

ASSESSMENT OF BIOECONOMIC AND MANAGEMENT ASPECTS OF TUNA FISHERY RESOURCE IN PAKISTAN

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ABSTRACT

The ongoing open-access regime in Pakistan raises a big question regarding the management and economic performance of commercially important fishery resources in Pakistan, such as tuna nei. This study appraises the management and economic aspects of tuna nei fishery through catch statistics (1995-2009) and survey data. The Gordon-Schaefer model was used to estimate levels of harvests and their corresponding efforts for three exploitation levels: maximum economic yield (MEY), maximum sustainable yield (MSY), and open-access yield (OAE). At MSY, the harvest, effort, and revenue were $H_{MSY} = 10,299$ MT, $E_{MSY} = 1,382$, and $\Pi_{MSY} = 40.325$ billion PKR; at MEY, they were $H_{MEY} = 10,267$ MT, $E_{MEY} = 1,305$, and $\Pi_{MEY} = 40.468$ billion PKR; and at OAE, harvest and effort were $H_{OAY} = 2,181$ MT and $E_{OAY} = 2,610$, respectively. Results find that effort is high for all exploitation levels and needs to reduce. Since tuna nei is biologically overfished, decrease in effort will result in not only larger catches but also more revenue. Revenue generated at MEY compared with MSY is significantly higher, which can be achieved by lowering effort. Thus, it is prerequisite to formulate and enforce fishery policies that simultaneously control effort, conserve tuna nei fishery, and increase revenue.

Keywords: maximum economic yield, bioeconomics, revenue, GS model, tuna, management, Pakistan.

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INTRODUCTION

Fisheries management is a complex process performed to achieve ecological, biological, economic, and social goals (Cochrane, 2002). In this process, data related to catch statistics, i.e., catch and effort are usually used to conserve fishery stock (Kar and Chakraborty, 2011). Several recent scientific studies employ catch statistics to develop management strategies for sustainably utilizing fishery resources and increasing the economic efficiency of marine commercial fishery (Hinton and Nakano, 1996; Maunder and Punt, 2004; Maunder *et al.*, 2006). To analyze catch statistics and other fisheries-related data scientifically, several statistical models are used in the field of fisheries economics (Seung and Waters, 2006). Among these models, the Gordon-Schaefer (GS) model is very popular in fisheries economics and management (Udumyan *et al.*, 2010) and has a long synthesis history. In 1954, a Canadian scientist named Scott Gordon laid the foundation of fisheries economics by presenting his theory. Afterwards, another scientist called Schaefer borrowed Gordon's ideas and merged them with his own thoughts to create a mathematical model—the GS model (Habib *et al.*, 2014).

The GS model explains the relationship between fishing activities and the fishery stock's biological

growth. It is based on two assumptions. First, per capita growth rate (r) is highest when the fishery population is small. Second, fish price and cost remain stable over time (Mohsin, 2017). Using this model and considering three reference points—maximum economic yield (MEY), maximum sustainable yield (MSY), and open-access equilibrium (OAE)—the fishery's revenue can be explained. At MEY, the maximum profit is made through fishing. On the other hand, the profit margin decreases at MSY. In contrast with MEY and MSY, normal profit is obtained at OAE, which is necessary to keep fishers in the fishery business (Fig. 1).

In the field of fisheries management, two reference points, MEY and MSY, are used depending on the aim of management. MEY is used to increase profit margins (Christensen, 2010), whereas MSY is generally used to biologically conserve fishery stock (Kumar *et al.*, 2017). In this regard, economists strongly prefer MEY to MSY, because operating fishery at MEY not only increases profit but also biologically conserves fishery stock (Gordon, 1954; Grafton *et al.*, 2007). Due to these benefits of operating fishery at MEY, several countries have implemented MEY to manage their fishery resources (Black, 2007; Tabureguci, 2007). Despite these claims, MEY's benefits over MSY are not obvious (Tabureguci, 2007). In fact, MEY is estimated by considering the economics of individual fishing boats,

and other aspects of the fishery industry, such as marketing, distribution, and processing are ignored (Christensen, 2010). Therefore, MSY has an advantage over MEY. However, employing MSY for fishery management is also risky, as the catch can unintentionally go beyond the MSY due to the open-access conditions (Hardin, 1968).

