ten.

The extension of the Fall East index into the Groundfish years is usable however, as the spatial areas covered east of the river were the same for the Groundfish Survey and the SEAMAP survey. The only calibration required is an adjustment for vessel speed, which (lacking comparative data) is treated as a constant. The calibrated East index for 1972-1986 is shown in Fig. 7. There are no size samples from the Groundfish years, so only an unaged extended index is available. Table 3 gives the lognormal parameters approximating the modeling results for the entire 1972-2004 time series.

The East and West Summer SEAMAP indexes (1987-2004) are shown in Figs. 8 & 9. Catch rates are lower in the summer than in the fall, so the number of size samples available was lower as well (Table 4). The west has at least a few fish every year, but the east has 4 years without any. However the main purpose of the age estimation in the summer is to eliminate the incompletely recruited age 0’s from the indexes. This ‘contamination’ is likely significant only in some years, and its existence would usually produce larger sample sizes. It would appear the Western index has sufficient data to make an age 1+ index, and that interpreting the unaged eastern index as it stands as age 1+ would be legitimate (parameters are part of Table 6). The West age 1+ index parameters are shown in Table 5.

The extensions of the summer indexes back in time via the predecessors of the modern SEAMAP survey appeared to work appropriately, so an extended index for the East is available for 1982-2004, and for the West, 1981-2004. Table 6 gives the lognormal parameters for these extended indexes. As there was no rigorous size sampling before 1987, these extended indexes cannot be made age-specific.

DISCUSSION

The West indexes available in this paper may be precision-limited, but they do cover the US portion of the western Gulf, 5-50 fm. The utility of the East indexes are less clear: only a small portion of the eastern Gulf can be covered. Also, sample sizes are much lower, so the East will generally be even more precision-limited than the West..

The unaged indexes are calculated by summing the individual stratum results from the common (Gulfwide) model of SEDAR9-DW-27 over the relevant geographic areas to get East and West indexes. The common model has 'Local' terms to pick up deviations from main effects (year, spatial stratum, day/night) predictions, but the absence of strong evidence for local effects in any cell, year effects common to all strata may dominate. I consider this structure preferable, but it may lead to East and West indexes that are more parallel over years than one might expect. (The summer indexes here are surprisingly parallel, the fall indexes less so.) Two alternatives would be to use totally separate models for east and west, or use purely-designed based estimation. Either of these alternatives will cause some index values to be based on very small sample sizes, so I don't recommend them. However, as the main effects estimates may tend to be dominated by western conditions, the model choice may justify some further discounting of the utility of the East indexes.

LITERATURE CITED

All references are to SEDAR7 and SEDAR9 documents.

Figure 1. Vermilion snapper, Fall survey, East, arithmetic scale, 1987-2004.

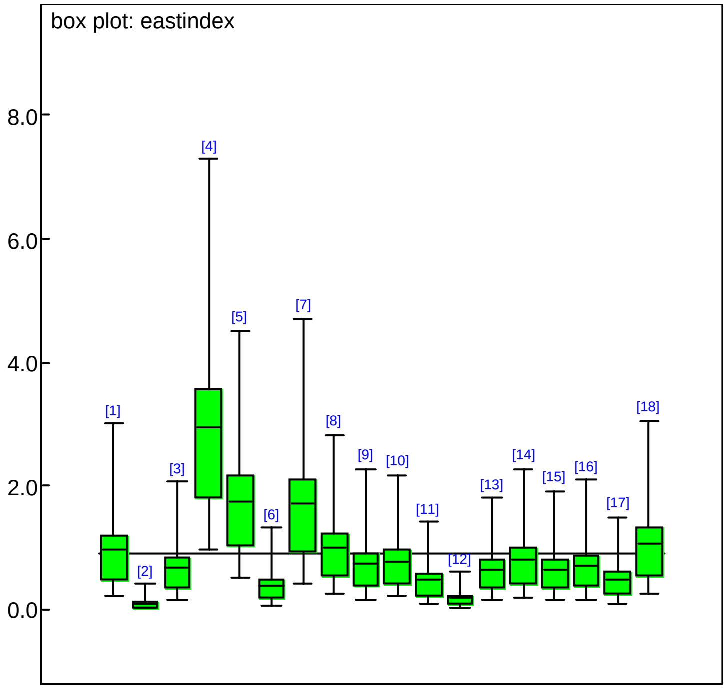

Figure 2. Vermilion snapper, Fall survey, West, arithmetic scale, 1987-2004.

