



An Economic Study on Fish Production and Marketing of Wadi El Rayan Lakes, Fayoum Governorate

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ABSTRACT

Lake Wadi El-Rayyan is located in the Fayoum Governorate, spans approximately 35 thousand feddan and has an average production capacity of about 3403.3 tons, as estimated between 2001 and 2020. Despite its diverse fisheries, its relative significance in Egyptian fish production remains limited, constituting about 0.24%. The research problem stems from insufficient fish production to meet consumer demands, resulting in a food gap of approximately 345.25 thousand tons during the same period. The study aimed to assess the current state of fisheries in Wadi El-Rayyan Lakes. Analysis of fisheries seasonality from 2017 to 2020 revealed extreme fluctuations, with a seasonality coefficient reaching 3.5%. This was based on an annual fishing effort involving around 129 boats, yielding approximately 2674.6 tons. It was observed that the actual production exceeded the maximum sustainable yield (MSY) level. The productivity elasticities of various factors were calculated, with values of approximately 0.061, -0.843, -0.744, and 0.779, leading to a combined elasticity of -0.747. Analysis of absolute marketing margins for fish species in Wadi El-Rayyan Lake showed relative margins ranging from 20% for tilapia fish to 22.8% for silver carp. Producer's shares of consumer pounds ranged from 77% for grass carp to 82.4% for shamus fish, indicating robust marketing efficiency.

INTRODUCTION

The fish production sector holds a crucial position in ensuring adequate food security and fostering economic and social development. It is a vital component of the national economy and a key element within the Egyptian agricultural sector. The fish production sector is vital because it provides a significant portion of animal protein, addressing the shortfall from other sources. Fish protein is rich in essential vitamins, minerals, and unsaturated fatty acids, making it highly nutritious. Recognizing its nutritional value, the Egyptian policymakers have emphasized the development of the fish production sector as a cornerstone for enhancing animal protein sources. Statistics reveal a substantial growth in fish production in Egypt, increasing from approximately 771.6 thousand tons in 2001 to about 2.01 million tons in 2020. Natural fisheries contribute around 30.97% of this production, with fish farming constituting the rest. Therefore, this highlights the importance of fisheries as a significant component of the economic structure. This includes large water bodies—nearly 14 million feddan—as well as a sizable fishing fleet made up of numerous boat types, human cadres, and

nearly 3 million fishermen. Furthermore, fish farming has grown to be of significant economic value and has a high rate of return on investment, while also producing a large number of jobs. Since Egypt has a lot of water bodies and a wide variety of natural fisheries in both fresh and salt water, the country produces fish from both natural fisheries and fish farming. The research problem is that, although Egypt enjoys many fisheries, it was found that fish production is insufficient to meet consumer needs, since the average annual production of fish was estimated at 1215.12 thousand tons, while the average annual consumption was 1508.37 thousand tons. This suggests an anticipated food deficit of 345.25 thousand tons between 2001 and 2020. Due to the growing gap between food supply and consumption, the issue of food containing animal protein in all its forms is one of the most significant obstacles facing the Egyptian economy. In light of the high cost of fish protein, compared to the costs of other animal protein products, it is now a reasonably priced resource. While, Lake Wadi El Rayan in Fayoum Governorate stands as a vital natural fishery in Egypt, its relative contribution to the nation's fish production remains modest and falls below the desired levels. Accounting for approximately 1.9%, 0.91%, and 0.24% of total lakes, natural fisheries, and overall fish production, respectively, from 2001 to 2020, the Lake is notable for the diversity and growth within its fisheries. Consequently, it negatively affects the conditions, the entry of and the level of the fishermen livelihood into that lake. Thus, the reason for the low productive efficiency of the fisheries of the lake under study is due to the presence of many obstacles that impede their development and the absence of proper scientific management for the optimal exploitation of these fisheries, in addition to their exposure to illegal fishing practices, which necessitates the study of the productive status of that Lake in order to develop and advance its production.

Through the following sub-objectives, the research primarily intended to determine the current status of fisheries in the Lakes of Wadi El Rayan:

1. Analyzing the temporal evolution of fish production volume in the Wadi El Rayan Lake fishery from 2001 to 2020.
2. Calculating the greatest sustainable production and the highest permitted fishing rate to strike a balance between the two.
3. Determining the most significant economic variables influencing fish production in the fisheries of Wadi El Rayan Lake between 2001 and 2020 to maximize the productive efficiency of these fisheries.
4. Estimating the Lake's fish production's seasonality and forecasting fish output for various fisheries between 2021 and 2030.
5. Studying marketing routes, estimating margins, and determining the share of the product for the most important fish species in the lake.
6. Identifying the key obstacles faced by Wadi El Rayan Lake, as perceived by respondents in the field study sample, is crucial for devising effective solutions and proposals to enhance fish production in the lake.

MATERIALS AND METHODS

The research methodology employed a combination of descriptive and quantitative economic analysis techniques to interpret and describe economic variables pertinent to the study. Crucial statistical techniques, including percentages and arithmetic averages, were used in this analysis. For estimating the equations of the general time trend for various economic variables, the surplus production model

as followed by **Schaefer (1957)** and the basic regression approach were utilized. These methods were particularly suitable for estimating catch rates in the context of the Egyptian database.

To obtain accurate mathematical representations consistent with economic and statistical principles, the study employed the autoregressive integrated model and moving averages (ARIMA) method to estimate the seasonality of fish production. Additionally, various statistical measures were used to estimate marketing margins. The research also relied on primary data, including prices of specific fish varieties collected through personal interviews with fishermen and traders in Fayoum Governorate markets in 2022. Moreover, field data on the significant challenges faced by fish production in Wadi El Rayan Lake were gathered through interviews with employees from the Fisheries Development Authority in Fayoum Governorate, members of the Fishermen's Cooperative Association, and local fishermen.

These comprehensive data sources, both primary and secondary, allowed for a robust analysis of the economic variables, providing valuable insights into the challenges and opportunities within the fisheries sector of Wadi El Rayan Lake.

RESULTS

The current state of fish production in Wadi El Rayan Lakes

In this section, the research assesses the relative importance of fish production in Wadi El Rayan Lake concerning the overall fish production in Egypt. Additionally, it explores indicators of average productivity within the Lake's fisheries. The analysis focuses on the evolution of fish production in the Wadi El Rayan Lakes in Fayoum Governorate over the period from 2001 to 2020.

The Wadi Al-Rayyan Lakes, situated southwest of Fayoum Governorate, are located 40km away from Fayoum City and 57km west of the Nile River downstream. These Lakes have a unique geographical feature, with their lowest level being 63 meters below sea level, lower than Lake Qarun's depth. The water is channeled through a drain in the valley, exiting near the Turbinat Mixed Station. The exposed channel is at a level of one meter above sea level and extends for 9km until it reaches the desert borders, where a tunnel begins at 10 meters below sea level. The lakes cover an estimated area of about 20 thousand acres, and they are interconnected by straits that facilitate the flow of water from one depression to another until it settles in the Wadi al-Rayyan depression. The total area of Wadi al-Rayyan Lakes is approximately 35 thousand feddans.