Tuna is a large pelagic fishery resource of Pakistan. The contribution of large pelagic fishery to the total marine catch is over 20%. Most of this catch is sent to Iran either by boats located in Gwadar or land vehicles. Small-sized, dried, and salted tuna, viz., frigate, kawakawa, and bullet tuna, are exported to Sri Lanka. Tuna fishing season peaks in March and spans over six months, that is, November to April. This resource is commercially hunted through gillnetters located in four cities, viz., Gwadar, Jiwani, Karachi, and Pasni. This fishery is known as inshore tuna fishery. Wooden boats, 7–11 m long, fitted with 33–200 hp inboard or 7–33 hp outboard engines locally known as *hora* (Sindhi language) and *rachin* (Balochi language) are used for inshore tuna fishery. Gillnets usually range from 3–5 km with mesh size from 5–14 cm. On the other hand, offshore tuna fishery is conducted by wooden boats of sizes ranging from 12–15 m and inboard fitted engines of 50–500 hp. Most offshore tuna fishing fleets are concentrated in Karachi, Gwadar, and Jiwani. Gillnets used by these boats are made of polyamide or nylon material with mesh size of 15 cm (Khan, 2017; FAO, 2009).

Tuna export from Pakistan has an enormous potential to increase (Customstoday, 2017). However, this opportunity has some associated disadvantages such as overexploitation, because it encourages fishers to catch more fish stock. Reported statistics indicate that the declining capture production of this fishery resource (MFD, 2012) is an alarming situation. In addition, higher tuna prices offered by Iran compel fishers to illegally trade tuna for money (Undercurrent News, 2014). Both these situations act as catalysts to increase tuna catches. It is reported that tuna fishery is likely affected negatively by overexploitation (FAO, 2009). Such overexploitation, if not controlled, will not only result in the decline of tuna capture fisheries but also overcapitalization of fishing fleets due to the fishery economic phenomenon because of decline in revenue. Despite it being very important fishery resource, prior literature highlights other aspects of tuna fishery in Pakistan (FAO, 2009; Moazzam and Nawaz, 2014). Thus, it is necessary to evaluate the fishery status of this resource and describe its bioeconomics comprehensively. For this purpose, this study employs a famous fishery model, the GS model, as the first attempt in this regard.

MATERIALS AND METHODS

Data procurement: For this study, data were obtained from multiple sources such as research papers, research reports, official surveys, and online websites. Both desk and field studies were conducted to collect data. Moreover, an extensive review of literature was done to understand the principles of fisheries economics. These concepts were used later for elaborating the obtained results and perceiving the ongoing bioeconomic and management implications of commercial tuna fishery in Pakistan. In this study, two types of data were used. First, commercial catch and effort data for 1995–2009 on tuna nei fishery in Pakistan were obtained from an officially published book by Marine Fisheries Department of Pakistan (MFD), viz., Handbook of Fisheries Statistics of Pakistan (MFD, 2012). It is necessary to mention that MFD is the sole official department which published statistics related to marine catch in Pakistan. The latest published statistics by MFD are up to 2009. Thus, we have used the latest available catch statistics of tuna nei fishery in this study. Second, data on unit price of the harvest and unit cost of fishing effort were estimated through survey data gathered from the Boat Builder Association, Karachi, and the Karachi Fisheries Harbor Authority. This data was collected through questionnaire survey designed specifically for this study. This survey was conducted at Karachi during January and February 2019. Face to face interviews were done to ensure reliability of the data obtained. In total, 10 participants took part in this survey among which 5 were from the Boat Builder Association, Karachi, whereas, 5 were from the Karachi Fisheries Harbor Authority. Details of the survey participants are given in Table 1.

Data analysis: The GS model was selected for the current study to analyze the commercial marine tuna fishery in Pakistan, which is generally considered to be under an open-access regime. The GS model uses a logistic growth equation represented as follows:

$$F(X) = rX \left(1 - \frac{X}{K} \right) \quad (1)$$

Where, $F(X)$ represents surplus biomass growth per unit of time, X stands for stock biomass, K is carrying capacity, and r denotes intrinsic growth rate. This equation refers to the parabolic curve as a function of X , graphically represented in equation 1.

The harvest rate (H) was estimated by using the simple relation of the Schaefer catch function given as follows:

$$H(E, X) = qEX \quad (2)$$

Where, $H(E, X)$ is the catch per unit of time measured in terms of harvest rate or biomass, q is the constant catchability coefficient, and E is fishing effort.

