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UPDATE OF STANDARDIZED CATCH RATES FOR LARGE AND SMALL BLUEFIN TUNA, *THUNNUS THYNNUS*, IN THE VIRGINIA-MASSACHUSETTS (U.S.) ROD AND REEL FISHERY

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SUMMARY

Separate abundance indices for large and small bluefin tuna off the coast of the United States from Virginia through Massachusetts were estimated using data obtained during interviews of red and reel/handline anglers in 1980-1996 (1983-1996 available for large bluefin tuna). Standardized catch rates were estimated through general liner models by applying the error distribution assumptions and final models from the previous year's analyses, with the addition of data for 1996.

RÉSUMÉ

Des indices d'abondance séparés pour le thon rouge de grande taille et le petit thon rouge au large de la côte des Etats-Unis, de la Virginie au Massachusetts, ont été estimés en utilisant des données obtenues au cours d'enquêtes auprès de pêcheurs à la ligne canne-moulinet/à main en 1980-1996 (pour le thon rouge de grande taille, données disponibles : 1983-1996). Les taux de capture standardisés ont été estimés par GLM en appliquant les postulats de distribution d'erreur et les modèles finaux issus des analyses de l'année précédente, avec addition des données de 1996.

RESUMEN

Se estimaron por separado índices de abundancia para atún rojo grande y pequeño frente a la costa de Estados Unidos, desde Virginia hasta Massachusetts, utilizando datos obtenidos durante entrevistas con pescadores de caña y carrete/liña de mano en 1980-1996 (disponible 1983-1996 para grandes atunes rojos). Se estimaron las tasas de captura estandarizadas mediante GLM, aplicando los supuestos de distribución de error y modelos finales de los análisis del año anterior, con la adición de datos para 1996.

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Material and Methods

Bluefin tuna *(Thunnus thynnus)* abundance indices were estimated by updating the analyses for small (Turner *et al.* 1997) and large (Turner and Brown 1997)) fish as reported to the 1996 SCRS meetings. Data from surveys of rod and reel and handline fishing effort off the northeast United States (Virginia through Massachusetts) during 1980-1996 were used for small fish (< 145 cm); data from New Jersey through Maine during 1983-1996 were used for large fish(> 195 cm). Surveys involved both dockside same day interviews (dock) as well as interviews of earlier trips conducted either at dockside or by telephone (recall). Information collected during the interviews usually included date, landing area, fishing area, numbers of lines fished, hours fished, target of fishing, catch including bluefin tuna size category since 1987 and size of the fish.

Small fish analysis: Fishing effort was defined as hours fished as has been done in recent analyses (Brown and Huang 1995). Data were collected from June to October. Observations were limited to those on which anglers indicated that they were targeting small bluefin. Although trips with other targets, such as marlin/tuna, did catch small bluefin, catch rates tended to be lower. Trips with targets other than small bluefin were not included because they were thought to be adding noise rather than information. Regulatory measures were in place to limit the catches of this fishery; when the allocated catch was met or about to be met the fishery was stopped for specific areas. Data collected during closed seasons was not included in the analysis based upon previous conclusions that there was little observed catch during periods where catch was prohibited (Turner *et al.* 1997, Turner and Brown 1997).

Large fish analysis: Observations were limited to those on which anglers indicated that they were targeting large bluefin. Marlin/tuna(other than bluefin) target was not included because it was thought to be adding noise rather than information. Beginning in 1995, a system of monthly allocations was implemented so that monthly closures occurred and a system of days when landings were prohibited to coincide with closures in the Japanese market. Data collected during closed seasons was not included in the analysis.

During preliminary analysis, it was discovered that there were bluefin size category inconsistencies in data recorded by one sampler during 1996. A high proportion of the measured bluefin recorded by this sampler as large fish actually fell in the medium size range. A conservative approach was adopted pending further investigation of the situation; the data collected by this sampler was removed from the analysis. This represented 21 observations out of 89 total observations in the analysis data set after all other necessary restrictions are applied (such as targeting and area restrictions, eliminating incomplete records or trips with effort values which fall in the extreme tails of the observed distribution, etc) as was done for previous analyses.

For both small and large fish analyses, the delta-lognormal (Lo) approach (Lo et al. 1992) was used to standardize abundance indices from the cpue data. The delta-lognormal models produced the results used for the 1996 SCRS bluefin tuna assessment. Those analyses are updated here by adding an additional year of data (1996) and following the same procedures for data treatment and then using the final model factors from Turner *et al.* (1997) and Turner and Brown (1997) for small and large fish, respectively.

Results and Discussion

Full analyses (*i.e.* the testing of all potential factors for possible significant effects on catch rates, as well as the iterative removal of non-significant effects) were not conducted for this study. However, with the addition of only a single year's data, it is unlikely that the final models would have differed significantly from the previous year's final models.

Small Fish Analysis: The results obtained employing the final models from the previous year's analysis, with the addition of data from 1996, are shown in Table 1. All factors were estimated to be significant effects. The standardized CPUE indices are shown in Figure 1.

Large Fish Analysis: The results obtained employing the final models from the previous year's analysis, with the addition of data from 1996, are shown in Table 2. All factors were estimated to be significant effects. The standardized CPUE indices are shown in Figure 2.

Both abundance indices show increasing trends in recent years. However, the estimates of relative abundance indices 1996 have decreased precision due to reduced sample sizes in that year. This is particularly evident in the large fish results, where the estimate for 1996 is by far the least precise of the estimates presented in Figure 2. This reduction in sample size (Tables 3 and 4) is primarily due to changes in survey objectives and methodology, including the elimination of catch rate data collection via telephone, which were implemented beginning in 1996.

