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Comparative Study on Current Fishing Status of Paalameenmadu and Kallar Barmouths in Batticaloa District, Sri Lanka

K. Aruniya [a*], I. U. Wickramaratne [a] and E.P.D.N. Thilakarathne [a]

[a] Department of Animal Science, Faculty of Animal Science and Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Batticaloa lagoon is one of the productive estuaries on the East coast of Sri Lanka and is connected to the sea at two points, Paalameenmadu and Kallar barmouths. The entire dynamics of the lagoon is based on the seasonal opening and closing of the above barmouths which influences the fish catch composition in nearby fishing areas. This study collects information on current fishing practices, species composition of the catch, and seasonal catch species composition, the level of awareness on fishing regulation and sustainable fishery using semi-structured questionnaire. Fisheries data were collected from 10 major barmouth fishery landing sites from January to April 2021. 210 respondents were selected using a stratified random sampling technique. A semi-structured questionnaire was used to collect responses after a pre-test and analysed with descriptive statistics method using SPSS. The study revealed that Paalameenmadu barmouth was

**Corresponding author: Email: aruniyakanagaretnam22@gmail.com;*

opened annually and Kallar barmouth has been closed for the last five years. The most practiced crafts in Paalameenmadu are outboard Fiber Reinforced Plastic boats (OFRP) by 35.26% of fishers and small lagoon canoes by 87.04% fishers in Kallar. A total of seven types of fishing gears are used, among them hook and line, cast net, and dragnet were identified as major fishing gears operated. 30 aquatic species have been recorded in the catch, representing 17 families. Among them, dominant fish families are Scombridae 17.11% and Penaeidae 14.81% in Paalameenmadu. In the Kallar, family Penaeidae 18.75% and Gerreidae 16.32% have been recorded. Barmouth opening is favourable for fishing and 38.57% Penaeidae species were caught during barmouth opening period. Community response that Irregular and early barmouth opening have caused a reduction in fish production which impacts on economic activities. Fishermen have good awareness on importance of fishery resources sustainability and these resources need to be preserved for future generations through proper management practices.

Keywords: Barmouth fishing; batticaloa lagoon fishery; fishing gear; seasonal changes.

1. INTRODUCTION

Fishing has historically played a key economic role in the island of Sri Lanka. Batticaloa district is one of the coastal areas which provide around 1.5% of the total fish production of the island of Sri Lanka [1,2]. Batticaloa lagoon is one of the estuarine lagoons and the largest coastal water body in the Batticaloa district. It occupies an area of 168km2 with 56km long and 14.3% of population in Batticaloa district is depending on fisheries for their income [3-5]. Batticaloa lagoon connected to the sea through two bar mouths, known as Palameenmadu and Kallar [5,6].

During the rainy season fresh water discharge into the lagoon from seasonal rivers, major and minor irrigation tanks and runoff from adjacent land mass [7]. It leads to rise of water level in the lagoon, when the water level rises under the Kallady Bridge by 0.838 m mean sea level the Palameenmadu barmouth is cut open by Road Development Authority and Koddaikallar barmouth is opened during wet season annually [5,8]. However, both barmouths are opened by human interventions and closed naturally in dry season by accumulation of sand due to wave action and ocean dynamics [5,9].

Barmouth biological and chemical characteristics would directly influence by mixing of lagoon water with marine water [10]. Lagoon does receive freshwater from seasonal rivers, tanks, ponds and other water resources seasonally. This inflow of freshwater and movement of seawater into the lagoon mainly determine the biological diversity, physical characters and the chemical composition of lagoon water [8,11]. Such inflows of water increase nutrients in system which enhance ecological productivity led to booms in fisheries of certain species, high variation of fish assemblages, rich fish biomass and it provides nursery grounds for many marine species. [12].

The primary factors attracting fish to this area are their high production, abundant food sources, diversity on ecosystem and ideal temperature for larval and juvenile growth. This seasonal changes and Movements of fish larvae between lagoons and adjacent seas are critical events influencing livelihoods of the people who are depending on these resources and attracts newcomers also. Sugirtharan [8,13].

Opening and closing barmouth affect the social and economic activities around it [14]. This lagoon provides the majority of the fishing community with their livelihood [6]. Unfortunately, in the recent years timing of opening of barmouth and Improper management of bar mouth mechanism has become more irregular due to various political influences [15]. Recent anthropogenic activities in the lagoon have adverse impacts in natural system of lagoon environment and this situation threatens the sustainability of fisheries productivity [16]. Therefore, it is essential to the renewal of fisheries resources [17].

There were lack of studies related to analyse both the direct and indirect affects as well as influences of barmouth opening on fishing. An understanding of fishing techniques and fish catch species composition in the two barmouth areas with critical habitats will be of great importance in the protection and sustainable management of fishery resources in this lagoon.

2. METHODOLOGY

2.1 Location of the Study Area

Batticaloa lagoon located in East coast of Sri Lanka is the third largest estuary and one of the most productive brackish water bodies in Sri Lanka. It is located between 7°24'-7°46' N and 81°35'-81°49' E. The lagoon is about 23 miles (56.8 km) long along meridian axis and its width varies widely 0.5 km to 4 km extending from Kalmunai in the south to Eravur in the north. the lagoon receive freshwater from about 19 fresh water impoundments, 5 major lakes, 8 rivers, numerous irrigational channels and many drainage basins. The lagoon opens to the sea by two points, one at Palameenmadu and the other at Kallar. During the rainy season lagoon is in open communication with the ocean, but in dry season the barmouth is closed ocean dynamics.