Interestingly, these lakes were not commercially utilized for fish production until 1976, when they were exploited for two months, yielding a production of 124 tons. Over the years, the production steadily increased, reaching around 6750 tons in 2020. This accounted for approximately 6.7% of marine fisheries, 2.84% of the Egyptian Lakes, 8.5% of the Nile River, 1.61% of the Egyptian capture fisheries, and 0.34% of the total Egyptian fisheries output for the same year. The average contributions of Wadi El-Rayyan Lake from these sources during the period from 2001 to 2020 were about 3.10%, 1.9%, 4.34%, 0.91%, and 0.24%, respectively.

Table (1) presents the fish production data from the Wadi El Rayan Lakes for the period 2001-2020:

1. **Annual fish production:** The average annual fish production was approximately 3,403.3 tons during this period. It ranged from a minimum of about 861 tons in 2001 to a maximum of about 6,750 tons in 2020. This represents a remarkable increase of about 683.97% since 2001. The production exhibited a statistically significant annual growth rate of approximately 0.330 thousand tons. This accounted for roughly 9.7% of the total fish production. The high coefficient of determination ($R^2 \approx 0.93$) indicates that 93% of the changes in total fish production can be attributed to the passage of time.
2. **Average fish productivity:** The average annual fish productivity was about 94.9kg/ feddan/ season. The productivity per feddan varied between approximately 24.6kg/ feddan/ season in 2001 and 192.9kg/ feddan/ season in 2020. The productivity exhibited a statistically significant annual increase of around 8.93kg, accounting for approximately 9.43% growth per year. The coefficient of determination ($R^2 \approx 0.92$) suggests that 92% of the changes in productivity per acre are influenced by time.
3. **Number of fishing days:** The average number of fishing days per season increased by about 18.5% from 2005 to 2009, ranging between approximately 200 and 237 fishing days per season. The number of fishing days displayed a statistically significant annual growth of about 11.65, equivalent to 5.2% per year.
4. **Daily boat departures:** The daily boat departures ranged from 148 boats/ season in 2002 to 198 boats/ season in 2017, showing an increase of about 33.78% since 2002. The average number of boat departures per season was about 177 boats. However, the annual increase was statistically negligible.
5. **Boat productivity:** Boat productivity varied from about 5.3 tons/ boat/ season in 2001 to 39 tons/ boat/ season in 2016, indicating a substantial increase of about 635.85% compared to 2001. The productivity exhibited a statistically significant annual growth of about 0.955, representing approximately 5.16% per year.
6. **Daily production:** Daily production ranged from approximately 3.4 tons/ day/ season in 2001 to 32 tons/ day/ season in 2020. This signifies a notable increase of about 841.2% since 2001. Production displayed a statistically significant annual growth of about 1.42, equivalent to approximately 9.53% per year. On average, daily production was about 14.9 tons per day/ season annually.

Proportional significance of fish species generated in Wadi El Rayan Lake

The variation in fish species and abundance in the production areas of Wadi El Rayan Lake is influenced by natural, climatic, and biological factors. Table (3) and Fig. (1) illustrate the relative importance of fish production from different species in Wadi El Rayan Lake during the period 2015–2020. The key fish species identified in the Lake's fisheries, based on their catch quantities, are as follows:

Tilapia fish: Occupy the top spot, accounting for approximately 25.4% of fish production in Wadi El Rayan Lake.

Other varieties: Contribute significantly, representing around 18.82% of the total production.

Mullet family: Holds the third position with a contribution of about 18%.

Grass carp: Represents approximately 15.6% of the total production and is the fourth most abundant species.

White-peeling fish: Account for about 7.03% of the production, securing the fifth position.

Various whiting fish: Hold the sixth position with a rate of about 6.14%.

Musa fish: Follow with a contribution of approximately 4.90%.

Silver carp: Occupies the eighth position, contributing around 4.18%.

Table 1. Average fish production in the fisheries of Wadi El Rayan Lakes in Fayoum Governorate during the period 2001-2020

Year	Fish production (tons)	Feddan productivity (kg/feddan /season)	Fishing days (season)	Daily departures average	Boat production average/season	Daily production average
2001	861	24.6	255	163	5.3	3.4
2002	1231	35.2	235	148	8.3	4.5
2003	1313	37.5	235	156	8.4	5.6
2004	1217	34.7	215	174	7	5.7
2005	1992	57	200	168	11.8	9.96
2006	1691	48.3	246	150	11.3	6.9
2007	2126	60.7	225	181	11.7	9.4
2008	2055	59	237	194	10.6	8.7
2009	2624	75	200	173	15.2	13.1
2010	2494	71	205	175	14	12.2
2011	3053	87	197	169	18	15.5
2012	3451	98.6	208	187	18.4	16.6
2013	3416	97.6	263	186	18.4	13
2014	3782	108.06	245	204	18.5	15.4
2015	4539	129.69	234	194	23.4	19.4
2016	5966	170.46	208	153	39	28.7
2017	6499	134.26	223	198	23.7	21
2018	6295	179.86	218	184	34.2	28.9
2019	6711	191.74	237	178	37.7	28.3
2020	6750	192.9	211	193	35	32
Average	3403.3	94.7	225	177	18.5	14.9

*Average feddan output equals total fish production in tons times lake area

*Average boat production equals daily fisheries times total fish production in tons times boat

*Average fisherman's production = total fish production in tons ÷ number of fishermen

*Average daily production = total fish production in tons ÷ number of fishing days

Source: The data were collected from the General Authority for Fish Resources Development, Nile Valley region in Fayoum and include both published and unpublished data

Application of Schaefer's model to analyze Wadi El Rayan Lake fisheries

In this section of the study, the overproduction model by **Schaefer (1957)**, which is suitable for estimating catch rates within the context of the Egyptian database, was employed. The application of this model serves multiple purposes, including the protection of fisheries as natural resources, the determination of optimal production rates based on the current state of the fishery, and the identification of the ideal number of fishing units to prevent over-exploitation of fisheries. The model establishes a relationship between production and fishing effort, which is influenced by the number of fishing units. It relies on the productivity of each fishing unit as a function of fishing effort to estimate the maximum sustainable fishing rate as follows:

$$Y/E = a + bE$$

where:

Y = Production of fish caught using the fish resource under consideration.

E = Effort; the number of fishing units is used to estimate fishing effort.

Constants = a & b. The production and fishing unit data that are readily available for the time period (2001-2020) in Table (1) in the appendix were utilized. Regression analysis was used to estimate the a & b constants, and the production curve was derived from the equation:

$$Y = aE + bE^2$$

The point at which the production curve is at its steepest is:

$$E = -a/2b$$

The greatest sustainable production is obtained by substituting the value of E into the production equation and is denoted by the following equation:

Maximum sustainable yield (MSY) is equal to $-a^2/4b$.

