

PRELIMINARY STANDARDIZED CATCH RATES FOR BLUEFIN TUNA (*Thunnus thynnus*) FROM THE TRAP FISHERY IN TUNISIA

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SUMMARY

A General Linear Modeling (GLM) approach to analysis of variance was used to examine bluefin tuna catch rates from the Tunisian trap fishery at the Mediterranean Sea. Preliminary standardized catch rates for bluefin tuna were developed for the period 1975-1999.

RÉSUMÉ

Une approche de modélisation linéaire généralisée (GLM) à l'analyse de la variance a été utilisée pour examiner le taux de capture du thon rouge en provenance de la pêche tunisienne en madrague dans la Méditerranée. Le taux de capture standardisé préliminaire du thon rouge a été calculé pour la période 1975-1999.

RESUMEN

Se utilizaron técnicas de análisis lineal generalizado (GLM) para analizar las tasas de captura de atún rojo procedente de la pesquería de almadrabas de Túnez, Mar Mediterráneo.

KEYWORDS

Catch/effort, Least squares method, Abundance, Trap fishing.

INTRODUCTION

In Tunisia, tuna fishing by traps has been practiced nearly since the beginning of times. It was introduced by the Phoenicians; the Arabs of the 7th century neglected it for a long time. From the 19th century this gear has experimented a rebirth. In fact we can situate around 1820 the first exploitations of Tunisian tuna fishing boats in Sidi Daoud, Cap Zebib and Monastir. Then, for a century and a half it became a purely Italian industry and until finally, trap-nets were granted to different concessionaires. In the beginning of the century, the number of operational tuna fishing boats was ten, not counting three other trap-nets granted in 1906 to Ras Salakta, at the outside of Menzel Temime and in the north of Mahdia, which did not seem to be exploited. These trap-nets were: Cap Zebib, in the east of Bizerte, Sidi Daoud, Ras El Ahmar, El Haouaria, Ras El Mihr, Ras Marsa, Monastir, Conigliera, Kuriat, Borj Khédija (not far from La Chebba). Until 1999, two trap-nets were exploited by l'Office National des Pêches (ONP; National Fishery Office); that of Sidi Daoud and that of Monastir (Kuriat island). Today, two trap-nets at Sidi Daoud and Ras Lahmar, both in the Tunisian gulf are exploited by private enterprises.

The Conception of trap-nets has been widely detailed in Project FAO- COPEMED 1999 final report. These gears are based upon an ancestral principle: capturing the fish going to the Western Mediterranean to spawn in waters with a specific temperature and salinity. In their trajectory, tuna must cross the Sicily

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Channel, generally near the Tunisian Coast. Fishers knew that the tuna appeared from the third decade of May in Sidi Daoud and in the beginning of June in Monastir until the beginning of July. In the last years, variations in the dates of appearance of these animals have been observed. As a matter of fact, this observation was perfectly verified in the thirties and not so much during the seventies. In the eighties, the appearance of bluefin tuna stopped in the middle of June. In the present, bluefin tuna are fished from the beginning of April until the end of May.

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MATERIAL AND METHODS

Data were obtained from the Tunisian trap at Sidi Daoud in the Mediterranean Sea. Information on catches in number of individuals and weight, size composition, effort (days of bunt set between consecutive net lifting operations or *Matanzas*), and trap characteristics was collected from 1975 through 1999.

A General Linear Modeling (GLM) approach to analysis of variance was used to examine logged catch rates (catch in number of individuals and weight per day of bunt set between consecutive net lifting operations) for differences among the effects of year and month (Gavaris 1980, 1988).

Annual abundance indices were obtained from marginal means (least squares mean estimates), adjusted for the GLM statistically significant terms.

RESULTS AND DISCUSSION

For catch rates in number of fish, a preliminary analysis resulted in factor Month not being statistically significant (Table 1). The final model, which included only Year, class level information and F-test are given in Table 2.

