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Abstract

We present a historical reconstruction of Thailand's total marine fisheries catches from 1950-2010. National marine fisheries statistics estimate small-scale and industrial fisheries using data collated from logbooks and fishing community surveys, but are incomplete. Sources of under-reporting are: i) illegal fishing by Thai industrial vessels outside the Thai Exclusive Economic Zone (EEZ); ii) under-reported small-scale subsistence and artisanal fisheries; iii) fish discards; and iv) catches from marine recreational fishing. We quantify catches from these sources and add them to annual marine landings statistics that are reported to the FAO. Thailand's reconstructed catch totalled 266 million t from 1950-2010, which was 2.8 times the reported landings of 95 million t. Of total reconstructed catch, 176 million t originated from outside the Thai EEZ, of which approximately 75% was caught by industrial fishing vessels either operating illegally in foreign waters or not properly reporting their catches. This suggests a failure of flag-state control, and indicates that stricter monitoring and enforcement of the Thai industrial fishing fleet should be pursued to mitigate un-controlled fishing effort both in the Thai EEZ and in the EEZs of other countries in the High Seas.

Introduction

As is the case for many countries around the world, the fisheries of Thailand went through a period of boom and bust. From the early 1960s to the mid-1980s, catches from both marine and freshwater fisheries had grown close to 8% per annum (Sriplang 1987). The introduction of efficient gears such as otter board trawls and the expansion to new fishing grounds outside of the Thai Exclusive Economic Zone (EEZ, Figure 1) contributed to the rapid increase in catches. The number of trawlers (otter board, pair, and beam) tripled within 10 years after their introduction in the early 1960s, and by 1989, the number of trawlers peaked at about 13,100 vessels. During this boom period, fisheries contributed about 10% to the Gross National Product (GNP) originating from the agricultural sector, or 3% of total GNP, and export values from fisheries went from about 235 million baht (about US$ 11.7 million) in 1966 to 5,019 million baht (US$ 250 million) in 1978 (DoF 1979). The growth rate in catches from 1976 onward, while still high, started to decline to less than 2% per annum, and was accompanied by a reduction in catch per unit effort from 300 kg·hour^{-1} in 1963 to 50 kg·hour^{-1} in the 1980s, and 30 kg·hour^{-1} in 1990 (Boonyubol and Pramokchutima 1984; Eiamsa-Ard and Amornchairojkul 1997) in the Gulf of Thailand, with a similar development along the Andaman Sea (i.e., Indian Ocean) coast of Thailand (Pauly 1979). Stock depletion and overfishing followed, with an increasing number of trawlers operating mostly in the Gulf of Thailand (Butcher 1999). The decline in the importance of the fisheries sector to the national economy was accentuated by the fast growing manufacturing and service sectors (Juntarashote and Chuenpagdee 1987).

To overcome the problem of degraded fisheries resources, an exploitation of the then 'under-utilized' pelagic fishes, such as scads, sardines and tuna-like fishes, began along with the expansion of fishing areas for Thai trawlers to the South China Sea and Bay of Bengal in 1972. Joint-venture arrangements were also initiated to enable Thai vessels to fish in neighbouring