The following equation can be used to determine the fishing effort that will result in the highest possible sustainable production:

$$E_{max} = -a/2b$$

The development of fish production and fishing units, as well as their relationship, were observed and evaluated in the fisheries of Wadi El Rayan Lake in order to ascertain the rationale of the fisheries there. MSY came from an annual fishing effort of approximately 129 boats and was equivalent to 2674.6 tons.

$$Y = 41.502 - 0.161 E$$

$$(3.51)^{**} \quad (-2.47)^*$$

$$R^2=0.57 \quad F= 6.13^* \quad MSY= (-a^2)/4b = 2674.6 \quad E_{max}= (-a)/2b = 128.9$$

Table 2. General equation for linear trend of the evolution of fish output and the key economic factors in Fayoum Governorate's Wadi El Rayan Lake between 2001 and 2020

Variable	General equation for linear trend	R ²	F	Average	Annual growth rate
Fish production (tons)	$\hat{Y}_i = 660.56 + 0.0330 X_i$)**14.97(	0.93	**224.2	3403.3	9.7
Feddan productivity (season/kg)	$\hat{Y}_i = 17.68 + 8.93 X_i$)**14.86(	0.92	221.04**	94.7	9.43
Fishing days (season)	$\hat{Y}_i = 178.64 + 11.65 X_i$)**3.67(	0.65	**49.68	225	5.2
Average daily departures	$\hat{Y}_i = 12.63 + 0.517 X_i$).67(	0.03	0.460	177	-
Average boat production/season	$\hat{Y}_i = 18.94 + 0.955 X_i$)**12.46(	0.89	**155.41	18.5	5.16
average daily production	$\hat{Y}_i = 28.45 + 1.42 X_i$)*2.36(	0.31	*28.51	14.9	9.53

Where, Y_i is equal to the estimated value of the dependent variables (fish output and the most significant economic factors) in year T

$I = (20, \dots, 2, 3, 1)$ and x_i = time factor in years as an independent variable in year T

The computed (t) value is shown in the numbers between the estimates

Significant at the (0.01) level is indicated by (**), at the (0.05) level by (*), and not significant by (-)

Source: Data from Table (1) were gathered and calculated

Table 3. The relative importance of fish species produced from Wadi El Rayan Lakes during the study period (2015-2020)

Statement	015	2016	2017	018	2019	020	Total	%
Tilapia	468	1673	2014	198	1271	436	9060	5.33
Perch	30	383	523	62	279	22	2199	.14
Mullet fish	093	1552	1137	91	914	51	6438	8.00
white-peeling fish	80	495	569	29	363	79	2515	.03
Grass carp	29	1214	1228	10	806	76	5563	5.6
Silver Carp	42	284	340	87	209	35	1497	.18
Musa	39	274	364	22	351	05	1755	.90
Other Varieties	8	91	324	296	2518	446	6733	8.82
Total	539	5966	6499	295	6711	750	35760	00

Source: Fish Statistics Bulletins, published in distinct issues by the Public Authority for Fisheries Development (2015–2020)

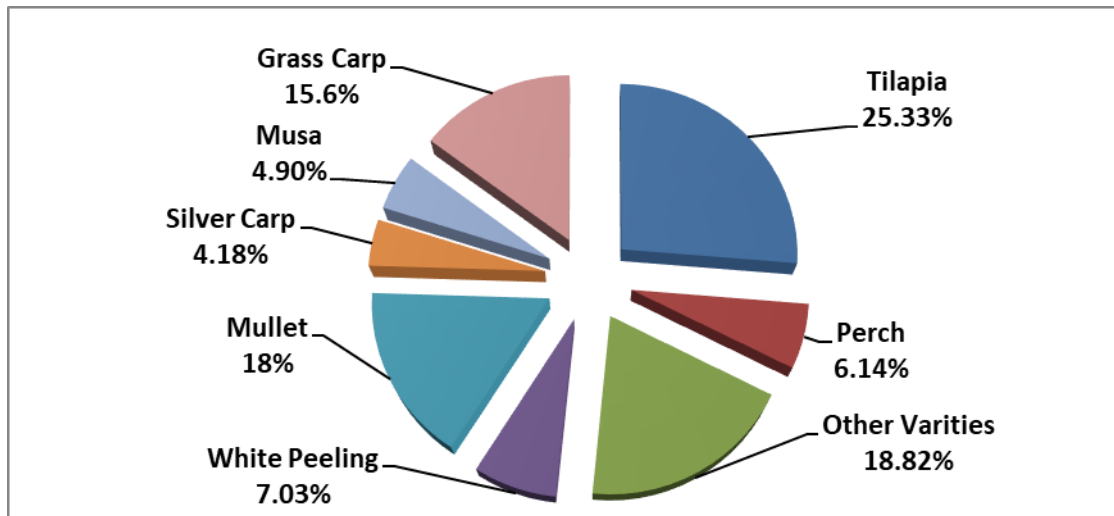


Fig. 1. Proportional significance of the fish species generated in the Wadi El Rayan Lakes between 2015 and 2020. **Source:** Calculated from the data presented in Table (1)

The results from the model were compared to the current state of Wadi El-Rayyan Lake, and it was found that during the last ten years of the study period—2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019—actual production exceeded the maximum allowed production volume (MSY), which was 14.15, 29.03, 27.72, 41.41, 69.71, 123.1, 142.9, 135.36, 150.92, and 152%. About 169, 187, 186, 204, 194, 153, 198, 184, 178, and 164 boats participated in the fishing effort that resulted in these numbers, correspondingly. With an increasing rate that is roughly 31.01, 44.96, 44.2, 58.14, 50.4, 18.60, 53.5, 42.63, 37.98, and 27.13% greater than the ideal fishing effort. As a result, it is obvious to what extent the fisheries of Wadi El-Rayyan Lake are negatively impacted by the rise in illegal fishing activities in recent years, particularly after Lake Qarun's fish production declined, and it was closed at the same

time as Lake Nasser. Since the majority of Lake Nasser's fishermen come from the Fayoum Governorate, it is expected that the Lake's fish stock will decline, which will result in a decline in the Lake's fisheries.

Analysis of key variables influencing fish production volume in Wadi El Rayan Lakes fisheries (2001-2020)

In this section, we estimated the fish production function for Wadi El-Rayyan Lakes, examining the relationship between fish production volume and various economic factors that potentially influence it. The analysis focused on econometric estimation, considering significant economic variables shaping fish production in Wadi El-Rayyan Lakes Fisheries in Fayoum Governorate over the period (2001-2020). This estimation was grounded in the assumptions of production theory and the available dataset. The following variables were considered: (X1) quantity of fry (in million units), (X2) volume of wastewater (in million m³), (X3) number of fishing boats (per boat), (X4) number of fishermen, (X5) number of fishing days (per day), (X6) average wholesale price (in thousand pounds per ton), and (X7) value of fish production (in million pounds).

