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RECONSTRUCTION OF THE ANDAMAN AND NICOBAR ISLANDS (INDIA) MARINE FISH CATCH FROM 1950-2010

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ABSTRACT

The Andaman and Nicobar (A&N) Islands, a Union Territory of India, are a group of 572 islands located in the Bay of Bengal. The islands are fringed with some of the most spectacular and intact reefs in the Indian Ocean. Human settlement to the islands occurred in two waves, one thousands of years ago, the other mainly from mainland India and which began in the early 1950s. Fisheries have been slow to develop past subsistence levels. This study aims to reconstruct the total marine fish catch from 1950-2010. It was found that total catch by all sectors is 2.4 higher than the national landings of about 666,300t reported by India's Central Marine Fisheries Research Institute on behalf of the A&N Islands. The greatest contribution to this difference was unreported industrial catch and by-catch produced by the joint-venture tuna fisheries and the unreported subsistence catch, which represented 28% of the total reconstructed catch. Unreported commercial catch sold to hotels and unreported catch of molluscs and by-catch from the coastal tuna fishery was estimated to be over 100,000 t from 1950-2010. Illegal fishing and poaching from foreign countries have been frequent in the EEZ of the A&N Islands and without improvements to enforcement and diligent monitoring of inshore waters, their rich resources may continue to be depleted.

INTRODUCTION

The Andaman and Nicobar (A&N) Islands, a union territory of India, is an archipelago of 572 islands located in the south east Bay of Bengal, between 6° 45'N and 13 41' E and longitudes 97° 57' and 93° 57' E (Figure 1; Pillai and Abdussamad 2008; Kar *et al.* 2011). These group of islands are known to be one of the most rich and uniquely biodiverse areas in the world (EQUATIONS 2008; Anon. 2011). Despite narrow shelves (about 35,000 km^2), the multiplicity of islands provides a wide range of marine habitats from coral reefs and atolls to mangroves, backwaters and tidal creeks (John *et al.* 2005; Pramod 2012). The Exclusive Economic Zone (EEZ) around the island encompasses an area of 660,000 km^2 (www.seaaroundus.org), which is about 30% of the total Indian EEZ. The seas surrounding these islands are known for their marine fisheries resources, with approximately 4,500 marine species, of which 220 are endemic. There are two marine protected areas for reefs in the Andamans: the Mahatma Gandhi Marine National Park (Anon. 2007, 2011) and the Rani Jhansi Marine National Park (Jeyabaskaran 2007). Due to the tropical climate of these islands, southwest (April/May-September) and northeast (October-December) monsoons are frequent and the average annual rainfall is between 3,000 and 3,500 mm.

Today, only 38 islands are inhabited and 34% of the forested area is home to six indigenous tribes and the earliest known inhabitants of these islands: The Great Andamanese, Shompen, Nicobarese, Sentinelese, Jarawa and Onge (Anon. 2007). These ancient and endangered tribes are some of the most isolated in the world, and their ancestors, the first inhabitants of these islands, may have arrived on the A&N Islands relatively shortly after the first humans left Africa, about 70,000 years ago. A second wave of settlement to the A&N islands occurred shortly after Indian independence in 1947. The Government of India encouraged migration to the islands by refugee families from East Pakistan (now Bangladesh), which were the first to settle on South Andaman from 1949-1952, followed by families from the States of Kerala and Tamil Nadu from 1955-1960 (EQUATIONS 2008).

Prior to the 1940s there was no organized fishing sector on the islands. The indigenous tribes lived in hunter-gatherer societies and subsistence fishing formed a small component of these daily activities (Pramod 2012). However, since the 1970s a large number of fishers from West Bengal, Andhra Pradesh, Tamil Nadu and Kerala have relocated to the A&N Islands and a formal fishing sector was hence created. The A&N Islands marine fisheries resources are estimated to be about 240,000 t (standing stock) which is 6.2% of estimated marine fishery resources of India (James 2005).

Marine fisheries in the A&N Islands can be classified into (i) coastal fisheries or inshore fisheries (subsistence and artisanal) and (ii) offshore fisheries (industrial). Most fishers still rely on traditional gear and boats, such as plank built or dugout canoes, which limits operations to approximately 7 km from shore. Gillnet (79%) is the most popular gear type, followed by hook and line (16%), and longline, 1.2% (FSI 2006; Pillai and Abdussamad 2008). Snappers (Lutjanidae), Jacks (Carangidae), Indo-Pacific king mackerel (*Scomberomorus guttatus*), narrow-barred Spanish mackerel (*S. commerson*), Indian mackerel (*Rastrelliger kanagurta*), tunas (Thunninae), sardines (Clupeidae) and anchovies (Engraulidae) are the important constituents of the landings (Rajan 2003).

The expansion of an industrial fishing sector has been slow and up until the late 1990s, as the marine fisheries were restricted to the narrow coastal belt and offshore regions were generally left unexploited. This was primarily due to the location of the islands far from mainland India, the fact that most fishing vessels were non-motorized, and inadequate landing and processing facilities. Now, however, under the controversial Letter of Permission (LoP) scheme of the Ministry of Agriculture, Indian entrepreneurs are permitted to operate in Indian waters through leasing and chartering of foreign fishing vessels (Sudhakara Rao 2009b). The industrial tuna fleet is based on mainland India and consists of about 52 longline and 7 hook and line vessels, which are of Taiwanese origin (Vijayakumaran and Varghese 2012). A large portion of the total Indian landings of oceanic tuna originates from the waters surrounding the A&N Islands (John *et al.* 2005). Commercially important oceanic tunas targeted in and around the A&N Islands are yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*) and skipjack tuna (*Katsuwonus pelamis*). However, non-target species such as sharks, Indo-pacific sailfish (*Istiophorus platypterus*), marlins *(Makaira* spp.) and swordfish (*Xiphias gladius*), make up about 50% of the catch and is typically landed as by-catch (Vijayakumaran and Varghese 2012).

The Indian Ocean earthquake of December 26, 2004, and the devastating tsunami that followed in its wake caused the largest natural disaster to hit the A&N Islands in history. It is estimated that over 3,500 people were killed and much of the coastal environment and infrastructure, including 938 fishing boats, was damaged. The Nicobar Island group was the most affected and most of their agricultural land (76%) was lost. Coral reefs were left exposed and destroyed along the Andaman coast, and tsunami waves eroded coastlines and surged sea water into mangroves and forests of the Nicobar Islands (Jeyabaskaran 2007; EQUATIONS 2008). A post tsunami survey showed a reduction in reef species such as sharks, moray eels (Muraenidae), triggerfishes (Balistidae), boxfishes (Ostraciidae), pufferfish (Tetraodontidae) and angelfish (Pomacanthidae), as well as a complete absence of shrimps and brachyuran crabs (Jeyabaskaran 2007).

The fishing industry on the Andaman and Nicobar Islands is an important means of livelihood, offering favorable employment opportunities and economic well-being to the people. Currently, the fish resources are considered to be underexploited, despite showing clear sign of 'fishing down', i.e., a declining trend of the mean trophic level of catches (Kirubasankar *et al.* 2013). However, the EEZ of the islands is vulnerable to illegal fishing by foreign vessels (DAHD 2004). In addition, due to heavy fishing pressure from local fishers and collectors, certain reef and coastal species (i.e., *Trochus* and *Turbo* spp.) have been overfished for sale to foreign markets. The reconstruction presented here should help provide a framework for dealing with these various issues.

METHODS

For the coastal fishery around mainland India, the Central Marine Fisheries Research Institute (CMFRI), under the Indian Council of Agricultural Research (ICAR), collects data on fish landings through a stratified multi-stage random sampling procedure (Malhotra and Sinha 2007), but for the A&N islands, the landing data reported by CMFRI are those submitted to it by the administration of this Union Territory. As for the oceanic fisheries, data are compiled from the log books received by the Fishery Survey of India (FSI) and from the Indian owned tuna fishing vessels operating under the LoP scheme (Vijayakumaran and Varghese 2012). In 1990, along with the FSI, the Andaman and Nicobar Administration[1] completed the first national marine census of the islands, followed by another in 2005 and again in 2010.

The national fishery data collected by Central Marine Fisheries Research Institute (CMFRI) , which was used in the previous reconstruction (Bhathal 2005) from 1950-2000, was used as the baseline in the reconstruction of the Andaman and Nicobar Islands. However, these catch statistics do not distinguish between most species and landings are mostly summarized as groups such as 'other carangids' or 'billfishes'. Following the approach in Zeller *et al.* (2007), information collected from local reports and the

[1] http://www.and.nic.in/[accessedApril 18, 2013].

Andaman and Nicobar Administration was used to identify missing catch data. Notably, landings data collected by the A&N Department of Fisheries from 2003-2010 were used to enhance the taxonomic breakdown in later years. Interpolations between taxonomic groups from 2000-2003 were used to generate a complete time series. Estimates for unreported catches in the EEZ of the A&N Islands (Pramod 2012) were incorporated into this study to provide a more comprehensive understanding and estimate of under/unreported sectors (i.e., artisanal and subsistence sector).

