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Fish Production and Evaluation of the Fishery Status for Shalateen Fishing Area, Red Sea, Egypt

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ABSTRACT

The marine fisheries of Egypt serve as a valuable economic resource, providing a significant source of sustenance and employment for its populace. However, the sustainability of marine fish stocks is beset by a multitude of challenges including the exacerbation of overfishing due to the augmenting fishing effort. In this study, the economic importance of fish production in Shalateen fishing ground was studied to evaluate its fishery status. The computer program CEDA (catch effort data analysis), where the catch and effort data of the Shalateen fisheries were analyzed using the surplus production models of Fox, Schaefer, and Pell-Tomlinson with three error assumptions of normal, log-normal and gamma. The maximum sustainable yield (MSY) of the catch of some important fishes was estimated in Shalateen to evaluate the present status of the fish stocks exploited in Shalateen waters.

INTRODUCTION

The Egyptian Red Sea coast is approximately 1,500km long, including the Gulfs of Suez and 'Aqaba and the intervening Sinai Peninsula. The width of the continental shelf is about 15km on average. The area of the Red Sea within the Egyptian borders is about 465 thousand feddans, or about 50% of the total area of the Red Sea. Shalateen is the largest town in the Halaib Triangle, 520 kilometers (320 miles) south of Hurghada.

Fish production in the Egyptian Red Sea fisheries comes from landing centers or fishing ports belonging to each of the fishing areas, such as Ataka, Hurghada, Baranis, Al-Qusier, Safaga, Abu Ramad and Shalateen, as well as the Nuweibaa landing center belonging to the western coast of the Gulf of Aqaba. Shalateen is considered one of the essential landing sites of the Red Sea coast in the Egyptian Red Sea fisheries.

Fisheries management refers to the intricate process of regulating fisheries with the aim of attaining sustainable usage and conservation of fish populations. This intricate process entails the formulation and execution of rules and regulations governing fishing activities, such as catch limits, gear restrictions, and closed areas, with the ultimate goal of achieving a delicate balance between socio-economic factors and ecological considerations. The achievement of this balance necessitates close collaboration between various stakeholders, including government entities, researchers, fishermen and other associated parties, aligned with effective, adaptive management strategies tailored to the specific needs of different fisheries systems.

The attainment of sustainable fish populations and the viability of the fishing industry are inextricably linked to the effective implementation of fisheries management. By employing a robust and nuanced fisheries management approach, marine resources can be maintained, ensuring availability for present and future generations. Despite the varied global implementation of fisheries management practices, the overarching objective is to achieve a delicate equilibrium between granting livelihoods for fishermen and safeguarding the well-being and fertility of the marine ecosystem.

The present work focuses on the marine fish sector in the Shalateen, Red Sea Governorate as the first basic steps to form the basis for real economic and social development in it, focusing on the nature of this economic structure to identify its strengths and weaknesses, and laying the sound scientific foundations to overcome the obstacles standing in the way of the development of the sector.

The present study aimed to study the current situation of Shalateen fish production, addressing the relative importance of the most important fish species and investigating the seasonality of fish production in Shalateen fishing ground.

MATERIALS AND METHODS

1. Study area

Shalateen, which is 520km south of Hurghada, is the largest town in the Halaib Triangle. It is one of the important and largest landing sites in the Egyptian Red Sea (Fig. 1). It is extending from latitude 23° 09' 07.31" North and latitude 35° 36' 51.14" East.

Fig. 1. The Red Sea map showing the main fishing landing sites and the study area of Shalateen

2. Data collection

Shalateen fish catch (tons), and total Shalateen catch in addition to fishing effort (expressed as the number of fishing boats) were obtained from the publications of the General Authority for Fish Resources Development (GAFRD, 2001-2020) (Table 1).

3. CEDA (Production Models Program)

CEDA version 3.0.1 **(Kirkwood *et al*., 2001)** is an advanced computer program that employs intricate algorithms and analytical models to accurately assess and evaluate the catch and effort involved in fishing activities as well as providing precise and reliable estimates for the current and untapped stock volumes. Additionally, it integrates the estimation of catchability and associated parameters into its comprehensive analysis, providing a holistic and all-encompassing assessment of the various facets related to fisheries management. In this study, we gathered and examined Shalateen fishery statistics for the 20 years between 2001 and 2020; Table (1) shows the input values. CEDA program is based on three non-equilibrium production models (the surplus production models) of Schaefer, Fox and Pella-Tomlinson, with three error assumptions (normal, log-normal and gamma distributions). The logistic population growth model is the basis of the Schaefer model:

$$\frac{dB}{dt} = rB(K - B)$$

Fox was based on the Gompertz growth equation:

$$\frac{dB}{dt} = rB(lnK - lnB)$$

While, the work of Pella-Tomlinson was on a generalized production curve:

$$\frac{dB}{dt} = rB(K^{n-1} - B^{n-1})$$

Where, B is fish stock biomass; t is time in a year;
K is carrying capacity; r is the intrinsic rate of population increase, and n is the shape of the parameter. The intermediate parameters and reference points produced by CEDA are the intrinsic population growth rate (r), carrying capacity (K), catchability coefficient (q), maximum sustainable yield (MSY), replacement yield (R yield) and final biomass (B). If the input value of the initial proportion (IP)is proximate to zero, it may be inferred that the fishery commenced from an unexploited and pristine population. Contrarily, if the input value is proximate to one, it can be deduced that the fishery has been subject to significant and intensive exploitation.

Table1. Shalateen catch and effort data from 2001-2020

Year	Shalateen catch (tons)	Effort	CPUE
2001	1172	1944	0.60
2002	1006	2022	0.50
2003	1232	2087	0.59
2004	1243	2210	0.56
2005	1084	2333	0.46
2006	1156	2333	0.50
2007	1455	2160	0.67
2008	1575	2025	0.78
2009	1668	2294	0.73
2010	1615	1933	0.84
2011	1940	1960	0.99
2012	1961	2040	0.96
2013	1880	1899	0.99
2014	2160	1963	1.10
2015	2280	1979	1.15
2016	2423	1912	1.27
2017	1576	1950	0.81
2018	2871	1619	1.77
2019	2571	2040	1.26
2020	3102	1512	2.05

2. Statistical analysis

The research methodology involved the implementation of a multifaceted analytical approach, comprising descriptive and quantitative analytical methods. The descriptive-analytical method showed a detailed description of the variables being studied, while the quantitative analytical method estimated overall trends. Furthermore, the annual growth rates of marine fish production were calculated through a comprehensive and sophisticated mathematical evaluation to augment the expansive and all-inclusive analysis.

RESULTS AND DISCUSSION

1- CEDA (Production Models)

Through a rigorous analysis of catch-effort data in the Shalateen region under uncertainty, advanced production models such as Fox, Schaefer and Pella-Tomlinson were employed to derive a nuanced understanding of various fisheries management parameters. The carrying capacity (k), catchability coefficient (q), intrinsic growth rate (r), and maximum sustainable yield (MSY) were estimated to provide a reliable and comprehensive assessment of the region's fisheries resources. The estimate of maximum sustainable yield (MSY) and their confidence limits for IP values ranging from 0.1 to 0.9 are given in Tables (2, 3).

Table 2. MSY values for Shalateen fishery (coefficient limits are in brackets) and the initial proportion (IP) ranging from 0. 1 - 0.5

IP			**0.1 (CL)**	**0.2 (CL)**	**0.3 (CL)**	**0.4 (CL)**	**0.5 (CL)**
Models	**Fox**	**Normal**	7.76E+08 (2773.93 – 2.08E+09)	1.02E+09 (13860.52- 3.07E+09)	4.2E+09 (1.24E+09- 1.39E+10)	3.04E+09 7.55E+09- 1.37E+10)	2.04E+09 (1.22E+08- 1.04E+10)
		Log-normal	76313.79 (12985.23- 101067.6)	219873.8 (77374.93- 762999.9)	510033.7 (234020- 2303666)	561264.1 (190830.4- 3259529)	818259.4 (248291.2- 6338012)
		Gamma	MF	MF	MF	2.57E+08 (8.55E+07- 1.22E+09)	MF
	Scheafer	**Normal**	87272060 (3781.77- 2.05E+08)	9.94E+08 (19277.9- 2.49E+09)	1.37E+09 (3.92E+08- 3.69E+09)	2.98E+09 (9.52E+08- 8.65E+09)	1.29E+09 (9.03E+07- 7.41E+09)
		Log-normal	3209.90 (3209.68- 3211.99)	326872.1 (137939.3- 801098.3)	366876.4 (176127.9- 1035445)	1685307 (679013.1- 7443867)	352751.2 (113458- 2068460)
		Gamma	MF	MF	MF	MF	10889.55 (2447.79- 5.96E+07)
	Pella-Tomlinson	**Normal**	87272060 (3654.53- 2.15E+08)	9.94E+08 (7751.40- 2.57E+09)	1.37E+09 (3.73E+08- 3.76E+09)	2.98E+09 (8.2E+08- 9.60E+09)	1.29E+09 (9.23E+07- 5.83E+09)
		Log-normal	3209.90 (3209.71- 3211.94)	326872.1 (148316.2- 756888.3)	366876.4 (179432.7- 1142374)	1685307 (794855.6- 7271690)	352751.2 (106333.1- 2196557)
		Gamma	MF	MF	MF	MF	10889.55 (2488.42- 4.02E+07)

