Sustainable Pole and Line Tuna Fisheries in the Indian Ocean: Does Lakshadweep hold up to Maldives' MSC standards?

Mahima Jaini[1] & Jafer Hisham[2]

[1]Research Assistant, Dakshin Foundation, Bangalore, Karnataka, India.

[2]Fisheries Officer, Directorate of Fisheries, Kavaratti Island, U.T of Lakshadweep, India.

ABSTRACT

Growing seafood awareness campaigns have increased the demand for sustainably harvested products including tuna. While the traditional pole and line tuna fishing method is considered sustainable, these fisheries operate on scales smaller than most others. Increasing demand for pole and line caught tuna may present an opportunity for better marketability and higher profits for these small-scale fisheries. The Maldives' pole and line tuna fishery was the first in the Indian Ocean to achieve the Marine Stewardship Council (MSC) certification. This technique, prevalent in both the Maldives and Lakshadweep islands of the Indian Ocean, is a highly selective method targeting the Indian Ocean skipjack tuna (*Katsuwonus pelamis*) stock under the guidelines of the Indian Ocean Tuna Commission (IOTC), local and customary bodies. Both fisheries utilize planktivores from the reef and lagoon as live-bait to target oceanic skipjack tuna. The main concerns regarding the MSC certification for Maldives stem from the ecological uncertainties behind the removal of lower trophic level baitfish species and lack of adequate harvest control strategies for the tuna stock. The Maldivian Ministry of Fisheries and Agriculture has proposed a baitfish management plan for 2014 that promotes best practice conservation and utilization of live-bait resources. Studies in the Lakshadweep Islands have just begun to understand the relationship between baitfish resources and fishing pressure. Improvements in skipjack tuna stock assessments are necessary for both fisheries. A management system with long-term objectives, fine-scale record keeping, adaptive decision-making and community participation is required to demonstrate the sustainability of the Lakshadweep fishery.

INTRODUCTION

With over 87% of the assessed fish stocks being fully or over exploited (FAO, 2011), the need for sustainable development of fisheries and seafood products is now more than ever. Seafood awareness campaigns, like seafood guides and ecolabels, have helped increase the demand for sustainably harvested seafood products, especially in Europe and North America. Such campaigns help promote sustainable fisheries, increase consumer awareness while promising producers better markets and higher premiums; thus providing managers and fishers incentives and rewards for managing their resources responsibly with long-term objectives in mind (Washington, 2008). The limited supply and growing demand for sustainable seafood in Europe and America, presents an opportunity for expanding the markets of best-practice small-scale fisheries.

Tuna, a global commodity, accounts for over 7% of total marine capture fisheries production (WWF, 2007) but is unfortunately threatened by declines worldwide (Juan-Jorda et al., 2011). Majority of the tuna catch comprises of skipjack tuna (57%; ISSF, 2013), a species most commonly used in canning (FAO, 2004) and capable of large harvests given its fast growth rate and low age at first maturity (Fromentin and Fonteneau, 2001). Tuna are harvested by artisanal and industrial fishing sectors using a variety of gear such as purse seines, longlines, pole and lines, gillnets etc. 62% of global tuna catch comes from purse seining (ISSF, 2013), a detrimental process with high levels of bycatch, especially when associated with the commonly used Fish Aggregating Devices (FADs) (WWF, 2007; Ingles et al., 2008; Gillett, 2011).

The pole and line fishing technique supplies 11% of global tuna (ISSF, 2013) and is considered as a best-practice due to its high selectivity and low environmental impact (Gillet, 2011). 10% of the Indian Ocean tuna catch comes from small-scale pole and line fisheries operating out of the Maldives and Lakshadweep islands (Gillett, 2013), landing a majority of skipjack tuna (*Katsuwonus pelamis*) amongst yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*), kawakawa (*Euthynnus affinis*) and *Auxis* spp. These fisheries utilize small planktivores from island lagoons and reefs as live-bait to target oceanic skipjack resources (Stone et al., 2009), thereby reducing the pressure on the sensitive coral reefs of their atoll ecosystems. Being a labor-intensive technique, these fisheries provide employment to a vast number of people (Stone et al., 2009; Gillet, 2011) and are critical to the socio-economics of small island groups like that in Lakshadweep and Maldives. With high stock abundance, low fishing mortality and low ecosystem impact, the Maldives pole and line skipjack fishery was certified by the Marine Stewardship Council (MSC) in 2012 (Anderson et al., 2012; MSC, 2013), thereby opening improved markets for the island fishers. In this paper, we use the Maldives MSC certification as a template against which to score the sustainability of the Lakshadweep pole and line skipjack fishery. The objective is to identify areas of weakness in the Lakshadweep fishery, ways in which it can be better developed, and the possibility of improving the livelihoods in these island communities.

MARINE STEWARDSHIP COUNCIL

While seafood guides, such as the Monterey Bay Aquarium's Seafood Watch program or Blue Ocean Institute's Seafood Guide, help consumers decide between the best and worst choices in popular seafood, they are limited to data-rich fisheries and fail to consider the full range of environmental and social costs of production. Sustainable seafood certifications, like that of the Marine Stewardship Council (MSC), critically analyze fisheries regarding their biological, ecological, social and political aspects, help identify responsible fisheries and work to improve them through post-certification action plans and regular evaluations (MSC, 2010). Sustainable seafood certifications boast of producer benefits including the expansion of markets, price premiums, greater credibility and improved public image, but currently the evidence for this is limited (Jacquet and Pauly, 2007). The MSC label is now well recognized worldwide and poses an effective way for consumers to identify sustainable products.