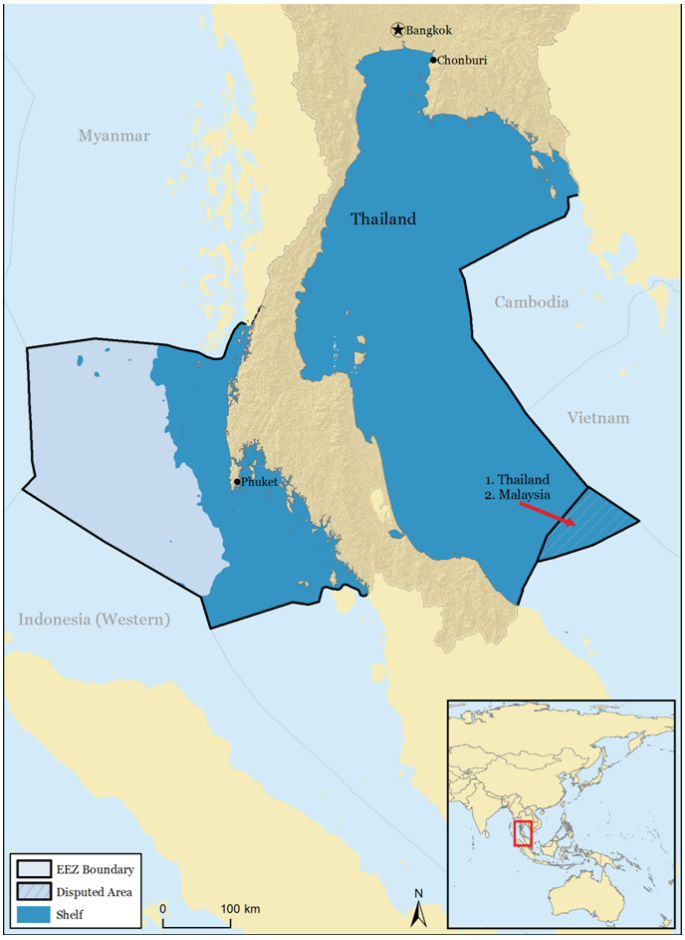

Figure 1. Thailand Exclusive Economic Zone (EEZ) and shelf waters of < 200 m.

countries' waters (DoF 1979). Reduction in catches continued, however, with the declaration of EEZs by neighboring countries beginning in 1977, and with prevailing shortage of fuel that escalated the cost of fishing (Panayotou and Jetanavanich 1987). For these reasons, some trawlers returned to fish in the Thai EEZ, causing further declines in catches and intensifying conflicts with domestic small-scale fisheries. Several trawlers, however, entered into agreements (such as fishing concessions and joint ventures) with neighbouring countries, while some unofficial arrangements, as well as illegal fishing without any arrangements, also took place (Butcher 1999).

Historical development

Fisheries in Thailand had historically been undertaken on a small scale, using bamboo stake traps and gillnet. The use of sail and non-powered boat began around 1917, with the use of gillnet and squid cast net (Butcher 1996, 2004). Engines were introduced to the fisheries in the 1930s, and by 1953 the number of boats with engine had risen to 430. Still more than 80% of boats were small-scale and non-powered. This proportion of small-scale fishing boats in the fisheries remained until 1985, when the total number of boats increased to 53,427 (DoF 1987). The development of commercial fisheries in Thailand has been at the peril of traditional, small-scale fishing sector, despite the fact that about 90% of the 47,620 fishing households are small-scale.

Pimoljinda (2002) characterizes small-scale fisheries as fishing using non-powered, outboard-powered and inboard-powered boats of less than 10 gross tonnage with gillnets, traps, set bag nets, push nets, lift nets, hooks and lines. Small-scale fisheries generally refer to fishing that involves family members, operating within 3-5 km from shore. Same as elsewhere around the world, the social, cultural and economic importance of small-scale fisheries and their contributions to food security and poverty alleviation are undermined and the sector has been marginalized (Pauly 2006; Chuenpagdee 2011). While some small-scale fishing methods can be very destructive, such as those involving the use of dynamite and cyanide, and are capable of destroying the resource base (Butcher 2004), the small-scale fisheries sector has overall been at a disadvantage, compared to its large-scale counterpart, with respect to financial support and policy attention from governments. Fisheries policies formulated to promote economic growth and development in fisheries, while contributing to increased income to fishing households, may result in displacing the small-scale fishing sector. The rising cost of fishing operations (due largely to high fuel prices) affect small-scale fisheries more so than large-scale sector since the former has little or no assets to fall back on (Chuenpagdee and Juntarashote 2004).

The consequences of the rapid development and modernization of commercial fisheries have been resource depletion and overfishing (Pauly 1979; Pimoljinda 2002) , as well as functional change in trophic functioning of the ecosystem, as demonstrated by Christensen (1998), and Pauly and Chuenpagdee (2003). Since the early 1970s, the degraded status of fisheries resources of Thailand, especially demersal species, was acutely noted as catches sharply declined, prompting the government to develop regulations to ban commercial trawling from within 3 km from shore. Yet, weak enforcement enables violations to occur, resulting in on-going destruction of nursery grounds, as well as conflicts with small-scale fisheries (Pimoljinda 2002). This is despite the establishment of a Fisheries Patrolling Section within the Thai Department of Fisheries (DoF), equipped with patrol boats to perform monitoring, control and surveillance (MCS) activities and suppress illegal fishing along the coasts.

