

UPDATED STANDARDIZED CATCH RATES OF BLUEFIN TUNA (*THUNNUS THYNNUS*) FROM THE TRAP FISHERY IN TUNISIA

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SUMMARY

A General Linear Modelling (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 adopted for the period 1975-2000.

RÉSUMÉ

Des techniques de modèle linéaire généralisé (GLM) ont été utilisées pour analyser les taux de capture du thon rouge en provenance des pêcheries de madragues tunisiennes opérant en Méditerranée. Des taux de capture standardisés préliminaires pour le thon rouge ont été adoptés pour la période 1975-2000.

RESUMEN

Se utilizó un modelo lineal generalizado (GLM) para analizar la varianza con el fin de examinar las tasas de captura de atún rojo procedente de la pesquería de almadrabas de Túnez en el mar Mediterráneo. Se adoptaron las tasas de captura estandarizadas preliminares de atún rojo para el periodo 1975-2000.

KEYWORDS

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

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1. 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 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.

This study was performed with the financial aid of the Project FAO- COPEMED and coordinated by the Instituto Español de Oceanografía. Centro Oceanográfico de Málaga.

2. 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 *ormatanzas*), and trap characteristics was collected from 1975 through 2000.

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.

3. Results and discussion

For catch rates in number of fish, a preliminary analysis resulted in factor Month not being statistically significant (**Table 1**) as in previous analysis (Hattour *et al.* 2001). The final model, which included only Year, class level information and F-test are given in **Table 2**.

As regards catch rates in weight (**Table 3**), both factors, Year and Month were statistically significant at the 5% level. R^2 was about 33.5%. 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 1**.

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 26 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 2000

Month 2 5 6

Number of observations 414

Dependent Variable: Lcpuen Lcpuen

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	49	87.3642485	1.7829438	3.83	<.0001
Error	364	169.6408576	0.4660463		
Corrected Total	413	257.0051062			

R-Square Coeff Var Root MSE Lcpuen Mean
0.339932 82.22180 0.682676 0.830286

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Year	25	70.67624790	2.82704992	6.07	<.0001
Month	1	0.96217433	0.96217433	2.06	0.1516
Year*Month	23	15.72582629	0.68373158	1.47	0.0778

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Year	25	57.22736743	2.28909470	4.91	<.0001
Month	1	0.72201938	0.72201938	1.55	0.2140
Year*Month	23	15.72582629	0.68373158	1.47	0.0778

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 26 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 2000

Month 2 5 6

Number of observations 414

Dependent Variable: Lcpuen Lcpuen

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	25	70.6762479	2.8270499	5.89	<.0001
Error	388	186.3288583	0.4802290		
Corrected Total	413	257.0051062			

R-Square Coeff Var Root MSE Lcpuen Mean
0.274999 83.46350 0.692986 0.830286

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Year	25	70.67624790	2.82704992	5.89	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Year	25	70.67624790	2.82704992	5.89	<.0001

Parameter	Estimate	Standard Error	t Value	Pr > t
Intercept	-0.152584617 B	0.20894301	-0.73	0.4657
Year 1975	0.627480904 B	0.26254979	2.39	0.0173
Year 1976	0.572914716 B	0.26254979	2.18	0.0297
Year 1977	0.847774003 B	0.26521043	3.20	0.0015
Year 1978	1.084770275 B	0.27142494	4.00	<.0001

Table 2. (Cont.)

Year	1979	1.299950242 B	0.26521043	4.90	<.0001
Year	1980	0.535278077 B	0.31147386	1.72	0.0865
Year	1981	1.121830863 B	0.26815285	4.18	<.0001
Year	1982	1.070965753 B	0.24787788	4.32	<.0001
Year	1983	1.042963084 B	0.25073162	4.16	<.0001
Year	1984	0.485767707 B	0.26254979	1.85	0.0650
Year	1985	1.238978110 B	0.26521043	4.67	<.0001
Year	1986	1.286017058 B	0.26013196	4.94	<.0001
Year	1987	0.926601017 B	0.26521043	3.49	0.0005
Year	1988	1.443167033 B	0.26013196	5.55	<.0001
Year	1989	1.564654747 B	0.24787788	6.31	<.0001
Year	1990	1.414183807 B	0.26013196	5.44	<.0001
Year	1991	1.341012055 B	0.25792486	5.20	<.0001
Year	1992	0.988757061 B	0.27921185	3.54	0.0004
Year	1993	0.347196452 B	0.33505422	1.04	0.3007
Year	1994	1.504906107 B	0.30278719	4.97	<.0001
Year	1995	0.538648119 B	0.30278719	1.78	0.0760
Year	1996	0.633404544 B	0.28926850	2.19	0.0291
Year	1997	-0.068520119 B	0.35170350	-0.19	0.8456
Year	1998	0.546711088 B	0.40461641	1.35	0.1774
Year	1999	0.181919758 B	0.31147386	0.58	0.5595
Year	2000	0.000000000 B	.	.	.

