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Alternative indices of abundance of juvenile red snapper from the Gulf of Mexico from SEAMAP surveys 1972-2003

by

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Introduction

Turner *et al.* (2004) presented and index of abundance of age 1 red snapper in the Gulf of Mexico which was used in modeling the age composition of red snapper taken in recreational and commercial finfish fisheries. That index was derived by averaging age 1 fall and summer survey indices. The index presented here is calculated in a slightly different manner and coefficients of variation are calculated. These indices are comparable to the indices used for age modeling by Goodyear (1995) and Schirripa and Legault (1999).

The modeling of the age composition was conducted under either of two stock structure assumptions: (1) that one stock of red snapper exists in United States waters in the Gulf of Mexico or (2) that two stocks exist separated by the Mississippi River. Therefore the indices are calculated for the same strata.

Methods

There are two red snapper catch per unit effort series from trawl surveys, one based on surveys conducted in the summer, $CPUE_{summer}$, and the other based on surveys conducted in the fall, $CPUE_{fall}$. Random samples of the catches from both surveys have been aged since 1981, so for those years it is possible to develop an index for age 1 red snapper by multiplying the overall catch per unit effort series by the proportion of the catch that is age one (*p*):

(1) $$I = pCPUE\ .$$

Since *p* and *CPUE* are effectively independent, the variance of *I* is

(2) $$V(I) = p^2 V(CPUE) + CPUE^2 V(p)\ .$$

The variance of *CPUE* is obtained by the usual methods employed when standardizing indices of abundance. Inasmuch as *p* is determined from a random sample of the catch with sample size *n* with *a* ages, the variance of *p* is

(3) . $$V(p) = (p(1-p) + 0.1/a)/n$$

The term $0.1/a$ is used to prevent
the expression from tending to zero as *p* approaches zero.

For years prior to 1981, or where the sample size was very small (< 10), the value of *p* was computed from the samples for all years combined (effectively a weighted average)

(4) $$\bar{p} = \frac{\sum_y n_{1,y}}{\sum_y n_y}$$

where $n_{1,y}$ is the number of age 1 animals in the sample and n_y is the total sample size for any given year *y*. The effective variance used in this case was

(5) $$V(p) = (\bar{p}(1 - \bar{p}) + 0.1/a)/10$$

For some applications it is desirable to have a single index for each area that goes back as far in time as possible. One way to do this is to simply sum the absolute catch per unit effort observations from each season:

(6) $$I_{combined} = I_{summer} + I_{fall} \quad , \; for\; y \geq 1982 \quad ,$$

Prior to 1981 however, there were no surveys conducted during the summer. Thus, in order to create a continuous index from 1972 to 2003 with a consistent scale, one must inflate the fall index appropriately,

(7) $$I_{combined} \approx I_{fall}(1 + \bar{R}) \quad , \; for\; y < 1982$$

Here $\bar{R}$ is the average ratio of the values of the summer and fall indices:

(8) $$\bar{R} = \frac{\sum_{y=1982}^{2002} I_{summer,y}}{\sum_{y=1982}^{2002} I_{fall,y}}$$

This approach approximates the index that would have been obtained if each season (fall and summer) had been sampled equally and allows the season with the greater catches of age 1 to be the most influential.

Inasmuch as the covariance between the independent summer and fall observations is thought to be negligible, the variance of the sum ought to be equal to the sum of the variances

(9) $$V(I_{combined}) \approx \begin{cases} V(I_{summer}) + V(I_{fall}) & y \geq 1982 \\ (1 + \bar{R})^2 V(I_{fall}) + I_{fall}^2 V(R) & y < 1982 \end{cases}$$

Here $V(I_{summer})$ and $V(I_{fall})$ follow from equations 1-5 and

$$V(R) \approx \frac{1}{\bar{I}_{Fall}^{2}} \frac{\sum_{y=1982}^{2002} \left(I_{summer,y} - RI_{fall,y} \right)^{2}}{N-1}$$

(10)

$$\bar{I}_{Fall} = \frac{\sum_{y=1982}^{2002} I_{fall,y}}{N}$$

where *N* is the number of years when surveys were conducted both in the fall and summer

Results

The calculated indices and their coefficients of variation are presented in Tables 1 and 2. The age 1 index values were very similar to those presented by Turner *et al.* (2004) when re-scaled to their means (Turner *et al.* did not present age 0 indices).

Literature Cited

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Table 1. Indices of abundance of age 0 red snapper derived from the combined fall and summer SEAMAP groundfish surveys.

