ESTIMATION ON THE LEVELS OF EXPLOITATION AND SUSTAINABILITY OF SOME MARINE AQUATIC FAUNA FROM NYAUNG TAN FISH JETTY, PAZUNDAUNG TOWNSHIP, YANGON REGION

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Abstract

This study is a piece of research work carried out as a sample to analyze the level of marine aquatic fauna exploitation and which species stocks needed to be sustained. The present study was an evidence based study obtained from 47 marine fauna of the daily catch weights and its respective daily prices of each species stock of Nyaung Tan Fish Jetty, Pazundaung Township, Yangon Region. The relationship between yearly average catch weights and yearly average prices were analyzed by Pearson's Correlation Coefficient method. It was observed that there were significant negative correlation between yearly average catch weights and yearly average prices as R^2= 0.7628, r= - 0.8860 for 2018 and R^2= 0.6634, r= - 0.8144 for 2019. To find out the level of exploitation of aquatic species, four groups were classified according to FAO, 2017 as (i) Lesser than 1000 kg, (Over exploited), (ii) 1000 kg - 10000 kg, (Fully exploited), (iii) 10000 kg - 100000 kg (Moderately exploited) and (iv) Above 100000 kg (Under exploited). Among them, levels of exploitation was found to be the highest from (Lesser than 1000 kg), which was regarded as over exploited group. It included 28.7% of aquatic species out from the average records of 2018 and 2019. Therefore, for the 28.7% of the aquatic species that were found to be over exploited, which were high in fishing pressure. The fishery potential has been exceeded and these stocks are in the unsustainable conditions. This will become bad for every thing if the nutritional value and commercially demanded aquatic species are lost in the ecosystem. In order to conserve these aquatic stocks, preventive managements are needed to monitor the decling aquatic species in the catch to control the fishing gears and to exclude the spawners from catching during the breeding seasons of the marine aquatic fauna.

Keywords: marine aquatic fauna, catch weights, prices, exploitation, over exploited, unsustainable

Introduction

In the ancient times, fishing including some aquatic fauna was the major source of food for humanity that provides employment and economic benefit. In recent years,fishery sector has developed drastically for food industry. It is clear that aquatic resources are renewable and should be sustained even if they are in an uncontrolled conditions of exploitation. Proper management is needed to sustain the resources to contribute the nutritional, economic and social well-being of the growing population. Nowadays, fisheries are facing with a range of challenges like anthropogenic disturbance on the ecosystems and on continuous of negative impact on biodiversity and fish stocks throughout the world. (Jessica and Nilsson, 2019).

Marine ecosystems of Southeast Asia has one of the most diverse ecosystem in the world but overfishing and destructive fishing is threatening the fishery natural resources. Across the Asian countries, 64%of the fisheries' resource base is at a medium risk of overfishing. (Kim, *et.al*, 2018). There are many clear signs of over exploitations on the fish stocks. It means that fish stocks are simply the harvested population of fish. It refers to one specific species in one particular place for each fish species where it existed. Therefore, we need to know how much fish can be harvested from the water bodies if we need to maintain the fish stock. To understand the stock assessment there are different kinds of data to estimate the population of fish stock and how much can be fished. Stock assessments can be determined as follows: (Wilcox 2017)

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- **Abundance of fish –**To estimate how many fish are in the populations. It can be based on samples that are gathered using various methods.
- **Biological data-** recording the age and length of fish to estimate the level of natural mortality and fishing mortality. These data can also determine the reproductive rate of a population which can predict how many fish will be around next year. Environmental data is also essential to be recorded, such as temperature, salinity, dissolved oxygen and other ecological variables.
- **Catch data-** It is a historical records of how many or what weight of fish was caught during a calendar year or a fishing season.

Yearly catch weights and its relevant yearly average prices were collected by creating mathematical models to predict how a population will respond to different level of fishing. There was a global list of fish stocks with different level of fishing that were ranked as follows from 600 marines stocks (FAO, 2017).

They were defined as: under exploited, moderately exploited, fully exploited, over exploited, depleted and recovering.

The recent study will also be ranked as above procedure to find out the level of some aquatic species exploitation. The United Nations Food and Agriculture Organizations (FAO) is focusing on the fisheries resources of how far the fish stocks are "sustainable" or "unsustainable" to the report on conclusions on which fisheries are overexploited and which are not.

Therefore, the aim of the present study was to carry out with the following objectives:

- to find out the relationship between yearly average catch weights and its relevant average prices among trophic levels.
- to classify the level of exploitation of some marine aquatic fauna during 2018 and 2019
- to compare the FAO, 2017 records with the records of recent study on the basis of the levels of exploitation, sustainability, fishery potential and food security during the study period

Materials and Methods

Study site

The species were collected from Nyaung Tan Fish Jetty, Pazundaung Township, Yangon Region. (Fig.1)

Study period

The study period lasted from January 2018 to December 2019.

Data collection

The estimated catching sites were from Ayeyarwady Region and Mon State. Daily catch weights and relevant prices of individual marine species were recorded from Nyaung Tan fish Jetty. Finally they were sum up to yearly average catch weights and yearly average prices respectively. Catching plots for this locations were two places on B11 to B20, C1 to C25 of Ayeyarwady Region and D16, 17, 21, 22 of Mon State. The species were captured by bottom trawl net which were attached to the fishing vessels in fishing grounds throughout the study period. The length of trawl

net fully stretch ranges from 60-76 m. The net is with 68 m in bottom rope and 55 m in head rope. The mesh size is 64 mm, 50 mm, 38 mm and 30 mm respectively. The size of fishing vessel is 27-29 m long, 7-8 m width. In a vessel, the total fishermen are about 22-25.