2.2 Data Collection

Ten study sites were selected from near two bar mouth regions. The questionnaire survey was conducted from 21st January 2021 to 21st May 2021 over the wet season to dry seasons with a pre-test. The questionnaire structure consisted multiple response questions, semi structured question and five-point Likert scale method. The data from selected locality collected from six key informative interviewees, questionnaire survey and two focus group discussion with twenty active fishermen. Key informative interview conducted to community leaders, fishers who have first-hand knowledge about the community and religious leader. Stratified random sampling technique was used to select two hundred and ten (210) samples out of 350 active fishermen population for the questionnaire survey.

2.3 Statistical Analysis

The collected primary data from questionnaires were entered into an Excel sheet and analysed and evaluated mainly by using descriptive statistical techniques, correlation coefficients analysis and univariate analysis.

Correlation analysis was used to evaluate the strength of the relationship between two quantitative variables (independent and dependent variable). Age, fishing experience, and number of fishing gears were considered as independent variables, while fishermen monthly income earned through fishing was considered as a dependent variable.

Univariate analysis was used to summarize or describe the only one variable. In this study, univariate analysis was mainly used to evaluate the level of awareness on fishery sustainability among barmouth fishing community.

Secondary data were collected from the Department of Fisheries and Aquatic Resources Development, journal articles and research reports.

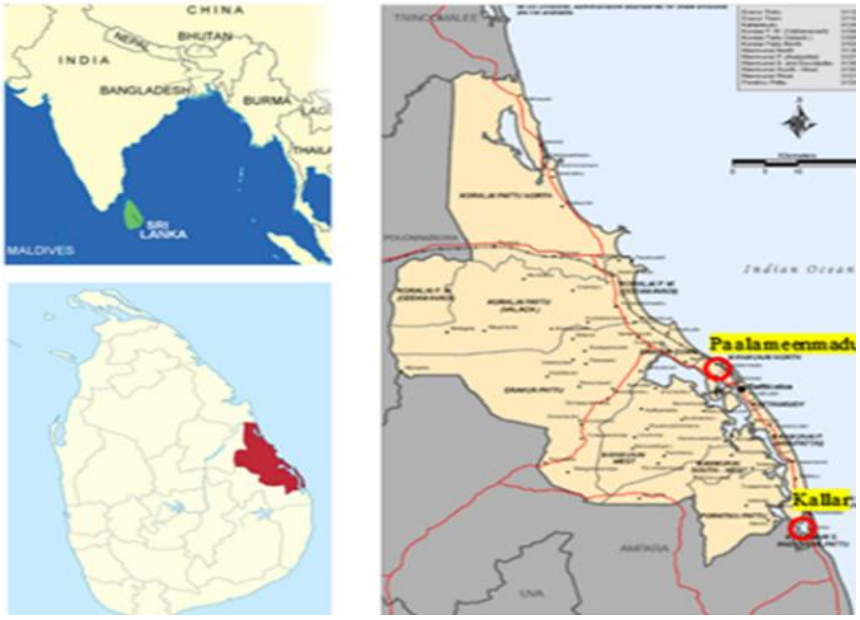

Fig. 1. Map of study area

3. RESULTS AND DISCUSSION

3.1 Socio-Economic Condition of the Batticaloa Barmouth Fishers

An individual's socio-economic status is a measurement of their standing in society and economy relative to others. It is based on a variety of variables, such as their income, education, employment, family influence, and social position, engagement with society, caste, and political influence [18]. General socio-economic characteristics such as gender, age group, marital status, fishing experience, nature of the occupation and monthly income range of fishermen were investigated in the present study [1,19].

The study reveals that all the respondents were males and about 96.19% of respondents belonged to married category.

The Fig. 2 shows that the majority of respondents (44.76%) belong to the category of age between 41 – 50 years. Then 42.86% of represent fishermen who are in age above 50 years group, 6.19% of respondents belonged to the category of between 31-40, 4.76% and 1.43% represent fishermen who are in age between 21-30 and below 20 years respectively.

The majority of respondents (89%) fall in more than ten years of experience, while 5.71%, 3.81 % and nearly 2% of the respondents are with fishing experience of 6-10 years, 1-5 years and below one year of experience respectively (Fig. 3). It was found that 96.2% of respondents belonged to the category of full-time and the rest are part-time.

The Fig. 4 shows that at the current study, monthly income range of fishermen in the selected landing sites revealed that 42.86% of the respondents belonged to the category of monthly income between Rs. 20,000 to Rs. 35,000. Also, 35.24% and 21.90% of the respondent's income were within the range of below Rs. 20,000 and between Rs. 35,000 to Rs. 50,000 respectively.

3.2 Relationship between the Socio-Economic Characteristics

The strength of the relationship between two variables evaluated and compared by Pearson correlation coefficient analysis. The relationship between the socioeconomic characteristics of fishermen, independent variables such as age and fishing experience has a strong positive relationship with monthly income while number of fishing gears has a weak positive relationship with monthly income.