Table 3. MSY values for Shalateen fishery (coefficient limits are in brackets) and the initial proportion (IP) ranging from 0. 1 - 0.5

		IP	0.6 (CL)	0.7 (CL)	0.8 (CL)	0.9 (CL)	1 (CL)
Models	Fox	Normal	4.78E+09 (2626.57-4.87E+10)	8.28E+09 (9806.40-1.72E+11)	3.31E+09 (2.51E-06-1.14E+11)	3.05E+09 (2.27E-06-1.09E+11)	1.59E+09 (1.04E-06-2.88E+09)
		Log-normal	342461.8 (53308.02-4194706)	2243450 (200883.9-3.34E+07)	1436534 (18994.62-3.27E+07)	631534.2 (6384.21-1.71E+07)	7726094 56079.12-2.96E+07
		Gamma	MF	MF	MF	MF	2.45E+09 (1.54E+08-1.79E+10)
	Scheafer	Normal	1.70E+09 (3672.06-8.12E+09)	2.36E+09 (8.15E-07-3.55E+10	1.96E+09 (351.06-2.63E+10)	29634.74 (3185.30-2.10E+09)	1.12E+09 (7.46E-07-2.41E+09)
		Log-normal	988098.3 (249987.2-8337028)	487808 (42616.65-5925196)	4688809.3 (3103.28-6960608)	29632.32 (15675.17-52521.58)	1.18E+07 (533166.7-6.92E+07)
		Gamma	2.11E+08 (4.39E+07-2.21E+09)	MF	MF	15496.97 (4893.82-2.58E+07)	3.32E+09 (2E+08-1.35E+10)
	Pella-Tomlinson	Normal	1.70E+09 (2583.6-6.77E+09)	2.36E+09 (1667.77-6.07E+10)	1.96E+09 (347.45-1.49E+10)	29634.74 (2932.43-1.4E+09)	1.12E+09 (7.46E-07-2.41E+09)
		Log-normal	988098.3 (227188.7-8080227)	487808 (36512.84-7399190)	4688809.3 (19352.26-5856720)	29632.32 (14450.48-72099.09)	1.18E+07 (447261.2-4.71E+07)
		Gamma	2.11E+08 3.97E+07-1.34E+09)	MF	MF	15496.97 (3343.543-9.69E+07)	3.32E+09 (2E+08-1.21E+10)

The outcomes obtained from the CEDA program are highly reliant on the IP, or initial proportion; inputs such that the slightest variations in this critical component can significantly alter the derived results. Moreover, it should be noted that the gamma error assumption exhibits some degree of minimization failure and potential drawbacks. The estimated MSY values were higher at lower IP values.

Production models parameters for moderate prior exploitation of Shalateen fishery with initial proportion IP of 0.5 (I= 0.5) are shown in Table (4). The Fox model's, estimated MSY values by two types of error assumptions (normal and log-normal), were 2.04E+09 t and 818259.4 t, respectively. The MSY values for Schaefer and Pella Tomlinson with the three error assumptions (normal, log-normal, and gamma) were 1.29E+09 t , 352751.2 t and 10889.55 t, respectively. The MSY values from the Schaefer and Pella-Tomlinson models were the same. Intriguingly, the estimated MSY values obtained from the Fox model under the assumption of standard or normal error were significantly higher, compared to the established Schaefer and Pella-Tomlinson models, posing a critical challenge for fisheries management practitioners.

Table 4. Production parameters for Shalateen fishery at initial proportion (I) 0.5

Parameters			K	q	r	MSY	R.yield	Final Biomass
Production Models	Fox	Normal	5.55E+10	2.15E-11	0.10	2.04E+09	4.42E+08	5.08E+10
		Log-Normal	2.09E+07	5.39E-08	0.11	818259.4	158682.3	1.94E+07
	Schafear	Normal	4.11E+10	2.91E-11	0.13	1.29E+09	3.33E+08	3.82E+10
		Log-Normal	1.10E+07	1.03E-07	0.13	352751.2	88238.49	1.02E+07
		Gamma	14518.93	7.15E-5	0.13	10889.55	-434.76	14662.43
	Pella - Tomlinson	Normal	4.11E+10	2.91E-11	0.13	1.29E+09	3.33E+08	3.82E+10
		Log-Normal	1.10E+07	1.03E-07	0.13	352751.2	88238.49	1.02E+07
		Gamma	14518.93	7.15E-5	0.13	10889.55	-434.76	14662.43

2- Fishery statistics

From north to south, the principal fishing landing spots along the Egyptian Red Sea are Ataka, Hurghada, Safaga, Qusier, Baranies, Shalateen and Abu-Ramad. During the 2020 fishing season, Shalateen's fishing fleet consisted of 1512 boats using hook, line, gillnets and trammel nets **(GAFRD annual data book, 2020)**.