These increasing abundance trends also coincide with the implementation of new regulatory measures, including size-specific quotas, bag limits and time-area closures. The most extreme measures occurred in the large fish fishery starting in 1995, where monthly quotas were set and restricted fishing days, on which no large fish could be caught for sale, are scattered throughout each month. This had the effect of concentrating the fishing effort into shorter pulses. It is unclear what direct effect these measures may have had on fishing behavior and catch rates; it is also possible that the measures contribute to an increase in catch rate. Fishermen have reported higher catch rates immediately after closures, and it is recommended that closure effects be examined.

Literature Cited

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Table 1. Results of the small bluefin tuna analysis.

GLM on proportion positives
General Linear Models Procedure

Dependent Variable: POS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	16	0.36148123	0.02259258	3.54	0.0110
Error	14	0.08923220	0.00637373		
Corrected Total	30	0.45071343			

R-Square	C.V.	Root MSE	POS Mean
0.802020	17.23566	0.079836	0.463200

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	15	0.31771821	0.02118121	3.32	0.0152
BOATTYPE	1	0.05508724	0.05508724	8.64	0.0108

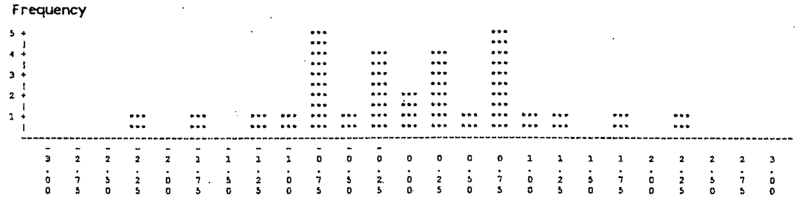
Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		0.4649076326 B	7.97	0.0001	0.05830370
YEAR	80	0.0302735974 B	0.38	0.7102	0.07983563
	81	-.2088031497 B	-2.11	0.0531	0.09885874
	82	0.1544868906 B	1.94	0.0734	0.07983563
	83	0.1015446632 B	1.27	0.2241	0.07983563
	85	-.0337322793 B	-0.42	0.6791	0.07983563
	86	-.0441656643 B	-0.55	0.5888	0.07983563
	87	-.0273765750 B	-0.34	0.7368	0.07983563
	88	-.0162506562 B	-0.20	0.8416	0.07983563
	89	-.0100728378 B	-0.13	0.9014	0.07983563
	90	-.0486294011 B	-0.61	0.5522	0.07983563
	91	-.0597194817 B	-0.75	0.4668	0.07983563
	92	-.1164816821 B	-1.46	0.1666	0.07983563
	93	-.1370171558 B	-1.72	0.1082	0.07983563
	94	-.2790558829 B	-3.50	0.0036	0.07983563
	95	-.1214880668 B	-1.52	0.1503	0.07983563
	96	0.0000000000 B	.	.	.
BOATTYPE	CHARTER	0.0857027735 B	2.94	0.0108	0.02915185
	PRIVATE	0.0000000000 B	.	.	.

Table 1. Results of the small bluefin tuna analysis. (cont.)

YEAR	LSMEAN	STDERR	COV1	COV2	COV3	COV4	COV5	COV6	COV7
80	0.53803	0.056452	.0031869	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
81	0.29896	0.081155	.0000000	.0065862	.0000000	.0000000	.0000000	.0000000	.0000000
82	0.66225	0.056452	.0000000	.0000000	.0031869	.0000000	.0000000	.0000000	.0000000
83	0.60930	0.056452	.0000000	.0000000	.0000000	.0031869	.0000000	.0000000	.0000000
85	0.47403	0.056452	.0000000	.0000000	.0000000	.0000000	.0031869	.0000000	.0000000
86	0.46359	0.056452	.0000000	.0000000	.0000000	.0000000	.0000000	.0031869	.0000000
87	0.48038	0.056452	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0031869
88	0.49151	0.056452	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
89	0.49769	0.056452	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
90	0.45913	0.056452	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
91	0.44804	0.056452	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
92	0.39128	0.056452	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
93	0.37074	0.056452	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
94	0.22870	0.056452	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
95	0.38627	0.056452	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
96	0.50776	0.056452	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000

COV8	COV9	COV10	COV11	COV12	COV13	COV14	COV15	COV16
.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
.0031869	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
.0000000	.0031869	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
.0000000	.0000000	.0031869	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
.0000000	.0000000	.0000000	.0031869	.0000000	.0000000	.0000000	.0000000	.0000000
.0000000	.0000000	.0000000	.0000000	.0031869	.0000000	.0000000	.0000000	.0000000
.0000000	.0000000	.0000000	.0000000	.0000000	.0031869	.0000000	.0000000	.0000000
.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0031869	.0000000	.0000000
.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0031869	.0000000
.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0031869

Residuals positive CPUE



Plot of VARIANCE*PRED. Legend: A = 1 obs, B = 2 obs, etc.

