FORECASTING AND MANAGEMENT OF ARTISANAL TUNA FISHERIES IN IRANIAN WATERS BY USE OF TIME SERIES

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INTRODUCTION

Tuna and tuna-like species are one of the most important resources for artisanal fisheries in developing countries in the region. Yellowfin is a commercially important source of protein for both developing and developed countries. It is therefore essential that we manage the resource properly and conserve it for future generations.

The total artisanal catch in Iran in 1994 was 42,045 t. The main species caught are yellowfin tuna (38.6%), longtail tuna (28.8%), skipjack tuna (17.4%), and kawakawa (2.87%) (other species are dealt with in Iran's national report). Before 1989 the catches of yellowfin and skipjack were recorded together, therefore we have analysed these two species together; the other two species are analysed separately.

The yellowfin resources in the Indian Ocean have been exploited for more than 200 years (IPTP/90/WP/20), but official statistics are available only for the last 40 years. According to these statistics, the catch of yellowfin has increased dramatically since 1984, due to the introduction of industrial purse-seine fishing in the western Indian Ocean.

For management purposes, a more practical methodology for analysis of the resource than those currently available is called for. In this regard, we believe that all the statistical analyses must be revised and improved by taking biological and environmental information into account.

Due to time constraints, this paper concentrates only on an application of the Statgraphics software. A simulation study of fisheries interactions is planned for a later date.

MATERIALS AND METHODS

The basic data for this study were obtained from artisanal fishery statistics for 1970-1993 compiled by the Iranian Fisheries Research and Training Organization (Table 1) (TWS/93/1/15).

Catch estimates, numbers of active vessels, effort and CPUE were calculated by Iranian Fisheries Research Centres in the south of Iran. We prepared forecasting analyses using time series procedures by comparing the results of four different types of trend calculation: linear, quadratic, exponential power, and S-curve and Q-spline (Figure 5).

We forecast the trends in tuna catches in Iranian waters from the curves obtained from these analyses.

RESULTS AND DISCUSSION

Yellowfin and skipjack

The forecast summary (Table 2) shows a lower mean error (ME) with the first two methods than with the others. We can therefore choose either one of them for future years, but since the increase in catch S-curve (Figure 1) is gradual, then, according to the rules of resource management and to increases in catch of other countries, Iran should decrease its catch, but these results should be confirmed by analysis of the other major industrial and artisanal fisheries.

Longtail tuna

The quasi-cubic spline curve for longtail tuna (Figure 2) shows that there is a decrease in the Iranian catch since 1989; we do not know the situation in the other countries of the region. We think that S-curve is the best predictor for future years.

Kawakawa

Catches increased from 1979 to 1984, but the decrease in recent years resulting from the high level of effort by the fishery. In order for the stocks to recover, effort and catch will have to decrease in future years, as shown by the quadratic curve in Figure 3.

All tunas

The fisheries for tunas use various types of gillnets, and management of these migratory species in such a multispecies fishery is difficult. Figure 4 shows that a gradual increase of the S-curve is most appropriate.

We hope that this Expert Consultation will consider the possible co-operative measures that may be taken to ensure the optimal exploitation of the fishery and the

Table 1. Landings of tunas and seerfishes in Iran, 1970-1993

Year	*YFT & SKJ*	*LOT*	*KAW*	*FIR*	*COM*	*GUR*	*SFA*	*No. of craft*	*Total*
1970	-	638	113	-	-	-	-	-	751
1971		114	79						193
1972	-	665	108	-	-	-	-	-	773
1973	-	858	176	-	-	-	-	-	1,034
1974	-	868	167	-	-	-	-	-	1,035
1975	-	947	183	-	-	-	-	-	1,130
1976	920	1,393	306	-	-	-	102	-	2,721
1977	719	1,553	318	-	-	-	28	-	2,618
1978	-	-		-	-	-	-	-	-
1979	392	846	198	-	-	-	74	-	1,510
1980	370	969	242	-	-	-	112	-	1,693
1981	-	2,229	429	-	-	-	16	-	2,674
1982	-	2,924	716	-	76	1,420	-	-	5,136
1983	-	5,924	2,633		1,436	1,676	-	1,151	11,669
1984	-	6,421	4,156	-	621	931	-	1,425	12,129
1985	-	11,848	1,707	-	735	490	5	1,664	14,758
1986	-	11,710	1,870	326	697	465	3	2,163	15,071
1987	-	12,069	647	394	1,063	706	8	2,163	14,887
1988	-	16,907	2,165	348	1,000	667	-	2,596	21,087
1989	1,327	19,399	766	160	2,510	1,673	-	2,848	25,835
1990	3,088	14,924	696	70	3,380	2,253	-	3,058	24,411
1991	4,386	14,552	660	480	3,720	2,480	170	3,941	26,448
1992	16,395	9,758	722	300	3,328	2,218	170	-	32,891
1993	17,653	8,150	518	436	2,869	1,636	740	-	32,002