MSC certifies fisheries based on three principles regarding the health of the fish stock, impact on the ecosystem and effectiveness of management system. Each principle is further divided into specific components and performance indicators (MSC, 2010). Certifications of fisheries are done by third-party certifiers; i.e. bodies not directly associated with the fishery or MSC. MSC clients seeking certifications can be fisher associations, industry associations, processors, management agencies or any stakeholder group (MSC, 2010). Clients may pay anywhere between 15,000 USD to 500,000 USD for the certification process, but full assessments are only conducted once the fishery passes pre-assessments, thus reducing the wastage of money, time and effort (MSC, 2010). In the full assessment, an expert team works with the certification body to score the MSC standard performance indicators, through reviews and site visits, with full transparency, peer review and stakeholder involvement (MSC, 2010). This detailed process can take anywhere from 12 to 24 months. Certifications are awarded for five-year periods and may also be given on conditional basis with the stipulation that certain criteria be met by established deadlines via the implementation of action plans. Yearly audits and evaluations are performed to check the sustainability of the fishery and process of improvement (MSC, 2010).

Currently there are 182 fisheries certified by MSC and another 104 in assessment, bringing all together 128 species in the MSC program ranging from clams to rays (MSC, 2013). MSC has certified 9 tuna fisheries worldwide that either use handlines, longlines, trolling, pole and line gear or purse seines or a combination of gears. Of these, three pole and line fisheries are currently certified, one in Mexico Baja California, another in Japan and the third in the Maldives. In terms of certified skipjack fisheries, the Maldives pole and line fishery is second in annual tuna landings to the western and central pacific purse seine fishery (MSC, 2013). Currently, tuna is the second most searched commodity on the MSC website, after salmon, thus indicating the high global demand for sustainable tuna (MSC, 2013). Additionally, certain retailers in Europe have pledged to shift their entire supply to skipjack pole and line products (Stone et al., 2009). Thus, with growing awareness and demand, an analysis of the sustainability and feasibility of opening new markets for the Indian pole and line tuna fishery is timely.

INDIAN OCEAN POLE & LINE SKIPJACK TUNA FISHERIES

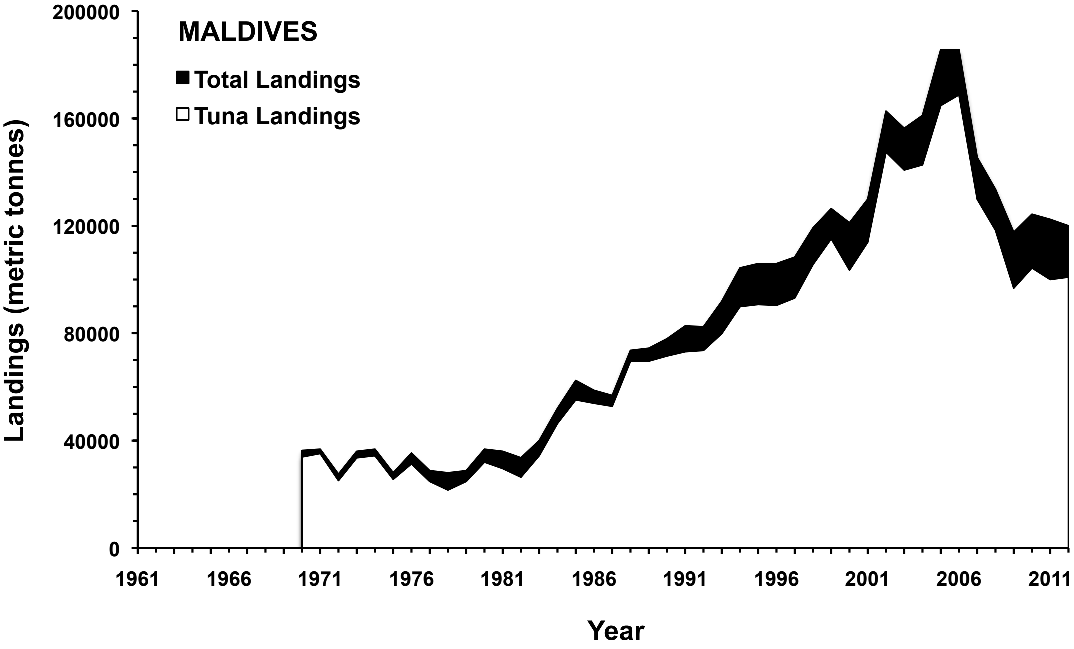
The main tuna species targeted by pole and line fisheries is the skipjack tuna (*Katsuwonus pelamis*). The Indian Ocean pole and line fisheries, i.e. those in the coral atolls of Maldives and Lakshadweep, catch 21% of the landed Indian Ocean skipjack (Fonteneau, 2003). The Maldives tuna catch is an order of magnitude higher than that in Lakshadweep but when considering it in light of the land area, the tuna catch per km^2 of land is comparable (Table 1; Figure 1). Using rough estimates of the EEZ of the respective island systems, the tuna catch per unit of EEZ is much higher in Maldives than in Lakshadweep (Table 1), possibly highlighting the relatively unexploited status of the Lakshadweep oceanic resources. Majority of the global skipjack tuna catch is used in canning (Fonteneau, 2003), but Maldives exports most of their skipjack in frozen form (MoFA, 2013) whereas Lakshadweep skipjack is exported as a dried product known as *mas* (DoF, 2013; Table 1). One should note that Indian Ocean skipjack tuna catch has been declining since 2006, and this trend is well represented in the Maldives catch data (ISSF, 2013; Pillai and Satheeshkumar, 2012; Figure 1). Authors have suggested that this may reflect declining skipjack abundance, limited availability of baitfish, or changes in economic incentives (rising fuel prices) (Kolody et al., 2011).

Table 1. Basic information pertaining to the tuna fisheries of Maldives and Lakshadweep archipelagos. Maldives motorized boats contain mostly motorized *mas dhoanis* used in the pole and line fishery where as the Lakshadweep motorized boats contain both tuna fishing boats and small crafts with outboard engines used in lagoon and reef fishing. Maldives fisheries data obtained from the Ministy of Fisheries and Agriculture (MoFA) and Lakshadweep data from the Lakshadweep Department of Fisheries (DoF).

