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Article

Bioeconomic Modelling in Sustainable Fisheries Management of Commercial Marine Fisheries in Kelantan, Malaysia

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Abstract: Bioeconomic modelling is an important issue in sustainable fisheries management of commercial marine fisheries in Kelantan, Malaysia. Previous studies focus on the impact of trawling on fisheries, tourism and the socio-environment, which overfishing is a direct threat to local fishing communities. In addition, bottom trawl fishing may affect fishing, environment and socio-economic management objectives. Moreover, fishing activities lead to changes in the structure of marine habitats and affect the diversity, composition, biomass and productivity of related biota. Finally, the previous research discussed on challenges of the fisheries industry in peninsular Malaysia. Studies focused on bioeconomic modelling in sustainable management of commercial marine fisheries in terms of fishing gear, climate changes, and anthropogenic disturbances are still limited. This study aims to investigate the sustainability of marine fish production and analyse the potential effect of climate changes and anthropogenic disturbances that affect fisheries activities. The theory and practice of the bioeconomic surplus production model by Gordon - Schafer (GS) are used to calculate the total biology and economic value. The result of the study indicated that trawl nets, anchovy purse seinses, climate changes and anthropogenic disturbances affect the sustainable management of commercial marine fisheries in Kelantan, Malaysia.

Keywords: bioeconomic modelling; sustainability; fisheries management; commercial marine fisheries

1. Introduction

Malaysia is in Southeast Asia. In Malaysia, there is a lot of fisheries activity in the East Coast Area. The fisheries and aquaculture sectors in East Coast Malaysia are in Terengganu, Pahang and Kelantan, Malaysia. Fisheries can be divided into two categories which are traditional and commercial. The fisheries sector in Terengganu and Kelantan is their main economic activity. The presence of Commercial Marine Fisheries activities in East Coast Malaysia leads to many social and economic impacts not only for the community and state itself but also can contribute to the whole country may lead to import and export activities. To our knowledge, two main fishing gear types are used for commercial marine fisheries activities in Kelantan: Trawl Nets and Fish Purse Seines. The study area in this research is East Coast Malaysia, located in Kelantan. The studied area is in Kelantan, Malaysia. A part of studied focuses on Commercial Marine Fisheries due to research on how the fisheries sector contributes to the gross domestic product.

The fishing port area in Malaysia is used to make a fish catch and land and other fisheries activities in every state. In Kelantan, the government has protected Tok Bali Port with policy and law. This study will discuss the possibility of sustainability of fisheries due to the distraction of foreign fishers from illegal fishing. This research will determine whether this planning will protect the Tok Bali Port and positively impact the environment and society. These are the problems that will be the focus of this research. According to all previous research, primarily the fisheries port is in peninsular Malaysia as the places have a big amount of contribution rather than Sabah and Sarawak. They are using trawl nets and fish purse seines, the most common fishing gear types in Malaysia, but there is an issue that trawls nets are efficient, not selective, but very destructive. This research will bring an outcome based on these issues. The accommodation of the port also affecting make the port potential to be a regional hub.

Through this research, the fishing area is expected to bring some effects to the fish contribution to the community, state and country are expected to control the effects of marine life. It is due to policy and law that will control the activities in the fisheries area, which is one of the activities that affects the fish catch as the population has increased rapidly in these few years. The government protects the Tok Bali Port with policies and laws that bring advantages to the fisheries area. The effort at the fishing area can reduce the issues of lack of fish stock in a country as the fishing area are protected and conserved. The fisheries area is expanding to meet the demand of people because the population is increasing rapidly. Malaysia Maritime Enforcement Agency has controlled the illegal activities in the fisheries area by imposing the law and policy. It also educates the people to protect the fisheries; for instance, the government has cooperated with the communities by giving them an initiative or subsidies to protect the fisheries sector.

The main idea of this research is about commercial marine fisheries in Kelantan. Kelantan is located on the east coast of Malaysia, with many rivers and seas. The biggest fishing activity is in Tok Bali, Kelantan, while the second biggest is in Pantai Tujuh, Tumpat, and Kelantan. These two places stated before were a type of commercial marine fisheries. In Kelantan, there are two types of fisheries: commercial and traditional. The fisheries activities are mainly economic in Kelantan due to the accommodations there. These two places also have a great and famous attraction that tourists always want to go there in real it was not only the tourist, but the Kelantan people also love to go there.

The Malaysian fish development board (LKIM) at Tok Bali has been monopolised by Vietnam and Thailand boats and fishers, bringing a loss to the community or the local fisherman. Harian Metro news on 11 November 2020 was written by Siti Norhidayatidayu Razali, who stated that the fish landing jetty at the port of Malaysian Fish Development Board (LKIM) Tok Bali was controlled by Vietnamese and Thailand boats. It has caused the local boat owner to lose more than 50 per cent over the past three years. Out of 50 deep-sea boats at the jetty, only 15 local boats and most of the local fishermen only have Trawl Net, and that port has become the centre of attention for Vietnamese, Thailand, and Myanmar.

Kelantan is one of the biggest contributions to the fisheries sector in Malaysia. Even in Malaysia has reached an excess in the level of subsistence in fish supplies in food production since 2010, the country still faces the issue of the increasing price of fish. It shows that the challenge that has been faced is not only to ensure the quantity of supply is enough. It is also about people getting their need for protein in their daily diet. Some challenges to ensuring the supply are enough for the future are climate change effect, limited supply factors, price of input increase, competence in food products and the liberation trade. The continuity of adequate fish supply depends on the viability of this enterprise to ensure income to fishers and fish farmers.

This study aims to investigate the way to sustain marine fish production. Next, analyse the potential effect of climate changes and anthropogenic disturbances such as lack of accurate information, pollution (on fish stock) and lack of legal law or enforcement against illegal fish catch. The current issues in East Coast areas such as Kelantan and Terengganu were the price of fish in the market remained unchanged even due to COVID-19, and the fish business was not affected. As in Kelantan, the latest news has been written in Air Times news on 21 July 2020 that the Malaysian Coast Guard (Maritim Negeri Kelantan, APMM Kelantan) held two Vietnamese boats with 11 Vietnamese Fisherman that entered the Kelantan Coast illegally. This case was reported at Pasir Puteh, Kelantan. The Vietnamese fisherman's disturbances that invade and catch the marine product in the country water brought bad luck when they got caught by APMM Kelantan at the Kelantan Water. The maritime legal law is not very strong because there are still encroachments going on by foreign fishers. It will cause the number of fish in the east coast sea to decrease and the lack of fish stock on the east coast. Other issues are about the fishing gear, such as the Trawl net it is efficient but disturbance because of the catch will damage coral reefs as fish sanctuaries. Trawl net not only damages coral reefs but will also indirectly catch all kinds of fish or marine life without filtering their needs. Commercial trawl fisheries aim to assess the sustainability of marine fish production and propose appropriate policy recommendations to improve the state of the country's capture fisheries.