Fisheries data collection

Information and statistics about Thai fisheries such as catches and values by main species are compiled and reported by DoF. Statistical records have improved with systematic data collection set up in 1998, which involves annual log book survey of commercial fisheries and community survey of small-scale fisheries. The Information Technology Center within the DoF is responsible for data collection and estimation of catches from both sectors. They maintain the databases and submit reports to FAO. This data collection system makes it possible to estimate small-scale fisheries catches and differentiate them from the total. Data from logbook surveys are combined with the small-scale fisheries catches (estimated based on the fisheries community surveys) and sent to FAO as the official catch record by the DoF. No disparity was found between these data sets, except for certain fish categories, i.e., tunas (except albacore) and swordfish. Based on the discussion with the experts, catches of these species are reported to FAO by the Foreign Fishing Division of the DoF, not the Information Technology Center. No information is available from the Foreign Fishing Division with respect to these data, thus no correction is made to the reported estimates. Information is available, however, quantitatively and qualitatively, to differentiate catches within and outside the Thai EEZ.

Table 1. Reported landings from fishing grounds within and outside the Thai EEZ. SourceThai DoF logbook surveys.

	Catches (t x 10^3)					
	Gulf of Thailand (GoT)			Indian Ocean (IO)		
Year	Thai EEZ	Outside Thai EEZ	Total (GoT)	Thai EEZ	Outside Thai EEZ	Total (IO)
1998	968	570	1538	306	560	865
1999	949	717	1665	333	407	740
2000	949	755	1705	369	314	683
2001	981	704	1685	411	283	695
2002	967	746	1714	421	312	733
2003	1007	712	1719	372	333	704
2004	978	704	1683	359	442	802
2005	975	692	1668	339	421	759
2006	868	587	1454	294	404	698
2007	784	541	1325	255	331	586
2008	789	72	861	262	203	464
2009	816	69	886	286	203	488

Fishing grounds where Thai commercial fisheries take place are divided into seven zones within the Thai EEZ and five zones outside the EEZ. EEZ Zones 1-5 are in the Gulf of Thailand, while 6-7 are in the Andaman Sea. On the Gulf of Thailand side, catches from non-EEZ Zone A include fishing in Cambodia and Vietnam waters, while those from Zone B involves fishing in Malaysia and Indonesia. On the Indian Ocean side, non-EEZ Zone C includes Malaysia and Indonesia, Zone D is Burma and Zone E includes fishing grounds in Indian and Bangladeshi waters. According to the logbook surveys from 1998 to 2007 (Table 1), about 58% of catches on average come from the Gulf of Thailand side (including Zones A and B, or the Western Central Pacific FAO region). Within this region, about 64% are from within the Thai EEZ, while the rest of the catches are reported to come from fishing grounds in Cambodia, Vietnam, Malaysia and Indonesia. In 2008-2009, however, less than 10% of the catches originated from outside the Thai EEZ. In the Indian Ocean, catches within Thai waters and outside, on average, are split more evenly. The general trend for both coasts is the declining amount of catches from outside Thai waters (Table 1), due largely to the repatriation of otter board trawls in the over 19 m categories back to the Gulf of Thailand (Appendix 1).

The analysis of the logbook survey data on catches by gears shows that catches from otter board trawling and purse seining dominate fisheries in the Gulf of Thailand and the Indian Ocean coast of Thailand (Appendix 1). In earlier years, small catches from otter trawls smaller than 14 m originated from outside Thai waters, but since 2002, all catches on both coasts come from within Thai EEZ. From 1998 to 2007, otter trawls larger than 25 m operated exclusively outside of the Thai EEZ. In 2008 and 2009, however, catches from this gear category were reported as coming from the Gulf of Thailand, whereas those in the Indian Ocean still show that these trawlers operate outside the Thai EEZ. .

IUU fisheries

Thai fisheries are managed under several acts and decree, most of which aim to regulate fishing activities, mostly through gear, area and seasonal restrictions. Vessel and gear registrations and licensing programs are also in place. For instance, licenses for fishing, gears and leased areas are issued on annual basis with fees specified in the Fisheries Act. The Thai Vessel Act, enacted in 1938, stipulates that boat owners of powered vessels or those of 6 GT and beyond must register their vessels with the Harbor Department. Collaboration between this department and the DoF is necessary because gear licenses are controlled by the latter. One of the issues with the current vessel and gear registration and licensing systems, which contribute to problem caused by Illegal, Unreported and Unregulated (IUU) fishing, is the use of non-licensed fishing gears in registered vessels. In particular, since no new licenses are issued for trawlers, as part of the effort to control this fishing activity, some vessels apply for gillnet licenses, when in reality they operate trawls.

