Assessment of the South coast spiny lobster fishery

South coast Fisheries management area - II

Hambanthota District

National Aquatic Resources Research and Development Agency &
The World Bank

Assessment of the South coast spiny lobster fishery

Fisheries management area II

(Hambanthota District)

Study Team

U.S.P.K. Liyanage, Senior Scientist - NARA

Dr. Rishi Sharma – Senior Fisheries Resources Officer-FAO

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National Aquatic Resources Research and Development Agency (NARA)

Regional Research Center

Kapparathota, Weligama

Sri Lanka

World Bank

Counyrt office, No 2, Chittampalam A. Gardiner Mawatha

Colombo 2, Sri Lanka

Aim of the study

Spiny lobsters are highly valuable export commodity in Sri Lanka mainly harvested by small scale fishes of the Hambanthota district; hence, this fishery plays vital role in their economy. Over exploitation of the resources and declining income would be create negative consequences on the ecosystem and socio-economic condition of the fishes. The fishery is managed under set of regulations including the fisheries co-management mechanism established under the FAO CIDA funded CENARA project. Current study is aimed to provide recommendations based on the resources status to the Department of Fisheries and Aquatic Resources for sustainable management of the fishery.

Executive summery

Lobsters are one of the most valuable and economically important crustacean species found in Sri Lankan coastal waters largely used for export. The resources are declining due to over exploitation with the increasing demand, violation of the regulations and environmental degradation etc. Understanding of the current status of the resource is important for review existing management regulations. Major lobster landings sites and exporting companied in the Hambanthota district were visited for sampling once or twice a month since 2006. Among the five species of lobsters recorded in coastal line of Hambanthota district; P. homarus is the most dominant species contributing more than 72 percent to the catch. Meanwhile P. versicolor amount has been gradually increasing from 1< % to 18%, but P. ornatus, the most valuable species composition declined drastically. Percentages of the P. longipes and P. penicillatus remain in same for a long time period and also no any individual of P. polyphagus found in the landings. The length frequency analysis of the P. homarus revealed that second spawners largely contributed to the catch (60-70 mm in CL) and larger lobsters are rarely found. Egg removed female lobsters are commonly found in the catch and also P. homarus LBSPR value around 20% (reference point 30%) emphasize the urgent need of immediate conservation and management regime against over exploitation. For protect spawners complete prohibition of catching females for some period or increase the minimum legal size for females more 20mm, extension of the closed season, strict enforcement of the regulations and fishing effort control through separate license and strengthen the co-management mechanism are recommended.

Acknowledgement

The spiny lobster fisheries data collection has been continuously carried out by National Aquatic Resources Research and Development Agency (NARA) for review the existing management regulations based on the current status of the fishery. This assessment work completed by the NARA with the technical assistance of the World Bank. Authors would like the express their sincere thanks to the Prof. Jayantha Wijeratne, Chairman, Dr. H.M.P. Kithsiri, Director General and Dr. S. Haputhanthri, Head, Marine Biological Resources Division of the NARA for their kind assistance. The corporation and technical assistance given by the World Bank team Mrs. Sachiko Kondo, Dr. Nadeera Rajapaksha, Mrs. Tijen Arin are also highly appreciated. Further, authors would like to thanks Mr. S.P. Jayasuriya, Mr. W.A.L. Wickremasinghe and all other staff members of the Kapparathota Regional Research Station of the NARA for their assistance in data collection and data entry. Support given by Srimic Sea food Export (PVT) Ltd, lobster collectors, lobster fishes of the Hambanthota district and the officers of the Department of Fisheries and Aquatic Resources Development are also highly appreciated. Valuable comments given for the reports and data analysis by Dr. Steven Creech and Mr. H.S.G. Fernando (Co-management consultant) are also highly appreciated.

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1. Introduction

Lobsters are one of the most valuable and economically important crustacean species found in Sri Lankan coastal waters largely used for export. Major fishery of the country is located in the south coast of Sri Lanka from Tangalle to Amaduwa in Hambanthota district and adjacent coastal region of the Ampara district. This fishery is very popular among the south coast small scale artisanal fishes specially in Hambanthota district and approximately 4000 people directly or indirectly depend on it. Mean annual lobster export of the country is around 225 MT (Fig. 1) and the Hambanthota district is contributing in an average 60% to the national lobster production. Since ninety five percent of the catch are been exported, increasing demand in the foreign market is accelerating the exploitation rate.

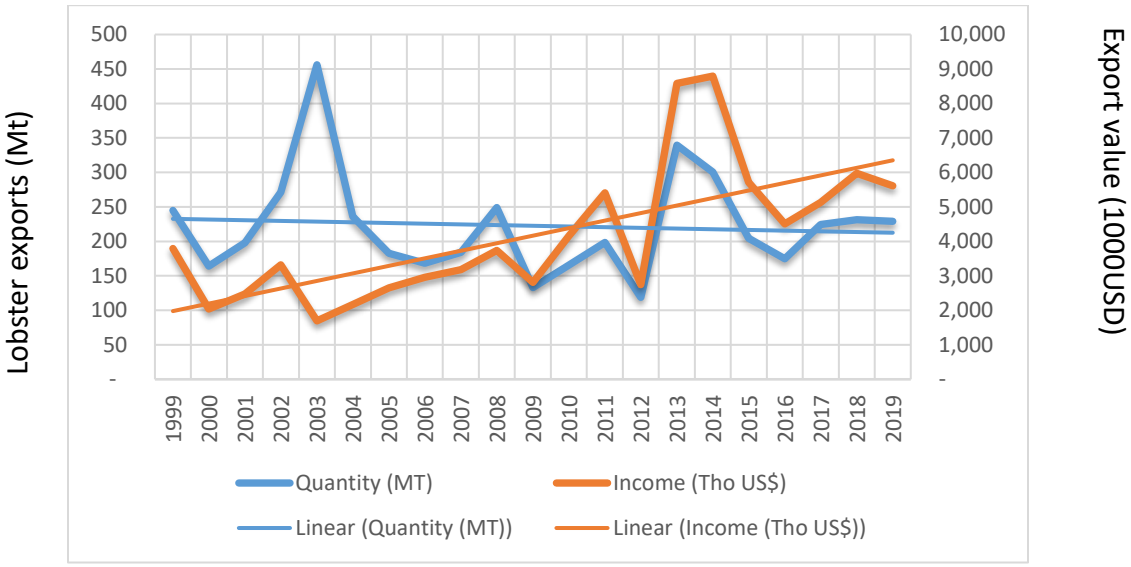

Figure 1. Spiny lobster export volume and income from 1999 to 2019 (Source Statistical division MOFAR)

