-SEAMAP Reef Fish Survey of Offshore Banks: Yearly Indices of Abundance for Vermilion Snapper, Greater Amberjack, and Gray Triggerfish

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INTRODUCTION

The objective of the annual Southeast Area Monitoring and Assessment Program (SEAMAP) offshore reef fish survey is to provide an index of the relative abundances of fish species associated with topographic features (banks, ledges) located on the continental shelf of the Gulf of Mexico (Gulf) in the area from Brownsville, TX to the Dry Tortugas, FL (Figure 1). The total reef area surveyed is approximately 1771 km²; 1244 km² in the eastern and 527 km² in the western Gulf. The offshore reef fish survey was initiated in 1992, with sampling conducted during the months of May to August from 1992-1997, and in 2001-2002. No surveys were conduced from 1998 to 2000 and in 2003. A survey was conducted in 2004, however data edits were not completed for SEDAR 9, and will be made available prior to the stock assessments. The 2001 survey was abbreviated due to ship scheduling.

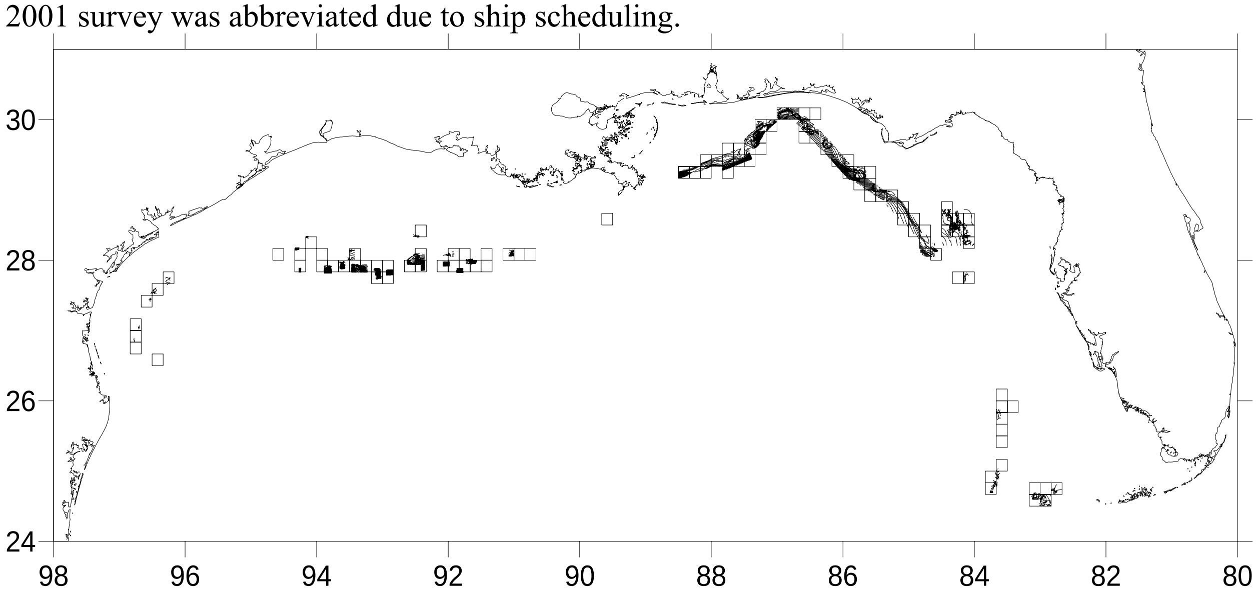

Figure 1. Gulf of Mexico shelf-edge banks sampled during SEAMAP offshore reef fish survey with sample blocks.

SAMPLE DESIGN

The survey area is large. Therefore, a two-stage sampling design is used to minimize travel times between sample stations. The first-stage or primary sampling units (PSUs) are blocks 10 minutes of latitude by 10 minutes of longitude (Figures 2 and 3). The first-stage units are selected by stratified random sampling. The blocks were stratified, with strata defined by geographic region (4 regions: South Florida, Northeast Gulf, Louisians-Texas Shelf, and

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SouthTexas), and by reef habitat area (Blocks ≤ 20 km² reef, Block > 20 km² reef). There are a total of 7 strata. The ultimate sample sites (second stage units) within a block are selected randomly. However, stratum 1 (South Florida, small blocks) and stratum 7 (S. Texas, small blocks) were not consistently sampled. So, these were dropped from annual indices.

GEAR

The SEAMAP reef fish survey currently employs four Sony VX2000 DCR digital camcorders mounted in Gates PD150M underwater housings. The housings are rated to a maximum depth of 150 meters. The four Sony VX2000 camcorders are mounted orthogonally and a height of 30 cm above the bottom of the pod. A chevron (or arrow) fish trap with 1.5-inch vinyl-clad mesh is used to capture fish for biological samples. In its greatest dimensions, the trap is 1.76 m in length, 1.52 m in width and 0.61 m in depth. A 0.4 m by 0.29 m blow out panel is placed on one side and kept closed using 7-day magnesium releases. The magnesium releases are examined after each soak and replaced as needed. The trap is deployed at a randomly selected subset of video stations. Both the camera pod and fish trap are baited with squid.