Concerns about IUU fishing are addressed through various initiatives. For instance, in 2009, a logbook information system was implemented to enable vessel operators to export their catches to European Union countries (EU). Of the 20,000 registered vessels with licenses (out of the total 54,000), 18% export their catches to the EU, which mean that their operators must strictly follow EU guidelines and regulations. Vessels that are not part of this system are encouraged to join, also as part of the regional cooperation in addressing IUU fishing issues in the Gulf of Thailand and Andaman Sea sub-region. Developing a common definition of what constitute IUU fishing for the region was the important first step. The agreed upon definitions, according to Torell (2012), are: (1) fishing conducted by national or foreign vessels in waters under the jurisdiction of a state, without the permission of that state, or in contravention of its laws and regulations; (2) fishing that is in violation of national laws or relevant international obligations; (3) fishing which has not been reported, or is misreported, to the relevant national authority; and (4) fishing in areas or for fish stocks where there are no applicable conservation or management measures and where such fishing activities are conducted in manner inconsistent with State responsibilities for the conservation of living marine resources under international law. A detailed account of these aspects of the IUU fisheries, according to the above definition, is provided by Butcher (1999), who referred to a report by the Foreign Ministry of Thailand in 1996, which estimated that only 28% of the total 3,889 Thai fishing vessels operating in other countries' waters were doing so legally. He further cited a report (May 1996) by *Bangkok Post*, one of the nation's English daily newspapers, stating that at least 2,400 fishing boats and 24,000 crew members had been captured in the waters claimed by neighbouring countries since 1982.

Methods

Reported landings

Data used to reconstruct total marine fisheries catches came largely from national reports, independent studies, grey literature and local experts. Landings data reported by the FAO were checked against the annual national reports compiled by the DoF, which dated back to 1957. From 1998 onward, data from logbook survey, fishing community survey and marine fisheries census were used to improve the estimates. Small-scale fishing community surveys are conducted by DoF on an annual basis, covering 22 coastal provinces and including data about quantity and values of catches by gear and species. Two-stage stratified random sampling is used to select villages and households for the survey. For this report, in addition to the estimates provided through the fishing community surveys (2005-2008), we also reported small-scale fisheries catches as the difference between logbook data and reported catches to FAO (1998-2008), based on the explanation by the Information Technology Center. These two sources of data are used to calculate the average percentage of small-scale fisheries in the total catches, and applied to estimate small-scale fisheries catches in earlier years.

Data from the logbook surveys, conducted annually by the DoF's Information Technology Center are available for 1998 to 2008. The survey records catches and effort by gear, key species and fishing grounds (within and outside the Thai EEZ). Stratified random sampling is employed to survey 10% of the fishing units in 22 coastal provinces using the nine main large-scale fishing gears, i.e., otter board trawl, pair trawl, beam trawl, purse seine, anchovy purse seine, king mackerel drift gill net, Indo-Pacific mackerel encircling gill net, push net and bamboo stake trap. Records of otter board trawls and pair trawls are further disaggregated based on gear size (four categories of smaller than 14 m, 14-18 m, 18-25 m and larger than 25 m for the former, and three categories of smaller than 14 m, 14-18 m, and larger than 18 m for the latter). These data sets are used in our study to estimate catches taken place outside of Thailand's EEZ by applying the average catches from 1998 to 2008 to those in other years. Note that trawlers smaller than 14 m and push nets are considered commercial fishing gears because of the high level of catches, some of which are destined for export markets.[1]

In addition, we draw heavily on two key publications (in Thai) for both reported and anecdotal information to account for IUU fisheries and those taken place outside of the Thai EEZ. These are the "Future of the Thai Fisheries" report of a joint seminar by the public and private sectors, which was held in Bangkok on 4-6 June 1987, organized by the Southeast Asian Fisheries Development Center (SEAFDEC), and the recently released report, "Five Decades of Trawl Fisheries of Thailand" (Boonvanich and Boonpakdee 2012), published by the Marine Fisheries Research and Development Bureau, Department of Fisheries, which provides a detailed account of historical development of trawling in Thailand and the current situation. These reports, as well as other documents, serve as a basis for estimates and discussion about commercial fisheries, IUU catches and discards. Finally, we conducted informal discussion with key DoF officials and experts knowledgeable about various aspects of the Thai fisheries, particularly about the Catch Certification Coordination Centre, established in 2011 to help increase compliance and address IUU fisheries issues. Information from this informal discussion is presented as supplementary data for the IUU section of the report.

