Emergence and Transformation of Marine Fisheries in the Andaman Islands

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Cover photo: Traditional motorised boat or *bonga dungi* anchored off Rutland Island (Photo: Sahir Advani)

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EMERGENCE AND TRANSFORMATION OF MARINE FISHERIES IN THE ANDAMAN ISLANDS

Sahir Advani, Aarthi Sridhar, Naveen Namboothri, Manish Chandi and Meera Anna Oommen

Dakshin Foundation and Andaman and Nicobar Islands Environmental Team (ANET)

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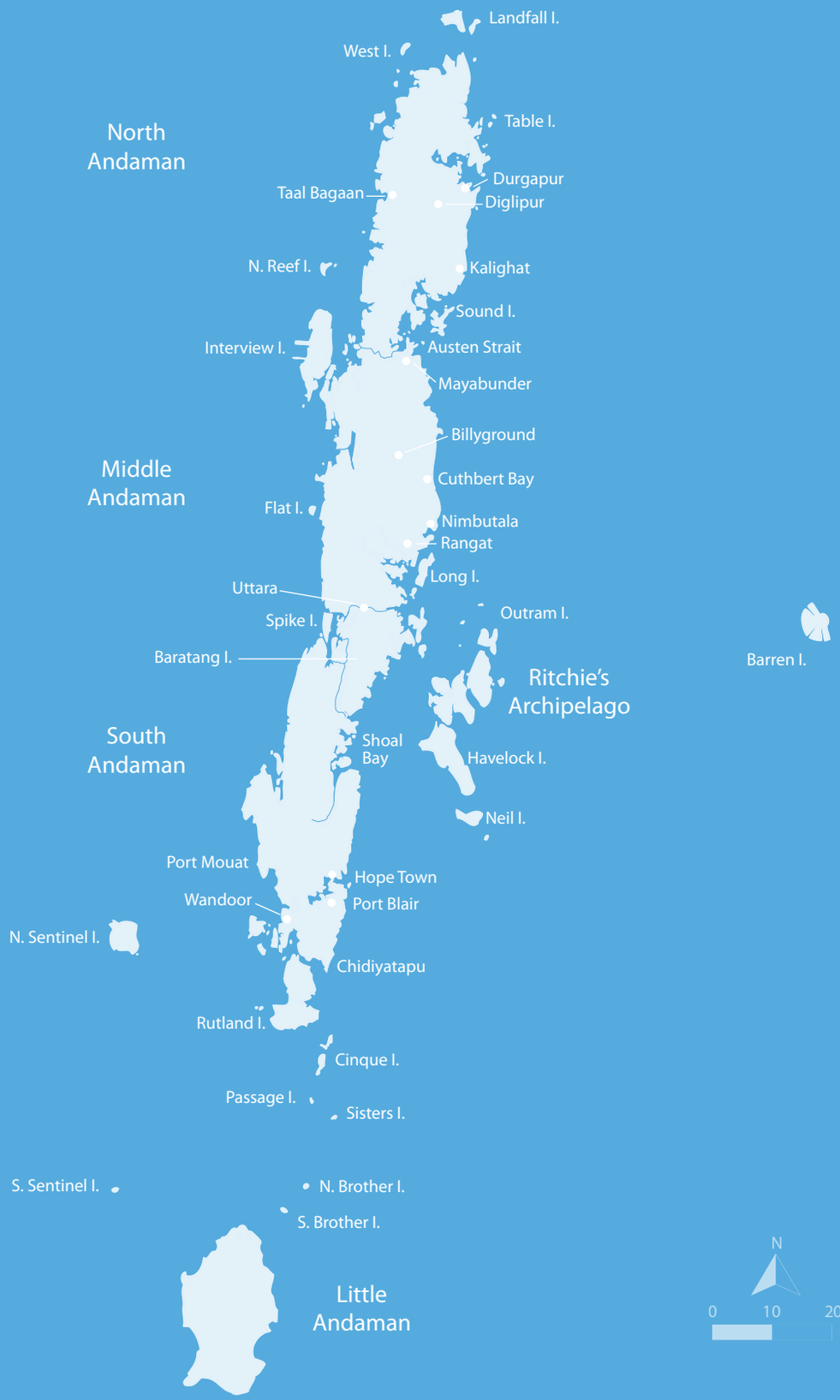
CONTENTS



INTRODUCTION

The coastal waters surrounding the archipelago of the Andaman and Nicobar Islands, located in the Bay of Bengal, account for about 28% of India's Exclusive Economic Zone, while the islands themselves make up 24% of the Indian coastline. Indeed, the entire political and social history of these islands and its inhabitants is shaped by its coastal and marine ecosystems and habitats.

306 islands and 206 islets form the Andaman group, which is divided into three major areas—North, Middle, and South Andaman. These islands are encircled by large coral reef banks and vast stretches of open ocean, which are habitats for demersal and pelagic fish stocks. Demersal fish stocks include coral reef associated fish and crustaceans, while pelagic fish stocks can include coastal and oceanic fish stocks present in the water column. Over 282 commercially important species are present in the waters of the Andaman and Nicobar Islands, making them important areas for fishing and marine resource extraction (Rajan 2003). Estimates by the Fishery Survey of India (FSI) suggest that these islands are home to 9.2% demersal, 57.1% coastal, and 33.7% oceanic fish stocks (Anrose et al. 2009).

The original inhabitants of these islands consisted of several aboriginal tribes who used to occasionally fish and glean shellfish off the reefs encircling these islands. Fishing practices and grounds varied between the tribes, whose territories covered large areas of the islands and near shore waters. Collective fishing was carried out by these tribes solely for self-consumption, i.e. subsistence, and these fisheries were most likely traditionally managed using simple gear.

The Jarawa, an aboriginal people now located in a tribal reserve on the eastern margins of North and Middle Andaman, used to catch fish near the shore by shooting at them with bow and arrow or by hand collecting molluscs and other shellfish (UNESCO 2010). The Great Andamanese and the Onge used to follow similar practices; however, they developed boat technology and used dugout canoes to paddle or punt to reef edges to catch fish, turtles, stingrays, etc. Located on Little Andaman, the Onges have been reported to be good seafarers with their fishing grounds stretching 60 km north up to Rutland. They would access this ground by sailing along the line of islands connecting Little Andaman to South Andaman. The Onge also used harpoons and fishing arrows with flattened, sharp heads (Sircar 2004). The Great Andamanese were actually an agglomeration of several tribes and covered a large area of the Andaman group of islands. According to reports by early British colonialists, they used to eat a variety of fish and shellfish. They had two types of fishing arrows, one which consisted of a shaft of *Bambusa nana* 3.6 feet long with a sharpened point; the other type was similar in construction, but was 4.5 feet long and had a tip that used to be made out of the serrated bone at the base of stingray tails (Man 1883). The Andamanese were one of the tribal groups that used nets to catch fish. Women used to make nets out of twine that was made by twisting natural fibres together. For stronger nets, fibres from *Melochia velutina* were used, while smaller hand nets were made from *Gnetum edule* (Man 1883). With colonisation and the establishment of a penal settlement, interactions of outsiders with the tribal population, both

positive and negative, began to increase. Hostile raids by the Jarawa were a frequent phenomenon. Attempts at 'civilising' tribal groups like the Great Andamanese and Onge led to the decimation of the Andamanese population and alteration of fishing practices for both groups. Nowadays, the reduced populations of both groups use modern fishing techniques like iron hooks and nylon lines for subsistence fishing.

In 1955, in order to exploit the pristine fish stocks of the Andaman Islands, the Directorate of Fisheries settled fisherfolk families from Kerala, Andhra Pradesh, Tamil Nadu, and West Bengal via the 'Fishermen Settlement Scheme'. Since then, many more fisherfolk families have settled in these islands, either voluntarily or through government settlement schemes (Dorairaj and Soundararajan 1985; Whittingham et al. 2003). The early commercial fishing settlements thus consisted of fisherfolk from multiple cultures who used only non-motorised craft and traditional fishing gear. An increasing influx of fishers from the mainland over the years, along with government-supported expansion of fisheries, has resulted in the highly organised fisheries of the Andaman Islands today that target a variety of marine species for both export and local consumption. However, the growth of various aspects of these fisheries have not been effectively documented before, and in recent times, neither has their continued sustainability been considered. This study aims at providing a snapshot of the multiple fisheries in the Andaman Islands, while retracing their development up to the present. Additionally, livelihoods of various fishing communities and threats to conservation of multiple targeted species are also considered.

Researchers from Dakshin Foundation and the Andaman and Nicobar Islands Environmental Team (ANET) undertook a week-long survey in December 2011, visiting important fishing locations in the Andaman Islands to understand their present day fisheries. Detailed interviews conducted with fishers at each of these landing sites and fishing villages helped construct our present understanding of the nature of fisheries in these islands. We were also able to hold detailed conversations with fisheries experts, government officials from the Andaman and Nicobar Directorate of Fisheries, and scientists researching fisheries in these islands. We provide in this report, a brief assessment that includes an overview of the targeted species, the transformations and modifications of fishing craft and gear utilised at present, and changes in the demographics of fisheries in these islands. We also identify priority areas for research and management of this under-studied fishery.

Facing page : *Top*: A Karen *dungi* anchored off one of Andaman's many islands;
Bottom: Motorised boats are popularly found across the Andamans

TYPES OF FISHERIES AND FISHING VESSELS

Subsistence fishing is done mainly to supply one's own household food requirements, with infrequent sale of fish and only when the catch is in surplus. Artisanal fishing, on the other hand, is carried out primarily for sale, with a small proportion of the catch kept for the household's consumption (Teh et al. 2009). At present, artisanal and subsistence fishers in the Andaman Islands mostly use motorised craft, i.e. those with small engines, which have limited speed and range. Due to this constraint, these fishers operate in inshore areas, close to the coast and over coral reefs. A third type of fishing present in these islands is the offshore, mechanised fishery that targets pelagic and demersal fish through long line and bottom trawl gear. It is noteworthy that even artisanal fishers catch a small percentage of pelagic species as they drag along a hook and line while sailing to coral reefs, a practice called 'trolling' (Rajan 2003).

With an increasing number of fisherfolk settling or migrating to the Andaman Islands each year, the commercial fishing fleet of these islands has steadily grown since its establishment. The earliest settled fishermen, in the 1960s and 1970s, operated a few traditionally built non-powered wooden canoes (Kumaran 1973; Marichamy 1974). In 1983, there were 760 traditional craft and 37 mechanised boats used in the commercial fishery (Mustafa 1983). Four years later, the fleet increased to 950 traditional craft, 101 outboard motor fitted boats, and 20 inboard mechanised boats (Mustafa et al. 1987).

Mustafa et al. (1987) categorise fishing crafts in the Andaman Islands as 'traditional', 'aboriginal', and 'tribal'. Aboriginal and tribal craft were mostly used for subsistence fishing by indigenous inhabitants, while traditional craft were used for commercial fishing by introduced fishermen. The word for small boats in these islands is *dungi*, which is a creolisation of the English dinghy, a small boat used as a tender for larger vessels (Chandi 2001). All traditional craft are locally made with the wood of 'taung-pienne' (*Artocarpus chaplasha*) as the preferred choice. Boats made entirely of planks, with a flat or round bottom, are called *haalish* or *takta dungis*, respectively. These craft are paddled, punted, or sailed in waters up to 20 m deep across the length of the Andaman Islands (Mustafa et al. 1987). Canoes made out of a single carved out tree trunk, with planking to make up the sides, were introduced in the Andaman Islands by the Karen community in North Andaman. These dugout canoes are another type of commercial craft that can, in addition to being paddled and sailed, be motorised. Because they are motorised, these *bonga dungis* can stay out at sea for more than a day and are usually operated in depths of over 50 m (Chandi 2001). In recent years, fibreglass hulled boats have also started being utilised. With the destruction of property during the 2004 tsunami, and the influx of aid following it, these *fibre dungis* were used in increasing numbers. Additionally, laws banning the cutting of timber made the process of building dugout canoes illegal and this decline in locally constructed *dungis* probably also facilitated the increase in the number of fibreglass vessels. A reconsideration of local *dungi* construction and legalisation of the practice could help sustain their demand and economy (Chandi 2001).

