ECOLOGICAL IMPACTS OF TUNA FISHERIES OF LAKSHADWEEP, THE ARCHIPELAGIC TERRITORY OF INDIA SITUATED IN THE CENTRAL INDIAN OCEAN

Mohammed koya, K., Abdul Azeez, P., Prathibha Rohit, E.M. Abdussamad and Rajesh, K.M.
(Central Marine Fisheries Research Institute, India)

Introduction:

Lakshadweep islands are an archipelagic territory of India situated some 200 nautical miles away in the eastern Arabian Sea off the South-West coast of India on the northern part of the Chagos Ridge. Oceanic situation of these atolls make them a haven for the oceanic resources like tunas and tuna like fishes. Similar to the Maldives, the adjacent island nation, tuna fishing have been the mainstay of the economy of this island group with a population of less than one lakh against land area of 32 sq.km. This is the only territory under India where pole and line fishing for skipjack tuna is in existence for a long time.

Pole and line skipjack fishery have been synonym for the fisheries of the Lakshadweep islands for a long time. Advancements in the technology and materials though have influenced slightly the way fishing is done as well as the type and size of the crafts, pole and line with live-bait chumming still remains the major fishing method and skipjack the principal species caught. Year-round presence skipjack around in the vicinity of the island territory and having a durable commodity out of the species (smoked and sun-dried tuna loins, namely the *Masmin*, identical to the Maldivefish) have been the principal reason for existence of the pole and line fishery here. The fishing technique and the scale of fishing almost remained the same here due to the tradition bound value chain.

Though diversification of fishing practices had been advocated for better resilience of the islands' fisheries sector in view of the species being a highly migratory one whose distribution and movement depends greatly on the oceanic environment and larger oceanic processes, overdependence on skipjack species had been the hallmark of Lakshadweep's fisheries. However, a sharp decline in skipjack tuna catch during 2011-13 had turned around the fishermen's attitude and they developed techniques indigenously to harness the yellowfin tuna, another abundant resource; though lack of value chain for the resource bridled the development. The fishermen first harnessed the surface shoaling smaller and medium sized yellowfin tunas using pole and line (at times with double poles) with live bait chumming. Consistent domestic demand for yellowfin tuna generated during this period persuaded scaling up of extant traditional handline fishing for yellowfin tunas with hooked live baits by the rowing and motorised crafts as well as the non-pole and line vessels. Traditionally, such handline fishery was limited to the dusk hours of winter months principally by the rowing canoes. A positive response of the yellowfins to chumming in the pole and line paved way for the fishermen to explore chumming for handline as well. With the fishermen acquiring skills to harvest livebaits such as fusiliers, green chromis, cardinal fishes etc. from outer shelf areas, the bait issues were overcome. Overwhelming response of the yellowfin to the red toothed triggerfish (*Odonus niger*) chumming gave way for an upsurge of a new and almost year-round fishery for medium and large sized yellowfins in almost all the islands. Induction of a new value chain for the yellowfin tuna involving mid-sea collection and transport of the tuna catch to mainland markets during the period catalysed this development.

On the strengths of its low ecological impacts, the Lakshadweep skipjack pole and line fishery have moved towards being another MSC (Marine Stewardship Council) certified fishery from the region after the Maldives. It's now an FIP lead by the World Wildlife Fund-India with the Central Marine Fisheries Research Institute (CMFRI) being a knowledge partner with focus on addressing the deficiencies in the fishery with respect fisheries management, fishery data improvement, study and documentation on the impacts etc. A full assessment of the fishery is expected to be carried out during 2020. The present paper attempts to study the ecological impacts of the two chumming based tuna fishing methods viz. the pole and line skipjack fishing and the handline yellowfin fishing widely practiced in the island group with mention on the impacts of anchored Fishing Aggregation Devices (aFADs). The paper is a preliminary analysis of the studies being done on the fisheries and the studies are continued.

Materials and Method

Landing data recorded by the Department of Fisheries during 2009 to 2018 and the on-board and landing center observation data collected by the CMFRI during September, 2017 to May, 2019 are the basis for the study. The Lakshadweep department of fisheries follow complete enumeration and record the catch daily covering all the fishery units by the field enumerators deployed in every island. The CMFRI scientists and project personnel deployed in four major fishing islands record the biological data every week and perform on board observation occasionally. Data is generated from 55 skipjack pole and line fisheries and 35 handline fishing operations observed on-board during the period - September, 2017 to May, 2019, spread across different seasons and covering major fishing islands i.e. Agatti and Kavaratti.

Results and Discussion

Trend of the Tuna Fishery

Fish landing in Lakshadweep have been increasing steadily over the years. Skipjack is the major species constituting nearly 70% of the total catch and the major gear being the pole and line. A major change in fishing pattern occurred during the late 2000s with introduction of Maldivian type larger pole and line fishing vessels. There was a sharp decline in the skipjack landing during 2011-13 (Fig.1). The fishermen naturally shifted to fishing for yellwofin during this time. Pole and line (often a double pole and line) emerged to be a prominent gear for fishing yellowfin this time. Similarly, there was an unusually high catches of skipjack during 2016 and the catches returned to the prior levels in the next year itself. The trend of the yellowfin indicates its predominance whenever the skipjack tuna abundance declined considerably. Since the year 2017, there had been emergence of chumming based handline fishery for the yellowfin in almost all the islands, which was partly due to the emergence of new value chain for the yellowfin emerged during the period (Fig 2). The Administration of Lakshadweep permitted deployment of larger (15-22m OAL) fishing vessels (without any kind of gear on-board) solely for collection of the catch in fresh condition from the fishing grounds or harbours.