Although there is a landing site or fishing port in Shalateen, it ranks the fifth in economic importance among the fishing ports on the Red Sea coast, contributing about 5.8% of the average fish production in the Egyptian Red Sea (Fig. 2) or about 3.46% of the total fish production in the Egyptian Red Sea. However, it is characterized by a higher annual rate of change than the rest of the other landing centers - previously mentioned - where it increases annually by about 5.2% during the study period 2001-2020 (Table 5).

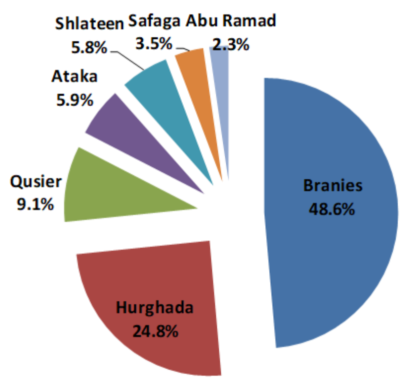

Fig. 2. The relative importance of fish production for different fishing grounds on the Red Sea coast in Egypt

The development of fish production in proper the Red Sea fisheries and its relative importance during the period (2000-2020) are shown in Table (5). Fish production in Shalateen is characterized by fluctuations between increase and decrease, as its lowest value was estimated in 2002 at about 1006 thousand tons, and its maximum value in 2020 was about 3102 tons, with an annual average estimated at 1798.5 tons (Table 5), and according to the best models representing this production, which is the function exponential and statistically significant at the level of 1%, production increases annually by an estimated rate of 5.2% and by an amount of 93.5 tons annually.

Table 5. The development of fish production in the proper Red Sea fisheries and its relative importance during the period 2000-2020

Year	Catch of Proper Red Sea from Ataka to Branies (tons)						
	Branies	Hurghada	Qusier	Shalateen	Safaga	Abu-Ramad	Total
2001	12669	16249	2150	1172	700	407	40960
2002	14383	11484	2200	1006	735	657	32703
2003	15045	8260	2247	1232	842	307	29630
2004	16283	7602	2400	1243	780	422	31030
2005	15662	7842	2928	1084	747	535	31292
2006	14706	7438	3124	1156	783	519	29923
2007	10970	7559	3440	1455	803	656	26565
2008	10985	7286	3643	1575	891	672	27378
2009	13868	6908	2900	1668	930	608	29361
2010	12198	6246	2887	1615	914	549	25579
2011	15771	6384	2882	1940	923	694	29535
2012	17374	6200	2888	1961	912	650	31228
2013	16627	6186	2879	1880	933	978	29767
2014	15847	6356	2885	2160	1265	880	29615
2015	18174	6395	2887	2280	1198	682	31966
2016	19296	6392	2886	2423	1626	909	33986
2017	18274	7470	2841	1576	2408	957	34502
2018	18194	7468	2843	2871	1557	1001	35548
2019	13767	7404	2838	2571	1344	821	31766
2020	14102	7979	3269	3102	1654	1274	32962
Average	15209.7	7755.4	2850.9	1798.5	1097.3	708.9	31264.8
% Total production of proper Red Sea (From fishing area)	48.6	24.8	9.1	5.8	3.5	2.3	100
Annual percentage change (%)	1.2	-2.2	1.1	5.2	5	5	---

By studying the varietal composition of fish production from Shalateen in the Red Sea fisheries (Table 6), we could address the relative importance of fish species for fish production in Shalateen by dividing these varieties into three main groups. The first group includes species that contribute more than 10% of the fish production, while the second group includes the varieties to which each species contributes more than 1% and less than 10% of the fish production, and the third group includes species that contribute less than 1% of the fish production. The varietal composition of this production differed during the study period (2001-2020); the number of fish species constituting fish production in Shalateen decreased from 45 fish species during the study period (2001-2020) to 28 fish species in 2020 (Table 7).