As regards catch rates in weight, both factors, Year and Month were statistically significant at the 5 % level. R^2 was about 32 %. The distributions of standardized residuals for both models (Figure 1) does not appear to be far from expected under Normal error assumption.

Standardized annual indices of abundance in number of fish and weight are shown in Table 4. Standardized CPUE with 95 % upper and lower confidence limits are shown in Figure 2.

LITERATURE CITED

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Table 1.- GLM results for bluefin tuna catch rates in number of fish from the Tunisian trap in the Mediterranean Sea.

Mediterranean Tunisian TRAP BFT. Dependent: Number of Fish

The GLM Procedure

Class Level Information

Class	Levels	Values
Year	25	1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
Month	3	4 5 6

Number of observations 424

Dependent Variable: Lcpuen Lcpuen

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	26	65.8984411	2.5345554	5.21	<.0001
Error	397	193.1592232	0.4865472		
Corrected Total	423	259.0576643			

R-Square 0.254378
 Coeff Var 82.51922
 Root MSE 0.697529
 Lcpuen Mean 0.845293

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Year	24	64.82296896	2.70095704	5.55	<.0001
Month	2	1.07547216	0.53773608	1.11	0.3322

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Year	24	64.71968612	2.69665359	5.54	<.0001
Month	2	1.07547216	0.53773608	1.11	0.3322

Table 2.- GLM results for bluefin tuna catch rates in number of fish from the Tunisian trap in the Mediterranean Sea (Final model).

Mediterranean Tunisian TRAP BFT Dependent: Number of Fish															
The GLM Procedure															
Class Level Information															
Class	Levels	Values													
Year	25	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999			
Month	3	4	5	6											
														Number of observations	424
Dependent Variable: Lcpuen Lcpuen															
Source		DF	Sum of Squares		Mean Square	F Value	Pr > F								
Model		24	64.8229690		2.7009570	5.55	<.0001								
Error		399	194.2346953		0.4868037										
Corrected Total		423	259.0576643												
		R-Square	Coeff Var	Root MSE	Lcpuen Mean										
		0.250226	82.54098	0.697713	0.845293										
Source		DF	Type I SS		Mean Square	F Value	Pr > F								
Year		24	64.82296896		2.70095704	5.55	<.0001								
Source		DF	Type III SS		Mean Square	F Value	Pr > F								
Year		24	64.82296896		2.70095704	5.55	<.0001								
Parameter		Estimate	Standard Error		t Value	Pr > t									
Intercept		0.029335141	0.23257108		0.13	0.8997									
Year	1975	0.445561146	0.28233058		1.58	0.1153									
Year	1976	0.390994958	0.28233058		1.38	0.1669									
Year	1977	0.665854246	0.28484023		2.34	0.0199									
Year	1978	0.902850517	0.29071384		3.11	0.0020									
Year	1979	1.118030484	0.28484023		3.93	0.0001									
Year	1980	0.353358319	0.32890517		1.07	0.2833									
Year	1981	0.939911106	0.28761923		3.27	0.0012									
Year	1982	0.863231300	0.26622479		3.24	0.0013									
Year	1983	0.823456655	0.26854995		3.07	0.0023									
Year	1984	0.343705483	0.28005266		1.23	0.2204									
Year	1985	1.057058352	0.28484023		3.71	0.0002									
Year	1986	1.104097300	0.28005266		3.94	<.0001									
Year	1987	0.726286492	0.27797560		2.61	0.0093									
Year	1988	1.319223762	0.27271376		4.84	<.0001									
Year	1989	1.382734990	0.26854995		5.15	<.0001									
Year	1990	1.232264049	0.28005266		4.40	<.0001									
Year	1991	1.159092297	0.27797560		4.17	<.0001									
Year	1992	0.806837303	0.29809562		2.71	0.0071									
Year	1993	0.165276694	0.35161442		0.47	0.6386									
Year	1994	1.322986350	0.32057710		4.13	<.0001									
Year	1995	0.356728361	0.32057710		1.11	0.2665									
Year	1996	0.451484786	0.30766261		1.47	0.1430									
Year	1997	-0.064694213	0.32057710		-0.20	0.8402									
Year	1998	0.205899681	0.32890517		0.63	0.5317									
Year	1999	0.000000000	.		.	.									