VIDEO TAPE VIEWING PROCEDURES

One video tape from each station is selected out of the four for viewing. If all four video cameras face reef fish habitat and are in focus, the viewed tape is selected randomly. Tape viewers examine 20 minutes of the selected video tape, identify, and enumerate all species for the duration of the tape. Identifications are made to the lowest taxonomic level and the time when each fish enters and leaved the field of view is recorded. This is referred as a time in - time out procedure (TITO).

Tapes are viewed from the time when the view clears from any silt plume raised by the gear when it landed. Less than 20 minutes may be viewed if the duration when water is not clear enough to count fish is less than 20 minutes, or if the camera array is dragged. If a tape contains a large amount of fish, it is sub-sampled. There are four cases for sub-sampling: 1) when there is generally a large number of fish of a given species present throughout the tape so that following individual fish is difficult; 2) large number of fish occur in pulses periodically during the tape; 3) a single school of fish; and, 4) multiple schools of fish. Three estimators of relative abundance are available from the video data: 1) presence and absence; 2) maximum count (each fish of each taxon is counted each time it appears on the screen); and, 3) a minimum count (i.e., mincount: the greatest number of a taxon that appears on screen at one time). Presence and absence (frequency of occurrence) and mincount estimators are advantageous because they avoid the potential of multiple counting of fish, and are reported here.

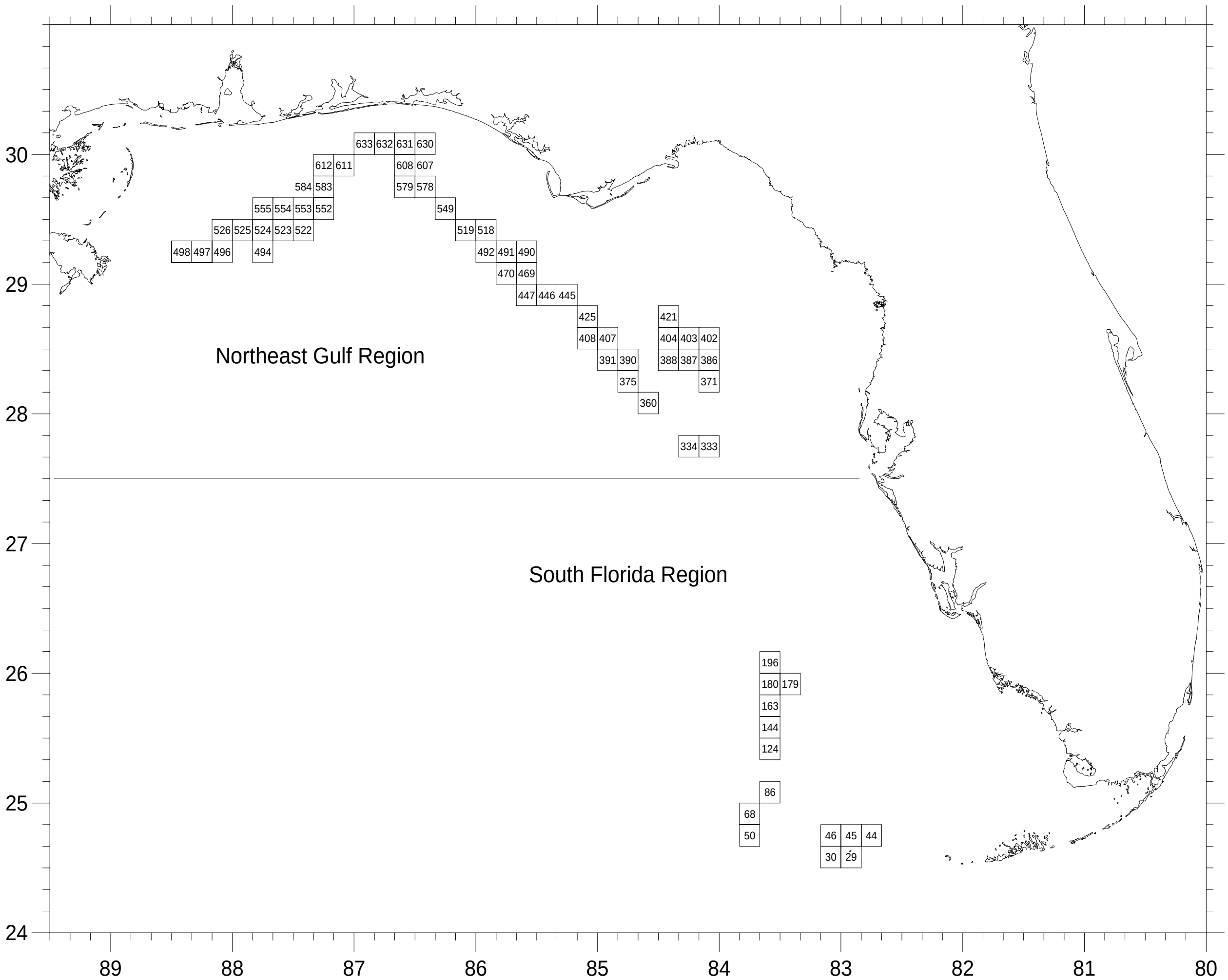

Figure 2. SEAMAP offshore reef fish survey sample blocks in the eastern Gulf of Mexico.

