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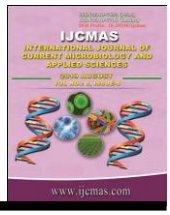

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Record of Indian Ocean Humpback Dolphin *Sousa plumbea* (Osbeck, 1765) along the Estuaries of the Northwest Coast of India in Association with Bag Nets

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A B S T R A C T

Karanja estuary, an important estuarine ecosystem located adjoining to the Jawaharlal Nehru Port (largest container handling Seaport in India), Raigad district of Maharashtra. The North West coast of India is famous for the dol nets fishery. Dol nets (a kind of bag net) are operated in coastal seas having strong tidal currents and amplitude with its mouth opening always facing towards the direction of the tide. The present study was undertaken from September 2016 to May 2017 in Karanja estuary to record the Indian Ocean humpback dolphin pods and their interaction with dol nets and to understand the effect of anthropogenic activities on their population. The dolphins were identified to be as Indian Ocean humpback dolphin, *Sousa plumbea* by using surface photo identification (photo-ID) techniques that rely on the natural marks on their dorsal fins, flukes and spot patterns. The food availability was found to be a significant reason for the interaction of dolphin with dol nets. The survey was conducted among the fisher folks to analyse the various threats associated with the dolphin pod survival. The stranding details of the dolphins around the study regions, recorded in past years, showed that this species is facing the pressure for its existence. The IUCN lists this species as endangered (EN) in the Red List of threatened species hence the immediate action is needed to protect this species before it becomes extinct from the estuarine habitat.

Introduction

The Indian Ocean humpback dolphins are well known to occur along the Indian coast and its adjacent estuaries, but the study on their interaction with fishing nets and aggregation around the artisanal nets are limited (Suttaria and Jefferson, 2004). The dolphins try to get food from the fishing nets of artisanal fishers because of its easy feeding strategies which is an adaptation by dolphins to save energy while foraging (Jefferson, 2000; Parsons, 1997; and Parsons, 1998). While doing so the dolphins get entangled into the fishing net or

get hit with the fishing vessel (Ng and Lung, 2003). Dol nets, a kind of stationary bag net operated in places of strong tidal currents with its mouth opening always facing towards the direction of tide are mostly operated along the Northwest and Northeast coast of India (Raje and Deshmukh, 1989). In Maharashtra, around 31% of its fishers depend on the dol net fishing for their livelihood (CMFRI, 2012). Majority of dol nets stations are restricted to shallow waters of less than 20 metre depth which also overlaps with the distributional range of Indian Ocean humpback dolphin, *Sousa plumbea* (Osbeck, 1765) (Ross 2002; Manojkumar and Dineshbabu, 1999). In recent years the strandings of dolphins in the beaches of India have increased which certainly indicates the threat on this Endangered (EN) species (Ramkumar *et al.,* 2014). The Karanja estuary is very near to the huge anthropogenic activities of Karanja Terminal Logistics Pvt Ltd and Jawaharlal Nehru Port Trust (JNPT) terminal which has resulted in the heavy traffic of bigger cargo ships along with the dredging activities. The heavy exploitation of juveniles of finfish and shellfish from the dol nets seem to create prey depletion for the dolphin living area in the Karanja estuary (Iburahim *et al.,* 2017), as a result of this, the dol net stations serve as the centres of dolphin aggregations. In the present study, their interaction with the anthropogenic disturbances, are discussed. The IUCN listed this species as endangered (EN) in the Red List of threatened species that rings the bell for immediate necessary actions to protect this species before it goes extinct (Braulik *et al.,* 2017)

Materials and Methods

Karanja estuary (18°50'5.60"N to 18°51'50.71"N Latitudes and 72°53'40.12"E to 72°59'5.83"E Longitudes), Raigad district, Maharashtra (Fig. 1), encircles the village named Karanja. The estuary is connected with the Dharamtar creek, Pen-Khopoli creek and joining the Arabian Sea near Uran. Dharamtar creek is uniformly deep with 10 meters in average depth and has the moderate cover of mangroves with mud flats and low lying marshy areas on their sides (Pawar, 2011). The livelihood of most of the fishers living around Karanja village solely depends upon dol net fishing (Sudesh and Nandini, 2016). The areas around Karanja region are well known for busy activities due to the presence of Jawaharlal Nehru Port Trust and there is a new fishing jetty coming up in the vicinity which will probably alter the natural estuarine flow. Though commercial fishing exists, subsistence or artisanal level fisheries dominate in this area (Table 2). In Karanja, the fishing season starts from 15th August or Narali Purnima day whichever is earlier and lasts up to end of April or beginning of May.