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 26 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 2000

Month 2 5 6

Number of observations 414

Dependent Variable: Lcpuew Lcpuew

Source	DF	Sum of		Mean Square	F Value	Pr > F
		Squares				
Model	26	452.362970		17.398576	7.49	<.0001
Error	387	898.916531		2.322782		
Corrected Total	413	1351.279501				

R-Square Coeff Var Root MSE Lcpuew Mean
0.334766 22.61930 1.524067 6.737908

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Year	25	435.2732582	17.4109303	7.50	<.0001
Month	1	17.0897122	17.0897122	7.36	0.0070

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Year	25	452.3000873	18.0920035	7.79	<.0001
Month	1	17.0897122	17.0897122	7.36	0.0070

Parameter	Estimate	Standard		t Value	Pr > t
		Error			
Intercept	3.896233954 B	0.48390420		8.05	<.0001
Year 1975	1.817135764 B	0.58094013		3.13	0.0019
Year 1976	1.974173714 B	0.58004064		3.40	0.0007
Year 1977	2.137890201 B	0.58467175		3.66	0.0003
Year 1978	3.072162684 B	0.60895611		5.04	<.0001

Table 3. (cont.)

Year	1979	3.544257467 B	0.59270385	5.98	<.0001
Year	1980	1.631995798 B	0.68536759	2.38	0.0177
Year	1981	2.975668985 B	0.59426238	5.01	<.0001
Year	1982	2.725341572 B	0.54833340	4.97	<.0001
Year	1983	2.796428935 B	0.55325268	5.05	<.0001
Year	1984	1.579771032 B	0.58094013	2.72	0.0068
Year	1985	2.998978204 B	0.58538588	5.12	<.0001
Year	1986	3.648828251 B	0.58105623	6.28	<.0001
Year	1987	2.729351917 B	0.58624568	4.66	<.0001
Year	1988	3.804935751 B	0.57837209	6.58	<.0001
Year	1989	4.162235113 B	0.54714215	7.61	<.0001
Year	1990	3.571763921 B	0.57218724	6.24	<.0001
Year	1991	3.087708975 B	0.56868821	5.43	<.0001
Year	1992	2.429067380 B	0.61566847	3.95	<.0001
Year	1993	1.488608283 B	0.74417958	2.00	0.0462
Year	1994	3.088686575 B	0.66591475	4.64	<.0001
Year	1995	0.790084912 B	0.66591475	1.19	0.2362
Year	1996	1.101218366 B	0.63630720	1.73	0.0843
Year	1997	-0.258478232 B	0.77359679	-0.33	0.7385
Year	1998	0.990633038 B	0.88999293	1.11	0.2664
Year	1999	0.305018799 B	0.68518527	0.45	0.6565
Year	2000	0.000000000 B	.	.	.
Month	5	0.452514005 B	0.16682796	2.71	0.0070
Month	6	0.000000000 B	.	.	.

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

<i>Year</i>	<i>Least Sqr. Mean</i>	<i>Std. Error</i>	<i>LN CPUE (number)</i>	<i>Lower CI 95%</i>	<i>Upper CI 95%</i>
1975	0,4749	0,1590	0,4875	0,18	0,80
1976	0,4203	0,1590	0,4330	0,12	0,74
1977	0,6952	0,1633	0,7085	0,39	1,03
1978	0,9322	0,1732	0,9472	0,61	1,29
1979	1,1474	0,1633	1,1607	0,84	1,48
1980	0,3827	0,2310	0,4094	-0,04	0,86
1981	0,9692	0,1681	0,9834	0,65	1,31
1982	0,9184	0,1334	0,9273	0,67	1,19
1983	0,8904	0,1386	0,9000	0,63	1,17
1984	0,3332	0,1590	0,3458	0,03	0,66
1985	1,0864	0,1633	1,0997	0,78	1,42
1986	1,1334	0,1550	1,1454	0,84	1,45
1987	0,7740	0,1633	0,7873	0,47	1,11
1988	1,2906	0,1550	1,3026	1,00	1,61
1989	1,4121	0,1334	1,4210	1,16	1,68
1990	1,2616	0,1550	1,2736	0,97	1,58
1991	1,1884	0,1512	1,1999	0,90	1,50
1992	0,8362	0,1852	0,8533	0,49	1,22
1993	0,1946	0,2619	0,2289	-0,28	0,74
1994	1,3523	0,2191	1,3763	0,95	1,81
1995	0,3861	0,2191	0,4101	-0,02	0,84
1996	0,4808	0,2000	0,5008	0,11	0,89
1997	-0,2211	0,2829	-0,1811	-0,74	0,37
1998	0,3941	0,3465	0,4542	-0,22	1,13
1999	0,0293	0,2310	0,0560	-0,40	0,51
2000	-0,1526	0,2089	-0,1308	-0,54	0,28