The fish species related to fish production in Shalateen are characterized by the stability in their production. Fish species continuing to be produced throughout the study period (2001-2020) were detected (emperors, groupers, seabream, Spanish mackerel and snapper); they represent 44% of the average total fish production, and are represented by.

The stability coefficient of these fishes was estimated at 100%, while there are 14 fish species whose stability coefficient ranges from 95% to 50%. They are needlefish, bayadh, peacock hind grouper, saddleback grouper, greasy grouper, great barracuda, jobfish, sweetlip, parrot fish, soldier fishes, grey mullets, siganus, common silver-biddy, and other varieties, representing about 53.59% of the average total fish production in two shells, while the rest of the fish species (26 varieties) has a stability coefficient of less than 50%. Their production is estimated at 2.41% of the average total fish production during the study period 2001 -2020 (Table 7).

By studying seasonal production fluctuations in Shalateen, it is clear that there are slight seasonal fluctuations, as the seasonality coefficient is estimated at 1.4, where the seasonal average is superior to the general average of about 149.9 tons during the spring and autumn seasons (seasonal rate for spring and autumn 114.4%, 115.0%, respectively). Whereas, the seasonal average is lower than the general average during the winter and summer seasons (seasonal rate for winter and summer 87.5%, 83.1%, respectively), as shown in Table (8).

Table 6. The evalution of fish production by species from Shalateen in the Red Sea fisheries during the period (2001-2020).

Common names	Production with tons per Year																				Average
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Saddied bream	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
Horse Makerel	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Spanish Makerel	36	56	46	66	74	79	74	76	66	38	104	71	45	87	78	46	31	56	85	83	64.8
kawakawa	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	1	4	0.5
Grey Mullet	68	58	73	3	0	0	1	0	0	0	1	0	0	28	5	23	28	50	80	75	24.6
Lizerdfish	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.1
Corb	0	0	0	1	0	5	0	0	3	1	0	0	2	0	0	0	0	0	0	0	0.6
Sweetlip	0	0	0	3	0	1	0	72	6	8	22	16	6	12	15	5	15	1	2	10	9.7
Sardine	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3
Emperors (Scavengers)	209	206	218	298	158	238	192	143	343	337	364	339	343	411	459	352	230	433	369	603	312.2
Squirrelfish	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0.1
Seabream	97	75	68	80	85	79	145	89	116	75	38	49	64	53	32	15	13	13	15	25	61.3
Yellowstrip barracuda	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3
Round herring	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.05
Groupers	266	206	143	169	137	205	185	163	297	329	382	462	430	415	480	536	259	434	352	334	309.2
Threadfinbream	0	0	0	6	0	0	0	69	0	2	1	2	0	0	0	0	1	0	1	1	4.1
Peacock hind grouper	0	0	0	110	0	193	158	169	441	365	302	434	369	324	321	353	215	305	244	321	231.2
Goat fish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.1
Jobfish	0	0	0	45	0	5	63	71	11	4	3	7	7	13	4	2	4	4	2	4	12.4
Anchovy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0.05
Snubnose emperor	0	0	0	0	0	2	0	0	3	0	1	1	1	3	0	0	5	0	3	55	3.7

Continue Table (6).

Common silver biddy	0	0	0	5	0	3	0	69	12	0	1		0	9	1	6	17	15	30	53	11.6
Greasy grouper	0	0	0	49	0	59	73	72	34	24	26	13	34	40	47	54	30	12	11	3	29.1
Great barrcuda	0	0	0	41	0	9	65	73	20	8	50	36	20	36	24	12	32	30	4	15	23.7
Yollowtailed Emperors	0	0	2	35	37	0	0	0	0	0	2	0	0	0	3	0	1	22	0	2	5.2
Indian mackerel	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	5	0.8
Rabbitfish	111	58	81	9	0	0	43	0	0	0	0	0	0	13	14	118	77	97	174	128	46.1
Striped Piggy	0	0	0	3	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0.3
Saddleback grouper	0	0	0	52	0	92	87	74	15	6	59	33	4	27	28	33	37	92	36	36	35.5
Snapper	159	52	30	39	76	7	70	75	10	32	91	48	14	37	19	31	37	36	1	10	43.7
Caranx spp	0	0	98	117	116	177	131	133	212	261	258	266	309	374	416	359	234	482	416	531	244.5
Parrot fish	126	134	138	10	0	0	21	0	22	0	2	0	0	46	36	271	175	453	428	493	117.7
Neddle fish	0	14	32	6	74	2	63	73	10	41	74	57	70	77	98	74	45	66	65	71	50.6
Gaint squid	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	3	6	13	1.2
Squids	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	13	9	2.3
Unicornfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	9	0.5
Soldier fish	0	0	0	0	0	0	0	86	43	84	153	122	158	153	193	126	89	241	216	190	92.7
Lobster	60	3	1	11	10	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4.3
Sea Cucumber	0	59	72	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6.6
Sharks, rays, skates, etc	0	0	51	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.5
Shrimp	0	0	0	2	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0.3
Crabs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	17	1.3
Cuttlefish	0	0	5	6	0	0	0	68	0	0	0	0	0	0	0	0	0	0	0	0	4
Bivalves	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0.6
Otheers*	40	85	169	0	317	0	70	0	2	0	3	3	0	0	4	4	0	0	0	0	34.8
Total	1172	1006	1232	1243	1084	1156	1455	1575	1668	1615	1940	1961	1880	2160	2280	2423	1576	2871	2571	3102	1798.5

