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Performance evaluation of mud crab fishing gears in Chilika lake

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ABSTRACT

The annual catch per unit effort (CPUE) values for nine different types of fishing gears in use in mud crab fishery in Chilika lake, Odisha were estimated to evaluate their comparative catching performance. The pooled mean annual CPUE values indicated that the lift net was the most efficient crab fishing gear (0.78 ± 0.04), followed by crab pot (0.61 ± 0.06) and baited long line without hooks (0.53±0.03). Monofilament gill net (0.44 ± 0.02), single hook hand line (0.37 ± 0.016), monofilament screen barrier (0.34 ± 0.02) and triangular push net (0.29 ± 0.02) showed moderate fishing efficiency, while split bamboo traps (0.19 ± 0.01) and scoop net (0.10 ± 0.006) were the least efficient gears. The results of the present study also indicate the need for regulation of crab fishing gears such as monofilament screen barrier trap and triangular push net, in which the catch of juvenile fishes, prawns and crabs predominate, in order to conserve fishery resources in the Chilika lake

Keywords: Catch per unit effort, Chilika lake, Fishing gear, Mud crab

Introduction

Over the last two decades, exploitation of mud crabs from the known natural habitats, particularly from the estuarine areas, has been intensified in many south-east Asian countries, mainly for live export of mud crabs. The mud crabs, *Scylla* spp., represent a valuable component of small-scale coastal fisheries in many countries of tropical and sub-tropical Asia and African coast including India. Different types of gears are being employed for the capture of mud crabs throughout the globe. In India, Chilika lake is an impotant mud crab fishing ground. After opening of the new artificial lake mouth in the year 2000, the seven years average landing (2001-2007) of mud crabs (135.55 t) showed spectacular increase against the seven years (1994-2000) average landings of mud crab (8.59 t) before opening of the new mouth in Chilika lake (Mohapatra *et al*., 2007). Several types of gears (non-selective and selective) are being employed by the fishermen in and around Chilika lake. However, detailed study on the fishing gears and their efficiency to capture the mud crabs have not been reported from this lake. Such a study is essential from fishery management point of view in the sense that some of the gears employed in Chilika lake target the juveniles. In this paper, an attempt is made to evaluate the mud crab fishing systems of Chilika lake. The present study is based on the data collected for a period of two years and is a first attempt from Chilika lake to study the different gears operated for mud crab fishery and their efficiency.

Materials and methods

The study area comprised the entire Chilika lagoon (19^0 28' and 19^0 54' N and 85^0 05' and 85^0 38' E) and the study duration was from July 2007 to June 2009. Hydrologically, Chilika is influenced by three sub-systems, the Mahanadi distributaries, 52 streams from western catchments draining into the lagoon and the sea (Bay of Bengal). The lagoon is broadly divided into four ecological sectors based on differences in ecological features. These sectors are called northern, central, southern and outer channel sectors while, Magarmukh acts as the gateway between the main lagoon and the outer channel. Nine

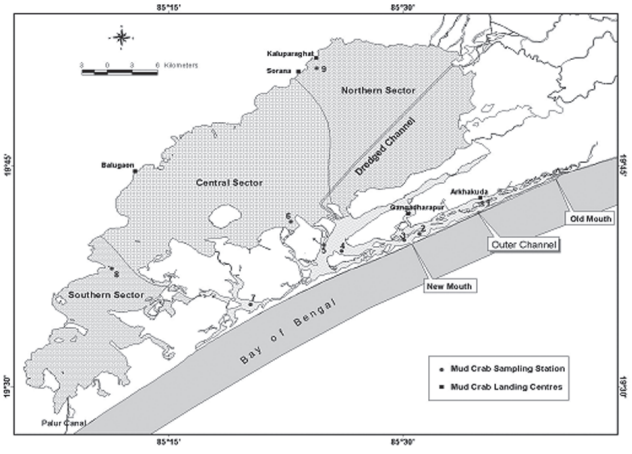

Fig. 1. Stations in Chilka lake selected for gear operation

stations distributed in all the four sectors were selected for the purpose of study (Fig. 1).