2. Literature Review

The fisheries industry is vital for Malaysia's economy (Saharuddin, 2001). There are growth potentials in deep-sea fishing, coastal fishing and aquaculture activities along the Malaysian coast. However, the development of the fisheries industry threatens the sustainability of the environment if it is not managed systematically. The environmental risk of the fisheries industry can result in water and air pollution and catastrophic ecosystem damage (Giger, 2009). As such, a new model is proposed for analysing environmental risks arising from fisheries activities. With this in view, this paper proposes a new analysis model using the Analytic Hierarchy Process and the decision-making rating tool. Environmental risk factors are identified and prioritised using the Analytic Hierarchy Process method (Ramanathan, 2001). Mitigation strategies for minimising the risk losses from fisheries activities are suggested and highlighted using a decision-making rating tool. Tok Bali fishing Port is selected as a case study to demonstrate the applicability of this proactive risk evaluation model. The result shows that water pollution is a focal environmental risk arising from fisheries activities in Tok Bali Fishing Port. The proposed model is capable of helping related government agencies such as Lembaga Kemajuan Ikan Malaysia and the Department of Fisheries Malaysia in conducting a proactive evaluation to enhance the environmental sustainability of the fisheries industry (Salleh & Halim, 2018).

Comment on the bioeconomic literature on habitat fisheries linkages. Many such connections have been explored in the bioeconomic literature. However, an analysis lacking in the literature is to combine the potential impacts of habitat on fish populations and fisheries into an overall theoretical model. This article attempts to clarify the nature of the link between habitat functions and the economic activities it supports. More specifically, theoretically determine how the habitat enters the standard Gordon-Schaefer model, and interaction is a general model. The impact of the place of animal stay is defined as bioeconomic. Bioeconomic effects are related to the function of animal stay place in the growth of fish population and may be crucial or easy to produce for the species. Bio-economic interaction is related to the impact of habitat on fisheries, which can be indicated by a harvest function or profit function (Foley et al., 2012). Review how animal stay loss affects populations, workloads, and harvests in open access economic and MEY management fisheries.

A study by Jones (1992) identified that a negative impact of scientific monitoring on the marine ecosystem had been ignored. In some cases, raising ethical standards and protection issues are based on the small scale compared to commercial fisheries. Ethical principles should lead to reconsideration of the monitoring of marine wildlife resources, such as fish and shellfish trawl surveys provided by science, which are the evidence required for fisheries management and an assessment of how environmental changes affect global marine shelf communities. To reduce the impact of marine monitoring, the methods and tools provided may take advantage of the latest advances in science and technology. There are other ways to consider modifying current practices and identifying areas that require further research. Out of ethical considerations, we commented on potential ways to reduce scientific trawling to monitor marine living resources. The study results indicate that this may require major changes, such as the replacement of survey vessels and observation technology (eDNA, open-closed trawl), as well as minor incremental modifications to current operations (reduced trawling time, biological Degraded gear material). Developments to reduce the impact of marine monitoring are expected to produce solutions suitable for fisheries and other marine activities.

Stiles et al. (2010) added that fishery trawling had impacted tourism and marine environments. It used to catch shrimp and fish living on the seafloor from shallow coastal waters to extreme depths of 60,000 feet (2km). In addition, shrimp and many other animals are captured and discarded, including undersized fish. Bottom trawling uses heavily weighted nets that are dragged across the ocean floor. A metal door weighing over several hundred pounds is used to open the net, which can be as large as feet fall and 200 feet wide. When the weighted net and trawl are dragged along the seafloor, everything in their path is destroyed, such as seagrass, coral reefs, or rock garden, where fish hide from predators. Fish-throwing issues show that the bottom trawling is one of the most destructive ways to catch fish and is responsible for up to half of all discarded fish and marine life worldwide. Much valuable fish, turtles, marine mammals and others are captured and discarded by bottom trawls, and many do not survive (Hiddink et al., 2020). Scientists estimate that almost four to ten pounds of marine resources are thrown away for every shrimp caught. Fish unwanted and discarded by the bottom trawl are often juveniles of valuable species caught by another fisherman (Althaus et al., 2009). Shrimp trawls catch significant numbers of red snapper, porgy, and mackerel. Slicks of snapper and other dead fish in their wake. Bottom trawling often leads to overfishing because the gear is not selective and discards a lot of dead fish. Overfishing by bottom trawlers directly threatens local fishing communities and tourism from sports fishing.

A framework for assessing the impact of mobile fishing gear on the seabed and benthic ecosystems is proposed. Frameworks that can be used on a regional and local scale provide indicators of trawl pressure and ecological impact. It is based on a high-resolution map of the trawl's strength and considers the trawl gear's physical impact on the seabed, the classification of marine life, and the function of the benthic ecosystem. The physical effects of these elements on the seafloor (including scraping the seafloor, mobilising sediment and infiltration) are a function of each component's mass, size and speed (Balvanera et al., 2006). Explore this framework to compare the pressure and ecological impact indicators of trawl bottom trawls among the three main seabed habitats in the North Sea. Fishing is one of the important man-made activities that affect the marine ecosystem, especially the extensive use of submarine trawls towed on the seabed of the continental shelf area (Balvanera et al., 2006). Physical interference from such devices can cause major changes in the seabed, cause the death of animals encountered, and affect biogeochemical processes at the sediment-water interface. The widespread use of bottom trawls has raised concerns about possible adverse effects on biodiversity, ecosystem functions, and ecosystem products and services. A complete ecosystem-based fisheries management approach also asks for full integration of the benthic ecosystem and its trawled fish stock. It will help predict the direct and indirect effects of trawl mortality on benthic organisms and fish into changes in the fish stock, the fisheries yield, the food web and the structure and function of benthic communities. This the- sis shows how only a mechanistic understanding of the factors that determine interactions between fisheries, fish and benthos may lead to such integration. This information is needed to shift the ecosystem approach to fisheries management from a policy objective to an effective instrument for successfully managing trawled fish stocks and conserving the benthic ecosystem (Américo et al., 2022).

The impact of trawl fishing discussions about the focus on the environment and biodiversity of social results about the costs and benefits of seafood production, as well as environmental and fisheries management regulations and certified processes. When trawling occurs in or near fragile marine ecosystems or biologically significant areas and ecologically, especially in this case, review and assessment should target other types of habitats. Management's effectiveness minimises the trawler's impact on seabed habitat and biota, including the gear design and operation, space control, changes affecting quotas, and workload control (Christie et al., 1987).

Shellfish and fish caught by otter bottom trawls, beam trawl, and shellfish dredgers account for about global capture for quarter fishery landings. However, the trawler is usually one of the most important forms of disturbance by physical on the seabed (Kaiser et al., 2002). Fishing activities lead to changes in the structure of marine habitats and affect the diversity, composition, biomass and productivity of related biota. The direct effects of fishing vary depending on the fishing gear used and the fishing habitat. Usually, they include scraping, scrubbing, and resuspending the substrate and occur in the context of natural disturbance. The relative impact of fishing on habitat and benthic community structure depends on the degree of natural disturbance (Handley et al., 2014). The direct impact of specific fishing methods on animal and epizoan communities will increase with the depth and stability of the substrate. In refuges where complex habitats such as coral reefs develop to the smallest depths, the direct impact of fishing may be obvious and have a profound impact on the habitat's ability to sustain fish production (Jennings & Kaiser, 1998).