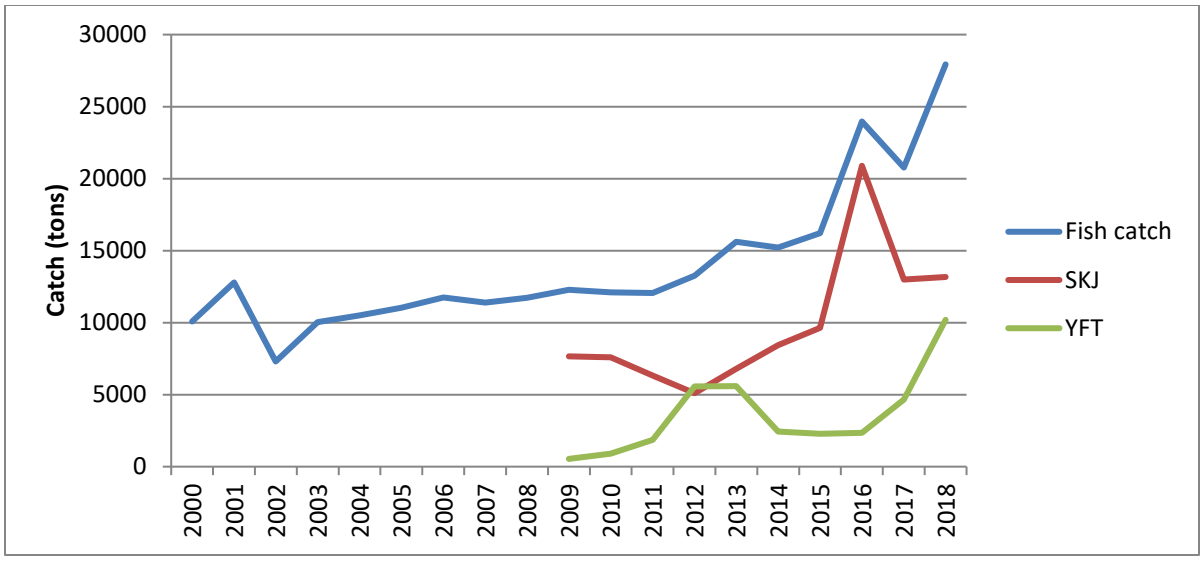

Figure 1 Trend of Fish landing in Lakshadweep

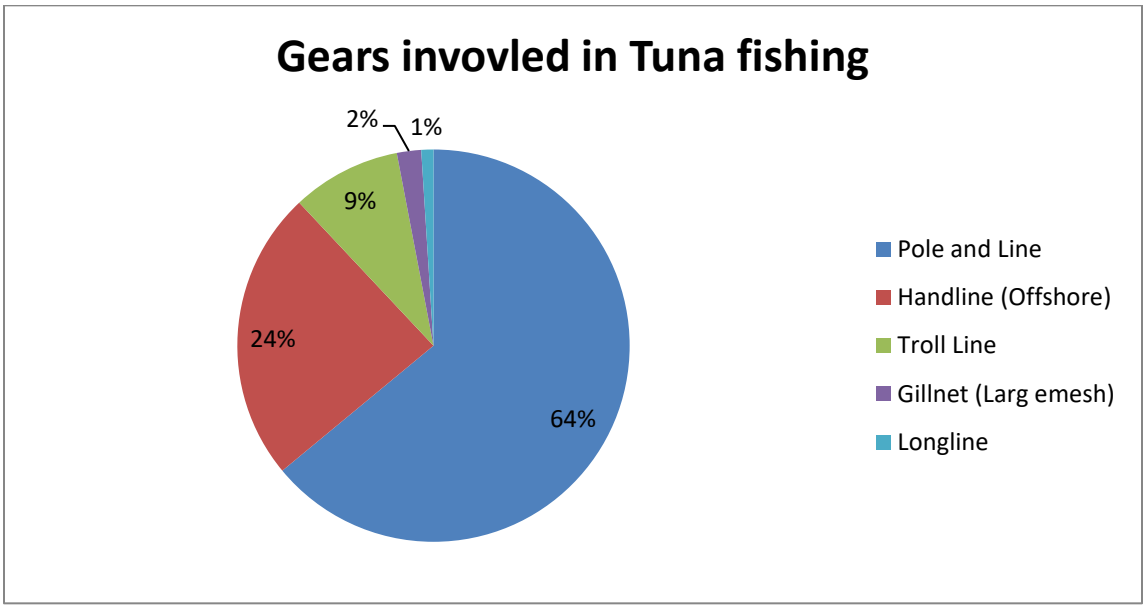

Figure 2 Major fishing gears in Lakshadweep during 2018

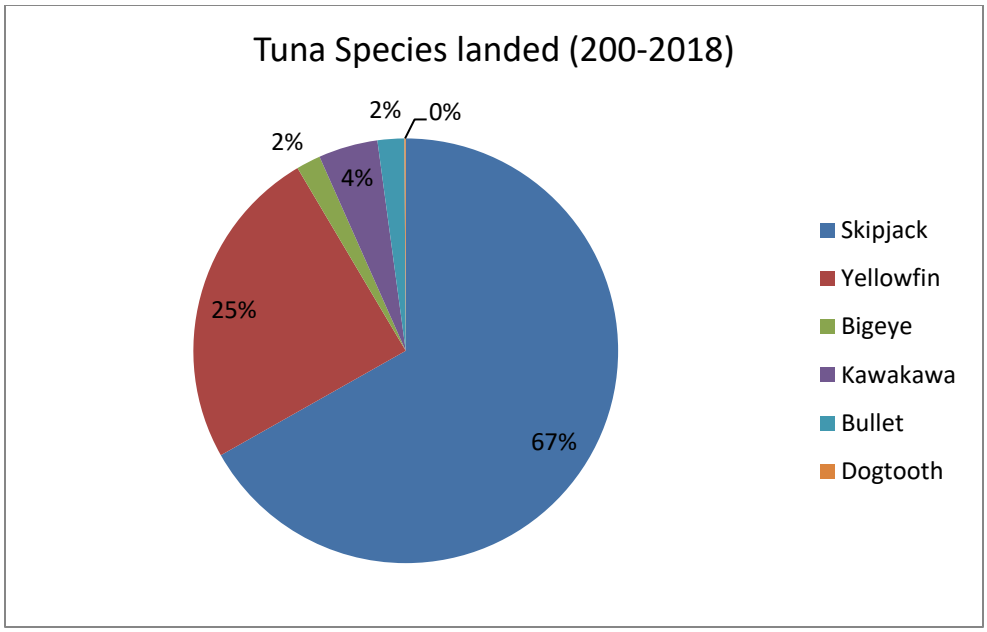

Figure 3 Tuna species landed in the Lakshadweep islands.

