International Journal of Fisheries and Aquaculture Sciences.
ISSN 2248-9975 Volume 4, Number 1 (2014), pp. 43-67

http://www.irphouse.com

Improvement of Status of Fisheries in Manabi Province, Ecuador: II: Analytical Study of Artisanal Fisheries with Evaluation of Large PelagicFishSpecies

Nader Abed S. Abo-Tubikh and Tania Lin Maldonado Sabando

PROMOTEO PROJECT – SENESCYT-ECUADOR
Facultad Ciencias Del Mar, Departmento Central De Investigacion
Universidad Laica "Eloy Alfaro" De Manabi, ULEAM, Manta, Ecuador
Email: ndrslmn1@gmail. com

ABSTRACT

The present paper is an attempt to analyse the annual catch of artisanal fishing in Manabi Province, Ecuador during the period from 2008 to 2011. The analysis based on landing data provided byfisheries authorities (Subsecretaria de RecursosPesqueros SRP, Instituto Nacional de Pesca INP and Viceministerio de Aquacultura y Pesca in Manta). The pursuit of the artisanal fisheries was monitored by means of the landings of large pelagic fishesalong with incidental fishing of sharks and rays in the main fishing ports of Manabi Province (Manta, Pedernales, PuertoLopiz and Bahia). Different fish species were studied, and categorized into major and minor species. Among the major are: Dorado *Choryphaenahippurus,* Picudo*Makairenigricans,* Albacora (Chapuleta) *Thunnus albacores* and Bonito *Katsuwonuspelamis,* and. The minor landing species include: Espada*Xiphiasgladius,* Gacho*Kajikiaaudax,* Meramelindo*Lepidocybiumflavobrunneum,* Wahoo *Acanthocybiumsolandi*andPatudo*T. obesus.* Data were analysed in term of total catch, fishing effort and management parameters. The yield was compared in respect to seasons, ports and species composition.

Key words: Artisanal fishing, Ecuador, Fishing effort, Yield, Species composition.

INTRODUCTION

The demand for fish products at national and global level is growing. The total fish food supply in Ecuador in 2009 reached 115, 400 tonnes, and the per capita supply of fish and fishery products in the same year is 8. 1 kg / year, which is lower than the

average in Latin America (10 kg) and the world (18 kg) (FAO Fishery and Aquaculture Statistics, 2010). In Ecuador fishing is considered as a highly significant activity both socially and economically. Fisheries provide a source of income, employment, cultural heritage and recreation to the inhabitants of Ecuador and Manabi Province in particular. It was estimated that about 20, 000 people live in different ways with this fishery (Castello 2001). According to FAO statistics (2010), this number increased to 43, 600 in 2010. The Sixth National Population Census estimated the number of people that engaged in fishing to be 61 560. Currently, it is estimated that the figure is between 80 000 and 100 000 people, of which about 6500 belong to the industrial subsector, which accounts for 6 to 8 percent of the total. Nearly half of the Ecuadorian artisanal fishermen are working in Manabi.

Thefishery in Ecuador is a multi-gear and multi-species. There are two main types of fishing in Ecuador, Industrial and artisanal fishing. The industrial fishing using big fishing vessels and modernized gears by commercial companies in the off-coast open ocean. While the artisanal or small-scale fishing involving fishing by households and using relatively small amount of capital, relatively small fishing vessels, making short fishing trips with relatively low level technology, close to shore, mainly for local consumption. Artisanal and industrial fisheries frequently target the same resources that may give rise to conflict. The present investigationdeals with the second type which represents the traditional fishing occurs in nearly 138 fishingportsalong the Ecuadorian coast. According to available data, an estimated 56, 000 to60, 000 traditional fishermen work at these ports. It is also anindirect source of jobs such as suppliers, boat repair and maintenance.

More than 300 marine species constitute the bulk of the artisanal fishing catch. Genus *Thunnus* (albacore) and *Katsuwomus*(bonito bonito), with *Coryphaenahippurus* (gold) represent the main species. According to fish statistics of NationalFishing Institute (INP, 2010), the yield for this subsector ranged from 8, 200 to16, 800 metric tons annually from 2001 to 2007. Lemay *et al*. (2008) pointed out that, amongvarious stressors to the artisanal fisheries resources such as dredging, reclamation and industrial effluents, overfishing represents a major adverse stressor.

In Manabi Province, where the present study is concentrated, the tuna catches exceed 200, 000 MT / year transferring Manta port to a capital of the world tuna. Manta concentrates 80% of the national tuna industry. The fisheries sector in Manabi generates annually more than 300 million dollars in foreign exchange. Currently there are averages of 3, 000 man-made fibers, which together with dozens of shrimp boats are the largest fleet of Ecuador. Artisanal landings mainly supply the domestic market for consumption of fish and seafood.

Apart from the tuna stocks currently managed by IATTC, and the chub mackerel and threadfin herring fisheries has had some assessment (Patterson *et al*. 1993), there is little information about target reference points for other fisheries. There is no published information that uncertainty analyses are a regular part of any stock assessments employed in Ecuador. Some papers from outside the country have employed such work. The lack of scientific evidence about the status of stocks and the level of fishing effort has precluded any support for management measures. The absence of scientific studies is influenced by scarce financial and human resources

nationally.

The general objectives of any research on artisanal fisheries in ManabiProvince is to ensure the conservation and sustainable use of fisheries resources in Manabi and to make artisanal fishing more competitiveand sustainable, as a way of boosting the economic development of fishing communities along Manabi coast. This paper aims to present an analysis for the catch of artisanal fisheries in the Ecuadorian waters near Manabi Province for the period 2008-2011 and make suggestions for future needs and development of this sector through:

1. Determine whether fish stocks in the costs of Manabi Province are fully fished or overfished, and whether increases in fishing capacity and/or fishing effort would threaten their conservation.
2. Evaluate measures to prevent or eliminate overfishing and excess fishing capacity and to ensure that fishing effort is compatible with the sustainable use of the fish stock.
3. Evaluate measures to ensure the long-term conservation and sustainable use of the fish stocks and to maintain or restore the harvested species at levels of abundance that will produce the maximum sustainable yield.

MATERIALS & METHODS

Data Collection

The data used to prepare this study comes from the monitoring process of artisanal fisheries carried out by Subsecretaria de RecursosPescqueros(SRP), Viceministereo de Aquacultura y Pesca(VMAP)and InstitutoNacional de Pesca (INP) in the main landing ports of Manabi Province: Manta, Puerto Lopiz, Pedernales and Bahia between 2008 and 2011. For studying the artisanal fishery status in Manabi, the following statistics, were used:

a. The annual reports of small-scale fisheries.
b. Fishery statistics for the period between 2008 and 2011.

In addition to data provided by SRP and INP, visits to the main ports were performed to record fishing activities, inspecting fishing gears and status of fishing operations in those ports. Special enquiry forms were used to investigate the fishermen views about fishing operation, management regulations and their socio-economic status.

Study area

As seen in Figure (1), the coastal areas of Ecuador are vast, containing more than 130 fishing port which cannot be covered in a single investigation. Instead, the present study was concentrated on the coastal line adjacent to Manabi Province. Four important ports were selected in the area starting from North of Manabi to the South. In descending geographic order the ports are: Pedernales, Bahia, Manta, and Porto Lopez.

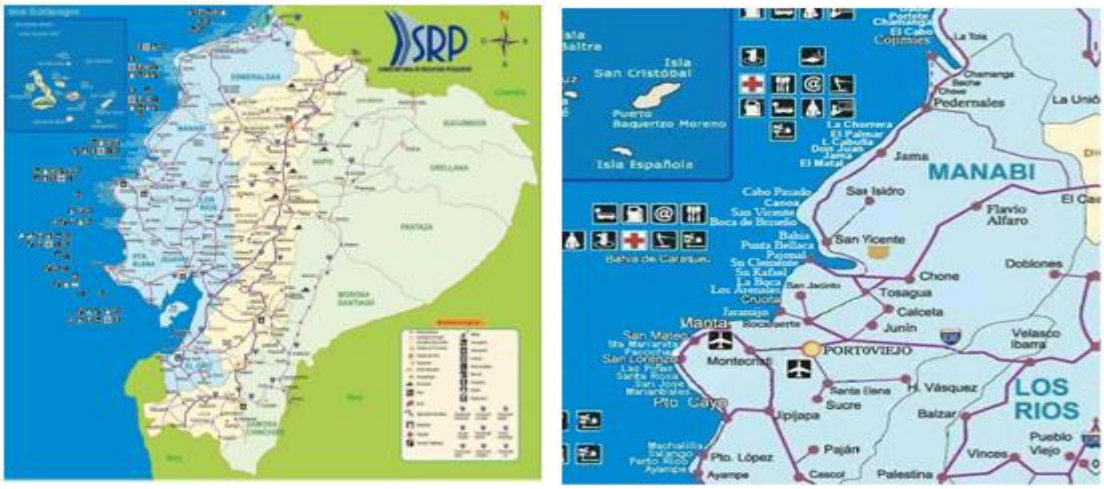


Figure (1): Map of Ecuador (left) and the study area in Manabi Province showing fishing ports from North to South: Pedernales, Bahia, Manta, and Pto. Lopez.