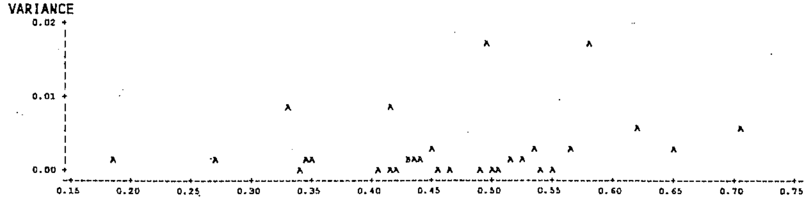


Table 1. Results of the small bluefin tuna analysis. (cont.)

GLM on positive catches
General Linear Models Procedure

Dependent Variable: LBFCR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	16	556.0281778	34.7517611	39.01	0.0001
Error	4128	3677.1874440	0.8907915		
Corrected Total	4144	4233.2156219			

R-Square	C.V.	Root MSE	LBFCR Mean
0.131349	-150.7021	0.943818	-0.626280

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	15	430.3863659	28.6924244	32.21	0.0001
BOATTYPE	1	128.7978833	128.7978833	144.59	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		-1.130026887 B	-13.33	0.0001	0.08477286
YEAR	80	0.743934414 B	7.86	0.0001	0.09461974
	81	-0.248001346 B	-2.27	0.0230	0.10907844
	82	0.654123384 B	6.45	0.0001	0.10144080
	83	-0.194015788 B	-2.01	0.0450	0.09674268
	85	-0.041860165 B	-0.41	0.6817	0.10205766
	86	0.194822568 B	1.98	0.0474	0.09820997
	87	0.440636977 B	4.40	0.0001	0.10017730
	88	0.112243205 B	1.08	0.2805	0.10398287
	89	0.415652045 B	4.38	0.0001	0.09492478
	90	-0.081685483 B	-0.86	0.3916	0.09532687
	91	0.585691544 B	6.05	0.0001	0.09687296
	92	0.144947501 B	1.44	0.1501	0.10069415
	93	0.049551690 B	0.35	0.7233	0.13997013
	94	-0.155128959 B	-0.78	0.4372	0.19963996
	95	-0.019877495 B	-0.17	0.8664	0.11812573
	96	0.000000000 B	.	.	.
BOATTYPE	CHARTER	0.402486417 B	12.02	0.0001	0.03347225
	PRIVATE	0.000000000 B	.	.	.

Table 1. Results of the small bluefin tuna analysis. (cont.)

YEAR	LSMEAN	STDERR	COV1	COV2	COV3	COV4	COV5	COV6	COV7
80	-0.18485	0.04615	0.0021300	0.0001719	0.0001517	0.0001493	0.0000220	0.0000232	-.0000214
81	-1.17679	0.07138	0.0001719	0.0050952	0.0002473	0.0002433	0.0000359	0.0000378	-.0000349
82	-0.27466	0.05900	0.0001517	0.0002473	0.0034813	0.0002148	0.0000317	0.0000333	-.0000308
83	-1.12280	0.05049	0.0001493	0.0002433	0.0002148	0.0025494	0.0000311	0.0000328	-.0000303
85	-0.97064	0.05973	0.0000220	0.0000359	0.0000317	0.0000311	0.0035678	0.0000048	-.0000045
86	-0.73396	0.05289	0.0000232	0.0000378	0.0000333	0.0000328	0.0000048	0.0027975	-.0000047
87	-0.48815	0.05634	-.0000214	-.0000349	-.0000308	-.0000303	-.0000045	-.0000047	0.0031744
88	-0.81654	0.06298	0.0000267	0.0000436	0.0000385	0.0000379	0.0000056	0.0000059	-.0000054
89	-0.51313	0.04644	0.0000029	0.0000047	0.0000042	0.0000041	0.0000006	0.0000006	-.0000006
90	-1.01047	0.04744	0.0000607	0.0000989	0.0000873	0.0000860	0.0000127	0.0000133	-.0000123
91	-0.34309	0.05038	0.0000283	0.0000462	0.0000407	0.0000401	0.0000059	0.0000062	-.0000057
92	-0.78384	0.05736	0.0000171	0.0000279	0.0000246	0.0000242	0.0000036	0.0000038	-.0000035
93	-0.87923	0.11293	0.0000540	0.0000880	0.0000777	0.0000765	0.0000113	0.0000119	-.0000110
94	-1.08391	0.18165	-.0000191	-.0000311	-.0000275	-.0000270	-.0000040	-.0000042	0.0000039
95	-0.94866	0.08439	0.0000737	0.0001200	0.0001060	0.0001043	0.0000154	0.0000162	-.0000150
96	-0.92878	0.08279	0.0000159	0.0000259	0.0000228	0.0000225	0.0000033	0.0000035	-.0000032