Identification of species

Species identification and each Trophic Level (TL) were divided as follow: www. Fishbase.org (Froese & Pauly 2012)

Herbivores + Detritivorous group TL 2 into 2.0 – 2.9

Carnivores + Detritivorous group TL 3 into 3.0 – 3.9

Top predator (Omnivores) group TL 4 into 4.0 – 4.9

Data analysis

The relationship between the yearly average price and yearly average weights were analysed by Pearson's Correation Coefficient method and shown in histogram and graphs for the year of 2018 and 2019.

Pearson's Correation Coefficient (Galton, 1877)

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2]\,[n(\sum y^2) - (\sum y)^2]}}$$

x = yearly average weight

y = yearly average price

n = number of exploited groups

Depending on the average catch weights, species were classified into the following groups according to FAO's report 2017 "Review of the State of World Fisheries Resources" which are regarded as the level of exploitation.

(i) Lesser than 1000 kg, (ii) 1000 kg-10000 kg, (iii) 10000 kg-100000 k

(iv) Above 100000 kg, (v) Depleted, (vi) Recovering

At each level of above average catch weight the number of species included were analyzed in ratios according to its trophic groups. Based on the level of exploitation the results were designated into four groups according to FAO's report 2017.

To estimate the type of sustainability, fishery potential and food security of fish species, it was referred to Bridgette Wilcox, 2017 "The type of sustainability and food security" as if a fishery is:

Fully–exploited or Fully-fished (Moderately fished). This group estimates as 60% of world fisheries

- Sustainable
- Fishery potential being reached
- Best for food security

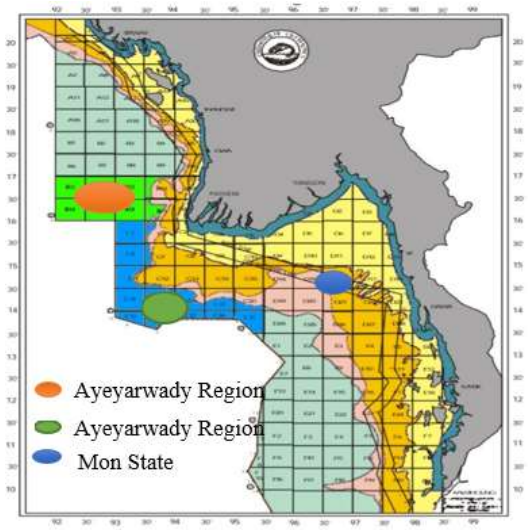
Over-exploited or Overfished. This group estimates as 33% of world fisheries

- Unsustainable
- Fishery potential exceeded
- Bad for everything

Under- exploited. This group estimates as 7% of world fisheries

- Sustainable
- Fishery potential not being reached
- Not good for food security

The outcome of the results will be compared according to the above definitions. Comparisons will be shown in Tables and graphs.



Source: BOBLME (2015)

Source: Google (2018)

Figure1 Fishing grounds of Myanmar and Map of Study site

Results

A total of 47 marine aquatic fauna were recorded from Nyaung Tan fish Jetty. Relationship between yearly average catch weights and yearly average prices were analyzed by Pearson's Correation Coefficient which were recorded as R^2= 0.7628, r = - 0.8860 for 2018 and R^2= 0.6634, r =-0.8144 for 2019 respectively Fig 10 and 11. It showed that they were significant negative correlations between yearly average catch weights and prices.

Among the catch weight groups, the least catch group was lesser than 1000 kg. Generally, this group showed that the average prices of these species were too high, but the average catch weights were extremely low. This group was regarded as **over exploited group**, 12 species existed in 2018 and 15 species existed in 2019.There were only 5 species, *Panulirus polyphagus* and *Oratosquilla nepa* from TL2, *Pampus argenteus*, *Pristolepis pentacantha* and *P.chinensis* from TL3 which cost more than 10000 kyats during these periods. (Fig 2, 3, 12)

In the average catch weight group between 1000-10000 kg, average catch weights were increased compared to (Fig 2 and 3). This group was regarded as **fully exploited group.** There were altogether 17 species existed in 2018 and 13 species included in 2019. But two species from TL 3 *Pampus chinensis* and *Dasyatis kuhlii* TL3 which appeared in 2018 were absent in 2019. Among them, 2 species from TL4, *Katsuwonus pelamis and Scomberomorus commerson* were absent in 2019, but *Argyrosomus amoyenenis* TL4 appeared instead. *Tenulosa ilisha* TL2*, P. chinensis* TL3 and *Leptomelanosoma indicum* TL3 touched the highest price of 10000 kyats. In TL4 all appeared to be in moderate prices, less than 10000 kyats. (Fig 4, 5, 12)

In the catch weight group between 10000-100000 kg they were regarded as **moderately exploited group.** In this group the averge catch weights increased while the prices were appeared to decrease**.** There were 15 species existed in 2018 and 14 species included under 2019. Both groups were absent of TL2. *Arius thalassinus* from TL3 appeared in 2018 was absent in 2019 and *Dasyatis kuhlii* TL3 appeared instead in 2019. Regarding to the averge prices, there were no high priced species contained in this catch range 10000-100000 kg. (Fig 6, 7, 12).