	Gulf wide		east		west	
year	index	CV	index	CV	index	CV
1972	79.571	0.949	44.566	0.367	95.901	1.731
1973	22.671	0.928	9.778	0.293	34.605	1.667
1974	15.137	0.928	10.773	0.288	13.724	1.680
1975	20.443	0.925	10.624	0.295	27.510	1.675
1976	16.689	0.924	10.875	0.281	17.602	1.667
1977	18.794	0.924	12.082	0.292	20.167	1.670
1978	37.939	0.930	8.243	0.295	76.156	1.670
1979	15.961	0.925	5.615	0.290	27.254	1.670
1980	46.052	0.929	15.474	0.302	80.378	1.672
1981	38.878	0.935	36.551	0.291	16.800	1.675
1982	38.843	0.931	35.305	0.277	19.392	1.667
1983	15.023	0.927	8.384	0.312	18.731	1.680
1984	7.125	0.938	5.602	0.312	5.333	1.699
1985	12.874	0.983	3.358	0.396	23.843	1.778
1986	12.822	1.063	6.743	0.593	15.108	1.969
1987	3.031	1.088	3.058	0.307	3.205	0.181
1988	5.281	0.124	4.785	0.290	5.378	0.128
1989	17.003	0.099	22.158	0.197	16.323	0.107
1990	15.939	0.097	18.402	0.174	15.669	0.104
1991	19.726	0.096	24.186	0.161	19.263	0.103
1992	5.186	0.133	3.907	0.309	5.291	0.136
1993	11.038	0.116	9.757	0.199	11.086	0.123
1994	30.450	0.094	6.277	0.201	32.843	0.096
1995	28.539	0.095	15.690	0.175	29.820	0.098
1996	11.106	0.109	6.221	0.206	11.577	0.114
1997	23.075	0.098	13.611	0.186	23.951	0.101
1998	11.312	0.120	4.162	0.269	11.899	0.123
1999	20.255	0.104	11.224	0.193	21.102	0.108
2000	15.753	0.104	14.718	0.191	15.703	0.111
2001	13.804	0.111	4.291	0.258	14.617	0.114
2002	12.283	0.111	7.178	0.212	12.792	0.115
2003	14.681	0.110	8.315	0.225	15.223	0.114

Table 2. Indices of abundance of age 1 red snapper derived from the combined fall and summer SEAMAP groundfish surveys.

	Gulf wide		east		west	
year	index	CV	index	CV	index	CV
1972	34.630	1.233	21.337	0.865	44.511	1.925
1973	9.867	1.217	4.681	0.836	16.062	1.868
1974	6.588	1.216	5.158	0.834	6.370	1.880
1975	8.897	1.214	5.087	0.837	12.768	1.875
1976	7.263	1.214	5.207	0.832	8.170	1.868
1977	8.179	1.213	5.784	0.836	9.360	1.870
1978	16.512	1.218	3.946	0.836	35.347	1.870
1979	6.947	1.215	2.688	0.835	12.650	1.870
1980	20.042	1.217	7.409	0.839	37.306	1.873
1981	16.920	1.222	17.499	0.835	7.798	1.875
1982	16.871	0.431	12.005	0.536	15.109	0.421
1983	6.635	0.421	4.698	0.485	7.269	0.644
1984	3.182	0.448	2.144	0.535	3.074	0.517
1985	6.138	0.429	2.120	0.494	7.827	0.781
1986	3.010	0.747	2.066	0.715	3.344	1.224
1987	5.287	0.296	2.837	0.325	5.297	0.157
1988	4.712	0.120	2.459	0.393	4.880	0.123
1989	3.205	0.150	5.276	0.395	3.091	0.159
1990	13.974	0.125	8.852	0.232	14.402	0.129
1991	5.964	0.140	4.619	0.240	6.075	0.146
1992	5.976	0.132	5.208	0.249	6.043	0.137
1993	6.219	0.120	3.215	0.239	6.618	0.122
1994	10.013	0.117	8.276	0.193	10.182	0.123
1995	7.408	0.127	2.179	0.327	7.824	0.129
1996	11.174	0.125	5.986	0.201	11.688	0.130
1997	7.779	0.132	5.538	0.227	7.987	0.136
1998	4.849	0.156	4.228	0.254	5.022	0.161
1999	3.396	0.139	3.075	0.290	3.451	0.143
2000	6.894	0.129	9.264	0.199	6.689	0.136
2001	4.254	0.141	4.415	0.236	4.367	0.145
2002	5.336	0.145	3.259	0.274	5.583	0.150
2003	4.974	0.252	1.794	0.554	4.971	0.272