When population at equilibrium and harvest equals the sustainable yield conditions, the surplus growth is $[H(E, X) = F(X)]$ or when rate of change of biomass is equal to $\frac{dx}{dt} = F(X) - H(E, X) = 0$. Based on equations (1) and (2), $qEX = rX(1 - X/K)$. Thus, biomass at equilibrium (X) is obtained as follows:

$$X = K \left(1 - \frac{qE}{r} \right) \quad (3)$$

The long-term catch equation can be derived by inserting (4) into (2) as follows:

$$H(E) = qKE \left(1 - \frac{qE}{r} \right) = qKE - \frac{q^2 KE^2}{r} \quad (4)$$

The linear relationship between the catch per unit effort (CPUE) and fishing effort can be derived by dividing both sides of (5) with effort (E) as follows:

$$CPUE = \frac{H}{E} = qK - \frac{q^2 KE}{r} \quad (5)$$

Total revenue (TR) in equilibrium as a function of standardized effort can also be defined from equation (5) by considering constant price as follows:

$$TR(E) = p.H(E) \quad (6)$$

In this mathematical equation, p denotes the constant price per unit of the harvest. Similarly, total cost (TC) of fishing effort is given as follows:

$$TC(E) = c.E \quad (7)$$

Where, c is the unit cost of effort. This cost comprises fixed, variable, and opportunity costs of capital and labor. Fixed costs do not depend on fishing operations (insurance, depreciation, and administration). Variable costs (e.g., for bait, fuel, and food) emerge when fishers go fishing. Opportunity costs refer to benefits that could have been achieved in the next best economic activity such as alternative employment, other regional fisheries, or capital investment. Hence, these costs should also be considered when estimating the total cost of fishing (Cochrane, 2002).

At equilibrium, resource rent as a function of fishing effort can be derived from equations (7) and (8) as follows:

$$\Pi(E) = TR(E) - TC(E) \quad (8)$$

Different parameters are estimated through regression of the CPUE statistics on the corresponding fishing effort. The results are presented in Table 2. It is necessary to mention that, for this study, it is assumed that average revenue ($AR = TR/E$) is equal to marginal cost [$MC = TC(E)$]. Hence, from (7) and (8), we get

$$\begin{aligned} \frac{pH}{E} &= c \\ \frac{H}{E} &= \frac{c}{p} \end{aligned} \quad (9)$$

The stock biomass under the open-access regime is

$$X_{\infty} = \frac{c}{qp} \quad (10)$$

The long-term harvest function from equation (4) can be expressed as follows:

$$H(E) = aE + bE^2 \quad (11)$$

Where, $a = qK$ and $b = \left(\frac{-aq}{r} \right)$. Since, the time-series catch and effort statistics of commercial tuna fishery in Pakistan are available, the “ a ” and “ b ” values can be computed by the linear regression of the CPUE on the relative fishing effort data. The results are presented in Table 2. From the above estimated “ a ” and “ b ” values, K and r can also be calculated as follows:

$$K = \frac{a}{q} \quad (12)$$

$$r = \left(\frac{-aq}{b} \right) \quad (13)$$

So, $CPUE = \frac{H}{E}$ can be expressed as follows:

$$CPUE = a + bE \quad (14)$$

E_{MSY} can be estimated by using equation (11) as follows:

$$E_{MSY} = \left(\frac{-a}{2b} \right) \quad (15)$$

$$MSY = \left(\frac{-a^2}{4b} \right) \quad (16)$$

Thus,

At the open-access equilibrium, $TR(E) = TC(E)$. Using

equations (6) and (7) $p.H(E) = c.E$, Hence, E_{OAY} can be estimated by using the GS model and the following equation:

$$E_{OAY} = \left(\frac{\frac{c}{p} - a}{b} \right) \quad (17)$$

The maximum economic yield (Π_{MEY}) can only be obtained by employing less total fishing effort. Moreover, economic rent (positive) can only be obtained at effort levels that are than E_{OAY} . Thus, MEY is obtained at the profit maximizing level by using equation (8) as follows:

$$\Pi(E) = 0 \quad \text{or} \quad \frac{dTR(E)}{dE} = \frac{dTC(E)}{dE}$$

Hence, E_{MEY} is obtained as follows:

$$E_{MEY} = \left(\frac{\frac{c}{p} - a}{2b} \right) \quad (18)$$

RESULTS

This study uses catch statistics (1995-2009), harvest price, and fishing cost of tuna nei fishery in Pakistan. During the study period, the maximum, minimum, and average catch of tuna nei fishery were observed for 2004 (12,862 MT), 2000 (5,773 MT), and 9,881 MT per year. On the contrary, maximum and minimum effort was observed in 2009 (1,866) and 1995 (932), respectively (Fig. 2). Furthermore, the computed results indicate that the estimated CPUE varied between 4.377 and 10.620. Results also showed that during the last five years of this study, CPUE decreased from 6.966 (2005) to 5.130 (2009) (Fig. 3). The respective values of a and b were calculated as 14.901 and -0.00538. Regression analysis of CPUE was conducted on the corresponding effort level to obtain these values. The standard error estimates of a and b remained at 1.733 and 0.001, correspondingly. The R^2 value obtained after regression analysis was 0.558. This value shows that the variation in CPUE data is 55.8% (Table 2). The values of K (458,976 MT) and r (0.089) were computed by inserting the estimates of a (14.901), b (-0.00538), and q ($3.25E-05$) in equations (12) and (13).

In this study, the GS model was employed to compute three types of very important fishery parameters: harvest levels (H_{MSY} , H_{MEY} , and H_{OAY}), effort levels corresponding to the harvest levels (E_{MSY} , E_{MEY} , and E_{OAY}), and economic rent (Π_{MSY} and Π_{MEY}). To estimate the harvest level values, a and b were solved in equation (11), while, the respective effort levels were computed by using equations (15), (17), and (18). On the other hand, equation (8) was used to estimate economic rent. Computed values of the harvest, effort, and economic rent levels are given in Table 3. The calculated values of H_{MSY} , H_{MEY} , and H_{OAY} remained at 10,299 t, 10,267 t, and 2,181 t, respectively. Here, a 95% confidence interval was used to estimate the lowest and highest bounds of these harvest levels. The estimated values of these bounds remained at 3,790–32,546 t, 3,768–32,481 t, and 1,058–5,548 t, in that order. In

addition, the estimated values of E_{MSY} , E_{MEY} , and E_{OAY} were computed as 1,382, 1,305, and 2,610, correspondingly. Similar to harvest, a 95% confidence interval was used for the effort level to compute the lowest and highest bounds. The estimated bounds for these levels were 685–3,475, 633–3,320, and 1,266–6,639, respectively. The estimated values of TR and TC at E_{MSY} were computed as 45,419,562,999 PKR and 5,094,312,488 PKR, respectively. Subtracting TC from TR, the economic rent at MSY (Π_{MSY}) was obtained as 40,325,250,510 PKR. On the other hand, at E_{MEY} , computed values of TR and TC remained at 45,276,716,954 PKR and 4,808,620,399 PKR, respectively. Hence, the calculated value of the economic rent at MEY (Π_{MEY}), subtracting TC from TR, is 40,468,096,555 PKR.

Table 4 presents estimates of two types, that is, cost per unit effort (c) and price per unit harvest. These estimates were made using survey data specifically gathered for this study. Three types of costs were considered for estimating c : fixed costs, variable costs, and opportunity costs. Aggregate c was calculated as 3,685,000 PKR per gillnetter per year. Total fixed cost (1,405,000 PKR) was calculated by adding the depreciation (25% on the average price of gillnetter; 1,375,000 PKR), registration fee (10,000 PKR), and license fee (20,000 PKR). Total variable cost per annum (2,160,000 PKR) was computed by considering fuel expenses (600,000 PKR) and labor expenses (10,000 PKR per person per month). It is essential to mention that estimates for variable costs were made for nine months in a year, because tuna fishing is done about nine months in a year. During the remaining three months, fishers take rest, repair boats, or engage in other business. Opportunity cost (120,000 PKR) was calculated by considering the estimated minimum labor wages of labor, i.e. at 10,000 PKR per month. On the other hand, price per unit harvest (4,410,000 PKR per year) and average per kilogram wholesale price of tuna nei (300 PKR) was used. Average per annum catch of tuna nei fishery was computed as 14,700 kg/gillnetter.

Table 1. Frequency analysis of research participants.