Spiny lobster export volume and income presented in figure 1 revealed that export volume has been slightly falling from 1999 to 2019, but income slightly increasing with the time due to growing demand in the foreign market. Meanwhile competition among the export companies and middlemen in the landing sites for limited production, influence the price growth. During the Corona epidemic all the fisheries collapsed worldwide, but Sri Lankan lobstermen received lucrative price in the history since lobster importing countries (China and Hong Kong) stopped or limit importation from other countries and ordered more than regular from Sri Lanka as Corona controlled country. But early period of the corana, lobster exports were collapsed due to cancellation of the air freight. Further, during this period local fish consumption declined seriously and distribution collapsed due to Corona infection to the venders of major fish markets. As a

consequences of poor market for local fish production and great prices for the lobsters, all the lobster fishermen linked with the lobster fishery for getting the benefits from corona. Thus, increasing market prices encourage the fishermen to harvest more lobsters and further hang on with lobster fishery without leaving under small catch rates. But in past years, all the lobster fishes were operated only during the peak season just after the closed period and left gradually with the declining catch rates.

World lobster fishery support to produce 260,000 MT annually through the industrial or artisanal fisheries (Penn et al., 2015) but declining catch rates revealed that majority of the lobster fisheries are fully exploited or over exploited (Phillips & Smith, 2006;). Even though lobster fishery resources are declined below the sustainable level due to overfishing, fisheries activities are continuing as a result of high price per kilogram and low operational cost. Industrial fisheries in the temperate regions are well manage under set of regulations including effort and biological controls limits but in most of the Asian and African countries, those regulations are primitive and inactive (Kulmiya et al, 2006).

1.1. Lobster fishery management in Sri Lanka

Sri Lankan spiny lobster fishery resources have been declining since 1970's, hence first spiny lobster regulations were implemented in 1973. Again in the year 2000 some of these regulations were revised and new regulations amended to it based on the scientific evidences. It includes

- Minimum legal size
- Closed season
- Prohibition of catching berried females and
- Effort control measures (License) operation and export measures

But past researches revealed that south coast lobster stocks are declining as a result of catching berried females, environmental degradation, increasing fishing efforts and violation of the available regulations (Sanders & Liyanage, 2009; Liyanage & Long 2009). Therefore, spiny lobster fisheries co management mechanism introduced to major lobster producing districts based on the scientific researches completed with the consultation of FAO stock assessment experts. Ultimately, in year 2012, gazetted the "fishing operation regulations of catching chank or lobster in south coast fisheries management area (Hambanthota district)" for further control the effort in major lobster producing district. In addition to the national legislation in the year 2000, fisheries co management regulation were formulated to each fisheries management area in consultation with all related stakeholder groups. As a major spiny lobster producing district in Sri Lanka, this study aimed to understand the current status of the fishery for review the available regulations.

2. Methodology

2.1. Study area

Hambanthota district is the major spiny lobster producing district in Sri Lanka which is contributing 60% to the national production. Lobsters are widely inhibiting in shallow coastal stretch from Tangalle to Patanangala in Yala national park (Figure 4) but currently Patanangala is not in use for operations. Six species of spiny lobsters were recorded in the lobster ground but one species, *P. polyphagus* rarely recorded in the past but now no records. Four species among five *P. homarus, P. versicolor, P. penicillatus and P. longipes* are inhibit in shallow waters below 20 m but *P. ornatus* is found in deeper waters below 30m (Jayakody & Kensler, 1986; De Bruin, 1962; De Bruin *et.al*., 1995).

2.2 Sampling

Major lobster landings sites and collecting centers (Branches of the exporting companies) in the Hambanthota district (Figure 2. Amaduwa, Kirinda, Hambanthota and Tangalle) were visited once a month for fisheries and biological sampling. Amaduwa is the largest lobster landing sites in the district mainly occupied by the migratory fishermen of Rekawa, Welipatanwila and Mawella villages. Lobster exporting companies are not established there branches in every landing site, therefore middlemen (Collectors) are brought this catch into the branches which we have selected for the sampling.

Historical data in the year 2007, 2014. 2015, 2017, 2018, 2019 and 2020 considered for the analysis. In the year 2007 all major lobster landings were visited twice a month and also in 2017 each landings site visited every week. While the sampling all the catch brought into the collecting center were measured during the sampling day (6.30 am to 12.30 pm). Carapace length (CL), total length (TL), sex, species composition presence or absence of external eggs or spermatogonia, craft type, gear, catch volume were recorded.

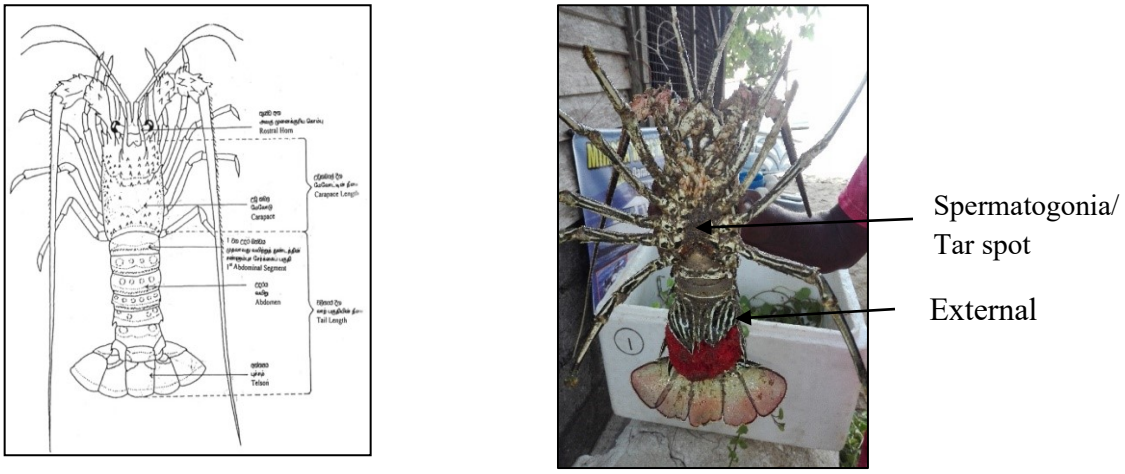

Figure 2. (A) Length measurements of the spiny lobster, (B.) Female lobster with eggs and spermatogonia