Catch and bycatch in the Skipjack Pole and line fisheries

Observation of the skipjack tuna fisheries in 55 fishing operations (103 fishing events) spread across aggregations such as free school, free school bear convergence areas, free school near seamounts, anchored FADs (aFAD) and Flotsams. Catch comprising of skipjack, yellowfin and neritic tunas constitute nearly 97% of the catch and the skipjack along constitute nearly 75% of the catch (Fig 4). Non target species in IOTC parlance, such as the rainbow runner, mahimahi, billfishes, wahoo, sharks and triggerfishes constituted 3.1% (Fig 5). Most of the catches were from the fishing events near the aFADs followed by free schools and free schools near convergence areas (Fig 6). There was only one instance of fishing near a flotsam near Agatti Island during the observation trips. Non target tuna species were caught more near aFADs. Catch rate of non-target species was also considerably high near flotsam (Fig 7).

Three instances where sooty terns inadvertently got hooked while feeding on the associated bait was the only direct interaction of ETP species constituting 0.01% of the total catch. Sharks were mainly caught during the fishing operations near the flotsams. There was one instance of fishing near a moderately active flotsam. Sharks were hooked using handline or collected using hands. Silky shark (*Carcharhinus falciformes*) was the dominant shark species followed by *C. amblyrhynchos*, *Galeocerdo cuvier*, *Alopias pelagicus*, *Negapriion acutedens* and *Sphyrna lewinii* .Almost all the non-target tuna species including the sharks have high demand in the local markets and are consumed locally. Some of the fishes like the file fishes and other deep sea fishes are not preferred for local consumption and were discarded immediately on harvest (Table 1).

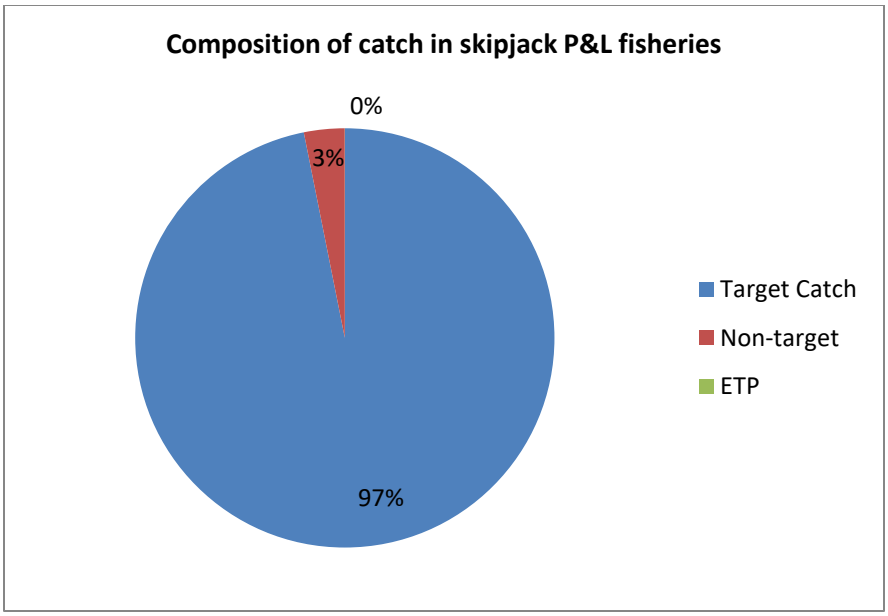

Figure 4 Catch split up for the observed skipjack tuna pole and line fishing operations