Different crab fishing gears and methods practised by crab fishers in Chilika lake were studied through field visits and interactions with the fishers. Specifications of each gear were recorded during the survey by actual measurements of various dimensions, mesh size *etc*. The mud crab fishing gears in use were (i) monofilament gill net of 30-60 mm stretched mesh size, (ii) monofilament screen barrier called as '*khanda*' or 'disco trap'of 16 mm stretched mesh size, (iii) crab lift net known as '*banda*', (iv) triangular push nets of 16 mm stretched mesh size, (v) crab pots known as '*kankada khadia*' and (vi) baited hook and line known as '*suti*'. Three numbers of each gear type were operated for 3 h at each fishing ground once in a month. Twelve numbers of observations were considered for each gear type. All gears except *khanda* and *kankada khadia* were operated during day time. *Kankada khadia* and *khanda* were operated during night hours. All the nine fishing gears were operated at six stations (Stations 1-6) and only two gears (*khanda* and *bozza*) were operated at Kalupadaghat in northern sector (Station 9). Since crab population was negligible in southern sector, no sampling was done at Alanda (Station 7) and Pathara (Station 8).

The mean CPUE (kg h^{-1} ± SE) value for each gear type (Gt) for each month was calculated and used to rank the fishing gears in terms of catch efficiency. The mean was expressed as:

Mean $CPUE_m$ = x kg Gt^{-1} h^{-1} ± S. E.

where; x kg = calculated mean catch weight in kg, Gt= a particular gear type, h = hour of operation, S. E. = standard error of mean, m = particular month

Results and discussion

The gear types used in Chilika lake for crab fishery can broadly be classified into two categories *viz*., selective gears and non-selective gears. In the non-selective gears, it was observed that mud crabs of all sizes (early juveniles to adult crabs) are caught whereas in selective gears, only particular size group of crabs (>100 g) were caught. Some of the gears were used throughout the year and some were operated during a particular season. In total, nine types of fishing gears are used in the mud crab fishery of Chilika lake of which six are of selective type and three are non-selective (Table 1).

Monofilament screen barrier

Nylon monofilament screen barrier locally known as '*khanda*' or 'disco trap' is a stationary gear with a guiding barrier net (leader wall) that leads to a number of enclosures. It has two wings sometimes with or without leader. The walls of the trap are made of multifilament netting materials and attached to bamboo poles and staked to bottom (Fig. 2)**.** The trap is set along the migratory path of the fishes, prawns and crabs that will guide them in to the traps. The trap provides an easy entrance, but it is difficult to exit. The screen barrier varies in shape and size depending upon the place of operation. During the harvest, the trapping chambers are lifted and the catch is collected. This is one of the most efficient gears for catching fishes, prawns

Table 1. Performance of different fishing gears used in mud crab fishery of Chilika lake