Using step wise regression, the statistical relationship between the amount of production (Y) (a dependent variable) and the prior factors (as independent variables) was measured in order to identify the most significant determinants or factors affecting fish production in Wadi El-Rayyan Lake and arrange these factors according to their degree of influence. It is possible to estimate the function using the following mathematical formulas:

$$Y = a + b_1X_1 + b_2 X_2 + \dots + b_7X_7 \dots \dots \dots (1)$$

$$Y = \ln a + b_1 \ln X_1 + \dots + b_7 \ln X_7 \dots \dots \dots (2)$$

$$\ln Y = \ln a + b_1 \ln X_1 + \dots + b_7 \ln X_7 \dots \dots \dots (3)$$

Where: a is the function's constant. The estimated regression coefficients for the independent variables X1.....X7 are b7.....b1. Based on the value of the updated determination coefficient (R^2), the function's test (F), and the (t) test for the estimated function parameters, the mathematical formula that best fits the situation has been chosen from an economic and statistical perspective.

The coefficients of the productive elasticity of the inputs with the predicted production function were also used to evaluate the physical production efficiency. According to the function's mathematical formula, the following production flexibility coefficients are determined for the production input EPXi:

$$\text{Linear function } b_i \bar{x}_i / \bar{Y} = b_i / (\bar{Y} / \bar{x}_i) \text{EPX}_i =$$

$$b_i / \bar{Y} \text{EPX}_i = \text{logarithmic function } b_i \text{EPX}_i = \text{logarithmic}$$

Where, y is the average output amount; b_i is the predicted regression coefficient for the production input, and x_i is the average input quantity during the time period.

It was discovered that the linear image was the best image to represent the function of total fish production in the fisheries of Wadi El Rayan Lakes, and the following function was obtained by analyzing the impact of the change in the most significant economic factors affecting the total fish production, which is assumed to have an impact on the volume of production.

$$Y_i = 9711.2 + 29.68 x_1 - 16.40 x_3 - 11.27 x_5 + 173.04 x_6$$

$$**(-4.28) *(-2.52) ** (10.85) ** (5.01)$$

$$R^2 = 0.973$$

$$F = 189.98**$$

whereas:

Y^{\wedge}_i = estimated value of fish production in thousand tons in year t.

X_1 = number of fry (in million units) per year t.

X_2 = the amount of wastewater (million m^3) per year t.

X_3 = the number of fishing boats (in the boat) in the year t.

X_4 = the number of fishermen (fishermen) per year t.

X_5 = the number of hunting days (per day) in year t.

X_6 = the average wholesale price (in thousands of pounds / ton) in the year t.

X_7 = value of fish production (in million pounds) per year.

The numbers in the brackets below estimates indicate the calculated "t" value.

* indicates significant at (0.05) level, ** indicates significant at (0.01) level.

The number of fry (X_1), the number of boats (X_3), the number of fishing days (X_5), and the average Wholesale price (X_6) are the most significant independent factors affecting the size of fish production during the study period, according to the estimation results of the previous equation based on the phased multiple regression analysis (linear form). The significance of the statistical model was fixed at a significant level of 0.01, where the value of F was approximately 189. The incidence was one of the earlier independent components in the model. According to the previous equation's results, there is a direct correlation between the size of fish production as a dependent factor, the quantity of fry (Q_1), and the average wholesale price (Q_6) as independent factors. This relationship is consistent with economic logic since it was demonstrated that an increase in one of these variables leads to an increase in the other. The aforementioned independent factors each contribute 1% to the increase in fish output in the lake, which results in increases of around 29.68% and 173.04%, respectively.

According to economic logic, it makes sense to treat fish species as a dependent factor, the number of boats (Q_3), and the number of fishing days (Q_5) as independent factors. The findings revealed that a 1% increase in any of the aforementioned independent factors led to a decrease in fish production volume in the lake by approximately 16.40% and 11.27%, respectively. However, due to the lack of statistical significance for these variables, the quantity of wastewater, the number of fishermen, and the price of fish output did not seem to have an impact.

The production elasticities of the elements of the number of fry, the projected values for the number of fishing boats, fishing days, and average wholesale price were 0.061, -0.843, -0.744, and 0.779, respectively. The non-economic stage of the Law of Diminishing Yields is where Wadi El Rayan is located. This is attributed to the excessive amount of fishing boats being used than is economically feasible, which makes it necessary to work to reduce the number of fishing boats in those fisheries. Moreover, the adaptability of fishing days throughout the season highlights the importance of adhering to fishing bans and curbing illegal fishing activities. Illegal practices exacerbate the depletion of fish stocks and hinder production in the region.

The seasonality of fish production from the lakes of Wadi El Rayan during the time period (2017-2020)

Seasonal productivity refers to the fluctuations in fish production throughout the year, influenced by various biological, environmental, and natural factors. These factors include fish life events like spawning, breeding, and migration, as well as environmental conditions such as temperature, frost, and wind. The importance of studying seasonal production lies in understanding the fluctuations in fish supply throughout the year due to various factors such as alternative commodities in the

market and their prices. Fish being a perishable commodity necessitates studying these patterns to organize its supply consistently. This knowledge enables planning to meet consumer demand during periods of low fish production, potentially reducing the need for imports. Additionally, understanding seasonal fluctuations aids in managing surpluses, whether by establishing refrigeration facilities for storage or encouraging exports. Decision-makers can use this information to develop production and marketing policies for the fish sector, promoting informed and strategic decision-making in the industry.

To study seasonality, the seasonality coefficient or the index of seasonal fluctuations was measured in order to identify its causes, where monthly averages are taken for the last four years, then the twelve months are divided into four periods, each period consisting of three months (a quarter of a year), and we extract the percentage for each 1/4 year of production. The total year, seasonality coefficient that occurs throughout the year is calculated by the following law:

Seasonality coefficient = the largest amount of production achieved during a quarter of a year / the least amount of production achieved during a quarter of a year.

Or seasonality coefficient = the largest percentage of production in a quarter of a year / the lowest percentage of production in a quarter of a year.

The seasonality coefficient or the seasonality index is always greater than one, and the higher it is, the more intense the seasonality, and vice versa. Seasonality is non-existent if the seasonality coefficient becomes = 1.

Analyzing the seasonality of the fisheries in the lakes of Wadi El Rayan from 2017 to 2020 revealed a seasonality coefficient of about 3.5%, indicating significant seasonal fluctuations. These fluctuations were most prominent during the first quarter (January-February-March), representing the highest productivity, with an average of about 2.9 tons per quarter, a rate of 33.2%, as shown in Table (4). In contrast, the lowest productivity occurred during the same period, with an average of about 829kg, or 9.5%, due to the cessation of fishing activities during that time. These findings highlight the pronounced impact of seasonal variations on fish production in the region, emphasizing the need for strategic planning and management to address these fluctuations effectively.