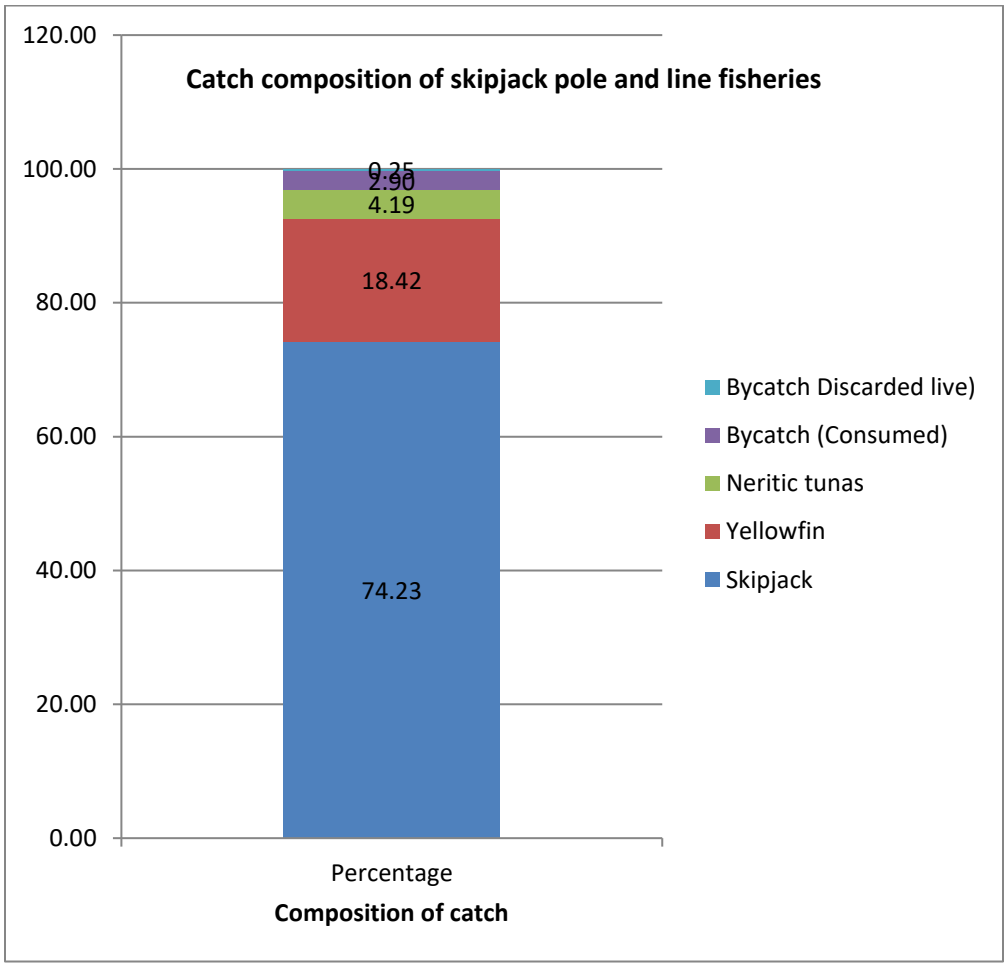

Figure 5 Catch and bycatch in pole and line fisheries observed

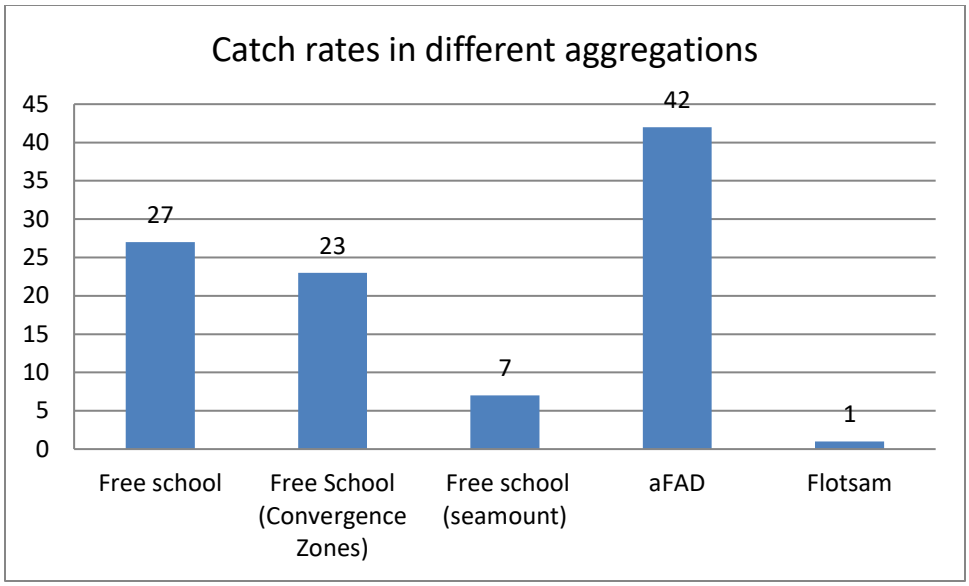

Figure 6: Catch rate of skipjack pole and fishing at different aggregations

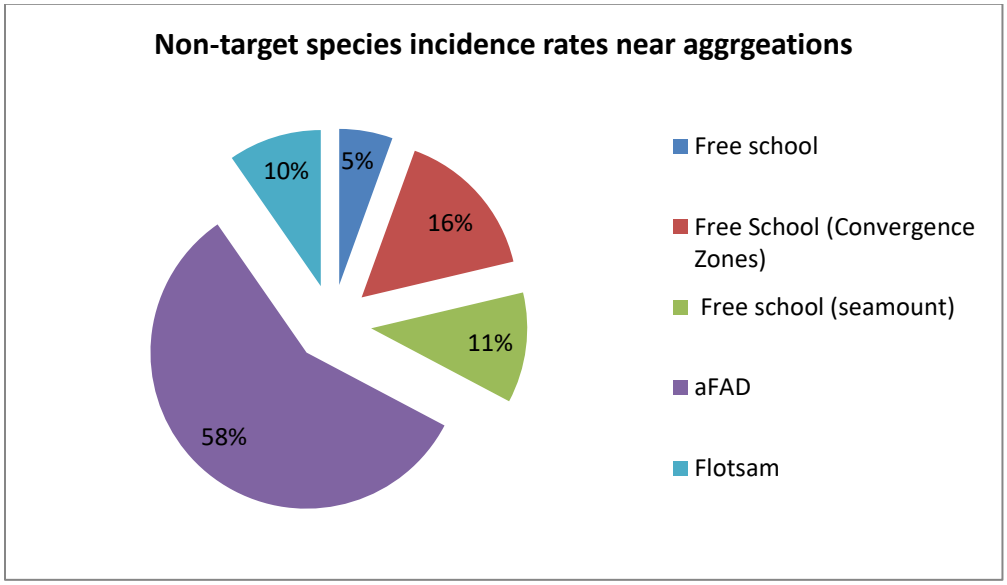

Figure 7: Catch rate of non-target tuna species at different aggregations

Table 1 Fate of the incidental catches in the pole and line fishery

Species/Group	Quantity caught	Percentage of total	Fate
Rainbow runner	586	1.30	Consumed
Mahimahi	518	1.15	consumed
Billfishes	25	0.06	consumed

Wahoo	74	0.16	Consumed
File/Trigger fishes	9	0.02	discarded live
sharks	103	0.23	Consumed
Others	102	0.23	discarded live
Turtle	0	0.00	
Dolphin	0	0.00	
Birds	3	0.01	safely released
Total (consumed)	1306	2.90	
Total (discarded)	114	0.25	
TOTAL	1420	3.16	

Catch and bycatch in Yellowfin handline fishing

Traditionally, yellowfins and bigeye tunas had been harvested by the fishermen for years using handline; at times, using live bait such as wrasses, red mullets, flying fishes etc. The fishery though occurred throughout the year, the peak of such activities was during the winter months. As mentioned earlier, sudden declines in catches of skipjack persuaded the fishermen to look for alternative resources. Though yellowfin is the natural choice, the value chain concerns were worrying for a fillip in its production. The recent imitative of the Lakshadweep Administration to permit the islanders to deploy collection vessels, often taken on lease from the mainland ports in Kerala; paved for establishing a new value chain for the yellowfin and other tunas to be collected and transported to the mainland ports for marketing. Meanwhile, in the last three years, the fishermen through continuous innovations developed a chumming based handline fishery for yellowfin tuna.