2.3. Data analysis

Data analysis was performed following both conventional and none conventional methods including Length Based Spawning Potential Ratio (LBSPR) calculated using the "Barefoot Ecologist ToolBox" (Hordyk *et al*., 2015).

Life History Parameters (LHP): Four key life history parameters (LHP) are required to run the length-based spawning potential ratio (Hordyk *et al*., 2015) app in Barefoot Ecologist's Toolbox (www.barefootecologist.au). The four LHP are

A. The ratio of natural mortality (M) to growth (k) i.e. M/k;
B. Asymptotic carapace length (L_{inf});
C. Carapace length at 50% maturity (L_{m50})
D. Carapace length on 95% maturity (L_{m95}).

Preliminary review of the literature describing values of M, k CL_{inf} and CL_{m50} for the scalloped spiny lobster (*Panulirus homarus*) is presented below

L_{∞} =117mm

M/K Ratio = 1.74

L_{50} = 61.2mm

L_{95} = 67mm

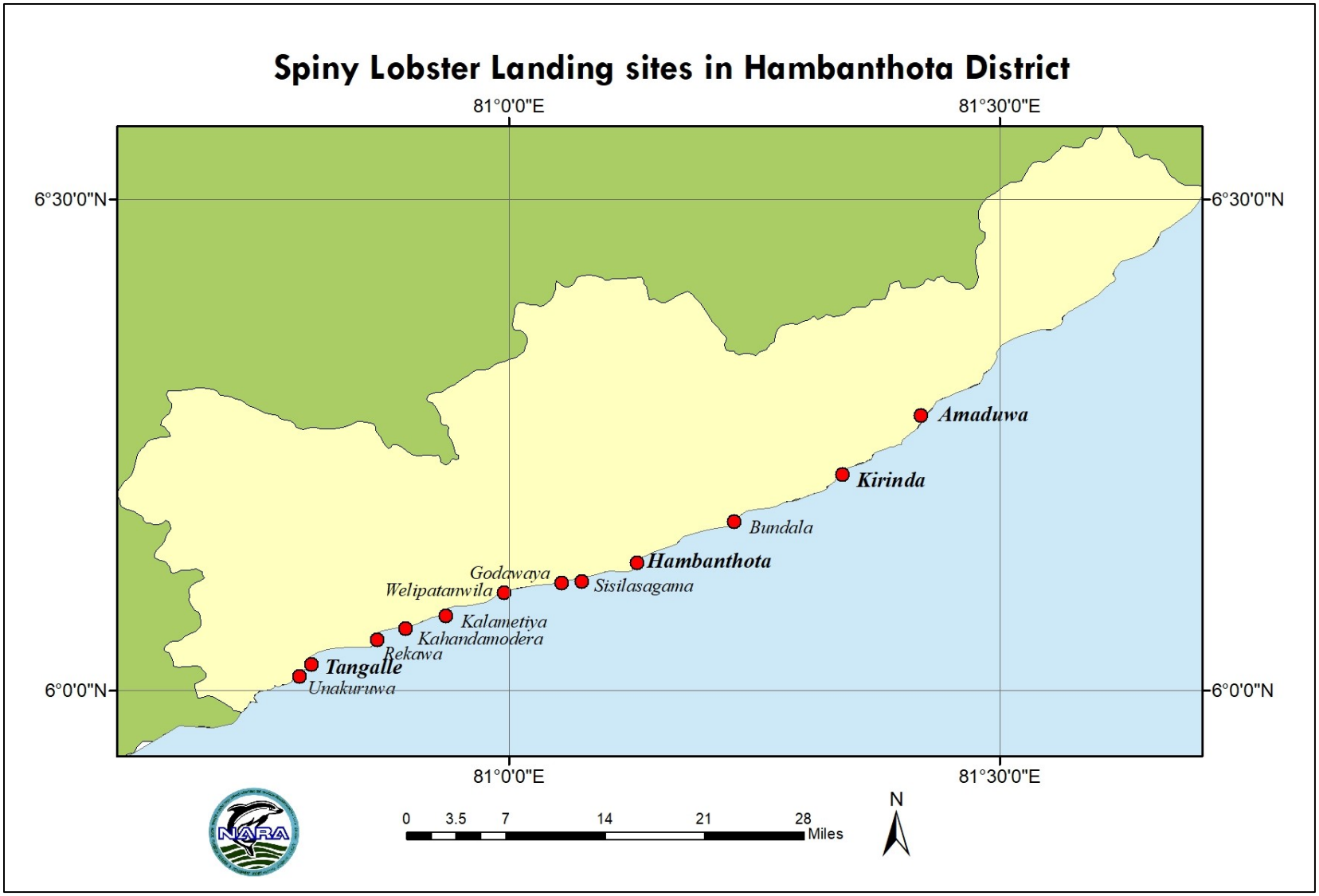

Figure 3. Lobster Landing sites in the Hambanthota district

3. Results

3.1. Species composition

The annual changes of the species composition in the landings are summarized in Table 1.