Type of fishing gear and the number (n) of monthly operations	Mean CPUE (kg h^{-1} ± SE)													
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June	Overall	Rank
Lift net (n=12)	0.73± 0.06	0.73± 0.06	0.62± 0.02	0.60± 0.03	0.48± 0.06	0.42± 0.01	0.36± 0.01	0.91± 0.03	1.26± 0.04	1.42± 0.03	1.23± 0.08	0.76± 0.04	0.78± 0.04	I
Crab pot (n=12)	0.53± 0.04	0.53± 0.06	0.50± 0.03	0.42± 0.01	0.40± 0.02	0.41± 0.04	0.30± 0.01	0.77± 0.04	0.83± 0.11	0.88± 0.12	1.05± 0.21	0.66± 0.05	0.61± 0.06	II
Hand line with multiple branch lines without hooks (n=12)	0.48± 0.01	0.62± 0.07	0.48± 0.03	0.41± 0.05	0.30± 0.01	0.40± 0.01	0.25± 0.02	0.70± 0.06	0.74± 0.03	0.63± 0.04	0.86± 0.03	0.55± 0.07	0.53± 0.03	III
Monofilament gill net (n=12)	0.39± 0.03	0.39± 0.03	0.37± 0.02	0.32± 0.01	0.28± 0.01	0.36± 0.02	0.30± 0.01	0.65± 0.06	0.58± 0.01	0.51± 0.03	0.73± 0.03	0.42± 0.02	0.44± 0.02	IV
Single hook hand line (n=12)	0.30± 0.01	0.30± 0.01	0.36± 0.02	0.31± 0.01	0.26± 0.02	0.24± 0.01	0.28± 0.01	0.60± 0.05	0.41± 0.01	0.50± 0.02	0.54± 0.01	0.30± 0.02	0.37± 0.016	V
Monofilament screen barrier (n=14)	0.27± 0.03	0.32± 0.03	0.22± 0.02	0.32± 0.02	0.16± 0.01	0.18± 0.02	0.28± 0.03	0.48± 0.03	0.60± 0.02	0.52± 0.04	0.41± 0.03	0.38± 0.02	0.34± 0.02	VI
Triangular push net (n=12)	0.31± 0.01	0.31± 0.01	0.30± 0.01	0.27± 0.01	0.22± 0.01	0.20± 0.01	0.24± 0.01	0.33± 0.06	0.36± 0.01	0.40± 0.02	0.38± 0.02	0.28± 0.05	0.29± 0.02	VII
Split bamboo trap (n=12)	-	-	-	-	-	-	-	0.56± 0.03	0.48± 0.05	0.43± 0.02	0.56± 0.03	0.31± 0.02	0.19± 0.01	VIII
Scoop net (n=12)	-	-	-	-	-	-	-	0.18± 0.02	0.32± 0.01	0.26± 0.01	0.30± 0.01	0.15± 0.02	0.10± 0.006	IX

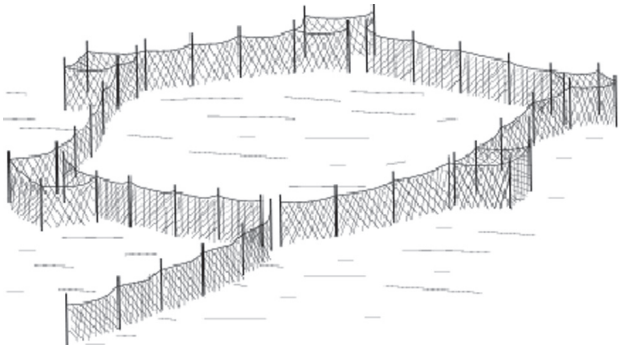

Fig. 2. Monofilament screen barrier

and crabs in Chilika lake. This gear is operated throughout the lake. The gear is operated for a period of 11-13 h, mostly overnight and the catch is collected early in the morning. No bait is used to catch crabs in this gear. This gear which was introduced by Bangladeshi refugees in Chilika lake during mid-eighties has become the most popular and common fishing gear in the lake today. The screen barrier has been identified as one of the destructive fishing gears in Chilika lake as the small meshed net box traps retain juveniles of crabs, prawns and fishes. The existing mesh size (16 mm stretched) should therefore be increased to at least 30 mm (stretched), so that the juveniles can escape into the lake.