With increasing reports of the unexploited marine resources of the Andaman Islands, the fisher population and fishing fleet continued to grow, and in 1996, there were 1,086 traditional craft and 92 mechanised craft (Easterson and Dharmaraj 1996). Ten years on, the Andaman fleet increased to 2,539 craft, with 165 mechanised, 764 motorised, and the remainder consisting of non-motorised boats (Anonymous 2005). The different types of craft are not distributed uniformly between South Andaman and North and Middle Andaman: currently, more non-motorised craft are found in North and Middle Andaman (730) compared to South Andaman (566) (Anonymous 2010a, b). Furthermore, possibly due to better infrastructure and berthing facilities in South Andaman, there are greater numbers of mechanised and motorised vessels here than there are in the northern island groups. The number of licenced mechanised vessels in the Andaman Islands has increased rapidly over the last few years, from 12 in 2009 to 55 in 2011 (Anonymous 2011). Additionally, 23 sport fishing vessels are now registered with the Directorate of Fisheries (Mustafa 2012 pers. comm.).

The commercial fishery of the Andaman Islands has grown steadily from its modest start of a few plank built canoes to a fleet of 2,813 craft. More than a half of these (1,465) are still non-motorised. However, if the number of motorised and mechanised craft entering fisheries continues to increase and remain unchecked, the stocks of species being targeted as well as the livelihoods of fishers who continue to operate non-motorised craft could be affected.

Flat-bottomed, plank built canoes, *haalish dungi*, are commonly used in creeks and estuaries and nearshore waters

PROFILES OF FISHING COMMUNITIES AND VILLAGES

There were very few active commercial fishers in the 1930s in the Andaman Islands. To counter this, the Directorate of Fisheries undertook a 'Fishermen Settlement Scheme' in 1955 where fisherfolk from mainland India were voluntarily settled in the Andaman Islands in order to boost the island's fishing economy and provide fish to the local populace (Dam Roy and Dorairaj 1998; Whittingham et al. 2003). The first set of fisherfolk settlers consisted of five families from Kerala who were settled in Hope Town (Panighat) in 1960. Over the course of the next 20 years, 87 other fisher families were settled in Panighat, Dundas Point, Prem Nagar, and Aberdeen (Whittingham et al. 2003). The settlement at Dundas Point consisted of five Malayalee fishermen families from Kerala, while the remaining fishing families in other settlements consisted of Telugu fishing families, predominantly from Srikakulam district of Andhra Pradesh. These fishermen settlers were settled close to well-populated areas, most of which were on the eastern coast of the Andaman group of islands (Kumaran 1973; Marichamy 1974). There were 24 fishing centres by the end of the 1960s, with some of the major centres at Diglipur, Mayabunder, Rangat, Neil Island, and several centres clustered around Port Blair, such as Dundas Point, Aberdeen Jetty, Ross Island, Madhuban, Rangchang, and Junglighat (Marichamy 1974). In 1996, the number of fishing centres increased to 54 (Easterson and Dharmaraj 1996) and this figure rose further in 2005 to 72 fishing villages in the Andaman Islands, with new major centres at Kadamtala, Havelock Island, and Little Andaman (Anonymous 2005). The fisher population also increased from 100 odd individuals in 1974 (Marichamy 1974) to 2,300 in 1983 (Mustafa 1983) to 13,098 in 2005 (Anonymous 2005), with fisherfolk accounting for 6% of the total settler population in 2002 (Whittingham et al. 2003).

The growth of the fisher population resulted not only from the settlement scheme, but also from fishers voluntarily immigrating to the islands due to better livelihood prospects and fishing potential (Dorairaj and Soundararajan 1985; Whittingham et al. 2003). However, influx of immigrants, fisherfolk or otherwise, from the mainland has been kept in check by a 2002 Supreme Court Order limiting further immigration to the islands and evicting land encroachers, several of whom were recently settled fisherfolk (Whittingham et al. 2003). Furthermore, our interviews in December 2011 along with certain reports suggest that the increase in fishing manpower has been due to the addition of opportunistic fishers from other communities such as the Ranchi and Bengali communities (Whittingham et al. 2003; pers. obs. 2011).

Bengali refugees from erstwhile East Bengal were settled in several parts of the Andaman Islands by the Government of India from 1949 onwards. Each family was allotted 10 acres of uncleared forest land, half of which was plain paddy land and the other half hilly terrain for growing fruits

and vegetables (Malhotra 1989). Fishing as an alternate livelihood source was adopted by this community over the years. Similarly, the Karen community in Mayabunder, who were originally introduced from Burma (now Myanmar) by the British as forest labourers as early as 1925, also entered diverse aspects of the Andaman fishery (Roy 1995).

Table 1:
Mainland origins of majority of fishers settled in some villages of the Andaman Islands

Locality	Area of origin
South Andaman	
Panighat	Andhra Pradesh and Kerala
Junglighat	Srikakulam, Andhra Pradesh
Hopetown	Kerala
Haddo	Srikakulam, Andhra Pradesh
Aberdeen Bazaar	Srikakulam, Andhra Pradesh
Burma Nallah and Chidiyatapu	Tamil Nadu and Kerala
Guptapara	Erstwhile East Bengal and West Bengal
Wandoor	Erstwhile East Bengal, West Bengal, and Andhra Pradesh
Shoal Bay	Erstwhile East Bengal and West Bengal
Chouldhari	Erstwhile East Bengal and West Bengal
Middle Andaman	
R.R.O. Camp Rangat	Srikakulam, Andhra Pradesh
Rangat Bay	Srikakulam, Andhra Pradesh
Betapur	Srikakulam, Andhra Pradesh
Mayabunder	Srikakulam, Andhra Pradesh
Webi	Erstwhile Burma
North Andaman	
Durgapur	Srikakulam, Andhra Pradesh
Kalipur	Erstwhile East Bengal

TARGET SPECIES AND FISHING GEAR

There are about eight types of gear used in the artisanal fishery of the islands, each deployed differently and targeting a distinct type of fish. Differing mesh sizes of nets and arrangement of weights can further distinguish a particular type of gear.

Cast nets or *haat jaal* are unfurled by a single fisherman in shallow waters. The rim of the net is weighed down and the centre is attached to a rope held by the fisherman. The net is thrown over a shoal of small fish like anchovies, sardines, and mullet, and when drawn upwards, the fish are trapped within the mesh of the net.

Shore seines consist of long rectangular frames of small mesh nets that are broad in the middle and taper towards the edges. This net is manpower intensive; one group stands on shore securing one end of the net while the other end is towed out to sea by a canoe encircling an area and then brought back to shore. Both ends of the net are then pulled towards the shore and the fish caught in the net are sorted. This net can only be deployed on sandy slopes where there are no rocks or coral to entangle the net. Marichamy (1974) recorded that these nets were operated in areas like Aberdeen Jetty, Corbyn's Cove, and Rangachang.

Gillnets, which are locally called *nylon jaal*, are widely used in the Andaman Islands. These are multifilament nets that can have mesh sizes varying from 3 to 14 cm. They are used to target mullets, coastal tunas, and mackerel.

In certain areas, nets are fixed at the mouths of brackish water creeks to take advantage of the tidal ebb and flow. These 'anchor' nets or *langar jaal* consist of a broad mouth that is anchored open in place with a tapering cod end of smaller mesh size to catch fish (Rajan 2003).

To target demersal fish like snappers and groupers, hook and lines are used. These can either consist of a single hook or the line can have three or four branches with a hook at each end. Trolling lines are gear used to target pelagic stocks while travelling between the shore and fishing ground. A hook on a length of line is towed behind the boat to optimise fishing effort. Spear fishing is also a common method employed to catch demersal fish and crustaceans. The spear can either consist of a single length of wood with spikes fastened to one end, or can have an elastic sling attached at the rear.

Nets are rarely made of natural fibres, and mostly consist of synthetic nylon. About five years ago, the Directorate of Fisheries banned the use of nylon monofilament net or *current jaal* due to its non-selective nature. Most of the fishers we met during our survey favoured this ban, stating that these nets were decimating fish stocks. However, certain villages continue to use them despite the apparent ecological consequences.

Fishers in Burma Nallah, a village south of Port Blair, are predominantly settlers from Kanyakumari district of Tamil Nadu. They belong to a small group of fishers that undertake multi-day fishing voyages in these waters to target sharks and groupers using bottom-set lines with about 300 hooks (Dam Roy and Dorairaj 1998).

Guptapara, a village located close to the Mahatma Gandhi Marine National Park, was originally an agricultural settlement given to Bengali settlers in the 1950s. Nowadays, more than half the village population is employed in fishing and they predominantly use hook and lines (65%) to catch groupers and snappers meant for the export market (Whittingham et al. 2003). Gill nets are predominantly used to catch mackerel, sardines, anchovies, mullets, carangids, and prawns by fishers from Andhra Pradesh (Telugu), originating mostly from Srikakulam district, who are now settled in areas like Aberdeen Bazaar, Haddo, Junglighat, Betapur, Rangat, and Durgapur (Dam Roy and Dorairaj 1998).

The Karen community in Middle Andaman, though small, has been actively engaged in the commercial fishery of these islands. Along with tending to their fields, members of the Karen community were actively engaged in shell collection during the agricultural off-season. Roy (1995) states that "…despite the education that could get them well-paid white collar jobs, [they] prefer to be shell collectors rather than serve as clerks." Initially employed by government contractors, over time they diversified into the shell industry by acting as commissioning agents. From our interviews with Karen fishers in Webi and Lady in Middle Andaman, we found that they are also one of the few communities that spearfish in these waters to catch groupers and lobsters. Along with Bengali fishers, they also manufacture bamboo fish traps that are deployed in creeks. They are also the principal fishers of the nauplii larvae of *Acetes indicus* shrimp, known locally as *jhinga*. They catch the shrimp using a home-made net consisting of a fine mesh net, usually a mosquito net, attached to two 2 m long bamboo poles that overlap at one end creating a wide mouth at the other end. The net is ploughed through brackish water marshes and the shrimp are then collected, dried, salted, and crushed into a paste called *nappi*. There is no organised fishery for *A. indicus* in the Andaman Islands despite the fact that they are reported to be highly abundant in some parts of the islands (see Lalmohan 1983 for sites). Only the Karen community engages in this fishery and consumes *nappi*, with a small percentage being sent to the Nicobar Islands (Lalmohan 1983).

The varied species targeted and the gear employed by the fishing communities in the Andaman Islands could be a product of the ecological nature of the marine systems they have access to or the geographical nature of the area where they are settled. However, the effects of these varied fishing practices on the common marine space are not easily determined, either by fishers or by scientists. Access to infrastructure, markets, and fishing grounds also play a significant role in the livelihoods of fishing communities in the Andaman Islands.

Facing page: Cast nets, such as the one seen here, are used mostly in mangrove creeks and estuaries

Top (left): Several hook and lines in a basket with a float; *Top (right)*: Single hook with stone sinker attached to a bamboo spool; *Bottom*: Multifilament gill nets are popular in the Andaman Islands

ACCESS TO INFRASTRUCTURE

While fishing villages in the Andaman Islands were mostly located on the eastern coast of the larger Andaman Islands in the 1960s, nowadays villages are scattered across the islands, including on islands like Little Andaman, Neil, Havelock, and Long Island. Some of them are not even close to the sea, but are instead connected to it by creeks cutting through mangroves, as is the case of the villages of Laxmipur, Kadamtala, Webi, Kalighat, Kishori Nagar, etc.—some of the sites surveyed during this study. Access to infrastructure like ice, fuel, markets, and transport greatly affect fisher livelihoods.