RESULTS& DISCUSSION

1. Characteristics of Artisanal Fishing in Manabi

Table (1) summarizes the various characteristics of the artisanal fishing in Manabi.

1. 1 Fishing Vessels

Mainly, two typical vessel types are used in the artisanal longline fleet in Manabi. The small fiberglass vessels called “Fibras” can operate independently close to shore, generally 7. 5 m to 7. 7 m in length and tend to use lines less than 4. 5 nm in length. Also half of the fiberglass boats used for fishing in Ecuador based in this province. The secondlarger boats called “Botes” or Wooden hulls, often tow 5-10 fibras. They range in length from 15 m to 22 m and tend to use lines 2. 5 to 6 nm in length. Artisanal fishermen depend on these commercial “mother ships” to pull their fibras to more productive offshore grounds (Largacha, 2005).

Recent survey by Viceministereo de Aquacultura Y Pesca VMAP (2012) for the type of vessels used in artisanal fishing in Manabi showed that the type Fibra is dominant with 40-60% followed by other boats with percentage of less than 20%. The dimensions of most of the boats (37%) in Manabi are between 6-9 m in length followed by boats of 3-6 m in length comprising 25%. Small size boats (<3m) and very large ones (>12m) comprise only 5% of the total boats because of the previously mentioned reasons. Fishermen use the compass, radio, GPS and cell phones as the main communication tools.

1. 2 Fishing Gears

As for the fishing gears, the use of gill net is dominant (51%) in artisanal fishing of Manabi followed by the use of Hook and Line (28%). Other types of nets (seines, cast nets, trammel nets, traps and drawers) compose less than 10%. Variation between

ports is obvious, with dominance for Hook and Lines in Manta (62%) and gill nets in Pedernales (75%) and Puerto Lopez (55%). Gear type that used in Manabi provincial coastal communities with their percent of total Ecuadorian gears are listed in Table (1).

1. 3 Fishing Areas

In 1984 the government declared the marine area within 8 nautical miles of the coast for the exclusive use of artisanal fisheries. Fishing area for the two types of artisanal fishing are different.

1. The coastal artisanal fleet operates at a distance of 80 – 100 nm to catch large pelagic species. In the case of demersal species, the fishing area expands 120 – 130 fathoms deep from the coast line.
2. The oceanic artisanal fleet, which is dedicated to the capture of large pelagic fish and sharks, has an operational area between the latitudes 07°N and 09°S and through 94°W. These fishers are using mother ships with 3 to 10 fiberglass boats (fibras) to reach offshore grounds.

1. 4 Fishery regulations

In the last two decades, growth in artisanal fisheries was uncontrolled. In early 2000, a regulation banned construction and importation of all kinds of vessels, except to replace another vessel already authorized to fish. However, compliance in the artisanal fisheries has been much more difficult. The main adopted fishing regulations are those related to closure seasons. Fishery closures exist and change annually. According to ASOEXPEBLA (2005), the closure season for PacificAnchoveta (*Cetengraulismysticetus*) is from January 1-June 30, while for Herring and Sardines (*Opisthonemalibertate*) started in March 1 – 31 and September 1 – 30.

Table (1): Characteristics of artisanal fishing activities in Manabi Province, as shown different types of fishing vessels and gears(SRP, 2007)

Feature	Manabi	Ecuador
Number of inlets	35	141
No. of fishermen	22 183	57 299
Bongo	224	3285
Canoe Mountain	132	1466
Panga	551	1431
Wooden Boat	110	2082
Fiberglass	2446	5224
Sloop	94	144
Total Vessels	3 557	15 929

Gear type	%
Surface Gillnets	38
Demersal Gillnets	
Multifilament	52
Monofilament	48
Surface long line	27
Bottom long line	48
Hand line	
Pelagic	10
Demersal	17
Chinchorro de playa	20
Larva net	3

Figure (2): Fiberglass and wooden boats for artisanal fishing in Manta port, Manabi.

2. Analysis of Catch (2008-2011)

The series of available data for the period from 2008-2011 which was obtained from the published statistics of the fisheries authority (SRP, 2010) and listed in Table (2), are not enough to calculate Maximum Sustainable Yield (MSY). They can be used to study the trends in landings, fleet structure and fishing effort during this period. It was found that catches had increased recently to levels unlikely to be sustainable in the long term without some management action to control fishing effort. For the four years in the present study, catches of large pelagic species and chondrichthys have risen, not only in Manabi, but in all Ecuador especially between 2008 and 2010 (Table, 2 and Fig. 3). The contribution of Manabi Province in the catch of large pelagic varied during 2008-2011 and ranged from 58 – 94 %. Its contribution in the incidental fishing of sharks and rays also varied between 61-85%. Contribution in the total catch in Ecuador reached 70-82%. (catch in the following ports Esmeraldas, Muisine, Pedernales, Bahia, Manta, Puerto Lopez, Santa Rosa, Anconcito and Puerto Bolivar).

According to other fish statistics provided by INP (2014) for artisanal landing of large pelagic fish in two ports in Manabi for the period 2008-2013, the landing was 67805 tons. Five families were recorded: coryphaenidae, Scombridae, Xiphiidae, Istiophoridae and Gempylidae, is the most representative with coryphaenidae 63. 4%. The ports of Manta, Puerto Lopez recorded the greatest contributions to the estimated catch in 2011 with approximately 17 327. 5 tons, and 14 699. 2 tons in 2012. Large pelagic had greater representation in the port of Manta during the latest five years with 66 025 tons corresponds to 97. 4% of the total catch (Fig. 4).

Records of increases and decreases in catches do not necessarily reflect similar changes in the exploited stock. The catches depend on several factors, and such as the introduction of new fishing methods or more powerful vessels can increase the catch from the same size of stock, leading to overexploitation and possible collapse of the fishery unless appropriate controls are introduced. The analysis should, therefore, include investigation of trends in fishing effort and changes in fishing methods to provide a comprehensive overview of the fishery. In the industrial fisheries with large vesselslanding at a few ports, it is often possibleto use sophisticated models toassess

the state of the stocks and to predicttheshort-term effect of possiblechanges in fishing activities (MacLennan, 1998). In the artisanalfisheries however, the uncertaindata and the nature of the fishery meanthat the most sophisticated populationmodels are not useful. The MSY was notcalculated due to inadequate data. Instead, it was necessary to adopt a morebasic approach, through the study ofgross trends. The exact state of a fish stock is unknown, as is often the case with artisanal fisheries in Manabí, trend analysis may still indicate need for management measures to sustain fishing activities nlong-term.

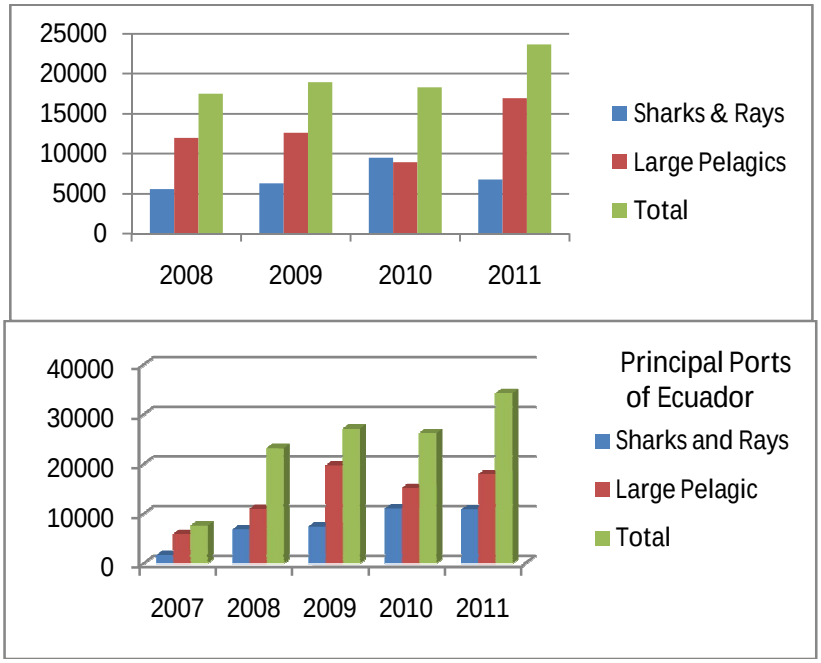


Figure (3): Graphic representation of the artisanal landings in Manabi Province and whole Ecuador during 2008-2011.

