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Economic valuation of gillnet fishing in Vembanad Lake, Kerala, South India using market price approach

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ABSTRACT

Gillnet is the most widely followed selective and passive fishing gear system in all water bodies, especially in the traditional fishing sector. Many past studies on gillnet fishing in the Vembanad Lake, Kerala, South India focussed on species availability and gear-wise catch of major fishes and showed that there was a significant reduction in the fish catch.The present study used market-based valuation method to estimate economic value generated through gillnet fishing operation in selected village panchayats spreading across three districts *viz.,* Ernakulum, Alappuzha and Kottayam, bordering the Vembanad Lake, during the period in 2019-20. The species-wise quantity and value of finfishes and shellfishes caught in the gillnets from Vembanad Lake, in the three districts were analysed during the survey period. The total number of gillnet fishers living around the Vembanad Lake is about 6157 and the catch was estimated at 4645.97 t of both finfish and shellfish species, out of which shrimps formed around 72%. The maximum quantity of catch was observed for catfishes (*Arius spp.*) at 278.6 t per annum, which fetched a value ₹4.46 crores, followed by *Etroplus maculatus* at 149 t (₹3.58 crores in value terms). The economic value generated through gillnet fishing is estimated at ₹57.94 crores.

Keywords: Economic value, Gillnet fishing, Market price method, Vembanad Lake

Introduction

Gillnets majorly and widely dominate in the traditional fisheries sector and are used for catching fish in all water bodies such as lakes, ponds, rivers and reservoirs. Gillnet fishing made crucial contributions to inland fish production and employment generation in the state of Kerala, South India. The simplicity in the design and low energy requirement during its operation makes the gear very popular in all sectors, especially in the traditional sector. The Vembanad Lake in Kerala is blessed with various types of finfish/shellfish species and based on the seasonal availability, specific types of gillnets are used. Earlier natural fibers were used for making gillnets, which later gave way of synthetic fibres, mainly polyamide transparent monofilament and this helped to increase the fish catching efficiency and durability (Vijayan *et al.,* 1993). Many studies reported different types of gillnets operated in the Indian rivers and backwaters for capturing fishes and shrimps (Saxena, 1988; Rema, 2020). The total number of gillnet fishers inhabiting the border panchayats of Vembanad Lake is 6157 and their livelihood is fully dependent on gillnet fishing.

There is always migration of juveniles and adult stages of finfishes/shellfishes, between the estuarine and marine zones for various reasons such as attaining sexual maturity, spawning and completion of the life cycle (Wallace, 1975; Jhingran, 1982; Muelbert and Weiss, 1991; Vieira and Castello, 1997). The average annual fish production in the Vembanad Lake is estimated at 14000 to 17000 t (Sugunan, 2010). Fish production purely depends on the health condition of the lake ecosystem. Several studies that have been carried out in the Vembanad Lake, on species availability and gear-wise catch of major fishes, indicated significant reduction in the fish catch (Shetty, 1965; Kurup, 1982; Kurup and Samuel, 1985a,b; Vijayan *et al.,* 1993; Anon., 2001; Bijoy Nandan, 2007; Harikrishnan *et al.,* 2011; Asha *et al.,* 2014). The reduction in fish availability in Vembanad Lake, could be attributed to various reasons such as overfishing, anthropogenic activities (urban encroachment, harbour development), sand mining, agricultural practices, discharge of effluents from various sources, both point and non-point sources (Jayachandran and Bijoy Nandan, 2012). In addition, Thanneermukkom Barrage dividing the Vembanad into saline (Northern part) and freshwater zone (Southern part) also led to biodiversity loss and reduction in the fish stock, affecting the livelihood of traditional fishers and other ecological services as well. Habitat degradation leads to a drastic reduction of fish and shellfish catches. The inland fishers follow traditional techniques to catch fish, without considering sustainability of the resources. Since gillnet

is a highly selective gear, use of this gear in a responsible way ensures resource conservation.

Materials and methods

Study area and sampling

The study area selected was 40 village panchayats bordering Vembanad Lake spread across three districts *viz*., Ernakulum (EKM) (15 village panchayats), Alappuzha (ALPY) (16 village panchayats) and Kottayam (KTYM) (9 village panchayats) (Fig. 1). Various types of gears were used for gillnet operation depending on the availability of fish and shellfish. A total number of 150 gillnet fisher respondents were selected using probability proportional sampling technique.

A primary survey was carried out to collect the fish catch details and the income generated which were used for the economic valuation of gillnet fishery. The secondary data on the number of registered gillnets present in the border village panchayats of Vembanad Lake were collected from district and panchayat level fisheries department offices. The data collected related to fishing gear particulars such as average fish catch and market price details of different types of gillnets, based on the area and season.