During the early days of the commercial fishery, the landed catch was consumed only locally. In cases of large catches, the surplus was salted, smoked, or sun-dried. A fraction of dried fish was exported to the mainland along with cured shark fins and liver oil (Mustafa et al. 1987). With the development of infrastructure and storage facilities in the form of an ice and cold storage plant in Port Blair in 1968, fishermen could preserve their catch before landing it, and transport it to either local or export markets. This was the only facility of its kind in the Andaman Islands and had a capacity of 15 tonnes of cold storage and 5 tonnes of ice production per day (Mustafa 1983). In 2005, there was one ice factory established in Havelock and Little Andaman, with the remainder clustered around Port Blair. Fishers used to, and in some remote villages continue to, rely on 'homemade ice', i.e. ice made in a household refrigerator. Additionally, large fish export houses, along with some local traders and businessmen, have taken on the responsibility of providing an ice supply chain to maintain export quality products. In the northern tehsil (sub-district) of Diglipur, an ice factory at Durgapur village was established by the Directorate of Fisheries four years ago. The management of this ice plant was subsequently transferred to the Andaman and Nicobar Islands Integrated Development Corporation (ANIIDCO), and today it supplies ice to nearly all of the 27 fishing villages in Diglipur. The insufficient quantity of ice supplied has been a limiting factor for fishermen, and in cases of a large catch, they are forced to discard a good proportion of it or sell it a lower price.

A recent judgement by the Supreme Court may close down the Andaman Trunk Road (ATR), which is the only road link connecting Northern and Middle Andaman to Port Blair. If this closure is effective and sea-borne routes do not take its place, it would cut off access to export houses, fuel, and cold storage facilities in South Andaman.

Like ice, availability of boat yards and berthing areas are not evenly distributed in the Andaman Islands. There are only three boat yards in the Andaman Islands and all of them are located close to Port Blair, in South Andaman. The construction and maintenance of jetties and breakwaters is undertaken by the Department of Andaman Harbour Works (AHW); however, some fishers feel that the Department is not performing its job adequately. Fishers interviewed at RRO village in Middle Andaman state that a site for a jetty and breakwater was surveyed two years ago, but since then no further action has been taken with regard to its construction. In an instance where a 'fishermen's jetty' was recently constructed in

Port Blair, fishers' access to this jetty is restricted, possibly due to security concerns in relation to the ferry terminal at Phoenix Bay Jetty (Giles 2009).

Whittingham et al. (2003) recognise that fish landing sites play an important role for fishing communities in the Andaman Islands by providing a space for social interaction and information exchange within the community. As mentioned earlier, the number of landing centres increased somewhat proportionally to the fisher population and number of villages. However, currently there are only 23 landing centres in the Andaman Islands, of which some are not accessible to fishing communities in many areas. In 2005, there were no landing centres in Diglipur or Mayabunder despite them having fisher populations of 3,082 and 761, respectively (Anonymous 2005). During our survey in 2011, there was one fish landing centre in Diglipur and none in Mayabunder. Conversely, Rangat, with a fisher population of 1,904, had seven landing centres. However, region-wise fish landings and their percentage contribution for some of these areas paint a different picture. According to Alagaraja (1987), South Andaman recorded higher landings from 1982 onwards as a result of better infrastructure and facilities in and around Port Blair. Between 2000 and 2007, Diglipur's percentage contribution to fish landings rose from 2% to 35%, while Billyground recorded the highest percentage of increased fish landings at 26%, starting only from 2004 (Singh et al. 2012). On the other hand, prominent fishing landing centres like Port Blair and Rangat have recently seen a decrease in fish landings to the magnitude of -0.39 and -0.72, respectively. Whether these changes in fish landings are related to ecological reasons or access to facilities remains to be seen. At the same time, intermediaries and market forces could very well be driving the landings of fisheries.

Left: Homemade ice, as seen in Diglipur market, continues to be manufactured

Facing page:

Top: Ice boxes are a regular feature on boats these days

Bottom: Access to fishing grounds is also dependent on tide, with boats being stranded in mangroves during low tide

MARKETING FACILITIES; INTERMEDIARIES IN FISHERIES

To support the widely spread fisheries in the Andaman Islands, there are several allied roles which do not seem to be centrally controlled. Women, in their roles as fishers and sellers, are not accounted for in most socio-economic surveys. In these islands, the roles of women in fisheries differ with respect to the community they belong to: women from the Telugu-speaking community actively help with the cleaning of fish and their sale. In the Bengali community of Guptapara, women are involved in agricultural activities and not in fishing related activities.

Fish traders, both from within and outside the community, have been operating in fishing villages for the last three decades. They purchase the majority of the catch and transport it on ice to the local and export markets in Port Blair (Whittingham et al. 2003). These fish traders are sometimes termed as *seths* if they are influential financiers. They provide fishers with infrastructure and capital in the form of bait, fuel, ice, and sometimes money, with the understanding that all fish caught are to be sold to the *seth* or his traders directly. The terms of such a sale are also arrived at based on the capital advanced. In some villages, there are also middlemen and money lenders, who may run and control the financial institutions of poorer fisher households (Whittingham et al. 2003). In the 1980s, middlemen very rarely used to market fish, and vending was usually carried out by members of the fishermen's family on a door-to-door basis using cycles or sold by the road side. Additionally, bartering of fish for rice, vegetables, etc. was also carried out at local markets. Today, door-to-door vending still occurs, but on a smaller scale and usually in communities that do not have proper access to markets such as in Panighat (Whittingham et al. 2003). Marketing of fish directly by the fisher or his family still occurs in the numerous local markets in the Andaman Islands.

In the 1980s, Port Blair had only one proper fish stall through which catch was sold (Mustafa et al. 1987). Today, there are multiple local market outlets in Junglighat itself, ranging from the landing centre, to the fish market, to homes and restaurants, and to export houses. The largest seaport and only airport in the Andaman Islands are in Port Blair and all fish meant for export pass through the capital. The large fish exporters have their offices in Port Blair and manage the shipment of processed or frozen fish from the various districts of the islands through Port Blair and on to Chennai in mainland India. Direct export from the Andaman Islands to foreign markets is not possible due to the lack of an international airport at Port Blair. There are six registered fish trading firms in Port Blair that send consignments in bulk to Chennai on a regular basis, and 144 smaller traders that send occasional shipments, subject to available cargo space (Mustafa 2011). The export market has had a profound effect on the Andaman fishery in the last decade, causing the fishery to expand rapidly. Whittingham et al. (2003) highlight the scenario in Guptapara where 60–70 seasonal migrants from West Bengal are brought by fish traders to solely target, using handlines, commercially important species of groupers and snappers during the peak season. However, this has also had a knock-on effect in local markets, with locals complaining of high prices and a shortage of fish available locally (Anonymous 2012).

Markets where fish are sold by fisherfolk and vendors are commonly found (*facing page*); however, several seafood export companies have also appeared in the last decade (*right*)

SPECIES TARGETED FOR FISHERIES

The Andaman Islands have had a long history of fishing. Initially, it was mostly subsistence fishing by the indigenous tribes of the islands. With the establishment of the penal settlement followed by immigration of other settlers, a commercial fishery undertaken by fisherfolk settlers from mainland India was soon established. Over the years, various species have been targeted and several specialised commercial fisheries have developed. The following sections describe the various fisheries for varied species, their history, and their present conservation status.

Fish stocks, both demersal and pelagic, have been targeted in the Andaman Islands since the 1900s. Mechanised fishing began in 1908 with the introduction of the trawler, *Golden Crown*, to these waters. In the late 40s, a private firm, Andamarine Development Corporation Ltd., was established to exploit fishery resources using only four craft (Dorairaj and Soundararajan 1985). The annual landings of fish (including elasmobranchs, prawns, and crustaceans) have been increasing steadily since the 1950s. Species composition data from some of these years are presented in the table below.

Table 2:
Annual species composition (tonnes) in landings for the Andaman and Nicobar Islands

Group	1951	1961	1971	1981	1992	2001	2011
Elasmobranchs	-	-	22	45	585	467	2,124
Sardines and anchovies	-	-	99	484	4,492	3,494	6,225
Perches	-	-	79	198	2,583	7,029	3,721
Carangids	-	-	64	196	1,494	2,144	2,426
Silver bellies	-	-	41	275	1,472	1,467	3,162
Mackerel	-	-	22	156	1,955	1,512	2,535
Seer fish	-	-	46	149	517	1,019	1,210
Mullets	-	-	52	78	911	1,682	1,210
Prawns and crustaceans	-	-	12	36	329	1,076	1,271
Total	**65**	**131**	**437**	**1,617**	**14,338**	**19,890**	**23,884**

- no data available

Source: Dorairaj and Soundararajan 1985; Raveendran et al. 2001; Directorate of Fisheries Statistics 2012.

SHELLFISH FISHERY

A variety of commercially important molluscs are found in Andaman and Nicobar waters, including pearl oysters (*Pinctada sps.*), mussels (*Perna sps.*), edible oysters (*Crassostrea* and *Saccostrea*), giant clams (*Tridacna sps.*), chanks (*Xancus sps.*), Nautilus, cowries (*Cypraea sps.*), and cone shells (*Conus sps.*). Worldwide, these species are gleaned from coral reefs, and their shells are utilised in marine shell and curio trade or used as raw material in the manufacture of poultry feeds, pottery glaze, toothpaste, etc. Certain species are also harvested for their meat and the layer of mother of pearl that is used in the manufacture of buttons, cufflinks, and jewellery.

Two species of gastropod—*Trochus niloticus* and *Turbo marmoratus* were especially targeted by the commercial industry from the 1920s to 2001, after which they were declared protected species and their extraction banned. Trochus or 'top shell' is conical with alternating red and white bands. Turbo or 'turban shell' or green snail has a thick shell that is dark green in colour and mottled with white patches (Appukuttan 1977, 1979). The method employed for the collection of these shells changed little in the 80 year period of existence of the fishery. Small motorised craft, either *sampans* (in the case of Japanese fishers) or *bonga dungis* (in the case of Indian fishers), were used to reach the shell-beds. Shells were collected by skin diving on coral reefs at depths of 10 to 25 m, hand picking the shells, and collecting them in a net bag (Dorairaj and Soundararajan 1998). Ten skin divers on each motorised boat could collect about 100 shells per day (Appukuttan 1979). For commercial production of the shells, the organisms along with their shells were boiled or pit cured to remove organic matter. Both shells have a nacreous layer present underneath the outer shell covering, which is revealed through a series of chemical treatments and mechanical grinding (Ramakrishna et al. 2010). Apart from being targeted for their shells, both species have also been targeted for their edible meat. Removing the meat without damaging the shell involves either prying the organism out with a short pointed gimlet-like implement or by leaving the organism exposed in the sun until it emerges, only to be scooped out. The meat, which mostly consists of the foot, is boiled, salted, and dried for consumption (Nayar and Appukuttan 1983).

Japanese fishers were the first to discover 'mother of pearl shell-beds' in the territorial waters of the islands and began harvesting large quantities of these shellfish (Anonymous 1939). The fishery was formally established in 1929 by the Andaman and Nicobar Administration, which issued licences to Japanese fishers and began collecting royalties on the quantity of shells fished. 1929 was also the year in which 21 Japanese fishing vessels were apprehended for poaching of trochus, turbo, and sea cucumbers in the islands' territorial waters (Anonymous 1939; Dorairaj and Soundararajan 1998). During the period of 1930–35, a large number of research projects were conducted by the Zoological Society of India (ZSI) on the biology, life history, and fishery of shellfishes in these waters. A considerable volume of research was carried out with help from Japanese licensees who were the most knowledgeable about this fishery. Landing statistics also showed a marked decline after the second year of the regularisation of the gastropod fishery (Anonymous 1939). These landing data and surveys led to the realisation that unless adequate management measures were taken, the shell-beds were under serious threat of being depleted at the then current rate of extraction. The Andaman and Nicobar Islands Fisheries Regulation, 1938, and the Andaman and Nicobar

Fishing Rules, 1939, were introduced to permit only licensed fishers to fish using registered gears and vessels, and to control the issuance of fishing licences. Moreover, the trochus and turbo fishery was closed from 1939 to 1945 to allow beds to recover (Ramakrishna et al. 2010) and there were hardly any landing statistics or distributional and systematic studies of these species in the period after 1940 (Krishnamurthy and Soundararajan 1997).