Artisanal fishery

The reported data presented by the CMFRI was considered to represent the artisanal catch from the coastal waters around the A&N Islands. The artisanal tuna catch was subtracted from these totals and reconstructed separately, as different data sources were used (see below).

Molluscan fishery

A fishery for sea shells has occurred in the A&N Islands since the early 1920s (Appukuttan 1977; Pramod 2012). Despite the commercial importance of this fishery, none of the gastropod catches are reported to the appropriate government agencies. According to Pramod (2012), licensed fishers on the islands land around 700 t of shells per year, none of which are reported in the official catch statistics. Thus, no catches of molluscs were included in the earlier reconstruction of the A&N Islands (Bhathal 2005), although it is possible they were included in the national catch statistics for India.

Many species of molluscs such as scallops, mussels and clams, as well as some gastropods are harvested for human consumption and make up a portion of the subsistence fishery. However, ornamental molluscs such as *Trochus niloticus* and *Turbo marmoratus*, are highly valued and landed for export through the aquarium and shell trade (Arumugam *et al.* 2010). These shells are primarily harvested by skin divers and annual landings in the 1980s were estimated to be between 400-600 t of *Trochus* and 100-150 t of *Turbo* (Appukuttan 1977; Alagarswami 1987). According to Appukuttan (1977), 505 t of *Trochus* and *Turbo* shells were landed in 1976. Interviews with locals suggest that many fishers continue to harvest the shells illegally, collect banned *Trochus* species and often smuggle the illegal catch from the islands in through Myanmar (Pramod 2012). To account for the unreported molluscan fishery, we linearly interpolated between the 1976 estimate and Pramod (2012) estimate of 700 t in 2008, as no other information was available. The 700 t was held constant until 2010. It was conservatively estimated that landings would be half in 1950 (i.e., 350 t) and were linearly interpolated to the catch in 1976 to generate a complete time series.

Tourist consumption

The Andaman and Nicobar Islands attract many visitors from the mainland of India as well as foreign tourists from all over the world. Tourism on the A&N Islands has seen slow but steady growth since the early 1980s (Figure 2). Following his 2008 field study, Pramod (2012) estimated that 1,023 t·year^{-1} of fish and other seafood products were sold directly to major hotels and tourist resorts. At the time he conducted

his interviews, there were about 180 different places for tourists to stay. Information on the number of tourist arrivals to the island from 1980-2010 (Figure 2) was obtained from the Department of Information, Publicity and Tourism (IP&T), of the A&N administration (EQUATIONS 2008). In order to estimate the amount of seafood consumed by tourists while visiting the Andaman and Nicobar Islands, we used the number of tourist arrivals in 2008 (about 184,000), divided by the estimated fish sold directly to the hotels in that same year. It was estimated that each tourist would consume on average 5.6 kg of fish per average stay of approximately 5 days. This consumption rate was applied to all tourists staying on the A&N Islands from 1980-2009. A linear interpolation from zero in 1950 to the estimated 1980 consumption was completed to generate a complete time series of tourist consumption from 1950-2010.

Tuna fishery

Based on exploratory surveys around these islands (FSI 2006), the region is known to support abundant tuna stocks (Abdussamad *et al.* 2012a). Oceanic fleets from the mainland fish extensively in the waters of the A&N Islands; however, domestic tuna landings from the A&N EEZ only contribute 2.2% to the national Indian tuna landings. The artisanal tuna fishery is restricted to coastal waters within 10 km from shore and targeted by motorized gillnet and hook and line vessels as well as traditional (non-motorized) vessels (Abdussamad *et al.* 2012a). Tuna landings are reported both by the CMFRI for 1950 to 2005 and the Fisheries Departments of Andaman and Nicobar for 2006-2010 (Abdussamad *et al.* 2012a).

Data collected by the CMFRI, only provides data for skipjack tuna and an 'others' category. It is documented that longtail tuna (*Thunnus tonggol*), yellowfin and bigeye tuna are all commercially harvested from coastal areas around the A&N Islands. According to Abdussamad *et al.* (2012b), 6.2 % of the total Indian longtail tuna landings originate from the A&N waters. This percentage was therefore applied to the reported longtail tuna landings for mainland India to estimate catch from the A&N Islands. The 'others' category was split into yellowfin (95%) and bigeye tuna (5%) catch.

The by-catch contributed by the tuna fishery ranged from 66-69% of the total catch and was applied to the period from 1950 to 2010. By-catch comprised of several species of sharks, billfish and commercially important species such as dolphinfish (*Coryphaena hippurus*), wahoo (*Acanthocybium solandri*) and barracuda (*Sphyraena jello*) (John *et al.* 2005; Kar *et al.* 2011). The reported categories of billfish and sharks were compared to the calculated by-catch for the same categories to estimate the total unreported by-catch from this fishery.

Groupers

Despite there being an established grouper fishery in the region (Kirubasankar *et al* 2013), groupers (Serranids) were not included in the reported data and a reconstruction of the fishery was necessary. Investigation into the Malabar grouper (*Epinephelus malabaricus)* in the Andaman Islands indicated that this specific species accounted for 21.6% of the total grouper catch and 4.3% of the total annual marine landings (Kirubasankar et al, 2013). Therefore, we assumed that groupers accounted for 5% of the

artisanal reported catch in 1950 and 20% in 2010 (information from the paper indicated all groupers to account for approximately 20% of the catch), with a linear increase of their significance over the time period, and assumed that the ratio between *E. malabaricus* and other grouper species in the catch remained the same throughout the time period.

Subsistence

Information regarding the subsistence fishing sector is scarce in the A&N Islands. The fisheries department is known to only record fish catches from licensed and motorized fishing vessels; thus, it is unlikely that estimates for this sector were included in the national (CMFRI) data. Interviews with local fishers also revealed that reef-base catches using cast nets, traps, and hook and line from shore are never accounted for in the islands' official catch statistics (Pramod 2012). Using data collected by Pramod (2012), total subsistence was estimated based on three different categories: (1) fish consumption by indigenous tribes, (2) take-home catch from fishing families[2] (including reef-based subsistence) and (3) subsistence catch from non-fishing families.

(1) Due to a lack of knowledge of fishing activities, subsistence catch by the indigenous tribes of the A&N Islands has been historically unaccounted for in the official catch statistics. Estimates of fish and shellfish consumption by these tribes was estimated in 2008 (Pramod 2012). The total indigenous catch estimate of 1,692 t was divided by the indigenous population to derive a *per capita* subsistence rate. Historical population data of the six indigenous tribes for the Andaman and Nicobar Islands were obtained from the Indian census data and were found on the official website of Andaman and Nicobar Administration (Figure 3). The four forest-dwelling tribes of the Andamans have been declining in recent years, while the Nicobarese and Shompens have steadily increased since 1950. The *per capita* subsistence catch rate of 55 $kg \cdot person^{-1} \cdot year^{-1}$ was applied to the entire indigenous population from 1950-2010 as these tribes have remained isolated from urban civilization and subsistence activities have likely remained the same over time.

(2) On the islands, fishers typically keep a portion of their catch for consumption by their families, as well as share with elders, widows and impoverished people of the local fishing communities (Pramod 2012). In order to estimate this 'take-home' catch, the number of fishing households, provided by the CMFRI and FSI, were used for 1987, 2005, 2008 and 2010 (FSI 2006, 2011; Pramod 2012). Linear interpolations were used to estimate fishing household numbers in years where no information was available. The average person per household on the A&N Islands is 4.66 (FSI 2006). However, to account for consumption by other members of the community, the number of fishing households was multiplied by 9.32 (i.e., 2 households) from 1987-2010. To estimate the number of fishing families from 1950-1986, the proportion of people living in fishing families in 1987, in respect to the total A&N population, was calculated and applied to the total population from 1950-1986.

[2] It should be noted that Pramod (2012) "interviews with fishermen", likely refer only to artisanal fishers and thus, our estimate of 'take home' catch by fishing families likely underestimates catches by those fishing solely for subsistence (i.e., true subsistence catch).

Human population data for the A&N Islands was obtained from the Government of India's Office of the Registrar General and Census Commissioner website[3] and were available for years when census was completed (every 10 years since 1951). Interpolations between each census year were performed to derive a complete time series of the islands population from 1950 to 2010 (Figure 4).

Household fish consumption among fishing communities on the A&N Islands was estimated to be 1,367 t and reef-based subsistence 164 t in 2008 (Pramod 2012). This information was used to derive a *per capita* fish consumption rate for the fishing household population. The *per capita* consumption rate was estimated to be 41 kg·person^{-1}·year^{-1} in 2008 and was held constant until 2010. It was assumed that the *per capita* consumption rates by fishing households would have declined over time due the migration of Indian fishers to the A&N islands in the early 1970s and the creation of commercial fish markets in urban areas. Taking this into account, the *per capita* consumption rate of fishing households was doubled in 1950 (i.e., 82 kg·person^{-1}·year^{-1}) and held constant until 1970. Thereafter, the *per capita* rate was decreased gradually from 1970-2008.