COV8	COV9	COV10	COV11	COV12	COV13	COV14	COV15	COV16
0.0000267	0.0000029	0.0000607	0.0000283	0.0000171	0.000054	-0.000019	0.0000737	0.0000159
0.0000436	0.0000047	0.0000989	0.0000462	0.0000279	0.000088	-0.000031	0.0001200	0.0000259
0.0000385	0.0000042	0.0000873	0.0000407	0.0000246	0.000078	-0.000027	0.0001060	0.0000228
0.0000379	0.0000041	0.0000860	0.0000401	0.0000242	0.000076	-0.000027	0.0001043	0.0000225
0.0000056	0.0000006	0.0000127	0.0000059	0.0000036	0.000011	-0.000004	0.0000154	0.0000033
0.0000059	0.0000006	0.0000133	0.0000062	0.0000038	0.000012	-0.000004	0.0000162	0.0000035
-.0000054	-.0000006	-.0000123	-.0000057	-.0000035	-0.000011	0.000004	-.0000150	-.0000032
0.0039659	0.0000007	0.0000154	0.0000072	0.0000043	0.000014	-0.000005	0.0000187	0.0000040
0.0000007	0.0021570	0.0000017	0.0000008	0.0000005	0.000001	-0.000001	0.0000020	0.0000004
0.0000154	0.0000017	0.0022508	0.0000163	0.0000099	0.000031	-0.000011	0.0000424	0.0000091
0.0000072	0.0000008	0.0000163	0.0025383	0.0000046	0.000015	-0.000005	0.0000198	0.0000043
0.0000043	0.0000005	0.0000099	0.0000046	0.0032898	0.000009	-0.000003	0.0000120	0.0000026
0.0000137	0.0000015	0.0000311	0.0000145	0.0000088	0.012753	-0.000010	0.0000377	0.0000081
-.0000048	-.0000005	-.0000110	-.0000051	-.0000031	-0.000010	0.032996	-.0000133	-.0000029
0.0000187	0.0000020	0.0000424	0.0000198	0.0000120	0.000038	-0.000013	0.0071212	0.0000111
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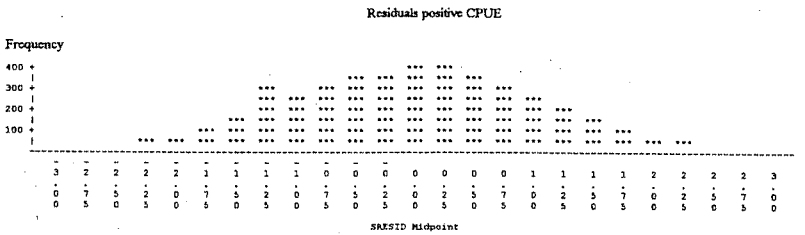
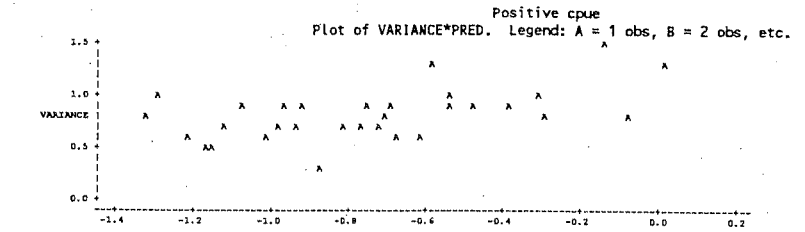




Relative Abundance Indices			
YEAR	INDEX	LCI	UCI
1980	0.8302	0.5685	1.2123
1981	0.1499	0.0712	0.3155
1982	1.0000	0.7592	1.3172
1983	0.3829	0.2835	0.5170
1984			
1985	0.3219	0.2047	0.5062
1986	0.3973	0.2785	0.5666
1987	0.5310	0.3770	0.7478
1988	0.3934	0.2758	0.5612
1989	0.5418	0.3918	0.7491
1990	0.2978	0.2075	0.4272
1991	0.5630	0.3966	0.7990
1992	0.3070	0.2033	0.4635
1993	0.2603	0.1552	0.4367
1994	0.1206	0.0485	0.2997
1995	0.2558	0.1608	0.4069
1996	0.3659	0.2505	0.5343

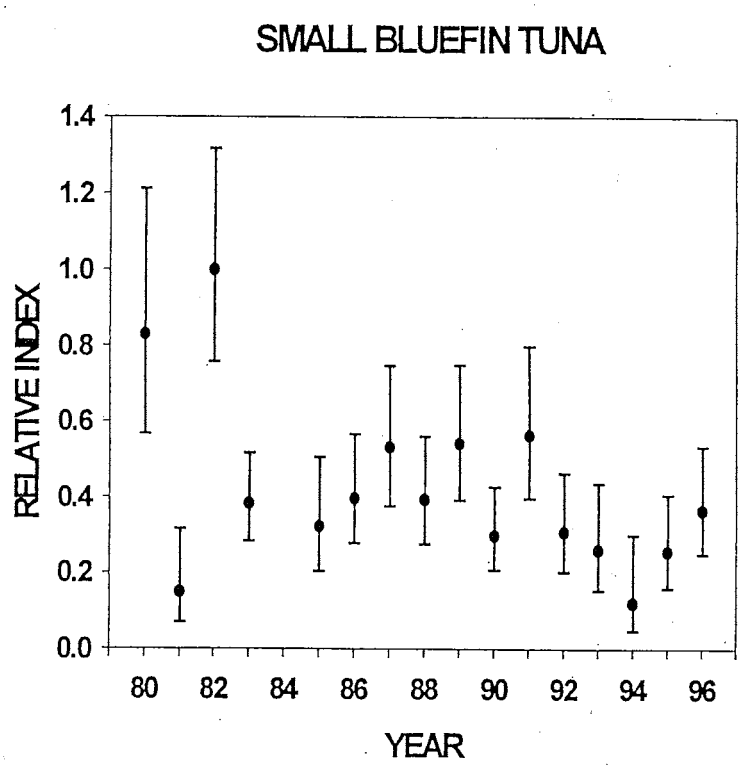


Figure 1. Relative abundance indices for small bluefin tuna with approximate 95% confidence intervals.

Model = YEAR + BOATTYPE (for both proportion positive and positive catches)

Table 2. Results of the large bluefin tuna analysis.