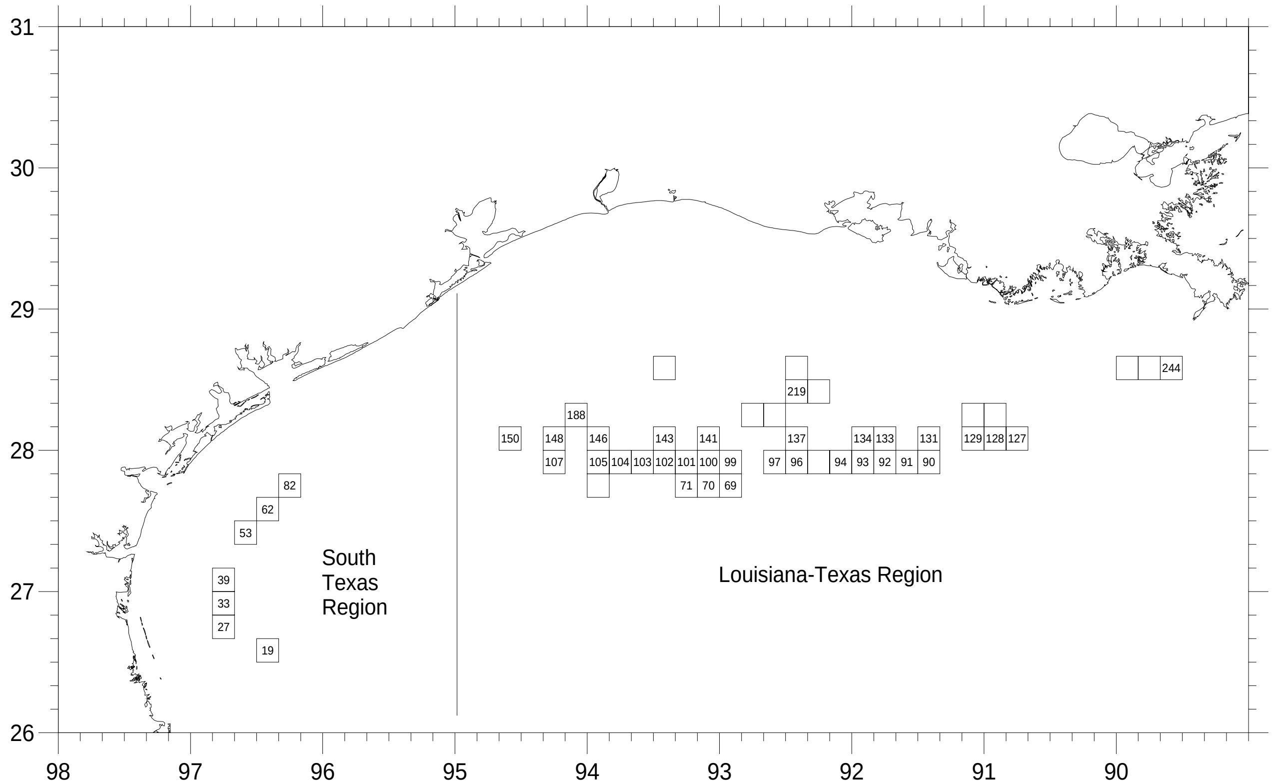

Figure 3. SEAMAP offshore reef fish survey sample blocks in western Gulf of Mexico.

STATISTICS

Design-based Estimator

The design-based estimators of abundance are those for stratified, two-stage sampling (Cochran, 1977). The number of strata and number of blocks sampled in the eastern and western Gulf of Mexico during SEAMAP reef fish survey are shown in Table 1.

1. Block means

$$\bar{x}_{hi} = \frac{\sum_{j=1}^{m_{hi}} x_{hij}}{m_{hi}},$$ where x_{hij} is the number of fish observed at the j-th site in the i-th block within the h-th stratum, and m_{hi} in the number of sites sampled in the i-th block and h-th stratum.

2. Stratum means

$$\bar{x}_h = \frac{\sum_{j=1}^{n_h} \bar{x}_{hi}}{n_h},$$ where $\bar{x}_{hi}$ is the i-th block mean in the h-th stratum and n_h is the number of blocks sampled in the h-th stratum.

3. Stratified mean

$$\bar{x}_{st} = \sum_h w_h \bar{x}_h ,$$ where w_h is the stratum weight estimated as the area of the stratum divided by the total survey area (A_h/A).