Table 7. The relative importance of fish species in Shalateen, Red Sea, Egypt

(2001-2020) (45 Fish group)				2020 (28 Fish group)		
Group I (>10%) (4 Types)				**Group I (>10%) (5 Types)**		
Fish group	**Production (ton)**	**% of Total Production**	**Fish taxonomic stability coefficient (%)***	**Types**	**Production (ton)**	**% of Total Production**
1- Emperors (Scavengers)	312.2	17.4	100	1- Emperors (Scavengers)	603	19.44
2- Groupers	309.2	17.2	100	2- Bagrus	531	17.12
3- Bagrus	244.5	13.6	90	3- Parrot fish	493	15.89
4- Peacock hind grouper	231.2	12.8	80	4- Groupers	334	10.77
Total	1097.1	61	———	5- Peacock hind grouper	321	10.35
				Total	2282	73.57
Group II (>1%) (12 Fish groups)				**Group II (>1%) (8 Fish groups)**		
Types	**Production (ton)**	**% of Total Production**	**Fish taxonomic stability coefficient (%)***	**Types**	**Production (ton)**	**% of Total Production**
1- Parrot fish	117.7	6.5	70	1- Soldier fish	190	6.13
2- Soldier fish	92.7	5.2	65	2- Rabbitfish	128	4.13
3- Spanish Makerel	64.8	3.6	100	3- Spanish Makerel	83	2.67
4- Seabream	61.3	3.4	100	4- Grey Mullet	75	2.42
5- Needlefish	50.6	2.8	95	5- Needlefish	71	2.29
6- Rabbitfish	46.1	2.6	60	6- Snubnose emperor	55	1.77
7- Snapper	43.7	2.4	100	7- Gerridae (Common silver-biddy)	53	1.71
8- Saddleback grouper	35.5	2	80	8- Saddleback grouper	36	1.16
9- Other types	34.8	1.9	50	Total	691	22.28
10- Greasy grouper	29.1	1.6	80			
11- Grey Mullet	24.6	1.4	65			
12- Great barrcuda	23.7	1.3	80			
Total	624.6	34.7	———			
Group III (<1%) (29 Fish group)				**Group III (<1%) (15 Fish group)**		
Type	**Prosuction (ton)**	**% of Total Production**	**Fish taxonomic stability coefficient (%)***	**Type**	**Prosuction (ton)**	**% of Total Production**
1- Jobfish	12.4	0.7	80	1- Seabream	25	0.81
2- Gerridae (Common silver-biddy)	11.6	0.65	60	2- Crabs	17	0.55
3- Sweetlip	9.7	0.54	75	3- Great barrcuda	15	0.48

4- Sea cucumber	6.6	0.37	15	4- Gaint squid	13	0.42
5-Yollowtailed Emperors	5.2	0.29	40	5- Sweetlip	10	0.32
6- Shark	4.5	0.25	10	6- Snapper	10	0.32
7- Lobster	4.3	0.24	30	7- Squids	9	0.29
8- Threadfinbream	4.1	0.23	40	8- Unicornfish	9	0.29
9- Cuttlefish	4	0.22	15	9- Indian mackerel	5	0.16
10- Snubnose emperor	3.7	0.21	45	10- Kawakawa	4	0.13
11- Squids	2.3	0.13	15	11- Jobfish	4	0.13
12- Crabs	1.3	0.07	10	12- Greasy grouper	3	0.1
13- Gaint squid	1.2	0.07	25	13- Goat fish	2	0.06
14- Lizerdfish	1.1	0.06	5	14- Yollowtailed Emperors	2	0.06
15- Indian mackerel	0.8	0.04	20	15- Threadfinbream	1	0.03
16- Corb	0.6	0.03	25	Total	129	4.15
17- Bivalves	0.6	0.03	5	Total amount	3102	100
18- Unicornfish	0.5	0.028	10			
19- Kawakawa	0.5	0.028	30			
20- Yellowstrip barracuda	0.3	0.017	5			
21- Striped Piggy	0.3	0.017	15			
22- Sardine	0.3	0.017	5			
23- Shrimp	0.3	0.017	20			
24- Saddied Seabream	0.2	0.01	5			
25- Goat fish	0.1	0.01	5			
26- Squirrelfish	0.1	0.01	10			
27- Horse Makerel	0.1	0.01	5			
28- Round herring	0.05	0.003	5			
29- Anchovy	0.05	0.003	5			
Total	76.8	4.3				
Total amount	1798.5	100				