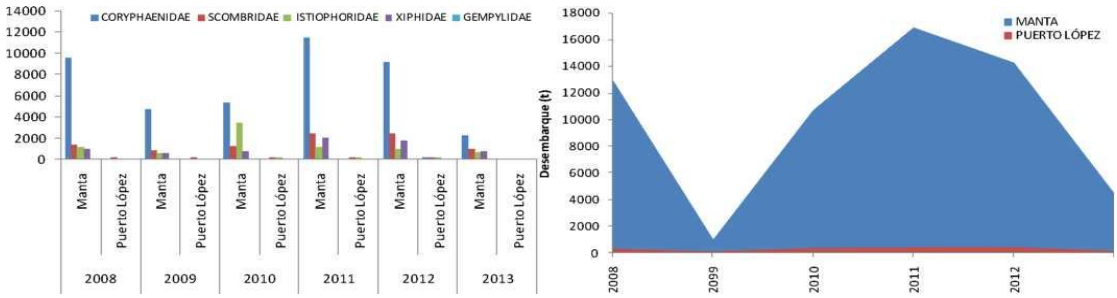


Figure (4): Landings of large pelagic (t) in Manabiduring 2008 to 2013 (INP, 2013).

Table (2): Total and percent contribution of Manabiartisanal landing during 2008-2011.

Year	Port	Large Pelagic	Sharks and Rays	Total Landing
2008	Manta	11792	5376	17168
	Pto. Lopez	101	92	193
	Pedernales	47	31	78
	Bahia	0. 25	0. 67	0. 92
Total in Manabi	All	11942	5500	17440
Total in Ecuador	All	16350	6820	23170
% Manabi		73. 0	80. 6	75. 3
2009	Manta	12229	6174	18403
	Pto. Lopez	330. 3	67. 2	397. 5
	Pedernales	33. 5	42. 2	75. 7
	Bahia	0. 4	0. 9	1. 3
Total in Manabi	All	12593	6284	18878
Total in Ecuador	All	19683	7406	27089
% Manabi		64. 0	84. 8	70. 0
2010	Manta	8543	9059	17603
	Pto. Lopez	254	272	526
	Pedernales	67	84	151
	Bahia	0. 9	1. 6	2. 5
Total in Manabi	All	8865	9417	18283
Total in Ecuador	All	15154	11051	26205
% Manabi		58. 5	85. 2	70. 0
2011	Manta	16500	6532	23032
	Pto. Lopez	294	66	360
	Pedernales	115	91	206
	Bahia	3. 4	4. 4	7. 9
Total	All	16912	6693	23605
Total in Ecuador	All	17937	10812	28749
% Manabi		94. 2	61. 9	82. 1

2. 1 Monthly variations of landings between fishing ports

Large Pelagics

Graphs showing the total catch in the main fishing ports in Manabiare illustrated in Fig. (5). It can be seen that Manta port stands first with an average of 1000tonnes/month (t/m) followed by Pto. Lopez(av. 25 t/m) and Pedrnales port (8 t/m). Bahia port was the lowest landings with only 400 kg/month. In Manta port monthly catch during 2008 and 2009 was higher than that during 2010 and 2011. So there was a decreasing trend in total landings. The peak of monthly catch in Manta port occurred during the period from September to January when values reached a record of 2500-3000 t/m, compared with low values of 500 t/m during March–August.

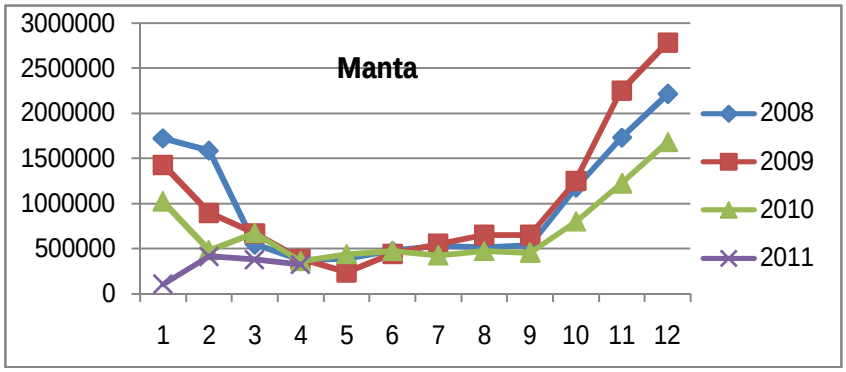
Sharks and Rays

For cartilaginous fish the biggest catch was in Manta port with an average monthly catch of approximately 600 ton reaching higher rates during 2010 and 2011. In Manta there was a progressive increase in monthly catch from January to June in 2010 (1400 t/m) and up to September and October in 2008 and 2009 (900 – 100 t/m) followed by a descending trend toward the end of the year. Other ports record lower rates of 15 and 7 t/m in Pto. Lopez and Padernales ports respectively. Bahia port records much lower catch rate of 500 kg/m. Again the year 2010 was the highest fishing season especially during May and September.

Total Catch

The total catch of large pelagic fish and cartilaginous fish (sharks and rays) for the main Manabi fishing ports are shown in Fig. (7). Again, Manta port recorded the highest landings per month of nearly 1500 t/m. The other fishing ports in Manabi Province recorded much lower landings compared with Manta with nearly 40 t/m in Pto. Lopez and 15 t/m in Pedrnales. Less than 1 ton was landed in Bahia port each month (av. 500 kg). The annual variation revealed that there was a progressive increase in the total catch for the period 2008-2010 and a drop in the year 2011. Fish landing during 2010 was the highest in all ports except in Manta where catch during 2010 dropped down from August-March. Data of 2011 are not complete as they showed the landings of only four months (January-April)

As for the seasonal variation in the total catch, there was no stable trend among various fishing ports, leading to a conclusion that the fishing activities are different between different fishing areas in Manabi. In Manta, the season between September-December of each year showed the peak catch. In Pedernales, the period between June-October showed the peak fishing activities in all years. In Lopez port the peak period starts early in April and extends to September. In Bahia port, no seasonal variations in fishing activities and total catch were noted around the year. Little activities were recorded in this port during the study period leading to a minimum total landing.



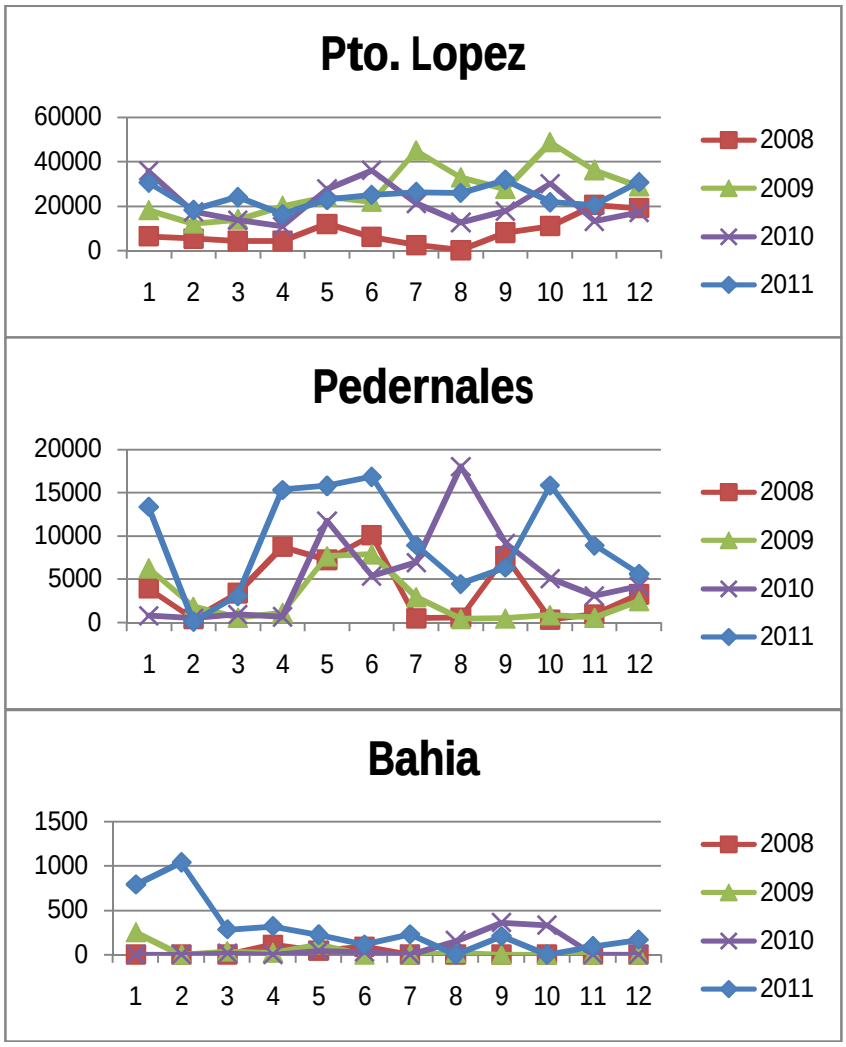
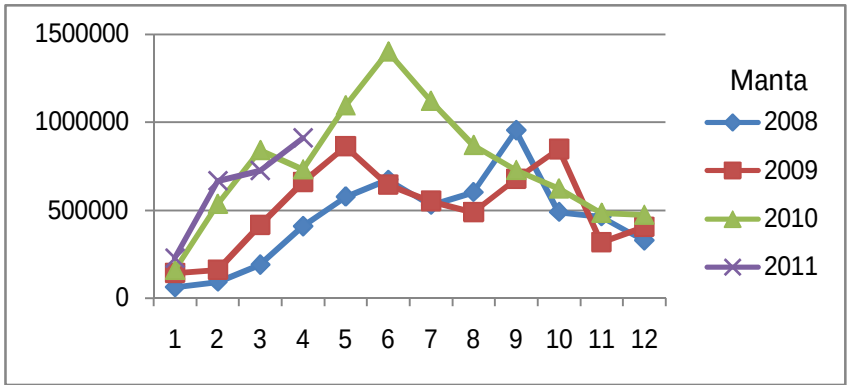