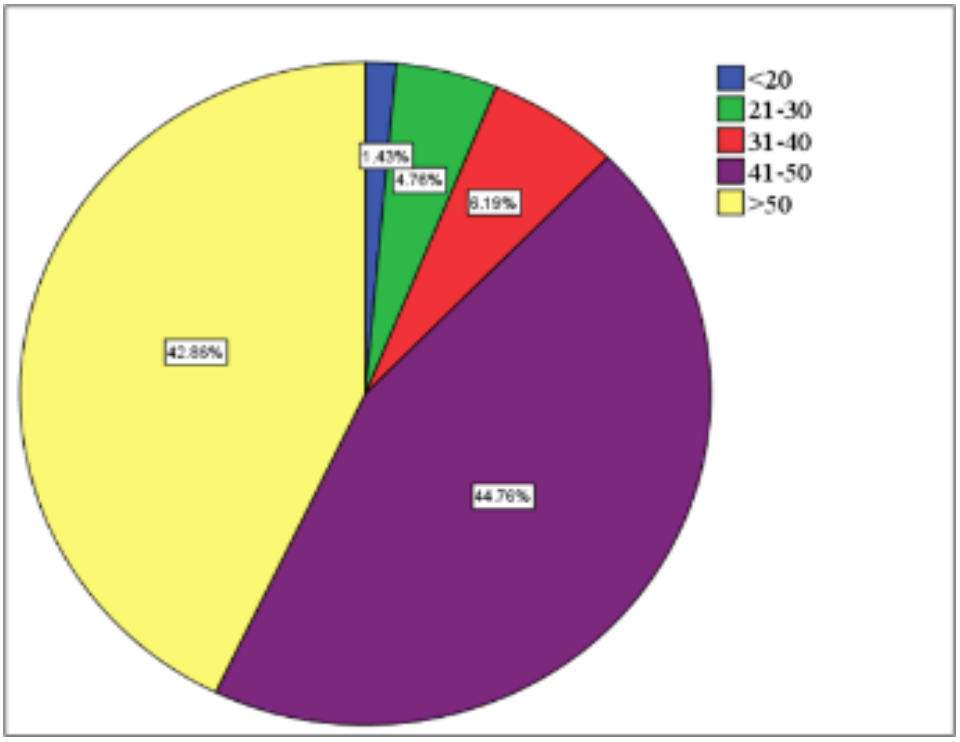

Fig. 2. Age group distribution of the studied fishermen

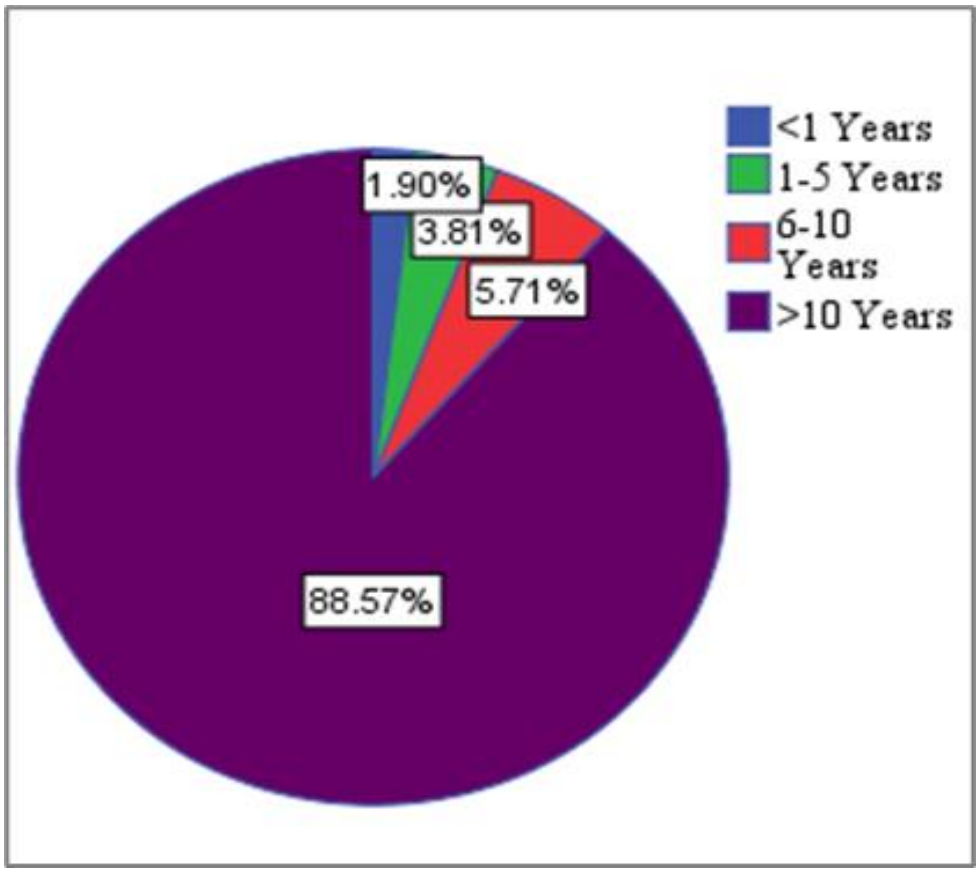

Fig. 3. Experience level of the studied fishermen

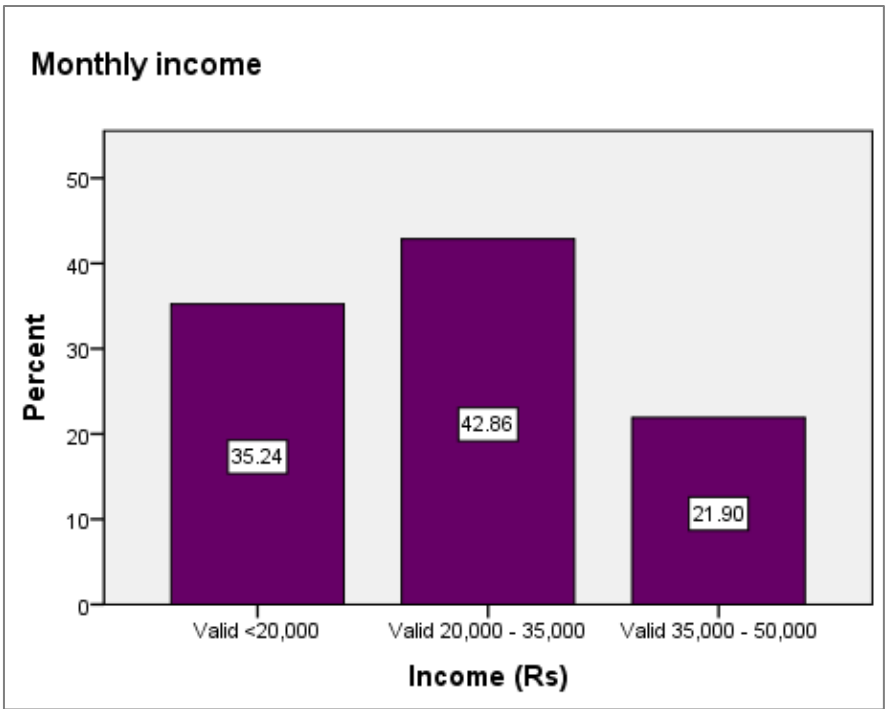

Fig. 4. Monthly income range of the studied fishermen

Table 1. Relationship between the socio-economic characteristics

Monthly Income (Rs)	Age (Years)	Experience (Years)	No of fishing gear
Pearson Correlation	.654**	.557**	.123
Sig. (2-tailed)	.000	.000	.076
N	210	210	210
Relationship strength	strong positive relationship	strong positive relationship	weak positive relationship

The study conducted by [20] stated that, number of fishing gear is one of the, determinants of fishing income which positively influencing fishing income. [21] Revealed that, fishermen's income were broadly influence by socioeconomic characteristics. These results are on par with the above statements.

3.3 Current Fishery Status of Barmouth Batticaloa

The main aim of this objective is to get a detailed idea about the different types of fishing practices and catch species composition in the selected landing sites, consequence of barmouth opening on fishing and awareness of the importance of fishery sustainability of barmouth fishing community.

3.3.1 Fishing regions of Paalameenmadu and Kallar barmouth fishermen

Multiple Response analysis on fishing regions in Paalameenmadu reveals majority of (34.84%) percentage of fishermen actively involving in bar mouth area and 33.0% of fishermen coastal sea for fishing. About 27.6% and nearly 5% of respondents belonged to lagoon and the mangrove fishing respectively.