collection of the necessary research and statistical data needed for co-operative management.

REFERENCES

NISHIDA, T. 1993. Preliminary analysis of yellowfin tuna (*Thunnus albacares*) resources in the Indian Ocean by the improved immature -adult dynamic model. IPTP Coll. Vol. Work. Doc. 8 : 150-161.

FIROOZI, A. REZA. 1993. The Status of Tuna and Seerfishes in Iran. IPTP Coll. Vol. Work. Doc. 8: 47-48.

Table 2. Forecast summaries.

	YFT & SKJ CATCHES						***Period 25***	***Period 26***	***Period 27***	***Period 28***	***Period 29***	***Period 30***	***Period 31***	***Period 32***	***Period 33***	***Period 34***
	Name of Model	***M.E.***	***M.S.E.***	***M.A.E.***	***M.A.P.E.***	***M.P.E.***	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***
Linear	-6240.61+694.627*T	0.00000E+01	22000000	3907.24	181.994	-65.0128	11125.1	11819.7	12514.3	13208.9	13903.6	14598.2	15292.8	15987.4	16682.1	17376.7
Quadr.	29731.6-5011.87*T+184.298*T^2	0.00000E+01	8700000	2736.03	255.655	94.477	19620.9	24008.2	28764.1	33888.6	39381.7	45243.4	51473.6	58072.5	65040	72376.1
Exp.	Exp(4.69507+0.178951*T)	1.55816E+04	22000000	2912.35	73.5927	-27.2942	9593.59	11473.6	13722	16410.9	19626.9	23473	28072.8	33574	40153.3	48021.8
S-curve	Exp(9.67468-27.2052/T)	2.10563E+04	33000000	3413.04	101.749	-50.1989	5358.66	5587.7	5808.5	6021.33	6226.48	6424.26	6614.97	6798.89	6976.32	7147.55
	LOT CATCHES															
Linear	-2870.9+727.48*T	0.00000E+01	11137000	2724.85	163.721	31.9758	15316.1	16043.6	16771.1	17498.5	18226	18953.3	19681	20408.5	21136	21863.4
Quadr.	-1803.63+475.333*T+10.1323*T^2	0.00000E+01	10940000	2556.6	123.259	7.29384	16412.4	17404.5	18416.8	19449.4	20502.3	21575.5	22668.9	23782.9	24916.5	26070.7
Exp.	Exp(5.74054+0.180504*T)	2.48210E+03	24081400	2943.89	56.8858	-20.4253	28371.8	33984.4	40707.2	48760	58405.8	69959.7	83899.2	100376	120233	144018
S-curve	Exp(8.68585-4.15108/T)	2.62738E+04	34505500	4344.37	130.404	-70.116	5012.96	5045.08	5075.01	5102.95	5129.11	5153.65	5176.71	5198.42	5218.89	5238.24
	KAW CATCHES															
Linear	139.845+56.215*T	0.00000E+01	820716	632.901	110.025	-86.9043	1545.22	1601.44	1657.65	1713.87	1770.08	1826.3	1882.51	1938.73	1994.94	2051.16
Quadr.	-794.852+277.041*T-8.8737*T^2	0.00000E+01	675176	607.96	149.255	-30.6271	585.133	409.595	216.33	5.31762	-223.442	-469.949	-734.204	-1016.21	-1315.96	-1633.45
Exp.	Exp(4.78329+0.109989*T)	2.16124E+03	1016700	984.797	58.3335	-24.2068	1868.74	2086.01	2328.54	2599.27	2901.48	3238.82	3615.38	4035.73	4504.95	5028.72
S-curve	Exp(6.66828-3.09644/T)	3.07469E+03	950668	527.541	73.8018	-34.0023	695.358	698.679	701.767	704.647	707.339	709.861	712.229	714.456	716.554	718.534
	TUNA CATCHES															
Linear	7269.2+1442.18*T	0.00000E+01	16726000	3369.32	238.911	121.9	28785.3	30227.5	31669.7	33111.9	34554	35996.2	37438.4	38880.6	40322.8	41764.9
Quadr.	1679.85-672.069*T+84.9593*T^2	0.00000E+01	3385300	1554.77	50.4676	-17.895	37977.7	41638.5	45469.3	49470	53640.6	57981.1	62491.6	67171.9	72022.2	77042.4
Exp.	Exp(5.92495+0.202462*T)	-2.77696E+03	20429400	2818.1	37.9091	-10.3622	59071.8	72328.3	88559.7	108434	132768	162563	199044	243712	298405	365371
S-curve	Exp(9.2209-4.6087/T)	4.90010E+04	111617000	7723.98	137.373	-74.4208	8404.71	8464.52	8520.27	8572.37	8621.16	8666.95	8710.01	8750.57	8788.84	8825.02
	CRAFT															
Linear	-3323.67+314.333*T	0.00000E+01	27143.3	133.333	5.3257	0.06698	4534	4849	5163.33	5477.67	5792	6106.33	6420.67	6735	7049.33	7363.67
Quadr.	1380.7-219.355*T+14.8247*T^2	0.00000E+01	19622.2	104.292	4.12732	-0.33723	5162.24	5698.95	6265.3	6861.3	7486.95	8142.26	8827.21	9541.81	10286.1	11060
Exp.	Exp(5.14825+0.141187*T)	6.89840E-00	19574.5	100.862	4.34138	-0.17998	58711.9	6762.32	7787.76	8968.7	10328.7	11895	13698.7	15776	18168.3	20923.3
S-curve	Exp(10.1777-43.8492/T)	5.70239E+01	24997.5	113.776	4.09721	-0.1374	4553.96	4871.78	5185.79	5495.47	5800.39	6100.23	6394.74	6683.75	6967.13	7244.8