In the catch weight group above 100000 kg only a few species were obtained. Although the catch weights were high their prices were too low. They were regarded as under exploited group.There were merely three species existed in 2018 and five species included in 2019. There were no species of TL2 in both 2018 and 2019. In the year 2019 two species increased one species was *Katsuwonus pelamis* from (TL4) and another species was *Arius thalassinus* from (TL3). Catch weighst were too high and those that were caught have poor value ranging below 5000 kyats (Fig. 8, 9, 12).

Results from Fig 2, 3, 4, 5, 6, 7, 8 and 9 indicated that there were negative correlation between yearly average catch weights and yearly average prices. Total percentage of aquatic species recorded during 2018 were 25.5% from overexploited group lesser than 1000 kg catch weight, 36.2% from fully exploited group 1000 kg-10000 kg catch weight, 31.9% from morderately exploited group 10000 kg-100000 kg catch weight and finally 6.4% from under exploited group greater than 100000 kg catch weight (Table 3).

In 2019 31.9% from overexploited group lesser than1000 kg catch weight 27.7 % from fully exploited group 1000 kg-10000 kg catch weight, 29.7% from morderately exploited group 10000 kg-100000 kg catch weight and finally 10.7% were from under exploited group greater than 100000 kg catch weight (Table 3).

Among the exploited groups, over exploited group is the group that world fisheries recorded as more than a sustainable amount of species exploited. The fishing pressure has already been exceeded that proved to be in the state of unsustainable conditions. In addition to this, these species are highly demanded by the consumers because they provide high content of nutrition to low poverty population. If the havesting pressure continued than the limited level these species can be wiped out from the water bodies affecting the dietary requirements, welfare of the people and national ecomomic growth. (Table 3)

The recent findings of over exploited group appered to be 28.7%which agreed with FAO, 2017 records of world fisheries 33%. (Fig. 13, Table 2)

Over exploited aquatic fauna included are *Oratosquilla nepa* and *Panulirus polyphagus* were included under TL2, *Pristolepis pentacantha*, *Pampus argenteus*, *Pomadasys kaakan* and *Aluterus monoceras* were recorded from TL3 and *Lactarius lactarius*, *Lobotes surinamensis*, *Lutjanus johnii*, *Rachycentron canadum*, *Psettodes erumei*, *Lutjanus sanguineus* and were observed under TL4 (Table 1). For fully exploited and moderately exploited groups, the havesting process has been carrying on and the catch rates are still in the stationary condition proving as sustainable species. They also served as high-protein sources which are best for food security. The recent combined data recorded as 62.6% which also agreed with FAO, 2017 world fisheries records as 60%. The lowest number of species obtained in under exploited group. They are non targeted species because the have low content of nutritional value. Mosty they were caught by by-catch, they are still abundant in the water bodies and not being reached to the maximun catching level .Still sustainable and not good for food security. The recent data recorded as 8.4% which is also compatible with FAO, 2017 world fisheries records as 7% (Fig. 13, Table 2)

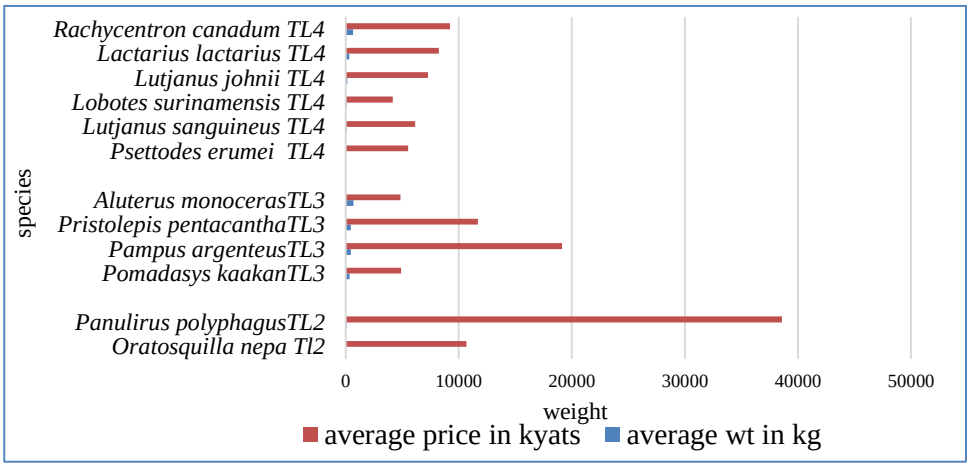


Figure 2 Relationship between average catch weight (lesser than 1000kg) and average price among TL2, TL3 and TL4 during 2018