Table 4. Seasonal coefficient of fish production from Wadi El Rayan Lakes during the period (2017-2020)

Statement	Month	Average seasonal production (tons)	Seasonal index %
1 st Quarter	February, January, and March	2906	33.2
2 ^{ed} Quarter	April-May-June	2224.3	25.4
3 ^{ed} Quarter	July - August - September	829	9.5
4 th Quarter	October-November-December	2789.7	31.9
Total		8749	100

* Seasonality coefficient = $2906 \div 829 = 3.5$

Source: Fish Statistics Bulletins, different issues (2017–2020), of the General Authority for Fish Resources Development, were used to collect and calculate the statistics

Future projections for the amount of fish produced in the Lakes of Wadi El-Rayhan (2021 -2030)

By using appropriate standard models to predict the future of fish production in the fisheries of Wadi El Rayan Lakes in the Fayoum Governorate during the period

(2021–2030), the autoregressive model was used. This is thought to be the real starting point for setting appropriate policies and mechanisms for the development of fish production in the Lake. Integrated and Moving Averages (ARIMA) "Average Moving Integrated Auto Regressive" was used to anticipate the amount of fish that will be produced in the future in the fisheries of the Wadi El-Rayan Lakes in the Fayoum Governorate.

Table (5) and Fig. (2) present the estimated fish production quantities in the Wadi El Rayan Lakes fisheries in Fayoum Governorate for the period 2001-2030. The results indicate a projected increase in production, from approximately 6,750 tons in 2020 to around 7,059.95 tons in 2021. This upward trend is expected to continue, reaching approximately 9,849.47 tons in 2030. The increase rates for the two forecast years, 2021 and 2030, are about 4.6% and 45.92%, respectively, compared to the theoretical values from 2020.

The minimum expected production is estimated to be around 6,164.56 tons in 2021 and 7,018.01 tons in 2030. On the other hand, the upper limit of production is projected to be approximately 7,955.34 tons in 2021 and 12,680.9 tons in 2030. These projections provide valuable insights into the potential variations in fish production, enabling better anticipation and planning for future fisheries management strategies.

Efficiency of the marketing system for fish produced in Wadi El Rayan Lake

Fish marketing involves the various stages of delivering fish from the producer, typically the fisherman, to the end consumer. Fish is considered a perishable commodity because it is highly sensitive to temperature changes. Additionally, traditional methods and means of transportation are often used in the fish marketing process, which can impact the quality and freshness of the fish being delivered to consumers. This section focuses on the study of the marketing system for fish produced in Wadi El-Rayan Lake in Fayoum Governorate. It involves examining the marketing channels for fish, understanding the producer, wholesale, and retail prices of the fish, analyzing marketing margins, and determining the product's share in the consumer's pound. Additionally, it explores the use of flakes made from drinking water or sea water to maintain the quality and freshness of the fish during the marketing process.

Marketing channels for fish in Wadi El Rayan Lake

Marketing channels is the way and path of fish transmission from the fish producer (fisherman) to its final consumer, depending on the nature of the product and the distance between the places of production and consumption. There are two types of marketing channels for fish, including direct marketing channels and indirect marketing channels.

- Direct marketing channels for fish: It is when fish are sold without intermediaries, i.e. directly between the producer (the fisherman) and the final consumer.

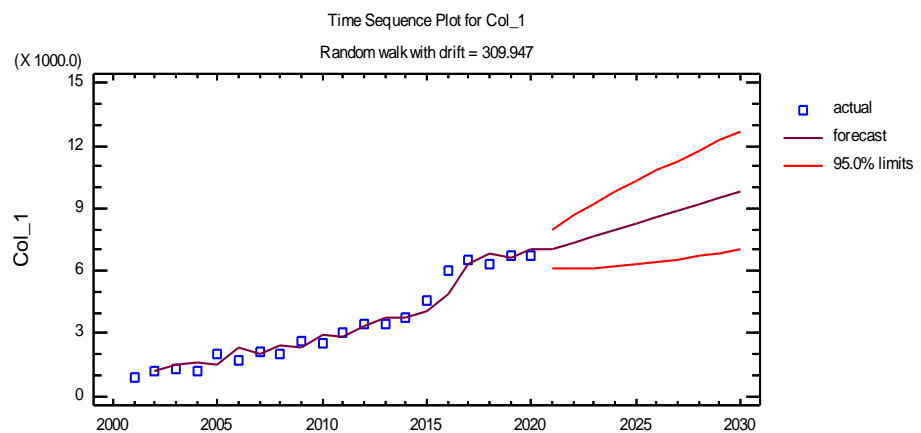
- Indirect marketing channels for fish: The marketing of fish is through many intermediaries, as it is transmitted to the wholesaler or broker, and from there to the retailer, and then to the consumer.

By studying the fish marketing system used in the lakes of Wadi El Rayan, it was found that there are 8 rings (fish collection centers) around the lakes of Wadi El Rayan, where fish are collected early in the morning, and an auction for the fish is held and sold to merchants who transport them to wholesale and retail markets, restaurants, etc. A 5% discount on fish is given to the Fishermen's Cooperative Association in Wadi El Rayan Lakes.

Table 5. Predicting fish production in Wadi El Rayan Lakes: A forecast for 2021-2030

Period	Production	Lower 95.0%	Upper 95.0%
	forecast	limit	limit
2021	7059.95	6164.56	7955.34
2022	7369.89	6103.63	8636.16
2023	7679.84	6128.98	9230.7
2024	7989.79	6199.01	9780.57
2025	8299.74	6297.59	10301.9
2026	8609.68	6416.44	10802.9
2027	8919.63	6550.66	11288.6
2028	9229.58	6697.04	11762.1
2029	9539.53	6853.36	12225.7
2030	9849.47	7018.01	12680.9

Source: gathered and calculated using the information in Table (1)

**Fig. 2.** Expected amount of fish output in the Fayoum Governorate's Wadi El Rayan Lakes 2021-2030

Producer, wholesale and retail prices of fish produced from Wadi El Rayan Lakes

The data presented in Table (6) reveal a range of prices for freshly produced and marketed fish items. Grass carp, for instance, was priced at a minimum of about 25 pounds/kg for the product, 28 pounds/kg for wholesale, and 32 pounds/kg for consumers. In contrast, the musa variety commanded higher prices, reaching up to 85 pounds for the product, 95 pounds for wholesale, and approximately 110 pounds for consumers.

Table 6. Average prices of fresh fish items produced from Wadi El Rayan Lakes during 2022

Fish varieties	Producer price (EGP/kg)	Wholesale price (EGP/KG)	Retail price (EGP/kg)
	Producer - Wholesale	Wholesale - Retail	Retail - Consumer
Tilapia	32	35	40
Perch	35	39	45
Mullet	55	60	70
Shamus	70	76	85
Grass Carp	25	28	32
Silver Carp	27	30	35
Mooses	85	90	110

Source: Collected and calculated from field data in 2022

The producer's share and marketing profit in the consumer's pound: A comparative analysis of fish market dynamics

Among the most crucial indicators of the effectiveness of the marketing system for fish from Wadi El Rayan Lake sold in the markets of Fayoum Governorate are the marketing margins to the product price or to the consumer price and the percentage of the producer's share of the final consumer price, where the low percentage of marketing margins is thought to be from the consumer price of a particular item and the high percentage of the share of the producer.