GLM on proportion positives
General Linear Models Procedure

Dependent Variable: POS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	37.42050629	2.07891702	1491.52	0.0001
Error	7417	10.33802351	0.00139383		
Corrected Total	7435	47.75852979			

R-Square	C.V.	Root MSE	POS Mean
0.783536	29.39349	0.03733401	0.12701453

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	13	24.17709297	1.85977638	1334.29	0.0001
MONTH	2	2.27890592	1.13945296	817.50	0.0001
AREA	1	0.48820669	0.48820669	350.26	0.0001
MONTH*AREA	2	1.81458290	0.90729145	650.93	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		0.1979466119 B	42.70	0.0001	0.00463559
YEAR	83	0.0368657169 B	7.90	0.0001	0.00466553
	84	-.0906546717 B	-19.13	0.0001	0.00473871
	85	-.0650222608 B	-13.16	0.0001	0.00494020
	86	-.1354676330 B	-23.71	0.0001	0.00571440
	87	-.1297312919 B	-26.60	0.0001	0.00487794
	88	-.0538223441 B	-10.50	0.0001	0.00512611
	89	-.1097604080 B	-22.57	0.0001	0.00486321
	90	-.1178596410 B	-24.79	0.0001	0.00475433
	91	-.1106748591 B	-23.25	0.0001	0.00476062
	92	-.0948136755 B	-19.68	0.0001	0.00481737
	93	-.1165971300 B	-22.49	0.0001	0.00518400
	94	-.0921026632 B	-16.25	0.0001	0.00566804
	95	-.0882741978 B	-17.34	0.0001	0.00508956
	96	0.0000000000 B	.	.	.
MONTH	7	-.0479256367 B	-20.69	0.0001	0.00231637
	8	0.0060741000 B	2.82	0.0049	0.00215771
	9	0.0000000000 B	.	.	.
AREA	GOMA	0.0523996651 B	28.85	0.0001	0.00181597

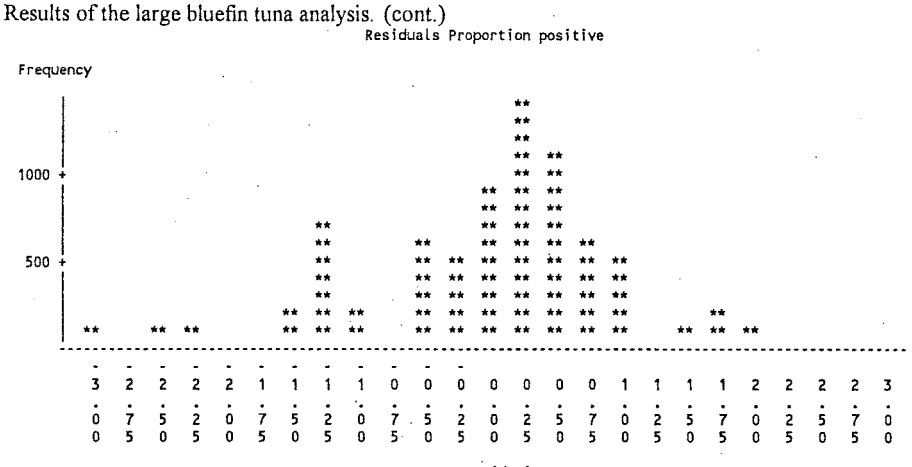
Table 2. Results of the large bluefin tuna analysis. (cont.)

	STHN	0.0000000000	B	.	.	.
MONTH*AREA	7 GOMA	-.0115249384	B	-4.29	0.0001	0.00268384
	7 STHN	0.0000000000	B	.	.	.
	8 GOMA	-.0824981791	B	-33.66	0.0001	0.00245089
	8 STHN	0.0000000000	B	.	.	.
	9 GOMA	0.0000000000	B	.	.	.
	9 STHN	0.0000000000	B	.	.	.

YEAR	LSMEAN	STDERR	COV1	COV2	COV3	COV4	COV5	COV6	COV7
83	0.23139	.0010194	0.0000010392	0.0000001814	0.0000001129	0.000000155	0.0000000614	0.0000000559	-.0000000356
84	0.10387	.0012340	0.0000001814	0.0000015229	0.0000002806	0.000000307	0.0000001461	0.0000001392	0.0000000128
85	0.12950	.0018951	0.0000001129	0.0000002806	0.0000035915	0.000000331	0.0000001456	0.0000002151	0.0000000477
86	0.05906	.0034332	0.0000001555	0.0000003068	0.0000003306	0.000011787	0.0000001745	0.0000002272	0.0000000313
87	0.06479	.0016896	0.0000000614	0.0000001461	0.0000001456	0.000000175	0.0000028546	0.0000001177	0.0000000231
88	0.14070	.0023327	0.0000000559	0.0000001392	0.0000002151	0.000000227	0.0000001177	0.0000054417	0.0000000313
89	0.08477	.0016922	-.0000000356	0.0000000128	0.0000000477	0.000000031	0.0000000231	0.0000000313	0.0000028635
90	0.07667	.0013682	-.0000000208	-.0000000040	0.0000000442	0.000000039	0.0000000219	0.0000000435	0.0000000278
91	0.08385	.0013715	0.0000000771	0.0000001491	0.0000001622	0.000000174	0.0000000800	0.0000001093	0.0000000122
92	0.09971	.0015668	0.0000000747	0.0000001871	0.0000002249	0.000000211	0.0000000826	0.0000001359	0.0000000263
93	0.07793	.0024513	0.0000001511	0.0000002597	0.0000001994	0.000000238	0.0000001174	0.0000001117	0.0000000012
94	0.10242	.0033601	0.0000000309	0.0000001122	0.0000000885	0.000000079	0.0000000397	0.0000000350	0.0000000160
95	0.10625	.0022612	0.0000001058	0.0000001986	0.0000002015	0.000000218	0.0000000982	0.0000001282	0.0000000124
96	0.19453	.0045534	0.0000000029	-.0000000994	-.0000000402	-.000000067	-.0000001030	-.0000000508	-.0000000268