	Categories	Frequency	Percentage
Status	Senior Research Fellow/Others	6	60.0
	Associate Research Fellow/Others	4	40.0
Education	Ph.D.	3	30.0
	Masters/Bachelor/Others	7	70.0
Working experience	Between 5 to 10 years	7	70.0
	More than 10 years	3	30.0
Region/Department	Boat Builder Association, Karachi	5	50.0
	Karachi Fisheries Harbor Authority	5	50.0
	Total	10	100.0

Table 2. Regression analysis of catch per unit effort on the corresponding effort level of commercial tuna nei fishery of Pakistan (1995-2009).

Parameters	Coefficients	Standard Error	Lower 95%	Upper 95%
<i>a</i>	14.901	1.733	11.069	18.733
<i>b</i>	-0.00538	0.001	-0.0080	-0.0026

* Adjusted $R^2 = 0.558$ **Table 3. Harvest, effort, and economic rent estimates of maximum sustainable, economic, and open-access yield of tuna nei fishery in Pakistan.**

H _{MSY} (MT)	E _{MSY}	Π_{MSY} (Billion PKR)	H _{MEY} (MT)	E _{MEY}	Π_{MEY} (Billion PKR)	H _{OAY} (MT)	E _{OAY}
10,299 *(3,790– 32,546)	1,382 (685–3,475)	40.325	10,267 *(3,768– 32,481)	1,305 *(633– 3,320)	40.468	2,181 *(1,058– 5,548)	2,610 *(1,266– 6,639)

Table 4. Cost per unit effort (c) and price per unit harvest for tuna nei fishery in Pakistan.

FIXED COST	
Depreciation = 25% on avg. price of gillnetter	1,375,000
Registration fee	10,000
License fee	20,000
TOTAL FIXED COST	1,405,000
VARIABLE COST	
TOTAL VARIABLE COST PER ANNUM	2,160,000
OPPORTUNITY COST	
Minimum wage of labor/month	10,000
TOTAL OPPORTUNITY COST PER ANNUM	120,000
COST PER UNIT EFFORT (c) =	PKR 3,685,000
PKR/gillnetter/year	
Avg. price/kg	300
Avg. catch per unit effort	14.7 MT/gillnetter/year
PRICE PER UNIT HARVEST	
1 MT	1,000 Kg
Per annum catch in Kg	14,700
	Kg/gillnetter/year
PRICE PER UNIT HARVEST (p) =	4,410,000

*Different cost and price values are in PKR (1 USD = 142.38 PKR).

DISCUSSION

This study obtains several results about the ongoing tuna nei fishery regime in Pakistan. The results show that capture production is decreasing due to the increasing fishing effort. It clearly indicates that tuna nei fishery is experiencing overexploitation in Pakistan, similar to many other fishery resources that are also being overexploited, as reported by several researchers (Memon *et al.*, 2015; Mohsin *et al.*, 2017). This condition represents poor fishery management in Pakistan. Unfortunately, in the past, fishery-related issues did not receive proper attention from the government. The first

comprehensive effort toward creating a concrete fishery legislation was made in 2004. For this purpose, the FAO (Food and Agriculture Organization of the United Nations) and Ministry of Food, Agriculture, and Livestock collaborated to devise Pakistan's first inclusive fisheries policy in 2007, called the National Policy and Strategy for Fisheries and Aquaculture Development in Pakistan. According to this policy's section 2.A, a majority of the fishery resources are overexploited (GoP, 2007). This study indicates that tuna nei fishery was overexploited in the past as the catch for previous several years had been above the harvest level at either MSY (H_{MSY} = 10,299 MT) or MEY (H_{MEY} = 10,267 MT).