Since the Kallar bar mouth closed for past five years, 89.0% of the fishermen depend on lagoon for fishing. Then coastal sea and mangrove fishing in equal level in percentage 5.56%.

3.3.2 Fishing craft operated in Paalameenmadu and Kallar barmouth

In Paalameenmadu study area, several type of fishing craft mostly used for fishing various means such as Outboard Fiber Reinforced Plastic Boat (35.26%), small lagoon canoe (32.05%), Inboard Day Boat (17.31%), and not used vessels for fishing (15.38%). As far as the fishing activities in the Paalameenmadu barmouth mainly by Outboard Fiber Reinforced Plastic Boat.

More than ¾ of respondents used small lagoon canoe for fishing in Kallar barmouth landing sites and it represents 87.04% of the sample. Then 7.41% of respondents used Outboard Fiber Reinforced Plastic Boat and 5.56% of respondents did not used vessel for fishing.

3.3.3 Fishing gear operated in Paalameenmadu and Kallar barmouth

According to the survey, hook and line, cast net, drag net, gill net, cage, drift net and stake net were identified as major seven fishing gears operated in the study sites. 27.30% of Paalamenmadu fishermen used hook and line and 22.37% of fishermen used cast net for fishing. Equal percentage 9.54% of respondents use gillnet and cage. Also, minimum number of respondents used drift net and stake net.

Thus, in Kallar bar mouth region more than half of all fishermen used cast net for fishing, which is 58.23%. The 31.65% of fishermen used Raal valai fishery or stakenet, 6.33% of respondents used hook and lines and 3.80% of respondents used cage for fishing. Since they used a variety of gears, then the gear selection at the time depended on fishing location and season.