	Maldives	Lakshadweep
Total Land Area	298 km^2	32 km^2
Exclusive Economic Zone (EEZ)	1,000,000 km^2	400,000 km^2
Total population (2012/2011)	328,536	64,429
Motorised boats 2012*	950	1016
# of fisherfolk 2011	10,972	8,978
Average Marine Landings 2012	120,000 metric tonnes	13,256 metric tonnes
Average Tuna Landings 2012	100,907 metric tonnes of tuna	10,678 metric tonnes of tuna
Tuna catch per unit land area	338.61 tuna tonnes per km^2 land	333.69 tuna tonnes per km^2 land
Tuna catch per unit EEZ	0.10 tonnes per km^2 EEZ	0.03 tonnes per km^2 EEZ
Tuna catch per capita	0.31 tuna tonnes per individual	0.17 tuna tonnes per individual
Main tuna export	Frozen skipjack; Frozen, Fresh or chilled yellowfin; Canned and dried tuna	Mas (dried skipjack)

Pole and line fisheries are considered sustainable as they target the relatively resilient skipjack tuna using highly selective gear that has minimal impact on the habitat. Skipjack tuna are characterized by large stock size, fast growth, early maturation, prolific year-round spawning over wide areas, relatively short life spans and highly variable recruitment (Gillet, 2013; Anderson et al., 2012). Skipjack tuna live up to 9 to 10 years and grow up to 110 cm or 36 kg in weight (IOTC, 2011 Stock Assessment summary; Kolody et al., 2011). They reach sexual maturity by 1.5 years of age i.e. at approximately 45 cm length and 1.7 kg in weight (Fromentin & Fonteneau, 2001). The skipjack stock in the Indian Ocean is considered as one contiguous population and a 2011 stock assessment deemed that neither is the stock overfished nor is it subject to overfishing and thus is being harvested well within the limits of B_{MSY} and F_{MSY} (Kolody et al., 2011).

The Maldives tuna fishery is considered to be at least a thousand years old (Anderson et al., 2012). The fishery spread to the Lakshadweep islands from the Maldives via Minicoy as it was colonized some 200 years ago (personal communication with elders in Minicoy Island, Lakshadweep). In Lakshadweep, Minicoy has the only traditional pole and line fishery and was introduced to the rest of the islands in the late 1960s by the Lakshadweep Department of Fisheries (DoF, 1990). Thus, having the same origins; the technique, craft and gear utilized in these fisheries are very similar with few modifications from island to island. The boats used for pole and line fishing range from 7 – 14 m in length, are constructed of wood but now fiberglass boats are also gaining popularity. The technique employs a simple barbless hooked line at the end of the pole to catch tuna. The tuna are attracted to the boat with the use live-bait and water spraying, leading to a feeding frenzy during which the tuna bite indiscriminately onto bait less barbless hooks and are then rapidly swung into the boat.



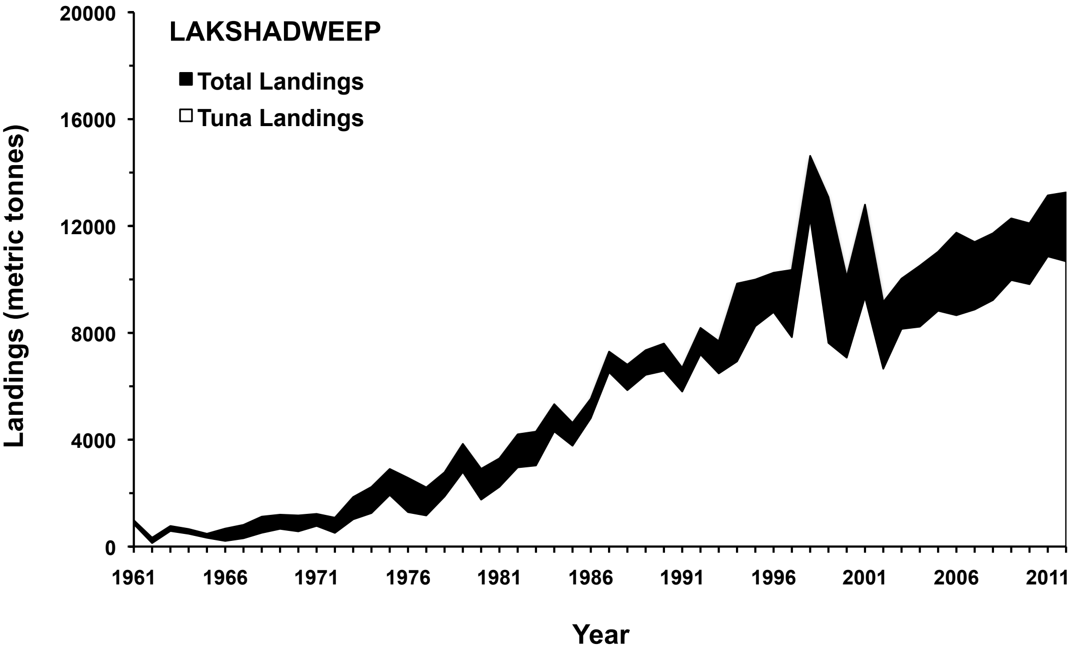


Figure 1. Maldives and Lakshadweep landings data in metric tones, showing total marine landings and total tuna landings. Note the order of magnitude difference in scales, with Maldives being 10x higher than that in Lakshadweep. Data obtained from the Maldives Ministry of Fisheries and Agriculture (MoFA) and the Lakshadweep Department of Fisheries (DoF).

Although the pole and line method is considered sustainable, given the resilient nature of skipjack tuna and due to its low impact and high selectivity, the use of small lagoon and reef planktivores as live-bait raises questions of ecological sustainability regarding impacts of removal of lower trophic levels in reef and lagoon ecosystems (Stone et al., 2009). The Indian Ocean pole and line tuna fisheries use a range of lagoon and reef planktivores from various families including: Clupeidae, Atherinidae, Caesionidae, Apogonidae, Pomacentridae and Serranidae (Kumaran et al., 1989; Anderson et al., 1997; Sivadas & Nasser, 2000; IPNLF, 2012). They most commonly employ lift nets. There has been a recent shift from fishing for coral associated baitfish (apogons, pomacentrids) to night fishing for bait that are attracted with the use of artificial lights (Anderson et al., 2012). In Lakshadweep, fishers target spawning populations of *Spratelloides delicatulus* that deposit their eggs on shallow sand banks during full moon (personal communication with active Lakshadweep fishermen). The impact of this technique is unknown. However, these commonly used clupeid species have rapid growth rates and high turnover and thus are considered to withstand the fishing pressure. But lack of regional data on the use of various baitfish and their trophic linkages makes it difficult to determine the true impact of baitfish removals (IPNLF, 2012).