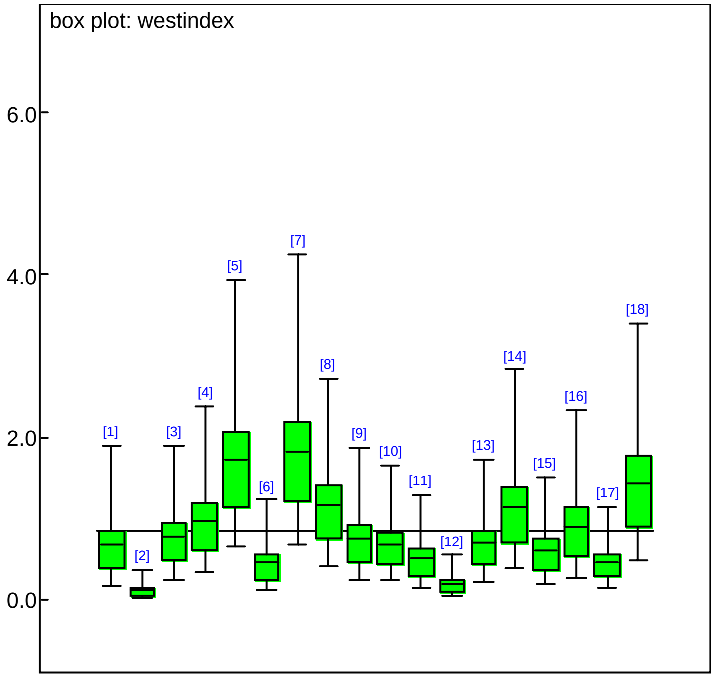

Figure 3. Vermilion snapper, Fall survey, East, log scale, 1987-2004.

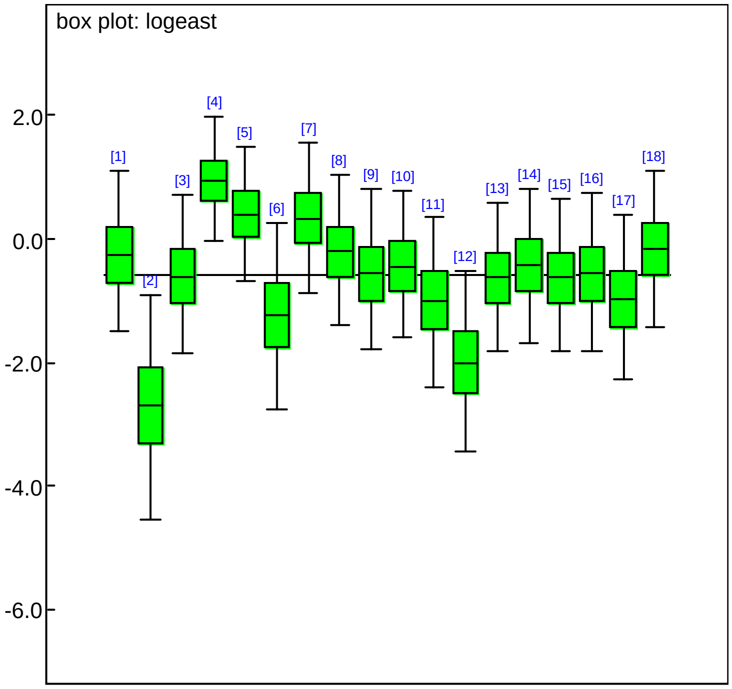

Figure 4. Vermilion snapper, Fall survey, West, log scale, 1987-2004.