Figure (5): Monthly variation in the catch of large pelagic (kg/month) in four fishing ports in Manabi during 2008, 2009, 2010 and part of 2011.



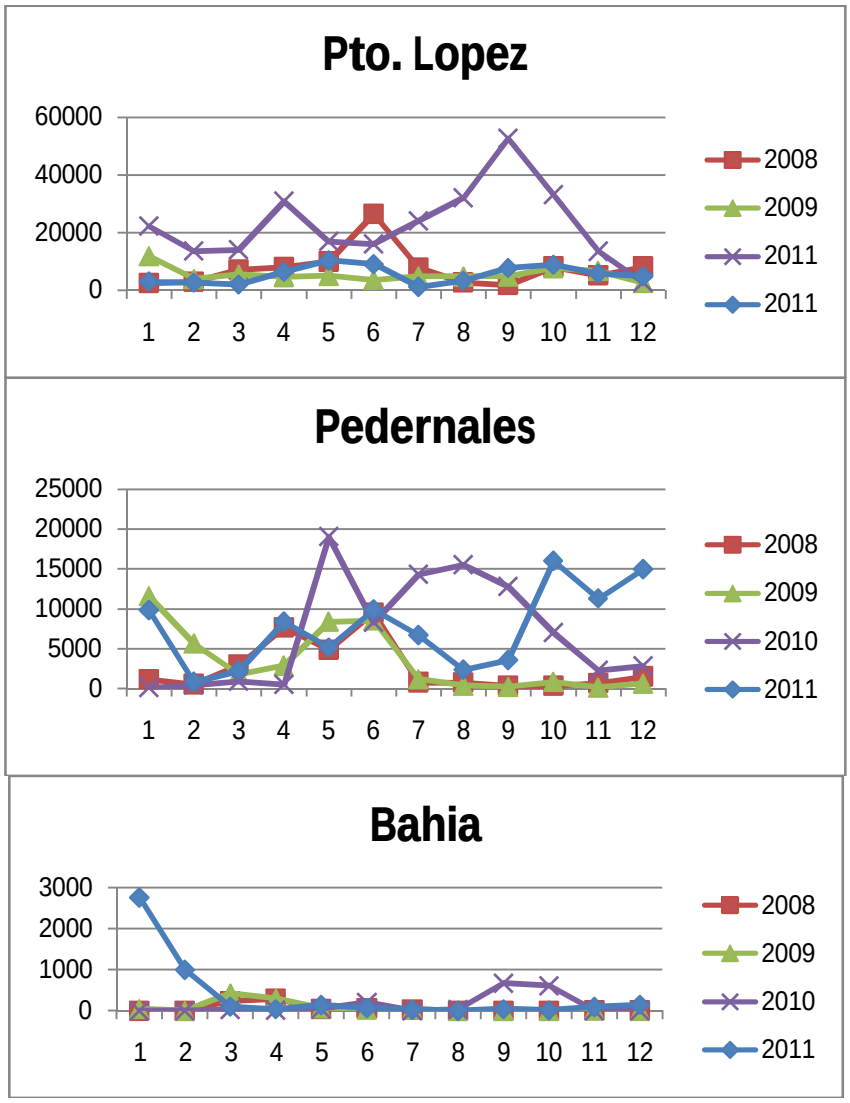
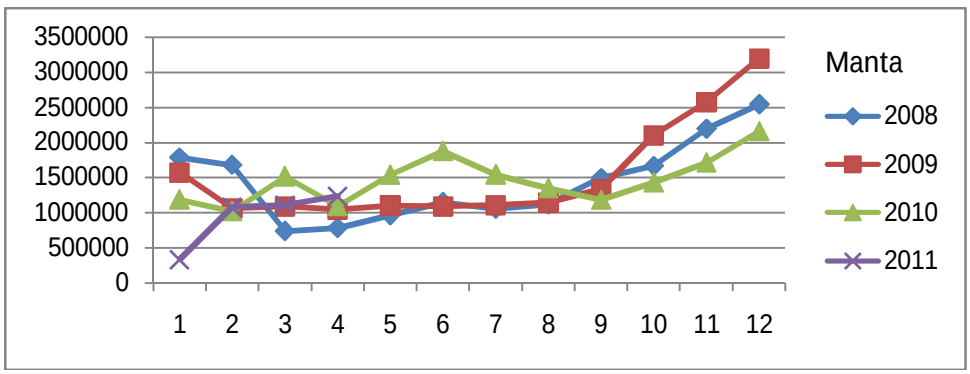


Figure (6): Monthly variations in the incidental catch of sharka and rays in Manbi ports during 2008-2011.