Table 1. Species composition of the catch since 2006 to 2020

Species	Percentage of the catch					
Year	2006	2015	2017	2018	2019	2020
P. homarus	86	86	91	72	85	73
P. ornatus	3	13	3	7	1	0
P. penicillatus	3	<1	1	3	2	8
P. longipes	2	<1	1	3	2	1
P. versicolor	6	<1	4	15	10	18

Among the five species of lobsters recorded in Hambanthota district *P. homarus* is the most dominant species contributing more than 72 percent to the catch. Meanwhile *P. versicolor* amount has been gradually increasing from 1< % to 18%, but *P. ornatus*, the most valuable species composition declined drastically. Percentages of the *P. longipes* and *P. penicillatus* remain in same for a long time period and also no any individual of *P. polyphagus* fond in the landings.

Mean annual species compositions of the catch are shown in the figure 3.

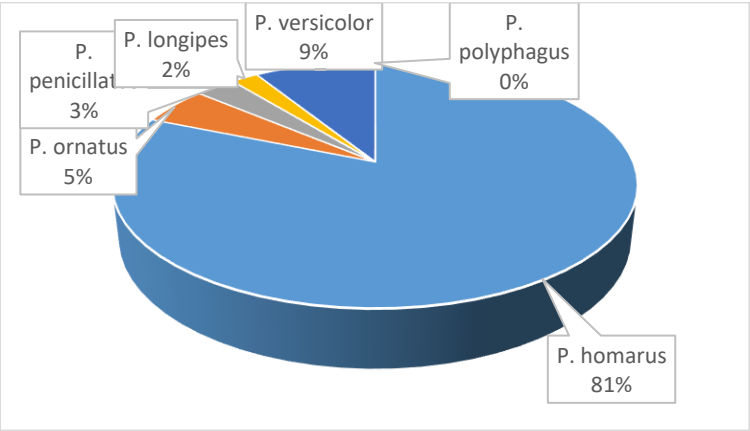

Figure 4. Mean annual species composition of the landings

Figure 4. reveal that scalloped spiny lobster (*P. homarus*) contributed 81% to the catch and second dominant species painted spiny lobster (*P. versicolor*) contributed 9 %. Meanwhile other species *P. longipes, P. ornatus* and *P. penicillatus* were represented respectively 2%, 5% and 3%. In year 2020 ornate lobsters (*P. ornatus*) are very rare in the catch and only two individuals recorded within the sampling period. But it doesn't mean that the threat level of the population because of

all the lobster net operators are setting their nets in shallower areas in between 4- 20 m and this species inhibits depth below 30m.

3.2. Length frequency analysis

Using the data collected in the year 2020 length frequency distribution for the two major species are shown in the figure 5.

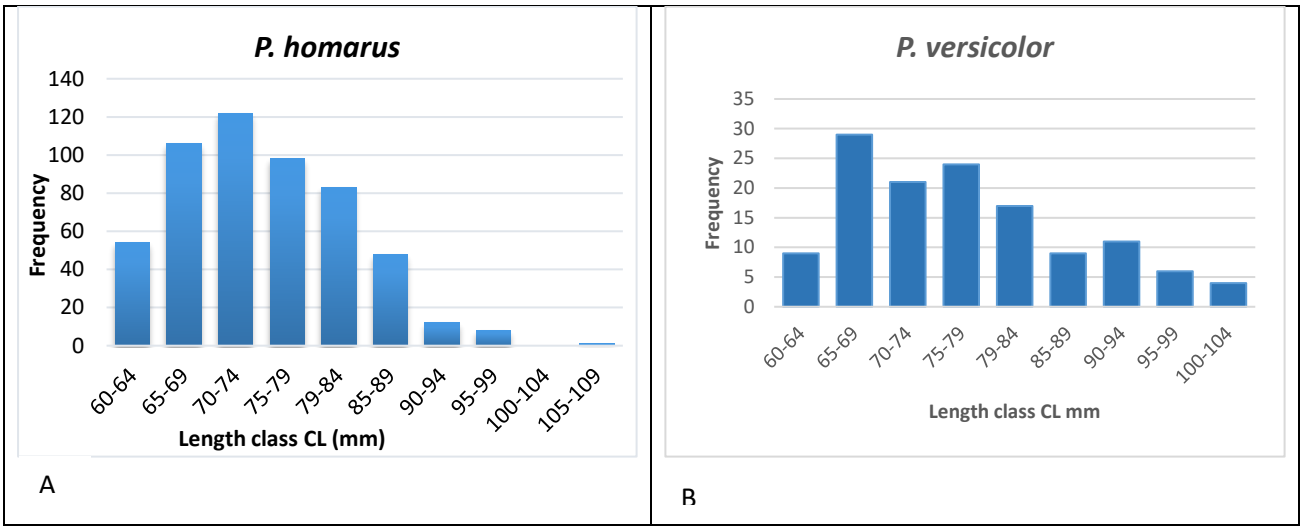

Figure 5. Length frequency A) Carapace length (mm) P. homarus, (B.) P. versicolor.

According to the length frequency distribution charts, *P. versicolor* stock is healthier than the *P. homarus*. Two individuals of *P. ornatus* were found in the catch but one of them was below the minimum legal size. Other two species also above the minimum legal size.

Table 2. Mean carapace length of the catch in mm

Species	*P. homarus*	*P. longipes*	*P. ornatus*	*P. penicillatus*	*P. versicolor*
2007	66.05±12.43	78.34±22.27	90.31±95.40	80.73±16.37	73.55±16.90
2017	71.20±18.7	68.90±9.2	100.2±24.1	78.20±13.10	80.4 ±18.7
2018	73.88±9.2	83.37±14.42	113.30±11.85	90.66±36.73	83.71±14.42
2019	72.05±8.1	80.38±9.44	74.2±10.2	93.74±20.98	81.59±11.9
2020	74.7±8.34	77.2±15.27	80.4±22.62	85.3±14.98	77.9±11.33

Length frequencies (LF) of the major species (*P. homarus*) is quite good compare to the past years (Table 2) and also LF of *P. penicillatus* and *P versicolor* also are better than the *P. homarus*. In 2020 all the lobsters in the catch were above the minimum legal size and mean carapace length (pooled all species together except *P. ornatus*) was 74.9 mm is 14.9 mm above the average minimum legal size. But in the year 2007, pooled mean carapace length (except *P. ornatus*) was 66.74mm was 6.74 mm above the minimum legal size but as an average 15.17% of the catch included under sized lobsters (except *P. ornatus).* According to the table 03, 83% of the *P ornatus*

in the catch were immature lobsters. Further, as a percentage *P. homarus* under sized lobster consisted 11.52%. However, large quantity of small lobsters were landed during the period as a consequences of poor implementation of the regulations and less awareness of the fishes regarding the available stocks size.