The marketing margin represents the portion of the consumer's expenses allocated to intermediaries, indicating the difference between what the consumer pays and what the producer receives. This margin can be either absolute or relative, with the absolute margin measured in monetary units. The relative marketing margin pertains to the selling price of the commodity (fish) to the consumer. The ratio of the product's income to the consumer's pound reflects the proportion of the fish commodity's price to the retail price. In essence, it delineates how one pound's worth of the final consumer's price is divided among the producer, wholesaler, retailer, and various marketing roles.

Marketing margins for fish produced from Wadi El Rayan Lakes: Absolute marketing margins

Since it was discovered that these margins ranged between a minimum of 7 pounds/kg for grass carp and a maximum of roughly 25 pounds/kg for moose fish, data in Table (8) show the absolute marketing margins for fresh fish.

Relative marketing margins

The data presented in Table (8) show the relative marketing margins for fish species; these margins ranged between a maximum of 22.8% for silver carp, and a minimum of about 20% for tilapia.

The proportion of the product's earnings derived from consumer pounds

The information in Table (8) shows the producer's share of the selling price to the customer for the same aforementioned fish products during the same year as well as the percentage of the product's income from the consumer's pound. This percentage was discovered to be highly marketable, ranging from a minimum of approximately 77% for grass carp to a maximum of approximately 82.4% for chamus fish.

Table 7. Analysis of significant fish species harvested from Wadi El Rayan Lakes in 2022: Producer's share, marketing margins, and production costs

Fish varieties	Total absolute marketing margins (EGP)	**Total relative marketing margins %	*** Producer's share of the consumer's pound %
Tilapia	8	20	80
Perch	10	22.2	77.8
Mullet	15	21.4	78.6
Shamus	15	17.6	82.4
Grass carp	7	21.9	79.1
Silver carp	8	22.8	77.2
Mooses	25	22.7	77.3

* (consumer price - product price) pounds / kg

** (absolute marketing margin / consumer price x 100)

***% of the product's share of the consumer's pound = (100 - relative marketing margin)

Source: Collected and calculated from the data of Table (7)

Challenges and solutions: Advancing fish production in Wadi El Rayan Lake, Fayoum Governorate

The fish production in Wadi El-Rayan Lake faces many problems that hinders its development and advancement affecting the production in the Lake. The research was based on the primary data obtained through personal interviews with workers in the authorities concerned with the field of fisheries, which include (the Fisheries Development Authority in Fayoum Governorate, the Fishermen's Cooperative Society) and some fishermen in Fayoum Governorate in 2022. The sample size comprised 90 observations, divided as follows: 62 individuals from fishermen and lake workers, and 28 individuals from workers in the General Authority for Fish Resources Development and the Fishermen's Cooperative Association.

Perceptions of fisheries workers on challenges in Wadi El Rayan Lake fish production

The data presented in Table (8) highlight the opinions of fisheries workers regarding the challenges encountered in fish production at Lake Wadi El Rayan in Fayoum Governorate in 2022. The foremost issue identified was the insufficient release of fry into the lake annually, with a relative frequency of approximately 93.30%. Following this, concerns were raised about fishermen not adhering to fishing bans and regulations, particularly regarding net openings, leading to overfishing due to fry hunting. This issue, coupled with the prevalence of illegal fishing, was noted with a relative frequency of about 85.14%. Additionally, the pollution of the lake water with sewage and industrial waste was a significant concern, indicated by a relative frequency of approximately 82.74%. Another major challenge highlighted was the absence of support from the Fishermen's Health and Financial Care Fund, especially during fishing bans, resulting in deteriorating living conditions and diminished income for the fishermen, impacting their livelihoods (relative frequency of about 77.28%). Moreover, the lack of infrastructure projects for fishing and manufacturing in the lake area was identified, with a relative frequency of approximately 70.52%. The inadequacy of marketing infrastructure, such as insufficient means of refrigerated transport to facilitate fish marketing, was another concern, with a relative frequency of about 64.91%. There were also concerns about the absence of an appropriate pricing policy for fish supplied by fishermen, with a relative frequency of approximately 57.63%. Furthermore, the decline in the repair of fishing tools and the renewal of licenses due to reduced loans provided to fishermen by the Fishermen's Cooperative Association was noted, with a relative frequency of about 54.70%. Lastly, a decrease in members' contributions to the capital of the Fishermen's Cooperative Association was observed, with a relative frequency of approximately 48.22%.

Proposed solutions from fisheries workers for advancing Lake Wadi El-Rayan in Fayoum Governorate: Addressing key challenges

The data presented in Table (9) outline the primary recommendations for addressing the challenges and advancing Lake Wadi El Rayan, as perceived by the respondents in the field study sample. Foremost among these is the need to increase the number of fish fry in the lake, with a relative frequency of approximately 91.40%. This is followed by the importance of developing the lake, enhancing its efficiency, and reducing water pollution from various sources, with a relative frequency of about 87.38%. Subsequently, respondents emphasized the urgency of addressing overfishing and ensuring compliance with fishing laws, particularly during fishing bans and lake closures to protect fish stocks, with a relative frequency of around 80.14%. The establishment of infrastructure projects, including fishing and processing facilities

along the lake's shores, follows closely with a relative frequency of approximately 73.25%. Additionally, there is a strong emphasis on developing an efficient marketing system by employing modern methods in fish collection and processing centers, as well as using refrigerated transportation to expedite the movement of fish to markets. This recommendation has a relative frequency of about 65.31%. Respondents also stressed on the importance of providing healthcare for fishermen, enhancing their living conditions through insurance and pension schemes, especially in cases of disability or death, and offering subsidies during fishing bans, with a relative frequency of roughly 62.70%. Activating the role of fishermen's cooperative societies in conducting marketing operations to prevent exploitation by wholesalers and secure fair prices for fishermen is another crucial aspect, with a relative frequency of approximately 58.92%. Moreover, increasing the financial resources available to fishermen through the Fishermen's Cooperative Society to facilitate tool repairs, license renewals, and encouraging members to contribute to the association's capital through annual subscriptions is highlighted, with a relative frequency of about 52.60%. There is also a notable emphasis on encouraging investments in fish processing within the Governorate to enhance the added value of captured fish, with a relative frequency of around 41.38%.