Typically pole and line boats locate surface tuna schools by sighting sea birds or floating debris. The open ocean schools tend to be size and species specific. Recently, in both the Maldives and Lakshadweep fisheries there has been an increase in the use of Fish Aggregating Devices (FADs) for tuna (Adam et al., 2003; Riyaz Jauharee & Adam, 2012; Pillai & Satheeshkumar, 2012). FADs tend to attract smaller skipjack and there is also a higher level of bycatch including juvenile yellowfin, rainbow runners and mahi mahi. Unfortunately, in addition to declines in Indian Ocean catch volume, the mean skipjack weight has also declined from 3kgs in 2006 to 2.3kgs in 2010 (IOTC, 2011 Stock Assessment summary), possibly a consequence of increased FAD use and industrial purse seining.

Despite these concerns, robust management systems that employ the precautionary approach while utilizing data from various sources to constantly guide decisions in an ever changing fishery can help withstand the detrimental effects of fishing pressure. The Indian Ocean Tuna Commission (IOTC), formed in 1993, is an intergovernmental agency operating under FAO that is mandated to manage tuna fish stocks within the Indian Ocean - FAO statistical areas 51 and 57 (Western and Eastern Indian Ocean) and its adjacent seas. It relies on the joint action of member countries in assessing and regulating regional tuna fisheries. Resolutions adopted by the IOTC are not entirely of a binding nature and rely heavily on the governments of member states to implement various measures. The Maldives has its Ministry of Fisheries and Agriculture (MoFA) and Lakshadweep has a state level Department of Fisheries (DoF) responsible for managing their fish stocks and ensuring the longevity of fisheries related livelihoods.

COMPARISON OF MALDIVES & LAKSHDWEEP POLE & LINE FISHERIES

The final report for the Maldives MSC certification (Anderson et al., 2012) provides a useful template against which to score the Lakshadweep fishery. The two fisheries are comparable given the geographic proximity, history of the fishing practice, geological and ecological similarities of atoll systems. At the closest point Maldives and Lakshadweep are a mere 125 km apart. These coral atolls belong to the same Chagos-Laccadive ridge, and thus closely resemble each other in terms of geological origins and ecology. The similarities are not only engrained in the geological and ecological structure but also in the history of the pole and line fishery, the technology being passed from Maldives to the rest of Lakshadweep over the past 200 years (personal communication with elders in Minicoy Island, Lakshadweep).

Here we use the Maldives MSC scoring and rationale section to evaluate Lakshadweep using the information available to us through various government and non-government resources and firsthand knowledge of the system. According to MSC, certifications are provided when fisheries obtain principle scores for each section at or above 80. For those indicators that score below 80 conditions are applied in the form of an Action Plan to improve the scores over the course of the certification (MSC, 2013). To help better interpret and judge our evaluations, we have used detailed tables to compare and score each individual performance indicator under the specific components belonging to the 3 MSC principles (Table 2 – 4).

1st MSC Principle: Target Species

The target species principle considers the health of the fish stock in terms of its status, reference points, stock rebuilding strategy, harvest strategy, control rules, information, monitoring and stock assessment (MSC, 2013; Table 2). Skipjack tuna have large population sizes, relatively fast growth and high reproductive potential, and due to their high mobility are treated as one single unit of stock for the entire Indian Ocean (Anderson et al., 2012). In 2011, the Working Party on Tropical Tuna (WPTT) of the IOTC conducted the first rigorous stock assessment, integrating all available Indian Ocean skipjack data (Kolody et al., 2011). The stock assessment concluded that the stock is not overfished and that overfishing is not occurring; the stock experiences high natural mortality and limited selectivity of the youngest spawners with high recruitment compensation indicating that large increases in effort may not effect recruitment and sustainable yield (Kolody et al., 2011).

Given the health of the stock, there are no formal harvest control strategies or rules in place for Maldives or Indian Ocean Skipjack (Table 2). But aside from this Maldives maintains regular records on stock structure, stock productivity and fleet composition that are fed into IOTC stock assessment and other analyses (Kolody et al., 2011; Anderson et al., 2012). Unfortunately there is insufficient skipjack data from other artisanal fisheries in the Indian Ocean including the Lakshadweep islands that hinder the support of harvests strategies on Indian Ocean scales (Anderson et al., 2012). Lakshadweep maintains records of fishery removals and fleet composition but data is insufficient for use in IOTC assessments; the tuna landings are grouped together, lacking in species and size specific details (DoF, 2013; Table 2). The IOTC conducts assessments of Indian Ocean skipjack but review with external parties is limited. The IOTC is working on formulating a precautionary approach to skipjack management in the Indian Ocean and has proposed interim target and limit reference points, but currently these have not been adopted (Anderson et al., 2012; Table 2).

Both Maldives and Lakshadweep scored similarly for principle 1, given the same target stock and governing body. For both fisheries, the weakest indicators include reference points, harvest control rules and tools, and information and monitoring (Table 2). In response, the Maldives fishery has agreed to meet conditions to improve the outlook of these indicators over the course of the certification, and the weight of this falls onto both the IOTC and local government (Anderson et al., 2012). Lakshadweep on the other hand will have to make great improvements in information gathering and monitoring of its resource in order to meet MSC requirements.

Table 2. Evaluation of MSC performance indicators for the Maldives and Lakshadweep pole and line skipjack tuna fisheries, belonging to the 1st principle: target species. Maldives scoring and evaluation obtained from MSC certification report (Anderson et al., 2012).