Generally, the less active fishing boats which abstain from skipjack fishing due to manpower shortage or smaller size of the craft perform the handline fishing for yellowfin. Livebait fishes such as fusiliers and triggerfish are collected mainly from the outer reef areas. In the absence of these two baits, fishes are green chromis collected from the lagoon and near reef areas are used. The baits are collected like they do for the skipjack pole and line using dip net or encircling boat seines and are stored in the livebait tanks. Motorised canoes, doing this fishing stores the bait in plastic tanks or fibre glass tanks specially made and fitted on board. Fishing ground is generally the southern and northern end of the islands, which due to geomorphological features are the convergence areas. Fishes are generally abundant in these zones anytime through the year and its abundance gets better during the early morning and dusk hours. Yellowfin tuna fishermen generally carry out fishing during this time. On reaching the ground, the fishermen release the live bait in small scoops. Meanwhile, they release hook and lines baited with one live fish each. Three to four lines are operated generally at a time.

In the 35 fishing operations observed on-board, nearly 93% of the catch was constituted by yellowfin tuna (Fig 8). The size of the fish varied from small (less than 10kg) to very large ones (more than 100kgs). There is likelihood of having certain amount of big eye tuna also in the catch, detailed information however has not been gathered in the present study. Another major catch was the billfishes, principally the sail fish. Marlines were caught on few occasions. However, there were no

incidences of hooking sword fish. Rainbow runner and mahimahi were the other prominent incidental catches. Skipjack tuna and wahoo were caught on rare occasions while steering to the yellowfin grounds or while shifting the positions when drifted away from the ground. Shark formed catch only on one occasion. Incidental hooking of turtle (hawksbill) occurred once and the turtle was released safely without hauling them on board. Dolphins and birds never had any direct interaction with the fishing gear in the handline fishing (Table 2).

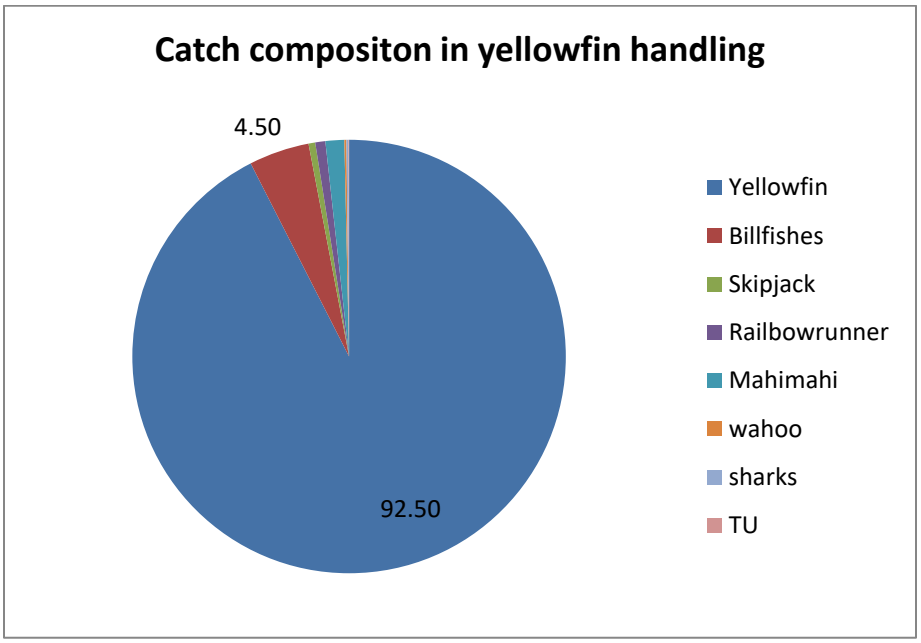

Figure 8 Composition of catches and bycatches in the yellowfin hand lining

Table 2: Fate of the incidental catches in Handline fishery for yellowfin tunas

Species/group	Catch	%	Fate
Yellowfin	1263	92.50	consumed
Sailfish/Marlin	61	4.50	consumed
Skipjack	7	0.50	consumed
Railbow runner	10	0.75	consumed
Mahimahi	19	1.40	consumed
wahoo	2	0.15	consumed
sharks	2	0.15	consumed
TU	1	0.05	discarded live
DO	0	0	
Birds	0	0	
Total	1365	100	

Catch and bycatch in the Bait fisheries for pole and line and handline tuna fishing.

Baiting for skipjack pole and line were predomeinantly done in lagoons in earlier days when the dependence was more on the sprats. But, in th erecent years, as the fishermen learnt to use multiple baits, the bait collection from outer reef areas have increased considerably though the lagoon is relatively dominant area (Fig. 10). However, in the case of baits for yellowfin handlining, the baits are predominantly (67%) (Fig. 13) collected form the outer reef areas mainly because of the area being the habitat of the preferred baits such as fusiliers and trigger fishes. As fishing is done on aggrgeations after confirming the species, the catch rate of bycatches are much lesser (Fig 11 and 14). The bycatch rate is relatively higher in the baiting for handline, mainly because of the fishing area and the method of fishing. A comparision of catch and bycath from lagoon and outer reefs in both baitings indicate a relatively higher incidence of bycatch in the baiting for handline. Use of chum (minced fish meat and offal) to attract the bait fishes, especially trigger fishes also attracts other fishes which thus get caught (Fig 15).

The major bycatch in the baitig for skipjack pole and line are the atherinid fishes which often aggrgeate close to the sprats (Table 3). Wrasses, trigger fishes, groupers, halbeaks etc get caught in minor quantities. Wrasses, groupers, halbeaks and other coral associated fishes get attracted to the chum get caugth incidentaly in the baiting for yellowfin handlining. These undesired fishes are generaly removed immediately on harvest and doften before transferring the catches to the tank itself and released to sea or kept for consumption so as to avoid crowding in the bait tank. The fate of the bait species in both cases are provided in Tables 3 and 4).