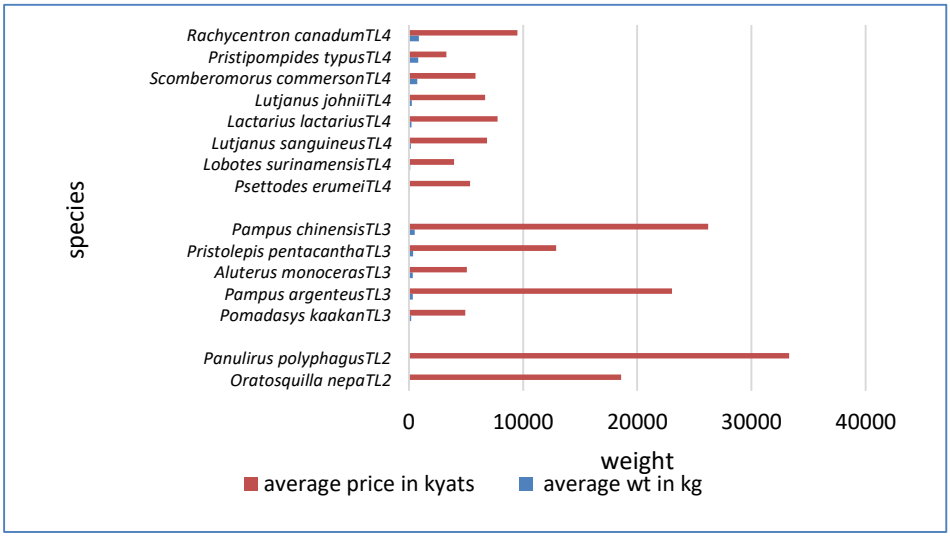


Figure 3 Relationship between average catch weight (lesser than 1000kg) and average price among TL2, TL3 and TL4 during 2019

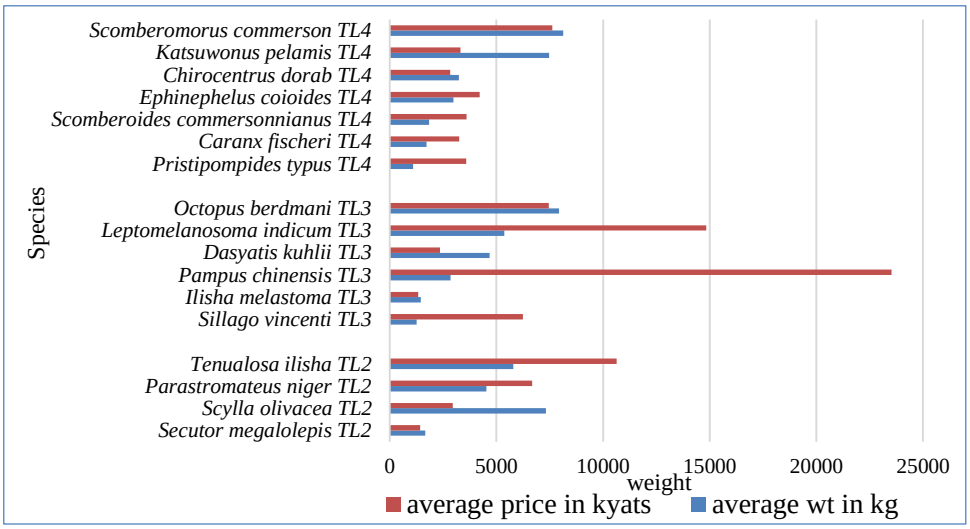


Figure 4 Relationship between average catch weight (1000-10000 kg) and average price among TL2, TL3 and TL4 during 2018

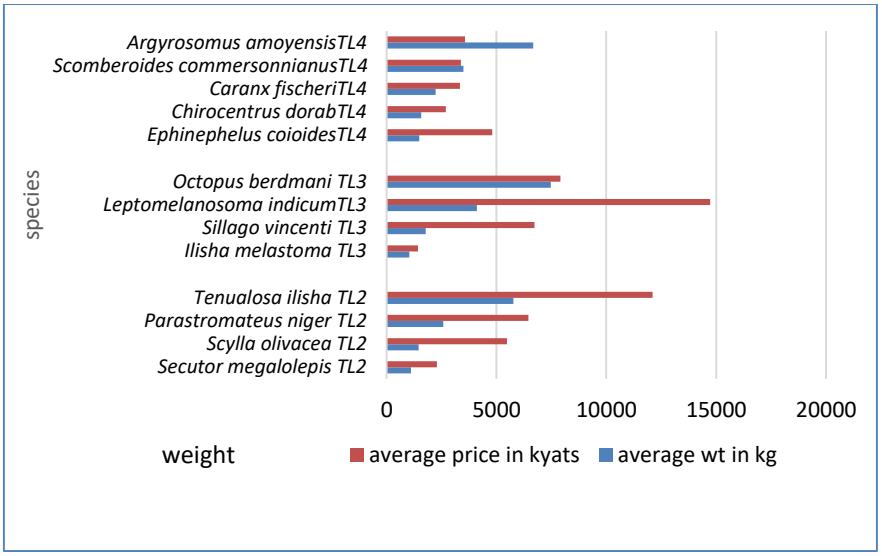


Figure 5 Relationship between average catch weight (1000-10000 kg) and average price among TL2, TL3 and TL4 during 2019