***Figure 1**. Trends of annual yellowfin/skipjack tuna catches in Iranian waters.*

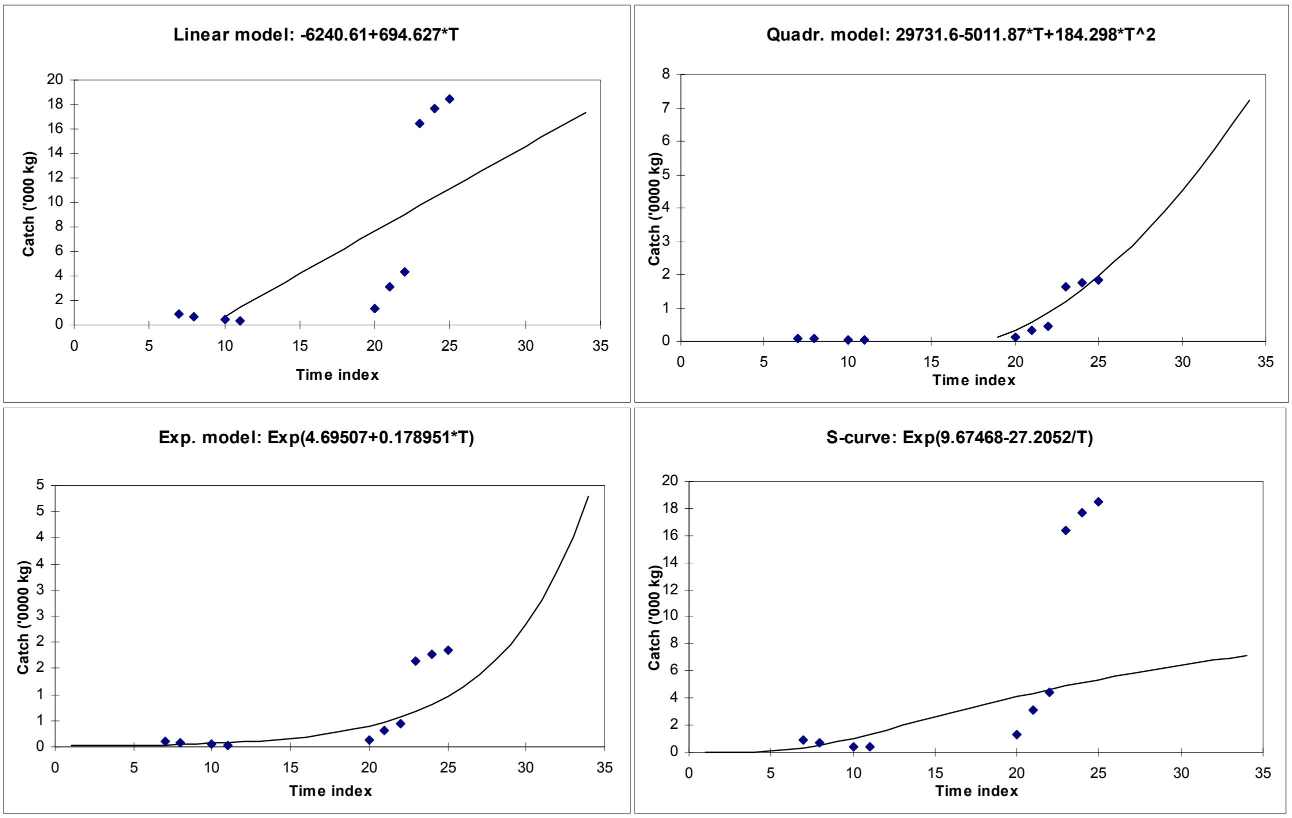