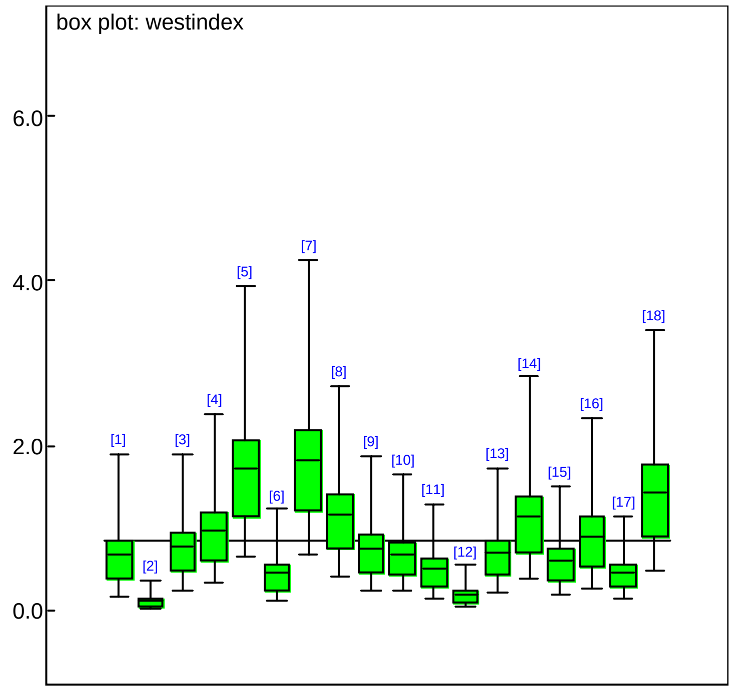

Table 1. Input values used to develop age-specific indexes in the fall survey. Mean and tau (tau is 1/variance) for a lognormal approximation to the posterior distribution for the unaged index (e units). The Fract columns are the age compositions for the East and West survey area. The N columns are number of fish actually measured in each survey area that year.

EAST						WEST				
Mean	Tau	Fract 0	Fract 1+	N		Mean	Tau	Fract 0	Fract 1+	N
-0.2722	2.294276	0.285254	0.714746	18	1987	0.5654	8.144038	0	1	2
-2.693	1.212659				1988	0.07889	248.1756	0	1	10
-0.6087	2.394293	1	0	3	1989	0.6591	8.477864	0.616652	0.383348	29
0.9346	4.067135	0.998244	0.001756	31	1990	0.8511	5.443207	0.268187	0.731813	15
0.3921	3.317481	0.880969	0.119031	30	1991	1.534	2.072678	0.463969	0.536031	96
-1.227	1.672152				1992	0.3704	17.93875	0.361564	0.638436	43
0.338	2.72499	0.673836	0.326164	9	1993	1.613	1.890919	0.133682	0.866318	99
-0.2051	2.699757	0	1	14	1994	1.022	4.153615	0.469313	0.530687	131
-0.5737	2.341889	0.557732	0.442268	18	1995	0.6334	8.437749	0.485521	0.514479	50
-0.4579	2.786571	0	1	17	1996	0.5892	10.6842	0.438689	0.561311	23
-0.9941	2.043352				1997	0.4271	16.87348	0.827575	0.172425	11
-2.005	1.769845	0	1	2	1998	0.1479	89.71583	0.038885	0.961115	5
-0.6389	2.730266	1	0	6	1999	0.602	9.737345	0.661825	0.338175	53
-0.4219	2.555037	0	1	1	2000	0.9679	3.866899	0.885096	0.114904	45
-0.642	2.604368	0.020165	0.979835	21	2001	0.5147	12.74258	0.218964	0.781036	34
-0.5675	2.406976	1	0	2	2002	0.7714	5.058224	0.715849	0.284151	44
-0.971	2.21157	1	0	4	2003	0.3953	22.57773	0.123516	0.876484	30
-0.1654	2.398693				2004	1.268	2.385529	0.771047	0.228953	146

Figure 5. Age 0 index for vermilion snapper, Fall survey, West, arithmetic scale, 1987-2004.