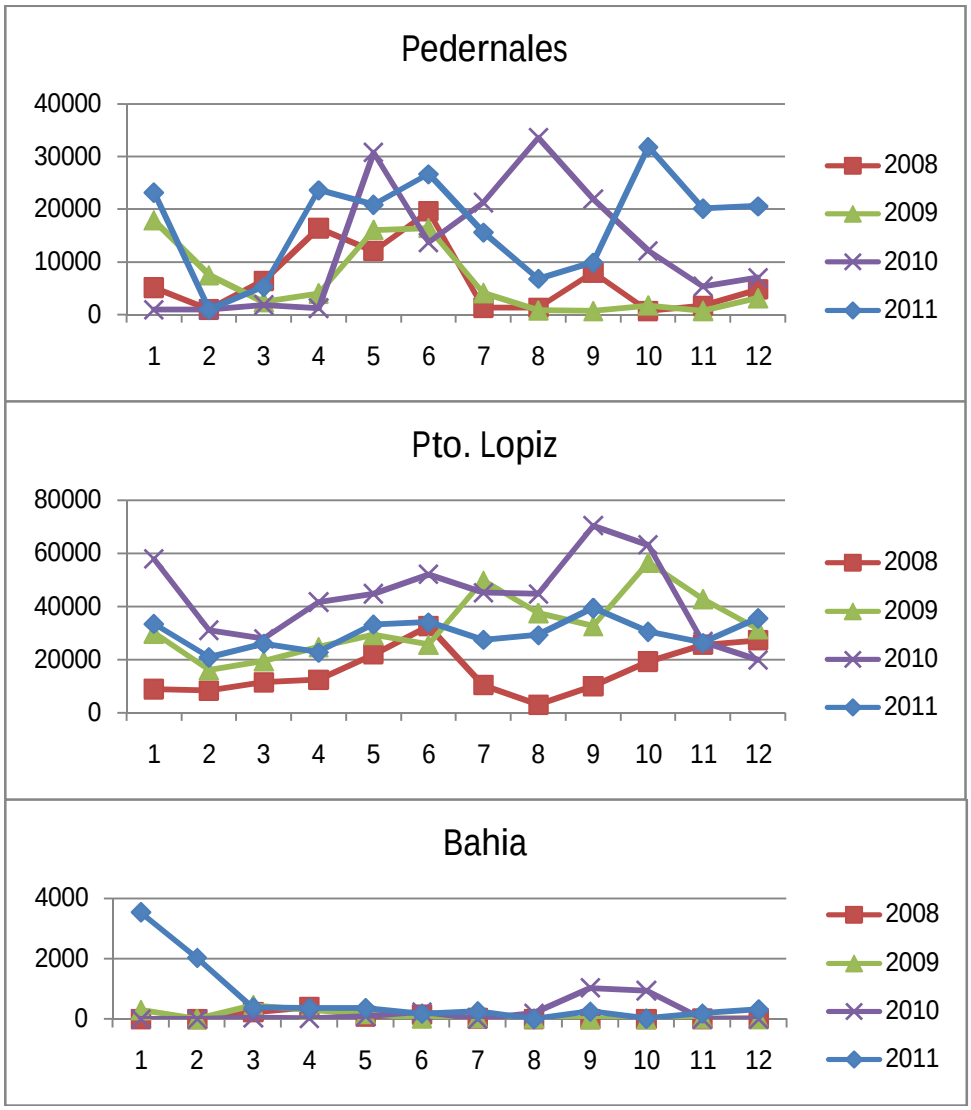
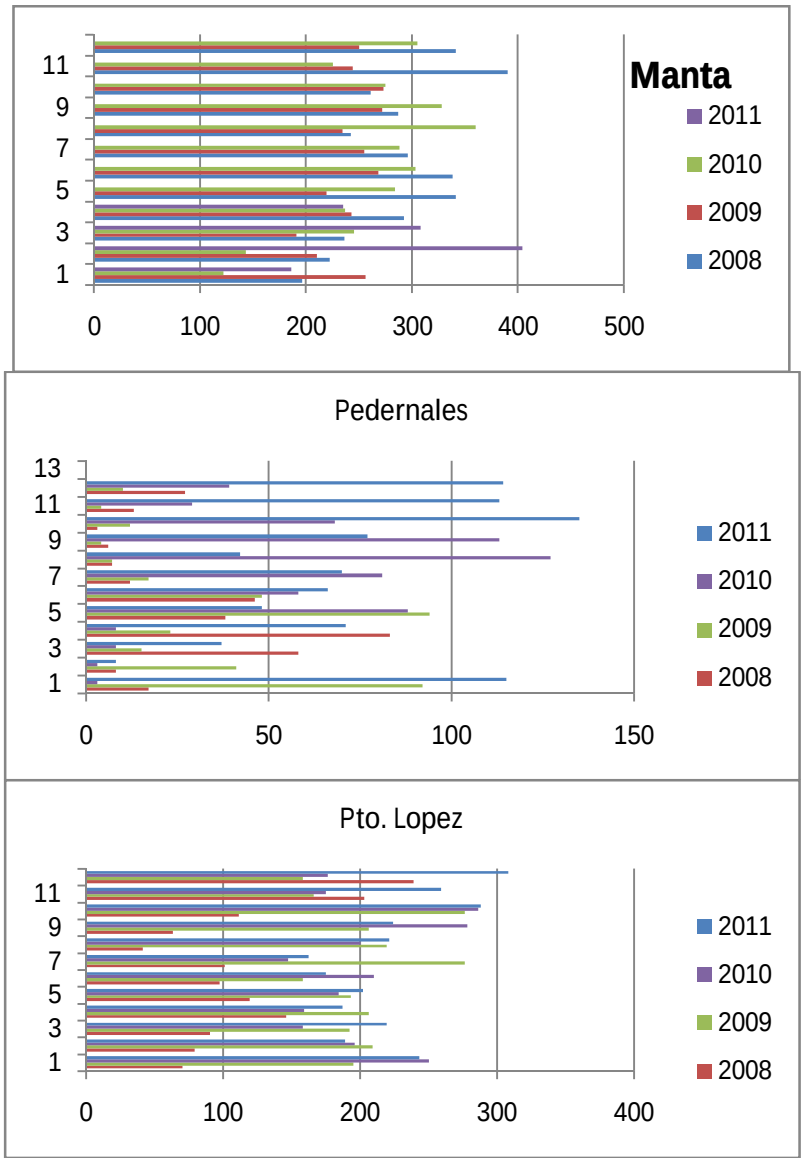


Figure (7): Monthly variations in the total catch in Manbi ports during 2008-2011.

3. Fishing Activities

Fishing activities are expressed in this study by the number of artisanal fishing permits allowed each month in the fishing ports of Province Manabi. They are another expression of the number of fishing boats sailing each month. They can be used also for calculating the fishing effort and then catch per unit effort. As seen in Fig. (8) Fishing activities in Manta port were the highest due to the high number of permits allowed each month which exceed 300 in the peak of the season in September and October 2008and 2010. Around 250 permits for fishing were proved during the rest of the season of the previous mentioned years. They were around 200 permits during 2009. Sharp increase occurred in 2008 and the following years 2010 and 2011.

In port Lopiz, the number are lower ranging from 200-250 permits during the peak months (September–January) and 100-150 permits during the rest of the season (February-August). In Pedrenales, number of permits increased from around 50 during 2008 and 2009 to nearly 100 permits during 2010 and 2011 especially during the period between August – January. Only 50 permits allowed during the rest of the fishing season. Low fishing activity was noticed in Bahia port with only 5 permits per month during our study period. They reach 10 permits only in January 2011.



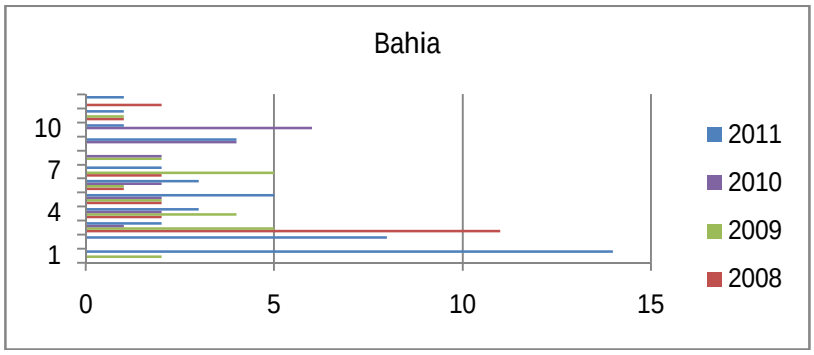


Figure (8): Fishing activities in Manabi ports as appeared by monthly number of fishing permits.

3. 1 Fishing Effort

Data supplied by INP (2014) about the active fishing vessels in Puerto Lopez and Manta are shown in Table (3). They described the composition of the artisanal fleet per port and vessels, monthly over the period of 2008-2013 for the province of Manabí. Data showed a higher activity of craft from type wood boat (59. 7%), followed by fiberglass (37. 4%). The big vessels 'Barco' usually accompanied by small 'Fibra' type. Some Fibra type can practice fishing independently.

It can be seen that there was a progressive increase of number of vessels operating in Lopez port. The numbers increased by 3 folds during five years indicating a massive expand of fishing activities. The same trend can be seen in Manta where number of vessels increased from 500 to 800 from 2008-2010. The following years, however, showed a decline in vessels number to less than 500 in 2013. The real reason for such decline is not known and could be related to many factors. Nevertheless, there was intensive fishing activity during 2010, 2011 and 2012 in Manta port. This is an indicator of increasing fishing effort which my lead to unsustainable fishing activities if catch exceeds the allowable catch. As for the peak season in terms of number of vessels, no obvious trend could be detected. One cannot draw a clear picture about the months that represent the peak fishing season. Fishing activities continued in various months during the years. This is probably because of the interaction of fishing seasons among various fish species. It reflects a local impact of certain conditions that govern sailing for fishing. This, again will allow a continuous fishing activity all around the year.

According to survey carried out by fisheries authority in Ecuador, number of crew on each boat differs markedly. It varied from solo (1 person) to 15 persons. However the most common number of crew is 3-6 which comprise 56 % (7879 person) followed by boats operated by 2 persons which comprise 22% (3180) followed by more than 15 person (10% or 1500) in the fishing boats worked in artisanal fishing in Manabi Province (VMAP, 2013). Varied numbers of hooks are used by fibras or botes in tuna fishery. Botes deploy fewer hooks per line (averaged 130) than fibras (averaged 163). For the dolphinfish fishery a total of 280 hooks were used per line in 2004 and 383 in 2005 (Largacha, 2005). The average soak time of the artisanal

longline sets in the tuna fishery was from 10 – 12 hours while the average time in the mahi-mahi fishery is ranging from 8-10 hours. Catch per unit effort (CPUE**)** ranged from12. 6-13. 9 per 1000 hooks for Tuna and 96. 3-149. 8 for Dolphin fish (Largacha, 2005).