Trawl fisheries are an important component of the capture fisheries sector in Malaysia. Although small licenses were issued (11.79%), their significance is underlined by their contribution to the overall landings (48.19%). Many issues and challenges are related to the capture fisheries sector. Some of these concerns all fishing methods are closely linked to the trawl fisheries, with varying degrees of importance. So far, there has not been any attempt to prioritise these issues, and they are dealt with as they arise or when the prevailing situation dictates that measures should be put in place to address them. Major issues related to the trawler fisheries are overcapacity, growth of overfishing and trash fish, trawl net specifications, fuel subsidy, licensing of trawlers, fisheries management plan, and funding for management (Nuruddin & Isa, 2013).

It is believed that fishing skills play a vital role in fishing. For fisheries managers, whether there is a monitorable and measurable captain or vessel attributes that can be monitored and adjusted to solve the captain's skills and the resulting fishing capacity problem has become a problem. Captain skills are equivalent to technical efficiency. This article evaluates the trawl fishery's technical efficiency and captain skills in Kedah, Malaysia. In developing countries, the captain's fishing skills are understood as the captain's technical efficiency, which has received little attention in the literature. This study reveals this problem through a case study of the Kedah trawl fishery in Malaysia. The statistically significant variables that affect the captain's skills are the year's season, the captain's face, and the use of large (>50 GRT) ships. The biggest area of skill improvement is in the off-season when monsoon weather and resource conditions greatly reduce production. The race is the only sociodemographic variable that can significantly affect skills. The captain's human capital seems difficult to grasp through the sociodemographic properties of the captain's proxy variables, and more research in this area may be helpful. Regardless of the background, increasing the efficiency of all captains will increase output. However, others must be used to curb the threat of sustainable resource use in open access resources to prevent overfishing from achieving social relations sustainability in a broad society (Botsford et al., 1997).

3. Materials and Methods

Bioeconomic Surplus Production Model by Gordon - Schafer Model (GS) is used in this research to calculate the total biology and economic value. The hypothetical catch, effort, carrying capacity, total cost, and revenue that will be used in this study is the Bioeconomic Surplus Production Model. Primary data is required in this research. There will be a questionnaire to value the fisheries' issues. People must answer some questions with the option of their income generated. Non-used value is calculated in this research. In the non-used value, the option value is calculated. Excel software is used to analyse the data. Secondary Data collection will be used in this research to get the previous data from 1988 - 2018 by the Department of Fisheries (DOF), Malaysia. These studies will be using secondary data collection. Data that will be discussed in this chapter is about Bioeconomic Modelling. Data were obtained from the Department of Fisheries (DOF), Malaysia. Time Series data from 1988 – 2018 about the catch, effort, fishing gear, vessel, fisherman and the species. The vessel that will be studied is 40 GRT and above, and the effort was trawl nets and anchovy purse seines. The data about cost and price was collected from the Department of Statistics Malaysia (DOSM).

Using Gordon Schaefer Bioeconomic Surplus Production Model to conduct the analysis. Bioeconomic modelling was a combination of biology and economic modelling. The biology model is about the relationship between stock and growth and between effort and catches, while the Economic model is about the relationship between total revenue and effort. The Bioeconomic Modelling will include a graph to show the relationship for each. In Malaysia, there are multispecies of commercial marine fisheries.

The executives' general objective of fisheries is to acquire reasonable organic, social, and monetary advantages from sustainable amphibian assets. In achieving long-term sustainability and increasing fisheries income, the static and dynamic behaviour of the system should be studied. It aims to reach the target points that refer to Maximum Sustainable and Economic Yield and address diverse fishery targets, which are central for choosing reasonable organisation measures. The other reference centres, open access (OA) changed, will undoubtedly be a framework than a performance target like MSY and MEY. Open access means the property rights to restrict harvest from public resource libraries. However, OA is not socially effective (optimal sub) due to greater efforts. In addition, compared with MSY, this approach can also produce the lowest capture stage, and the cost is much higher. Therefore, MEY is considered the best solution because it is equivalent to the marginal benefit of additional work. However, in contrast to the OA, MSY and MEY solutions, the "best" allocation of fisheries allocated resources can be determined through biophysical or bioeconomic models, which usually depend on the goals of specific fishery management.

In the bioeconomic demonstration, the excess creation model as a balance model can decide the maintainable yield for a given fishing exertion (Figure 1), in any event, when time is restricted or information is restricted. A significant apparatus for the first guess. These models are ordinarily used to check fisheries' financial presentation or lease scattering and are notable in fishery monetary writing. Moreover, it is exceptionally easy to fuse natural ascribes into the model, and its boundaries can be assessed utilising catch volume and responsibility information. Utilising the Gordon-Schafer (GS) model to grow (like living space, natural factors) can recognise the expected connections among the included factors, populaces, jobs, and reaps under open access and most extreme economic yield the board fisheries.

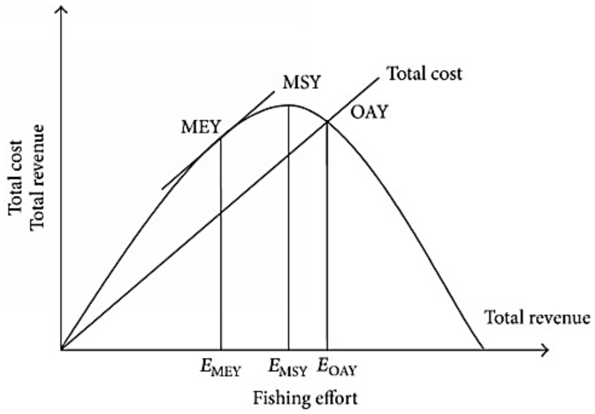

Figure 1. The Gordon - Schafer Model

Gordon and Schafer develop the GS model. Thus, this investigation picked the GS overflow creation model. This model enjoys extraordinary benefits for single-species and multispecies fisheries; it requires restricted information and great roughing guidelines. Fisheries (inward development rate) and potassium (conveying limit) because of exceptionally useful natural assets may support enormous fishing endeavours under open access. Among all populaces, the regular overflow development rate for high and low stock levels is exceptionally little, while some medium-level overflow development rates are the most noteworthy. Be that as it may, the GS model depends on the calculated development condition:

$$F\ (X) = rX\ (1 - \frac{X}{K}) \tag{1}$$

Where F(X) is the leftover biomass increment per unit time. X is the crude material biomass. This condition depicts the parabola as a component of X. The collect rate (H) is accepted by the basic relationship of the Schafer get work.

$$H\ (E, X) = qEX \tag{2}$$

Where E is fishing exertion and q is a consistent catchable coefficient. At the point when the collect equivalents the abundance development, the practical yield will be created; that is the point at which the pace of progress of biomass.

$$\frac{dy}{dx} = F\ (X) - H\ (E, X) = 0 \tag{3}$$

This implies qEX = rX (1-x/K) considering (1) and (2). In this manner, the biomass at balance point X is addressed.