NOTE: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

Table 3.- GLM results for bluefin tuna catch rates in weight from the Tunisian trap in the Mediterranean Sea

Mediterranean Tunisian TRAP BFT Dependent: Weight of Fish

The GLM Procedure

Class Level Information

Class	Levels	Values
Year	25	1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
Month	3	4 5 6

Number of observations 424

Dependent Variable: Lcpuew Lcpuew

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	26	452.142741	17.390105	7.19	<.0001
Error	397	959.613517	2.417163		
Corrected Total	423	1411.756259			

R-Square 0.320270
 Coeff Var 23.01375
 Root MSE 1.554723
 Lcpuew Mean 6.755626

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Year	24	433.7813647	18.0742235	7.48	<.0001
Month	2	18.3613768	9.1806884	3.80	0.0232

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Year	24	431.8163176	17.9923466	7.44	<.0001
Month	2	18.3613768	9.1806884	3.80	0.0232

Parameter	Estimate	Standard Error	t Value	Pr > t
Intercept	4.193970159 B	0.54556298	7.69	<.0001
Year 1975	1.515566615 B	0.63428249	2.39	0.0173
Year 1976	1.672221270 B	0.63320262	2.64	0.0086
Year 1977	1.835298933 B	0.63725184	2.88	0.0042
Year 1978	2.773060992 B	0.66244543	4.19	<.0001
Year 1979	3.244498319 B	0.64654548	5.02	<.0001
Year 1980	1.328595353 B	0.73388184	1.81	0.0710
Year 1981	2.674505677 B	0.64722947	4.13	<.0001
Year 1982	2.359335789 B	0.59856062	3.94	<.0001
Year 1983	2.430485581 B	0.60227899	4.04	<.0001
Year 1984	1.335308993 B	0.62944197	2.12	0.0345
Year 1985	2.696791524 B	0.63816621	4.23	<.0001
Year 1986	3.348907268 B	0.63535326	5.27	<.0001
Year 1987	2.416177096 B	0.62638816	3.86	0.0001
Year 1988	3.642128728 B	0.61873270	5.89	<.0001
Year 1989	3.859913571 B	0.60173513	6.41	<.0001
Year 1990	3.267837511 B	0.62456842	5.23	<.0001
Year 1991	2.785117707 B	0.62201774	4.48	<.0001
Year 1992	2.126649507 B	0.66703478	3.19	0.0015
Year 1993	1.188791336 B	0.79291349	1.50	0.1346
Year 1994	2.784396035 B	0.71454917	3.90	0.0001
Year 1995	0.485794372 B	0.71454917	0.68	0.4970
Year 1996	0.797413333 B	0.68615683	1.16	0.2459
Year 1997	-0.354551326 B	0.73313452	-0.48	0.6289
Year 1998	0.295487959 B	0.76643884	0.39	0.7000
Year 1999	0.000000000 B	.	.	.
Month 4	0.067167588 B	0.41349637	0.16	0.8710
Month 5	0.459796598 B	0.17048565	2.70	0.0073
Month 6	0.000000000 B	.	.	.

NOTE: The XX matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

Table 4.- Standardized CPUE series in number of fish (upper) and weight (lower) for the Tunisian BFT Trap fishery in the Mediterranean Sea.