COV8	COV9	COV10	COV11	COV12	COV13	COV14
-.0000000208	0.0000000771	0.0000000747	0.0000001511	0.000000031	0.0000001058	0.000000003
-.0000000040	0.0000001491	0.0000001871	0.0000002597	0.000000112	0.0000001986	-.000000099
0.0000000442	0.0000001622	0.0000002249	0.0000001994	0.000000089	0.0000002015	-.000000040
0.0000000388	0.0000001742	0.0000002108	0.0000002384	0.000000079	0.0000002180	-.000000067
0.0000000219	0.0000000800	0.0000000826	0.0000001174	0.000000040	0.0000000982	-.000000103
0.0000000435	0.0000001093	0.0000001359	0.0000001117	0.000000035	0.0000001282	-.000000051
0.0000000278	0.0000000122	0.0000000263	0.0000000012	0.000000016	0.0000000124	-.000000027
0.0000018720	0.0000000166	0.0000000229	0.0000000002	-.000000002	0.0000000163	0.000000001
0.0000000166	0.0000018810	0.0000001062	0.0000001140	0.000000039	0.0000001063	-.000000024
0.0000000229	0.0000001062	0.0000024550	0.0000001254	0.000000064	0.0000001325	-.000000009
0.0000000002	0.0000001140	0.0000001254	0.0000060091	0.000000066	0.0000001510	-.000000066
-.0000000016	0.0000000392	0.0000000638	0.0000000662	0.000011290	0.0000000524	-.000000051
0.0000000163	0.0000001063	0.0000001325	0.0000001510	0.000000052	0.0000051131	-.000000028
0.0000000010	-.0000000243	-.0000000091	-.0000000655	-.000000051	-.0000000284	0.000020734

Table 2. Results of the large bluefin tuna analysis. (cont.)



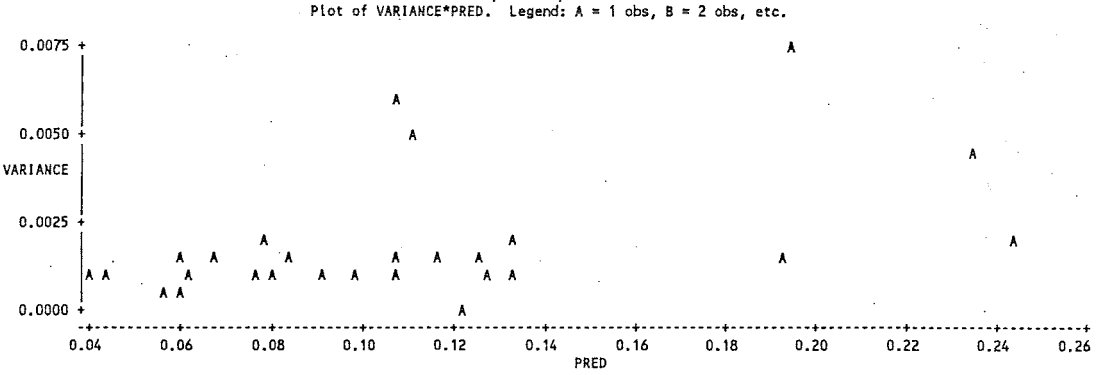


Table 2. Results of the large bluefin tuna analysis. (cont.)

GLM on positive catches
General Linear Models Procedure

Dependent Variable: LBFCR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	14	46.43644181	3.31688870	12.38	0.0001
Error	1020	273.23597334	0.26787841		
Corrected Total	1034	319.67241515			

R-Square	C.V.	Root MSE	LBFCR Mean
0.145263	-16.90890	0.51756971	-3.06092982

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	13	34.01096504	2.61622808	9.77	0.0001
AREA	1	7.32742903	7.32742903	27.35	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		-2.895736623 B	-21.59	0.0001	0.13410159
YEAR	83	0.117956525 B	0.86	0.3891	0.13691349
	84	0.141687142 B	0.99	0.3228	0.14324310
	85	-0.472711721 B	-3.09	0.0020	0.15278000
	86	-0.084208315 B	-0.35	0.7245	0.23889278
	87	-0.132843320 B	-0.81	0.4177	0.16384105
	88	-0.421802362 B	-2.62	0.0089	0.16099429
	89	-0.057233673 B	-0.36	0.7164	0.15751875
	90	-0.189769923 B	-1.25	0.2124	0.15210206
	91	0.057693198 B	0.38	0.7010	0.15020389
	92	-0.053233934 B	-0.35	0.7230	0.15012551
	93	-0.231332517 B	-1.31	0.1890	0.17600485
	94	-0.298684018 B	-1.57	0.1175	0.19065227
	95	0.044121956 B	0.27	0.7870	0.16321562
	96	0.000000000 B	.	.	.
AREA	GOMA	-0.218992108 B	-5.23	0.0001	0.04187179
	STHN	0.000000000 B	.	.	.