4. Variance of the stratified mean ($V(\bar{x}_{st})$), ignoring finite population correction

$V_{\bar{x}_{st}} = \sum_h w_h^2 \left[\frac{s_{1h}^2}{n_h} + \frac{s_{2h}^2}{n_h m_h} \right]$, where w_h is the stratum weight, $s^2{}_{1h}$ and $s^2{}_{2h}$ are the variances among the first-stage and second-stage units, n_h and m_h are the number of first stage and second-stage units sampled.

5. Variance among first-stage units, $s^2{}_{1h}$

$$s_{1h}^2 = \frac{\sum_h (\bar{x}_{hi} - \bar{x}_h)^2}{n_h - 1}.$$

6. Variance among second-stage units, $s^2{}_{2h}$

$$s_{2h}^2 = \frac{\sum_i \sum_j (x_{hij} - \bar{x}_{hi})^2}{n_h (m_{hi} - 1)}.$$

The estimates for the frequency of occurrence of each species were calculated using the same equations where x_{hij} was either 0 or 1. The final estimate is a stratified mean proportion.

Model-based estimator

In addition to the calculations of stratified means, a delta-lognormal modeling approach (Lo et al., 1992) was used to develop abundance indices. In order to develop standardized indices of annual average mincount for each species in the U.S. Gulf of Mexico, a delta-lognormal model, as described by Lo et al. (1992), was employed. This index is a mathematical combination of yearly mincount estimates from two distinct generalized linear models: a binomial (logistic) model which describes proportion of positive mincounts (i.e., presence/absence) and lognormal model which describes variability in only the nonzero mincount data. The GLMMIX and MIXED procedures in SAS was employed to provide yearly index values for both the binomial and lognormal sub-models, respectively. The parameters included in each sub-model were year, stratum, and block nested within stratum. Also, the estimates from each model were weighted using the stratum area, and separate covariance structures were developed for each survey year. For the binomial models, a logistic-type mixed model was employed. The fit of each model was evaluated using the fit statistics provided by the GLMMIX macro. Initially, several model types were used to describe the nonzero mincount data. These included lognormal, Poisson and negative binomial. Based on analyses of residual scatter and QQ plots, the lognormal model was more fitting than the others in describing the variability in the nonzero data in most of the models. Those models where a lognormal approach did not fit as well were those where there were very few data points. In those cases, the other two model types did not perform any better. As with the design-based analyses, model-based estimators were developed for each species Gulfwide, East Gulf only and West Gulf only.

Fish Sizes

The size of the fish observed during the survey come from two sources, fish captured in traps and fish measured on video tape with lasers. Lasers were first introduced in 1995. However, since both the capture of fish in traps, and the instances where fish are hit by lasers is infrequent, size distributions were not estimated. We report only the average size and size range of fish.

RESULTS

Abundance data from five strata were included for analysis during all years except 2001 (design-based estimates: Tables 2-7; model-based estimates: Tables 8-16). Stratum 1 was sampled only in 1994, 1996 and 1997. This stratum was 62.847 km^2 in area. Stratum 7 was sampled only in 1996, 1997, and 2002, and was 13.030 km^2 in area. Since these strata were not sampled during all years of the survey, they were excluded from design-based and model-based estimates of annual mean mincount. However, when included for those years, the stratified means and variances changed very little since their stratum weights were small. Figure 4 illustrates similarities between designed-based and model-based indices for each species.

The 2001 survey was abbreviated. Only one stratum was sampled in the eastern Gulf of Mexico. We recommend that the 2001 estimates of abundance for the entire Gulf of Mexico, and for the eastern Gulf of Mexico not be used for estimating trends in fish abundance. However, the two strata in the western Gulf of Mexico were sampled, and provide useful estimates of abundance.

Tables 17 and 18 provide size information on each species captured in traps and on video, respectively.

LITERATURE CITED

Cochran, W.G. 1977. Sampling Techniques. John Wiley & Sons. New York, NY. 428 p.

Lo, N. C. H., L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49: 2515-1526.

Table 1. The number of strata and number of blocks sampled in the eastern and western Gulf of Mexico during SEAMAP reef fish survey.

	Eastern Gulf of Mexico		**Western Gulf of Mexico**	
Year	**Number of Strata**	**Number of Blocks**	**Number of Strata**	**Number of Blocks**
1992	3	13	2	11
1993	3	18	2	9
1994	3	14	2	9
1995	3	12	2	10
1996	3	21	2	11
1997	3	20	2	17
2001	1	5	2	9
2002	3	19	2	14

Table 2. Stratified mean abundance of vermilion snapper observed during SEAMAP reef fish video survey.