In 1955, the Andaman and Nicobar Islands Shell Fishing Rules were enacted, leading to the demarcation of nine shell fishing zones (for more information see "Fishing Grounds" on page 37), which could be formally auctioned to shell collecting agencies on an alternating two year basis, thereby allowing for a two year recovery period of gastropod stocks. There were about seven licenced shell collectors during this period and each was allowed to harvest up to 25 tonnes of shells a year (Appukuttan 1977). In 1976, 400 tonnes of trochus were landed with a cost of INR 4,000 per tonne, while 105 tonnes of turbo were landed costing INR 10,000 per tonne, as reported by Appukuttan (1977). An amendment to the 1955 rules, the Andaman and Nicobar Islands Shell Fishing Rules, 1978, introduced a maximum quota of 15 tonnes in one season from each zone. It also made it mandatory that shells collected in a zone would have to be landed at an authorised port and submitted for size inspection. Trochus shells that passed through a metal ring of diameter 9 cm were deemed undersized, as were turbo shells with an operculum diameter of less than 6.5 cm. Such shells were meant to be returned to the sea if the gastropod was still alive, and licences cancelled and catches confiscated if there were more than 10% of undersized individuals in a particular catch. The Director of Fisheries was the authorised officer to oversee and regulate the shellfish fishery in each zone.

Despite the series of rules and regulations managing these gastropod fisheries, the stocks of both species continued to show signs of dwindling (Krishnamurthy and Soundararajan 1997). In a survey conducted by the Central Marine Fisheries Research Institute (CMFRI) in 1978, no specimens of turbo were obtained (Nayar and Appukuttan 1983). However, the survey indicated that Zones I, II, III, and IV were being exploited for turbo shells, and that the Karen community in Zone V exploited this species in fairly large numbers for commercial purposes and to extract meat for consumption. Turbo was usually found in deeper waters ranging from 12 to 25 m and therefore required skilled skin divers to extract them (Nayar and Appukuttan 1983). The population of turbo seems to have been exploited to levels of extirpation; Dorairaj and Soundararajan (1998) reported nil catches of the species between 1984 and 1998. Despite inhabiting a broad range of depths—from the subtidal to 20 m—trochus populations have managed to resist fishing pressures. Nayar and Appukuttan (1983) reported an average trochus density of 5 individuals per 10 sq. m. An average of 1,825 kg per year of trochus shells were collected between 1994 and 1999 (Ramakrishna et al. 2010). But even these landings have been subjected to major fluctuations, with only 450 kg being landed in the 1995–96 season. Furthermore, due to their scarcity, the price of these shells has increased six-fold from the 1977 price estimate (Appukuttan 1977). Currently, one metric tonne of raw trochus shell is valued at between INR 60,000 and 65,000 (Ramakrishna et al. 2010). Due to increasing concerns about the plummeting stocks of *Trochus niloticus* and *Turbo marmoratus* as a result of heavy fishing pressure and improper protection from poachers, both species were added to Schedule IV of the Wildlife (Protection) Act, 1972, through the Ministry of Environment and Forests' notification dated December 5, 2001.

Recently, a survey of the status of trochus in Andaman and Nicobar waters was undertaken by the ZSI, Port Blair, from August 2009 to March 2010. This survey was in response to a request submitted to the Andaman and Nicobar Administration by the Andaman and Nicobar Islands Sea Shell Artisans Welfare Association for the relaxation of the 2001 ban on the trochus fishery (Ramakrishna et al. 2010). The survey found specimens of trochus in all 79 sampling stations along the length of the Andaman and Nicobar Islands. Trochus density was reported to be on average 8 individuals per 100 sq. m, which is much lower than the densities reported by Nayar and Appukuttan (1983) of 6 individuals on average per 10 sq. m. Moreover, no specimens of turbo were documented during this survey, suggesting the near extinction of the gastropod in these waters.

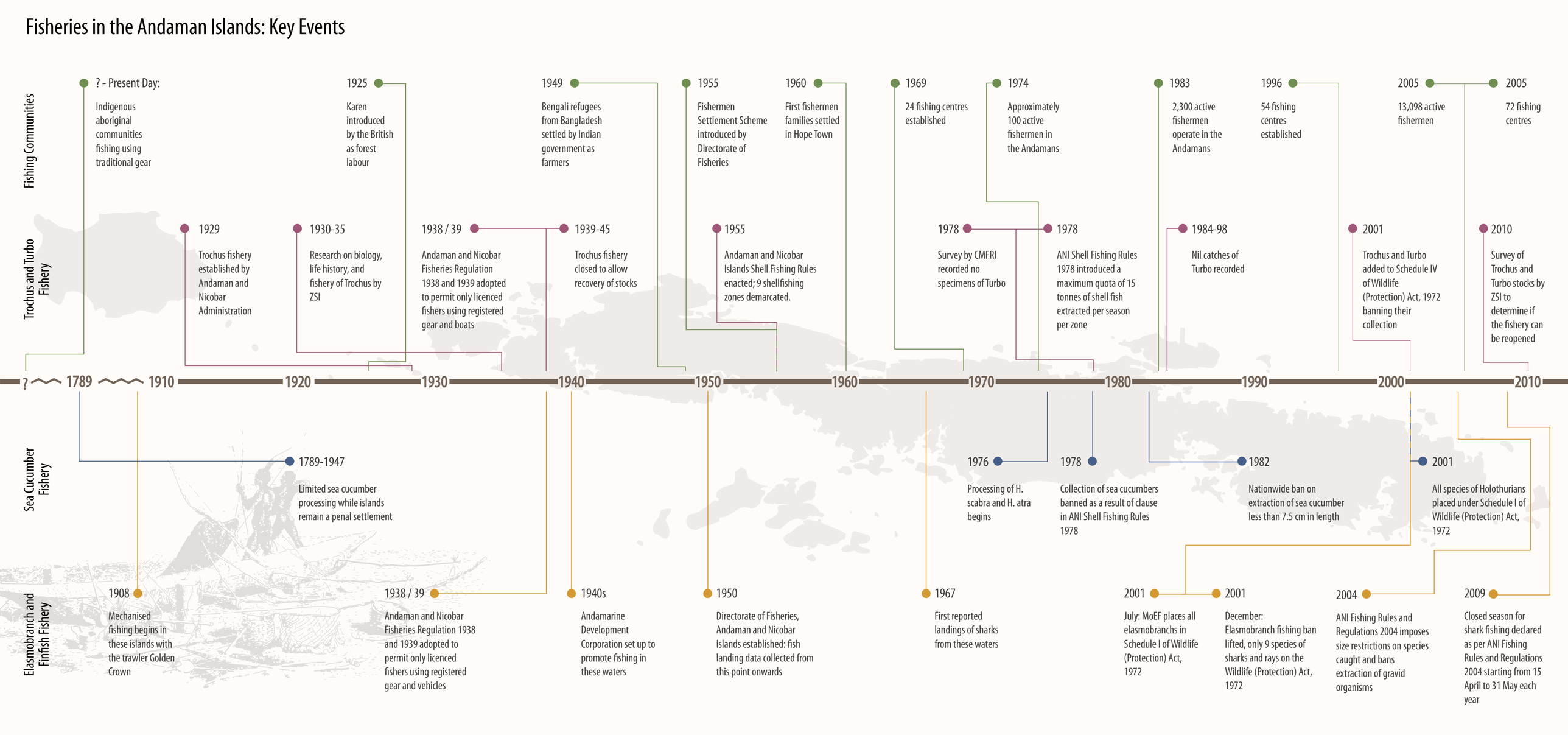
Some sources suggest that lifting the ban on trochus extraction would help crack down on illegal extraction by foreign poachers (MoEF 2011). By delisting protected marine species like sea cucumbers and trochus, local fisherfolk who were denied their livelihoods as a result of the ban, could once again have an income and help keep enforcement agencies informed about the activities of poachers. Of course, reopening of the trochus and sea cucumber fishery would be based on strict scientific parameters such as fixed quotas, closed seasons, and further information about the organism's life history characteristics and ecology (MoEF 2011). ZSI's recent survey report endorses the opening of the trochus fishery for a limited period of three years (Ramakrishna et al. 2010). Delisting both trochus and sea cucumbers would involve a similar status survey of sea cucumbers, keeping in mind the fisheries' past.

SEA CUCUMBER FISHERY

Harvesting and processing of sea cucumbers to produce bêche-de-mer or dried sea cucumbers was introduced to India by Chinese traders in the twelfth century (James 1991). The origins of the fishery in the Andaman Islands are unclear; James (1989) states that the islands were once famous for their bêche-de-mer resources, with processing being stopped around the time when the islands were a penal settlement (i.e., between 1789 and 1947). A cottage level export industry for bêche-de-mer was established in 1975 by settlers from Tamil Nadu (James 1983, 1991). However, only one species of sea cucumber, *Holothuria scabra*, was targeted (for export and not for local consumption) despite records of seven other commercially important species being found in these islands (James 1983). *H. scabra* was processed mostly at Port Blair, but specimens were collected in Rangat, Mayabunder, Diglipur, and Landfall Island, the northernmost in the Andaman group of islands (James 1989). Other commercially important species found in these islands included—*Holothuria atra*, which was first processed in 1976; *Actinopyga mauritiana*, which was regularly collected by the Taiwanese sailors stationed in Port Blair between 1975–76; and *Holothuria leucospilota*, which was found at high densities of 25 to 125 individuals per 25 sq. m in Hut Bay, Little Andaman (James 1983). Bêche-de-mer from India was exported mainly to Singapore, from where it was re-exported to Hong Kong, China, and other Asian countries.

The bêche-de-mer industry in the Andaman Islands involved simple harvesting and processing

Fisheries in the Andaman Islands: Key Events



techniques to produce a high quality product. Sea cucumbers were collected by hand picking them off muddy reef flats during low tide and skin diving for them in shallow waters. Processing comprised of de-gutting the organisms, boiling them in sea water in a cast iron container, burying them in the sand for twelve hours, and boiling them once more to remove any remaining impurities, followed by sun drying them for 3–4 days (James 1987). Processing was cheap; the sea cucumbers were placed on wooden platforms and fires from locally available firewood were lit underneath them. Several factors determined the quality of the bêche-de-mer product: longer, sturdier, and stouter ones fetched better prices, and with shrinkage of up to a third of the original size during processing, the size of the live holothurian was an important factor. Additionally, a cylindrical shape with an unmarked surface free from dirt, sand, and white chalky deposits was favoured. Darker coloured products fetched a higher price, as did products that were well dried and did not have any odour (James 1994). The industry in the Andaman Islands was limited by rains, which prevented processing for eight months of the year, and high humidity, which spoiled the end product. Despite these limitations, James (1983) also notes that the bêche-de-mer industry had extremely good prospects due to the high abundance of several commercially important species. He also added that products from these islands fetched 10–15 times more money than the mainland due to their high quality.

Despite the lucrative nature of the bêche-de-mer industry in the Andaman Islands, it was closed down in 1978, following the ban imposed by the Andaman and Nicobar Administration on collection of sea cucumbers (James 1989; James and James 1994). Under Provision 11 of the Andaman and Nicobar Islands Shell Fishing Rules, 1978, extraction of sea cucumbers was banned in areas demarcated as 'Shell Fishing Zones', which covered nearly all of the area where the holothurians were located. There is no clear estimate about the quantities of bêche-de-mer from the Andaman and Nicobar Islands that contributed to India's export between 1975 and 1978 as their landings were not reported in Directorate of Fisheries' statistics. In 1982, a nationwide ban on the export of bêche-de-mer less than 7.5 cm was implemented by the Government of India, in order to conserve stocks that were showing signs of overfishing of immature individuals (James 1987, 1991). Predictably, this size limitation did not affect the already closed bêche-de-mer fishery of the Andaman Islands, but strengthened the case for lifting the already present local ban and managing the sea cucumber fishery of these islands, as advocated by researchers like Dr P.S.B.R. James and Dr D.B. James (1994) during the 'National Workshop on Bêche-de-mer'. In 2001, all species of holothurians were listed under Schedule I of the Wildlife (Protection) Act, 1972, affording them the highest level of protection, including protection from any form of extraction. Despite this high level of protection, sea cucumbers continue to be extracted from the Andaman and Nicobar Islands by poachers, both local and of foreign origin. Poaching in the islands will be discussed in a following section.