Table 3. Species wise composition of the undersize lobsters in the catch (Year 2007)

Species	*P. homarus*	*P. longipes*	*P. ornatus*	*P. penicilatus*	*P. versicolor*
No of lobsters sampled	2577	2	104	5	22
No of Undersized	297	25	87	58	107
Percentage of the undersized	11.52	20	83	8.6	20.56

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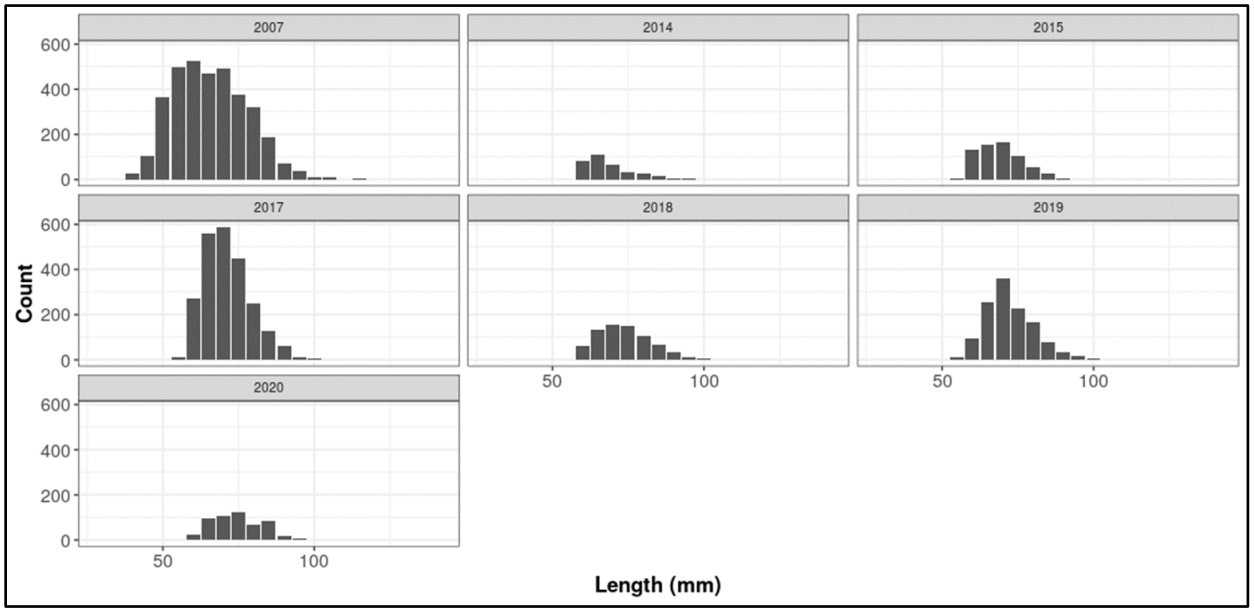

Figure 6. Annual length frequencies of the P. homarus

Annul length frequency distribution charts generated through the barefoot ecologies tools for the major species *P. homarus* are summarized in the figure 5. Those charts revealed that during the base year (2007) catch consisted large number of undersized lobsters as well as small once just above the minimum legal size. However, with the time undersize lobsters are not further available in the catch and mean crarapace length of the catch has been increasing gradually (Table 2).

3.3. Female lobsters carrying eggs

Since the harvesting of berried females adversely influence on the growth of depleted lobster stock, several actions have been taken by the Sri Lankan government for conservation of them included closed seasons (Feb, Sep & Oct) and prohibition of catch or possession of berried females and remove their external eggs. Regulation on closed season is strictly enforced but removal of external eggs is widely practiced because fishermen remove eggs and tar spot very carefully without sign of occurrence. Since long experience is needed to detect the signs of removed eggs law enforcement on this matter is poor. The socio economic status of the lobster fishes and high price of the lobster also coupled with this egg removal. Since the individual value of a lobster several thousand of Sri Lankan Rupees, never release them to the sea. In the year 2007 found around 14 % of lobsters with eggs, but this bad practice is still continuing.

Monthly variation of the percentages of berried females in the catch was shows in figure 6.

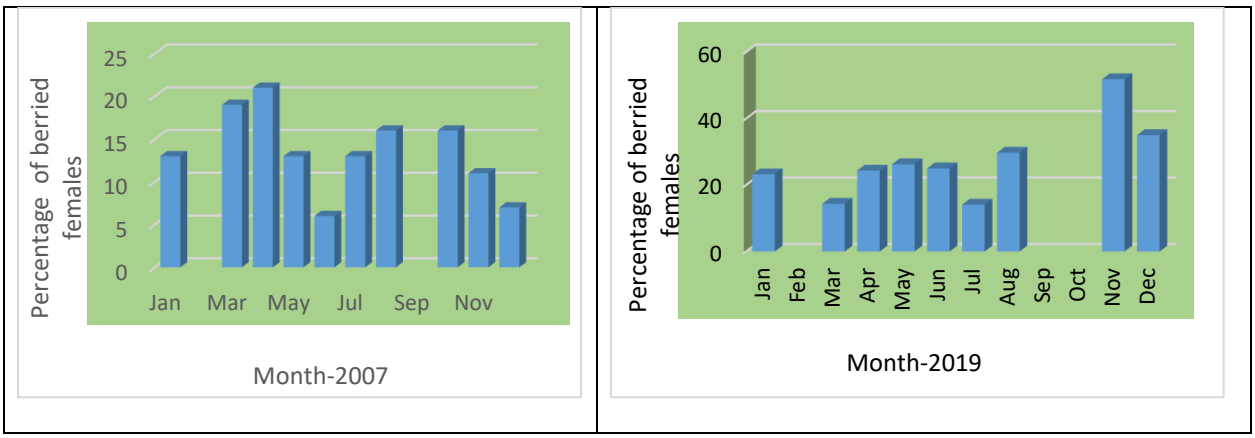

Figure 7. Monthly variation of the berried females in the catch (a) 2007 and (b) 2019

Peak breeding seasons of the lobsters are determine by the oceanographic conditions including temperature, salinity and length of photo period in their environment (Muesy & Payen 1988; Sachlikidis et al., 2005). In the Indian ocean around Sri Lanka, reversal monsoonal wind are (Southwest and northeast) playing vital role influencing oceanographic changes which are inducing biological productivity of the ocean ecosystem (Yapa, 2000; Vinayachandran et al., 2004; De Vos et al., 2014). Therefore breeding cycles of the many ocean creatures and sea birds are couple with this seasonal changes (Claereboudt, et al., 2005; Monticelli et al., 2007; Abesamis et al., 2015).