$$X = K\ (1 - \frac{qE}{r}) \tag{4}$$

As insert (Eq. 4) and (Eq. 2) to give the long-term capture equation.

$$H\ (E) = qKE\ (1 - \frac{qE}{r}) = qKE - \frac{q2KE2}{r} \tag{5}$$

Partitioning the two sides of (5) by the responsibility (E) gives the direct connection between the catch per unit responsibility (CPUE) and the fishing responsibility.

$$CPUE = \frac{H}{E} = qK - \frac{q2KE}{r} \tag{6}$$

Accepting the cost doesn't change, equation (5) can be utilised to characterise the harmony absolute pay (TR) under the normalised responsibility work.

$$TR\ (E) = p.H\ (E) \tag{7}$$

Where P addresses the steady cost per gather unit. The all-out cost of fishing exertion (TC) is

$$TC\ (E) = c.E \tag{8}$$

Where C addresses the unit work cost, including the chance expense of work and capital. From conditions (7) and (8), the harmony asset lease (π) can be gotten as a component of fishing exertion (E).

$$\pi (E) = TR (E) - TC (E) \quad (9)$$

In most repetitive creation models, natural variables will be overlooked over the long run. Notwithstanding, environmental factors and human-driven ecological changes affect fishery populaces and their development. The expansion in human exercises has become a central point in the progressive corruption of the climate worldwide, particularly the organic design and natural cycles, which implies that the conveying limit of the environment has declined. Hence, this model considers nine natural situations, including the current circumstance (Scenario 0). These situations depend on current models, each addressing conceivable environmental change and human outcomes. Creation and fishing exertion information. Time-series information (1988-2018) of business fisheries fishing and exertion in Kelantan. Information has been gathered from the Malaysian Department of Fisheries (DOF). The biomass addresses the catch in the tint, and the responsibility is addressed by the number of fishing days. Business fishing information is assembled by the Department of Statistics Malaysia (DOSM) as a monetary year (i.e., 1988-2018). The expense of fish is the expense paid in the markdown financial market and measurable boundaries. The boundaries are assessed by the relapse of information per unit of responsibility on the relating responsibility information of Kelantan business marine fisheries. In this examination, the OA balance shows that the normal pay AR = TR/E is equivalent to the minimal expense (MC = TC'(E)). In this way, from (7) and (8).

$$pH/E = c$$

$$H/E = c/p. \quad (10)$$

By utilising the fishing cost unit and the asset lease per fishing unit, it can discover the harmony level of open access for fish stocks. The unit cost of reap is controlled by utilising (2) and (8).

$$C (X) = (TC (E))/H = cE/qEX = c/qX \quad (11)$$

It shows that the unit cost of gather diminishes as the stock increments. With the cost of fish unaltered, the asset lease per unit reap is;

$$b (X) = p - c/qX \quad (12)$$

In open access balance, the stock level Xoo begins from b (Xoo = 0), open admittance to stock biomass;

$$Xoo = c/pq \quad (13)$$

The drawn-out reap capacity can be communicated as;

$$H (E)=aE + 〖bE〗^2 \quad (14)$$

Hence, CPUE can be communicated as;

$$CPUE = a + bE \quad (15)$$

Where CPUE = H/E, a = qK, b = (- aq/r)

Since Kelantan Fisheries can get catch and exertion information, we can assess the boundaries an and b by straight relapse of catch per unit exertion. By setting the fractional subordinate of H regarding E equivalent to 0, the most extreme reasonable yield exertion can be gotten from (12).

$$EMSY = ((- a)/2b) \quad (16)$$

In this way, the yield of MSY is

$$MSY = ((- a2)/4b) \quad (17)$$

Further at point OA, the complete fishing cost is equivalent to the absolute fishery pay (TR(E) = TC(E)). Along these lines, utilising the Gordon-Schafer model, the OA yield exertion can be acquired through the condition.

$$MC = AR \quad (18)$$

or on the other hand.

$$c = (pH (E))/E$$

$$cE = pH (E) = EOAY = (c/p - a)/b \quad (19)$$

The best financial return is accomplished with a lower all-out-fishing exertion, and a positive monetary lease must be acquired with an exertion lower than EOA. On account of utilising (9) (E)=0 or dTR(E)/dE = dTC(E)/dE, the most extreme financial advantage (MEY) can be gotten at the degree of benefit with the best exertion. Along these lines, MEY's endeavours are

$$EMEY = ((c/p - a)/2b) \quad (20)$$

By considering the fundamental catch and responsibility information (4), the change in functional example (i.e., moving toward different regions, longer days). These elements are respected to take a critical shift around 1988. However, no such changes have been seen throughout significant periods that can get upsides of K and r, individually, as follows.

$$K = a/q \quad (21)$$

$$r = (- aq)/qb \quad (22)$$

3. Results

In this section, there are two main parts will be shown. The first result is based on the trawl net, and the second will be based on anchovy purse seinses.

3.1. Trawl Nets

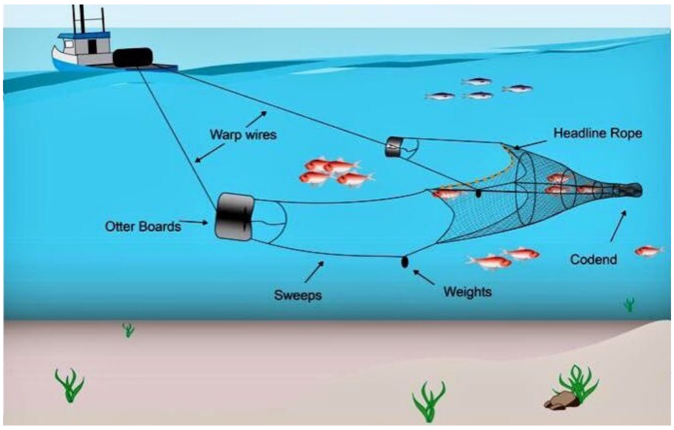

Figure 2. The trawl nets

Figure 2 display the trawl nets. Trawl net consists of 1 large trawler with large nets containing warp wires, headline rope, codend, weights, sweeps and other boards. A trawl net is used to catch fish in the deep sea that can reach the seabed. Trawl nets are fishing gear that is not selective but destructive because trawl nets will catch all types of fish, including baby fish that cannot be commercialised in the market. The baby fish needs to be thrown away, which will risk the baby fish's habitat. If these trawl nets are used widely, they can harm the fish species and indirectly destroy the coral reef.