The study period was from September 2016 to May 2017 in Karanja estuary, for examining the dolphin pods interaction with dol nets. The fortnightly (monthly twice with one-week interval) onboard surveys and interviews with key informants (fishers) were undertaken. Surface photo identification (photo-ID) technique that relies on the natural marks of their dorsal fins, flukes (Fig. 2 and 3), spot patterns, and typical hump under dorsal fin were used for dolphin identification (Jefferson *et al.,* 1993).

On-board samplings of fishes caught in dol net were recorded in order to predict the reason for the attraction of dolphins nearer to the stations.

Garmin oregon@650 GPS was used to locate the latitude, longitude of dol net stations and dolphin pod locations. Sony cyber shot 5x optical zoom camera was used to capture the dolphin pictures. Dolphins were observed at a distance of 5 to 50 m from the on board dol netters.

Results and Discussion

Indian Ocean humpback dolphin, *Sousa plumbea* (Osbeck, 1765) commonly inhabit in estuarine and coastal habitats at a depth less than 20 m (Sutaria and Jefferson, 2004). The average depth of 10 metres of the Karanja estuary (Velamala *et al.*, 2016) is suitable for the dolphin occurrence. In Raigad region, though dolphin was first reported a century back (Sterndale, 1887), the present study revealed the first report of dolphins from Karanja estuary (area nearer to Jawaharlal Nehru port trust). The report on the interaction of dolphins with dol nets also first of its kind. The spotting and behaviour records of *Sousa plumbea* listed in Table 1.

The study on catch composition of dolnets during the present study were *Acetes indicus* (Paste shrimps), *Arius maculatus* (Catfish), *Charybdis (Charybdis) callianassa* (Crab), *Chrysaora caliparea* (Jellyfish), *Coilia dussumieri* (Rat tailed anchovy), *Harpadon nehereus* (Bombay duck), *Lepturacanthus savala* (Ribbon fish), *Miyakella nepa* (Squilla), *Mystus gulio* (Cat fish) and *Parapenaeopsis sculptilis* (Shrimps) at the time of visits of dolphins near to the fishing net (Table 3). The similar studies in other localities reported that *S.plumbea* gets attracted towards the estuarine and areas of the abundance of demersal species (Bijukumar and Smrithy, 2012; Jefferson and Hung, 2004). So, the dolphins get attracted to the net to forage upon any of the above-mentioned species in the cod end of dol nets.

Interaction with fishing nets

As per the underwater observations (using the underwater camera) the dolphins create problem to fisher by tearing the cod end part of the dol nets from backside of the net to prey the fishes caught in the net; thereby releasing the fishes caught in the net. The pictorial presentation presented in Figure 4. These also force the fishermen to spend extra money in mending their nets before the next operations. In all the observations the dolphins were never caught in dol nets. Sighting of dolphins near to the dol net stations was common in this region during hauling of catch in the early morning of post-monsoon seasons. The information and perception collected from the fishermen based on the survey based questionnaire.

Though negative attitude of fisherman towards dolphin was noted in the southern part of Maharashtra by hurting the dolphins (Jog *et al.*, 2017), but in spite of facing catch loss due to the dolphins fisherman of Karanja always showed a positive attitude towards dolphin, because of their deep respect for dolphin and whales as per religious faith which descended over generations.

Threats for dolphin in the study area

Overfishing

A very small mesh size of 8 mm in the cod end of dol net results in catching of juvenile fishes which may deplete the fishery resources for the estuary in future (Iburahim *et al.*, 2017).

Heavy vessel Traffic

The Jawaharlal Nehru Port Trust (JNPT) is the largest container port in India, handling about 40-50% of nations container traffic annually (Dasgupta and Sinha, 2016). The coastal stretches of Uran experiencing considerable stress due to the existence of various industries, JNPT, container freight stations etc. (Pawar, 2011). Around 100 fishing vessels operate from Karanja regions use this estuary for transportation (CMFRI, 2012). In the present study, the dolphins were found to move closer to small dol netters whereas they move away from cargo ships and dredgers.