MSC Principle 1: TARGET SPECIES				MALDIVES		LAKSHADWEEP	
Component	**Performance Indicator**	**MSC standard**	**Weight**	**Score**	**Comments**	**Score**	**Comments**
Outcome	Stock status	The stock is at a level which maintains high productivity and has a low probability of recruitment overfishing	0.25	100	IOTC - Indian ocean skipjack stock not overfished and not subject to overfishing according to 2011 stock assessment.	100	IOTC - Indian ocean skipjack stock not overfished and not subject to overfishing according to 2011 stock assessment.
	Reference points	Limit and target reference points are appropriate for the stock	0.25	**65**	IOTC- Lacks well defined reference points and thus fishery is not managed in precautionary manner.	**65**	IOTC- Lacks well defined reference points and thus fishery is not managed in precautionary manner.
	Stock rebuilding	Where the stock is depleted, there is evidence of stock rebuilding		0	Not applicable. Stock is not depeleted.	0	Not applicable. Stock is not depeleted.
Management	Harvest strategy	There is a robust and precautionary harvest strategy in place	0.125	80	IOTC - No formal harvest control strategy for IO skipjack.	80	IOTC - No formal harvest control strategy for IO skipjack.
	Harvest control rules & tools	There are well defined and effective harvest control rules in place	0.125	**60**	IOTC - No explict harvest control rules exist as stock is currently fished at sustainable levels.	**60**	IOTC - No explict harvest control rules exist as stock is currently fished at sustainable levels.
	Information & monitoring	Relevant information is collected to support the harvest strategy	0.125	**75**	Maldives regularly maintains sufficient data regarding stock structure, stock productivity, fleet composition etc. which in turn are used in IOTC assessments. There is insufficient catch data from other artisinal fisheries in the Indian ocean.	**60**	Lakshadweep conducts regular monitoring of fishery removals and fleet composition but data is insufficient for use in IOTC assessments.
	Assessment of stock status	There is an adequate assessment of the stock status	0.125	95	IOTC - assessment with limited external review.	95	IOTC - assessment with limited external review.
Overall Score				80		**78.1**	

2nd MSC Principle: Ecosystem

Under the second principle, fisheries are scored in regard to their ecosystem impact taking into consideration all retained species, bycatch species, endangered threatened and protected (ETP) species, habitats, ecosystem structure and function (MSC, 2013). Retained species for the pole and line skipjack fishery include the targeted skipjack tuna, along with the landed yellowfin, kawakawa tuna and sharks, plus the baitfish species utilized in the process. The gear itself being a pelagic surface fishery has very little impact on habitat and ecosystem function. Fisheries tend to harvest mixed species schools at FADs or floating objects, not in the open ocean. Given the large extent of the fishery and the limited number of FADs (approximately 44 in Maldives and 20 in Lakshadweep), MSC finds minimal habitat, ecosystem and trophic impact from their use (Anderson et al., 2012). For the most part, the concern for ecosystem impact stems from baitfish harvest, as it is done in shallow lagoon and reef habitats and targets lower trophic level fish that may be important links in the lagoon and reef food webs. The species, habitat, ecosystem and trophic impact of baitfish removal deems further study (Anderson et al., 2012)

Lakshadweep being very data poor, scored lower for the information performance indicators for all five components, improvements under this principle involve improved data collection regarding the ecosystem as well as the development of effective strategies to manage ecosystem impacts (Table 3). Lakshadweep fishery has similar impacts on retained species but has been given a lower score given the lack of a ban on shark exports and emerging information regarding a potentially unsustainable bait fishing practice (Table 3). Although not found in published material, the authors have come across evidence of pole and line fishers harvesting *Spratelloides delicatulus* at time of spawning in Lakshadweep and this practice may date back at least 15 – 20 years, the long-term ecological impact of this practice needs further study. Additionally risk to ETP is highly unlikely but needs better data and management. Habitats utilized by pole and line fishers include the open ocean and FADs for tuna harvest, and shallow lagoon and reef zones for bait fishing. The fishery is considered to have minimal impact on habitats but lack of sufficient data collection and management strategies are an impediment (Table 3).

Impact of the pole and line fishery on trophic function is most critical given the removal of top oceanic predators along with the lower trophic level planktivorous lagoon and reef fish. Unfortunately lack of data and scoring mechanisms make it difficult to determine. The certification body has assumed the trophic impact to be low given the resilient biology of retained species (Table 3). An ongoing study undertaken by Dakshin Foundation, with advice form the Nature Conservation Foundation and Lakshadweep Department of Fisheries, aims to access the current status of baitfish populations and driving factors, and thus may help shed more light in regards to ecosystem impacts.

The Maldives fishery is assumed not to pose any ecosystem risk due to its moderate use of FADs, high selectivity of gear, resilient skipjack and baitfish biology, recent ban in shark exports and minimal impact on ETP species (Anderson et al., 2012; Table 3). Weakest areas in the MSC Maldives certification with regard to ecosystem impacts included lack of data and management of baitfish species and lack of information to support full strategies to manage impacts on ETP species (Anderson et al., 2012; Table 3). In light of the limited data on baitfish utilization, the Maldives MoFA is working on a baitfish management plan that is due in 2014 (Anderson et al., 2012).

Table 3. Evaluation of MSC performance indicators for the Maldives and Lakshadweep pole and line skipjack tuna fisheries, belonging to the 2nd principle: ecosystem. Maldives scoring and evaluation obtained from MSC certification report (Anderson et al., 2012).