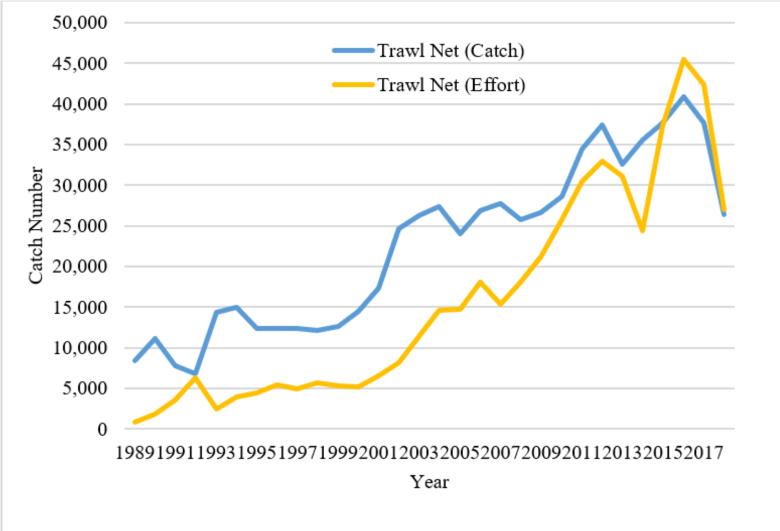

Figure 3. The trawl nets for catch and effort (Exercise-1)

Figure 3 and Figure 4 show the data collected from the Department of Fisheries, Malaysia (1989 – 2018). In fisheries and conservation biology, the catch per unit effort (CPUE) is an indirect measure of the abundance of a target species. Changes in the catch per unit effort signify changes to the target species' true abundance. A decreasing CPUE indicates overexploitation, while an unchanging CPUE indicates sustainable harvesting. CPUE has several advantages over other methods of measuring abundance. It does not interfere with routine harvesting operations, and data are easily collected. The data are also easy to analyse, even for non-specialists, in contrast to methods based on transects. It means that the people doing the harvesting can also make decisions about stock management.

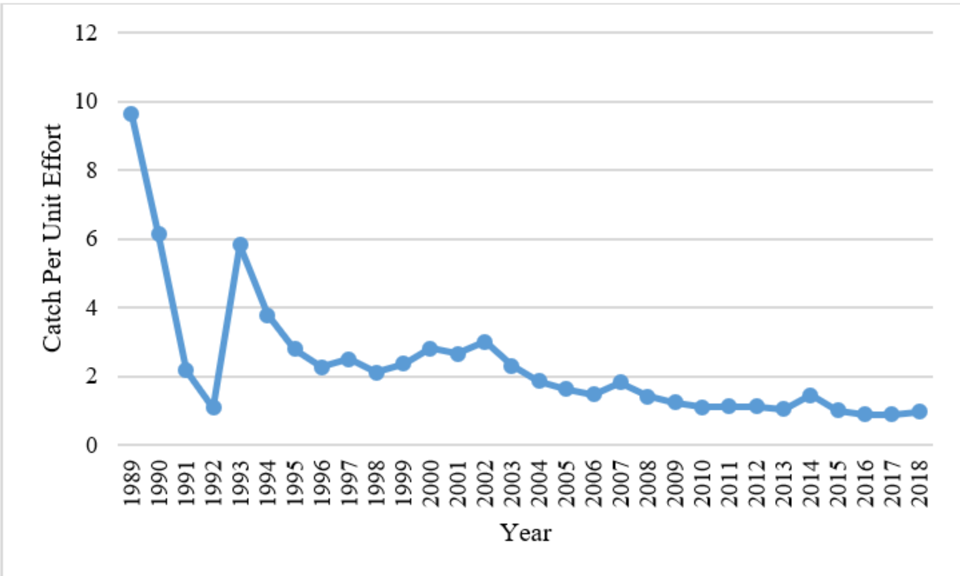

Figure 4. The trawl nets for catch per unit effort (Exercise-1).

The best practice is to standardise the effort employed (e.g., number of traps or duration of searching), which controls for the reduction in catch size that often results from subsequent efforts. Although CPUE is a relative measure of abundance, it can be used to estimate absolute abundances. The main difficulty when using measures of CPUE is to define the unit of effort.

Table 1. Result of the coefficient testing (Exercise-1).

Parameters	Coefficients	Standard Error	t Stat	P-value
a	3.76238945	0.436431572	8.6208004	2.288E-09
b	-8.8959E-05	2.14201E-05	-4.153062	0.0002784

Table 1 shows the coefficient test result explaining the significance of the factors affecting sustainability management in commercial marine fisheries. The coefficient was tested with simple linear regression using a t-test. A p-value is a probability that the null hypothesis for all populations is the same. The p-value reflects a lower value ≤0.05, which shows that it is more significantly different. The inherent development rate and the conveying limit depended on the model's assessed coefficients. The GS model has expected that the potential gains of K and r had been 132,933 tons and 0.133 by (Eq. 21) and (Eq.22) separately, and the catchability coefficients (q = 0.0000283 in 2003) were taken from Fedele (2017). The collect capacity for the Kelantan fishery is reliant upon (Eq.14) and potential gains of limits surveyed from Table 2. Thus, a yield–effort bend was found to be

Table 2. Result of the Gordon Schefer model (Exercise-1).

K = 132,933	r = 0.133 - 20%	r = 0.133 - 10%	r = 0.133
r = 0.133	Scenario 2	Scenario 1	Scenario* 0
	$E_{OA} = 2,795$	$E_{OA} = 3,145$	$E_{OA} = 3,494$
	$E_{MEY} = 1,398$	$E_{MEY} = 1,572$	$E_{MEY} = 1,747$
	$E_{MSY} = 1,881$	$E_{MSY} = 2,116$	$E_{MSY} = 2,351$
	$H_{OA} = 10,521$	$H_{OA} = 11,836$	$H_{OA} = 13,151$
	$H_{MEY} = 5,259$	$H_{MEY} = 5,917$	$H_{MEY} = 6,574$
	$H_{MSY} = 7,079$	$H_{MSY} = 7,964$	$H_{MSY} = 8,849$
	$\Pi_{MEY} = 26 * 106$	$\Pi_{MEY} = 29 * 106$	$\Pi_{MEY} = 44 * 106$
	$\Pi_{MSY} = 35 * 106$	$\Pi_{MSY} = 40 * 106$	$\Pi_{MSY} = 33 * 106$
K = 132,933 - 10%	**r = 0.133**	**K = 132,933 - 20%**	**r = 0.133**
	Scenario 3		Scenario 4
	$E_{OA} = 3,359$		$E_{OA} = 3,186$
	$E_{MEY} = 1,682$		$E_{MEY} = 1,595$
	$E_{MSY} = 2,353$		$E_{MSY} = 2,351$
	$H_{OA} = 11,390$		$H_{OA} = 9,064$
	$H_{MEY} = 5,701$		$H_{MEY} = 4,803$
	$H_{MSY} = 7,977$		$H_{MSY} = 7,083$
	$\Pi_{MEY} = 27 * 106$		$\Pi_{MEY} = 22 * 106$
	$\Pi_{MSY} = 38 * 106$		$\Pi_{MSY} = 32 * 106$

Table 2 shows the Gordon Schefer model result for Exercise-1. Estimation of reference focuses the critical advance towards drawing nearer the bioeconomic investigation; subsequently, MSY, MEY, OA, relating effort levels, and economic rent were determined because of changes in the natural boundaries. The worth of effort at MSY and MEY was determined utilising (Eq. 16) and (Eq. 20), while harvests at MSY, MEY, and OA were determined utilising this fishery's harvest equation (Eq. 14). Economic rent is the difference between total revenue and total cost. Thus, total cost and revenue were determined using (Eq. 7) and (Eq. 8). For the assessment of changes at different degrees of r and K, variety was expected to run between 10% and 20%. An adjustment of K and r may infer changes in harvest, corresponding effort and economic levels. As shown in the Table above, MSY was 7083 tons esteemed at RM 32 million and created at exertion worth 2351 standard units. When these assessed values were contrasted and the recorded catch and efforts value, it was tracked down that the current catch level is almost a way to deal with MSY esteem from this empirical model.