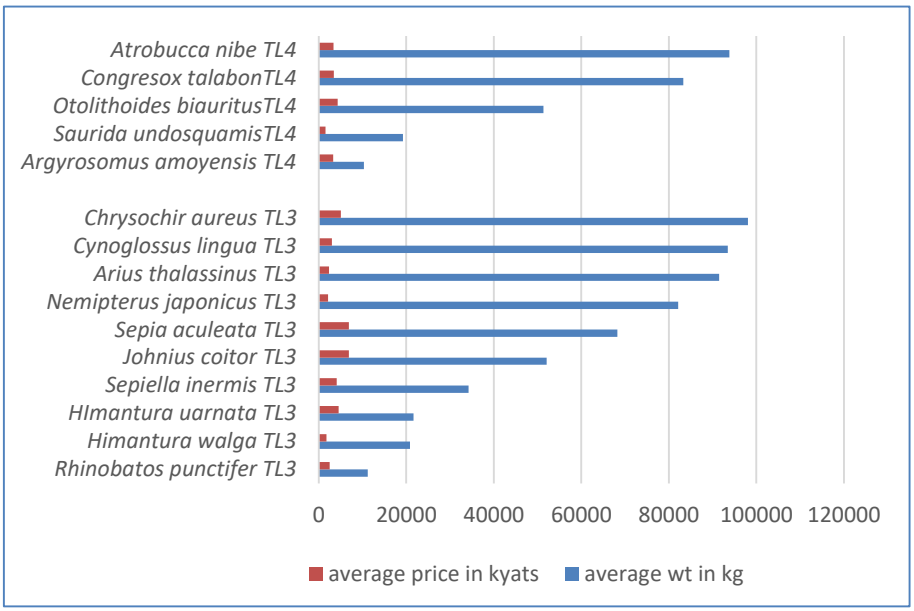


Figure 6 Relationship between average catch weight (10000kg-100000kg) and average price among TL3 and TL4 during 2018

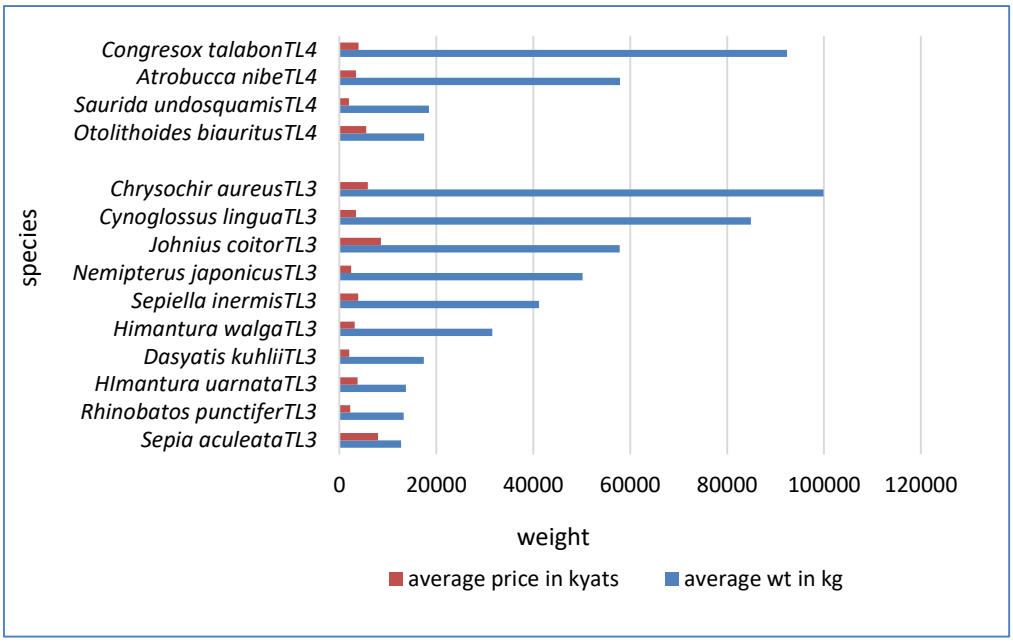


Figure 7 Relationship between average catch weight (10000kg-100000kg) and average price among TL3 and TL4 during 2019

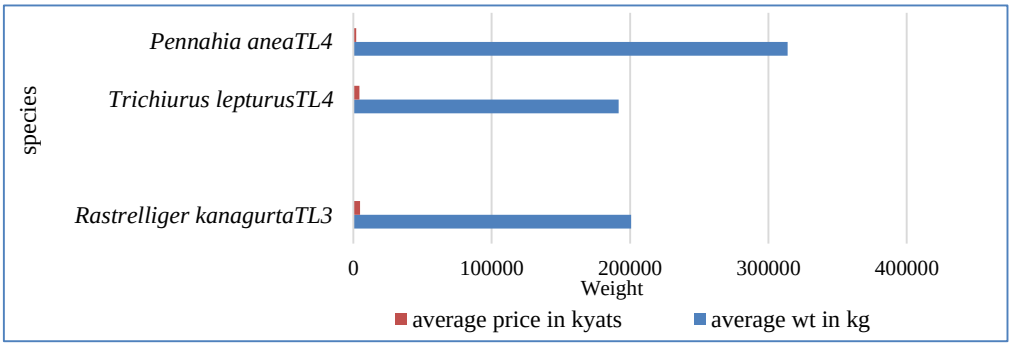


Figure 8 Relationship between average catch weight (>100000kg) and average price among TL3 and TL4 during 2018