	Gulf of Mexico Stratified Means			Eastern Gulf Region Stratifed Means			Western Gulf Region Stratified Means		
Year	**n**	**mean**	**se**	**n**	**mean**	**se**	**n**	**mean**	**se**
1992	23	5.02859	6.69132	13	2.14732	2.74426	11	11.83490	16.01540
1993	27	3.53715	5.43834	18	2.09246	3.57096	9	6.94989	9.84960
1994	23	4.19894	4.58391	14	4.22666	3.64164	9	4.13345	6.80980
1995	22	3.40568	3.96039	12	1.53844	1.62635	10	7.81663	9.47400
1996	32	1.36499	1.89149	21	0.7576	1.21043	11	2.79982	3.50032
1997	37	3.98796	3.98332	20	2.23192	2.18983	17	8.13620	8.22010
2001	14	1.01887	1.49052	5	0	0	9	3.42572	5.01155
2002	33	2.78000	3.4748	19	3.12016	4.03667	14	1.97630	2.14770

Table 3 Stratified mean proportion of sites where vermilion snapper were observed during SEAMAP reef fish video survey.

	Gulf of Mexico Stratified Means			Eastern Gulf Region Stratifed Means			Western Gulf Region Stratified Means		
Year	**n**	**mean**	**se**	**n**	**mean**	**se**	**n**	**mean**	**se**
1992	23	0.21714	0.17407	13	0.18460	0.15881	11	0.29401	0.21014
1993	27	0.16605	0.18906	18	0.15061	0.17225	9	0.20253	0.22876
1994	23	0.20655	0.17306	14	0.20378	0.16186	9	0.21311	0.19953
1995	22	0.22400	0.15726	12	0.16856	0.13951	10	0.35194	0.19917
1996	32	0.13976	0.12090	21	0.13216	0.11884	11	0.15773	0.12576
1997	37	0.20361	0.14324	20	0.14350	0.11970	17	0.34560	0.19887
2001	14	0.03806	0.04651	5	0.00000	0.00000	9	0.12796	0.15637
2002	33	0.18661	0.16645	19	0.15109	0.14425	14	0.27051	0.21888

Table 4 Stratified mean abundance of greater amberjack observed during SEAMAP reef fish video survey.

	Gulf of Mexico Stratified Means			Eastern Gulf Region Stratifed Means			Western Gulf Region Stratified Means		
Year	**n**	**mean**	**se**	**n**	**mean**	**se**	**n**	**mean**	**se**
1992	23	1.94588	3.27287	13	2.37573	4.32501	11	0.93047	0.78744
1993	27	0.15007	0.35306	18	0.18103	0.46528	9	0.07694	0.08798
1994	23	0.67244	0.83264	14	0.54303	0.86382	9	0.97815	0.75898
1995	22	0.37868	0.32167	12	0.2218	0.25732	10	0.74927	0.47369
1996	32	0.37322	0.47432	21	0.34044	0	11	0.45064	0.63833
1997	37	0.43260	0.67295	20	0.42112	0.77474	17	0.45972	0.43249
2001	14	0.59547	0.63732	5	0.65982	0.73351	9	0.44345	0.41007
2002	33	1.22084	1.06756	19	1.43846	1.30273	14	0.70670	0.51200

Table 5 Stratified mean proportion of sites where greater amberjack observed during SEAMAP reef fish video survey.

	Gulf of Mexico Stratified Means			Eastern Gulf Region Stratifed Means			Western Gulf Region Stratified Means		
Year	**n**	**mean**	**se**	**n**	**mean**	**se**	**n**	**mean**	**se**
1992	23	0.30128	0.21692	13	0.23295	0.21621	11	0.46270	0.21861
1993	27	0.04695	0.07234	18	0.03425	0.06572	9	0.07694	0.08798
1994	23	0.26442	0.20502	14	0.21533	0.19127	9	0.38040	0.23750
1995	22	0.20754	0.14771	12	0.11744	0.11564	10	0.42040	0.22349
1996	32	0.16126	0.14295	21	0.15309	0.14736	11	0.18058	0.13253
1997	37	0.12597	0.12254	20	0.07573	0.09449	17	0.24464	0.18881
2001	14	0.15096	0.11972	5	0.11183	0.08713	9	0.24339	0.19672
2002	33	0.33869	0.19412	19	0.30335	0.16532	14	0.42217	0.26215

Table 6. Stratified mean abundance of gray triggerfish observed during SEAMAP reef fish video survey.

	Gulf of Mexico Stratified Means			Eastern Gulf Region Stratifed Means			Western Gulf Region Stratified Means		
Year	**n**	**mean**	**se**	**n**	**mean**	**se**	**n**	**mean**	**se**
1992	23	0.68549	0.53380	13	0.76107	0.47108	11	0.50695	0.68196
1993	27	0.37395	0.30779	18	0.49471	0.38822	9	0.08869	0.11778
1994	23	0.33632	0.26596	14	0.35244	0.22379	9	0.29825	0.36556
1995	22	0.31823	0.27911	12	0.42140	0.32738	10	0.07451	0.16509
1996	32	0.29654	0.23129	21	0.33761	0.20766	11	0.19954	0.28711
1997	37	0.62533	0.59674	20	0.55431	0.41697	17	0.79310	1.02143
2001	14	0.05343	0.06709	5	0.07605	0.09549	9	0.00000	0.00000
2002	33	0.29957	0.28094	19	0.36289	0.30140	14	0.14997	0.23260

Table 7. Stratified mean proportion of sites where gray triggerfish observed during SEAMAP reef fish video survey.