MSC Principle 2: ECOSYSTEM				MALDIVES		LAKSHADWEEP	
Component	**Performance Indicator**	**MSC standard**	**Weight**	**Score**	**Comments**	**Score**	**Comments**
Retained species	Outcome	The fishery does not pose a risk of serious or irreversible harm to the retained species and does not hinder recovery of depleted retained species	0.0667	80	Low impact based on the harvest of baitfish and bycatch species, moderate spatial and temporal coverage of fishing effort including that at FADs and resilient nature of targeted species.	**70**	Criteria similar to that in the Maldives but data poor. Scale of fish catch and effort probably much smaller. Removal of *Spratelloides delicatulus* at time of spawning may be unsustainable.
	Management	There is a strategy in place for managing retained species that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to retained species	0.0667	**60**	No strategy for managing baitfish, only partial strategy for retained species such as skipjack, yellowfin, bigeye tuna and silky shark including a 2010 ban in shark exports that may help reduce shark landings.	**60**	No strategy for managing baitfish or retained species such as yellowfin, bigeye tuna and silky shark.
	Information	Information on the nature and extent of retained species is adequate to determine the risk posed by the fishery and the effectiveness of the strategy to manage retained species	0.0667	**75**	Lacks accurate verifiable information on catch of all retained species especially regarding baitfish removals for management.	**65**	Insufficient. Qualitative data on retained species, unreliable quantitative catch data on target species with very limited information on baitfish.
Bycatch	Outcome	The fishery does not pose a risk of serious or irreversible harm to the bycatch species or species groups and does not hinder recovery of depleted bycatch species or species groups	0.0667	100	Bycatch very rare. High degree of certainty that bycatch species are well within biologically based limits.	90	Bycatch very rare, likely within biologically based limits.
	Management	There is a strategy in place for managing bycatch that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to bycatch populations	0.0667	80	Current practice involves very low bycatch and thus maintaining it is regarded as a management measure.	80	Current practice involves very low bycatch and thus maintaining it is regarded as a management measure.
	Information	Information on the nature and the amount of bycatch is adequate to determine the risk posed by the fishery and the effectiveness of the strategy to manage bycatch	0.0667	80	Some qualitative information available to support a partial strategy to manage bycatch.	**70**	Only qualitative information, insufficient to support management.
ETP species	Outcome	The fishery meets national and international requirements for the protection of ETP species. The fishery does not pose a risk of serious or irreversible harm to ETP species and does not hinder recovery of ETP species	0.0667	80	Risk to ETP highly unlikely.	80	Risk to ETP highly unlikely.
	Management	There is a strategy in place for managing ETP species that is designed to ensure the fishery does not hinder the recovery of ETP species	0.0667	85	Limited interaction or impact to ETP, involves management strategies but lacks data and quantitative analysis.	**75**	Limited interaction or impact to ETP, but lacks strategies, data and quantitative analysis.
	Information	Relevant information is collected to support the management of fishery impacts on ETP species including: Information for the development of the management strategy; Information to assess the effectiveness of the management strategy; and Information to determine the outcome status of ETP species	0.0667	**75**	Quantitative data on ETP interaction available but limited ability to support full strategy.	**65**	Data on ETP interaction sparse and qualitative.
Habitats	Outcome	The fishery does not cause serious or irreversible harm to habitat structure, considered on a regional or bioregional basis and function	0.0667	80	Detrimental impact on benthic habitats from anchoring and mooring during baitfishing highly unlikely.	80	Limited impacts on benthic habitats from anchoring and mooring. Requires consideration of FADs in deep water and their impacts on pelagic and benthic habitats.
	Management	There is a strategy in place that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to habitat types	0.0667	80	Minimal risk to habitat, sufficient information on open ocean, FAD and baitfish habitat but lack of strategies to manage habitat impacts.	**70**	Minimal risk to habitats but lacks sufficient information and management strategies.
	Information	Information is adequate to determine the risk posed to habitat types by the fishery and the effectiveness of the strategy to manage impacts on habitat types	0.0667	80	Data present and collected on open ocean, FAD and baitfish habiats, but insufficient.	**70**	Some data present on habitats but not regularly collected, unreliable and insufficient.
Trophic function	Outcome	The fishery does not cause serious or irreversible harm to the key elements of ecosystem structure and function	0.0667	100	Skipjack being a mid-level predator and with minimal impact of fishing on lower trophic level baitfish, the fishery doesnot cause serious harm to key ecosystem components.	100	Skipjack being a mid-level predator and with minimal impact of fishing on lower trophic level baitfish, the fishery doesnot cause serious harm to key ecosystem components.
	Management	There are measures in place to ensure the fishery does not pose a risk of serious or irreversible harm to ecosystem structure and function	0.0667	80	Fishery posses no risk to ecosystem structure and function, partial strategy in place for further development if catches rise.	**70**	Fishery posses no risk to ecosystem structure and function but no strategy in place to minimize risk if conditions change.
	Information	There is adequate knowledge of the impacts of the fishery on the ecosystem	0.0667	80	Sufficient information exists but has not been investigated.	**60**	Limited information on key ecosystem components, their function and interaction with the fishery.
Overall Score				81		**73.7**	

3rd MSC Principle: Management Systems

Under this principle MSC tests the fishery management systems and their ability to deliver on principles 1 and 2. Management of the Indian Ocean pole and line fisheries fall under the jurisdiction of the IOTC. In both the Lakshadweep and Maldives, regional governmental bodies are well defined as to their roles and responsibilities regarding fisheries management (Table 4). In Maldives, there are good formal and informal consultation mechanisms for management and policy developments, but regionally there are only implicit fisheries management objectives (Anderson et al., 2012). Use of the precautionary approach in Maldives MoFA is evident via the restriction of certain fishing methods and the ban on shark exports. The Maldives fishery is relatively data rich and is supported in part by the Marine Research Center (MRC) that coordinates research with MoFA and has a considerable focus on tuna stocks and fisheries (Anderson et al., 2012).