The non-existent fish species in 2020 compared to the study period (17 types) are sea cucumbers, lobster, shark, cuttlefish, lizardfish, corb, bivalves, yellowstrip barracuda, striped piggy, sardine, shrimp, squirrelfish, horse mackerel round herring anchovy, saddied seabream and others . The disappearance of these species may be due to the bad recording system.

Though the monthly seasonality of fish production in Shalateen is characterized by months, during which the seasonal rates increase (March, April, May, September, and October), where the maximum increase was reached during May, showing an increase rate of about 50.3%, there are months in which the seasonal percentage decreases (January, February, June, July, August, November, December), where it reaches the lowest in July, with a decrease of about 36.5%. The seasonal ratios or the value of the seasonal coefficient during the period (2000-2020) fluctuated between these two values, increasing and decreasing (Table 9 & Fig. 3).

Table 8. Seasonal productive fluctuations in the Shalateen fisheries during the period 2001-2020

Season	Month	Monthly average (Tons)	Seasonal average (Tons)	% Seasonal fluctuations *	**Seasonal coefficient
Winter	**January**	133.4	131.1	87.5	1.4
	February	111.3			
	March	148.6			
Spring	**April**	159.2	171.5	114.4	
	May	219.4			
	June	136			
Summer	**July**	96	124.5	83.1	
	August	112.2			
	September	165.3			
Autumn	**October**	198.9	172.4	115	
	November	156.6			
	December	161.6			
Average		149.9	149.9	—	

***** % of seasonal fluctuations = seasonal average for each season/year average.
****** Seasonality coefficient = highest seasonal production/lowest seasonal production.

Table 9. Monthly seasonality of fish production from Shalateen fisheries, the Red Sea during the study period (2000-2020)

Month	Average monthly fish production (ton)	Trend value Typical * (ton)	Monthly averages / Trend value ×100	The seasonal trend ratio after excluding the effect of the temporal trend (Seasonal coefficient)
January	**133.4**	**135.7**	**98.3**	**98.3**
February	**111.3**	**138.2**	**80.5**	**80.5**
March	**148.6**	**140.8**	**105.5**	**105.5**
April	**159.2**	**143.4**	**111**	**111**
May	**219.4**	**146**	**150.3**	**150.3**
June	**136**	**148.6**	**91.5**	**91.5**
July	**96**	**151.2**	**63.5**	**63.5**
August	**112.2**	**153.7**	**73**	**73**
September	**165.3**	**156.3**	**105.7**	**105.7**
October	**198.9**	**158.9**	**125.2**	**125.2**
November	**156.6**	**161.5**	**97**	**97**
December	**161.6**	**164.1**	**98.5**	**98.5**
Total	**1798.5**	——	**1200**	**1200**
Average	**149.9**	——	——	——

* The equation for the time trend is $\hat{Y} = 133.08 + 2.5836\ t$.