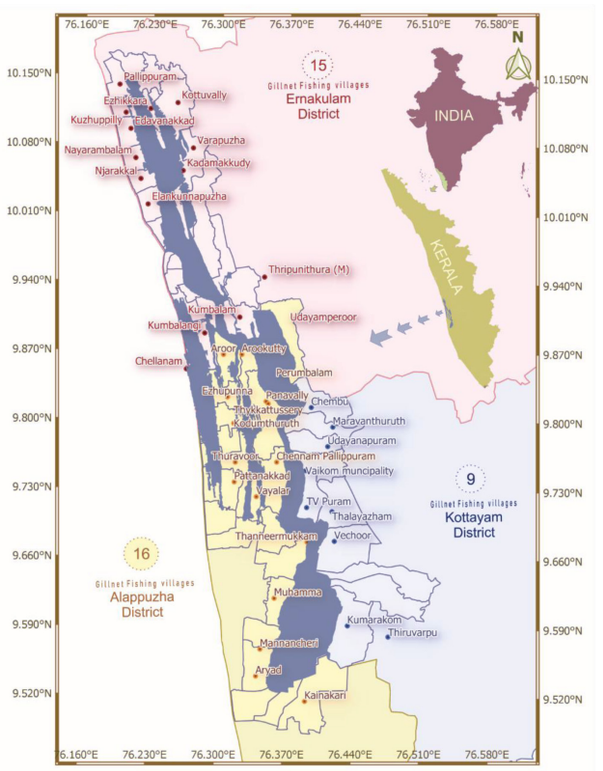

Fig. 1. Map depicting the study area

Market price approach model

Market-based valuation methods rely on the market price to evaluate the flow of resources and existing stocks. This method uses the actual price as an indicator of the true value of a resource. Here, willingness-to-pay (WTP) is taken to be equal to the market price. Many ecosystem services provide benefits to society, but, have no direct market value and therefore a monetary value is attached to them. In well-functioning markets, preferences and the marginal cost of production are reflected in the market price, which implies that these can be taken as accurate information on the value of commodities (Barbier, *et al*., 1997). Market price-based approaches are used to obtain the value of provisioning services and commodities such as fish and shrimp that are often sold in fish markets. The price of the commodity times the marginal product of the ecosystem service is an indicator of the value of the service. Consequently, market prices can also be good indicators of the value of the ecosystem service that is being studied. In this study, the gross return obtained per annum from the individual gillnet operating in the Vembanad Lake was estimated using the quantity of fish and shrimp caught in different seasons in a year and its average market price. The benefits obtained by using gillnet fishing were measured using the market valuation approach and were calculated using the formula:

$$V_i = \sum_{i=1}^{n} (P_i Q_i)$$

where, V_i = Value of the ith resource (₹ unit^{-1} year^{-1}); P_i = Price of the ith resource (₹ kg^{-1}); Q_i = Quantity of ith resource (kg) and i = No. of resources (fish/shrimp) caught by gillnetters

Results and discussion

Traditional craft and gillnets operated by inland fishermen in Vembanadu Lake

Based on the primary survey conducted in various fishing villages along the Vembanad Lake, different types of gillnets used by the inland fishermen were identified and classified based on their usage. It acts as the basic indicator of the abundance of the particular species in the Vembanad Lake. There are various types of specialised gillnets developed and used by the traditional inland fishers based on the various fishing grounds and types of fish and shellfish available in the lake. The list of different types of gillnets used in the Vembanad Lake are locally called as *Catla vala, Chemmeenvala, Idi vala, Kandalivala, Kanampuvala, Kara vala, Karimeenvala, Nanduvala, Kidukkuvala, Kola vala, Konckuvala, Koori vala, Kozhuvavala, Malan vala, Meenvala, Nankuvala, Neettuvala, Odakkuvala, Ooduvala, Ottamvala, Ozhukkuvala, Pattuvala, Thirandivala* and *Thiruthavala.*

The annual catches of various species of fish and shellfish from Vembanad Lake have declined (Kurup, *et al*., 1993). The inland gillnet fishers use a minimum of four types of gillnets for catching various finfishes and shellfishes. Based on the seasonal availability of different fishes, specific gears are used. For catching shrimps, a separate gear locally called *Chemmeenvala* with mesh size varying from 30 to 36 mm is used. It is used for catching shrimps during the months from December to June with an average catch of about 10 to 15 kg per day. It is operated both during the day and night time. The shrimp species caught are *Penaeus indicus* and *Metapenaeus monoceros*. Another gillnet mainly used for tiger shrimp *Penaeus monodon* is Karavala, with mesh sizes ranging from 40 to 50 mm. Disco net is used for catching pearl spot *Etroplus suratensis*, locally called as *Karimeenvala. Oduvala* is used to catch catla and *Nanduvala* is used to catch crab. *Koori vala* is mainly used for catching catfish throughout the year. *Ozhukkuvala* also known as *Oduvala* is used for mullet (*Mugil cepahlus*) and croakers (*Daysciaena albida*) which are native species. Some gillnets are not in use presently, due to the non-availability of particular species.