***Figure 2.** Trends of annual longtail tuna catches in Iranian waters.*

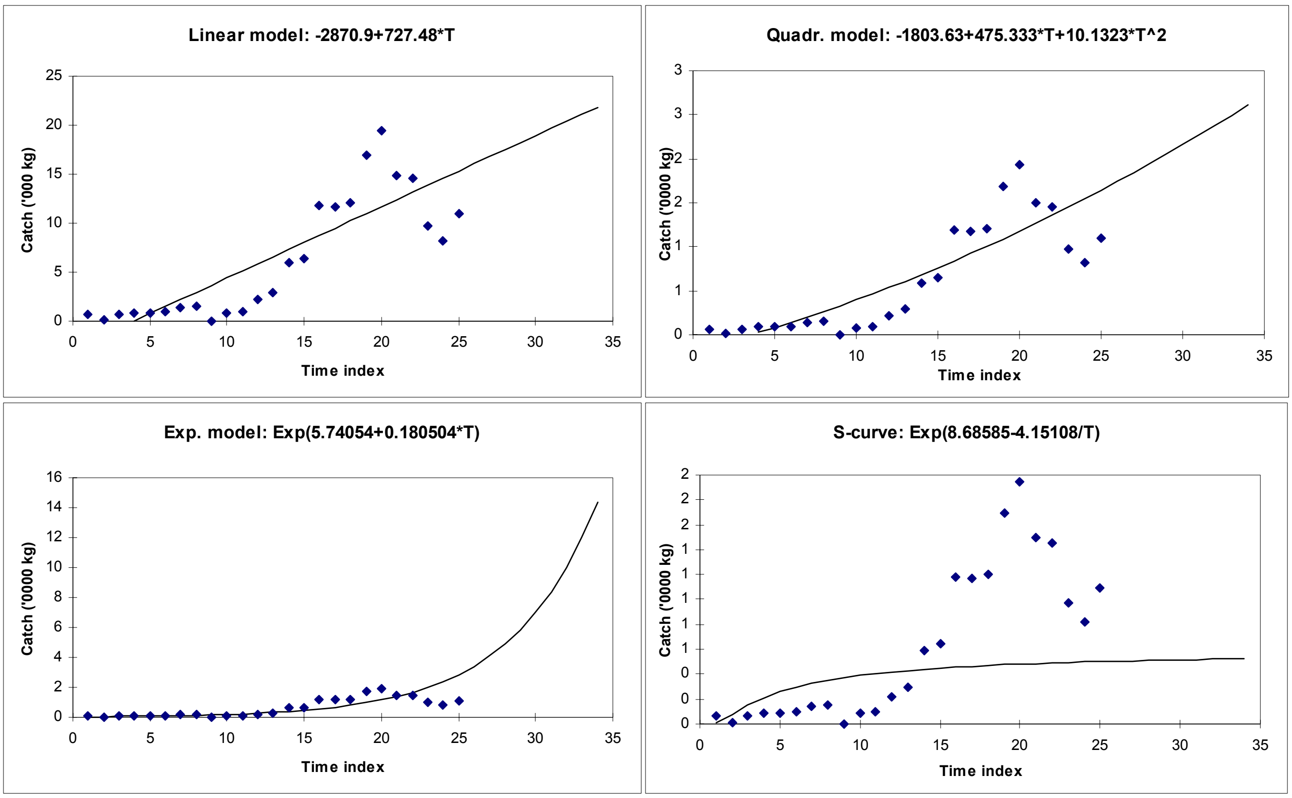