Table.1 Spotting and behaviour records of *Sousa plumbea*

Sl. No	Date of sampling	Time of sighting/sampling	Location in Karanja estuary	Weather condition	No. of dolphins observed	Tide table	Lunar Cycle (In day)	Type of behaviour
1	12 - 9-2016	10.10 AM (low tide)	18º50'10.24"N-72º54'39.70"E	Rainy (6 AM-8 AM)	4	2.08 m	4th	Chasing the fishing boat
2.	23-9-2016	11.45 AM (Low tide)	18º49'16.38"N-72º54'42.97"E	Rainy	2	3.92 m	25th	Swimming near to the hauling cod end
3.	6-10-2016	9 AM (Low tide)	18º49'05.09"N-72º54'31.98"E	Heavy rain	6	4.1 m	4th	Moving away from the cargo ships
4.	23-10-2016	-	Karanja estuary	Clear sky	-	3.5m	22nd	-
5.	6-11-2016	9 AM (Low tide)	18º51'03.61"N-72º58'30.30"E	Clear sky	2	3.9m	6th	Swimming near to the fishing boat
6.	25-11-2016	9 AM (High tide)	18º51'04.75"N-72º58'28.55"E	Clear sky	3	3.6m	23rd	Swimming near to the fishing boat
7	12-12-2016	10 AM (High tide)	18º50'18.67"N-72º54'42.60"E	Clear sky	4	4m	12th	Swimming near to the Jellyfish
8	10-1-2017	10 AM (Low tide)	18º50'17.25"N-72º54'42.59"E	Clear Sky(More Colder)	2	3.8	10th	Snatching fishes from the net while hauling
9	26-1-2017	11 AM (High tide)	Karanja estuary	Clear sky	-	4m	28th	-
10	9-2-2017	8.30-9.30 AM		Clear sky	-		13th	-
11	27-2-2017	9-10 AM		Clear sky	-	4.4m	2nd	-
12	15-3-2017	1-2 PM		Clear sky	-	4.3m	17th	-
13	9-4-2017	10.30-11.30 AM		Clear sky	-	4	13th	-
`14	28-4-2017	1-2 PM		Clear sky	-	5	2nd	-
15	6-5-2017	9-10 AM		Clear sky	-	3.8	10th	-

Table.2 Details of dol net fishing

Fishing ground	**Rocky on the seaward side, muddy on riverine side**
Type of operation	
Based on the scale of operation	Small scale
Based on the number of vessels used	One boat
Depth of operation	8-10 m
Method of finding the fish shoal	Visual(current),wind direction
The time required for **a.Setting the net** **b.Hauling the net**	 20 min 20 min
Net immersion period	4-5 hours(depends on the lunar cycle)
Duration of single trip	2 hours
The average number of dol net operations per trip	2-3 Dol nets per trip
The average quantity of fish caught per trip	10-15 kgs (excluding By catch)
Average returns from the sale of fish per trip	Rs.500-1000/-
Cost of mending dolphin teared codends	Rs 25

Table.3 Monthly top five fish species in dol net fishery

Month	Major catch in the Dol nets	Catch Composition (%)
September 2016	Bombay duck Paste shrimps Ribbon fish Burrowing goby Shrimps	41.73 32.11 13.93 4 2
October 2016	Paste shrimps Shrimps Bombay duck Ribbon fish Mullets	42.2 18.95 11.5 6 2.5
November 2016	Jelly fish Paste shrimp Anchovy Shrimp Crab	37.5 25 11.3 9.5 6.6
December 2016	Jelly fish Anchovy Ribbon fish Shrimp Craoakers	60.6 17.3 4.3 2.8
Jan 2017	Jelly fish Shrimp Crab Croaker Ribbon fish	50 20 15 10 5
Feb 2017	Catfish Crabs Stomatopod Shrimps Jellyfish	39.9 20.1 20 10.2 9.8
March 2017	Croaker Crab Shrimp Anchovy Stomatopod	35 25 21 11 8
April 2017	Cat fish Shrimps Stomatopods Crabs Croaker	40 22 15 13 10
May 2017	Cat fish Shrimps Stomatopod Paste shrimp Anchovy	42 27 13 10 8