The major types of fishing crafts used for gillnet fishing are plank-built canoes, made of wooden planks from jungle jack tree (*Artocarpus hirsute*) locally called Anjili or from Punna (*Calophyllum inophyllum*) wooden planks which are joined together with coir ropes and pitch/ tar is applied along the joints to make it water tight. The durability of the wooden fishing crafts depends on the type of wood used and its length typically runs from 15 to 25 feet.

Finfish and shellfish species caught by the sample gillnet fishers of Vembanad Lake

In the Vembanad Lake, 11 fish species and 7 shrimp species have been identified among the major species caught during the survey and it is found that almost all the identified species are being caught for more than 6 months (Table 1). It was observed that maximum number of species were caught during August to February months, but during June and July months, less number of species were caught (Boopendranath *et al.,* 2009). The average quantity and value of various fish and shrimp species harvested during the study period by the respondent gillnet fishers, who were residing in and around the bordering villages of the Vembanad Lake were classified District-wise (Table 2). The average annual quantity of fish and shrimp caught by individual gillnet fishers is estimated to be about 755 kg *i.e.,* 0.755 t per year, out of which around 72% were contributed by shrimps and the remaining 28% by fish. The average economic value generated by each gillnet fishing unit is calculated to be ₹0.94 lakhs per fisher per annum out of which ₹57,871 were generated from shellfishes by incurring an annual cost of ₹32,903 per gillnet unit operation.

The species-wise quantity and value of finfishes and shellfishes caught by gillnetters in the three districts of Vembanad Lake during the survey period are presented in Table 3. The maximum quantity of fish catch was noted in the case of cat fishes (*Arius* spp.) at 278.6 t per annum which fetched a value of ₹4.46 crores followed by *Etroplus maculatus* at 149 t (₹3.58 crores).

Table 1. Seasonal availability of common finfish and shellfish species in the Vembanad Lake ecosystem

Months/Season	No. of Months	Local name	Common name	Scientific name
Finfish species				
May-Nov	7	*Karimeen*	Pearl spot	*Etroplus suratensis*
Aug-Feb	7	*Kaari*	Cat fish	*Arius spp.*
Aug-Feb	7	*Tilapia*	Thilopi	*Oreochromis mossambicus*
Aug-Feb	7	*Thirutha*	Grey mullet	*Mugil cephalus*
Aug-Dec	5	*Poomeen*	Milk fish	*Chanos chanos*
Aug-Feb	7	*Palamkanni*	Oxeye herring	*Megalops cyprinoides*
Aug-Feb	7	*Kalanchi*	Asian seabass	*Lates calcarifer*
Aug-Feb	7	*Nandan*	Glass fishes	*Ambassis* spp.
Aug-May	10	*Kanambu*	Gold spot mullet	*Liza parsia*
Aug-Feb	7	*Pallathi*	Orange chromide	*Etroplus maculatus*
Aug-Feb	9	*Kaala*	Indian salmon	*Eleutheronema tetradactylum*
Shellfish species				
April-Oct	7	*Kara and Naran*	Tiger/Indian white shrimp	*Penaeus monodon* and *Penaeus.indicus*
May-Sept	5	*Karikkodi*	Kiddi shrimp	*Parapenaeopsis stylifera*
July-Oct	4	*Thelly/Poovalan*	Brown shrimp/Flower tail shrimp	*Metapenaeus dobsoni*
Nov-May	7	*Kara*	Tiger shrimp	*Penaeus monodon*
Nov-May	7	*Choodan*	Speckled shrimp/Brown shrimp	*Metapenaeus monoceros*
Dec-June	7	*Naran*	Indian white shrimp	*Penaeus indicus*
April-Oct	7	*Kayal njandu*	Mud crab	*Scylla serrata*

Table 2.District-wise average quantity and value of fishes and shrimps caught by the gillnet fishers