Spiny lobsters are breeding throughout the year with two peak breeding seasons (Figure 7). Based on the previous research which have been done in 2007, two peak breeding seasons were determined; hence February, September and October months were declared as closed seasons. According to the figure 7(b) second peak breeding extended up to November, and many of the fishes are operate during November since the calm sea condition favorable for diving. In Hambanthota district not allowed to SCUBA diving for lobsters but chank fishes illegally collect lobsters while diving for chank. In addition to the chank divers in November outside divers of the

district are who are operate for the marine ornamental fish also illegally operate in this sea area. Since the berried females are more vulnerable to the catch by scuba divers, illegal diving catch included many berried lobster but statistics are rare (Personnel Communication with fishermen).

3.4. Length Based Spawning Potential Ratio (LBSPR)

Not like bony fishes it is difficult to estimate the age structure of the crustaceans through the conventional methods since lack of permanent hard parts in their body which can be used for age determination (Prince et al., 2020). Therefore, the Length Based Spawning Potential Ratio (LB-SPR) is a well-accepted and cost effective method for sustainable management of small scale data deficient fisheries. (Hordyk et al., 2015). Sri Lankan spiny lobster fishery also have been identified as small scale artisanal data deficient fishery, hence LBSPR used to assess the current status of the spawning stock size.

Length based spawning potential ratio was calculated only for the major species *P.homarus* since no enough data for calculated to other four species.

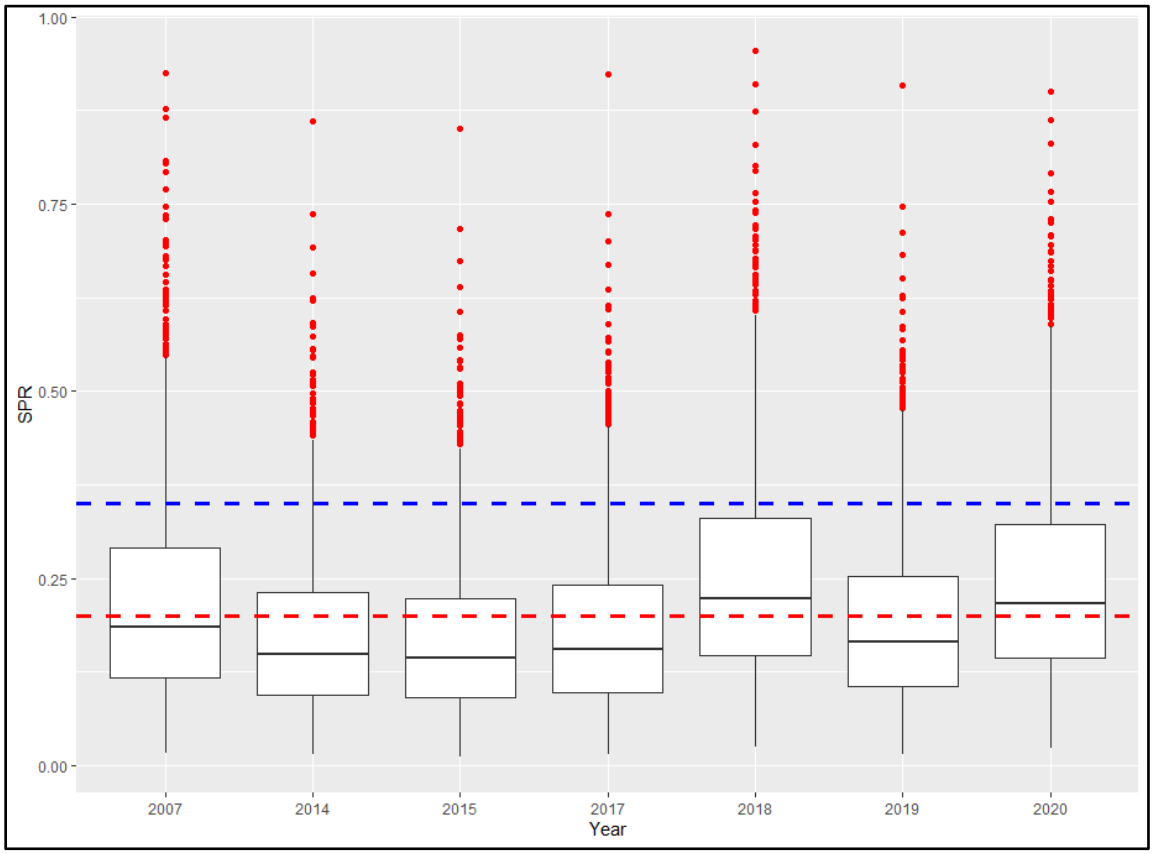

Figure 8. Annual LBSPR values blue line is a threshold of reference point.

Calculated LBSPR values for whole period reflect the threat levels of the stock. LBSPR values for whole period is below the 20% and values for this two years are just above the 20 %, but expected

Lower reference point range 30-40% since these species is more vulnerable to fishery. The currents values are sometimes below the threshold limit 20%.