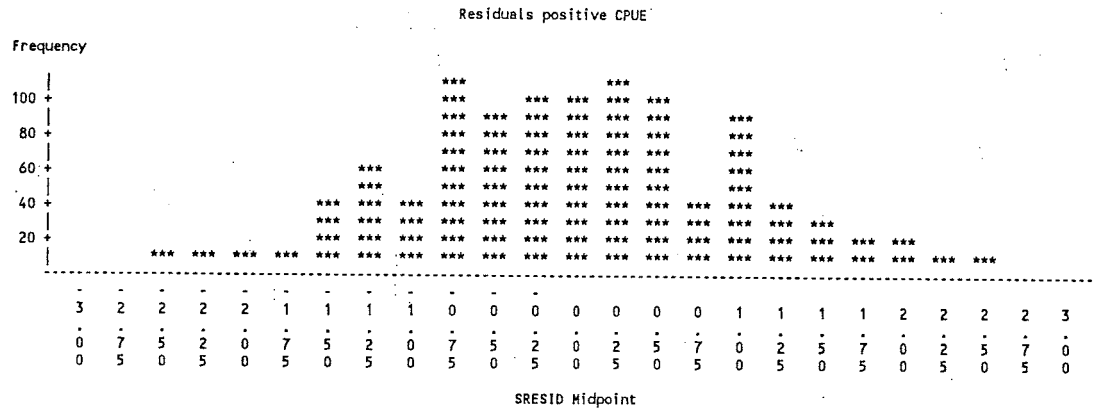
Table 2. Results of the large bluefin tuna analysis. (cont.)

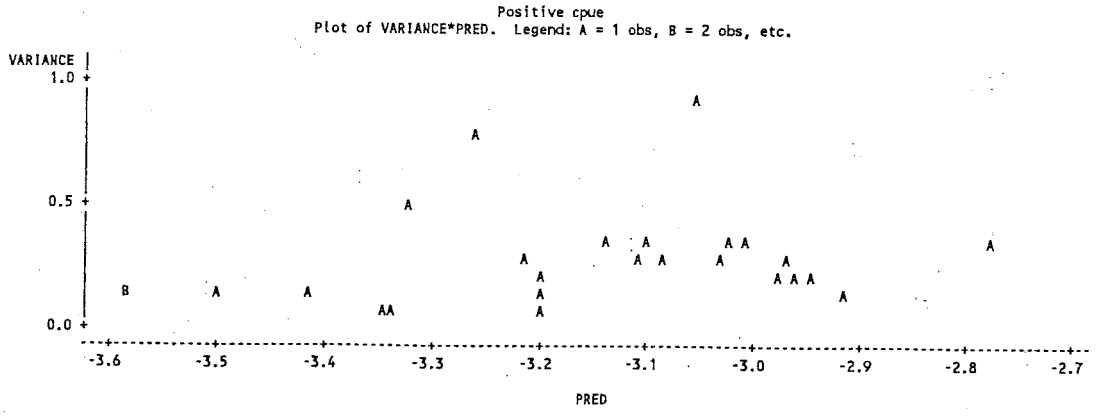
Positive cpue

YEAR	LSMEAN	STDERR	COV1	COV2	COV3	COV4	COV5	COV6
83	-2.88728	0.02570	0.00066057	0.0001401	0.0001401	0.000140	0.0000587	0.0001012
84	-2.86355	0.04643	0.00014006	0.0021555	0.0004383	0.000438	0.0001838	0.0003166
85	-3.47794	0.07056	0.00014006	0.0004383	0.0049786	0.000438	0.0001838	0.0003166
86	-3.08944	0.19674	0.00014006	0.0004383	0.0004383	0.038707	0.0001838	0.0003166
87	-3.13808	0.09337	0.00005873	0.0001838	0.0001838	0.000184	0.0087183	0.0001328
88	-3.42704	0.08758	0.00010115	0.0003166	0.0003166	0.000317	0.0001328	0.0076697
89	-3.06247	0.08154	0.00007174	0.0002245	0.0002245	0.000225	0.0000941	0.0001621
90	-3.19500	0.07128	0.00003435	0.0001075	0.0001075	0.000108	0.0000451	0.0000776
91	-2.94754	0.06526	0.00011946	0.0003739	0.0003739	0.000374	0.0001568	0.0002700
92	-3.05847	0.06567	0.00009265	0.0002900	0.0002900	0.000290	0.0001216	0.0002094
93	-3.23657	0.11231	0.00014006	0.0004383	0.0004383	0.000438	0.0001838	0.0003166
94	-3.30392	0.13451	0.00010271	0.0003214	0.0003214	0.000321	0.0001348	0.0002321
95	-2.96111	0.09209	0.00007003	0.0002192	0.0002192	0.000219	0.0000919	0.0001583
96	-3.00523	0.13399	-.00006536	-.0002045	-.0002045	-0.000205	-.0000858	-.0001477