Conversely, the MEY was at 4803 tons, esteemed RM 22 million and acquired as effort levels of 1595 standard units. Contrasting these and the actual catch and effort figures, MEY was accomplished as of late somewhere in the range of 2006 and 2007. The OAY was at 9064 tons and delivered at an effort level of 3186 standard units, which is exceptionally near the catch information of 2007 – 2008 considered for the current studies. Notwithstanding the current circumstance, five potential situations were introduced in light of potential climate change and anthropogenic prompted changeability in the biological boundaries of K and r. The boundary esteem has been changed under each framework with individual climatic and anthropogenic results. All circumstances have stood out from changing conditions to quantify the possible impact on the fishery's assets. In like manner, the certainty span (95% level) of environmental change impacts stock and effort levels at OA, MEY, and MSY. Lower and upper worth has been presented. Simply the current circumstance has shown for this change.

3.2 Anchovy Purse Seinses

Anchovy purse seinses that are used in catching anchovies. As we know, the anchovy species is a group of fish that live in huge populations and travel fish (Figure 4). When anchovy purse seinses are used to catch the anchovies, they will turn into unfortunate fish that get caught together with the anchovy being caught coincident.

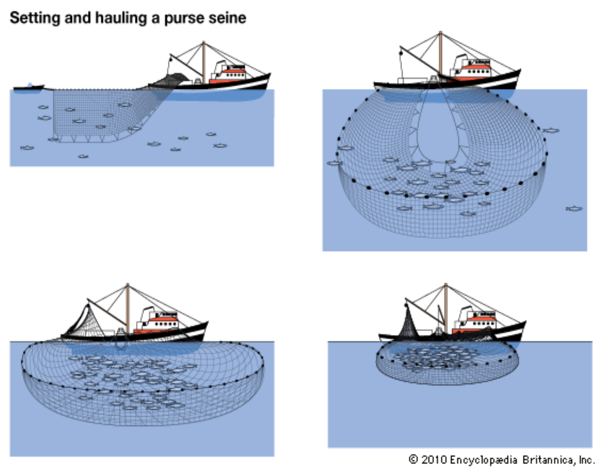

Figure 5. The anchovy purse seines.

The anchovy purse seinses look similar to trawl nets, but the trawl nets catch the moving boats. In contrast, anchovy purses seinses refer to stopping boats and throwing anchovy nets, surrounding the anchovies into the net, and lifting them onto the ship. Figure 5 shows data collected from the Department of Fisheries, Malaysia (1989 to 2018). In fisheries and conservation biology, the capture in step with unit attempt (CPUE) is an oblique degree of the abundance of a goal species. Changes withinside the capture in step with unit attempt are inferred to suggest adjustments to the goal species' genuine abundance. Figure 6 displays the trawl nets for catch and effort (Exercise-2).

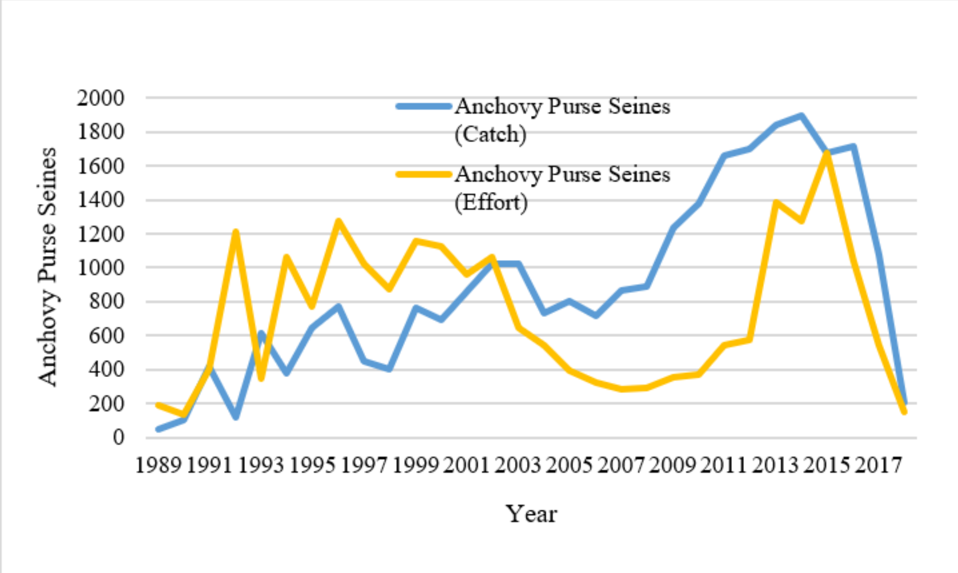

Figure 6. The trawl nets for catch and effort (Exercise-2).

A reducing CPUE shows overexploitation, even as an unchanging CPUE shows sustainable harvesting. CPUE has some blessings over different techniques of measuring abundance. It no longer intervenes with habitual harvesting operations, and facts are collected without difficulty. The facts are also smooth to analyse, even for non-specialists, in assessment techniques primarily based on transects. This approach that choices approximately inventory control can also be made via means of the humans doing the harvesting.

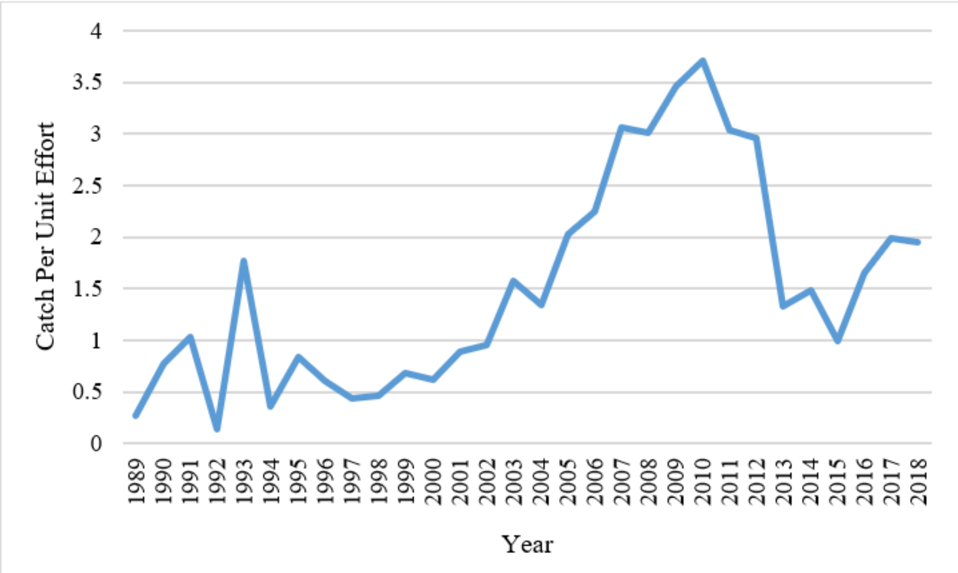

Figure 7. The trawl nets for catch per unit effort (Exercise-2).