Table (3) Variation in number of fishing vessels operates in the two main ports in Manabi Province during the period 2008-2013.

Year	Manta Barco	Manta Fibra	Puerto Lopez Fibra
2008	599	79	208
2009	504	47	174
2010	806	18	460
2011	713	0	476
2012	651	7	602
2013	435	0	726

Source INP (2014)

3. 2 Catch per unit effort

The catch per unit of effort (CPUE) was investigated in Manta and Puerto Lopez during 2008-2011 using data recorded in Table2 (2) and (3). CPUE values are expressed as catch (tons) per boat per year. Results are shown in Fig. (9). Since the CPUE is obtained directly from the recorded vessels data, it is not affected by sampling errors. The total CPUE in Manta ranged from 32. 3 tonnes/boat/year in 2011 to 21. 4 tonnes/boat/year in 2010. CPUE values in Manta refer to an increase in the catch per unit effort of large pelagic, sharks & rays in addition to total catch in the year 2008, 2009 and 2011, while the year 2010 showing lower values. The progressive increase in the amount of catch per boat per year reflects a state of under-exploited stock. This could be related to many factors in terms of fishing efficiency. Data of the year 2010, however, express a different conclusion. It showed a huge increase in number of boats which has resulted in a significant ($p<0.05$) reduction in CPUE. The higher CPUE values of the previous year had a negative impact on the CPUE in 2010.

In Puerto Lopez the CPUE values are significantly ($p>0.05$) than those recorded in Manta. This might be due to the large number of fishing vessels employed and the lower value of the total landings. The total CPUE ranged between 0. 76 in 2011 to 2. 28 tonnes/boat/year in 2009. It is interesting to realize that the relatively high CPUE value of sharks in 2010 has resulted in averaged low value in 2011.

In an earlier study, MacLennan (1998) stated that in order to analyse the trends in fishing effort, it is first necessary to identify the catches of various fishing boats correctly, because the catching power of the GRP launches will be different if they are fishing alone or associate with a balandra. It is therefore reasonable to conclude that the increased landings indicate a real improvement in the pelagic fish stocks since 2007. In the case of the large pelagic fish, the CPUE was more than that of the previous year. So there was a progressive increase in fishing effort. It is rather

important to knew, whether a change in fishing methods could cause the increase in catches. This is a crucial question because, if fishing methods become more efficient, larger catches can be taken from the same size of stock leading to severe over-exploitation.

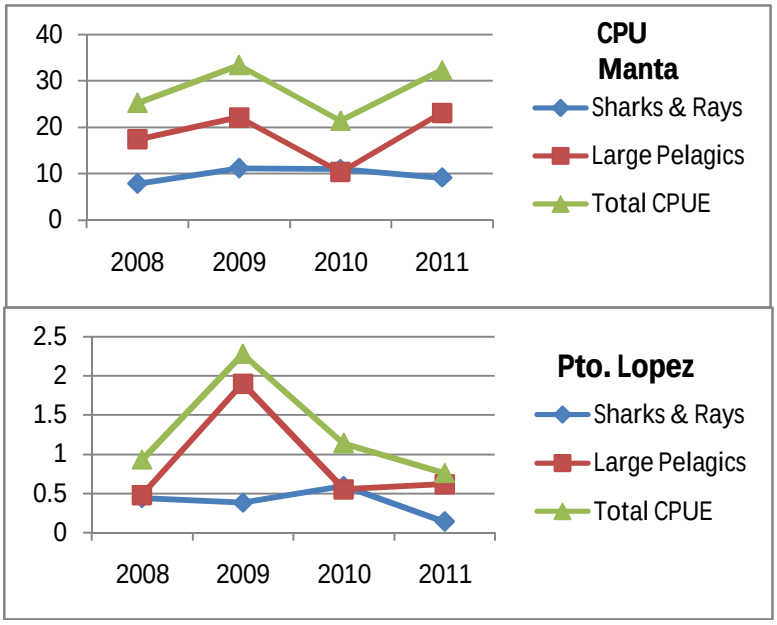


Figure (9): Catch per unit effort CPUE (tons/boat/year) in Manta and Pto. Lopez during 2008-2011

4. Species Composition

The main large pelagic species in the artisanal fisheries sector in Manabi Province are listed in Table (4). They comprise 10 species belonging to five families, the most abundant is family Scombridae (INP, 2013). List of the scientific and common names and of various cartilaginous species appeared as incidental catch in artisanal fishing in Manabi is shown in Table (5).

Table (4) List of the most important large pelagic in artisanal fisheries in Manabi

Scientific Name	Family	Common Name
Coryphaenahippurus	Coryphaenidae	Golden
Makaira sp.	Istiophoridae	Weevil
MakairaMazara	Istiophoridae	Billfish white striped
Istiophorusplatypterus	Istiophoridae	Weevil flag that
Thunnusalbacares	Scombridae	Albacore
Katsuwonuspelamis	Scombridae	Skipjack Bonito
Acanthocybiumsolandri	Scombridae	Wahoo, sierra peje
Scomberomorus sierra	Scombridae	Sawfish

Xiphiasgladius	Xiphiidae	Swordfish
Lepidocybiumflavobrunnerum	Gempylidae	Miramelindo, escamudo

Table (5):List of the common names and scientific names of the most important cartilaginous species appeared in the catch of artisanal fisheries in Manabi

Common Name	Scientific name
Azul	*Prionaceglauca*
Aleton	*Carcharhinuslongimanus*
Cachuda Blanca	*Sphyrnazygaena*
Mico	*Carcharhinusfalciformis*
Cachudaroja	*Sphyrnalewini*
Punta negra	*Carcharhinuslimbatus*
Rabonamargo	*Alopiassuperciliosus*
Rabon Bueno	*Alopiaspelagicus*
Tigre	*Galeocerdocuvier*
Tinto	*Isurusoxyrinchus*
Raya	*Dasyatis longa*

4. 1 Catch Comparison

Large pelagic species

For species composition of the catch, three species were selected as the major species from the catch point view. Major species are those exceed 25 ton monthly and four minor landing species (lower than 25 ton). The major species are:

1. Dorado *Choryphaenahippurus*
2. Picudo*Makairenigricans*
3. Albacora (Chapuleta) *Thunnus albacores*
4. Bonito *Katsuwonuspelamis*

In Manta port the Dorado stands first in all years (2008-2011). The peak catch of Dorado occurred during October-January where maximum catch exceeds 2000 ton per month and average 1000 t/m as seen in 2008 and 2009. Catch decreased during February – September reaching 20 t/month in May. Picudo stands second with catch ranging between170-280 t/m during the peak season between June-October. Albacora stands third in regard to total catch per month in Manta. Its catch increased gradually from January to September reaching 173 t/m in August, 2008. June – November represents the peak season for Albacora in Manta where the catch increased from 170-207 t/m in 2009. The catch was less in 2010 ranging between 65-117 at its best season, the rest averaged 20 t/m. As for Bonito, the third major species, the catch ranged between 40-50 t/m in 2008, decreased to 20-30 in 2009 and to 10-20 t/m in 2010. The minor landing species include:

1. Meramelindo*Lepidocybiumflavobrunneum*
2. Espada*Xiphiasgladius*
3. Gacho*Kajikiaaudax*

4. Patudo*Thunnusobesus*

The catch of the minor species ranged between 20 – 40 t/m. Picudo in Manta is considered as a major species and in other ports as minor. Among the three species, Espadawas the first in the amount of catch which reached high value of 40-50 ton/month in 2008, increased to record values of124 – 176 t/m in July & August, 2009 with normal catch of 60-70 t/m in other months. Gachostands second with nearly 15-20 t/m during 2009-2010 in Manta. Meramelindocatch in Manta is low ranging between 1-3 t/m. Patudo, however, showed wide variations in amount of catch in manta ranging from 1-50 t/m with noticeable increase during 2010. Wahoo *Acanthocybiumsolandi*catch was, surprisingly, low in Manta during 2008-2010 with average rate of 5-10 t/m, while it is consider as a major species in other areas in Ecuador.

Sharks and Rays

In Manta port, the catch of Rabon Bueno stands first with amount reaching 300-700 t/ m in the peak season April – November in all years. Azul stands second with catch reaching 60-160 t/m During June –November. The shark Mico stands third with a range of 20-70 followed by Raba Amergo and Cachuda with monthly catch of 5-20 t/m. The last two species are Punta negraand Tinto with catch ranging between1-10 t monthly. The rays appeared infrequently in the catch with less than 0. 5 t per month.