3.5. Selectivity and Maturity

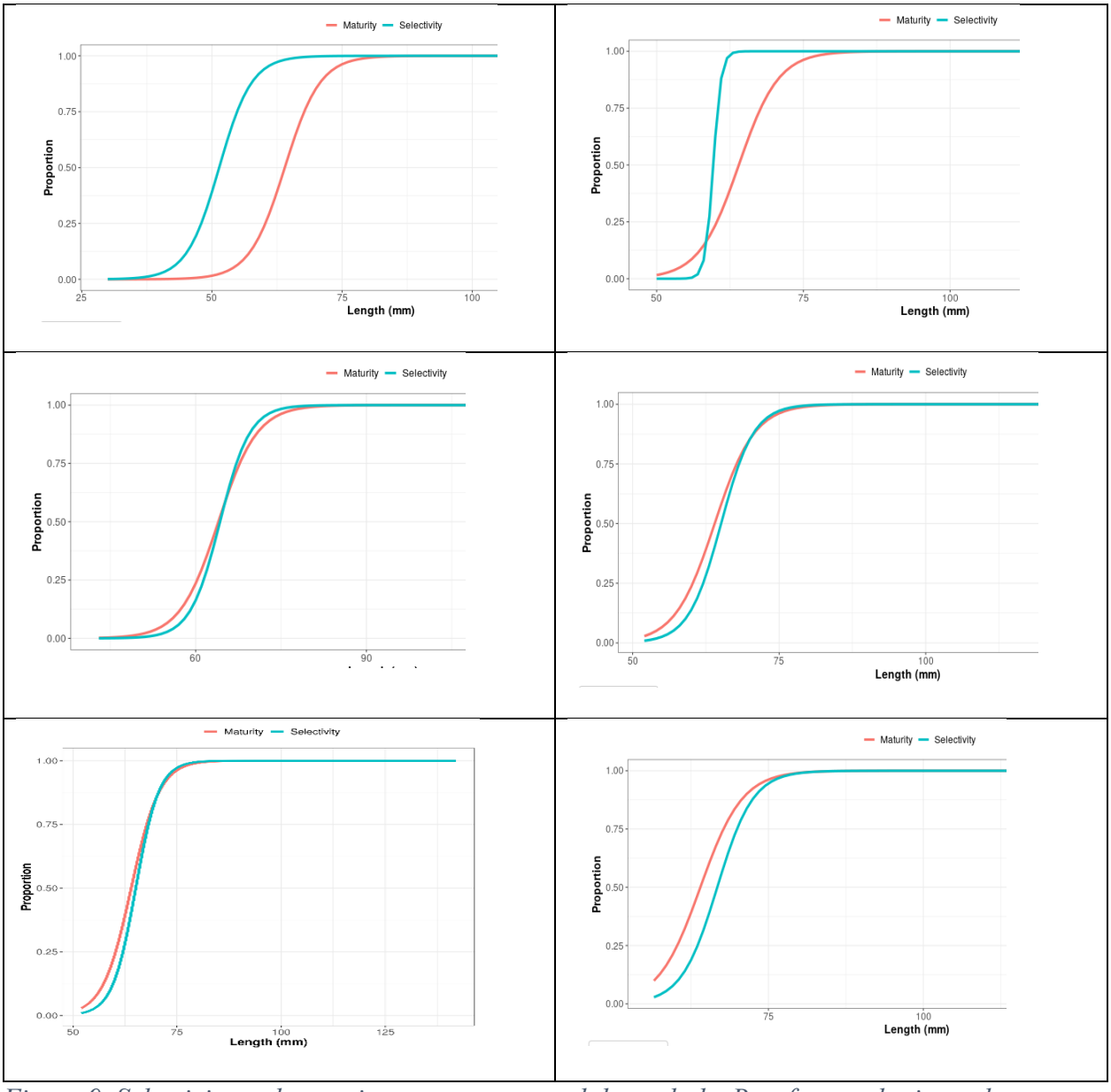

Figure 9. Selectivity and maturity curves generated through the Barefoot ecologist tools

As evident from the figures above the selectivity and maturation ogives are quite similar; in the earlier periods this was skewed to fish on immature cohorts but has changed over time. However, the size structure still indicates through the stochastic LBSPR that the exploitation is quite high.

Years	SPR	SL50	SL95	F/M
2007	0.22 (0.2 - 0.24)	54.44 (53.33 - 55.55)	66.54 (64.58 - 68.5)	1.39 (1.24 - 1.54)
2014	0.18 (0.15 - 0.22)	59.91 (59.63 - 60.19)	60.6 (58.43 - 62.77)	2.22 (1.81 - 2.63)
2015	0.17 (0.15 - 0.19)	60.52 (59.68 - 61.36)	64.94 (62.98 - 66.9)	2.57 (2.16 - 2.98)
2017	0.2 (0.19 - 0.21)	63.89 (63.21 - 64.57)	71.23 (70.03 - 72.43)	2.68 (2.42 - 2.94)
2018	0.27 (0.24 - 0.31)	64.87 (63.49 - 66.25)	73.02 (70.55 - 75.49)	1.83 (1.49 - 2.17)
2019	0.21 (0.2 - 0.23)	65.66 (64.79 - 66.53)	74.09 (72.57 - 75.61)	2.76 (2.41 - 3.11)
2020	0.27 (0.23 - 0.31)	67.15 (65.17 - 69.13)	75.73 (72.23 - 79.23)	2.17 (1.63 - 2.71)

Table 4: SPR values obtained from equilibrium SPR model

Table 5. Model estimates (95% CI) from the stochastic LBSPR

SPR	2007	2014	2015	2017	2018	2019	2020
2.50%	0.04	0.03	0.03	0.04	0.06	0.04	0.06
50%	0.19	0.15	0.14	0.16	0.22	0.16	0.22
97.50%	0.63	0.49	0.47	0.50	0.65	0.51	0.63
>	apply(Ex.Spp.LobSL$Sel50,2,quantile,c(0.025,0.5,0.975),na.rm=T)						
sel50	**2007**	**2014**	**2015**	**2017**	**2018**	**2019**	**2020**
2.50%	58.6	59.3	60.1	61.0	61.7	62.3	62.6
50%	59.5	60.1	60.9	61.8	62.6	63.1	63.5
97.50%	60.1	60.7	61.5	62.3	63.1	63.6	64.0
>	apply(Ex.Spp.LobSL$Sel95,2,quantile,c(0.025,0.5,0.975),na.rm=T)						
Sel 95	**2007**	**2014**	**2015**	**2017**	**2018**	**2019**	**2020**
2.50%	64.2	64.5	65.3	66.7	67.7	68.5	68.9
50%	66.0	66.1	66.9	68.2	69.3	70.1	70.6
97.50%	67.3	67.4	68.2	69.4	70.4	71.1	71.6

There are slight difference between the analytical equilibrium based assumption of LBSPR and stochastic LBSPR, but in general the CI's overlap and show concurrence in the two approaches.