This obtained results are in agreement with [11], who observed that, main fishing techniques such as drawnet, gillnet, cast net and hook and line at Batticaloa lagoon. Thus, these findings are in line with the same.

3.4 Species Composition

About 30 aquatic species have been recorded in the both Paalameenmadu and Kallar locality which include 17 families. Freshwater, brackish, fresh-brackish, and marine-brackish migratory species were among the fish species recorded.

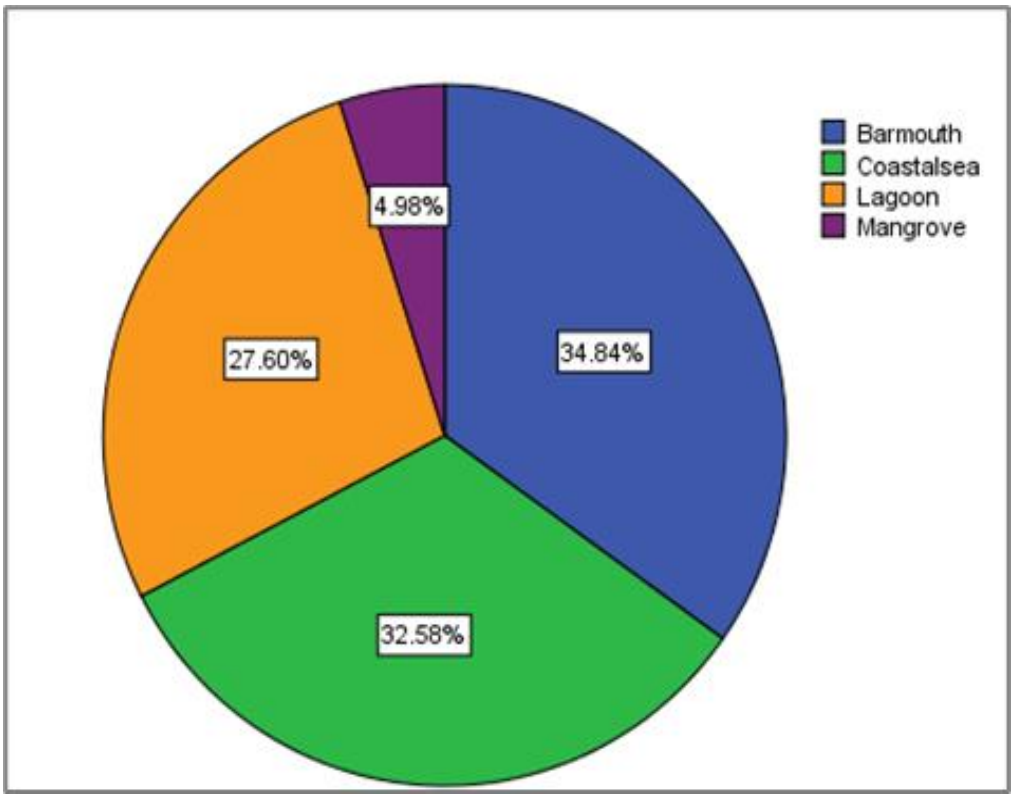

Fig. 5. Fishing regions of Paalameenmadu fishermen

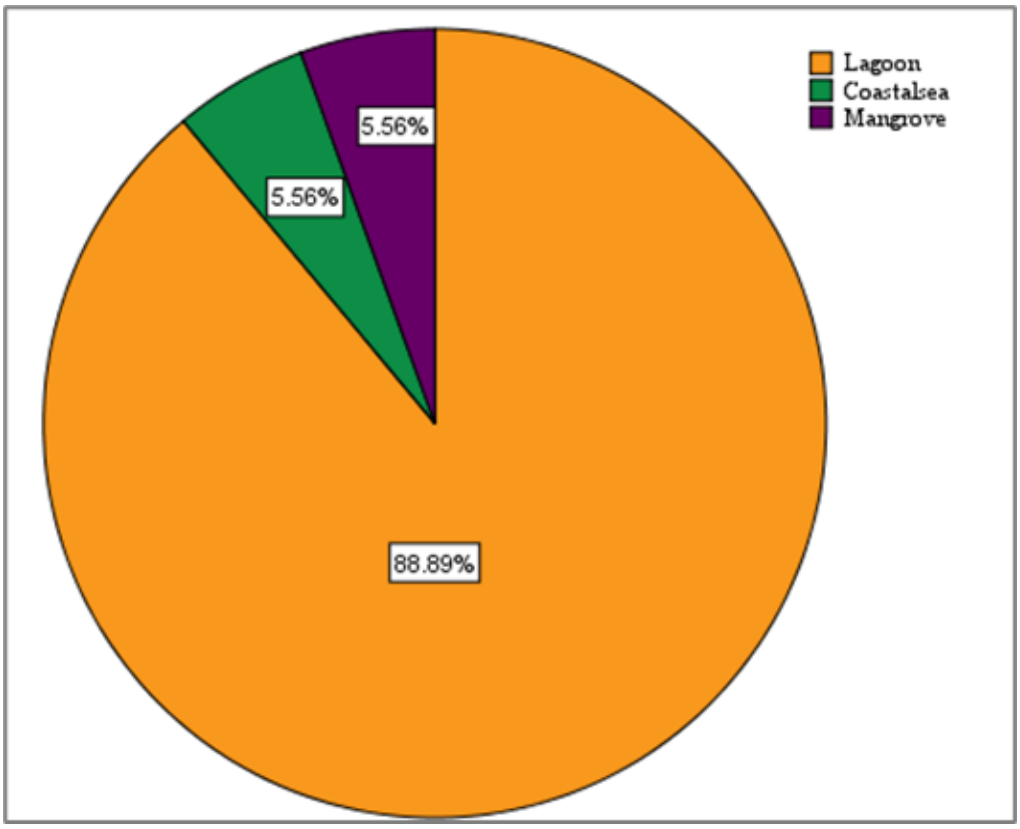

Fig. 6. Fishing regions of Paalameenmadu fishermen

Table 2. List of species composition Paalameenmadu and Kallar locality

No	Scientific name	Common name (English)	Common name (Tamil)
		Family: Ambassidae	
1.	*Ambassis gymnocephalus*	Bald glassy	Selunthal
		Family: Anabantidae	
2.	*Anabus testudineus*	Climbing bass	Panayan
		Family: Ariidae	
3.	*Arius sp*	Catfish	Keluthi
		Family: Belonidae	
4.	*Belone belone*	Garfish	Mural
		Family: Carangidae	
5.	*Caranx melampygus*	Bluefin trevally	Paarai
6.	*Carangoides malabaricus*	Malabar trevally	Kannadi paarai
7.	*Caranx sansun*	Yellow-fin trevally	Manchal paarai
		Family: Carcharhinidae	
8.	*Scoliodon palasorrah*	Grey dog shark	Paal surah
		Family: Channidae	
9.	*Channa striata*	Mudfish, snakehead murrel	Viral
		Family: Cichlidae	
10.	*Oreochromis mossambicus*	Tilapia	Golden
11.	Tilapia niloticus	Tilapia	Selvan
12.	Etroplus suratensis	Pearl spot	Seththal
		Family: Clupeidae	
13.	*Escualosa elongate*	Slender white sardine	Vella sudai
14.	*Sprattus Sprattus*	Sprats	Netholi
15.	*Nematalosa sp*	Hair back	Koimeen
16.	*Amblygaster sirm*	Spotted sardinella	Keeri meen
		Family: Gerreidae	
17.	*Gerreomorpha setifer*	Black striped silver biddy	Thirali
		Family: Mugilidae	
18.	*Mugil cephalus*	Mullet	Manalai
		Family: Penaeidae	
19.	*Metapenaeus monoceros*	Speckled shrimp	Kooni eraal
20.	*Penaeus indicus*	Indian white shrimp	Vella eraal
21.	*Penaeus monodon*	Giant tiger prawn	Karu eraal
		Family: Portunidae	
22.	*Portunus pelagius*	Blue swimming crab	Neela nandu