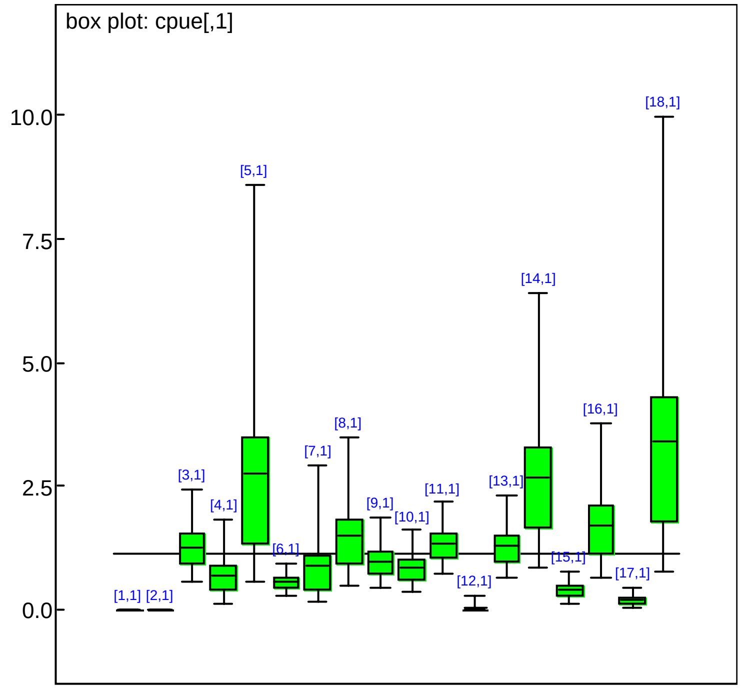

Figure 6. Age 1+ index for vermilion snapper, Fall survey, West, arithmetic scale, 1987-2004.

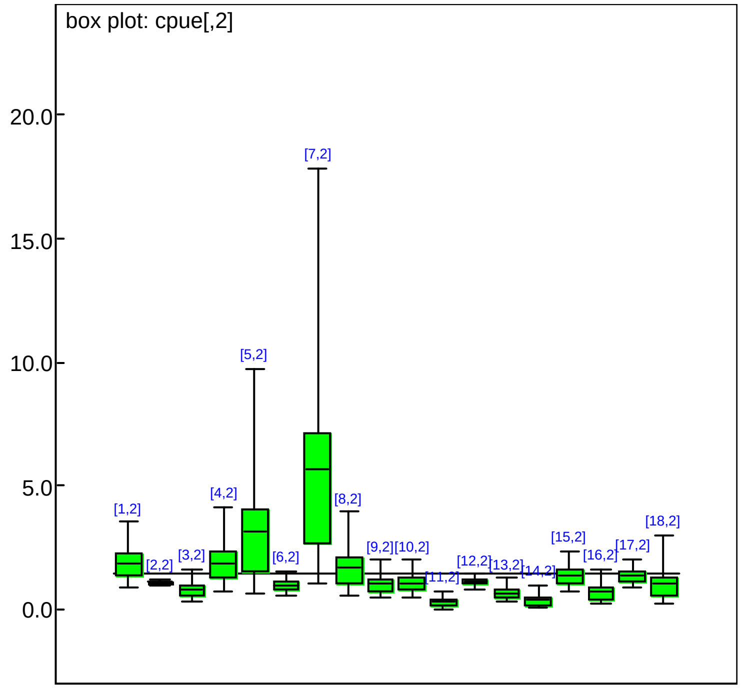

Table 2. Lognormal parameters approximating the aged index posteriors, Fall survey.