Lakshadweep on the other hand, scored the lowest under this principle as it lacks adequate governance and policy frameworks, and a fishery specific management system (Table 4). Unfortunately, currently the Lakshadweep Department of Fisheries (DoF) only has implicit objectives and lacks long-term objectives to guide decision-making. Management also provided incentives for fishing including subsidies for boat repairs, building, storage gear etc. and these aren't regarded as contributing to overcapacity as current harvest levels are considered to be at 12% for Lakshadweep's water (Table 4). Limited engagement with stakeholders, decision-making process, fishery monitoring, control and surveillance mechanisms, and research plans make the Lakshadweep pole and line fishery a weak contender in the MSC certification arena. Currently there is no information generation in response to the research needs of the fishery but the Lakshadweep DoF has formed a research division to attend to its research needs (Table 4). Additionally, Dakshin Foundation is in the midst of initiating a community based pole and line fishery monitoring program in certain Lakshadweep islands with the hope to increase stakeholder engagement while generating accurate landings statistics regarding targeted, retained, and bycatch species. Despite this, it is a long road ahead for Lakshadweep to improve on each performance indicator (Table 4).

Over the course of the certification, MSC also had concerns regarding IOTC's ability to respond rapidly to fisheries issues and instate a precautionary approach to fisheries management for all parties involved. And this concern would be evident for the Indian pole and line fishery as well. In order to improve Maldives management systems conditions in place for certification include the development of explicit short term fisheries objectives and a clear demonstration of the effectiveness of Maldives monitoring, control and surveillance mechanisms (Anderson et al., 2012; Table 4).

Table 4. Evaluation of MSC performance indicators for the Maldives and Lakshadweep pole and line skipjack tuna fisheries, belonging to the 3rd principle: management system. Maldives scoring and evaluation obtained from MSC certification report (Anderson et al., 2012).

MSC Principle 3: MANAGEMENT SYSTEM				**MALDIVES**		**LAKSHADWEEP**	
Component	**Performance Indicator**	**MSC standard**	**Weight**	**Score**	**Comments**	**Score**	**Comments**
Governance and policy	Legal & customary framework	The management system exists within an appropriate legal and/or customary framework which ensures that it: Is capable of delivering sustainable fisheries in accordance with MSC Principles 1 and 2;Observes the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood; Incorporates an appropriate dispute resolution framework.	0.125	95	Management system involving the IOTC and MoFA are capable of delivering sustainable fisheries while observing local and customary laws and incorporating a dispute resolution framework.	**75**	Management system involves the IOTC and DoF which are capable of delivering sustainable fisheries but there are few frameworks in place, minimal incorporation of customary laws and dispute regulation.
	Consultation, roles & responsibility	The management system has effective consultation processes that are open to interested and affected parties. The roles and responsibilities of organisations and individuals who are involved in the management process are clear and understood by all relevant parties	0.125	90	IOTC and MoFA roles and responsibilities well established, consultation with affected parties frequent but could use better engagement.	**70**	Management parties roles and responsibility well established but consultation involving affected parties is limited.
	Long term objectives	The management policy has clear long-term objectives to guide decision-making that are consistent with MSC Principles and Criteria, and incorporates the precautionary approach	0.125	80	IOTC and MoFA have clear long term objectives but arent required by management policy.	**60**	IOTC and DoF management policy possesses only implicit long-term objectives.
	Incentives for sustainable fishing	The management system provides economic and social incentives for sustainable fishing and does not operate with subsidies that contribute to unsustainable fishing	0.125	80	Management provides social and economic incentives for sustainable fishing, currently does not operate with subsidies that contribute to unsustainable fishing but doesn't have measures to prevent rise of perverse incentives.	**60**	Management provides subsidies for boat building, repairs, diesel, fish storage and support for the deployment of FADs, as according to present estimates Lakshadweep is exploiting only 12% of its fishery potential. Lacks measures to prevent the rise of perverse incentives.
Fishery specific management system	Fishery specific objectives	The fishery has clear, specific objectives designed to achieve the outcomes expressed by MSC's Principles 1 and 2	0.1	**70**	Management plan doesn't have clear short term objectives. Some long term objectives exist but lack short-term implementation strategies. Baitfish management plan due for 2014.	**60**	Management plan lacks clear short and long term objectives, only implicit objectives exist within the fishery management system.
	Decision making processes	The fishery-specific management system includes effective decision-making processes that result in measures and strategies to achieve the objectives	0.1	80	Fisheriy-specific management has effective decision making processes but lacks in certain aspects such as developing the baitfish management plan and formally reporting to all interested parties.	**60**	Fishery-specific management has limited decision making processes and lack formal explanations for parties involved.
	Compliance & enforcement	Monitoring, control and surveillance mechanisms ensure the fishery's management measures are enforced and complied with	0.1	**70**	Moderate levels of monitoring, control and surveillance to ensure compliance with fishery's management measures but require better integration and demonstration of effectiveness.	**60**	Lacks adequate monitoring, control and surveillance mechanisms.
	Research plan	The fishery has a research plan that addresses the information needs of management	0.1	80	Timely research is undertaken to provide reliable information to interested parties, but fishery requires comprehensive research plan.	**60**	Currently no research plan that addresses information needs. DoF research division formed in 2013.
	Management performance	There is a system of monitoring and evaluating the performance of the fishery-specific management system against its objectives. There is effective and timely review of the fishery-specific management system	0.1	80	Performance review internal but occassionally external.	**60**	Performance review lacking.
Overall Score				81.125		**63.1**	

CONCLUSION

Unfortunately, the Lakshadweep pole and line fishery scored below the 80 mark in all the three principles, thus raising important concerns if one were to proceed with an MSC certification (Table 2 – 4). The management system faired the lowest, whereas the others were low due to the lack of sufficient and accurate information. Additionally, being somewhat crude, we used a stricter approach when allotting scores for the Lakshadweep fishery than that observed in the Maldives certification report. Nonetheless, this work helps identify areas of weakness for the Lakshadweep pole and line tuna fishery. Managers and fisheries operators interested in the certification should propose ways in which one can improve data collection and management, especially in terms of the bait fishery and tuna harvest control strategies, prior to applying for a certification.