Table 8. Workers perceptions towards the problems facing fish production in the field of fisheries in Wadi El Rayan Lake (2022)

Item	Proposals	Frequency %
1	The lack of fry released into the Lake annually.	93.30
2	Non-compliance by some fishermen with fishing ban periods and fishing laws, especially with regard to net openings, It caused overfishing due to fry fishing to expand, as well as the phenomenon of illegal fishing, which caused the strategic stock of fish production in the Lake to decline and, consequently, the Lake's overall fish output.	85.14
3	The Lake water is polluted by sewage and industrial waste.	82.74
4	The absence of the role of the Fishermen's Care Fund in health and financial terms, especially during the period of the fishing ban, which led to poor living conditions for fishermen and poor income, which is reflected in their subsistence.	77.28
5	The Lake lacks infrastructure projects for fishing and manufacturing, such as insufficient ice factories, collection and processing operations, and refrigerators for keeping fish near the Lake's fishing grounds, which leads to weak added value of fish.	70.52
6	Poor marketing infrastructure, such as insufficient means of refrigerated transportation to facilitate the marketing of fish to markets, which leads to high fish loss rates, and the failure to provide wholesale and retail markets with refrigerated warehouses to protect fish from spoilage and damage during transportation and circulation.	64.91
7	The lack of an appropriate price policy to determine the prices of fish supplied by fishermen.	57.63
8	Decrease in the repair of fishing tools and renewal of licenses due to the low volume of loans provided to fishermen by the Fishermen's Cooperative Association.	54.70
9	Decrease in the members' participation in the capital of the fishermen's cooperative.	48.22

Source: Data from the 2022 field study sample were gathered and calculated

Table 9. Proposals of those working in the field of fisheries to address the problems for the advancement of Wadi El-Rayan Lake (2022)

um	Proposal	Frequency %
	Increasing the amount of fish fry in the Lake water.	91.40
	Paying attention to developing the Lake, raising its efficiency, and reducing the pollution of the lake water from various sources, and working to remove the effects of pollution on an ongoing basis, which limits the increase in fish production.	87.38
	Confronting overfishing and non-compliance with fishing laws to prevent fishing operations during the fishing ban period and closing the lake to preserve fish stocks from depletion, by applying appropriate legal procedures.	80.14
	Establishing basic infrastructure projects for fishing and manufacturing near the shores of the Lake, such as establishing factories for the production of fishing supplies, boat maintenance workshops and ice factories, and establishing complexes for transporting, packing and processing fish to increase the added value of fish.	73.25
	Establishing an efficient marketing system through the use of modern means in the collection and processing centers of fresh fish supplied by fishermen, and the development of means of transportation equipped with refrigerators to speed up the process of transporting fish to the markets until it reaches the final consumer in the best possible condition, in order to reduce the percentage of lost and damaged fish.	65.31
	Work to provide health care for fishermen through an appropriate health system, with the need to improve their living conditions for them through the umbrella of insurances and pensions, especially in circumstances of disability or death, in addition to providing them with the necessary subsidies that are disbursed to them in periods of prevention of hunting through the Fishermen's Cooperative Union.	62.70
	Activating the role of fishermen's cooperative societies in carrying out marketing operations to eliminate the exploitation of wholesalers and to ensure a remunerative price for fishermen.	58.92
	Increasing the volume of financial resources provided to fishermen by the Fishermen's Cooperative Association to enable them to repair and maintain fishing tools and renew boat licenses.	52.60
	Paying attention to increasing the financial resources of the Fishermen's Cooperative Association by encouraging fishermen's members to contribute to the association's capital through annual subscriptions.	47.82
0	Encouraging investments in the field of fish processing in the Governorate, leads to an increase in the added value of caught fish, especially with the increase in local demand for processed fish.	41.38

Source: Data from the 2022 field research sample were collected and calculated

Conclusion

The fish production sector plays a significant role in Egypt's economic and social development, as well as in ensuring food security. In Egypt, fish production comes from both natural fisheries and fish farming, accounting for approximately 30.97% and 69.03%, respectively, during the period (2001-2020). Wadi El Rayan Lake in Fayoum Governorate stands out as a crucial natural fishery for Egypt, characterized by its vast area of about 35 thousand acres and an average production capacity of about 3403.3 tons during the same period. Despite its significance, there existed a food gap of about 345.25 thousand tons, given Egypt's average consumption of about 1508.37 thousand tons and the relatively modest contribution of Lake Wadi El Rayan, accounting for only about 0.24% of the total production. The research also delved into the trends in fish production in Wadi El Rayan Lake from 2001 to 2020. The analysis revealed a statistically significant annual increase of about 0.330 thousand tons, with an average production of 3403.3 tons. This study aimed to assess the current state of fisheries in Wadi El Rayan Lakes, representing approximately 9.7% of the yearly average fish production. The seasonality coefficient in Wadi El Rayan Lakes' fisheries, ranging around 3.5% from 2017 to 2020, highlighted the

substantial seasonal fluctuations in fish production. Furthermore, the overproduction model (Schaefer) was employed to determine the maximum allowable fishing rate. The study indicated that the maximum sustainable yield (MSY) for Wadi El Rayan Lake's fisheries was approximately 2674.6 tons per year, achieved with a fishing effort of 129 boats. This yield demonstrated a consistent and statistically significant annual increase of about 0.330 thousand tons. It was also found that the actual production exceeds the allowable amount of production (MSY) during the study period's last ten years. Additionally, it is clear from how much the fisheries of Wadi El Rayan Lake suffer from the phenomenon of an increase in illicit fishing activities that the actual fishing effort in that Lake surpasses the ideal fishing effort, and from the production function statistical estimate. The Lake's fish productivity is expected to decrease in the coming years due to the expected fall in the Lake's fish stock. The statistical model's significance was set at a significant level of 0.01, which corresponds to an annual rate of about 0.330 thousand tons. The analysis revealed several significant findings regarding fish production in Wadi El Rayan Lake. First, it was determined that the number of fry, the number of boats, the number of fishing days, and the average wholesale price were the most influential factors impacting fish production during the study period. Fish production was observed to occur in the third stage of the law of declining returns, which is the uneconomic stage. This was a result of the overuse of the number of fishing boats, with an overall elasticity of approximately (-0.747). The productive elasticities of the individual elements were calculated to be around 0.061, -0.843, -0.744, and 0.779, respectively. The adjusted coefficient of determination "R²" indicated that approximately 97% of changes in fish production volume were caused by alterations in these factors.

Examining the absolute and relative marketing margins revealed interesting patterns. Relative marketing margins varied, with silver carp having a maximum of 22.8% and moose fish reaching about 25 pounds/kg. Conversely, grass carp had a minimum of 7 pounds/kg, while moose fish also had a maximum of about 25 pounds/kg. The proportion of product income derived from customer pounds ranged from a minimum of about 77% for grass carp to a maximum of approximately 82.4% for shamus fish, showcasing significant marketing efficiency. In contrast, tilapia fish had the lowest proportion at around 20%. Regarding future production, the research predicted a rise from approximately 6750 tons in 2020 to about 7059.95 tons in 2021 and then to roughly 9849.47 tons in 2030, representing an increase of 309.95 tons, 3099.47 tons, or approximately 4.6%, and 45.92% for the two years of prediction, respectively, from 2020.