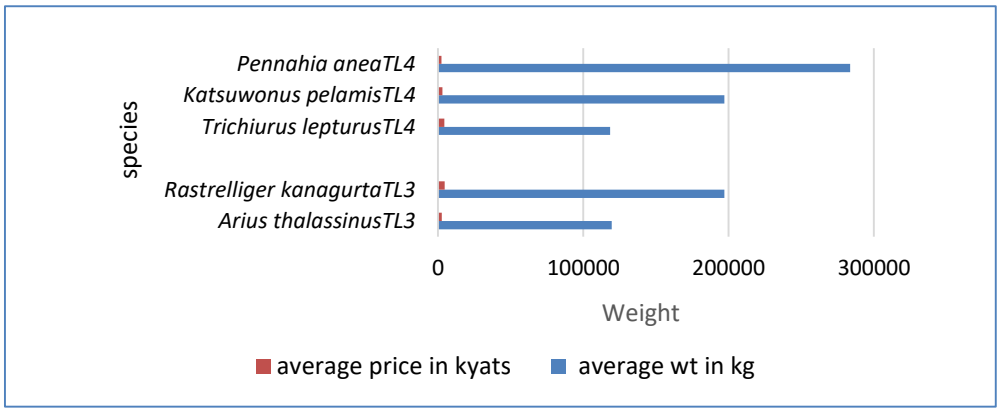


Figure 9 Relationship between average catch weight (>100000kg) and average price among TL3 and TL4 during 2019

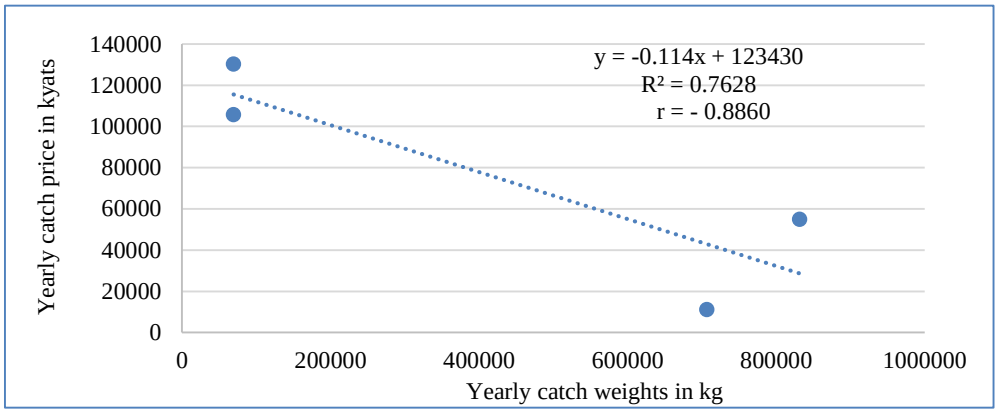


Figure 10 Relationship between yearly averge catch weights and yearly average price in kyats 2018 among four groups

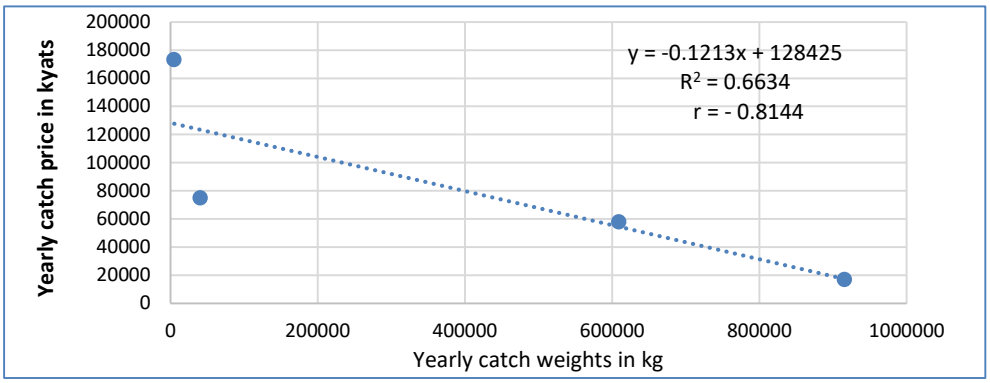


Figure 11 Relationship between yearly average catch weights and yearly average price in kyats 2019 among four groups

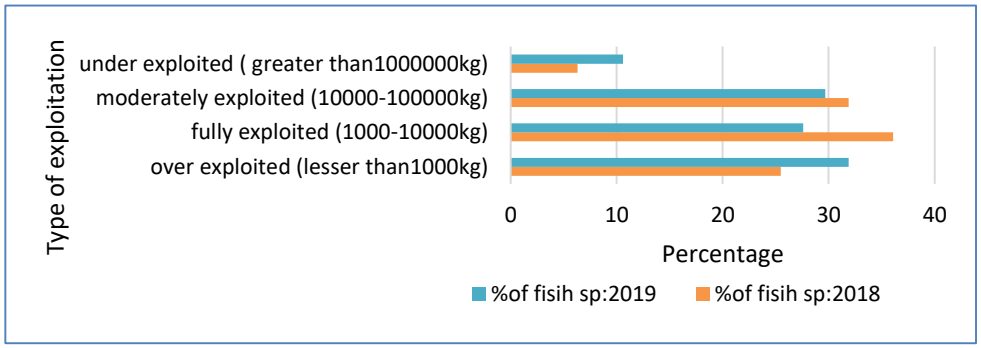


Figure 12 Level of exploitation showing the percentage of marine aquatic species during 2018 and 2019