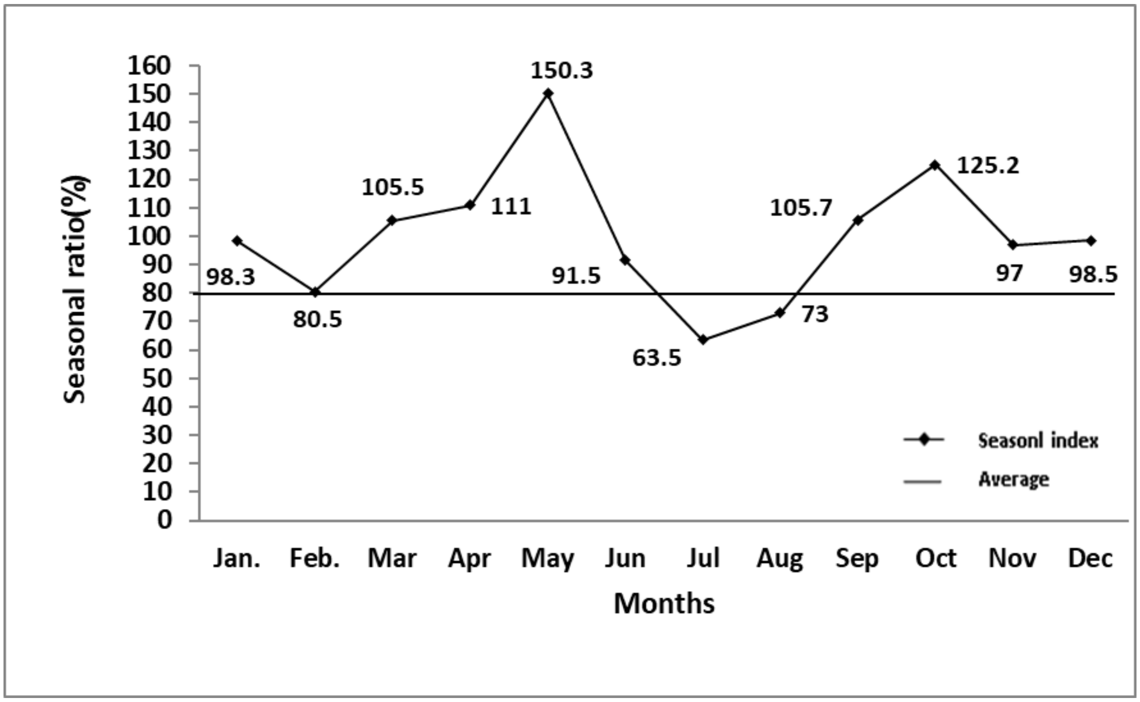

Fig. 3. The seasonal index after excluding the effect of the time trend in Shalateen, the Red Sea during the study period (2001-2020)

The primary aim of fisheries management is to attain and maintain a thriving ecosystem and safeguard fish populations for posterity. The multifaceted and intricate process of fisheries management necessitates the collaboration of a wide range of stakeholders, comprising fishermen, scientists, policymakers and conservationists, among others. The process encompasses the meticulous collection and analysis of extensive data on fish populations, the prognostication of population dynamics and fluctuations, and the making of informed decisions based on a meticulous assessment of the best accessible scientific knowledge. Only through such prudent and comprehensive decision-making, grounded in science and evidence, may successful and durable fisheries management be achieved.

Simple surplus production models based on catch and effort data are helpful with fisheries management strategy. The maximum sustainable yield (MSY) is the output of production models and is widely used as the biological target reference point.

The rigorous scrutiny of essential catch per unit effort statistics (CPUE) and corresponding catch reports remains of paramount significance in the complex undertaking of stock assessment studies. These data inputs represent the fundamental components central to the utilization of effective surplus production models and remain a vital component of the continued pursuit of robust fisheries management **(Mehanna & El-Gammal, 2007)**.

Even in their natural, unexploited state, fish stock sizes and distributions can vary greatly due to environmental factors and the effect of other species with whom they interact **(Panhwar *et al*., 2012)**. The surplus production models exclude age-structured models and do not describe the associated environmental factors **(Kalhoro *et al*., 2013)**.

Overfishing of aquatic resources is caused by an increase in fishing fleets in response to rising demand for seafood for export and domestic consumption.

Notwithstanding the extensive spatial expanse of marine fisheries in Egypt, the intricate and multifaceted array of factors contributing to the decline in the proportional abundance of fish stocks has thwarted the diligent and efficient exploitation of this vital and essential resource. The calamitous effects of rampant pollution stemming from both domestic and industrial wastewater treatment mismanagement, alongside rampant and indiscriminate overfishing and illegal fishing activities precipitate a precipitous decline in this regional fishery **(Maiyza *et al*., 2020)**.

If the MSY values estimated from models are more than the most recent catch data, the population is in a safe state. When the yearly catch of the fish equals the predicted MSY values from surplus production models, the fish stock may be assumed to be in a sustainable state. However, if the capture exceeds the projected MSY results, it indicates that the fish stock is facing a decline **(Kalhoro *et al*., 2013)**. MSY data were commonly regarded as biological reference points from which fishery management might be carried out **(Bonfil, 2004; Prager, 2005; Musick & Kalhoro *et al*., 2013)**. The MSY values were higher than the Shalateen catch thus the fish population in Shalateen is in a safe state.

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