PRAWN AND CRUSTACEAN FISHERY

Until the 1980s, there was no organised prawn fishery in the Andaman Islands, although landings of prawn still contributed to the annual landings recorded by the Directorate of Fisheries. Silas et al. (1983) recorded 19 species of penaeid prawn, with *Penaeus merguiensis* (49%) and *Metapenaeus dobsoni* (45%) being the dominant species found

Left: A live crab with bound claws at a seafood export house; *Right*: A live, chilled lobster about to be packed for export

in the Andaman Islands. These organisms are mostly caught in bag nets, boat seines, drag nets, cast nets, and by handpicking. The total catch of prawn has increased gradually over the years with a reported 28 tonnes in 1975, 201 in 1983, and 300 tonnes in 2000 (Dam Roy et al. 2001). However, landings of prawn recorded a negative 1.98 growth between 2000 and 2007 with an average landing of 444 tonnes in this period (Singh et al. 2012). Currently, a lot of attention is being invested in the research of aquaculture and seed collection of *Penaeus monodon*, the tiger prawn. The Marine Products Export Development Authority (MPEDA) has established two bio-secure tiger prawn hatcheries in Betapur and Kodiaghat, where rearing and growing out techniques are being investigated with scientific accuracy. Additionally, brackish water aquaculture of prawns is being promoted by the Central Agricultural Research Institute (CARI) in areas where subduction and inundation of land has taken place following the earthquake and subsequent tsunami of 2004 (Dam Roy and George 2009).

Three species of Portunid crabs—*Scylla serrata*, *Portunus pelagicus*, and *P. sanguinolentis*—have always been caught in very low volumes in these islands, with crab landings contributing negligibly to the fishery (Kathirvel 1983). Andrews and Vaughan (2005), in their interviews with crab fishermen (crabbers) after the December 2004 tsunami, reported increased crab catches, a phenomenon possibly arisen due to the upliftment of mangrove areas or changes in the inundation level in some parts of the Andaman Islands. It is important to note that crab and lobster fisheries on the western coasts of North, Middle, and Little Andaman occur in Jarawa and Onge Tribal Reserves—areas where extraction of natural resources is prohibited and considered as poaching. While this may be due to habitat change along the coastline, it could also be due to a low frequency of patrols in these waters.

The spiny lobster fishery has always been unorganised, and in the past, they were usually caught incidentally along with crabs and prawns. With no local demand, they were disposed of by being sold to passing passenger ships (Shanmugham and Kathirvel 1983). The technique used to catch the four common species of lobsters—*Panulirus polyphagus*, *P. homarus*, *P. ornatus* and *Thenus orientalis*—differs along the length of the Andaman Islands. Hand picking

lobsters off exposed reefs at low tide at night is a method used across the islands along with spear fishing. Spear fishing however, requires skill in skin diving, and also damages the product, thereby fetching a lower price. While there is no discernible trend in lobster landings over the years, a majority of the lobsters caught are exported, with 72% originating from the Port Blair region alone (Kumar et al. 2010). It is important to note that certain areas have been depleted of lobsters and their sizes have also been reducing over the years. Diving for lobsters while spear fishing involves turning over rocks and moving boulders, thereby disturbing and destroying lobster habitats.

The Andaman and Nicobar Islands Marine Fishing Rules, 2004, protect commercially important species of prawns, crabs, and lobsters by imposing size limits on individuals that can be caught or exported from the islands. This limitation on export also applies to brooding specimens and gravid females.

ELASMOBRANCH FISHERY

Elasmobranchs are a sub-class of cartilaginous fish and include various orders like sharks, stingrays, electric rays, and skates. Landings of elasmobranchs are treated as one unit in the Government of India's records and statistics. Distinctions at the species level or even at the level of sharks, rays, and skates for data collection are not made by the Andaman and Nicobar Islands Directorate of Fisheries, or by similar agencies on the mainland. Thus, the elasmobranch fishery encompasses all three groups, with sharks having the greatest commercial value. There has been an organised shark fishery in mainland India since the 1960s and the first catches of sharks (under the label of Elasmobranchs) were reported by the Andaman and Nicobar Islands Directorate of Fisheries around the same time, with about 20 tonnes being landed in 1966–67 (James 1973). However, James (1973) states that there was no local demand for sharks and that there was no major impetus to develop the fishery. Over the years, landings of elasmobranchs in the Andaman Islands have steadily increased. Between 1971 and 1983, the landings fluctuated from 22 to 305 tonnes, with an average percentage contribution to fish landings during this period of 4.3% (Dorairaj and Soundararajan 1985). Recent records between 2000 and 2007 describe fluctuating, yet continually increasing, landings of elasmobranchs and pelagic sharks, with a growth rate of 10.84 (Singh et al. 2012). These landings, however, contributed only 7% to the total landings of these islands (Kar et al. 2011).

Our interviews with artisanal fishers revealed that in the 1970s, only a few fishers would specifically target shark, and these were predominantly fishers from the Telugu community (Uncle Paung 2011 pers. comm.). Hammerheads were often caught, as were tiger sharks. In the 1970s, shark fins were priced at INR 25 per kg, while guitarfish would fetch INR 200. Shark liver oil was also extracted by boiling, straining, and then allowing it to separate into its various fractions. They would use 0.5 km long nets with 2 inch mesh size attached to flags and buoys, and would set off from Diglipur or Betapur for 15–20 day fishing trips around Havelock and Outram. Many fishers stopped targeting sharks when they perceived that their catches were declining or when fishing for sharks was no longer feasible (Andrews and Vaughan 2005). A temporary ban on shark fishing in 2001 may also have played a role in the reduction in number of shark fishers. Presently, there are a few boats still engaged in the shark fishery. These fishers hail from Thoothoor district of Tamil Nadu and come to the Andaman Islands only during the shark fishing season—November to April. During fishing trips that are between five and fourteen days long, they predominantly target deep sea and pelagic sharks using bottom- and mid-water-set long line hooks. They use fishing villages in the Andaman Islands as a base to refuel, rest, and sell their catch to local processing plants (pers. obs. 2012).

The declining status of shark fisheries globally and in mainland India and the unhindered demand for shark fins in Asian markets highlight the need for more information on elasmobranch stocks in the Andaman Islands as well as in Indian waters. Very few studies have been carried out on life history patterns, population structure, and abundance of sharks in these waters. Additionally, despite increased landings of sharks observed in the mainland, the lengths of sharks caught have gradually decreased, indicative of overexploitation (Pillai and Parakal 2000). Using data from FSI's tuna long lining surveys, John and Varghese (2009) attempted to calculate the distribution and Catch Per Unit Effort (CPUE) of pelagic sharks that were caught as bycatch. Their findings indicate that compared to the rest of the Indian Exclusive Economic Zone (EEZ), the waters around the Andaman and Nicobar Islands had the highest hooking rates (1.6 sharks caught per 100 hooks in 1992–93) for sharks. However, the CPUE of the Andaman and Nicobar Islands' EEZ along with the east and west coast of mainland

Along with sharks, stingrays are also caught in the Andaman Islands

India showed a declining trend between the years 1984 and 2005, suggesting a decline in abundance of sharks throughout the Indian EEZ. The steepest decline in CPUE of the Andaman and Nicobar Islands was in the year 1996–97, with CPUE not having since increased beyond 0.4 (John and Varghese 2009). At the same time, there have been reports of certain species of shark, like the tiger shark, not having been encountered or landed since 1993–94 (Andrews and Vaughan 2005). A more recent study has determined that the percentage contribution of sharks towards total catch has reduced from 46.36% between 1989–98 to 34% between 2006–08, a reduction of nearly 12% (Sajeevan and Sanadi 2012). The findings of this study indicate a decline of shark stocks in Andaman and Nicobar waters and highlight the need for a conservation approach to their exploitation.

Another concern is that shark mortality often goes unrecorded either due to understated records (Vivekanandan 2001; Hausfather 2004) or the actual bodies of the sharks not being landed. Fishers in the Andaman Islands are reported to fin sharks, a practice where the fins of a caught shark are cut off and the body dumped overboard. Vivekanandan (2001) suggests that this is due to the low local value for shark meat in the Andaman Islands and the high export value for shark fins. Trade in sharks and shark products increased from the 1980s due to increased consumption of shark meat on the Indian mainland along with a reduction in tariff rates on the import of shark fins by Southeast Asian countries (Pillai and Parakal 2000; Verlecar et al. 2007). Presently, the shark fin trade is an informal business, with the majority of fins being exported from Chennai to Singapore. Trade records of MPEDA are often underestimated due to couriers illegally transporting fins to Singapore by air (Vivekanandan 2001). During a visit to fish processing plants located around Port Blair, the authors were shown storage rooms stocked with more than 70 tonnes of processed shark bodies. This stock had accumulated in the previous two months and was destined for shipment by sea to Chennai and then onwards to markets in Kerala. Shark fins were stored separately in insulated boxes and were going to be air freighted to China and South Asian markets via Chennai. Shark livers from deep sea oil sharks (*Centrophorus spp.*), that have a high squalene content, were macerated and stored in large drums for further refinement into shark liver oil. While the royalties for shark product exports from the Andaman Islands are paid to the Directorate of Fisheries, actual data on the volume of these exports are not widely known and sometimes difficult to obtain.

The elasmobranch fishery, both in the mainland and in the Andaman Islands, has very few laws and regulations in place. In 2001, the Government of India attempted to impose a blanket ban on the extraction of all elasmobranchs. However, due to pressure from the affected fishing community and scientists who felt that the ban was ill thought out, the restriction on the elasmobranch fishery was lifted (see Vivekanandan 2001 for arguments to lift the ban). In April 2009, under Rule 17(a)(i) of the Andaman and Nicobar Islands Marine Fishing Rules, 2004, a closed season for shark fishing was declared. This 47 day ban commences from April 15 to May 31 each year and has been introduced to give shark populations a chance to recover from fishing mortality. Additionally, in 2001, nine species of sharks and rays were added to the Wildlife (Protection) Act, 1972, and only a few of these of these, such as the largetooth sawfish (*Pristis microdon*), longcomb sawfish (*P. zijsron*), and the giant guitarfish (*Rhynchobatus djiddensis*), are found in the waters of the Andaman and Nicobar Islands. Table 3 lists the species of sharks commonly encountered in the waters of the Andaman Islands. The majority of species are Near Threatened, but sharks from the family Alopidae are all categorised as Vulnerable. It is important to note that the genus Alopias was reported to be frequently caught during FSI's research surveys (Kar et al. 2011). Black tip reef sharks are the most commonly caught species in the reef fishery of the Andaman Islands (Rajan 2003). They are mostly caught using line and hook, long lines, and gill nets (James 1973; Rajan 2003).

A reassessment of the sustainability of the shark fishery in the Andaman and Nicobar Islands as well as in India is needed in order to prevent the economic extirpation of this unregulated fishery (Hausfather 2004). Both Vivekanandan (2001) and Hausfather (2004) advocate banning shark finning in the Andaman Islands, but caution that any new regulations should be made while considering the impact on fishing communities. An assessment based on current shark landings and the associated effort as well as a study of shark populations in these waters will provide answers regarding the continued sustainability of this fishery.