23.	*Scylla serrata*	Mangrove crab	Peru nandu
		Family: Siganidae	
24.	*Siganus javus*	Streaked spine foot	Oora
25.	*Siganus oramin*	White spotted Spine foot	Oddi
		Family: Sillaginidae	
26.	*Sillago shigama*	Silver Whiting	Kilakkan
		Family: Triacanthidae	
27.	*Triacanthus biaculeatus*	Short-nosed tripod fish	Tholi
		Family: Scombridae	
28.	*Thunnus albacares*	Yellowfin tuna	Kilawala
29.	*Rastrelliger kanagurta*	Indian mackerel	Kumbala
30.	*Thunnus obesus*	Bigeye tune	Arukkula

3.4.1 Catch species composition from Paalameenmadu

Fig. 7 shown that belongs to 13 families species caught in Paalameenmadu barmouth landing sites. Among them dominant fish families are Scombridae 17.11% and Penaeidae 14.81% and 11.84% of Mugilidae species caught and it accounted that highest percentage of Scombridae species caught compared to the other species. Less than 10% of Cichlidae, Carangidae, Portunidae, Gerreidae, Clupeidae, Belonidae, Carcharhinidae, Siganidae, Ambassidae and Channidae were caught in Paalameenmadu barmouth landing sites.

3.4.2 Catch species composition from Kallar

Fig. 8 shown that in Kallar barmouth landing sites belongs to 12 family's species caught and highest percentage of Penaeidae species caught which was 18.75%. In particular speckled shrimp caught in high amount at Kallar fishing grounds. Also 16.32% of Gerreidae species, 12.15% of Ambassidae species, 10.07% of Cichlidae species caught at this barmounth. Family Channidae, Sillaginidae, Siganidae, Clupeidae, Scombridae, Carangidae, Mugilidae and Portunidae species were caught less than 10% in the Kallar barmouth landing sites. Hence, both catch species composition revealed that considerably high amount of Penaeidae species caught in the both barmouth related fishing regions.

3.5 Barmouth Opening and Species Composition

3.5.1 Advantages of barmouth opening in fishing

Barmouth opening is favourable for fishing community with regards to High catch, seasonal species catch composition and easy of transport to coastal sea. Among them seasonal species catch more advantageous for fishermen.