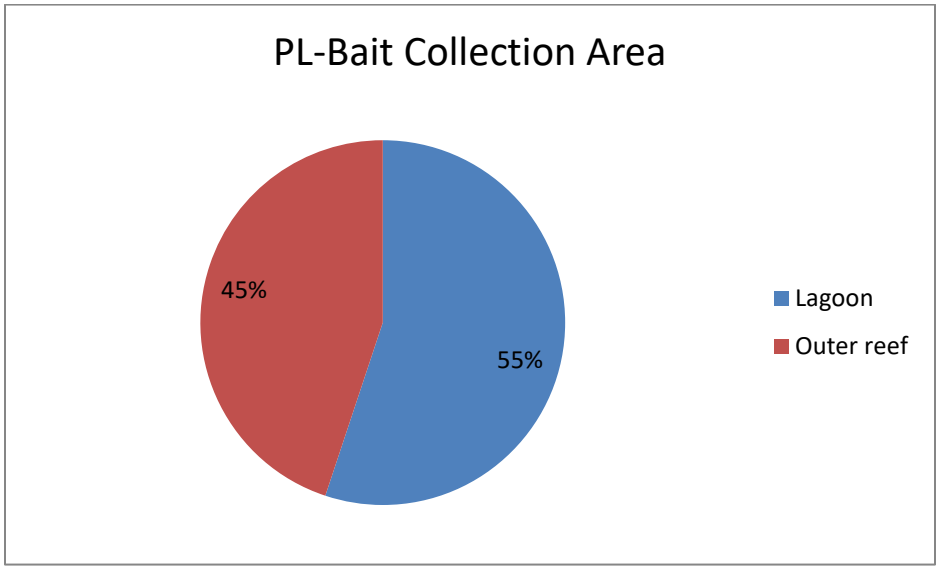

Figure 10: Bait collection area of the pole and line fishing vessels

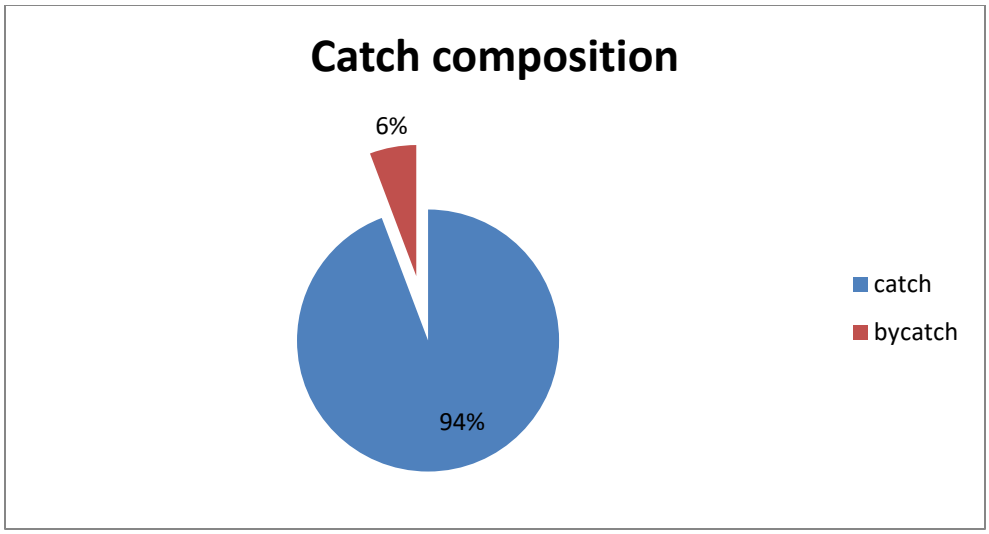

Figure 11: Catch and bycatch levels in the pole and line live bait fishing operations

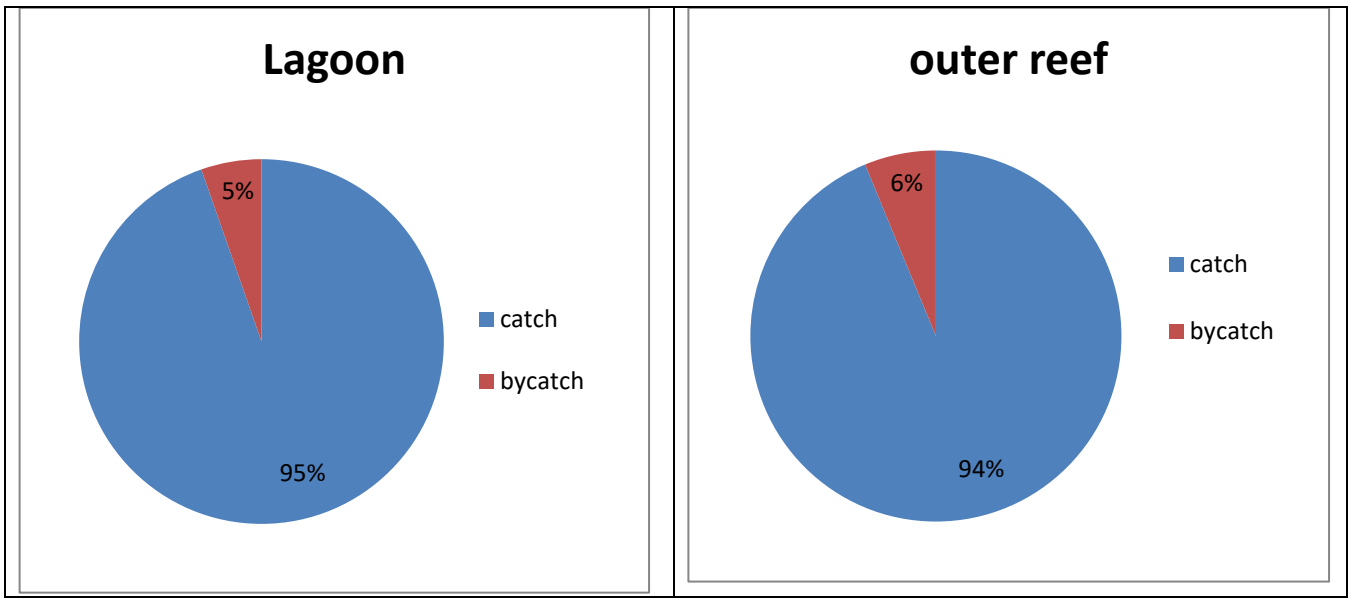

Figure:12: Operational area-wise Catch /bycatch levels in bait fishing operation by skipjack pole and line fishing vessel