Fig.1 Map showing the study area (Karanja estuary)

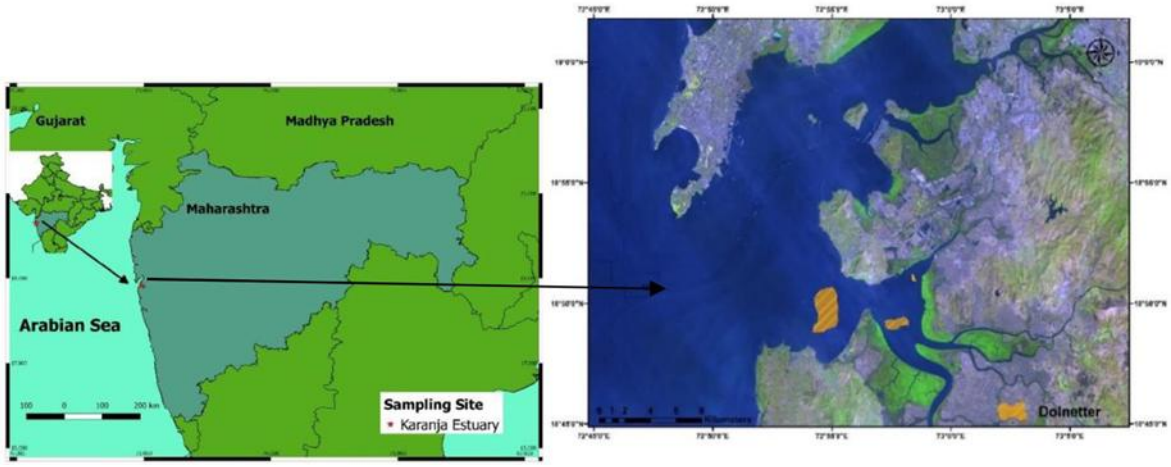
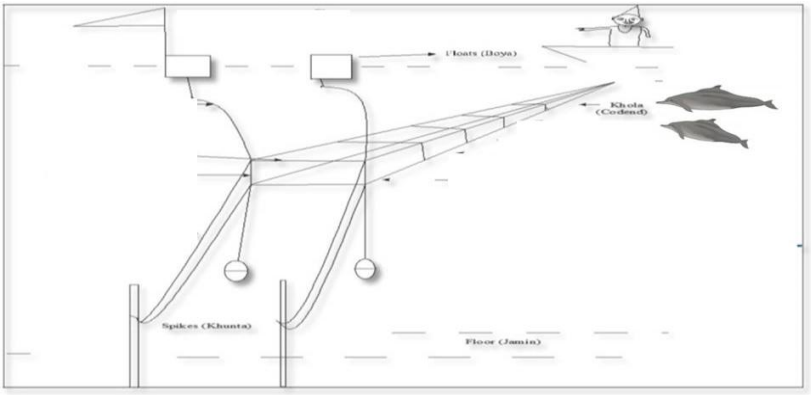


Fig.2 Pair of dolphins surfacing nearer the dol net stations

Fig.3 *S. plumbea* dolphin with its identification characters of dorsal fin hump Surfacing out of water

Fig.4 Pictorial representation of Dol net (Bag net) parts with dolphin interaction



Pollution

Domestic waste from the Uran and Mumbai, waste discharge from surrounding industries, loading and unloading of fertilizers in the port area, etc. are the major cause of pollution into the Karanja estuary (Gupta *et al.*, 2005 and Pawar, 2013). The dol net fishers of the study area face a problem of debris clogging the net as more than 10% of the catch is plastics and they throw back the filtered debris from their nets into the same estuary (Kripa *et al.*, 2018), confirming heavily polluted nature of the estuary.

Anthropogenic activities

A new jetty is being built across the Karanja estuary for docking the ships. Restless activities such as Container Freight Stations (CFS), urbanization, industrialization and encroachment along the stretch of the estuary have resulted in the loss of huge mangrove cover and the associated biodiversity (Pawar, 2011).

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