	Gulf of Mexico Stratified Means			Eastern Gulf Region Stratifed Means			Western Gulf Region Stratified Means		
Year	**n**	**mean**	**se**	**n**	**mean**	**se**	**n**	**mean**	**se**
1992	23	0.31484	0.17499	13	0.37885	0.18336	11	0.16363	0.15524
1993	27	0.20569	0.13648	18	0.25522	0.14440	9	0.08869	0.11778
1994	23	0.23263	0.17613	14	0.26254	0.16794	9	0.18976	0.21651
1995	22	0.16870	0.13775	12	0.21559	0.14534	10	0.05792	0.11982
1996	32	0.19306	0.12238	21	0.23834	0.12799	11	0.08610	0.10912
1997	37	0.26684	0.16111	20	0.30158	0.16252	17	0.18478	0.15777
2001	14	0.04243	0.04934	5	0.06039	0.07023	9	0.00000	0.00000
2002	33	0.15436	0.11654	19	0.18839	0.12272	14	0.07399	0.10193

Table 8. Gulfwide model-based index for vermilion snapper.

Survey Year	Frequency	N	Lo Index	Standardized Index	CV	LCL	UCL
1992	0.20301	133	1.35170	1.10362	0.42437	0.48907	2.49040
1993	0.14970	167	1.23911	1.01169	0.45195	0.42715	2.39615
1994	0.20661	121	2.89631	2.36474	0.37234	1.15029	4.86137
1995	0.13242	219	0.81285	0.66366	0.37390	0.32192	1.36820
1996	0.13495	289	0.32937	0.26892	0.42117	0.11985	0.60342
1997	0.23643	258	1.63294	1.33324	0.30594	0.73298	2.42506
2001	0.09091	77	0.45596	0.37228	0.91059	0.07869	1.76131
2002	0.17625	261	1.08008	0.88185	0.36054	0.43828	1.77435

Table 9. Eastern Gulf Region model-based index for vermilion snapper.

Survey Year	Frequency	N	Lo Index	Standardized Index	CV	LCL	UCL
1992	0.16418	67	0.83699	0.81208	0.48851	0.32194	2.04845
1993	0.13333	120	0.83654	0.81164	0.49436	0.31858	2.06783
1994	0.19737	76	2.50334	2.42882	0.40401	1.11597	5.28615
1995	0.08088	136	0.47823	0.46400	0.52873	0.17189	1.25249
1996	0.13869	137	0.29689	0.28805	0.54549	0.10379	0.79942
1997	0.11486	148	0.88687	0.86047	0.46290	0.35646	2.07711
2001	0.00000	32	0.00000	0.00000	.	.	.
2002	0.14706	170	1.37589	1.33494	0.40489	0.61240	2.90994

Table 10. Western Gulf Region model-based index for vermilion snapper.

Survey Year	Frequency	N	Lo Index	Standardized Index	CV	LCL	UCL
1992	0.24242	66	3.48810	1.35878	0.47752	0.54889	3.36365
1993	0.19149	47	4.26413	1.66107	0.58712	0.55935	4.93285
1994	0.22222	45	1.84805	0.71990	0.56082	0.25296	2.04878
1995	0.21687	83	1.92420	0.74957	0.43166	0.32792	1.71336
1996	0.13158	152	1.04334	0.40643	0.45666	0.17020	0.97052
1997	0.40000	110	4.43396	1.72723	0.28213	0.99306	3.00418
2001	0.15556	45	2.33142	0.90820	0.76046	0.23519	3.50706
2002	0.23077	91	1.20351	0.46882	0.38520	0.22281	0.98648

Table 11. Gulfwide model-based index for greater amberjack.

Survey Year	Frequency	N	Lo Index	Standardized Index	CV	LCL	UCL
1992	0.33835	133	0.45414	1.25672	0.23452	0.79115	1.99627
1993	0.04790	167	0.06868	0.19006	0.50069	0.07380	0.48944
1994	0.27273	121	0.50239	1.39023	0.24971	0.85009	2.27358
1995	0.20091	219	0.29836	0.82563	0.21890	0.53565	1.27262
1996	0.14533	289	0.19732	0.54602	0.24230	0.33865	0.88040
1997	0.14341	258	0.19946	0.55196	0.24567	0.34013	0.89574
2001	0.24675	77	0.55437	1.53406	0.31823	0.82427	2.85506
2002	0.33716	261	0.61625	1.70531	0.18287	1.18649	2.45098

Table 12. Eastern Gulf Region model-based index for greater amberjack.