Additional factors to consider regarding an MSC certification of the Lakshadweep pole and line fishery is the limited demand in western markets for the fish product at hand, inaccessibility to western markets and the rising use of questionable practices. One of the main motives for certifying a fishery is the possibility of an improved market. Unfortunately, the dried tuna product of the Lakshadweep pole and line fishery, *mas*, is only in demand in countries such as Sri Lanka and Japan, where the interest in sustainability is minimal. Thus certifying Lakshadweep *mas* as MSC may not achieve any goals of improved markets or prices. It is important to note that in addition to its canned form, Skipjack is also imported frozen in large quantities by Europe and America for canning (FAO, 2004). Improving the chain of supply and changing the end product may help fetch Lakshadweep small-scale fishers higher profits, thereby ensuring livelihoods and safeguarding their fishery. Skipjack if marketed well in fresh, frozen or canned form may also do well in Indian metropolitan cities that are seeing a growth of environmentally aware consumers, but this requires further research.

Another issue with the Lakshadweep pole and line fishery is its increased dependence on FADs. These structures provide assured catch, save fuel and increase safety but may pose detrimental impacts to pelagic fish communities as they tend to attract smaller size individuals and a diverse range of species, thus greatly increasing bycatch. European consumers are increasingly becoming aware of the environmental impacts and are choosing FAD free tuna and this may be something for Lakshadweep managers to consider. Other unsustainable practices like the harvest of bait at time of spawning also require further research.

At the end of the day, the Lakshadweep pole and line fishery is still a good example of a best-practice fishery. However, in order to improve markets, one needs to improve the final product that comes out of Lakshadweep thus involving development of infrastructure to shift, from the dried form with limited markets, to the globally demanded canned and frozen form of skipjack tuna. Management requires further development and capacity building in order to be at par with the Maldives fishery and MSC standards. Greater transparency, stakeholder involvement and fine scale information generation are necessary.

REFERENCES

Adam, M.S., Anderson, R.C. and Hafiz, A. 2003. The Maldivian tuna fishery. IOTC proceedings no. 6: 202-220.

Anderson, C. 1997. The Maldivian tuna live-bait fishery – Status and Trends. Workshop on Integrated reef resources management in the Maldives, Bay of Bengal Programme. FAO report. 18pp.

Anderson, C., Huntington, T., Macfadyen, G., Powers, J., Scott, I. and Stocker, M. 2012. Pole and line skipjack fishery in the Maldives. MSC certification final report. 257pp.

DoF. 1990. Thirty years of fisheries development in Lakshadweep. Lakshadweep Department of Fisheries Report. 94pp.

DoF. 2013. Fisheries Statistics. Lakshadweep Department of Fisheries.

FAO. 2004. World tuna markets. Globefish Market Research Programme, Fish Marketing and Utilization Service (FIIU), Fisheries Department, FAO. Volume 74, 104pp.

FAO. 2011. Review of the state of world marine fishery resources. FAO Fisheries and Aquaculture Technical Paper Rome No. 569. 334 pp.

Fonteneau, A. 2003. A comparative overview of skipjack fisheries and stocks worldwide. 16th Meeting of the Standing Committee on Tuna and Billfish. Working paper. 23pp.

Fromentin, J.-M. and Fonteneau, A. 2001. Fishing effects and life history traits: a case study comparing tropical versus temperate tunas. Fisheries Research, 53: 133-150.

Gillett, R. 2011. The promotion of pole-and-line tuna fishing in the Pacific Islands: Emerging issues and lessons learned. ISSF Technical Report 2011-08. International Seafood Sustainability Foundation, McLean, Virginia, USA.

Gillett, R. 2013. Tuna for tomorrow: Information on an important Indian Ocean fishery resource. Smartfish working papers. EU. 55pp.

Ingles, J., Flores, J. and Musthofa, I., 2008. Getting Off the Hook: Reforming Tuna Fisheries of Indonesia. Technical Report. World Wide Fund for Nature.

IPNLF (2012). Ensuring Sustainability of Live-bait Fish. International Pole-and-line Foundation, London, 57 pages.

ISSF. 2013. ISSF Tuna Stock Status Update, 2013: Status of the world fisheries for tuna. ISSF Technical Report 2013-04. International Seafood Sustainability Foundation, Washington, D.C., USA.

Jacquet, J.L. and Pauly, D. 2007. The rise of seafood awareness campaigns in an era of collapsing fisheries. Marine Policy, 31: 308-313.

Juan-Jorda, M.J., Mosqueira, L., Cooper, A.B., Freire, J. and Dulvy, N.K. 2011. Global population trajectories of tunas and their relatives. PNAS, 108(51): 20650-20655.

Kumaran, M., Pillai, P.P., Mohan, R.S.L., Murty, V.S. and Gopakumar, G. 1989. Live-bait resources and development. Marine living resources of the union territory of Lakshadweep. CMFRI bulletin 43(5): 39-45.

MoFA. 2013. Fisheries Statistics. Ministy of Fisheries and Agriculture.

MSC. 2010. Get certified fisheries: a practical guide to the Marine Stewardship Council's fishery certification process. Marine Stewardship Council.

MSC. 2013. Online resources. www.msc.org

Pillai, N.G. and Satheeshkumar, P. 2012. Biology, fishery, conservation and management of Indian Ocean tuna fisheries. Ocean science journal, 47(4): 411-433.

Riyaz Jauharee, A. and Adam, M.S. 2012. The evolving Maldivian tuna fishery and its increasing dependence on the anchored FADs. Report submitted to the IOTC. 6pp.

Sivadas, M. and Nasser, A.K.V. 2000. Tuna live-baits. Marine Fisheries Research and Management. Central Marine Fisheries Research Institute. Ed: Pillai, V.N. and Menon, N.G. Chapter 29: 468-478.

Stone, R., Toribau, L and Tolvanen, S. 2009. Developing sustainable and equitable pole and line fisheries for skipjack. Greenpeace report. 20pp.

Washington, S. 2008. Ecolabels and marine capture fisheries: current practice and emerging issues. Food and Agriculture Organization, GLOBEFISH, Fish Products and Industry Division.

WWF. 2007. Tuna in trouble: The challenges facing the world's tuna fisheries. WWF Report. 25 pp.