Crab pot

As in many other countries, 'crab pots' or 'crab traps', are widely used in Chilika lake for trapping mud crabs in shallow fishing grounds, locally called '*Kankada Khadia*'. The crab pots used in Pulicat lake and Killai backwaters are locally known as '*Nandu Katcha*' (Mahesh Raj, 1992). In Bangladesh, the crab pot (*boon*) is a common mud crab fishing gear (Khan and Alam,1992) and in Myanmar, the use of cylindrical bamboo crab pots has been reported (Win *et al*., 1992). Similarly in Sri Lanka, baited crab pot is most common (Jayamanne, 1992), while in the Philippines, crab pot locally known as, '*bubo*' is considered as an efficient mud crab fishing gear (Ladra and Mondragon, 1992). An elongated oval shaped crab pot, known as '*wadong*' or '*bubu*') are in use in Indonesia (Cholik and Hanafi, 1992) and rectangular or round crab pots in Queensland (Lee, 1992) for harvesting crabs. Crab pots that are used in Chilika lake are commonly designed as square or rectangular box with single non-return valve for easy entrance but difficult exit. The crab pots are made of bamboo strips of about 0.63 cm width separated from each other by about 2.5 cm. The single opening (valve) normally measures 15-25 cm x 5-10 cm. The opening of the non-return valve is surrounded by a conical structure made of bamboo splits, projected inside the trap.

The size of the crab pots range from 30 to 60 cm in length and 30 to 50 cm in width, and 15 to 25 cm in height. The fishers fix baits (normally trash fish) inside the trap. The crab pots are placed at the bottom by a rope (length depends upon the depth) with a float on the other end of the rope. This is the best gear used by the fishermen of Gangadharpur village throughout the year, where most of the fishers are dependant on crab fishery and they operate the gear in the outer channel area. The gear catches normally the sub-adult and adult groups and hence is classified as selective type of crab fishing gear. One fisherman can operate more than 15 crab pots at a time. The gear is normally operated overnight. On an average, each pot brings in 3-4 crabs, which corresponds to a catch of 0.8-1.0 kg day^{-1}.

Scoop net

This is a seasonal gear, particularly operated during the period of high salinity and low turbidity conditions occurring in summer, when the water depth becomes low. The gear is made of a conical nylon monofilament bag (30 mm stretched mesh) attached to a circular iron or wooden frame with a long handle. The fisherman scoop out the crabs after visual location. Normally the diameter of the metal ring is from 25 to 45 cm. Generally, sub-adult and adult crabs are targeted by fishers. The use of scoop net in mud crab fishery is also very common in other Asian countries such as Indonesia (Cholik and Hanafi, 1992), Thailand (Rattanachote and Dangwatanakul, 1992) and Sri Lanka (How-Cheong and Amandakoon, 1992). In Chilika lake, the scoop nets having long handle are used for catching mud crabs from the bottom substrata of the lake in shallow and low turbid waters when the movement of the crabs at the bottom are visible from the surface. Scoop net fishing is more prevalent in areas having seagrass meadows, particularly in the outer channel area. The scoop net with short handle is normally used to collect crabs from hand line and long line hooks.

Split bamboo trap

This gear is commonly used only by the fishermen of northern sector basically for prawn and small catfish (*Mystus gulio*) fishery. This trap is operated by local fishers in the proximity of weeds along the fringe areas of the lake near western shore during post-monsoon and summer months when juvenile crabs up to 70 mm carapace width (CW) and sub-adult crabs up to 80-85 mm CW are caught in substantial quantity. This small trap, locally known as '*bozza*' is made of split bamboo screen in the shape of a rectangular box. The size of the trap varies from 40-80 cm in length, 20-50 cm breadth and 20-30 cm in height. One side of the gear has one entrance hole which is devised for easy entrance and difficult exit. A fisherman can set a

number of traps at a time which is lifted in the next morning to collect the crabs, fishes and prawns from the trap. Crab fishing using '*bozza*' is carried out only in summer (pre-monsoon) season.