(3) The subsistence catch by non-fishing households was also derived using *per capita* consumption rates and the remaining A&N population (i.e., total island population minus the indigenous population and fishing household population). The subsistence rates for the non-fishing households were assumed to be half of the fishing household *per capita* rates (i.e., 41 kg·person^{-1}·year^{-1} and 20.5 kg·person^{-1}·year^{-1} respectively). A linear interpolation from 1950-2008 was used to derive a complete time series of subsistence catch by non-fishing households. The 2008 rate was held constant until 2010.

Industrial fishery

Tuna longliners

The oceanic (i.e., industrial) tuna fleet operating chartered (1991-1995) and leased (1995-1997) vessels in the EEZ of A&N Islands caught on average 2,140 t·year^{-1} from 1991-1997 (John *et al.* 2005) and 1,310 t·year^{-1} in recent years (Vijayakumaran and Varghese 2012). Chartered vessels began operation in India in 1985; therefore, it was assumed there was no longlining in the EEZ of the A&N Islands in the years prior. To mimic a gradual increase in activity, we linearly interpolated from a catch of zero in 1984 to the most recent reported landings in 1991. We interpolated again from 1997 to 2010, as no other information was available. As catches were given in gilled and gutted form, the nominal catch was worked out by applying a raising factor of 1.15 (Vijayakumaran and Varghese 2010).

Interviews with joint-venture (LoP) longliners have suggested that only 20% of the actual catch caught during the year is reported and by-catch is rarely reported (Pramod 2012). Therefore, all tuna longline catch from the A&N EEZ was increased by 80% from 1985-2010 to account for this underreporting.

[3] http://censusindia.gov.in/[accessed April 10, 2013].

By-catch

The catch composition and proportion of by-catch species typically caught by the industrial tuna vessels was given from 1991-1997 (John *et al.* 2005). The by-catch associated with tuna longlining in the Indian Ocean is considered to be substantial and survey data collected by the FSI has suggested that industrial longliners rarely report their by-catch, specifically sharks (Pramod 2012; Vijayakumaran and Varghese 2012). Taking this into account, it was conservatively assumed that only 10% of the by-catch was reported fr0m 1985-1997. It was estimated that by-catch represented about 40% of the catch from 1984-1997 and would increase to 66% by 2010 (Kar *et al.* 2011).

Trawlers

Exploration of demersal resources was initiated in 1971 (John *et al.* 2005); however, commercial operations for deep-sea lobsters and prawns off the A&N Islands didn't get started until 1991 by 16 trawlers of 8 companies (Sudhakara Rao 2009a). These catches were often landed at ports on the east coast of India and separate landings data for A&N Islands were not available.

Foreign fishing

Exploitation of resources by foreign operations around the A&N Islands has been poorly documented. Due to the remoteness of the islands many issues dog the monitoring of the EEZ, for both registered and illegal foreign vessels. Serious instances of Myanmar, Thai, Sri Lankan, Indonesian and Taiwanese vessels poaching (Rajan 2003), often in the middle of the night, were observed from 1960 to 1980. Few arrests were made in the early years. However, apprehension rates have increased in recent decades, and 136 boats were apprehended from 1990 to 2000 and 104 from 2008 to 2011 (Rajan 2003; Anon. 2011; Pramod 2012; Table 1).

Foreign fishing by Thai gillnet and seine vessels was reported from 1971 to 1983 (Madhu *et al.* 2002); these vessels appear to have targeted longtail tuna followed by kawakawa and frigate tuna (*Auxis thazard*). Thai poachers also harvested reef fish, sharks, ornamental fish and sea cucumbers within the EEZ of the A&N Islands.

TAXONOMIC COMPOSITION

Artisanal fisheries

The taxonomic composition for the reported artisanal catch was derived from data previously collected (Bhathal 2005) and provided by the CMFRI from 1950-2005. Additional species information provided by the A&N Department of Fisheries was used from 2003-2010 (Table 2). Linear interpolations were used between the years 2000-2003 where data were missing. As most artisanal fishers would be selling commercially important species to hotels, the same taxonomic breakdown was applied to the estimated unreported consumption of fish by tourists from 1950 to 2010 (Table 2).

Molluscan fishery

Various species of molluscs found in the A&N Islands were included in (Rajan 2003) and this helped toward deriving a possible taxonomic composition to apply to the unreported molluscan fishery from 1950 to 2010 (Table 3). The ornamental gastropod shells (*Trochus* and *Turbo* spp.) are of great commercial importance (Kumaran 1973; Pramod 2012), and were given the highest contribution from 1950 to 2000. However, due to overfishing, they have decreased in recent years (Table 3). Other species included were the giant clams (*Tridacna* spp.), oysters (*Pinctada* spp. and *Crassostrea* spp.) and scorpion shells (*Lambis* spp.).

Subsistence

Along with the inshore coastal waters, the backwater fisheries in the mangrove creeks form an important part of the subsistence fishery on the A&N Islands. Some important species found in these areas are mullets (*Mugil* spp. and *Liza* spp.), barramundi (*Lates calcarifer*), milkfish (*Chanos chanos*), groupers (*Epinephelus coioides*, *E. fuscoguttatus*, *E. malabaricus* and *E. polystigma*), and snappers (*Lutjanus argentimaculatus*). The species composition for the subsistence fishery was derived from information in Rajan (2003) and the reported artisanal landings from the CMFRI (Table 4).

Tuna fishery

The species composition of the coastal and oceanic tuna fishery (including by-catch) was given by John et al. (2005) and Kar *et al.* (2011). For the coastal fishery, skipjack makes up the bulk of the catch and for the oceanic fishery, yellowfin was the most common. By-catch comprised of billfish (*Makaira* spp., *Istiophorus platypterus* and *Xiphias gladius*), sharks (most commonly the family Carcharhinidae) and other large pelagic species (Table 5).

Discards

The discards for 'mechanized' (i.e., industrial) vessels were assumed to consist of the young of retained species, and we therefore applied the same taxonomic breakdown as to the reported artisanal catch. However, commercially important tunas and other large pelagics were not included in the species composition of the discards (Table 6).

RESULTS

Artisanal fisheries

The total artisanal catch (excluding the tuna fishery), as reported to the CMFRI, amounted to 654,000 t from 1950-2010 (Figure 5). Documentation of this fishery was poor in the early years and in 1950, only 1 tonne of catch was reported by CMFRI. Landings steadily increase in the 1980s, reaching 29,300 t by 1992 and remained relatively stable at 40, 000 $t \cdot year^{-1}$ from 2000-2010.

The total unreported catch within the artisanal sector amounted to over 185,000 t from 1950-2010 (Figure 5). This includes the unreported molluscan fishery, which was estimated to be about 30,300 t from 1950-2010, tourist consumption (i.e., artisanal catch sold to hotels), which was estimated to be about 13,140 t from 1950-2010 and unreported by-catch from the coastal tuna fishery (described below).

Subsistence

The overall total subsistence catch amounts to 414,000 t over the 1950-2010 period. Catches were reconstructed at 1, 500 t in 1950, and gradually increased to its peak of 10,220 t in 2001, before returning to 9,700 t in 2010.

Fish consumption by indigenous tribes of the A&N Islands totaled to approximately 74,600 t from 1950-2010 (Figure 6). Subsistence catch from all tribes was only about 700 $t \cdot year^{-1}$ in the early 1950s and grew steadily to over 1,000 t by 1970. Through the 1990s, average catch was about 1,550 $t \cdot year^{-1}$, and increased to almost 1,700 t by 2010 (Figure 6).

Take-home catch by artisanal fishing families amounted to about 61,300 t from 1950-2010 (Figure 6). In the early years catch was low, with an average catch of 318 $t \cdot year^{-1}$ from 1950-1960. By the late 1970s and early 1980s, take-home catch exceeded 1,000 $t \cdot year^{-1}$ and gradually increased to about 1,900 $t \cdot year^{-1}$ by 2010.

Total subsistence catch of non-commercial fisher households amounted to approximately 278,000 t from 1950-2010 (Figure 6). Catch was about 700 t in 1950 and exceeded 1,000 t by 1955. Catch gradually increased over time and reached just over 7,000 t by 1994. Subsistence catch decreases to an average of 6,500 $t \cdot year^{-1}$ from 2003-2010.