The first-rate exercise is to standardise the attempt employed (e.g., wide variety of traps or period of searching), which controls for the discount in capture length that regularly affects from next efforts. Although CPUE is a relative degree of abundance, it may be used to estimate absolute abundances. The primary problem whilst the usage of measures of CPUE is to outline the unit of attempt (see Figure 7).

Table 3. Result of the coefficient testing (Exercise-2).

Parameter	Coefficients	Standard Error	t Stat	P-value
a	2.445012234	0.328141507	7.451091	4.087E-08
b	-0.00125744	0.000388609	-3.2357486	0.0031101

Table 3 shows the coefficient test result explaining the significance of the factors affecting sustainability management in commercial marine fisheries. The coefficient was tested with simple linear regression using a t-test. A p-value is a probability that the null hypothesis for all populations is the same. The p-value reflects a lower value ≤0.05 shows a more significant difference. The natural development rate and the conveying limit depended on the model's assessed coefficients. The GS model has expected that the potential gains of K and r would be 86,396 tons and 0.069 by (Eq. 21) and (Eq. 22). The catchability coefficients (q = 0.0000283 in 2003) have been taken from Fedele (2017). The gathered work for the Kelantan fishery is reliant upon (Eq. 14) and potential gains of limits evaluated in Table 4. Subsequently, a yield–effort curve was found to be.

Table 4. Result of the Gordon Schefer model (Exercise-2).

K = 86,396	r = 0.069 - 20%	r = 0.069 - 10%	r = 0.069
r = 0.069	Scenario 2	Scenario 1	Scenario* 0
	E_{OA} = 1,182	E_{OA} = 1,330	E_{OA} = 1,478
	E_{MEY} = 591	E_{MEY} = 665	E_{MEY} = 739
	E_{MSY} = 978	E_{MSY} = 1,101	E_{MSY} = 1,223
	H_{OA} = 2,893	H_{OA} = 3,254	H_{OA} = 3,616
	H_{MEY} = 1,446	H_{MEY} = 1,627	H_{MEY} = 1,808
	H_{MSY} = 2,393	H_{MSY} = 2,692	H_{MSY} = 2,991
	$\Pi_{MEY} = 6 * 10^6$	$\Pi_{MEY} = 6 * 10^6$	$\Pi_{MEY} = 7 * 10^6$
	$\Pi_{MSY} = 10 * 10^6$	$\Pi_{MSY} = 10 * 10^6$	$\Pi_{MSY} = 12 * 10^6$

K = 86,396 - 10%	r = 0.069	K = 86,396 - 20%	r = 0.069
	Scenario 3		Scenario 4
	E_{OA} = 1,365		E_{OA} = 1,232
	E_{MEY} = 681		E_{MEY} = 614
	E_{MSY} = 1,215		E_{MSY} = 1,215
	H_{OA} = 3,005		H_{OA} = 2,411
	H_{MEY} = 1,498		H_{MEY} = 1,201
	H_{MSY} = 2,674		H_{MSY} = 2,378
	$\Pi_{MEY} = 5 * 10^6$		$\Pi_{MEY} = 4 * 10^6$
	$\Pi_{MSY} = 10 * 10^6$		$\Pi_{MSY} = 8 * 10^6$

Table 4 shows the result of the Gordon Schefer model (Exercise-2). Assessment of reference centres is the basic development towards moving closer to the bioeconomic examination; accordingly, MSY, MEY, OA, relating catch levels, and the financial lease was resolved on account of changes in the normal limits. The value of catch at MSY and MEY was resolved using (Eq. 16) and (Eq. 20), while harvests at MSY, MEY, and OA were resolved using this present fishery's gather condition (Eq. 14). Financial lease is the distinction between absolute income and complete expense. Along these lines, absolute expense and complete income were resolved using (Eq. 7) and (Eq. 8). In evaluating the changes of r and K, the assortment was required to run someplace for 10% and 20%. A change of K and r may similarly derive changes in the collection relating to effort and economic levels (Table 4).

As displayed in Table 4, MSY was 2991 tons regarded at RM 12 million and tried worth 1223 standard units. Exactly when evaluated values are differentiated and the recorded catch and endeavours esteem), it has been found that the current catch level nearly approaches to manage MSY regard that is gotten from this experimental model. Then again, the MEY was at 1808 tons, regarded as RM 7 million and obtained as exertion levels of 739 standard units. Differentiating these and the genuine catch and exertion figures, MEY has cultivated someplace in the scope of 2006 and 2007. The OAY was at 9064 tons and conveyed at an exertion level of 1478 standard units, close to the catch data of 2007 – 2008 considered for the current examinations. Despite the current condition, five potential circumstances were presented, considering potential environmental change and anthropogenic incited variability in the organic limits of K and r (Table 4). The boundary esteem has been changed under each framework with individual climatic and anthropogenic results. All circumstances have diverged from changing conditions to measuring the possible impact on the fisheries' assets. Moreover, the certainty span (95%) of environmental change impacts stock and effort levels at OA, MEY, and MSY. Lower and upper worth has presented. Simply current circumstance has shown for this change.

4. Discussions

This study investigates the effect of climate changes, trawl nets and anchovy purse seinses, and anthropogenic disturbances on sustainable fisheries management. This study also proposes that policy and law protect the port from sustaining the commercial fisheries. Supervising multispecies fisheries is a troublesome task; as needs are, a reliable exertion has been made to encourage new models to oversee complex fisheries structures (Newman, 1984). To examine natural and financial overfishing of fish stocks, unmistakable reliable information on stock levels, recovery, and catch are major. In any case, the excessive for seeing certain pointers like catch per unit of exertion, changes of immense worth in market supplies, and a rate plan change of species or size over the long haul can be agreeable references to address overfishing in information vulnerable structure. Along these lines, Catch Per Unit Effort (CPUE) had been utilised as a report of stock bounty appraisal (Dunn et al., 2000). CPUE showed growth in the 1990s and started in 2000s, which is recognised to proceed. The key CPUE expansion is most presumably considering the expansion of modernised fishing maritime powers in the ocean shorefront and marine water of Kelantan. The Kelantan fishery is portrayed as a more unassuming pelagic and humbler demersal fishery in the new different years. This could be an indication of "fishing down the food web" and a looking at low CPUE. Consequently, effort pressure that is applied on little fish, which doesn't contribute an incredible arrangement to the extent of full-scale weight in yield, participates in the most reduced CPUE.

The relapse results show that the Gordon Schefer (GS) model hopes to explain a huge part of the assortment found in the observational information. The result similarly showed that fisheries of the Kelantan are depicted by growing fishing exertion and lessening CPUE. A couple of assessments expected that Kelantan fisheries could be incredible with the constant development of fishing exertion without real rules and nonattendance of executions of the current drive. It is similarly doubtlessly maintained by the yield exertion bend from the current model outcome. The status of high effort, less gathering, and less biomass stock likewise showed that the danger of using the assets couldn't be hindered. Fish costs have been moving with the declining market supplies compared with the augmentation in individuals, which may recommend that the stock is lacking (Stone, 1997).