Hand line with multiple branch lines without hooks

The hand line with multiple branch lines without hooks are used in Chilika lake for catching mud crabs, particularly in the outer channel sector. The multiple hand line basically consists of a main line made up of HDPE rope of 0.5-0.7 cm dia and about 75-100 m in length. The main line has branch lines attached to it at an interval of 3-3.5 m. The baited hand is locally called as "*lamba suti*" in Chilika**.** The baits used include decaying prawns, de-skinned tripod fish, dead eels and small catfish (*Mystus gulio*). The baits are tied to the end of the branch lines and hooks are not used. One end of the long line is tied to a bamboo or casuarina pole which is fixed at a selected point and the line is gradually released as the boat is moved away from the pole. The line settles at the bottom of the lake and is slowly hauled after a soaking time of 5-30 min. Crabs are attracted towards the bait and grasp the bait with their powerful chelipeds. As the lines are gradually hauled in, crabs can be seen clinging on to the bait and as soon as they are noticed from just below the water surface, they are scooped out using a scoop net. The gear is operated by two people. While one is engaged in punting and maneuvering of the boat, the other person is engaged in laying the lines, hauling and collection of crabs. This gear is operated only during day time. The catch rate varies with the season and from place to place depending on the density of crab population. The gear is a selective one as it catches only medium and large crabs (>80 mm CW).

Baited long line is a common gear used in mud crab fishing along the east coast of India and Kerala coast (Mahesh Raj, 1992). There is variation in the operation and construction of the gear from place to place. The distance between branch lines is 1-2 m in Andhra Pradesh and 2 m in Killai backwaters of Tamil Nadu and the length of the line is about 300 m (Mahesh Raj, 1992). The gear operated in Chilika lake differs in specification from the long lines used in other areas of the country. Long lines in mud crab fishery accounts for the bulk (47.3%) of the total landing of the mud crabs landed in Pulicat Lake (Srinivasagam and Raman, 1985). In Myanmar, the hand lines consist of 0.75 cm dia nylon rope of 300 m in length and branch lines of 0.4 cm dia and 23 cm length with a distance of 1.5 m between branch lines (Win *et al*., 1992). This gear is more or less similar to the long line used in Chilika lake, except the length of the main line and the interval between branch lines. Ahmed (1992) described similar long line, from Bangladesh.

Single hook hand line

Single hook hand lines are mostly used in outer channel sector of the lake throughout the year. It consists of a single line made of nylon monofilament at the end of which a barbless hook is attached (No. 12, 50 mm long). All the trial hook and lines operated in the crab fishing grounds were of equal length (300 m) with 150 numbers of barbless hook. The line with baited hook is cast into the water and the other end of the line is tied to the front end of the boat used for operation. As soon as the crab catches hooked bait, the line is slowly hauled and the crab is collected with a scoop net. Baits used in the gear in Chilika are dead shrimps, cut pieces of tripod fish, small catfish and cut pieces of eel. Usually larger baits (32-35 mm size) are used in the hooks. The fishermen, on an average, catch about 15-20 crabs of all sizes per day (2-3 kg) earning about Rs. 150-250. Although crabs of all sizes are caught in both long line and hook and line, the fishermen collect only the medium and larger crabs, as small sized crabs usually escape and survive. Similar hooks and lines are used with chicken heads as bait, in the intertidal areas of Sunderbans (West Bengal) and the catch per day was 15-20 crabs (Mahesh Raj, 1992).

Crab lift net

This is the most efficient crab gear operated to target all size of mud crabs from the lake. This gear is operated in the outer channel and eastern part of central sector of Chilika lake throughout the year. But the intensity of operation decreases from monsoon towards summer. The gear is very widely used by the fishers of the village Mahisha, Berhampur, Khirisahi, Jahnikuda, Alupatna, Gangadharpur and Arakhakuda. The gear locally known as 'banda' is gnerally square in shape. The four sides of the gear is made up of four split bamboo strips and the bottom part of the gear is covered by nylon netting. In between the two sides, another bamboo is fastened which is used for attaching the bait. Four sinkers weighing about 0.5 - 1.0 kg each, are attached to four corners of the net. Synthetic ropes of 0.5 mm dia are attached to the four corners of the frame of the net which are knotted at a single point keeping a distance of about 1.0-1.2 m from the center of the net and a single rope of 0.7 mm dia is attached at this point. A float made up of broken thermocole or empty capped plastic bottles or jerry cans are attached to the other end of the rope.