Tuna fisheries

Coastal fishery

Total landings by the coastal tuna fishery amounted to about 80,400 t from 1950-2010 (Figure 7), including the estimated catch of about 7,800 t of longtail tuna for the same time period. The tuna fishery was almost non-existent in the early years, but even as it grew more popular, the average catch of tuna, except for a peak of 100 t in 1978, did not exceed 100 t until 1986. Landings reached a peak of almost 78,000 t in 1998. Thereafter, landings return to about to about 3,500 t and increased to approximately 3,800 $t \cdot year^{-1}$ from 2007-2010. Total reported by-catch amounted to almost 31,000 t from 1950-2010 (Figure 7); the estimated unreported by-catch was almost double, amounting to approximately 64,130t for the same time period.

Oceanic fishery

The total catch of oceanic tuna amounted to about 182,900 t from 1985-2010 (Figure 8). By the early 1990s, the tuna catch exceeded 6,000 t·year^{-1}, and increased to a peak of almost 9,000 t in 1997. In the 2000-2010 period, the average annual catch was about 7,500 t·year^{-1}. The unreported by-catch was about 187,800 t from 1950-2010 (Figure 8). From 19585-2000, the by-catch was lower than the target catch for tuna and increased to 8,000 t·year^{-1} in 2000. Total by-catch increased to over 10,000 t·year^{-1} from 2005-2010.

Foreign catch

Total catch by Thai vessels operating in the waters of the Andaman and Nicobar Islands amounted to about 33,300 t from 1971-1983 (Figure 9). Average catch by seine vessels was about 2,600 t·year^{-1} from 1971-1981, with the highest recorded catch of 9,600 t in 1982 (Figure 9).

Reconstructed total catch

The reconstructed total catch for the Andaman and Nicobar Island marine fisheries was estimated to be over 1.7 million tonnes from 1950-2010 (Figure 10a, Appendix Table A1). This total catch by all sectors is 2.5 times higher than the official landings of about 695,000 t reported by the CMFRI on behalf of the A&N Islands for the same time period. The greatest contribution was by the artisanal sector, which contributed 53.9% of the total reconstructed catch. Within the artisanal sector, the unreported catch sold to hotels and the unreported catch of molluscs and by-catch from the coastal tuna fishery was estimated to be over 200,000 t from 1950-2010. The subsistence sector, which is unreported in the national landings, was estimated to be over 413,800 t million tonnes and 23.9% of the total reconstructed catch (Figure 10a).

The industrial sector with 370,000 t, only represented 21.4% of the reconstructed total catch, as the operations of joint-venture longliners began in the mid-1980s only. Discarded catch by mechanized vessels, contributed only 0.01% to the total reconstructed catch. This should be viewed as a very conservative estimate since catch data for trawlers operating in the A&N Islands were unavailable.

Foreign catch was not included in the reconstructed catch. However, it was estimated that catch by Thai vessels (gillnet and seine) operating in the waters of the Andaman and Nicobar Islands amounted to about 33,300 t from 1971-1983 (Figure 9).

The taxonomic composition of the total reconstructed catch was dominated by ten families: Clupeidae (13.5%), Scombridae (13.4%), Carcharhinidae (9.0%), Serranidae (7.8%), Percidae (5.1%), Leiognathidae (4%), Alopidae (3.6%), Mullidae (3.1%), , and Coryphaenidae (2%); the remaining 52 taxa along with 'marine fishes nei' made up the remaining 35% (Figure 10b; Appendix Table A2).

DISCUSSION

The total reconstructed catch for the Andaman and Nicobar Island marine fisheries was estimated to be 2.4 higher than the official national landings (about 695,000 t) reported by the CMFRI on behalf of the A&N Islands from 1950-2010 (Figure 10a). The greatest contribution was by the artisanal sector, which represented 54% of the total reconstructed catch. Within this sector, the unreported catch was estimated to be over 236,000 t from 1950-2010. The industrial sector totaled about 370,000 t and was dominated by the oceanic tuna fishery, which was grossly underestimated in the national statistics. The subsistence sector, which is unreported in the national landings, was estimated to contribute over 413,800 t million tonnes and 24% of the total reconstructed catch.

Tuna are described as the single largest "untapped" marine fishery resource of A&N Islands (Ghosh 2001), yet we estimated that total catch (including by-catch) of the coastal and oceanic tuna fisheries amounted to about 350,000 t from 1950-2010, representing 24% of the total reconstructed catch. Limited species identification in the national data (i.e., grouping under 'other tunnies') and underreporting of oceanic catch were both highlighted as issues with reporting this fishery.

Similar to the fisheries of the mainland of India (Hornby *et al.* in press), small pelagics (Clupeidae) were the largest contributor to domestic fisheries in the Andaman and Nicobar Islands.

Pelagic resources appear underexploited in the A&N waters, which may be the result of a small island population, and the inshore nature of the artisanal fisheries (Pramod 2012). Due to the remoteness of the islands and limited human presence, it is difficult for India to monitor the EEZ for the presence of illegal foreign vessels, mainly from Myanmar and Thailand. It is the responsibility of the Indian Coast Guard (ICG) along with the A&N Administration and police to patrol the waters surrounding the islands. And since the year 2000, the Indian Government has increased naval presence in the A&N Islands to confront growing activity of Chinese vessels operating from Myanmar waters (see also Pramod 2012; Pauly *et al.* 2013). In this study, we were able to derive catch estimates only for Thai vessels fishing in the A&N EEZ from 1971-1983. However, in a recent survey Pramod (2012) conservatively estimated that on average 34,500 $t \cdot year^{-1}$ of shell fish, sea cucumbers and finfish is illegally caught from the waters surrounding the A&N islands.

The domestic fisheries of the A&N islands have been slow to develop. This is due in part to lacking or poorly developed infrastructure such as adequate shore-based facilities for landing, processing and cold storage, and marketing facilities for inland and island-to-island transportation, as well as shipment to the mainland (Ghosh 2001). Most of the commercial catch stays on the islands and fishing is primarily for consumption by the island inhabitants and tourists. The 2004 tsunami damaged vital agricultural land both on Andaman and Nicobar, resulting in increased fish consumption in recent years. With new immigrants and tourists arriving to the islands every year, it is expected that more pressure will be placed on natural resources and local food security, and that the indigenous tribes may be further threatened.

It is apparent that reporting of marine fisheries has historically been poor in the A&N Islands and comprehensive catch data is difficult to access. However, it remains important to account for all sectors when assessing the status of a fishery (Zeller *et al.* 2007; Kirubasankar *et al.* 2013).

In order to maintain sustainable domestic fisheries on the A&N Islands, effort should be placed on enforcement and monitoring of the islands EEZ for protection of resources from foreign poaching. Emphasis on community-based policing and cooperation with Indian Coast Guards and Navy is necessary to reach this difficult goal.

ACKNOWLEDGEMENTS

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Table 1. The number of foreign vessels seized and foreign crew apprehended from 1994-2000 (Rajan 2003).

	1994	1995	1996	1997	1998	1999	2000
No. of boats apprehended		11	19	27	31	11	12
Origin of boats							
Myanmar	138	39	146	134	200	233	225
Thailand	38	12	7	10	60		10
Sri Lanka		9	185	25	32	15	
Indonesia	18	8	3	42	6		4
China	55						
Philippines			5				
Taiwan			1				
Total	249	68	180	211	298	248	239

Table 2. Taxonomic composition of the reported artisanal catch, 1950-2010 (CMFRI).

Taxa		Composition (%)			
		1950-1960	1980	2000	2010
Ariidae	*Arius* spp.	0.8	2.0	1.9	0.7
Brachyura	*Charybdis cruciata*	0.8	0.1	2.7	1.8
Bregmacerotidae	*Bregmaceros mcclellandi*	0.0	0.0	0.0	0.0
Carangidae	*Caranx* spp.	7.4	5.3	0.3	0.6
	Scomberoides commersonnianus	0.8	5.8	2.6	7.8
Carangidae	*Parastromateus niger*	0.8	0.2	1.8	0.9
Cephelapoda		0.8	0.1	0.3	0.1
Chirocentridae	*Chirocentrus dorab*	0.8	1.0	0.9	0.2
Clupeidae		15.3	10.7	17.9	16.2
	Tenualosa toli	0.8	0.0	1.1	0.8
	Other shads	0.8	1.0	0.1	0.0
Dasyatidae		0.4	0.1	0.0	0.0
Engraulidae	*Anchoviella*	7.4	6.8	3.1	4.4
	Thrissocles	5.5	3.9	1.9	2.7
Exocoetidae	*Exocoetus monocirrhus*	0.8	0.0	0.0	0.0
Istiophoridae		0.8	0.0	0.9	4.1
Leiognathidae		3.1	6.4	5.7	9.2
Mullidae	*Liza* spp.	3.1	7.3	5.2	3.5
Muraenesocidae		0.4	0.1	0.0	0.0
Myliobatidae		0.8	0.4	1.2	0.8
Palinuridae	*Panulirus polyphagus*	0.8	0.1	0.1	0.1
Penaeidae		0.8	3.4	1.1	1.6
Non-penaeid prawns		0.8	0.1	0.2	0.3
Pleuronectiformes		0.0	0.0	0.0	0.1
Polynemidae	*Eleutheronema tetradactylum*	0.8	0.1	1.6	0.1
Rhinobatidae		0.8	0.4	0.9	0.5
Sciaenidae		0.8	0.2	0.2	2.6
Scombridae		1.2	1.2	0.2	0.3
	Rastrelliger kanagurta	3.7	7.2	5.0	7.1
	Scomberomorus commerson	3.1	2.4	1.6	1.8
	Scomberomorus guttatus	2.5	2.2	1.5	1.7
	Katsuwonus pelamis	0.8	0.4	1.2	0.2
Selachimorpha		1.2	2.8	3.5	8.5
Serranidae	*Epinephelus* spp.	23.5	18.8	20.7	10.9
	Nemipterus spp.	0.0	0.0	0.0	0.8
	Upeneus spp.	0.8	2.3	0.6	0.0
Sphyraenidae	*Sphyraena* spp.	3.1	2.6	1.6	1.5
Stromateidae	*Pampus argenteus*	0.8	0.7	6.8	4.3
Synodontidae	*Saurida spp.*	0.0	0.0	0.0	0.0
Trichiuridae	*Lepturacanthus savala*	0.8	0.6	1.7	0.6
Zenarchopteridae	*Hemiramphus* spp.	1.8	1.6	3.3	0.8
Marine fishes nei		0.5	1.7	0.6	2.4