Figure 3. *Trends of annual kawakawa catches in Iranian waters.*

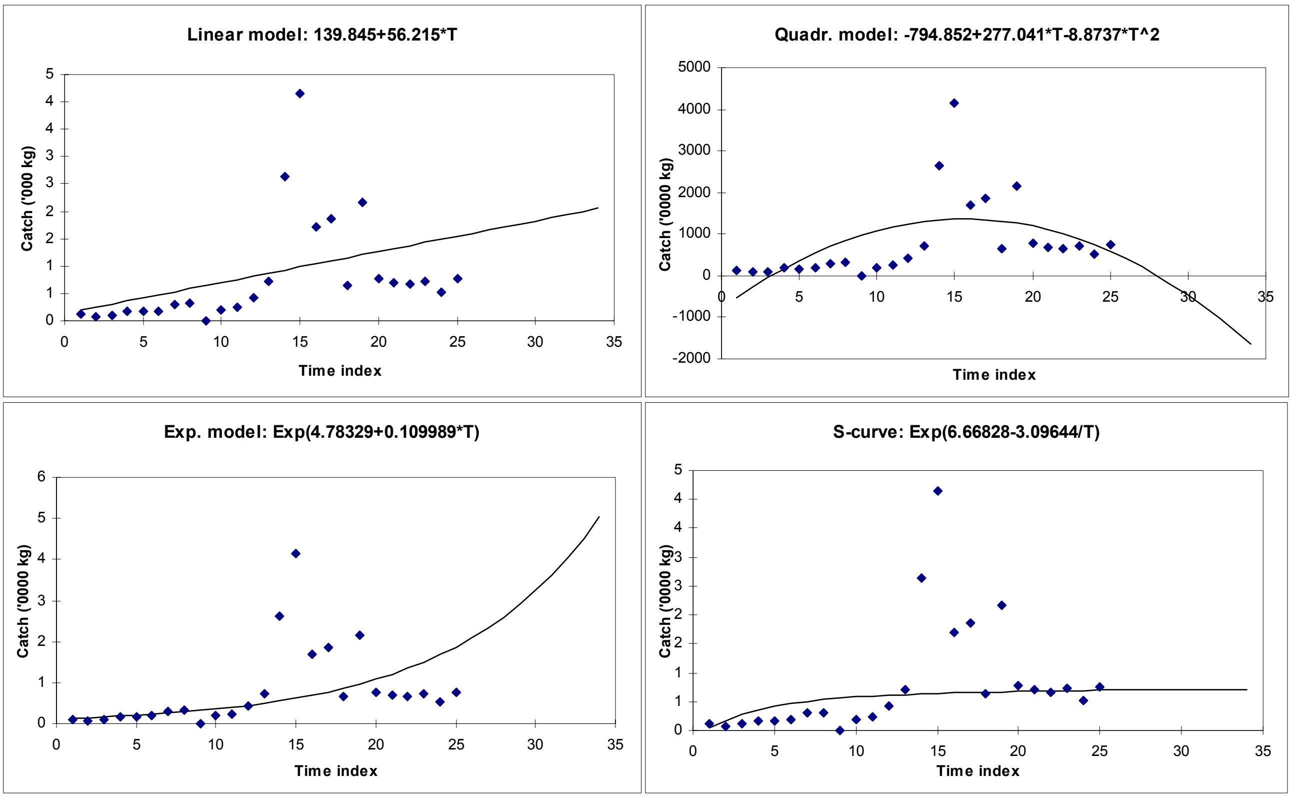

Figure 4. *Trends of