Table 3. Advantages of barmouth opening in fishing

Advantages	Frequency	Valid Percent	Cumulative Percent
Easy of transport	69	32.9	32.9
Seasonal species catch	81	38.6	71.4
High catch	60	28.6	100.0
Total	210	100.0	

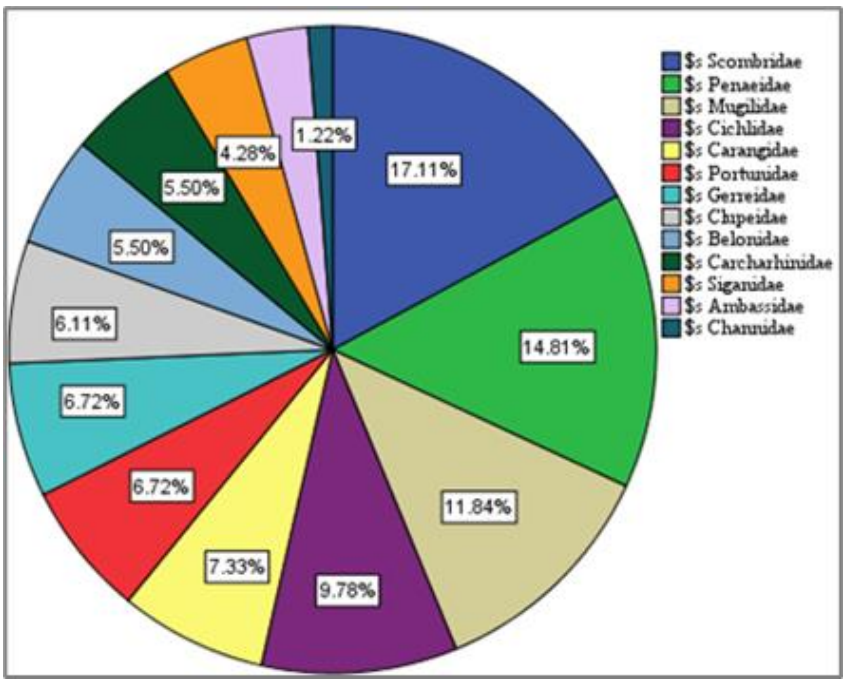

Fig. 7. Catch species composition from Paalameenmadu

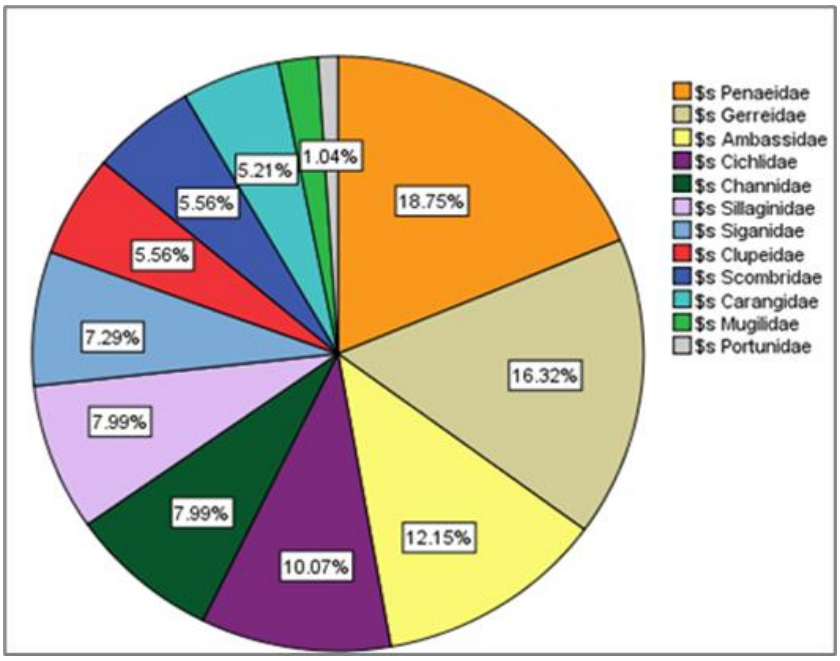

Fig. 8. Catch species composition from Kallar

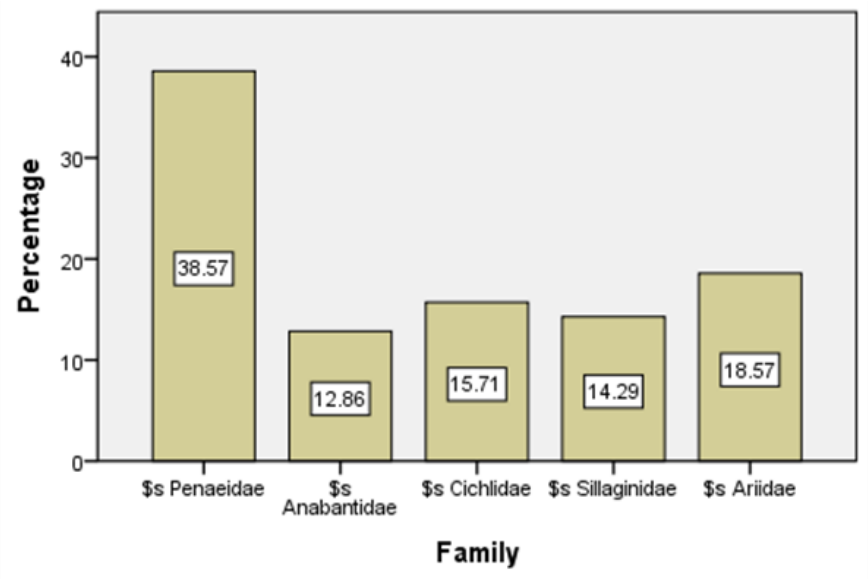

Fig. 9. Seasonal catch species composition

3.5.2 The catch species composition during the Paalameenmadu barmouth opening period

Paalameenmadu barmouth opening between December to January and closed between August to September. Thus, Kallar barmouth closed for last five years. Fig. 9 showed that the highest percentage of family Penaeidae species were caught 38.57% during Paalameenmadu barmouth opening period and the exotic species includes family Ariidae, Cichlidae, Sillaginidae and Anabantidae high catch during the bar mouth opening season.

Among the Penaeidae species Indian white shrimp, giant tiger prawn and speckled shrimp were the most abundant species. Hence, in that barmouth opening season, most of the fresh water fish species come to the barmouth region with the seasonal fresh water inputs, so due to that, the fresh fish such as family Ariidae, Cichlidae, Sillaginidae and Anabantidae catch increases.

Table 4. Values for awareness of the importance of fishery sustainability of barmouth fishing community

Variables	Mean	Level of awareness
Awareness of sustainable fisheries	4.53	Good awareness
Sustainable fishery and resources	4.60	Good awareness
Awareness of concern on the environment	4.37	Good awareness
Barmouth closed season and fishery sustainability	4.17	Good awareness
Proper barmouth opening and fishery sustainability	3.29	Good awareness

(Source: SPSS out from field information)

Gajaba Ellepola, [2014] recealed that, During the rainy season, when there was a greater inflow of freshwater from streams, a variety of freshwater species were generally observed in lagoon [22]. Harris and Vinobaba, stated that there was little variation in species composition and high species richness in Paalameenmadu with respect to seasons [23]. The availability and composition of aquatic resources, along with the livelihoods of the people who depend on them, are all influenced by variations in the salinity of the lagoon water [11].

These obtained findings are in line with findings by Gajaba Ellepola [22] and Harris and Vinobaba [24].

3.6 Awareness of the Importance of Fishery Sustainability of Barmouth Fishing Community

The main aim of this objective is to get a detailed idea about level of awareness of the fishing community in the barmouth landing sites on sustainable fishery. To know the awareness of sustainable fishery, five statements were asked from both two fishing groups. Overall mean values for the awareness of the importance of the fishery sustainability of barmouth fishing community during the study period are shown in Table 4.