Year	Least Sqr. Mean	Std. Error	Lower CI 95%	Upper CI 95%
1975	0,4749	0,1601	0,16	0,79
1976	0,4203	0,1601	0,11	0,73
1977	0,6952	0,1645	0,37	1,02
1978	0,9322	0,1744	0,59	1,27
1979	1,1474	0,1645	0,83	1,47
1980	0,3827	0,2326	-0,07	0,84
1981	0,9692	0,1692	0,64	1,30
1982	0,8926	0,1296	0,64	1,15
1983	0,8528	0,1343	0,59	1,12
1984	0,3730	0,1560	0,07	0,68
1985	1,0864	0,1645	0,76	1,41
1986	1,1334	0,1560	0,83	1,44
1987	0,7556	0,1523	0,46	1,05
1988	1,3486	0,1424	1,07	1,63
1989	1,4121	0,1343	1,15	1,68
1990	1,2616	0,1560	0,96	1,57
1991	1,1884	0,1523	0,89	1,49
1992	0,8362	0,1865	0,47	1,20
1993	0,1946	0,2637	-0,32	0,71
1994	1,3523	0,2206	0,92	1,78
1995	0,3861	0,2206	-0,05	0,82
1996	0,4808	0,2014	0,09	0,88
1997	-0,0354	0,2206	-0,47	0,40
1998	0,2352	0,2326	-0,22	0,69
1999	0,0293	0,2326	-0,43	0,49

Year	Least Sqr. Mean	Std. Error	Lower CI 95%	Upper CI 95%
1975	5,8852	0,3807	5,14	6,63
1976	6,0418	0,3807	5,30	6,79
1977	6,2049	0,3904	5,44	6,97
1978	7,1427	0,4153	6,33	7,96
1979	7,6141	0,3925	6,84	8,38
1980	5,6982	0,5365	4,65	6,75
1981	7,0441	0,4000	6,26	7,83
1982	6,7290	0,3074	6,13	7,33
1983	6,8001	0,3170	6,18	7,42
1984	5,7049	0,3656	4,99	6,42
1985	7,0664	0,3900	6,30	7,83
1986	7,7185	0,3746	6,98	8,45
1987	6,7858	0,3477	6,10	7,47
1988	8,0118	0,3248	7,38	8,65
1989	8,2295	0,3277	7,59	8,87
1990	7,6375	0,3758	6,90	8,37
1991	7,1547	0,3650	6,44	7,87
1992	6,4963	0,4366	5,64	7,35
1993	5,5584	0,6041	4,37	6,74
1994	7,1540	0,5129	6,15	8,16
1995	4,8554	0,5129	3,85	5,86
1996	5,1670	0,4706	4,24	6,09
1997	4,0151	0,4937	3,05	4,98
1998	4,6651	0,5275	3,63	5,70
1999	4,3696	0,5406	3,31	5,43

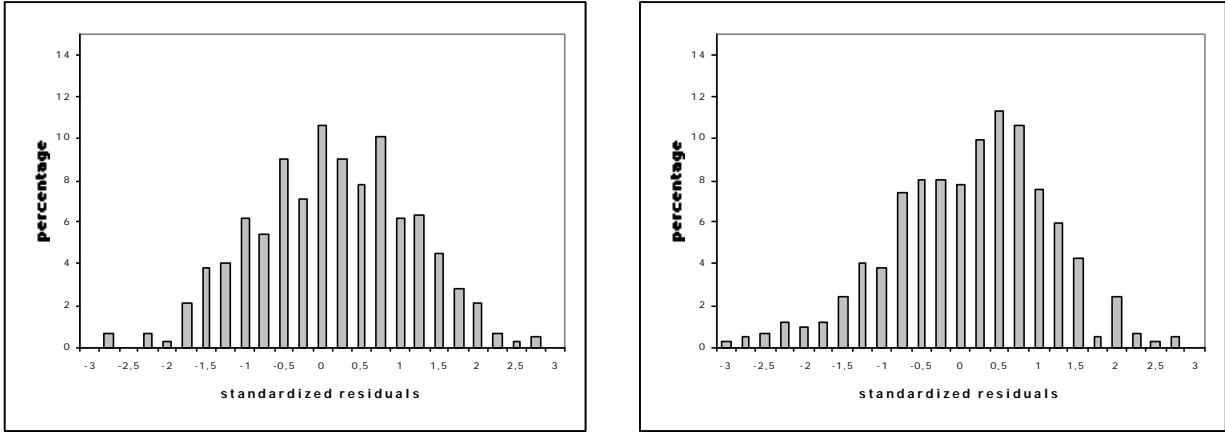


Figure 1.- Standardized residuals for GLM fits (left panel for model with catch rates in number of fish and right panel for catch rates in weight).