Survey Year	Frequency	N	Lo Index	Standardized Index	CV	LCL	UCL
1992	0.25373	67	0.38473	1.20711	0.42095	0.53817	2.70754
1993	0.02500	120	0.03806	0.11941	0.89581	0.02572	0.55431
1994	0.19737	76	0.38884	1.22001	0.40108	0.56350	2.64139
1995	0.08824	136	0.09344	0.29317	0.39318	0.13734	0.62579
1996	0.16788	137	0.19401	0.60873	0.34989	0.30850	1.20117
1997	0.08784	148	0.11964	0.37539	0.46268	0.15557	0.90581
2001	0.25000	32	0.74329	2.33214	0.53581	0.85388	6.36964
2002	0.29412	170	0.58772	1.84403	0.28844	1.04767	3.24575

Table 13. Western Gulf Region model-based index for greater amberjack.

Survey Year	Frequency	N	Lo Index	Standardized Index	CV	LCL	UCL
1992	0.42424	66	0.55934	1.22248	0.20760	0.81063	1.84356
1993	0.10638	47	0.11890	0.25985	0.49665	0.10160	0.66460
1994	0.40000	45	0.64651	1.41298	0.24713	0.86826	2.29944
1995	0.38554	83	0.68508	1.49728	0.20069	1.00625	2.22791
1996	0.12500	152	0.20486	0.44773	0.28787	0.25465	0.78721
1997	0.21818	110	0.36593	0.79975	0.23616	0.50189	1.27439
2001	0.24444	45	0.49897	1.09053	0.33466	0.56837	2.09239
2002	0.41758	91	0.58081	1.26940	0.17776	0.89207	1.80633

Table 14. Gulfwide model-based index for gray triggerfish.

Survey Year	Frequency	N	Lo Index	Standardized Index	CV	LCL	UCL
1992	0.31579	133	0.18319	1.75021	0.45295	0.73768	4.15255
1993	0.25150	167	0.11955	1.14216	0.49057	0.45121	2.89120
1994	0.31405	121	0.13040	1.24584	0.48471	0.49711	3.12228
1995	0.11872	219	0.06997	0.66843	0.58091	0.22735	1.96529
1996	0.17647	289	0.09409	0.89890	0.46078	0.37376	2.16190
1997	0.29070	258	0.14659	1.40046	0.45125	0.59202	3.31288
2001	0.05195	77	0.01105	0.10561	1.90184	0.00890	1.25315
2002	0.15326	261	0.08252	0.78837	0.53966	0.28681	2.16702

Table 15. Eastern Gulf Region model-based index for gray triggerfish.

Survey Year	Frequency	N	Lo Index	Standardized Index	CV	LCL	UCL
1992	0.43284	67	0.15471	1.82133	0.58990	0.61059	5.43286
1993	0.31667	120	0.09637	1.13449	0.59715	0.37595	3.42355
1994	0.39474	76	0.10380	1.22205	0.58687	0.41168	3.62759
1995	0.16912	136	0.06139	0.72276	0.64637	0.22171	2.35610
1996	0.29927	137	0.08369	0.98528	0.57603	0.33776	2.87414
1997	0.33784	148	0.09996	1.17677	0.58935	0.39485	3.50712
2001	0.12500	32	0.01018	0.11989	1.56521	0.01295	1.11009
2002	0.18824	170	0.06943	0.81743	0.62705	0.25839	2.58597

Table 16. Western Gulf Region model-based index for gray triggerfish.

Survey Year	Frequency	N	Lo Index	Standardized Index	CV	LCL	UCL
1992	0.19697	66	0.36808	1.59463	0.40389	0.73285	3.46980
1993	0.08511	47	0.11838	0.51285	0.86507	0.11502	2.28671
1994	0.17778	45	0.26040	1.12814	0.52773	0.41863	3.04014
1995	0.03614	83	0.05886	0.25500	1.31463	0.03438	1.89115
1996	0.06579	152	0.13012	0.56373	0.57065	0.19494	1.63020
1997	0.22727	110	0.55790	2.41700	0.28635	1.37860	4.23757
2001	0.00000	45	0.00000	0.00000	.	.	.
2002	0.08791	91	0.12202	0.52863	0.68219	0.15354	1.82004

Table 17. Mean fork lengths (mm) of fish captured in fish traps during SEAMAP reef fish survey.

Species	Year	n	Mean	Minimum	Maximum	SE
Vermilion Snapper	1992	122	272.48	209	421	4.0185
	1993	89	224.34	165	442	5.3630
	1994	130	219.78	141	374	4.1069
	1995	39	245.44	194	372	7.1362
	1996	48	311.21	195	472	12.5915
	1997	6	310.17	268	365	14.7680
	2002	40	243.05	195	409	8.8145
Gray Triggerfish	1992	45	323.18	184	535	8.8625
	1993	4	299.25	268	335	13.9545
	1994	14	325.43	285	384	8.3808
	1995	3	301.33	272	322	15.0702
	1996	19	316.53	255	390	8.7524
	1997	10	290.70	123	404	34.1406
	2002	19	351.84	239	565	20.5172

Table 18. Mean fork lengths (mm) of fish measured on video tapes with lasers during SEAMAP reef fish survey.