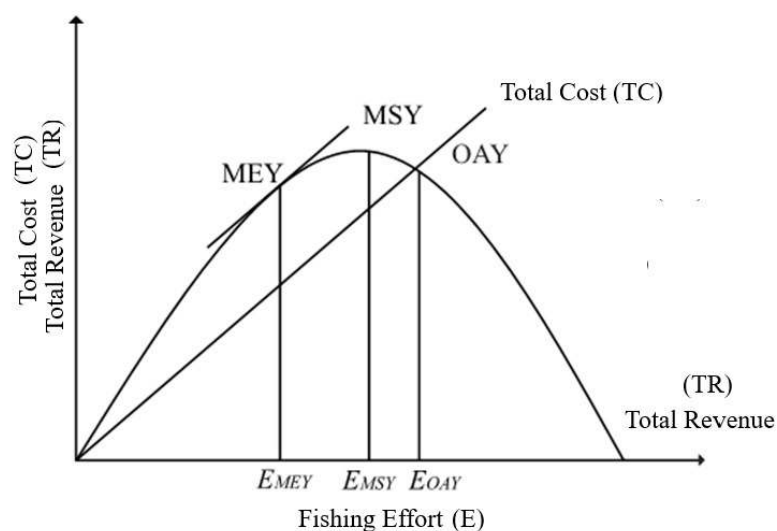


Fig. 1. Graphical description of Gordon-Schaefer model.

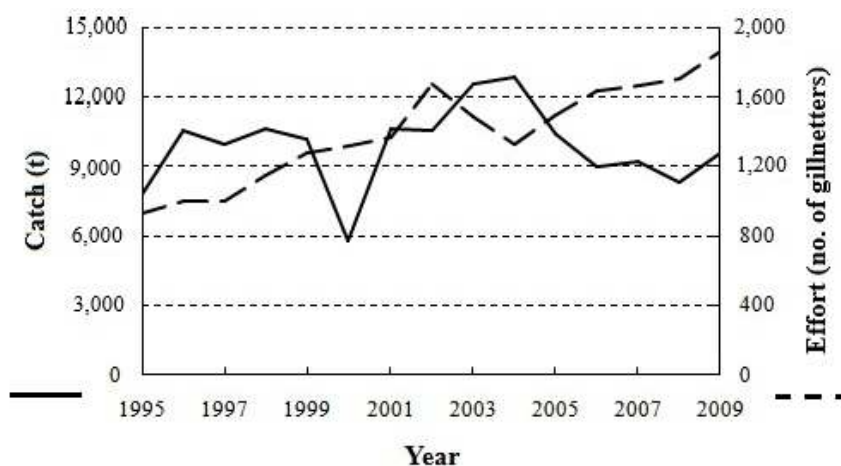


Fig. 2. Catch (MT) and effort (no. of gillnetters) statistics for tuna nei fishery in Pakistan.

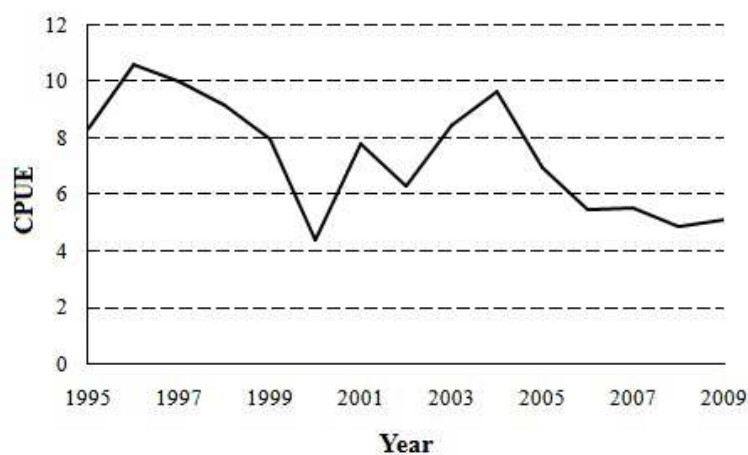


Fig. 3. Computed cost per unit effort (CPUE) for tuna nei fishery in Pakistan.

Several prior studies conclude that overexploitation is a product of increased fishing effort

(FAO, 1999), which has increased uncontrolled in Pakistan. A published report declares that, in Sindh, the

number of trawlers is double the number of recommended ones (Schmidt, 2014). This is the same with gillnetters operating in Baluchistan, as the effort required at MSY ($E_{MSY} = 1,382$) and MEY ($E_{MEY} = 1,305$) was achieved in 2004. Thus, the number of operating gillnetters, 1,866, is considerably high compared with the number at MSY and MEY. Although, sections 2A.2 and 2A.3 of the national policy insist on controlling the fishery catch and fishing effort (GoP, 2007), practical implementation of this policy seems vague. As Pakistan follows FAO's Code of Conduct of Responsible Fisheries, it must control this ongoing situation (FAO, 1995). CPUE trends have the potential to indicate the state of the fishery. There are three possibilities with respect to the change in CPUE. First, a stable CPUE generally indicates that fishery is not affecting the fish stock. Second, an increasing CPUE signposts that fishery has the possibility to flourish. Third, a decreasing CPUE usually suggests that fish stock is experiencing overexploitation (Hoggarth *et al.*, 2006). The CPUE of tuna nei fishery in Pakistan is declining over time, which also indicates overexploitation.