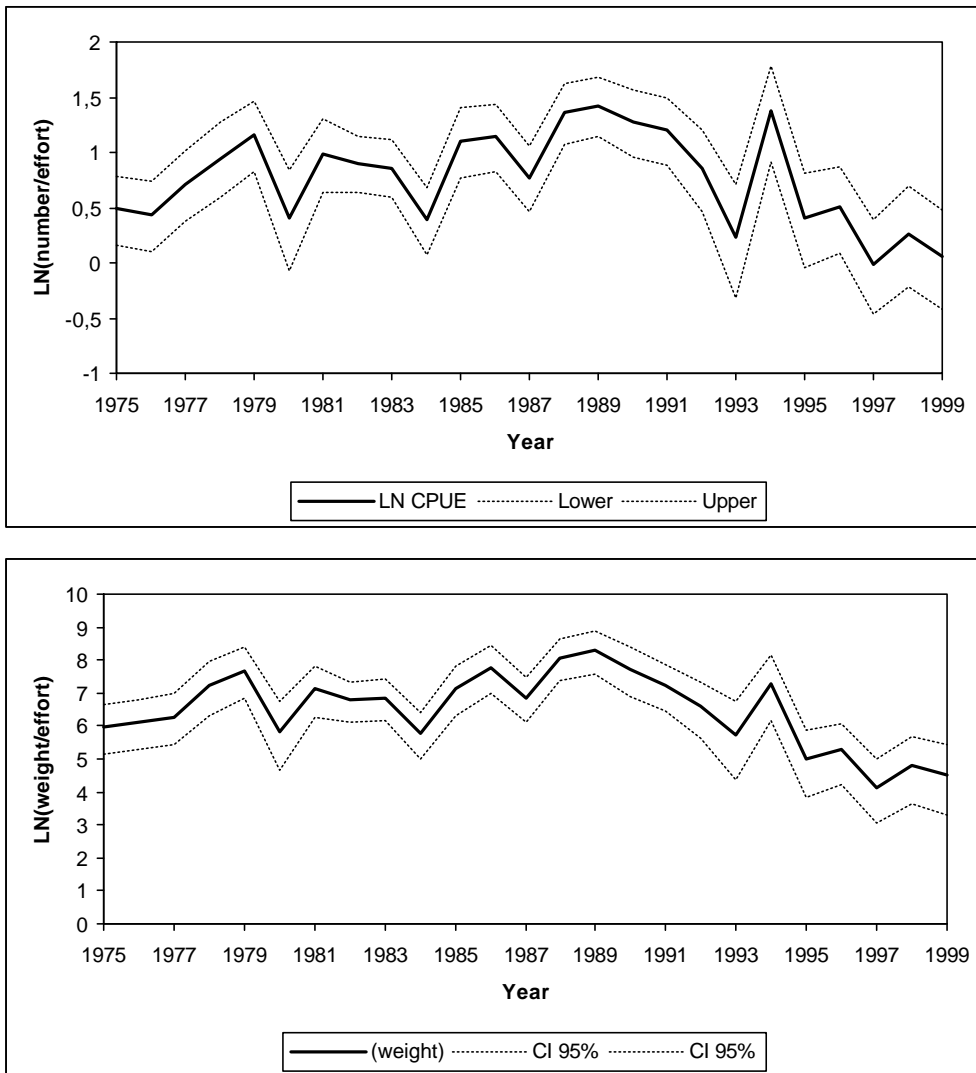


Figure 2.- Standardized CPUE series in number of fish and weight for the Tunisian BFT Trap fishery in the Mediterranean Sea. Dashed lines indicate 95% confidence bands.