annual Tuna catches in Iranian waters.*

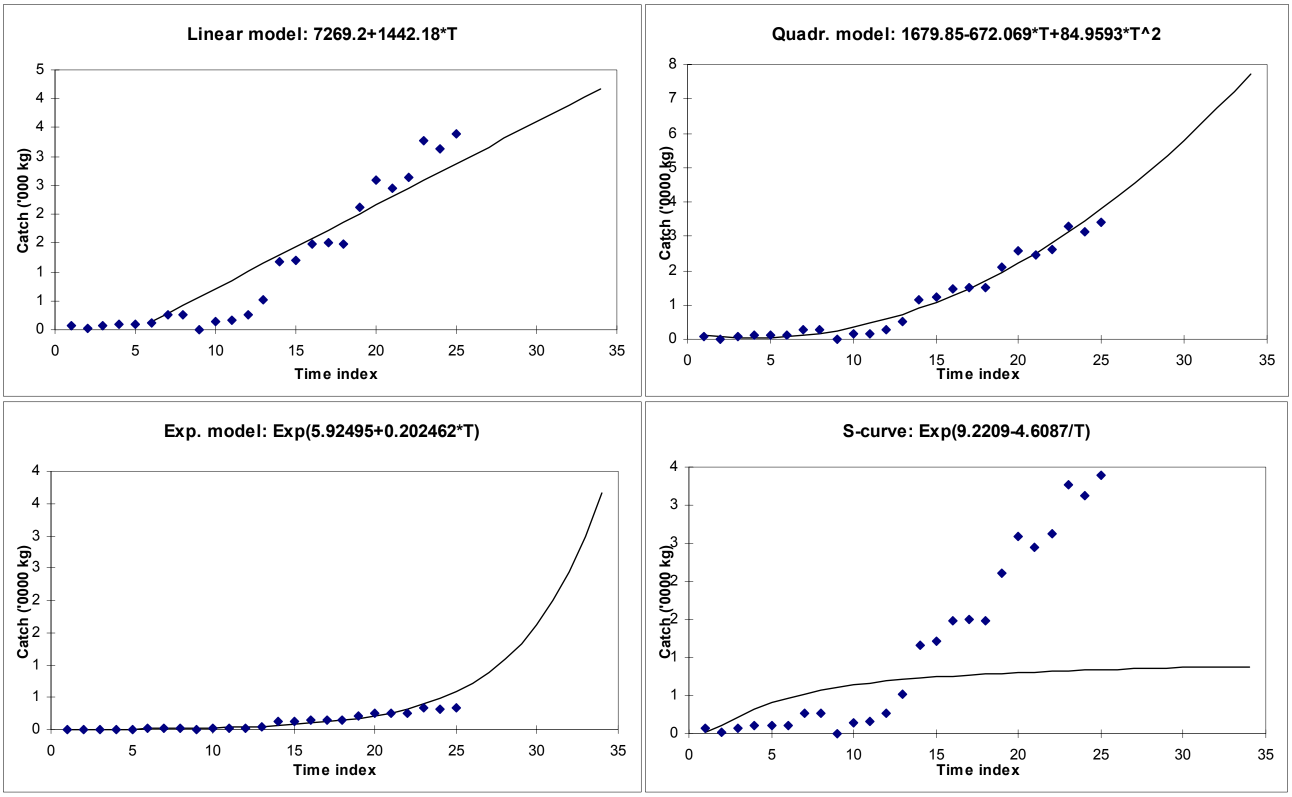

Figure 5. *Graphs of smoothing by Q-Spline.*