4. 2Biology of the main species

1. Family Scombridae, Albacora (Chapuleta): *Thunnusalbacares* (yellowfin)

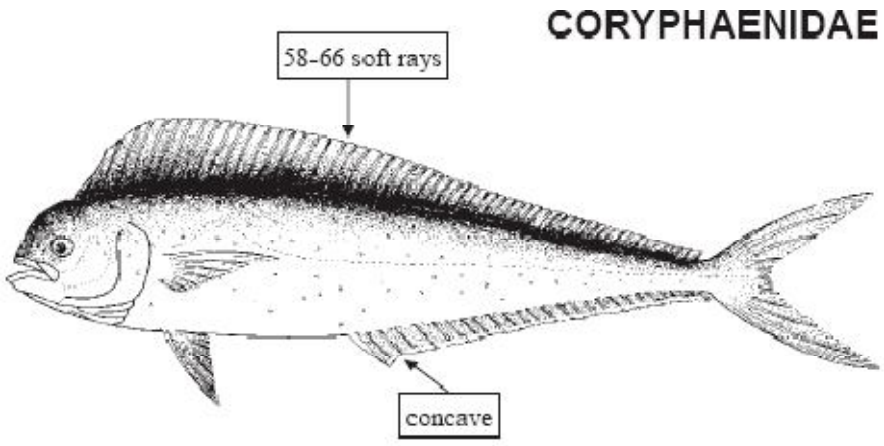
Albacorainhabit warm waters of the Pacific oceans. It is an oceanic epipelagic species found above and below the thermocline, at water temperatures between 18 and 31 ° C and very sensitive to low oxygen levels. Its size achieves more than two meters as fork length. The species is known for its high fecundity. Afemale of 51 cm can produce approx. 319 000 eggs; that of 127 cm producefour million eggs and the 165 cm TL, can produce eight million eggs(CIAT 1995).

Bonito barrilete: ***Katsuwomuspelamis*** (skipjack)

The species has a vertical distribution from the surface to 260 m depth during the day, and near surface waters at night. It is an epipelagic oceanic species, adults are preferably distributed in the isotherm of 15 ° C. The maximum size attained by this fish reaches108 cm as fork length. According to CIAT (1995), the skipjack tuna spawn in the western and central Pacific Ocean.

2. FamilyCoryphaenidae, Dorado (Mahi-mahi): ***Choryphaenahippurus*** ***(***Dolphinfish)

It is a highly migratory fish which inhabits tropical and subtropical regions of every ocean (Palko*et. al*., 1982). Peralta (2008) describes it as an epipelagicpredator widely distributed in warm waters all over the world. This author also indicatesthat in the Pacific Ocean, this fish is to be found between 47° N and 38° S, 180° Wand 180° E, at depths ranging, on average, from 0 to 85m. Icochea (2007) describes dolphinfish catches made by longlinefleets in areas where the surface water temperature varies between 19. 8°C and 28°C. The FAO reported that Ecuador catch between 2001 and 2010 of57, 275t(Fisheries Statistics and Economics Division). For the period 2008-2012, according to the SRP (MAGAP)Control System, 55, 165t were unloaded at the main dolphinfish landing sites, representing 59. 03% of total landings of large pelagic fish species. During thisperiod, 2010 was the year of lowest unloadings, with 7, 226t (47. 68% of largepelagic landings), whilst the peak year was 2012 when 14, 464t were landed, representing 59. 45% of large pelagic landings (SRP 2013).



With respect to its reproductive biology, it spawnsin the open sea. The average size at 50% sexual maturity was found to be different foreach area, from 68. 83 to 92. 89 cm FL, slightly above the minimum catchlength (67. 5 cm FL = 80 cm TL). It is one of the most important species in artisanal fisheries in Ecuador and in ManabíProvince inparticular. The resource represents over 65% of the artisanal landings of large pelagic fish and 35-40 of their export (Martinez-Ortiz, *et al*, 2012). The fishing season is from November to May with maximum catch between December and January. In the Ecuadorian artisanal fishery, the size of landed individuals hasranged from 28 to 196. 4cm in total length (TL), with a maximum weight of26kg. However, an important latitudinal pattern has been observed, assmaller average sizes (80cm in FL) are fished in southern areas, andbecome larger (100cm FL) as you move further north.

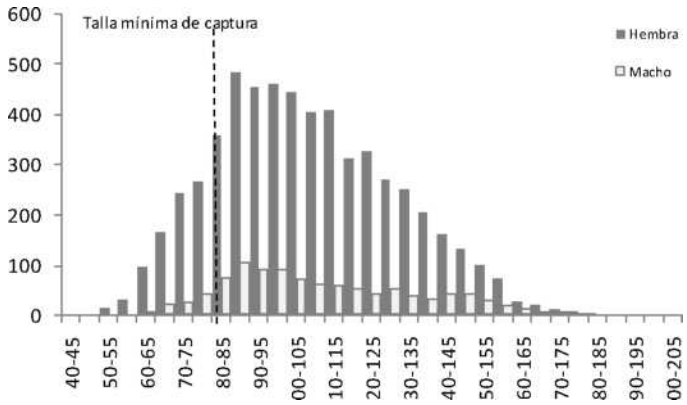


Figure (10): Length frequency distribution of female and male *Coryphaenahippurus* in Manta, 2008-2012 (INP, 2014)

Capturing the Dorado *Coryphaenahippurus* was carried out between October to March during winter, with maximum peaks in October and January. During the period 2008-2012, 6709 specimens of Dorado were analyzed for length frequency distribution. They were caught by surface long line in Manta. The size composition for females ranged from39-181 cm TL, with an average of 101. 1 cm and 83 cm as mode; while for males the size composition presented interval between 58-246 cm LT, the mean was 104. 5 cm and 85 cm for mode. It worth noting that the 14:27% of female and 0. 92% male were below the minimum capture size (80 cm TL), with a male: female sex ratio of 1: 5. 8 (Fig. 10).

5. Fishery Management

Practical measures to manage the fisherydepend on knowledge of changes in theexploited stocks. If the stocks are stableor increasing, then all is well, but if theyare declining then current catch levels arenot sustainable and some action is necessaryto ensure a long term future for thefishery. The central problem is that measuresto

improve an overexploited stockgenerally involve a reduction of catchesfrom the present level. Unfortunately, the short term economic consequencesfor the fishermen can be severe, in whichcase they will try to maintain theircatches by any means.

Management measures which areimposed without the support of the fishermenare unlikely to be effective. According to MacLennan (1998), thereare two key issues to be considered in dealing with this problem:

1. Proposedmanagement measures must bebased on reliable scientific advice whichfully justifies the need for constraints onfishing, and this advice must beexplained to the fishers in terms that theycan understand.
2. The socio-economiccircumstances of the fishermen must be well understood, to avoid measureswhich cause unacceptable hardshipand to promote cooperation between thefishing communities and the regulatoryauthorities. A cooperative and multi-disciplinaryapproach to stock assessment isessential for the beneficial managementof fisheries as a long term sustainableresource.

Artisanal-fishing management systemswill have aneconomic impact with successful regulation that increases the catch levelspermitted while maintaining fish stocks steady and reduces efforts tosocially optimize fish catches.

5. 1 Artisanal-fishing management systems

Four management methods are suggested:

1. Free access withcontrols in the form of closed seasons for certain species.
2. External regulationthrough fines to encourage optimal catch levels.
3. Regulation through fishermen self-management.
4. Co-management between fishermen and fishing authoritiestoensure capture at optimal levels.

Among those four types the co-management seems to ensure the lowest catch level, the greatest profits, and the highest stocklevels in Manabi. This agreed with previous findings outlined by Lemay*et al.* (2008) and Maldonado (2008).

5. 2 Sustainability of artisanal fishing

The economic and social sustainability ofartisanal fishing depends on the state of the natural resource. It is therefore criticalthat fishing be managed and that agreements reached between fishermen to allowfor a catch rate consistent with natural rates of reproduction and growth of thestock. The population numbers of traditional fish stocks—such as mahimahi, marlin, swordfishare unknown, and allowable fishinglevels that would ensure long-term sustainability have not been determined. Somespecies, such as shark, are protected by international agreements. Current management methods such as closed seasons, fishing restrictions have been ineffective in this regard, especially for artisanal fishing. The16, 000 fleet of traditional fishing vessels is considered oversized inproportion to the availability of fishing resources.