COV7	COV8	COV9	COV10	COV11	COV12	COV13	COV14
0.0000717	0.0000344	0.0001195	0.0000927	0.000140	0.000103	0.0000700	-0.000065
0.0002245	0.0001075	0.0003739	0.0002900	0.000438	0.000321	0.0002192	-0.000205
0.0002245	0.0001075	0.0003739	0.0002900	0.000438	0.000321	0.0002192	-0.000205
0.0002245	0.0001075	0.0003739	0.0002900	0.000438	0.000321	0.0002192	-0.000205
0.0000941	0.0000451	0.0001568	0.0001216	0.000184	0.000135	0.0000919	-0.000086
0.0001621	0.0000776	0.0002700	0.0002094	0.000317	0.000232	0.0001583	-0.000148
0.0066486	0.0000551	0.0001915	0.0001485	0.000225	0.000165	0.0001123	-0.000105
0.0000551	0.0050807	0.0000917	0.0000711	0.000108	0.000079	0.0000538	-0.000050
0.0001915	0.0000917	0.0042583	0.0002473	0.000374	0.000274	0.0001869	-0.000174
0.0001485	0.0000711	0.0002473	0.0043130	0.000290	0.000213	0.0001450	-0.000135
0.0002245	0.0001075	0.0003739	0.0002900	0.012615	0.000321	0.0002192	-0.000205
0.0001646	0.0000788	0.0002742	0.0002126	0.000321	0.018094	0.0001607	-0.000150
0.0001123	0.0000538	0.0001869	0.0001450	0.000219	0.000161	0.0084808	-0.000102
-.0001048	-.0000502	-.0001745	-.0001353	-0.000205	-0.000150	-.0001023	0.017954

Table 2. Results of the large bluefin tuna analysis. (cont.)





Relative Abundance Indices			
YEAR	INDEX	LCI	UCI
1983	1.0000	0.9206	1.0862
1984	0.4318	0.3525	0.5289
1985	0.2942	0.2118	0.4088
1986	0.1889	0.0589	0.6060
1987	0.2008	0.1141	0.3533
1988	0.3377	0.2327	0.4900
1989	0.2858	0.1904	0.4291
1990	0.2258	0.1520	0.3356
1991	0.3174	0.2314	0.4354
1992	0.3401	0.2508	0.4612
1993	0.2195	0.1144	0.4212
1994	0.2717	0.1387	0.5323
1995	0.3998	0.2697	0.5926
1996	0.7271	0.4747	1.1136

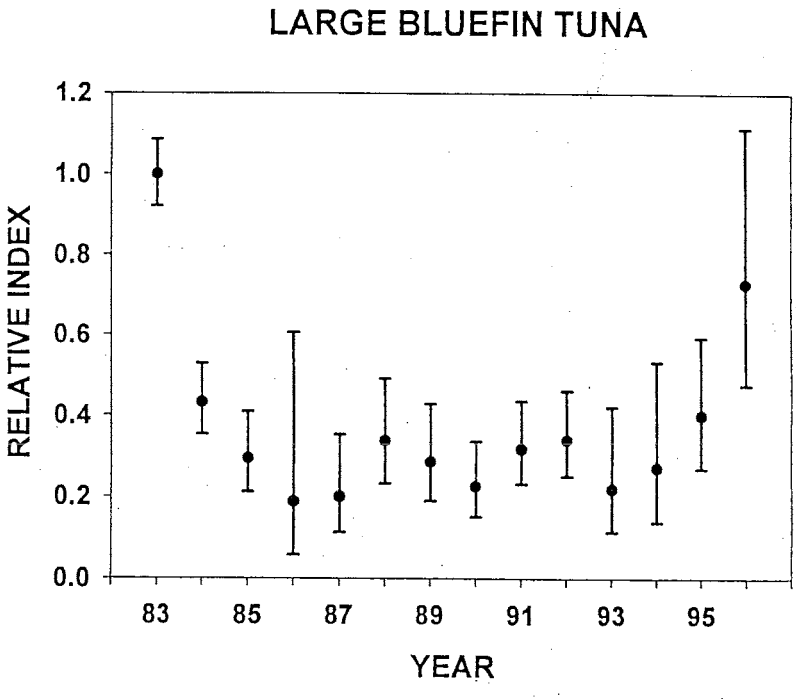


Figure 2. Relative abundance indices for large bluefin tuna with approximate 95% confidence intervals.

Model = YEAR + MONTH + AREA + MONTH*AREA (for proportion positive)
Model = YEAR + AREA (for positive catches)

Table 3. Small Bluefin Tuna Analysis - distribution of observations across model effects

TABLE OF YEAR BY BOATTYPE

YEAR / Frequency	PRIVATE	CHARTER	Total
80	98	622	720
81	0	454	454
82	16	292	308
83	29	436	465
85	219	195	414
86	250	288	538
87	328	161	489
88	192	165	357
89	347	297	644
90	260	406	666
91	306	313	619
92	345	242	587
93	90	70	160
94	58	47	105
95	100	152	252
96	103	94	197
Total	2741	4234	6975

Table 4. Large Bluefin Tuna Analysis - distribution of observations across model effects

TABLE OF YEAR BY MONTH

YEAR / Frequency	7	8	9	Total
83	60	777	730	1567
84	174	464	563	1201
85	147	211	70	428
86	24	77	21	122
87	138	266	104	508
88	89	167	9	265
89	235	127	132	494
90	312	276	168	756
91	208	368	200	776
92	217	246	144	607
93	28	113	99	240
94	45	32	47	124
95	65	136	79	280
96	21	18	29	68
Total	1763	3278	2395	7436

TABLE OF YEAR BY AREA

YEAR / Frequency	GOMA	STHN	Total
83	1092	475	1567
84	1201	0	1201
85	428	0	428
86	122	0	122
87	373	135	508
88	209	56	265
89	282	212	494
90	411	345	756
91	577	199	776
92	507	100	607
93	203	37	240
94	83	41	124
95	227	53	280
96	25	43	68
Total	5740	1696	7436