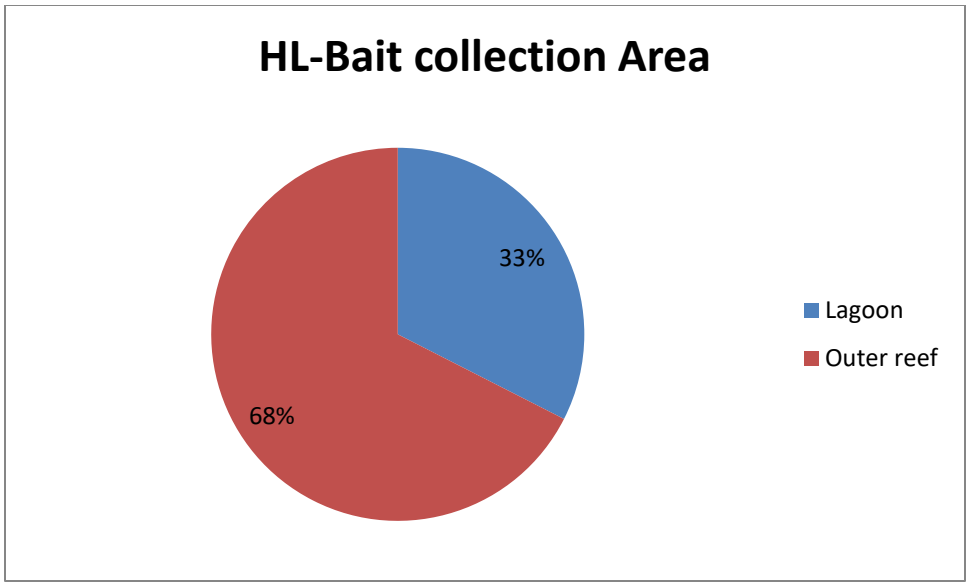

Figure 13: Area of operation of baitfishing for yellowfin handline fishery

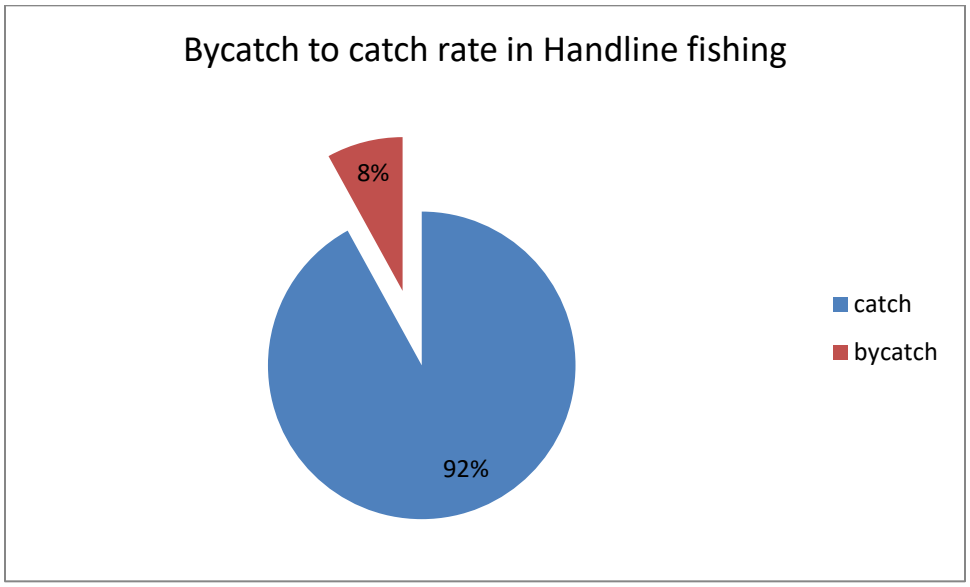

Figure 14: Catch and bycatch in Bait collection for handline yellowfin fishery

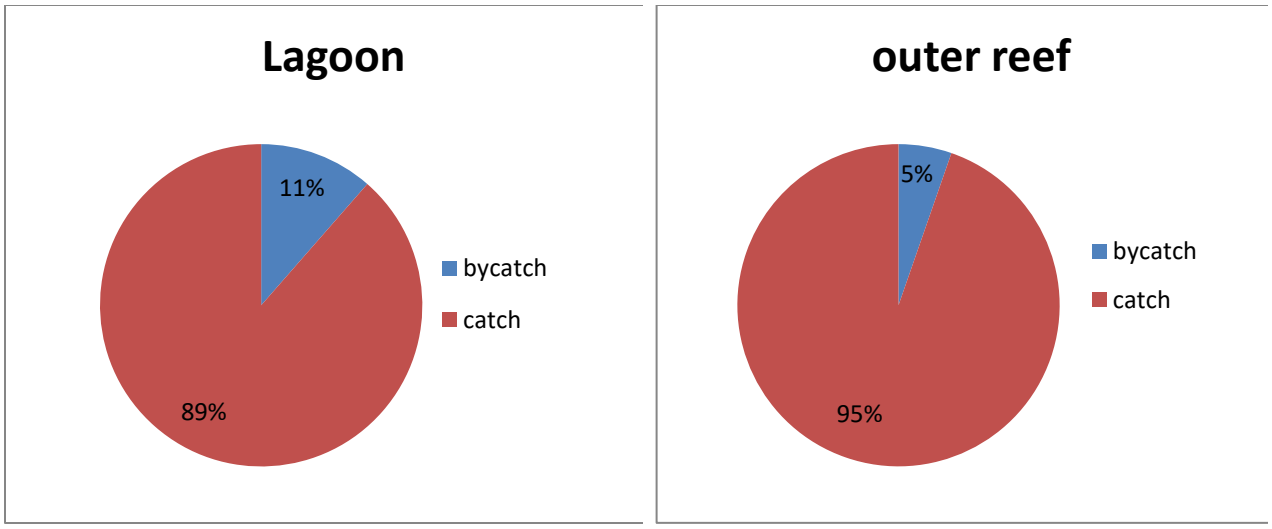

Figure 15: Catch and bycatch rate in the yellowfin handline fisheries

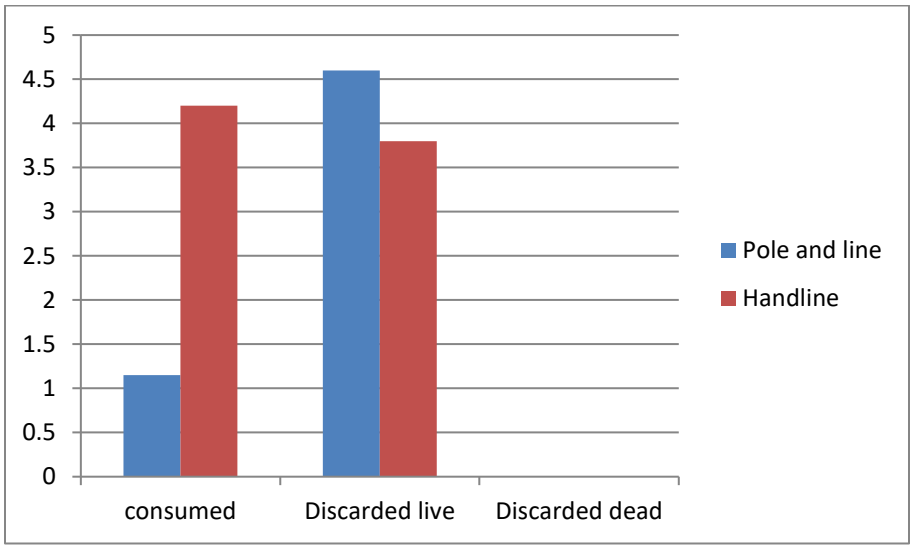

Figure 169 Fate of the bycatch in baiting for pole and line and hand line

Table 3 Percentage composition in bait fishery for skipjack pole and line (catch and bycatch) (35 fishing operation observed)

Species/group	Lagoon %	Outer reef %	fate
Silver sprat	37	5	used up
Blue sprat	5	12	used up
Ceasio spp	1.3	11	used up
Ptero ceasio spp	1.2	7	used up
Green chromis	3	0.5	used up
Lepidozygous tapeinosoma	3	1.4	used up
Fusliers (others)	0.5	2.5	used up
Cardinal fishes	1.15	2.7	used up
Trigger fishes	0	1.3	discarded live
Anthias	0	0.5	discarded live
Atherind	1.7	0.3	discarded live
wrass	0.45	0	consumed
half beak	0.3	0.4	consumed
others	0.5	0.3	discarded live
TOTAL	**55.1**	**44.9**	

Table 4: Percentage composition in bait fishery for yellowfin handline (catch and bycatch) (25 fishing operation observed)

Species/group	*Lagoon %*	*Outer reef %*	Fate
Ceasio spp	5	11	Used up
Pteroceasio spp	5	7	Used up
Chromis caeruleus	6.1	0	Used up
Lepidozygous tapeinosoma	5	0	Used up
Fusliers (others)	3	3	Used up
Trigger fishes	4.2	42.7	Used up
Cardinal fishes	0	0.9	discarded live
Anthias	0	1.1	discarded live
wrasses	3	0	consumed
half beak	0.5	0.7	consumed
others	0.7	1.1	discarded live
	32.5	67.5	

Direct interaction of turtles, dolphin and birds were almost absent in all cases including baiting. Information on the sighting of these species in the vicinity of every fishing event was recorded in the data (Table 5). In almost all skipjack pole fishing events and in case of few handline fishing events, the birds were sighted in close vicinity. Dolphins were sighted often in the vicinity of baiting events in the outer reef areas. Turtles, especially the hawksbill and green turtles were also seen swimming in lose vicinity of baiting events, especially in the lagoon. In three instances, hawksbill ocurred in the baiting net, however, they were waded out of th net safely. The fisherm take additional care with respect to turtles as it may damage their bait nets and cause loss of bait. Sharks and rays were often sighted moving close to the baiting operations, especialy in the lagoon.