Fishing is a freely accessibleactivity, with few incentives for artisanal fishermen to participate in efforts toimplement and monitor any form of management. For

improved, more effectivemanagement, a number of actions must be designed and implemented to:

a. Improve the information on resources.
b. Develop co-management plans on anappropriate scale.
c. Promote productive alternatives to help reduce pressure onresources.

Maintaining stocks at levels capableof producing the maximum sustainable yield (MSY), is a targetreference point. According to IATTC (2005), the current effortlevel of yellow fin tuna is below that capable of producing the MSY and that biomass is above the BMSY level. For bigeye tuna the current biomass level appears to be below the BMSY. With the exception of chub mackerel, few of the most important stocks can be considered depleted (INP website). According to Turriago(2001), the lack of scientific evidence about the status of stocks and thelevel of fishing effort has precluded any support for management measures. Furthermore, no specific information is available about fishing of juveniles and spawnerswhich should be restricted to safe levels,

5. 3 Fishermen's Cooperative

The situation varies among fishing communities (Turriago*et al.,* 2001). While somecommunities suffer from lack of governmental attention and have a minimal institutional presence (with theexception of education, health and security services), others receive national, international and nongovernmentalsupport through different development programmes. According to Poggie et al. (1988), the most important factors influencing fishermen's cooperativesuccess in Ecuador are management style and social solidarity. Of the two, socialsolidarity seems to be the most important, related strongly and significantly to bothmariculture and capture cooperatives. In an earlier analysis of the same data, PoggieandFierro (1987) emphasized education level of administrator as an important determinantof cooperative success.

Management and social solidarity are differently related to the success of mariculture and fish capture cooperatives.. Emphasis on both styles, however, will result in a greater probability of success.

Over-fishing and habitat destruction impose serious dangers on fish stocks. Both artisanal and industrial fishermen suffer from such destruction. However, it was more severe on small scale fishing activities. Fisheries law must be respected and the call to law enforcement is essential. Fishermen cooperatives or associations can help in such act by preserving their usual fishing habitats or for domestic consumption, using small boats.

5. 4 Strategic Plan

Artisanal fishing in Manabi Province needs an action plan based on four basic strategies:

a. Regulation of fishing activity toensure sustainability and conservation marine resources.
b. Control and monitoring of fishing laws and regulations.
c. Comprehensive fisheries research that address specific purposes.

d. Improvementof socioeconomic indicators in artisanal fishing communities.

Similaraction plan has also been suggested and adopted by the (SRP) for artisanal fisheries.

6. Recommendations

To enhance the sustainability and regulation of artisanal fishing in Manabí Province, the following recommendations are suggested:

1. Encouraging investment small communities that depend on artisanal fishing.
2. Establishing areas devoted exclusively to artisanal fishing and resource conservation.
3. Implementation of a fishing co-management system via fishermen's associations.
4. Developing economic analysis capacity.
5. Design and establishment ofa monitoring system to collect and analyze statistical data.
6. Establishment of a network of service centers at fishing facilities.
7. Implementation of a comprehensiveresearch plan to generate the information needed to manage artisanal fishing,

ACKNOWLEDGMENTS

The present investigation was carried out as partial activity of ¨Prometeo Project¨ funded by SENESCYT, Ecuador. Facilities have been provided by ULEAM University and Fisheries Authority (VMAP, SRP) in Manta and National Fisheries Institutes (INP) in Guayaquil, Ecuador. The authors are indebted to all these institutes, and their efforts are deeply acknowledged.

REFERENCES

[1] Asociación de Exportadores de Pesca Blanca de Ecuador (ASOEXPEBLA) 2005.
[2] http://www. pescablanca. com/pesca-blanca. php?id=44&gid=14.
[3] Castello, M. 2001. Estudio se la calidad microbiologica de los pescadosfrescos en exportación. Tesis de grado la obtención del titulo de dectora en Quimica y Farmacia. Universidad de Guayaquil Facultad Ciencias Quimicas. Guayaquil-Ecuador. 315 pp.
[4] CIAT, http://www. iattc. org/ResolutionsActiveSPN. htm.
[5] FAO (2010) Fishery statistics. Food and AgriculturalOrganization of the United Nations website. http://www. fao. org/fishery/statistics/global-commodities-production/ec.
[6] IATTC (2005) website, http://www. iattc. org/HomeENG. htm
[7] Icochea, L. 2007. Qué Sabemos y Qué no Sabemos de la Oceanografía Física
[8] y Biología Asociada con las Migraciones del Dorado/Perico
[9] INP. 2010. El Instituto Nacional de Pesca http://www. inp. gov. ec/marco. htm.

[10] Largacha, E., Parrales, M., Rendón, L., Velásquez, V., Orozco, M. & Hall, M. 2005. Working with the Ecuadorian fishing community to reduce the mortality of sea turtles in longlines: The first year March 2004-March 2005. Western Pacific Regional Fishery Management Council. 57 p.

[11] Lemay M., Llaguno D., Ardila S., Bazán F., Killmer A., Crausaz P., Alemán M., Buchara D. and Chávez E. 2008. Ecuador support for coastal artisanal fishing (EC-L1059). Loan Proposal, Inter-American Development Bank.

[12] MacLennan, D. N. (1998) Development of an Information System on Effort, Catches and Characteristicsof Artisanal Fisheries in Ecuador. *Summary reports of European Commission supported STD-3 projects (1992-1995), published by CTA1998, 27p.*

[13] Maldonado, J. H. 2008. Analysis of surveys conducted in fishing communities to Support for the preparation of project EC-L1059 (PROPESCAR). September. 2008.

[14] Martínez-Ortiz, J., Zúñiga-Flores, M. S., Moreira-Merchán, M., Zambrano-Zambrano, R., Rivadeneira-Cagua, Y., Bravo-Vásquez, K., Mero-Veliz, P., Lavayen-Zapata, F., García-Domínguez, M., Cevallos-García, A., Reyes-Lucas, J., Alcívar-Leones, F., Ávila-Zambrano, E., Daza-Bermeo, C. &Gilces-Anchundia, M. 2012. Estudio de caso: Estado actual del conocimientodel recurso dorado (*Coryphaenahippurus*) Linnaeus, 1758 en aguas del Océano Pacifico Suroriental (2008-2011). Informe Técnico Final del proyecto

[15] titulado: "Dinámica de la población: la pesca y la biología del dorado en Ecuador" / Case Study: Currentstate of knowledge of theresource (*Coryphaenahippurus*) Linnaeus, 1758 in SoutheastPacificOcean (2008-2011). Final Technical Report of the Project entitled: Dynamics of thepopulation: fisheries and fish biology of the mahimahi in Ecuador". Martínez-Ortiz J & MS Zúñiga-Flores (eds.). Boletín Técnico MAGAP-MSC-EPESPO. 142 pp.

[16] Palko, J. B., Beardsley, G. L. & Richards, W. J. 1982. Synopsis of thebiological data on dolphin-fishes, Coryphaenahippurus and Coryphaenaequiselis L. NOAA Technical Report NMFS Circular 443, FAO Fish SynopsisNo. 130, 28.

[17] Patterson, K. R., Pitcher, T. J. and Stokes, T. K. (1993) A stock collapse in a fluctuating environment: the chub mackerel *Scomberjaponicus*(Houttuyn) in the eastern central Pacific. *Fisheries Research* 18: 199-218.

[18] Peralta, M. 2008. Aspectos Biológicos y Pesqueros del Recurso Dorado(Coryphaenahippurus) en Aguas Ecuatorianas; INP

[19] Poggie, J. and M. Fierro. 1987. Correlacion sociocultural del exito de las cooperativas pesquerasartesanales ecuatorianas. In C. Mariscal, F. Carrion, and A. Kallweit (eds.): *La PescaArtesanal en el Ecuador*, Quito: el Centro de Planificacion y Estudios Sociales.

[20] Poggie J., Pollnac R. and Fierro M. 1988. Factors Influencing the Success of Fishermen'sCooperatives in Ecuador. *Marine Resource Economics*, Volume 5, pp. 231-242.

[21] SRP (2013). Subsecretaria de recursos pescqueros, Ecuador. Website www. SRP. gob. ec.

[22] Turriago, C. S. B. 2001. Promoción de la ordenación de la pesca costera: Aspectos socioeconômicos y técnicos de la pesca artesanal en El Salvador, Costa Rica, Panamá, Ecuador y Colombia. FAOFisheries Circular No. 957/2. 79 p.

[23] VMAP. 2012. Indicadores Socioeconomicos del Sector Pesquero Artesanal de la Continental Ecuatoriana. CENSO PESQUERO (FASE I + FASE II + FASE COMPLEMENTARIA). Vice Ministerio de Aquaculture y Pesca Project.