Particulars	Ernakulam	Alappuzha	Kottayam	Vembanad
Average quantity of catch per gillnet fisher (kg)				
Fish catch	150	224	250	209
Shrimp catch	627	562	360	546
Total catch	776	787	610	755
Average value of catch per gillnet fisher (₹)				
Fish catch value	29175	39144	37590	36227
Shrimp catch value	71664	57702	36372	57871
Total gross return	100839	96846	73962	94097

Table 3. Species-wise quantity and value of finfish and shellfish catch by fishers in the three districts of Vembanad Lake

Species	Quantity (t)				Average price (₹ kg^{-1})	Total value (₹ crores)
	Ernakulam	Alappuzha	Kottyam	Overall		
Finfishes						
Chanos chanos	6.4	10.1	12	28.5	290	0.83
Arius spp.	184	56	38.6	278.6	160	4.46
Eleutheronema tetradactylum	70	25	47	142	223	3.17
Etroplus maculatus	101	16	32	149	240	3.58
Etroplus suratensis	60	12	35	107	350	3.75
Lates calcarifer, Ambasis spp.	45.2	22	37	104.2	180	1.88
Liza parsia	42	8	23	73	200	1.46
Megalops cyprinoides	15.5	25	28	68.5	120	0.82
Mugil cephalus	38	6	21.7	65.7	180	1.18
Oreochromis mossambicus	36	14	16	66	140	0.92
Others	4.6	8.9	16.2	29.7	90	0.27
Sub-total	602.7	203	306.5	1112.2	197.55	22.30
Shellfishes						
Metapenaeus dobsoni	1402	285	223	1910	109	20.82
Metapenaeus monoceros	681	75	95	851	94	8.00
Parapenaeopsis stylifera	180	45	33	258	110	2.84
Penaeus indicus	89	40	42	171	90	1.54
Penacus monodon	69.3	23	18	110.3	130	1.43
Scylla serrata	18.7	16	13.4	48.1	80	0.38
Others	83.5	25	16	124.5	50	0.62
Sub-total	2523.5	509	440.4	3472.9	94.714	35.64
Total	3126.2	712	746.9	4585.1	146.13	57.94

In the case of shrimps, the maximum quantity of catch was from *Metapenaeus dobsoni* at 1910 t followed by *Metapenaeus monoceros* and *Parapenaeopsis stylifera.* In terms of value, *M. dobsoni* contributed about 55% of the total value generated from gillnet fishing. The total number of gillnet fishers living around Vembanad Lake is about 6157. The catch was estimated at 4646 t comprising both fish and shrimp species, out of which 72% was shrimps. The total economic value of gillnet fishing estimated using the average market price of individual species collected from the fish market during the survey period is ₹57.94 crores.

Vembanad Lake provides suitable environment for various growth stages starting from larval development, feeding, breeding and spawning of both fresh and marine water finfish and shellfish species. However, the sustainability of fisheries resources of the lake for future generation is in question, due to increasing pressure from various fishing activities in the lake, such as gillnet, stake net, sine net, cast net, hook and lines, trap, Chinese fishing net and other nets. Gillnet fishing is practiced by hundreds of fishermen for their livelihood along the Vembanad Lake. Major threats to livelihood of gillnet fishers seem to be reduction in the species availability and decline in catch. However, according to this study, the estimated economic value of gillnet fishing activity in the Vembanad Lake is ₹57.49 crores per annum, highlighting the contribution of this small-scale fishery to fisheries economy of Kerala. The average amount of income generated by each gillnet fishing unit is calculated

as ₹0.94 lakhs per fisher per annum, out of which ₹57,871 was generated from shellfishes. Generally, finfish and shellfish catches from the lake have reduced drastically due to impact of various anthropogenic activities like extraction of sand, dumping of household and industrial wastes and waste generated by recreational activities (tourism) which has affected the ecosystem. Hindrance to the fishing operation by aquatic weeds, mainly *Eichhornia crassipes* (water hyacinth) has also impacted the fishery (Krishnakumar and Priyadarsanan, 2012). In addition, periodic dredging in the harbours and shipping channels also negatively affected the fauna and other biological life in the lake and the fishery (Gopinath and Qasim, 1971). The decline in fish catches is also a sign of reduction in fisheries resources. It is suggested that a holistic approach towards conservation needs to be adopted by taking certain preventive measures like monitoring pollution, checking unlawful sand mining, regulating the dredging activities which may affect the flora/fauna of the lake. The traditional economic activities associated with lakes like clam fisheries, traditional shrimp farming and Chinese fishing net operation can be encouraged and brought back along the lake, with new management regimes. This will ensure fishers' livelihood and nutritional availability for future generations. A new system of management approach is required to be implemented with a separate regulatory authority for the lake, in order to conserve the fishery resources of the this important aquatic ecosystem.

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