Table 3. Species composition of unreported molluscan catch from 1950-2010.

Taxa	Composition (%)	
	1950-2000	2000-2010
Crassostrea madrasensis	1.4	7
Harpago chiragra	1.4	7
Lambis lambis	1.4	7
Perna viridis	1.4	7
Pinctada margaritifera	1.4	7
Saccostrea cucullata	1.4	7
Tridacna spp.	1.4	8
Trochus niloticus	70.0	40
Turbo marmoratus	20.0	10

Table 4. Taxonomic percent composition for the subsistence catch, 195
2010.

Taxa		Composition (%)
Acanthuridae		2
Ariidae	*Arius* spp.	5
Carangidae		5
Chanidae	*Chanos chanos*	2
Clupeidae	*Sardinella* spp.	6
	Dussumieria spp.	3
	Anodontostoma spp.	3
Gerreidae		3
Haemulidae		2
Holothuroidae	*Holothuria scabra*	3
	Holothuria leucospilota	3
Latidae		4
Leigonathidae		8
Lethrinidae		2
Lutjanidae	*Lutjanus* spp.	5
Mugilidae	*Mugil* spp.	3
	Liza spp.	3
Mullidae		2
Muraenesocidae		2
Palinuridae	*Palinurus* spp.	3
Sciaenidae		2
Scombridae		4
Serranidae	*Epinephelus* spp.	4
Siganidae		3
Toxotidae	*Toxotes* spp.	2
Trichiuridae		2
Tridacninae	*Tridacna* spp.	2
Trochidae	*Trochus* spp.	2
Bivalvia		2
Rays and skates		3
Marine fishes nei		5

Table 5. Taxonomic composition of the coastal and oceanic tuna fisheries, including by-catch (John *et al.* 2005; Kar *et al.* 2011).

Taxa		Coastal (%)		Oceanic (%)	
		1950-2000	2000-2010	1950-2000	2000-2010
Alopiidae	*Alopias pelagicus*	5.0	3.2	5.0	3.2
	Alopias superciliosus	5.0	3.2	5.0	3.2
	Alopias vulpinus	5.0	3.2	5.0	3.2
Carcharhinidae	*Galeocerdo cuvier*	3.4	3.1	3.4	3.1
	Rhizoprionodon acutus	3.4	3.1	3.4	3.1
	Scoliodon laticaudus	3.4	3.1	3.4	3.1
	Carcharhinus limbatus	3.5	3.2	3.4	3.2
	Carcharhinus albimarginatus	3.5	3.2	3.4	3.2
	Carcharhinus amblyrhynchos	3.5	3.2	3.4	3.2
	Carcharhinus melanopterus	3.5	3.2	3.4	3.2
	Carcharhinus macloti	3.5	3.2	3.4	3.2
	Carcharhinus sorrah	3.4	3.2	3.4	3.2
	Carcharhinus longimanus	3.4	3.2	3.4	3.2
Coryphaenidae	*Coryphaena hippurus*	0.6	0.7	0.6	0.7
Istophoridae	*Makaira mazara*	1.0	2.0	1.0	2.0
	Istiompax indica	1.0	2.0	1.0	2.0
	Tetrapterus audax	1.0	2.0	1.0	2.0
	Istiophorus platypterus	5.0	3.0	5.0	3.0
Lamnidae	*Isurus oxyrhincus*	3.0	3.2	3.0	3.2
Scombridae	*Acanthocybium solandri*	0.6	0.7	0.6	0.7
	Thunnus albacares	10.0	15.0	30.0	33.0
	Thunnus obesus	1.0	4.0	0.5	0.5
	Katsuwonus pelamis	20.0	15.0	1.0	0.5
Sphyraenidae	*Sphyraena jello*	0.6	0.7	0.6	0.7
Sphyrnidae	*Sphyrna zygaena*	2.0	3.2	2.0	3.2
	Sphyrna lewini	2.0	3.1	2.0	3.1
	Sphyrna mokarran	2.0	3.1	2.0	3.1
Xiphiidae	*Xiphias gladius*	0.7	1.0	0.7	1.0

Table 6. The percent composition and main taxa found in the discards by mechanized vessels.

Taxa	% Composition			
	1950-1960	1980	2000	2010
Ariidae	0.8	2.2	2.1	0.9
Brachyura	0.8	0.1	3.0	2.3
Carangidae	9.7	12.5	5.2	11.4
Cephalopoda	0.8	0.1	0.4	0.2
Chirocentridae	0.8	1.1	1.0	0.3
Clupeidae	18.5	13.0	21.0	20.9
Engraulidae	14.1	11.9	5.5	8.7
Leiognathidae	3.4	7.0	6.3	11.3
Mullidae	4.2	10.6	6.4	4.4
Muraenesocidae	0.8	0.1	0.0	0.0
Myliobatidae	0.8	0.4	1.3	0.9
Penaeidae	0.8	3.7	1.2	2.0
Sciaenidae	0.8	0.3	0.3	3.2
Scombridae	5.4	9.3	5.7	9.1
Sphyraenidae	3.4	2.9	1.7	1.9
Stromateidae	0.8	0.8	7.5	5.2
Trachipterus	0.8	0.6	1.9	0.7
Zenarchopteridae	2.0	1.8	3.7	1.0
Others	31.0	21.5	25.8	15.7

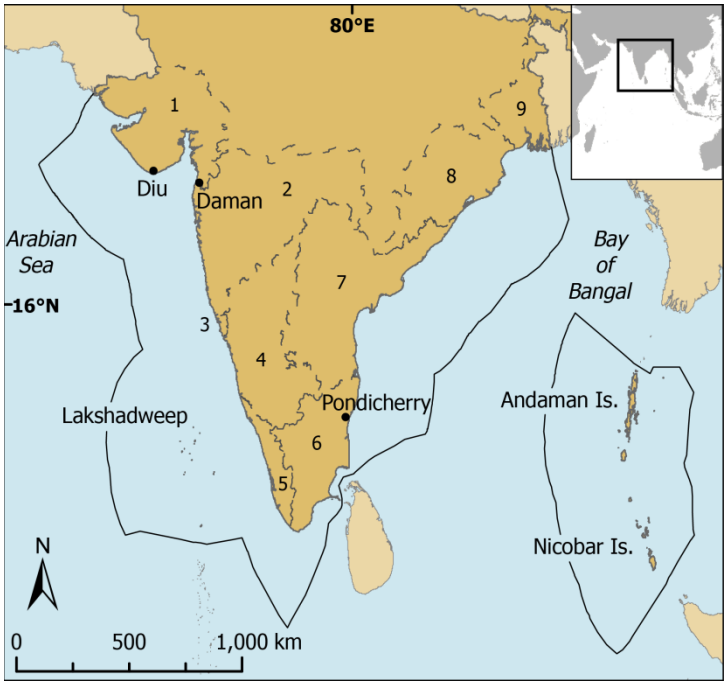

Figure 1. Map and Exclusive Economic Zones (solid line) of the Andaman and Nicobar Islands in relation to mainland India.