All of the respondents have good awareness on sustainable fishery, importance about leaving enough fish in the water bodies, Efficient and effective use of resources lead to sustainability, individual need to limit their use of common sources lead to sustainability, Barmouth closed season helps to improve the sustainability of resources and Annual proper barmouth opening lead ensure the survival of all species.

4. CONCLUSIONS

This study reveals that bar mouth opening season is most favourable for fishing activities. Higher amount of flower prawn and tiger prawn catch during bar mouth opening season has been recorded. The survey, it was found that a total of 12 types of fishing gears and 10 types of fishing crafts used in Batticaloa bar mouth region. A total number of 30 species were identified in the landing site during the study period.

Even though there are two barmouths, the only effective one is the Palameenmadu barmouth. It is opened annually with human intervention between the periods of December to January. The Paalameenmadu barmouth fishers highly depend on barmouth and coastal sea for fishing with the ease of transportation between the lagoon and coastal sea through barmouth. Marine species such as Yellow fin tuna, Indian mackerel and mullet were the most dominant species in their catch composition. The seasonal catch species composition contains freshwater species such as climbing bass, mudfish, streaked spine foot and white spotted spine foot.

The Kallar barmouth fishers greatly depend on lagoon since the barmouth has not opened for the last five years. Fresh water species such as black striped silver biddy, bald glassy and tilapia were the most dominant species in their catch composition. The barmouth opening greatly influence on capture fishery and catch species composition.

The barmouth fishing community people have good awareness of fishery sustainability. However, the lack of government involvement to restrict the banned fishing practices and unregistered fishing boats also a major constraint to local fishermen. It helps State Government agencies in terms of monitoring, evaluation and

reporting consequence of annual barmouth opening. It is expected that the study finding will help to improve the management system of the Batticaloa lagoon and bar mouth area and also it will support to obtain the attention of the government to implement an optimum management strategy.

5. RECOMMENDATION

I would recommend the major and minor irrigation tanks have to be dug properly to increase the water capacity which can prevent early flooding and irregular barmouth opening. Limiting fishing during the breeding season to facilitate spawning and to protect young species is very important. And also it is essential to restrict the use of different illegal gears and mesh size which can damage the species. It would be great if coordination between fishing community and advisory committee such as government departments, NGOs and other agencies can be improved in order to improve the quality of service.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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