	EAST				WEST			
	Age 0		Age 1+		Age 0		Age 1+	
Year	Mean	Std Err	Mean	Std Err	Mean	Std Err	Mean	Std Err
1987	-1.595	0.78059	-0.6203	0.67792			0.5661	0.347151
1988							0.07862	0.063492
1989	-0.613	0.644858			0.1627	0.375343	-0.3269	0.427182
1990	0.9227	0.497413			-0.5217	0.631811	0.5284	0.457827
1991	0.2678	0.552195	-1.828	0.778366	0.7657	0.708832	0.91	0.708313
1992					-0.6505	0.316017	-0.08355	0.262272
1993	-0.07789	0.66554	-0.8707	0.821806	-0.429	0.769166	1.471	0.725956
1994			-0.2062	0.609942	0.2649	0.502602	0.3915	0.49576
1995	-1.174	0.699269	-1.415	0.713206	-0.0954	0.373838	-0.04082	0.366647
1996			-0.4571	0.603745	-0.2538	0.396885	5.16E-04	0.357381
1997					0.2389	0.281465	-1.401	0.77844
1998			-2.013	0.74649			0.1218	0.131811
1999	-0.6327	0.612018			0.1843	0.335112	-0.5	0.370354
2000			-0.419	0.619849	0.8405	0.508458	-1.258	0.675547
2001			-0.6615	0.621284	-1.031	0.439962	0.2697	0.296387
2002	-0.564	0.645228			0.4321	0.449673	-0.5133	0.506827
2003	-0.9794	0.677327			-1.735	0.564871	0.2589	0.221797
2004					1.015	0.657756	-0.2096	0.677623

Figure 7. Vermilion snapper, Fall groundfish results calibrated to SEAMAP scale, East, arithmetic scale, 1972-1986.

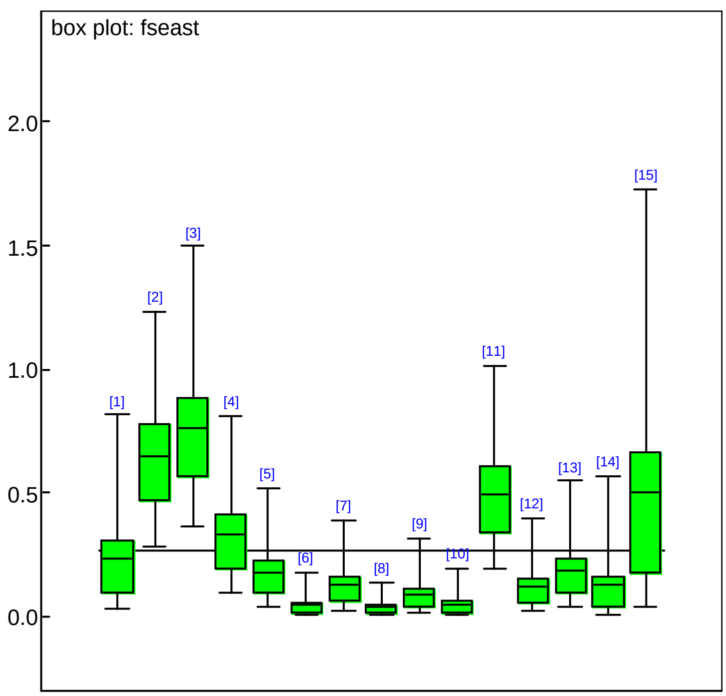

Table 3. Parameters for lognormal distribution approximating the extended East index posteriors, Fall. Parameters are in natural log (e) untis.

Year	Mean	Std Err
1972	-1.775	0.862874
1973	-0.5011	0.374135
1974	-0.341	0.325579
1975	-1.264	0.553678
1976	-1.92	0.659016
1977	-3.485	0.99705
1978	-2.266	0.669395
1979	-3.668	0.944417
1980	-2.717	0.836929
1981	-3.411	0.994826
1982	-0.7952	0.441889
1983	-2.396	0.770953
1984	-1.913	0.66124
1985	-2.538	1.102314
1986	-1.047	0.988376
1987	-0.2722	0.660203
1988	-2.693	0.908094
1989	-0.6087	0.646266
1990	0.9346	0.495856
1991	0.3921	0.54903
1992	-1.227	0.773325
1993	0.338	0.605784
1994	-0.2051	0.608608
1995	-0.5737	0.653457
1996	-0.4579	0.599053
1997	-0.9941	0.699566
1998	-2.005	0.751679
1999	-0.6389	0.605198
2000	-0.4219	0.625607
2001	-0.642	0.619653
2002	-0.5675	0.644561
2003	-0.971	0.672434
2004	-0.1654	0.645673