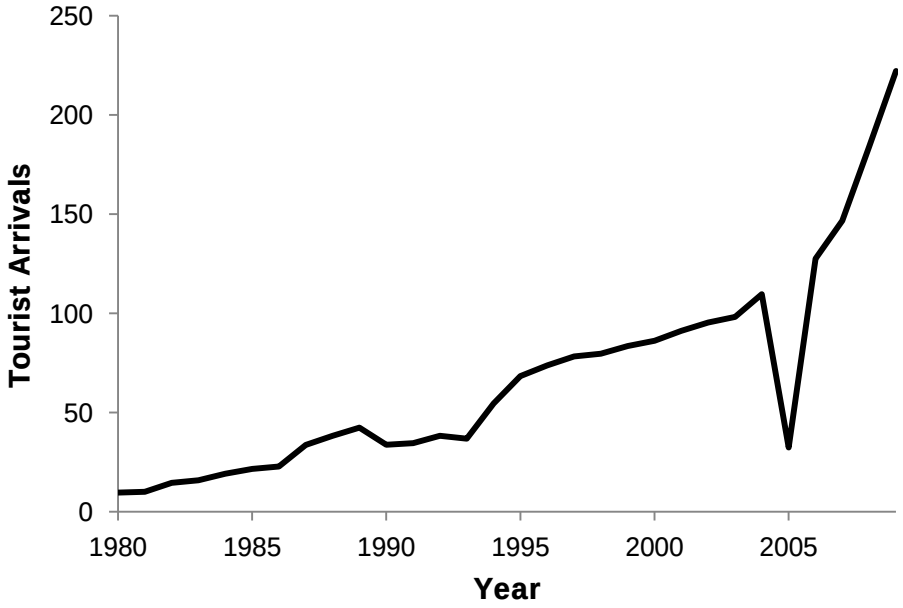

Figure 2. The total number of tourist arrivals to the Andaman and Nicobar Islands (1980-2010).

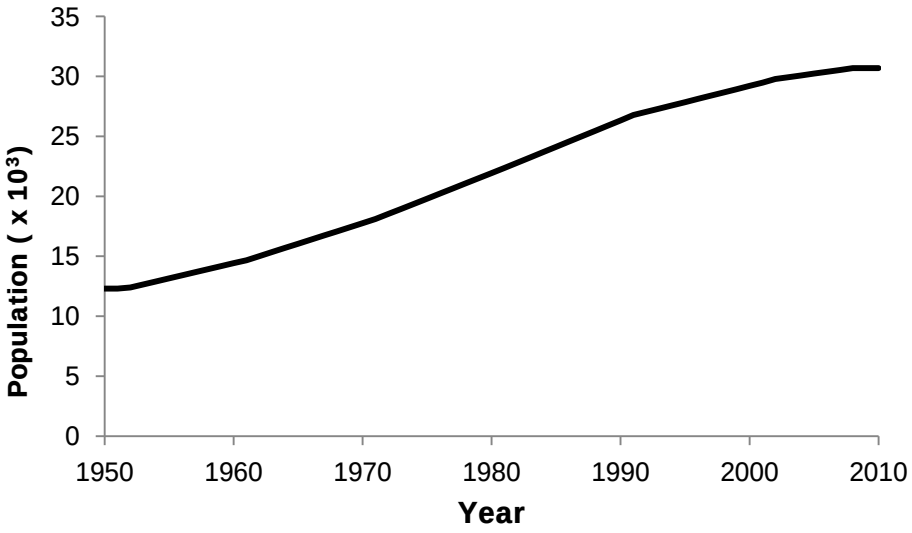

Figure 3. Indigenous population data for the Andaman and Nicobar Islands from 1950-2010.

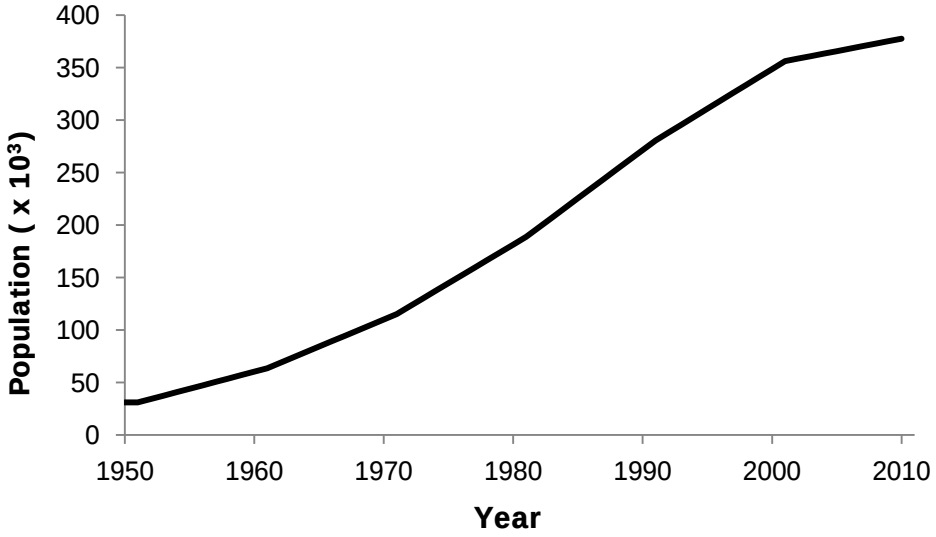

Figure 4. Total human population data for the Andaman and Nicobar Islands from 1950-2010.

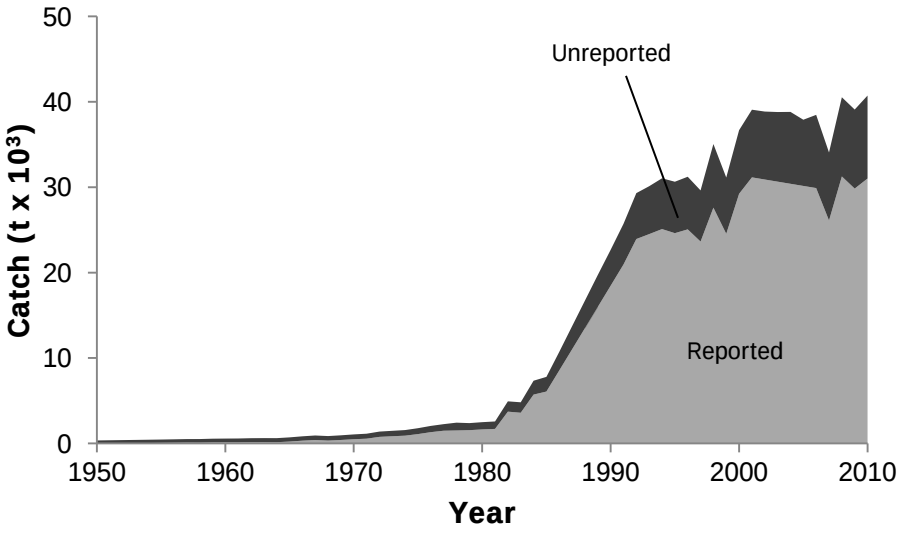

Figure 5. Total reported (CMFRI) and unreported artisanal catch for the Andaman and Nicobar Islands from 1950-2010.

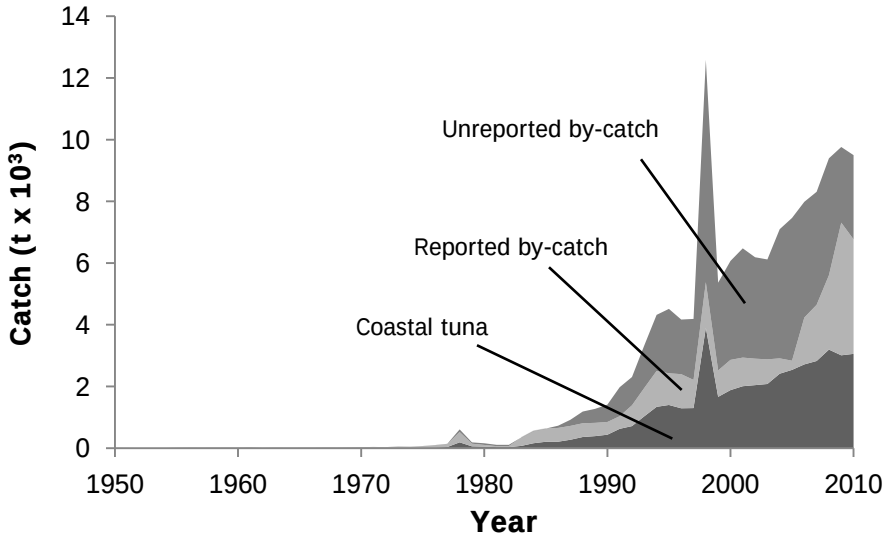

Figure 6. The total coastal (artisanal) tuna catch harvested from the Andaman and Nicobar waters from 1950-2010, including the reported and unreported by-catch associated with this fishery.