Some interaction with the coral reef was observed, especialy in baiting events inside the lagoons (Table 6). Due to shalow nature of the lagoon and proximity of the baits to the corals, fishermen swimming to aid baiting inadvertently hits the staghorn coral and cause damage. Aberration casued by fishing net is another form of interaction casuing damage to corals besides anchoring by the boats on the corals at times. However, the sharp staghorn corals are carefuly avoided for intreraction as it cause physical injury to the fishermen and dameges to the net.

Table 5: Encounters with the ETP Species recorded during the fishing trips (baiting and fishing) in pole and line and handline fishing boats

ETP species	Frequency	Interaction	Fate
Dolphin	18%	Swimming closely	Not captured
Turtle	35%	Swimming closely or entering the net	Not captured or waded out safely
Shark	7%	Swimming closely or entering the net	Not captured or waded out safely
Sting Ray	15%	Swimming closely	Not captured
Seabirds	65%	Flying nearby	Not captured

Table 6: Interaction of bait fishing with the corals (underwater observation of 25 fishing operations at Agatti and Kavaratti islands)

Interaction	Lagoon	Outer reef
Damage to corals by net	3	1
Damages by fishermen	5	0
Damages by anchoring	1	1
	2.3%	0.5%

Conclusion

Lakshadweep islands are important grounds for the oceanic tuna resources like the skipjack and yellowfins. The subsistence scale fishery for these species is the mainstay of the economy of these islands. Low scale of operation and prevalence of highly selective and passive gears such as pole and line and handline fishing methods makes the fishery highly ecologically sound. The bait fishing which has minor interactions with the ecosystem if managed following science based management plans prepared

in with active participation of the stakeholders would yield the fishery to be best model to the world for an ecologically sound fishery. RFMOs like IOTC should flag these fisheries in right perspectives so that the environment conscious communities around the world would source such sustainability caught tunas benefiting these marginal fishermen. Worries of such fishermen need to be reflected rightly in the policies evolved by the IOTC.