Additionally, the perspectives of professionals in the fishing industry highlighted several pressing issues affecting fish production in Wadi Al-Rayan Lake. The lack of fry compared to the quantity needed, poor fishing and manufacturing infrastructure, inadequate marketing facilities, pollution from sewage and industrial waste, and the ineffective role of the Fishermen's Care Fund were significant concerns. Moreover, there was a decrease in member contributions to the capital of the Fishermen's Cooperative Association, at rates of approximately 85.14%, 82.74%, 77.28%, 70.52%, 64.91%, 57.63%, 54.70%, and 48.22%, respectively, leading to a decline in tool repairs and license renewals. Proposed solutions included establishing natural reserves for fish breeding, controlling fishing effort based on fish stock assessments, establishing more fish hatcheries, and enhancing their productivity to provide the lake with required fish fry varieties.

RECOMMENDATIONS

Through the research findings that have been reached, the research recommends the following:

1. Establishing natural reserves in the Lake's creeks (natural places for breeding and breeding fish) by setting boundaries for the Lake's fisheries in order to increase fish reproduction.
2. In order to control the number of boats that are allowed to operate due to the intense fishing activity now taking place in the Lake, it is necessary to plan the fishing effort by evaluating the fish stock.
3. Expanding the establishment of fish hatcheries and increasing their efficiency to supply the lake with the required types of fish fry, which are annually released into the lake in large quantities to bolster fish stocks and thus increase the amount of fish produced, especially the species that can and are suitable to live in the aquatic environment of Wadi El Rayan Lake.
4. Organizing training courses for fishermen on modern fishing methods and systems to raise their capacities, with the need to educate them about the environmental dimensions in order to preserve the Lake from pollution and protect them from the damage that may befall them from various sources of pollution.

ARABIC SUMMARY

تمثلت المشكلة البحثية في عدم كفاية الانتاج السمكي لمقابلة الاحتياجات الاستهلاكية حيث بلغ متوسط الانتاج السمكي في مصر نحو 1215.12 ألف طن في حين بلغ متوسط الاستهلاك نحو 1508.37 ألف طن بفجوة غذائية قدرت بنحو 345.25 ألف طن خلال نفس الفترة، كما أن الأهمية النسبية لبحيرة وادي الريان للإنتاج السمكي في مصر ما زالت محدودة حيث تمثل نحو 0.24%، لذلك استهدف البحث التعرف على الوضع الراهن للثروة السمكية بمصايد بحيرات وادي الريان، وبدراسة تطور الانتاج السمكي لبحيرة وادي الريان خلال الفترة (2001-2020) تبين ان متوسط الانتاج بلغ حوالي 3403.3 طن، وأن الإنتاج أخذ اتجاهاً عاماً متزايداً بمعدل سنوي معنوي إحصائياً بلغ حوالي 0.330 ألف طن أي يمثل حوالي 9.7% من متوسط العام للإنتاج السمكي. بدراسة الموسمية في مصايد بحيرات وادي الريان خلال الفترة (2017-2020) يتضح أن الإنتاج السمكي يتسم بتقلبات موسمية شديدة جداً حيث بلغ معامل الموسمية نحو 3.5%، وبدراسة نموذج فائض الإنتاج (شيفر Schaefer) خلال الفترة (2001-2020) لتقدير أقصى معدل للصيد مسموح به، تبين أن الإنتاج الأقصى المستدام (MSY) بمصايد بحيرة وادي الريان قد بلغ حوالي 2674.6 طن في السنة وذلك من جهد صيد بلغ حوالي 129 مركب. قدرت المرونات الإنتاجية للعناصر السابقة بحوالي 0.061، -0.843، -0.744، 0.779 على الترتيب، وتقدر المرونة الإجمالية لتلك العناصر والمتضمنة للنموذج المقدر بحوالي (-0.747) والتي تدل على أن الإنتاج السمكي يتم في المرحلة الثالثة من قانون تناقص الغلة وهي المرحلة غير الاقتصادية ويرجع ذلك إلى الاستخدام الزائد لعدد مراكب الصيد عن الحد الاقتصادي لجهد الصيد وزيادة عدد أيام الصيد خلال الموسم. بدراسة الهوامش التسويقية المطلقة للأصناف السمكية المنتجة ببحيرة وادي الريان، تبين أن تلك الهوامش تراوحت بين حد أدنى بلغ 7 جنيه/كجم لأسماك مبروك الحشائش، وحد أعلى بلغ حوالي 25 جنيه/كجم لأسماك موسى، في حين أن الهوامش التسويقية النسبية تراوحت بين حد أعلى بلغ 22.8% لأسماك المبروك الفضوي، وحد أدنى بلغ حوالي 20% لأسماك البلطي، بينما أن نسبة دخل المنتج من جنيه المستهلك تراوحت بين

حد أدنى بلغ حوالي 77٪ لأسمك مبروك الحشائش، وحد أعلى بلغ حوالي 82.4٪ لأسمك الشاموس، الأمر الذي يشير الي كفاءة تسويقية عالية، وتبين من دراسة التوقعات المستقبلية للإنتاج السمكي ببخيرة وادي الريان خلال الفترة (2021-2030)، أنه من المتوقع أن كمية الإنتاج تزداد من نحو 6750 طن عام 2020 إلي نحو 7059.95 طن عام 2021، وتزداد لتصل الي نحو 9849.47 طن عام 2030 بمعدل زيادة قدرها 309.95، 3099.47 طن أو ما يمثل نحو 4.6%، 45.92% لعامي التوقع علي الترتيب عن نظريتهما من عام 2020.

من خلال النتائج البحثية التي تم التوصل اليها يوصي البحث بما يلي.

1. إقامة محميات طبيعية في اخوار البحيرة (الاماكن الطبيعية لتكاثر وتربية الاسماك) من خلال عمل حدود لمصايد البحيرة بهدف زيادة تكاثر الاسماك.
2. العمل علي تنظيم جهد الصيد وذلك من خلال تقدير المخزون السمكي والذي يمكن من خلاله تحديد أعداد القوارب التي يصرح لها بالعمل وذلك بتقنين أعدادها نظراً لجهد الصيد العالي في الوقت الحالي بالبحيرة.
3. التوسع في انشاء المفرخات السمكية وزيادة كفاءتها لمد البحيرة بالانواع المطلوبة من زريعة الاسماك والتي يتم اطلاقها في البحيرة سنويا بكميات كبيرة لزيادة المخزون السمكي وبالتالي زيادة الكمية المنتجة من الاسماك خاصة الانواع التي يمكنها وتلائم ان تعيش في البيئة المائية لبحيرة وادي الريان.
4. تنظيم دورات تدريبية للصيادين علي وسائل ونظم الصيد الحديثة لرفع كفاءتهم، مع ضرورة توعيتهم بالابعد البيئية بهدف الحفاظ علي البحيرة من التلوث وحمايتهم من الاضرار التي قد تصيبهم من مصادر التلوث المختلفة.

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