Species	YEAR	n	Mean	Minimum	Maximum	SE
Vermilion Snapper	1995	47	287.62	218	483	51.9557
	1996	191	312.26	135	475	5.0306
	1997	291	260.93	152	568	3.3447
	2001	8	277.50	210	329	16.9284
	2002	927	266.31	144	586	2.0875
Gray triggerfish	1995	4	338.75	253	483	51.9557
	1996	56	367.71	266	623	10.2886
	1997	73	369.45	210	543	8.2549
	2001	1	383.00	383	383	-
	2002	65	361.63	272	530	8.2029
Greater amberjack	1995	68	555.50	267	1381	17.8616
	1996	72	665.78	255	1187	22.2849
	1997	73	586.58	295	1413	26.1735
	2001	28	748.43	345	1229	53.0216
	2002	555	571.67	218	1563	6.9895

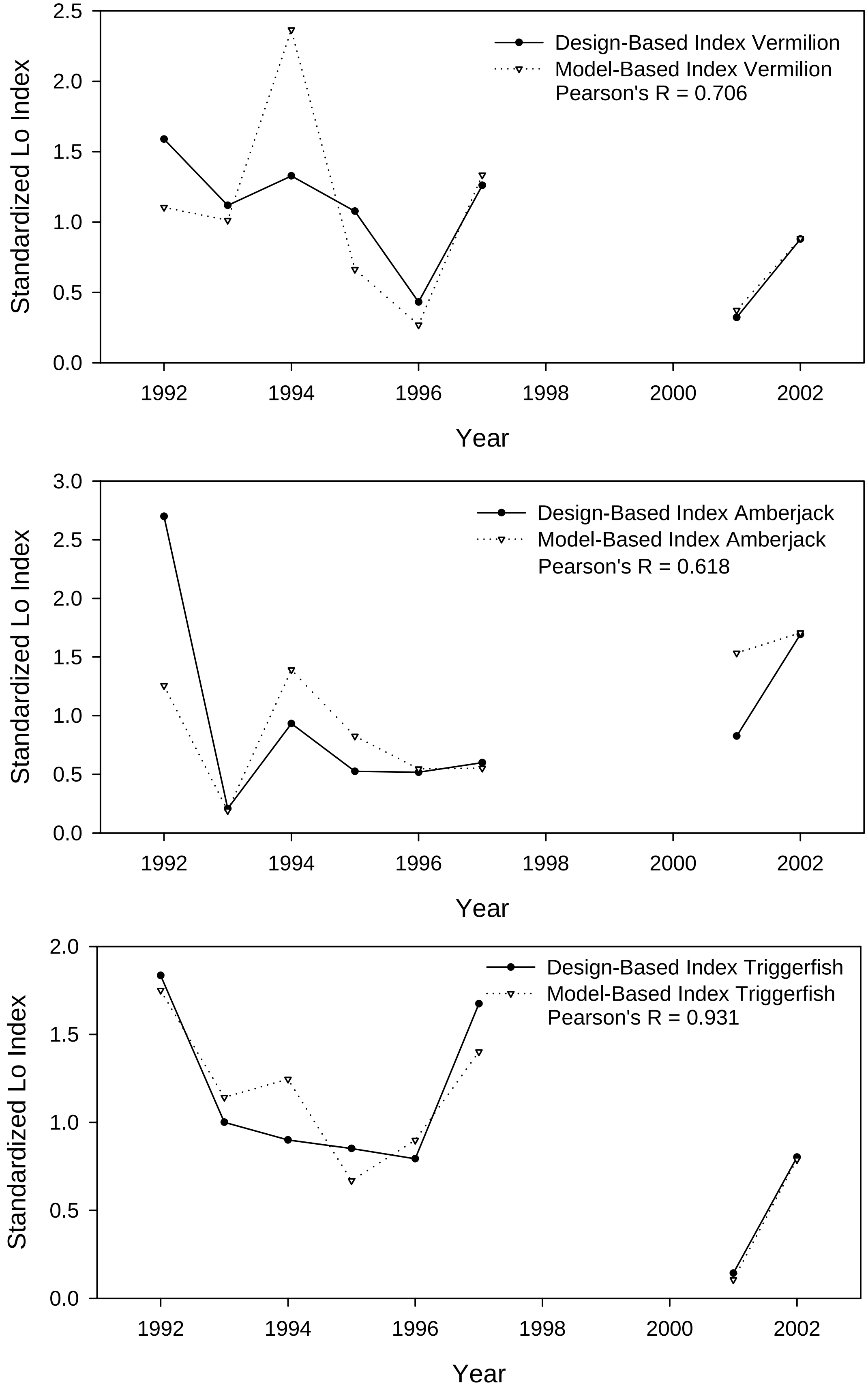

Figure 4. Similarities between designed-based and model-based Gulfwide indices for vermilion snapper, greater amberjack, and gray triggerfish.