In addition to the catch and effort trends and CPUE drifts, some other reference points such as MSY also indicate the state of the fishery. If the computed values of MSY are greater than the observed catch values in this condition, more fishing can be done. On the other hand, if the estimated MSY is lower than the observed catch values, the situation clearly represents overexploitation of the fishery resource (Hoggarth *et al.*, 2006). Thus, this study indicates that there is overexploitation of tuna nei fishery in Pakistan. Overexploitation results in economic losses. Fishers try to make more and more profit by increasing their catches, which results in larger fishery catches. The fish stock may encounter extinction if this increase in fish catches is not stopped (Clark, 1973). However, several studies indicate that higher economic gain is associated with overexploited fish stock (Grafton *et al.*, 2007).

By considering the results, that is, decrease in tuna nei fishery catch, increase in fishing effort, decrease in CPUE, and the computed MSY levels, it is confirmed that the tuna nei fishery resource is experiencing overexploitation. However, use of more recent and comprehensive data is suggested for making decisions in this regard. The results obtained are exactly according to the description of the GS model, wherein revenue is maximum at MEY. At MEY, the calculated revenue ($\Pi_{MEY} = 40.468$ billion PKR) is higher than the computed revenue at MSY ($\Pi_{MSY} = 40.325$ billion PKR). To obtain this revenue, the effort must be reduced to the corresponding effort level at MEY ($E_{MEY} = 1,305$). If the fishing effort is not controlled in the future, the cost of fishing will rise and revenue will decrease due to the economic phenomenon of the open-access regime mechanism (Hardin, 1968). Thus, to avoid this condition,

the existing fishery policies should be revised, and more attention should be paid to the increase the total economic revenue and reduce total cost with proper implementation of these policies to achieve these goals.

As a member of the Indian Ocean Tuna Commission, Pakistan is responsible for managing tuna fishery (FAO, 2009). To achieve this, it is suggested that Pakistan reduce the fishing effort and implement a of quota system. For this purpose, the scope and perspective of the existing fisheries management policies should be diversified. Rather than focusing on limited aspects of the fisheries, policies should encompass various aspects such as fishery resource rent, revenue, and cost. This can be achieved by involving all the stakeholders.

Finally, it is necessary to mention that similar to other statistical models, the GS model used in this study has some limitations due to various non-real assumptions. For instance, mortality, growth, and recruitment have positive impacts on the catch and effort relationship. The catchability coefficient remains stable and does not change with the passage of time. Although CPUE represents the impartial abundance of index, the biological process and spatial distribution are ignored. Moreover, technological and ecological considerations of the fishery stock are not considered by this model. The reasons for fluctuations in the fishery process due to fishing or natural processes are not clear (Seijo *et al.*, 1998). Although, these assumptions may not be met practically, however, this is a comprehensive model that can be used to understand the fate of fishery under the natural open-access regime and has the potential to describe the economic efficiency of fisheries (McGoodwin, 1995; Valatin, 2000). This study indicates that tuna nei fishery may experience overexploitation, mainly because of increase in corresponding effort, if there is no any effective management and conservation policy. Since, exploitation levels of tuna nei fishery has already achieved both MSY and MEY, thus there is a dire need to observe dynamics of this fishery resource for its sustainable long-term exploitation. Introduction of new fishing technology can also threaten tuna nei fishery resource. Thus, not only increase in effort should be controlled but also performance of current fishing ways should be monitored. However, effort reduction can result in unemployment which may cause social disorder because in Pakistan most of the coastal communities mainly rely on fishing for earning their livelihood. In order to encounter the effects of effort reduction individual transferable quotas and individual quotas of habitat impact units approaches may be adopted (Squires *et al.*, 1998; Holland and Schier, 2006). Moreover, monitoring and implementing fishery policies and regulation will also assist to improve the situation. Furthermore, in order to strengthen fisheries sector as a whole, more in depth studies should be conducted related to economic and management aspects of fishery

resources before making any management plan as this study is just a preliminary study.

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