The length of the rope normally depends upon the depth of operation. The size of the lift net is normally between 40 x 40 cm to 60 x 60 cm. The common bait used in this gear is trash fish or some times molluscan remains. A person can operate more than 15 such nets at a time. The crabs come to the gear being attracted by the bait. While the crab is engaged in feeding, the gear has to be lifted.

If not lifted in proper time, the crab escapes easily. The capture is effected by vertical lifting. Crab lift nets more or less of similar design with little modifications locally called '*tangkul*' have been reported from Indonesia (Cholik and Hanafi, 1992) and Thailand (Tookwinas *et al.*, 1992).

Monofilament gill net

Crab gill nets are used in Chilika lake and Killai estuary in India (Mahesh Raj, 1992). Gill net for mud crab fishing in Chilika is made up of nylon monofilament netting of 0.5 mm dia twine and is rigged with both head rope and foot rope. The mesh size varies from 70 to 100 mm (stretched). It is about 150-200 m long and about 2-3 m in depth. The gill nets are operated with anchor-sinker at one end of the foot rope and the other end is fastened to a bamboo or casuarina pole. The gill net is allowed to move along with the water current. Baits are attached to the foot rope at several points to attract the crabs. Fishermen use broken thermocole or capped empty plastic bottles and small jerry cans as floats in the gill net. The number of floats used depend upon water depth and length of the net in operation. The gill net is mostly operated during night. The crabs are caught by entaglement and are collected by lifting the net in the morning. The gill nets are also operated during day time and entangled crabs are collected by lifting the net at regular intervals. Crabs of all sizes are caught in the gill net. These gill nets are mostly operated in the outer channel sector and at Khirisahi area of the central sector.

Triangular push net

Triangular push net is a seasonal gear for catching mud crabs in Chilika lake. These push nets are made of nylon filament nettings, mounted on two small bamboo poles of nearly 1.2-1.8 m long, crossed over each other at the upper side and at the lower side. The two bamboo arms are kept apart with the help of a third piece of bamboo being tied with both ends of the two crossed over arms to form a triangular frame. The crabs are caught by the forward and horizontal movement of the gear along the bottom in shallow waters. This gear is widely used in summer season at Arakhakuda, near old lake mouth area, Khirisahi, Mahisha and Satpada area. The gear is operated where the water is clear so that the crabs, if present, are visible. One person can operate one gear at a time. This small meshed triangular push nets are found to be detrimental for the crab fishery in Chilika lake as they catch small juvenile crabs. Similar type of push nets are used in mud crab fishing in the Philippines (Ladra, 1992).

Efficacy of fishing gears

The mean catch rate per year of different crab fishing gear operated in Chilika lake are given in Table 1. The mean catch rate was highest for crab lift net (0.78 ± 0.04), followed by crab pot (0.61 ± 0.06), baited long line (0.53 ± 0.03), monofilament gill net (0.44 ± 0.02), single hook hand line (0.37 ± 0.016), monofilament screen barrier (0.34 ± 0.02), triangular push net (0.29 ± 0.02), split bamboo traps (0.19 ± 0.01) and scoop net (0.10 ± 0.006). Most of these fishing gears are operated in outer channel sector and along the eastern part of the central sector. Monofilament screen barrier is used in all the four sectors whereas split bamboo trap is operated only in northern sector during summer season. Scoop net, which is used seasonally to catch mud crabs, is also deployed for collecting crabs which are caught by line operation. The use of screen barrier and triangular push net in which the catch of juveniles of fishes, prawns and crabs predominate need to be regulated, in order to support the conservation of fishery resources in Chilika lake.

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