Figure 8. Vermilion snapper, Summer survey, East, arithmetic scale, 1987-2004

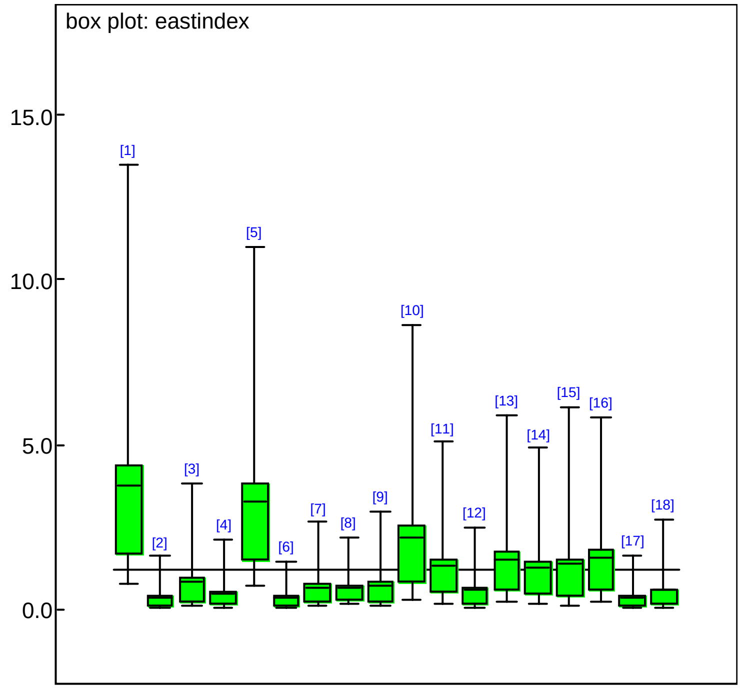

Figure 9. Vermilion snapper, Summer survey, West, arithmetic scale, 1987-2004

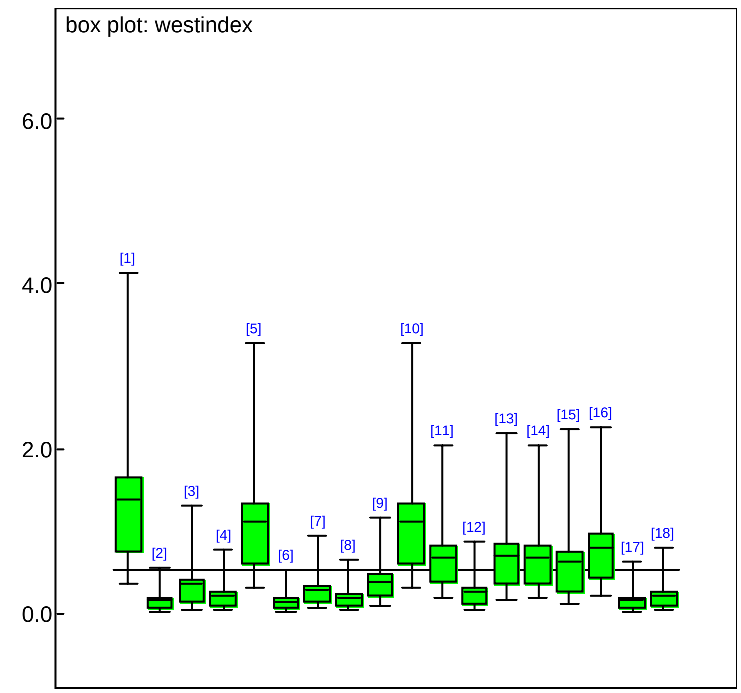

Table 4. Input values used to develop age-specific indexes in the Summer survey. Mean and tau (tau is 1/variance) for a lognormal approximation to the posterior distribution for the unaged index (e units). The Fract columns are the age compositions for the East and West survey area. The N columns are number of fish actually measured in each survey area that year.