Table 3:
List of common sharks found in the Andaman and Nicobar EEZ and their conservation status

Scientific name	Common name	IUCN Red-list Status*
Alopias pelagicus	Pelagic thresher	Vulnerable
A. superciliosus	Bigeye thresher	Vulnerable
A. vulpinus	Common thresher	Vulnerable
Carcharhinus limbatus	Blacktip shark	Near threatened
C. melanopterus	Blacktip reef shark	Near threatened
C. plumbeus	Sandbar shark	Vulnerable
C. sorrah	Spot tail shark	Near threatened
Chiloscyllium griseum	Grey bamboo shark	Near threatened
C. indicum	Ridgebacked bamboo shark	Near threatened
Galeocerda cuvieri	Tiger shark	Near threatened
Prinoace glauca	Blue shark	Near threatened
Triaenodon obesus	White tip reef shark	Near threatened

Source: James 1973; Mustafa et al. 1987; Kar et al. 2011. * www.iucnredlist.org

[1]For a complete list of elasmobranch species caught in the Andaman and Nicobar Islands, refer to Rajan (2003) and Kar et al. (2011).

FINFISH FISHERY

Sardines, anchovies, and silver bellies have always had a high percentage composition in catch as they are used both as bait and for food. These fish are mostly caught using gill nets, boat seines, and shore seines (Marichamy 1974). Gill nets and boat seines are the preferred gear to catch carangids, mackerel, and mullets, which are sold for local consumption only. Juveniles of some of these fish may also be used as bait (Madhu et al. 2002). However, certain groups have been showing a declining rate of growth in landings, a possible indication of overfishing. Between 2000 and 2007, negative growth rates for the fisheries of sardines (-10.93), carangids (-27.06), and mullets (-12.26) were recorded.

Prior to the mid-90s, perches from the families Lethrinidae, Lutjanidae, and Serranidae (emperors, snappers, and groupers, respectively) fetched a low market price and were thus not exclusively targeted. Even the species targeted were completely different from the ones considered important nowadays. Marichamy (1974) states that the blue and yellow snapper, *Lutjanus kasmira*, and the golden striped snapper, *Lutjanus lineolatus*, were considered valuable fish, while species from other families like Serranidae were common but unimportant. The last 15 years has seen a sudden increase in demand for only 16 species from the Lethrinidae, Lutjanidae, and Serranidae families for export to Southeast Asian markets (Mustafa et al. 2001). From 1997 to 2010, a total of 3,705 tonnes of perch was exported from Port Blair. Additionally, 400 tonnes of exportable varieties are consumed every year in South Andaman, along with a large percentage of unreported catch (Ganapathiraju 2012).

The life history characteristics of some of these species, especially the Serranids, make them vulnerable to fishing pressure. Groupers are long lived, slow growing, and are protogynous hermaphrodites, meaning that they have a long life span, are females at maturity, and only became males after several years of slow growth. Additionally, older females can produce more eggs than younger ones. They also have a peculiar habit of mating in large congregations only once a year usually between January and March, a phenomenon called spawning aggregation. All these factors combined suggest that for there to be a healthy population of groupers in the Andaman Islands, individuals need to be of various sexes and ages (preferably older) and need to be present in reasonable numbers not too isolated from each other. Currently, the legislation in place to protect grouper stocks prohibits the export of brooding and juvenile stocks, and permits only groupers larger than 30 cm in length to be landed.

The growth of the perch fishery has been rapid and unchecked with no proper population dynamic studies or legislation controlling the fishery. At the most, the Andaman and Nicobar Islands Marine Fishing Rules, 2004, prohibits the landing of fish smaller than 30 cm and the export of brood stock and juveniles. Moreover, there are no recorded accounts of spawning aggregations or other ecological aspects of the fishery. The ever increasing demand for groupers and other perches from foreign markets is not alleviating the situation. A systematic study of the various fisheries in the Andaman Islands, especially the grouper fishery, along with an effective monitoring mechanism and conservation goals seems to be the most reasonable way to protect these vulnerable fish stocks (Mustafa 2011).

Tuna resources in Andaman waters can broadly be divided into coastal and oceanic realms. Coastal

Table 4:
The approximate percentage of exported volume for Lethrinidae, Lutjanidae, and Serranidae along with their genera

Family and Genus	% contribution to annual export	
Lethrinidae	16.8	
Lethrinus		16.8
Lutjanidae	66.6	
Lutjanus		43.3
Pristipomoides		16.6
Aphareus		6.6
Serranidae	16.6	
Epinephelus		11.6
Cephalopholis		1.6
Plectropomus		3.3

Source: Mustafa 2011

species of tuna and allied fish include little tunny (*Euthynnus affinis*), long tail tuna (*Thunnus tonggol*), oriental bonito (*Sarda orientalis*), frigate tuna (*Auxis thazard*), and dog tooth tuna (*Gymnosarda unicolor*). These species are landed by artisanal fishers in moderate quantities using small wooden crafts with gill nets and troll lines as gear. Highly valued species of tuna like yellow fin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*), and big eye tuna (*Thunnus obesus*) are found in the oceanic region and can only be targeted by mechanised fishing vessels with good storage facilities and long lining gear. Compared to the level of exploitation of demersal and coastal fish stocks, oceanic fish stocks have largely been untapped. In 2007, tuna landings accounted for only 2% of the total marine catch (Pillai and Abdussamad 2009). MFV Blue Marlin, a tuna long liner, has been conducting exploratory surveys of oceanic tuna resources for the Fishery Survey of India since 1991. Their estimates of standing stock when compared to

Groupers, such as the one above, are highly valued in export markets

The three important export families - Lutjanidae, Lethrinidae, and Serranidae

the annual oceanic landings suggest that only 19% of the stock has been exploited (Anrose et al. 2009). In order to fill this gap in resource utilisation, several government departments like CARI, FSI, and MPEDA have been promoting the development of infrastructure to exploit the oceanic tuna resources of these waters. In July 2007, MPEDA organised a stakeholders' workshop to create an action plan for the development of the tuna fishery in the Andaman and Nicobar Islands. Capacity building is one of the major objectives of this plan, where local personnel will be trained on the post-harvest handling, export quality packing, and export operations that are specific to this fishery. Tuna to be sold in the international market has to pass several quality tests. The fish has to be killed instantaneously with least stress to prevent the release of histamines that can destroy the flesh and render it toxic. Additionally, the fish has to be chilled to 1°C as soon as possible, and this temperature has to be maintained through all stages of processing. Along with capacity building, introduction and improvement of infrastructure has also been incorporated into the plan. Currently, there are very few tuna long liners operating in the Indian EEZ. Introduction of 50 fishing vessels operating from the Junglighat Jetty has been proposed (Anonymous 2008). Additionally, upgrades of traditional fishing vessels with long lining gear and adequate storage facilities have also been suggested. If these goals are successfully met, the Andaman and Nicobar Islands could become a major centre for tuna fishery in the Bay of Bengal and would enjoy the economic returns if export standards of production are met. However, these plans require large amounts of investment from government and private stakeholders and interest from concerned parties, a situation that has not been accomplished as yet (Nithyanandan 2009).

BYCATCH

The amount of bycatch in artisanal fisheries is usually negligible, but is also highly dependent on the gear employed. Hook and line are very selective, and unwanted catch can often be thrown back with a low mortality rate. Gill nets and shore seines with small mesh sizes, on the other hand, are not selective and catch a wide range of species from various trophic levels. But in small scale artisanal fisheries, such as those in the Andaman Islands, if non-targeted species are caught in fishing gear, they are either utilised as bait or consumed by the fishing community, leading to no classifiable bycatch. However, bycatch resulting from long lining and trawling is an emerging concern. FSI's exploratory long lining surveys have had higher hooking rates for bycatch than for targeted tuna.

An analysis of FSI's landing data from 2003 to 2010 in Andaman waters by Kar et al. (2011) revealed 30 species from 12 families being caught as bycatch. Shark species caught as bycatch included the blue shark, shortfin mako, silvertip shark, hammerhead shark, etc.; Billfish comprised of sailfish, marlin, and swordfish; while other species caught as bycatch included seerfish, wahoo, dolphin fish, barracuda, and sunfish, among others (Kar et al. 2011). In a separate analysis by Somvanshi et al. (2005), sharks contributed 45%, other species 21%, and billfish 10% to landed bycatch. In fact, Andaman and Nicobar waters had a higher rate of long lining bycatch than the Arabian Sea (Somvanshi et al. 2005). Varghese et al. (2010) have also included sea turtles as bycatch species as they are often found entangled in trawl and drift nets, or hooked onto long lines. However, sea turtle bycatch mortality in Andaman waters has been negligible, probably due to a lack of catch reporting or a smaller oceanic fishing fleet (Varghese et al. 2010).

Reef fish, such as these surgeonfish (*left*) and parrotfish (*right*) are often caught as bycatch, but consumed in local markets

FISHING GROUNDS

As per Andaman and Nicobar Islands Shell Fishing Rules, 1978, there were seven shell fishing zones demarcated in the Andaman Islands and two in the Nicobar Islands[1]. These zones were meant to be auctioned to the highest bidder for shellfish extraction for a duration of two years only. The licensee was expected to land his catch at the specified port for inspection by an officer (Dorairaj and Soundararajan 1998).

Currently there are no specifically demarcated fishing grounds for finfish resources. Instead, the territorial waters of the Union Territory have been divided into Fishing Zones A and B. Fishing Zone A extends up to six nautical miles from the high tide mark and only vessels fitted with 30 hp or less engines and non-mechanised boats are permitted to fish in this zone. They are also permitted to use gill nets and shore seines with mesh sizes greater than 25 mm, hook and lines, and fish traps. Territorial waters beyond six nautical miles from the high tide mark form Fishing Zone B. Vessels with engines of more than 30 hp are permitted to fish in these waters using gear like long lines, purse seines, squid jigger, and trawl nets, with an appropriately sized turtle excluder device attached.

Mustafa (2011) has identified four core offshore fishing grounds in the Western Fishing Zone of South Andaman—namely the South Coral Bank, North Sentinel Island, South Sentinel Island, and North of Little Andaman. However, for the most part, fishing grounds are variable, and there are no legal limitations on fishers accessing different fishing grounds, provided they are not within the islands' marine national parks or the Jarawa Reserve. During our survey, a common complaint by North and Middle Andaman fishers was against fishers from Port Blair accessing local fishing grounds. Fishing grounds are also seasonal, with fishing occurring close to shore during inclement weather. A representation of seasonal fishing grounds of fishers from Guptapara, Junglighat, and Panighat is provided on the following page.

Facing page: Fishing villages are located within and adjacent to mangrove forests

[1]The Nicobar Central Group of Islands Zone includes the islands of Tillangchang, Teressa, Bompoka, Kamorta, Nancowrie, Trinkat, and Katchal, but excludes Chowra Island. The Nicobar Southern Group Zone includes Little Nicobar, Pulo Milo, Great Nicobar and other islets. Fishers in both island groups were required to report their catches at the authorised port of Nancowrie.