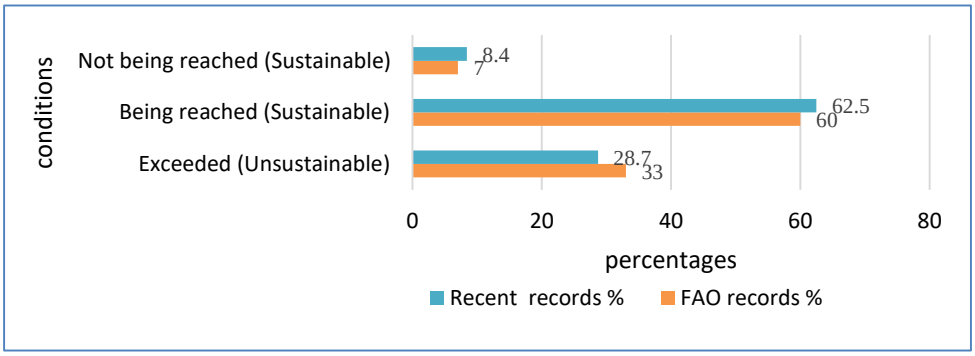


Figure 13 Comparison of FAO and recent records based on fishery potential and sustainability of some marine aquatic species

Table 1 Trophic levels, exploitation and conditions of sustainability of studied species

Sr No	Marine aquatic Spesies	Levels of exploitation				Conditions of sustainability	
		Over exploited	Fully exploited	Moderately exploited	Under exploited	Sustainable	Unsustainable
1	*Congresox talbon* TL 4.0			√		√	
2	*Ephinephelus coioides* TL 4.0		√			√	
3	*Rachycentron canadum* TL 4.0	√					√
4	*Caranx fischeri* TL 4.0		√			√	
5	*Lobotes surinamensis* TL 4.0	√					√
6	*Argyrosomus amoyensis* TL4.0			√		√	
7	*Atrobucca nibe* TL 4.0			√		√	
8	*Pennahia anea* TL 4.0				√	√	
9	*Otolithiodes biauritus* TL 4.1			√		√	
10	*Lactarius lactarius* TL 4.2	√					√
11	*Lutjanus johnii* TL 4.2	√					√
12	*Pristipomoides typus* TL 4.2		√			√	
13	*Scomberoides commersonnianus* TL 4.3		√			√	
14	*Chirocentrus dorab* TL 4.4		√			√	
15	*Trichiurus lepturus* TL 4.4				√	√	
16	*Katsuwonus pelamis* TL 4.4				√	√	
17	*Psettodes erumei* TL 4.4	√					√
18	*Lutjanus sanguineus* TL 4.5	√					√
19	*Scomberomorus commerson* TL 4.5		√			√	
20	*Saurida undosquamis* TL 4.6			√		√	
21	*Rastrelliger kanagurta* TL 3.2				√	√	
22	*Sillago vincenti* TL 3.3		√			√	
23	*Pristolepis pentacantha* TL 3.3	√					√
24	*Pampus argenteus* TL 3.3	√					√
25	*Ilisha melastoma* TL 3.4		√			√	
26	*Johnius coitor* TL 3.4			√		√	
27	*Dasyatis kuhlii* TL 3.5		√			√	
28	*Himantura walga* TL 3.5			√		√	
29	*Arius thalassinus* TL 3.5				√	√	
30	*Pomadasys kaakan* TL 3.5	√					√
31	*Chrysochir aureus* TL 3.5			√		√	
32	*Cynoglossus lingua* TL 3.5			√		√	
33	*Himantura uarnata* TL 3.6			√		√	
34	*Pampus chinensis* TL 3.6		√			√	
35	*Sepia aculeate* TL 3.6			√		√	
36	*Sepiella inermis* TL 3.6			√		√	
37	*Rhinibatos punctifer* TL 3.7			√		√	
38	*Nemipterus japonicus* TL 3.7			√		√	
39	*Aluterus monoceras* TL 3.8	√					√
40	*Octopus berdmani* TL 3.8		√			√	
41	*Leptomelanosoma indicum* TL3.9		√			√	
42	*Oratosquilla nepa* TL 2.6	√					√
43	*Panulirus polyphagus* TL 2.6	√					√
44	*Secutor melagalolepis* TL 2.8		√			√	
45	*Scylla olivacea* TL 2.8		√			√	
46	*Tenualosa ilisha* TL 2.9		√			√	
47	*Parastromateus niger* TL 2.9		√			√	

Table 2 Comparison of FAO 2017 records and recent results on sustainbility, fishery potential and food security

Average catch weight	Level of exploitation	Conditions of Sustainbility	Fishery potential	Food security	FAO records Of world fisheries	Recent findings from 2018 and 2019 average records
Lesser than 1000kg	Highly exploited	Unsustainable	Exceeded	Bad for every thing	33%	28.7%
1000kg-10000kg	Fully exploited	Sustainable	Being reached	Best for food security	60%	62.6%
10000kg-100000kg	Moderately exploited	Sustainable	Being reached	Best for food security		
Above 100000kg	Under exploited	Sustainable	Not being reached	Not good for food security	7%	8.4%

Table 3 Levels of exploitation sustainability, fishery potential and food security of some study marine aquatic species based on FAO records of sustainable fisheries 2017

Average catch weight	Total Percentage of fish species 2018	Total Percentage of fish species 2019	Level of explotation	Conditions of sustainability	Conditions of sustainability among Trophic groups	Fishery potentials	Food Security
Lesser than 1000kg	25.5%	31.9%	Highly exploited	Unsustainable	TL4>TL3>TL2	Exceeded	Bad for everything
1000kg-10000kg	36.2%	27.7%	Fully exploited	Sustainable	TL4>TL3>TL2	Being reached	Best for food security
10000kg-100000 kg	31.9%	29.7%	Moderately exploited	Sustainable	TL3>TL4 TL2 absent	Being reached	Best for food security
Higher than 100000 kg	6.4%	10.7%	Under exploited	Sustainable	TL4>TL3 TL2 absent	Not being reached	Not good for food security