Finally, using the LH data from a similar spiny lobster from Indonesia, the YPR curve suggests a target around SPR of 0.3, with a limit around 0.2. The last value (dotted line of 2020 is 0.22 from the stochastic LBSPR). Hence, it appears that the stock is overfished.

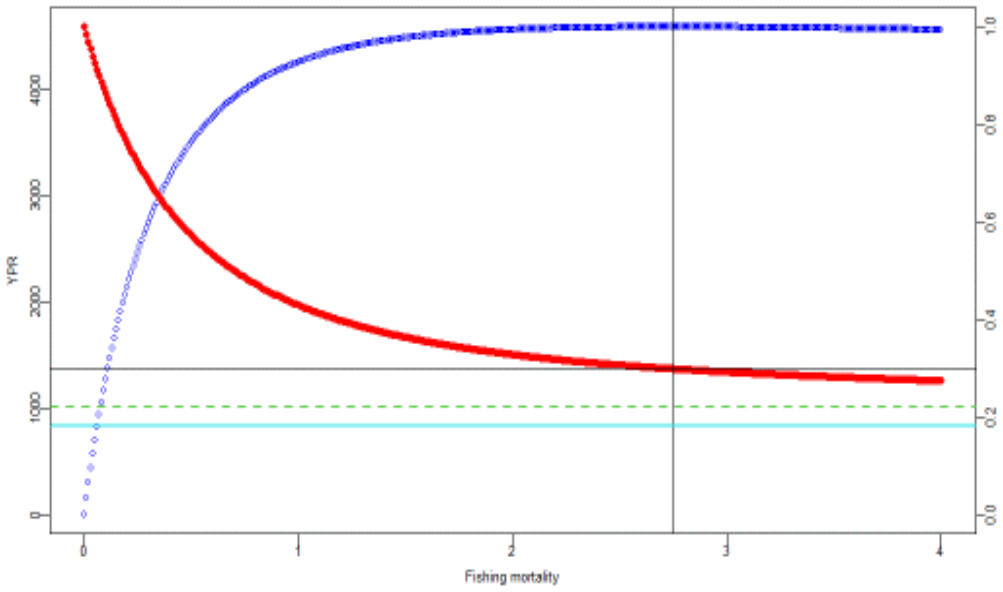

Figure 10. YPR Curve for the scalloped spiny lobster (Panulirus homarus) based on LH data obtained from the same species in Indonesia (https://doi.org/10.14710/marj.v2i4.4247).

3.7. Catch Per Unit Effort (CPUE)

Three types of crafts namely Outboard fiber reinforce boats (OFRP), Non motorized traditional canoes (NMTC) and Motorized traditional canoes (MTRC) and two types of gears (Gill net and lobster Rings) are used by the lobster fishermen in Hambanthota district. Scuba operations for the spiny lobsters are not allowed within the districts but some fishes noted that Chank divers are illegally collect lobsters while collecting chank. Little number of skin divers (less than 5%) are fishing nearby reefs or rocky area without craft or with inflated vehicle tube to set lobster rings. These operations are doing well experienced people but limited to calm season. Therefore no enough data to calculate CPUE for the lobster rings. CPUE calculated for the net operating crafts are indicate in the table 4 only for four years since data deficient to calculate for the whole period.

Table 4. Catch per unit effort (Kg/craft/day)

Craft	2007	2017	2019	2020
OFRP	2.46	1.590.	1.506	1.622
MTRC	1.20	1.074	1.566	1.052
NMTC	0.92	1.333	1.269	1.069

The CPUE values of each craft types revealed that the declining trend of the catch with the resource scarcity. Further there is a significant difference between the catch of each crafts ($P=0.0011$, $\alpha=0.05$).

4. Conclusion and recommendations

The main recommendations from this work are the following:

1. Still spiny lobster fishery in the Hambanthota district plays vital role among the small scale artisanal fishes economy but stock (*P. homarus*) is over exploited
2. Fishermen are not respecting to the available regulations, they are catching berried females in large scale. LBSPR analysis revealed that current LBSPR is around 20 % but target should be at least 30%.
3. Length frequency analysis revealed that there is high fishing pressure on *P. homarus* but not on other species. Further, undersized lobsters are very rare in the catch (export) except *P. ornatus*.
4. Changes of the species composition revealed that *P. polyphagus* is not recorded in the catch during the whole sampling years and also *P. ornatus* composition declining with the time.
5. Large number of egg bearing females are consisted in the catch during the month of March, August and November.
6. Bottom set gill net is the main fishing gear used to catch lobster is prohibited gear set on the reef areas.
7. Declining CPUE values are reflecting falling trend of the stocks.

Based on this work, the primary recommendations for this species are:

1. Strict enforcement of the regulations for egg removing.
2. Introduction of ecofriendly fishing gear on behalf of the bottom set gill net.
3. Emendation of the second closed season. (For the September and October month should be declared October and November).
4. Complete prohibition of catching females at least one year or revision of the minimum legal size at least more 2 cm.
5. Further effort control through the specific license for lobster fishing and number of fishing gear units per crafts or giving subsidies to facilitate for other fisheries.
6. Based on the CENARA assessment survey declaration of the Basses area as a lobster sanctuary
7. The set of regulations implemented by the DFAR were not enough strength to conservation and management of the fishery. Ultimately, Department of Fisheries and NARA and the support of other stakeholder groups established Spiny lobster fisheries Co management committees in the east and south coast targeting the sustainable utilization of the resource. Therefore it is necessary to restoration of the inactive co-management committees.

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