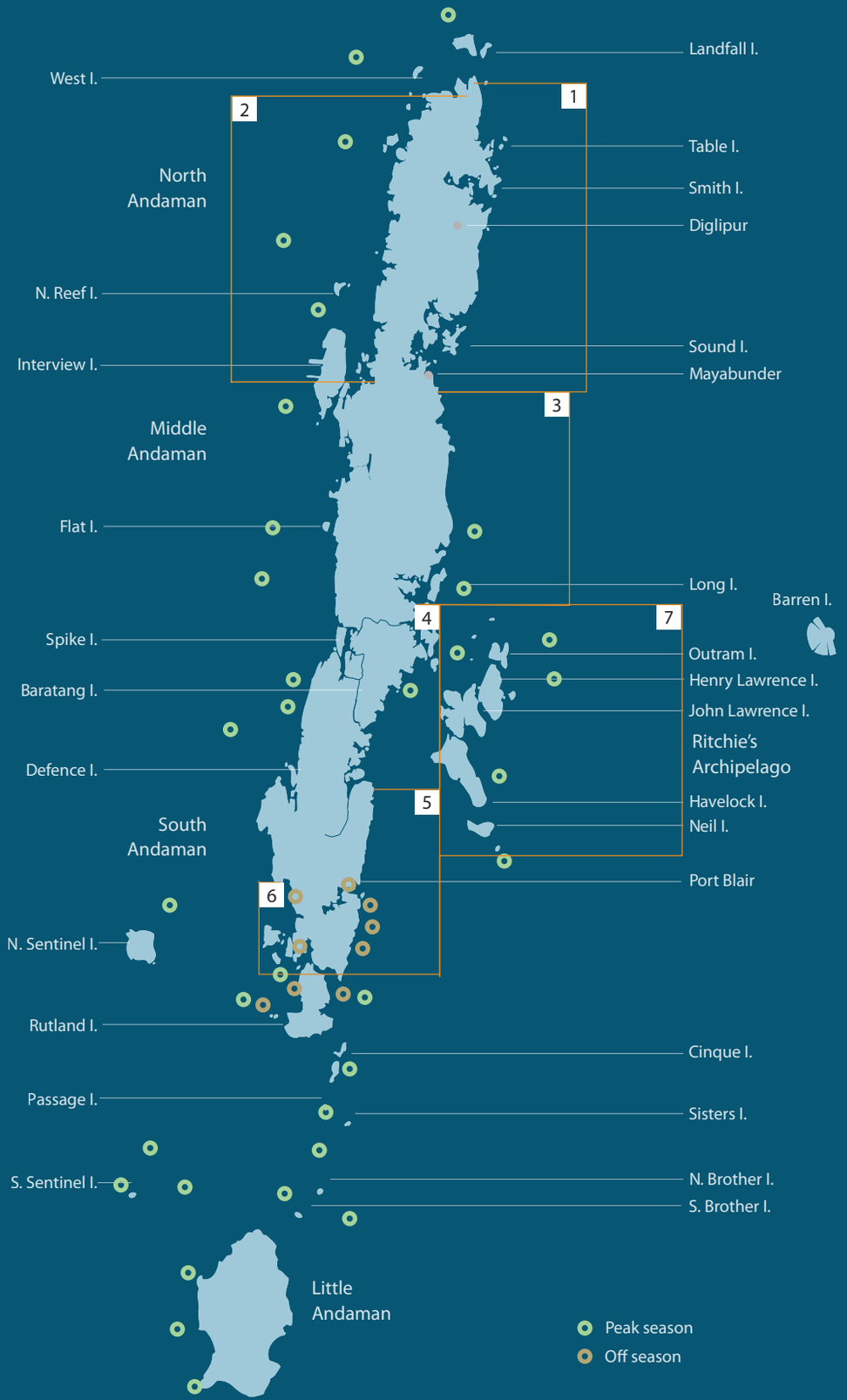


Table 4:
Shell Fishing Zones, as per Andaman and Nicobar Islands Shell Fishing Rules, 1978, [Rule 5(2)]

Zone	Area	Boundaries	Authorised Port
1.	Cape Price to Mayabunder	Between latitude 12°66.5′ N and 13°34.5′N from Cape Price to Brown Point along the east coast of North Andaman Islands including Land Fall Is, East Is, Sound Is and other islands and islets along this coast between the said latitudes	Mayabunder
2.	Cape Price to Austen Strait	Between latitudes 12°54 N and 13°34.5′ N from Cape Price to South Passage of Austen Strait along the west coast of N. Andaman Is including Interview Is and other islands and islets along this coast between the said latitudes	Mayabunder
3.	Mayabunder to Long Island	Between latitudes 12°24′ N and 12°55′ N from Aves Point to South Andaman Is including Long Is and other islands and islets along this coast between the said latitudes	Long Island
4.	Long Island to Shoal Bay	Between latitudes 12°05′ N and 12°18′ N from eastern entrance of Humphrey's Strait to Cape Persain along the east coast of South Andaman Island, including Colebrooke Is, Passage Is, Strait Is, and other islands and islets along this coast between the said latitudes	Long Island
5.	Shoal Bay to Chidiyatapu	Between latitudes 11°29′N and 10°56.4′N from Cape Masy to Chiriatapu along the east coast of South Andaman Is, including islands and islets along this coast between the said latitudes	Port Blair
6.	Chidiyatapu to Port Mouat	Between latitudes 11°29′N and 11°38′N from Chidiyatapu along Macpherson Strait to Perseus Point in South Andaman Is and other islands to the west of this demarcation including Labyrinth Is, Tarmugli Is, Twins Iss, and other islands and islets, but excluding Rutland Is and North Sentinel Is	Port Mouat
7.	Ritchie's Archipelago	Islands and islets situated between latitudes 11°46.5′N and 12°19′N and comprising Ritchie's Archipelago including Outram Is, Henry Lawrence Is, John Lawrence Is, Inglish Is, Wilson Is, Peel Is, Nicholson Is, Havelock, Neil Is, and Hugh Ross Is, but excluding North, Middle, and South Button Iss	Port Blair

Facing page: Map of the Andaman Islands depicting the seven Shell Fishing Zones, and peak and off season fishing grounds. (Adapted from Whittingham et al. 2003).

FISHERIES GOVERNANCE

Settler communities from various parts of mainland India arrived in the Andaman Islands only 60 years ago. Due to this ethnic diversity within the fishing community and their short colonisation time, there is no clear hierarchy or traditional governance mechanism in place as there is on the mainland. A better understanding of the governance system among fishing communities in the Andaman Islands would provide further information about the way fishermen are organised and how they interact with each other.

Presently, our knowledge of fisheries governance in the Andaman Islands is limited to the existence of a few fisheries co-operative societies in the islands, and membership in these co-ops is also very low. Only about 760 fishers are members of fisheries cooperatives, while approximately 230 are members of other cooperatives (Anonymous 2005). During our survey in December 2011, we met the President of the Srikakulam Society, a fishery cooperative based in Durgapur. The society was established several years ago with an initial membership fee of INR 55, which has now risen to INR 125. Membership is open to only seagoing fishers. To avail of some of the Directorate of Fisheries schemes, fishers need to be organised as part of a society. The Srikakulam Society sources gear and takes advantage of savings and insurance schemes for its members. Whittingham et al. (2003) mention the Surmai Co-operative Society, a now-defunct society in Guptapara, which was influential in the past in providing loans and insurance schemes. This role, however, has now been taken over by traders, money-lenders, and middlemen.

Systematic and regular monitoring of fish landing centres is a critical mechanism required to advise upon the status of fisheries in an area. This will also help in the implementation of existing regulations such as catch size limits, and restrictions on species caught. The Directorate of Fisheries currently has a monitoring programme; however, this needs to be conducted on a regular basis with updated standardised scientific protocols. Given the logistical difficulties in monitoring the widespread fish landing centres and the multispecies nature of the fishery, this task thus far has been challenging to implement.

FISHERIES SCHEMES AND SUBSIDIES

The Fisheries Settlement Scheme introduced by the Directorate of Fisheries in 1955 was an important event in the history of fisheries in the Andaman Islands. This scheme was meant to help establish a commercial fishery in these islands using skilled fishermen communities from mainland India. Under this scheme, there was a provision to settle 20 fishers every year. The early fisherfolk settlers were provided with subsidised sea fare to the Andaman Islands, fishing implements worth INR 1,000 each, money to construct houses, and a subsistence allowance of about INR 200 per month for each family (Dam Roy and Dorairaj 1998; Whittingham et al. 2003). They were also allocated 200 sq. m of land for housing. However, the scheme and allocation of land was stopped in 1989. This has created a shortage of housing in fishing communities, and in islands like the Andamans, land for coastal development is at a premium, further aggravating the problem. Fishermen claim that the government has failed to implement schemes like the 'Model Fishermen Village' at Chunnabhatta, where 100 dwellings and facilities like net mending centres, schools, and hospitals were to be allotted to fishermen families (Giles 2009).

The Directorate of Fisheries also has several welfare measures in place for fishers to avail of. They provide an INR 1,00,000 insurance for every fisher in the event of death, and INR 50,000 for partial disability. There is also a 50% subsidy for damage to fishing boats from natural calamities with a maximum cap of INR 50,000. In terms of management and regulation of fisheries in the Andaman Islands, the Directorate is responsible for annual issuance of fishing licences and registration of fishing vessels. A recent scheme has been introduced to provide each fisher with a unique biometric identity card in the interest of security. Monitoring of fish landings is also included in the Directorate's mandate, as is investigating each export consignment and collecting royalty for the same (Mustafa 2012 pers. comm.).

There is a whole host of subsidies offered by the Directorate of Fisheries in the interest of promoting the mechanisation and development of fisheries in the Andaman Islands. 25% and 50% subsidies are offered for the purchase of fishing vessels. Even for the purchase of a motorised boat or a non-motorised craft or engine, 50% subsidies with a maximum cap of INR 5 lakhs are available. In addition to materials being sourced through these schemes, it has been observed that fishermen are being provided with required gear by the traders or middlemen that they are associated with. There is a lack of clarity about the process by which middlemen obtain this gear, but it seems likely that it is through co-operative schemes. In this regard, there is a need for a comprehensive list of all such existing operations. In terms of infrastructural development, subsidies are available for construction of a fish market or an ice plant and cold storage, purchase of a fish transport vehicle or deep freezer and ice box. Fifty per cent subsidies also exist for the purchase of all essential fishery related material and lifesaving and fire fighting equipment (Mustafa 2012 pers. comm.).

EXPORT MARKETS

The perch fishery, driven by demand from foreign markets, is an important fishery to regulate. The number of export traders has increased rapidly in the last decade, as have the volumes of export consignments. In the late 90s, there existed three sets of exporters—Andaman Fisheries Ltd. (AFL), Island Marine Products Ltd. (IMPL), and several private traders. In terms of volumes of fresh and frozen perches for export, in 1998, AFL exported 111 tonnes, IMPL 39 tonnes, and private traders 21 tonnes (Mustafa et al. 2001). In 2007, AFL was dissolved, leaving only IMPL and private traders as the major exporters. Alarmingly, the percentage contribution of exported volume for both these parties changed rapidly in the span of nine years. IMPL exported only 40%, while private traders exported 60% of the 2007 export volume. The total exported catch in 2010 was 577 tonnes, with 85% of the volume originating from small private traders despatching ice packed consignments (Mustafa 2011). At present, there is a lack of information about the number of operational export traders and the network within which they operate. Additionally, the quantities of fish handled by each of them are unknown. Information on this aspect of the export market could greatly inform plans for incorporation of sustainable fishing practices and conservation measures of vulnerable species.

The live reef food-fish trade (LRFFT) is extremely lucrative, with a profit of USD 7 per kg of fish in Southeast Asian markets. LRFFT was attempted between 2005 and 2007 by a company called Oya Exim (P) Ltd. This involved hiring a live fish carrier vessel, which had high operating costs and faced several export authorisation issues. Only 15 tonnes of live perch were exported (Mustafa 2011), and a likely reason for the failure of this venture was the small volume of live fish consignments and in turn the low profit margin generated. There are plans to continue supplying fish for LRFFT by rearing commercially important species of perch like groupers in cages. MPEDA has a grouper hatchery at Chidiyatapu where rearing and growing out techniques of four species of groupers are being tested. Once cage culture is developed in these islands and a stable stock of live fish is obtained, the trade in live reef fish may once again resume. However, it is important to note that cage culture at sea comes with its own host of ecological problems if improperly managed.