To set up the biological supportability of current fish collecting rehearses, the surveyed MSY and the connected effort level stood out from the real catch and exertion figures. MSY for the GS model of the Kelantan fishery was found to occur later. It's everything except exemplary that during a comparative time, exertion increased from 2003 – 2007. It has been acknowledged that there is little contrast between the circumstance to some degree of OA. Regardless, according to a financial viewpoint, MSY doesn't recommend proficient collecting, relating capability to increasing the net benefit with using monetary assets, that is, growing the assets lease (Gregor et al., 2006). Henceforth, MEY is seen as a proper tendency point for the Kelantan fisheries executives. Also, by–gets off the Kelantan fishery has any time been represented to be discarded by the fisher. Considering the recently referenced markers, natural overfishing was not genuine for the fishery assets.

A fishery can't be maintainable if all complete catch surpasses the MSY level. Regardless, the reality of the situation is that the MEY plan is best portrayed as one that considers the monetary impacts identified with the feasible yield bend. There are a few striking benefits of seeking after a particular level-headed – or, if nothing else, evaluating it for some arbitrary fishery.

Given this situation, the present model result showed that the Kelantan fishery is breathing simple, as both MSY and MEY have been refined within a short time (2003 – 2008). Most importantly, among the references point, considered MEY the key references point is essential on account of the four huge real factors which are according to the accompanying: this philosophy is responsive to changes in financial condition, its idea is powerful, it limits gathering cost, and eventually MEY might be seen as attractive over the MSY as an organisation objective is that the MSY course of action deals the limit of a business fishery to stay practical. The assessments of genuine catch and exertion figures reveal that the Kelantan fishery upheld monetary overfishing from 2005 onwards. In like manner, altogether more raised degree of exertion to some degree as of late didn't get adequate measure of catch. It is upsetting and demands a brief objective of methodologies makers and associations. Henceforth, further development in fishing effort will undeniably post an unfriendly result on the fish stock, and none of the centres of the reference (MSY and MEY) will be in concordance condition. Moreover, this examination commented that twice augmentation of current fishing exertion would genuinely influence the fisheries of Kelantan, declining major assigned business pelagic and demersal fish bundle. In addition, a clarification study showed that a huge part of the business fish social occasion of Kelantan had a trophic capability (EE) > 0.90 marker that the system overwhelmingly abuses the customers. That is the brief explanation thought ought to be taken to re-evaluate the current organisation measures for the acceptable organisation of Kelantan fishery.

Affectability fisheries against possible climatic change and anthropogenic agitating impacts have been considered as to passing on the limit, advancement rate, and financial execution under nine frameworks. A notable degree of progress in gather level (OA, MEY, and MSY), relating exertion, and benefit level had been shown in circumstance 4. The present circumstance showed a benefit level of RM 22 million, RM 4 million (20%) at MEY level exclusively diverged from the current situation. The current condition isn't normal happening case of Kelantan fishery. In any case, current anthropogenic unsettling influence, changing climatic example and existing organisation extents of Kelantan fishery can, without a very remarkable stretch, lead to a condition which is expected under the circumstance 1, 2, 3, and 4. In any case, in that possible natural change results, the fishery boss ought to contribute adequate energy to keep up with existing MEY, which will help support the Kelantan fishery.

Environmental change may impact fishery creation through changes in propagation, development, enlistment, movement design, precipitation, and hydrology. Development shows that mortality and enlistment depend on the natural condition, even between small distances. Along these lines, an evaluation and projections about future fishery can't be made without considering the climatic effect. Moreover, the yield of the abundance creation model uncovers that climate-driven change in the fishery's productivity can generally sway fisheries' economy. The informational collection on climate variables of tropical Kelantan is poor. In any case, typical tropical sea surface temperature is expected to augment by 50 – 80% of the ordinary natural change over a comparative period. It may change the typical ocean PH and can significantly damage the young adult and adults, leading to an adjustment of fish stock movement. The situation might be almost identical or far more terrible for tropical Kelantan. The inlet even more consistently encountered various anthropogenic agitating impacts and catastrophic events. Finally, the certainty span changes have shown how climate changes influenced change in the exertion levels and yields. In current circumstances, 44% of exertion levels could increase during certainty span change at OA, MEY, and MSY levels. The certainty span has shown that gather may increase by 73%, 23% and 45% at OA, MEY, and MSY levels.

Additionally, fishing zones and fish creation in the coastline space of Malaysia are declining bit by bit all through the long haul and those credited to the sea level ascent, contamination, augmentation of spice in the waterfront belt, standard twister, and change PH and oceanic stream plan. Freshwater discharge is a colossal factor in the enrolment of young adults and the dispersal of marine and estuarine species in the Bali Sea estuary of Kelantan. Since the amount of stream has found their last technique to Kelantan, it is except this stream estuary could accept an enormous part in selecting significant business marine species. This way, under changing environmental conditions, the normal selection cycle may manage major issues.

5. Conclusions

The business fishery of the Kelantan may successfully incite overexploitation, fundamentally property to the higher contrasting exertion, in the missing of a suitable conversation, the executives and strategy measures. This examination furthermore showed that exertion level might augment shortly. Obviously, for MSY, assets lease cannot be expanded without a gigantic exertion decline. Since, in the new year, the fisheries of Kelantan have achieved both MSY and MEY, a closer audit is required to ensure the acceptability of this asset abuse. Any impetus changes in the fishery region, the exertion and the chiefs rule may lead the fishery to such an essential condition that could be difficult to oversee, especially given the vulnerable organisation system assets of Kelantan. The perpetual expansion of exertion level can occur because of the broadening individuals' level at the coast, high joblessness rate, solicitation of fish, and fishery things for the country. Lessening fishing exertion to accomplish MSY, OA, or MEY is expected to raise the marine fisheries' practicality. In any case, it will reduce the joblessness of fishermen working with our fisheries. It could be a critical issue in countries like Malaysia, where waterfront fishing neighbourhoods are overwhelmingly on marine fisheries, or at whatever point, they are no elective work openings outside the local fishing area.

Regardless, drawing fishing would mean cost reduction similarly to expansion in asset lease, which could be used to reimburse the jobless fishing people. Individual transferrable guidelines (ITQs) can also decrease access challenges and venture into restricted and open-access fisheries. Individual standards of effects units (HIU) to direct natural surroundings harm emerging from kinds of social affair, for instance, bass fishing and anchovy purse seines, could be two adequate decisions for Kelantan fishery leaders. Other than this, business fishing boat proprietors could organise a mission, a mindfulness program, and schooling related to reasonable fishing. A decrease in cost, exertion, show and elective work opportunity, specific and determined assistance, and especially saw market might help reimburse the fishery's climatic and anthropogenic driven monetary disaster. Finally, legitimate execution of rules and rules on different specific issues of fishing should be immovably done and noticed.

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