Discussions

In the present study a total of 47 marine aquatic species were recorded from Nyaung Tan fish Jetty. They were arranged into trophic groups based on the feeding types.Six species of herbivorous type included under TL2. Twentyone species of carnivorous type belonged to TL3, while the rest 20 obtained under TL4. Based on the yearly catch weights the previous species were classified into four groups for the year 2018 and 2019, accordingly FAO, 2017:

(i) Lesser than 1000 kg were regarded as over exploited,

(ii) 1000 kg-10000 kg fully exploited,

(iii) 10000 kg-100000 kg moderately exploited and

(iv) Above 100000 kg under exploited

There were no records of depleted fish species from the earlier days of Myanmar. Recovering stage is far more impossible to conduct. Because it needs an expertise to reintroduce the depleted species back into the natural ecosystem. Thus, conditions of (v) Depleted and

(vi) Recovering stages could not be discussed in this study. Therefore, four groups will be classified.

To begin with the highest catch weight groups it will start from (iv) Above 100000 kg. They were regarded as under exploited group, these group included five species *Pennahia anea*, *Trichiurus lepturus, Katsuwonus pelamis* in TL 4, *Rastrelliger kanagurta, Arius thalassinus in TL 3.* They are abundantly caught from the study sites and poorly demanded by the consumers.They are still sustainable in the water bodies with poor nutritious value regarding as not good for food security. Thus this population results indicated as 8.4%, which are nearer to the records of FAO, 2017 showing as 7%.

For the two groups that ranged between (ii) 1000 kg-10000 kg which were fully exploited group, these group included 16 species *Scomberomorus commerson, Chirocentrus dorab, Ephinephelus coioides, Scomberoides commersonnianus, Caranx fischeri, Pristipompides typus,* in TL 4, *Octopus berdmani, Leptomelanosoma indicum, Dasyatis kuhlii, Pampus chinensis, Ilisha melastoma, Sillago vincenti* in TL 3, *Tenualosia ilisha, Parastromateus niger, Scylla olivacea, Secutor megalolepis* in TL 2, another group ranged between (iii) 10000 kg-100000 kg were moderately exploited, these group included 14 species *Atrobucca nibe, Congresox talabon, Otolithoides biauritus, Saurida undosquamis, Argyrosomus amoyensis* in TL 4, *Chrysochir aureus, Cynoglossus lingua, Nemipterus japonicus, Sepia aculeata, Johnius coitor, Sepiella inermis, Himantura uarnata, Himantura walga, Rhinobatos punctifer* in TL 3. In both of the groups fishing potential was still in stationary conditions and proved to be sustainable in the study area. Most of the species that included in this group have commercial value, highly demanded by the consumers. They have high-protein content known as best for food security. Therefore, the combinations of this two groups comprises as 62.6%, which proved to be nearer to the world fisheries records of FAO, 2017 which showed 60%.

Finally, the catch weights (i) Lesser than 1000 kg were designated as over exploited group, these groups included 12 species *Rachycentron canadum, Lutjanus johnii, Lobotes surinamensis, Lutjanus sanguineus, Psettodes erumei, Lactarius lactarius* in TL 4, *Aluterus monoceras, Pristolepis pentacantha, Pampus argenteus, Pomadasys kaakan* in TL 3, *Panulirus polyphagus, Oratosquilla nepa* in TL 2. This group existed as 28.7% which was nearer to the records of FAO, 2017 as 33%. The fishing pressure in this group passed over the maximum sustainable limited. The amount of marine stocks were heavily havested every year, they are unsustainable because the population of these species became declining. From the perspective of food security they are ideal as they produced nutritious high content of protein rich food in the ocean. At one time, most of the marine stocks from this group served as commercial species exporting to the adjacent countries and supporting our country for economic growth. They were highly demanded by the consumers. The number of marine stocks obtained from TL4, showed that they are omnivores with larger body sizes and these stocks became the targeted species for catching.Thus, proper management and guidelines are urgently needed to prevent the loss of valuable marine stocks from their envirnment. It shoud be primarily addressed to the decision-makers, policy-makers in the marine fisheries sector and non-government organizations with the interest in sustainable development of fisheries resources. (FAO, 1999)

Conclusion

It could be concluded that they were significant negative correlation between yearly average catch weight and yearly average price. In this study it showed as when the average catch weights increased the average price rates decreased in this study. Among the classification of four groups by yearly catch weights, level of exploitation was found to be from the overexploited group (Lasser than 1000 Kg, it included 28.7% of fish species out of the total collected records. The

recent results indicated as 28.7% for over exploited, 62.6% for the combination of fully exploited and moderately exploited group and finally 8.4% for under exploited group. These findings the nearer to the records of FAO, 2017 reports, showing as 33% for over exploited, 60% for the combination of fully exploited and moderately exploited group and finally 7% for under exploited group. Therefore, the conclusion was drawn as these species are unsustainable because of over exploitation. Due to that consequences, there will be a loss of nutritionally valued marine aquatic species in the environment affecting the health and economic benefits of human population. The comments for the food security for this group will be "bad for everything". Therefore, there is a need in fishery management to monitor the marine species especially fish that are decling in catch to control the type of fishing gears and to excluded the spawners from catching during the breeding seasons.

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