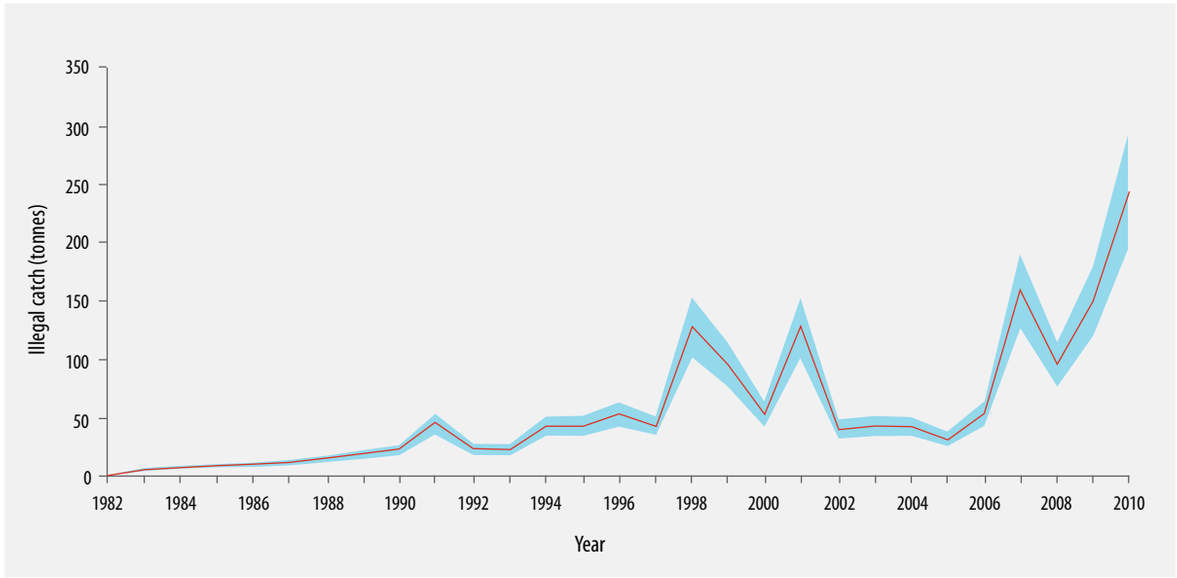
ILLEGAL FISHING

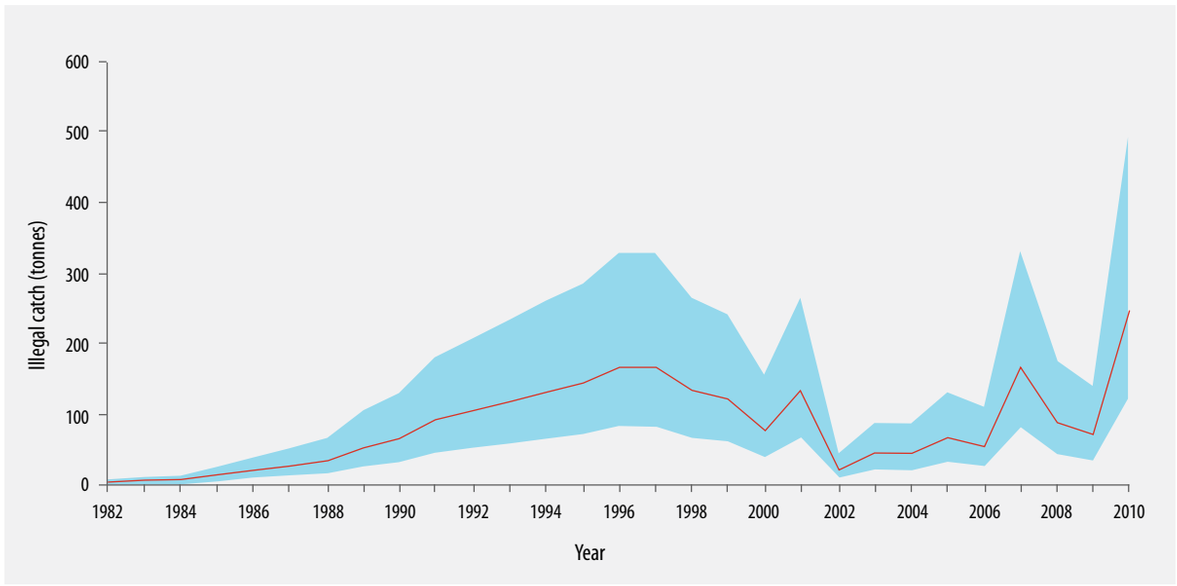
Currently, there is a small fleet of mechanised vessels operating in Andaman and Nicobar waters that is not directly controlled by the Directorate of Fisheries. These vessels operate in these waters through a 'Letter of Permit' (LOP) that allows them access to fishing grounds in the region. They are tuna long liners or mid-water trawlers of foreign enterprises that have been purchased by registered Indian firms, and can be operated in the EEZ. However, there have been instances of LOP registered vessels fishing in the Andaman and Nicobar EEZ that are dually registered to foreign firms, an act that is not in accordance with the Merchant Shipping Act, 1985 (Article 435) (Greenpeace 2012). LOP vessels are also permitted to trans-ship or transfer their catch to larger 'motherships' outside the EEZ, while paying the due royalties to the Government of India. The Maritime Zones of India (Regulation of Fishing by Foreign Vessels) Act, 1981 empowers and authorises the Indian Coast Guard to track the position of LOP vessels at sea and record the trans-shipment of catch. However, the positions of most vessels are infrequently made available to the Indian Navy or Coast Guard, and the volume and nature of these vessels' catches are rarely monitored during trans-shipment (Greenpeace 2012).

Similarly, the number of vessels from the mainland has also steadily risen in the last few years, as fishers from the east coast have increasingly become aware of the vast potential of unexploited resources in this region. However, there is growing resentment among local fishers regarding the sites accessible to these vessels. According to some, both foreign and mainland vessels fish at sites six nautical miles offshore, rather than the 12 nautical mile limit where they are permitted to, an act that violates the boundaries of the Fishing Zones described in the Andaman and Nicobar Islands Marine Fishing Rules, 2004 (Giles 2009). In order to address such cases of violation, the Andaman and Nicobar Administration recently passed an amendment to the 2004 rules—the Andaman and Nicobar Islands Marine Fishing (Amendment) Regulation, 2011. This law will help strengthen coastal security by prohibiting fishing by vessels that are not registered under the rules of the Merchant Shipping Act, 1958.

Poaching by both domestic and foreign fishers has long been a problem in the Andaman and Nicobar Islands. Rich and relatively unexploited marine life, numerous uninhabited islands with narrow creeks and sheltered lagoons, and proximity to other countries has encouraged poachers to fish in these waters (Ganapathiraju 2012). The Myanmar landmass is roughly 280 km north of Landfall Island, with the actual southern extent of Myanmarese territory separated by a few kilometres by the Coco Channel. In the south, the distance between Great Nicobar Island and Sumatra is a mere 145 km. A wide variety of fish and invertebrates in the EEZ of the Andaman and Nicobar Islands are targeted by poachers. Burmese fishers target sea cucumbers, trochus,

Facing page: *Plectropomus pessuliferus* or 'dollar macchi' is highly valued in the export market





Total estimated illegal catch of trochus (*top*) and sea cucumber (*bottom*) taken by foreign fishing vessels in the Andaman and Nicobar Islands' Exclusive Economic Zone between 1970 and 2010. The red line in the figure represents the estimated illegal catch that was confiscated from vessels arrested; lower and upper bound estimates are represented by the blue shaded area.

Source: Ganapathiraju 2012

and coral; Thai poachers catch crocodiles, tuna, sharks, ornamental reef fish, and sea cucumbers; Sri Lankan and Taiwanese fishers make incursions into Indian territorial waters to catch yellow fin tuna and sharks; and Indonesian poachers predominantly catch sharks (Ganapathiraju 2012). Although enforcement agencies routinely apprehend them, it is believed that an even larger number slip away undetected (Rajan 2003). Using small wooden boats that can escape radar detection and can be easily camouflaged in creeks, poachers have improved their strategies to avoid detection. With the Indian policy of repatriation after a certain amount of time spent in jail, it has been noticed that some poachers are repeat offenders (MoEF 2011). A Ministry of Environment and Forest report suggests that, bolstered by their cultural and lingual ties, Karen from North and Middle Andaman collaborate with foreign poachers by passing on poached sea cucumber and trochus shells (MoEF 2011). While the Karen are easily blamed on this count, sources also allege that Bengali fishermen in North Andaman are known to collaborate with foreign poachers.

The estimated total illegal catch of sea cucumbers and trochus taken by foreign fishing vessels in Andaman and Nicobar Islands' EEZ between 1970 and 2010 is represented on the opposite page. The red line in the figure represents the estimated illegal catch that was confiscated from vessels arrested, while lower and upper bound estimates, calculated by Ganapathiraju (2012), were derived at from interviews, surveillance data, industry, and government records of vessels that were observed poaching in Andaman and Nicobar Islands' EEZ. The number of poachers in these waters has decreased over the years as a result of successful apprehensions and increased vigilance. In the 1980s and 1990s, Thai poachers used to frequently poach in these waters, but effective joint patrolling by the Navy and Coast Guards of both countries has brought this number down in the last decade. To put the decreasing number of apprehended poachers into perspective—1,045 poachers and 104 vessels were seized by enforcement agencies in the last four years (MoEF 2011). Increased Coast Guard surveillance in the northern islands has also reduced the number of Myanmarese poachers in North Andaman, who used to be prolific in this area between 1980 and 1999. Now, however, these poachers have shifted their grounds further south, to the relatively unguarded waters of the Nicobar Islands (Ganapathiraju 2012).

The infrastructure available to enforcement agencies to cover the entire stretch of the islands has recently been reported to be very low (MoEF 2011). While the Coast Guard and Navy have a reasonably sized fleet patrolling these waters, other agencies operating on land and close to the shore, like the Department of Environment and Forests, Police Marine Force, and Indian Reserve Battalion, have very inadequate infrastructure at their disposal. Only 'Field Divisions' like Port Blair, Wandoor, Havelock, Mayabunder, and Interview Island are equipped with small fibreglass boats, wireless sets, and arms. Marine Police outposts are presently not equipped with seaworthy boats, and offer token protection to near shore areas (MoEF 2011). The suggestions of the MoEF report (2011) on poaching in the Andaman and Nicobar Islands include the allocation of nearly INR 6,000 lakhs to be spent over five years to purchase new equipment, increase the number of posts offered, and increase the incentives for working in the frontlines. The implementation of these recommendations will help send a strong message to both local and foreign poachers and will effectively reduce illegal harvesting of protected species.

OPPORTUNITIES FOR ADVANCING FISHERIES MANAGEMENT

Fish stocks have declined in both mainland India and the Andaman Islands as a result of fishing pressure (Bathal and Pauly 2008). On the eastern coast, according to Bathal and Pauly's (2008) calculations of fish landing statistics, Tamil Nadu and Pondicherry showed a greater decline in trophic level of fish caught compared to the Andaman Islands. This suggests that from 1950 to 2000, the mean trophic level of landed fish has gradually reduced as fish populations in higher trophic levels have declined. Sea cucumbers caught in the mainland are reducing in size, and their catches are declining, indicative of overfishing (James 1994). In the Andaman Islands, as a result of the harvesting ban since 1978, the sea cucumber stocks are very healthy and underexploited (James 1994; Ramakrishna et al. 2010). The shark fishery in these islands, however, continues to persist, despite reports of declining shark populations and no sightings of some species for several years (Andrews and Vaughan 2005). The perch fishery in the Andaman Islands, while experiencing rapid growth, is barely regulated, and adequate studies on perch fish stocks in these waters are yet to be carried out (Mustafa 2011).

Large scale mechanised fisheries have been blamed the world over for declining fish stocks (Pauly et al. 2002). However, small scale artisanal fisheries can have a significant negative impact on reef fish communities as both non-selective (nets) and selective (spears and hand lining) gear can alter reef fish communities (Campbell and Pardede 2006). At the same time, the driving forces behind fisheries, which include foreign markets and local demand, are often not considered in management frameworks. In the Andaman Islands, the pressure placed on fisheries by these markets has not been quantified. Additionally, the role of fisher communities, their governance mechanisms, their knowledge of marine ecosystems, and their interactions with each other are poorly understood. Furthermore, initiating dialogues between scientists, managers, and community leaders would improve our perceptions of how fishers interact with the marine ecosystem as well as provide an opportunity to introduce conservation goals to the primary stakeholders, the fisher communities.

Species-based management of these fisheries, as has been carried out in the past, may not be the answer. Market surveys would only provide an indirect measure of fishing effort. Complete bans on fisheries are also not viable, as they have profound impacts on the livelihoods of entire fisher communities. Instead, an ecosystem based approach which engages the social groups associated with fisheries may provide a more integrated means to addressing management challenges in the Andaman Islands. Engagement with the local community, via community based monitoring and knowledge sharing, along with a market analysis would provide a fuller appreciation of ecosystem dynamics and the status of fisheries in the Andaman Islands.

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