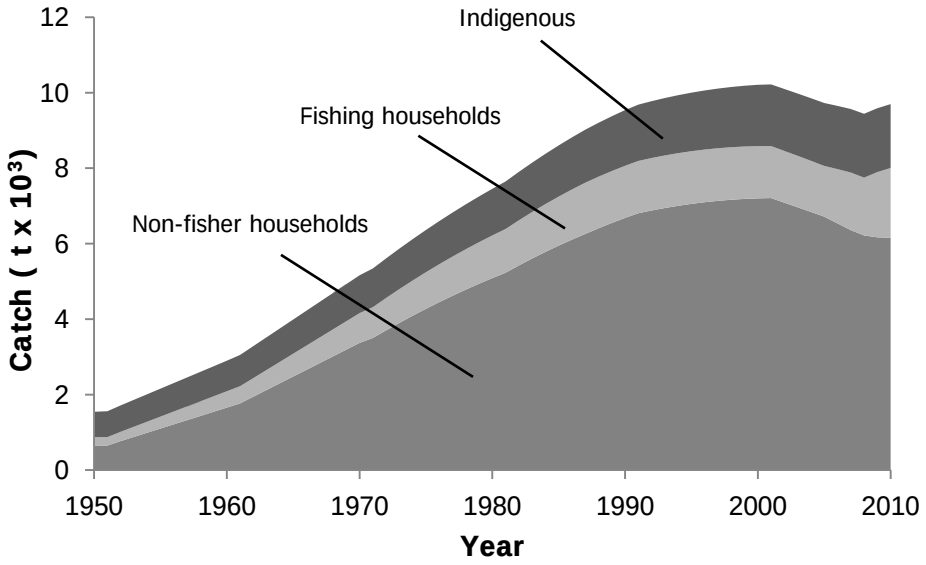

Figure 7. Total subsistence catch from the indigenous tribes, fishing households and non-fisher households from 1950-2010.

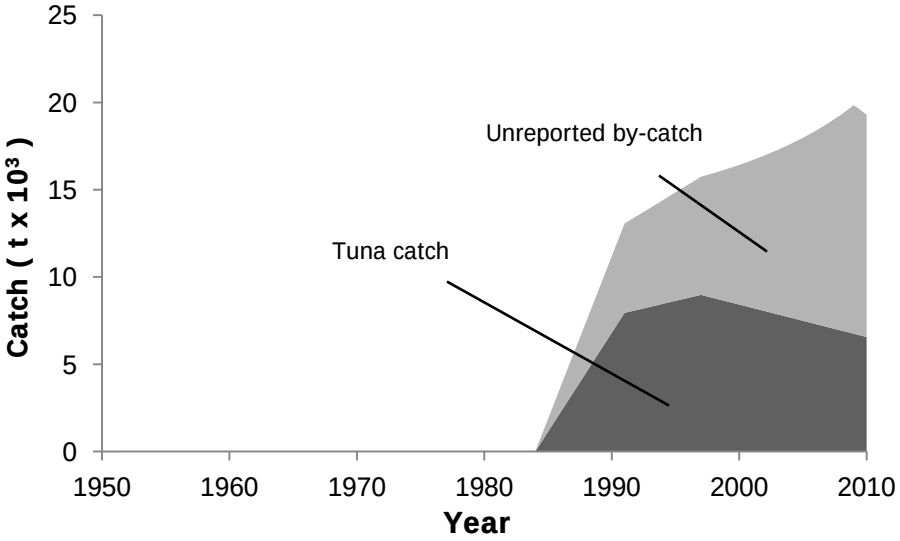

Figure 8. Total reconstructed catch for the oceanic (industrial) tuna fishery from 1950-2010.

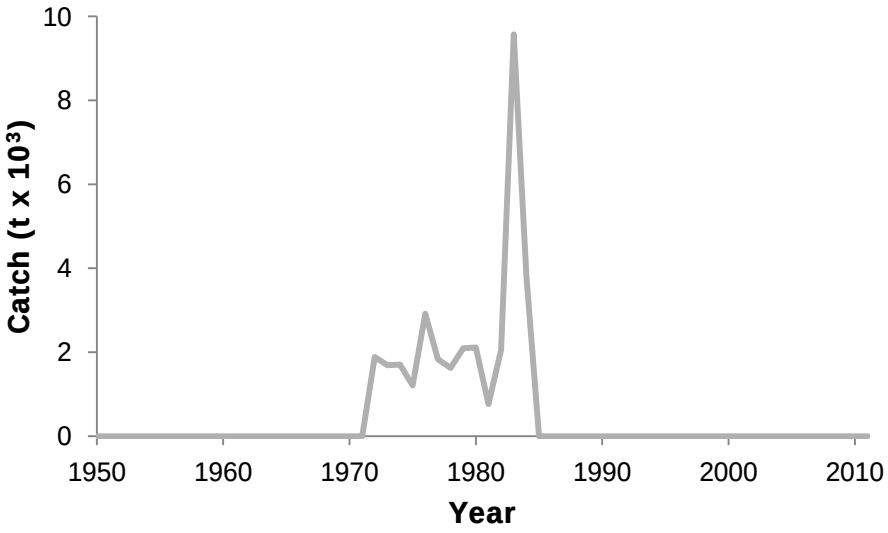

Figure 9. Total catch by Thai foreign vessels operating from 1971-1983 (Madhu *et al.* 2002).

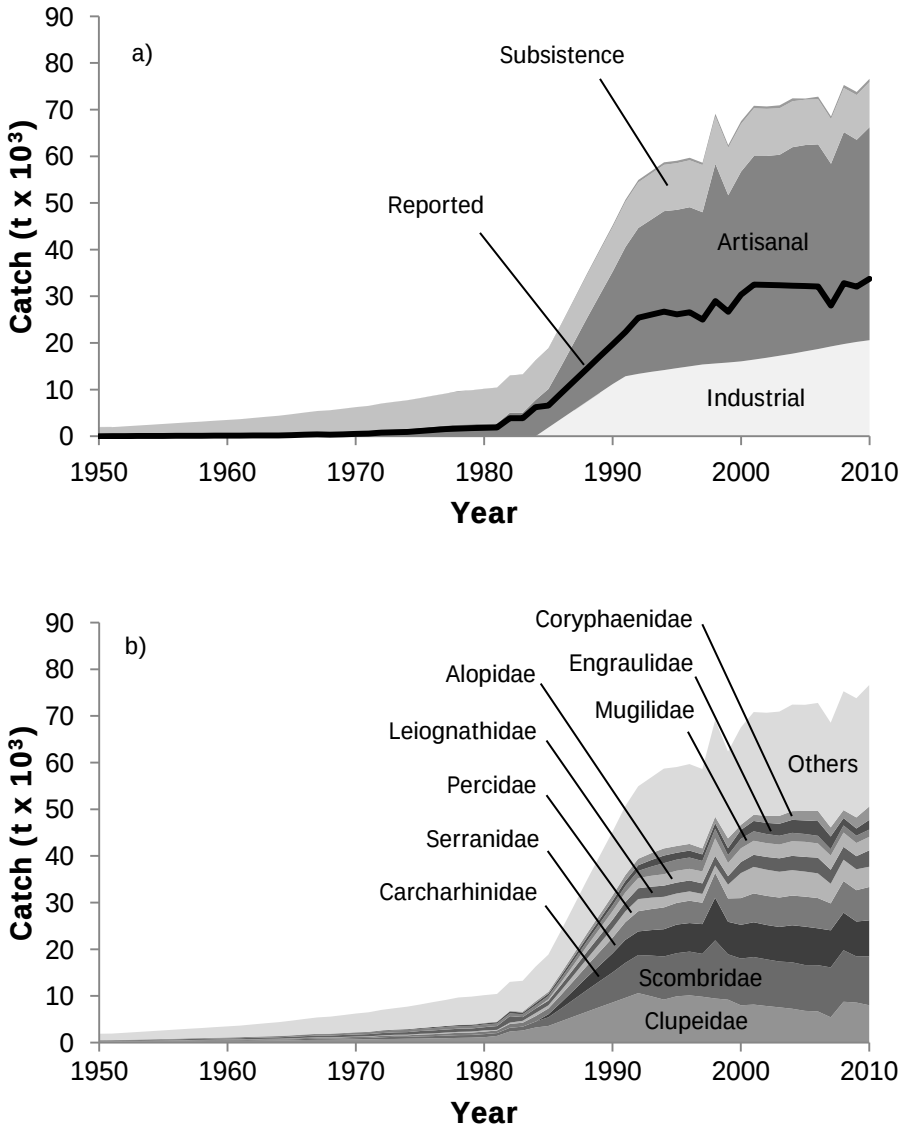

Figure 10. Reconstructed total catch of the Andaman and Nicobar Islands from 1950-2010 by a) sector, with official reported data overlaid as line graph. Note: discards plotted but not visible in graph; and b) by major taxa, with 'Others' consisting of 53 additional taxonomic categories.

Appendix Table A1. National data vs reconstructed total catch (in tonnes), and catch by sector with discards shown separately for Andaman and Nicobar Islands, 1950-2010.