East						West				
Mean	Tau	Fract 0	Fract 1+	N		Mean	Tau	Fract 0	Fract 1+	N
0.9752	1.978672	0	1	11	1987	0.09136	2.790091	0	1	21
-1.493	1.218023	0	1	3	1988	-2.198	1.607414	0	1	6
-0.7346	1.037306	0	1	5	1989	-1.45	1.50283	0	1	4
-1.252	1.108779				1990	-1.871	1.705338	0	1	9
0.8534	2.056405	0	1	61	1991	-0.119	2.940307	0.84731	0.15269	37
-1.549	1.227444	0	1	6	1992	-2.262	1.682458	0	1	4
-0.8742	1.383197	0	1	2	1993	-1.569	1.982805	0	1	16
-0.786	2.135106	0	1	36	1994	-1.979	1.742245	0	1	3
-0.7805	1.228049				1995	-1.174	2.482336	0.810005	0.189995	24
0.354	1.479345	0	1	9	1996	-0.1115	2.981092	0	1	105
-0.1449	1.495482	0	1	4	1997	-0.6177	2.987972	0	1	54
-1.085	1.142595				1998	-1.675	1.856695	0.04766	0.95234	8
0.00648	1.493586	0	1	7	1999	-0.6394	2.368684	0.086987	0.913013	40
-0.2085	1.347949				2000	-0.6202	2.720261	0.415228	0.584772	58
-0.2354	1.087454				2001	-0.8088	1.685374	0	1	3
0.04107	1.577033	0.630873	0.369127	2	2002	-0.4474	2.975529	0.078142	0.921858	47
-1.593	1.002793	0	1	1	2003	-2.243	1.383197	0	1	3
-1.179	0.968559				2004	-1.853	1.531645	0	1	6

Table 5. Parameters for lognormal distribution approximating the West age 1+ index, Summer (e units).

Year	Mean	Std Err
1987	0.09136	0.598675
1988	-2.198	0.788744
1989	-1.45	0.815727
1990	-1.871	0.765764
1991	-0.119	0.583181
1992	-2.262	0.770953
1993	-1.569	0.710166
1994	-1.979	0.757609
1995	-1.174	0.634702
1996	-0.1115	0.579178
1997	-0.6177	0.578511
1998	-1.675	0.733888
1999	-0.6394	0.64975
2000	-0.6202	0.60631
2001	-0.8088	0.770286
2002	-0.4474	0.579719
2003	-2.243	0.850272
2004	-1.853	0.808018

Table 6. Parameters for lognormal distributions approximating East and West indexes (unaged), Summer.

	East		West	
Year	Mean	Std Err	Mean	Std Err
1981			-2.968	0.974811
1982	-2.097	1.153464	-2.095	1.037821
1983	-0.9208	1.301242	-0.6217	0.854809
1984	-2.894	1.535234	-2.585	1.213509
1985	-0.5625	1.325224	-0.1254	0.891266
1986	-2.983	1.46481	-2.675	1.178668
1987	0.9752	0.710908	0.09136	0.598675
1988	-1.493	0.906092	-2.198	0.788744
1989	-0.7346	0.981853	-1.45	0.815727
1990	-1.252	0.94968	-1.871	0.765764
1991	0.8534	0.697342	-0.119	0.583181
1992	-1.549	0.902608	-2.262	0.770953
1993	-0.8742	0.850272	-1.569	0.710166
1994	-0.786	0.684369	-1.979	0.757609
1995	-0.7805	0.902386	-1.174	0.634702
1996	0.354	0.822177	-0.1115	0.579178
1997	-0.1449	0.817729	-0.6177	0.578511
1998	-1.085	0.935522	-1.675	0.733888
1999	0.00648	0.818248	-0.6394	0.64975
2000	-0.2085	0.861317	-0.6202	0.60631
2001	-0.2354	0.958947	-0.8088	0.770286
2002	0.04107	0.796305	-0.4474	0.579719
2003	-1.593	0.998606	-2.243	0.850272
2004	-1.179	1.016101	-1.853	0.808018