<i>Year</i>	<i>Least Sqr. Mean</i>	<i>Std. Error</i>	<i>LN CPUE (weight)</i>	<i>Lower CI 95%</i>	<i>Upper CI 95%</i>
1975	5,9396	0,3497	6,0007	5,32	6,69
1976	6,0967	0,3499	6,1579	5,47	6,84
1977	6,2604	0,3603	6,3253	5,62	7,03
1978	7,1947	0,3846	7,2687	6,51	8,02
1979	7,6667	0,3611	7,7319	7,02	8,44
1980	5,7545	0,5101	5,8846	4,88	6,88
1981	7,0982	0,3697	7,1665	6,44	7,89
1982	6,8478	0,2935	6,8909	6,32	7,47
1983	6,9189	0,3057	6,9656	6,37	7,56
1984	5,7023	0,3497	5,7634	5,08	6,45
1985	7,1215	0,3597	7,1862	6,48	7,89
1986	7,7713	0,3424	7,8299	7,16	8,50
1987	6,8518	0,3593	6,9163	6,21	7,62
1988	7,9274	0,3412	7,9856	7,32	8,65
1989	8,2847	0,2941	8,3279	7,75	8,90
1990	7,6942	0,3458	7,7540	7,08	8,43
1991	7,2102	0,3337	7,2659	6,61	7,92
1992	6,5516	0,4080	6,6348	5,84	7,43
1993	5,6111	0,5771	5,7776	4,65	6,91

1994	7,2112	0,4866	7,3296	6,38	8,28
1995	4,9126	0,4866	5,0310	4,08	5,98
1996	5,2237	0,4435	5,3220	4,45	6,19
1997	3,8640	0,6247	4,0591	2,83	5,28
1998	5,1131	0,7666	5,4069	3,90	6,91
1999	4,4275	0,5148	4,5600	3,55	5,57
2000	4,1225	0,4646	4,2304	3,32	5,14

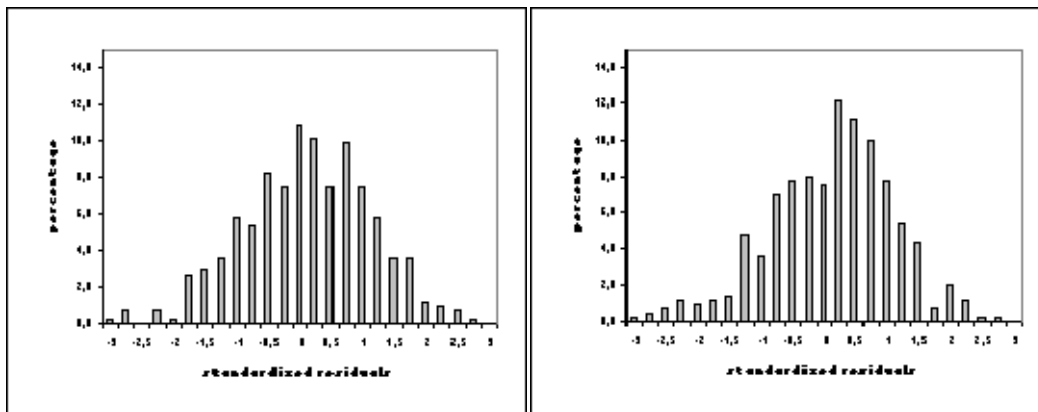


Figure 1. Standardized residuals for GLM fits (left panel for model with catch rates in number of fish and right panel for catch rates in weight).