Year	Reported	Reconstructed total catch	Industrial	Artisanal	Subsistence	Discard
1950	1	1,910	0	360	1,550	0
1951	14	1,940	0	379	1,560	0
1952	26	2,110	0	396	1,710	0
1953	39	2,280	0	417	1,860	1
1954	52	2,450	0	438	2,010	1
1955	64	2,620	0	465	2,160	1
1956	82	2,800	0	494	2,310	1
1957	100	2,980	0	521	2,450	2
1958	96	3,130	0	525	2,600	2
1959	127	3,320	0	565	2,750	2
1960	133	3,480	0	582	2,900	3
1961	135	3,650	0	596	3,050	3
1962	158	3,910	0	619	3,290	3
1963	160	4,160	0	633	3,520	3
1964	149	4,390	0	628	3,760	3
1965	224	4,710	0	716	3,990	4
1966	330	5,070	0	836	4,220	7
1967	410	5,400	0	933	4,460	8
1968	341	5,570	0	867	4,690	7
1969	414	5,890	0	956	4,930	8
1970	501	6,230	0	1,061	5,160	10
1971	570	6,500	0	1,147	5,340	11
1972	780	7,010	0	1,388	5,610	16
1973	854	7,370	0	1,482	5,870	17
1974	920	7,700	0	1,565	6,120	18
1975	1,104	8,170	0	1,783	6,360	22
1976	1,334	8,670	0	2,051	6,600	27
1977	1,532	9,140	0	2,288	6,820	31
1978	1,627	9,680	0	2,493	7,040	142
1979	1,722	9,850	0	2,569	7,250	34
1980	1,804	10,170	0	2,678	7,450	36
1981	1,864	10,430	0	2,746	7,650	37
1982	3,860	13,020	0	5,038	7,900	77
1983	3,868	13,260	0	5,031	8,150	77
1984	6,227	16,260	0	7,760	8,380	125
1985	6,588	18,860	1,860	8,259	8,600	132
1986	9,213	24,040	3,730	11,305	8,820	185
1987	11,837	29,390	5,590	14,539	9,020	239
1988	14,464	34,790	7,460	17,835	9,200	292
1989	17,089	40,010	9,320	20,969	9,380	346
1990	19,713	45,210	11,170	24,096	9,540	399
1991	22,339	50,700	12,850	27,717	9,680	447
1992	25,404	54,920	13,370	31,270	9,780	508
1993	26,050	56,810	13,800	32,630	9,860	521
1994	26,695	58,710	14,180	34,065	9,930	534
1995	26,120	59,050	14,590	33,934	10,000	522
1996	26,551	59,680	14,980	34,110	10,060	531
1997	24,974	58,620	15,380	32,635	10,110	499
1998	28,983	69,110	15,590	42,788	10,150	580
1999	26,673	62,370	15,800	35,858	10,180	533
2000	30,339	67,540	16,040	40,676	10,210	607
2001	32,514	70,830	16,420	43,643	10,220	543
2002	32,430	70,680	16,820	43,254	10,100	511
2003	32,346	70,930	17,260	43,074	9,980	621
2004	32,262	72,420	17,700	44,255	9,850	620
2005	32,178	72,380	18,200	44,211	9,730	243
2006	32,094	72,780	18,690	43,867	9,650	572
2007	28,005	68,550	19,250	39,156	9,570	577
2008	32,795	75,280	19,760	45,437	9,440	647
2009	32,065	73,790	20,220	43,327	9,590	660
2010	33,740	76,610	20,580	45,668	9,700	663

Appendix Table A2. Reconstructed total catch (in tonnes) by major taxa for Andaman and Nicobar Islands, 1950-2010. 'Others' contain 53 additional taxonomic categories.

Year	Clupeidae	Scombridae	Carcharhinidae	Serranidae	Percidae	Leiognathidae	Alopidae	Mugilidae	Engraulidae	Coryphaenidae	Others
1950	186	65	3	62	1	124	1	93	0	0	1,370
1951	188	68	2	63	2	126	1	95	1	0	1,390
1952	209	77	0	70	5	140	0	104	1	0	1,500
1953	230	84	0	77	7	151	0	113	1	1	1,620
1954	249	91	0	83	10	166	0	122	1	1	1,730
1955	268	101	3	90	13	178	1	131	4	1	1,830
1956	288	111	4	98	17	191	2	140	4	1	1,950
1957	315	118	4	105	24	202	2	149	7	1	2,050
1958	329	129	4	111	19	214	2	159	9	1	2,150
1959	354	138	4	119	24	226	2	172	15	1	2,260
1960	374	137	4	126	33	237	2	179	20	1	2,370
1961	386	142	6	133	33	255	3	186	29	1	2,480
1962	418	164	2	144	30	273	1	200	35	1	2,640
1963	447	173	3	154	29	291	2	217	35	1	2,810
1964	472	179	3	163	25	309	1	232	33	1	2,970
1965	511	199	2	179	38	332	1	251	49	1	3,150
1966	555	223	1	199	56	356	0	272	72	1	3,330
1967	596	241	1	216	69	379	0	293	88	1	3,510
1968	612	240	1	220	56	394	0	303	74	1	3,660
1969	651	260	1	237	67	417	0	324	89	1	3,840
1970	674	291	1	257	69	442	0	365	97	1	4,030
1971	707	299	2	272	76	471	1	376	99	1	4,200
1972	768	370	1	306	90	510	1	415	144	1	4,410
1973	787	454	2	327	103	524	1	440	145	1	4,580
1974	836	384	1	346	135	550	1	462	158	1	4,830
1975	860	486	2	379	161	598	1	475	168	1	5,040
1976	927	468	3	417	147	658	1	508	217	1	5,330
1977	948	556	6	453	197	650	2	549	198	12	5,570
1978	1,015	566	48	477	205	658	21	560	207	72	5,850
1979	1,064	570	23	501	214	655	10	552	200	125	5,940
1980	1,160	648	28	524	258	689	12	556	242	126	5,920
1981	1,441	595	22	544	134	818	10	520	301	137	5,910
1982	2,383	787	21	818	275	1,386	9	576	426	115	6,220
1983	2,597	825	2	838	413	794	1	617	332	216	6,620
1984	3,235	1,260	5	1,176	647	972	2	699	463	378	7,430
1985	3,571	1,852	641	1,250	667	1,014	283	720	498	396	7,970
1986	4,582	2,729	1,310	1,643	937	1,177	578	827	611	549	9,090
1987	5,604	3,672	2,009	2,048	1,209	1,345	886	939	714	701	10,260
1988	6,612	4,636	2,736	2,465	1,481	1,511	1,207	1,049	808	852	11,430
1989	7,618	5,539	3,407	2,896	1,753	1,677	1,503	1,159	898	1,002	12,560
1990	8,600	6,436	4,096	3,338	2,026	1,838	1,807	1,265	981	1,151	13,670
1991	9,596	7,493	4,924	3,794	2,299	2,003	2,067	1,374	1,065	1,302	14,780
1992	10,605	8,156	5,068	4,329	2,596	2,321	2,169	1,545	1,221	1,388	15,530
1993	9,941	8,707	5,460	4,497	2,449	2,356	2,329	1,951	1,421	1,461	16,240
1994	9,214	9,246	5,840	4,669	2,278	2,391	2,442	2,376	1,631	1,527	17,100
1995	9,921	9,244	6,128	4,645	2,020	2,335	2,538	2,381	1,478	1,440	16,920
1996	10,121	9,381	6,119	4,783	2,000	2,333	2,498	2,420	1,488	1,431	17,110
1997	9,829	9,187	6,375	4,588	1,885	2,256	2,562	2,242	1,410	1,289	17,000
1998	9,454	12,461	9,126	5,333	1,585	2,040	3,793	2,040	1,185	1,380	20,720
1999	9,203	9,719	6,965	5,008	2,945	1,827	2,807	1,681	1,516	2,096	18,610
2000	7,998	10,014	7,235	5,718	5,362	2,364	2,940	2,027	1,916	1,086	20,880
2001	8,150	10,192	7,450	6,180	5,682	2,588	3,003	2,033	2,215	1,337	22,000
2002	7,841	9,996	7,371	6,241	5,604	2,732	2,957	1,952	2,393	1,510	22,090
2003	7,557	9,820	7,405	6,302	5,526	2,878	2,955	1,877	2,575	1,686	22,350
2004	7,260	9,940	7,946	6,363	5,447	3,060	3,132	1,800	2,784	1,870	22,820
2005	6,805	9,814	8,236	6,422	5,370	3,142	3,231	1,680	2,903	2,050	22,730
2006	6,690	9,905	7,897	6,484	5,292	3,369	3,046	1,633	3,158	2,216	23,090
2007	5,430	10,687	7,946	5,774	4,202	3,007	3,034	1,378	2,711	1,958	22,420
2008	8,758	11,041	8,046	6,773	4,571	2,765	3,049	1,525	1,588	1,707	25,460
2009	8,586	9,887	7,475	6,716	4,475	2,805	2,828	1,558	1,550	2,375	25,530
2010	8,010	10,465	7,734	7,136	4,338	3,513	2,886	1,558	2,079	2,861	26,030