Unreported catch

Industrial demersal fisheries

For years not included in the logbook surveys, other information sources are used to determine proportions of catches by fishing grounds. For instance, Boonvanich and Boonpakdee (2012) noted that, in 1972, at least 500 Thai vessels fished outside the 12 nautical mile limit and also in the water of neighboring countries, such as Vietnam and Cambodia, and to a lesser extent, Malaysia, Indonesia, Burma, Bangladesh and India. According to Phasuk (1987), trawling outside of the Thai waters began in 1968. Phasuk (1987) also estimated that from 1971 to 1985, about 64% of demersal fish were caught in the Gulf of Thailand and 16% in the Andaman Sea, while the other 20% were from outside of the Thai EEZ. This observation was based on the unusually high catch rate from otter board trawl of larger than 25 m in 1984, while fisheries resources in the Gulf of Thailand were known to decline. According to the logbook data, this proportion is the same as the average percentage of demersal catches outside of Thai waters during the period between 1998 and 2008. Thus, we use 20% to adjust for catches of demersal fisheries starting from 1965, the year we begin accounting for commercial trawling in this reconstruction.

Other IUU fisheries

We start accounting for IUU fisheries in 1968, the year trawling expanded outside Thai waters (Phasuk 1987), by adding on the portion of catch taken by Thai fishing vessels that operate illegally outside the Thai EEZ and whose catches are not reported to DoF. We established two anchor points – due to lack of data we assumed that the magnitude of IUU fisheries in 1968 was at least equivalent to that of demersal catches from outside Thai waters. Thus, we set the first anchor point in 1968 as 20% (Phasuk 1987), i.e., we assumed that the reported catches in 1968 of 966,400 tonnes represented only 80% of actual (reconstructed) catches. We linearly increased 20% to the second anchor point of 70% in 1996. This value was based on Butcher's (1999) estimate that only 28% of Thai fishing vessels operating in other countries at that time were legal (i.e., more than 70% operated illegally). Subsequently, 70% was maintained from 1996-2010. A portion of catch from Thai vessels that fish illegally outside the Thai EEZ may already be accounted for in the 'industrial demersal fisheries' catch. Therefore, from 1968-2010 we subtracted demersal fisheries catch from IUU fisheries catch to avoid double counting.

Low value fish and discards

Thailand has a long tradition of fish consumption and utilization in various forms, including using certain types of fish, especially those with low values, as raw materials in the production of fish sauce (for human consumption) and fish meal, notably for aquaculture and poultry farming (Pauly 1996). In a study by Kaewnern and Wangvoralak (2004) for FAO, low value fish in Thailand constituted 765 t, or about 31% of total catches in 1999, 95% of which came from trawling (especially otter board trawls and push net). They also suggested that the price of low value fish would likely increase given the high demand from the fish meal industry. Some fish meal is even imported to support the animal feed industry, especially chicken farming.

As such, discards are low or negligible in both small-scale fisheries and in the commercial sector (Funge-Smith *et al.* 2005), and were estimated to account for only about 1% of total marine catches (Kelleher 2005). FAO (2004)

[1] Another reason is that Sea Around Us, following Martín (2012), generally considers all mobile gear as industrial, even when pulled by relatively small vessels.

reported, however, that discards from shrimp fisheries and demersal trawl fisheries were rather high, accounting for 50% of total discards, representing about 22% of total landings. On the other hand, a report to the FAO by Kungsawan (1996) stated that little discarding occurs in the Thai shrimp industry. To reconcile the two contrasting findings, we assumed that discards initially accounted for 22% of reported catch when trawling started in the mid-1960s, but the emergence of alternative uses and markets for fish discards reduced discards to comprise only 1% of total catches by 2000.

Small-scale fisheries

Since 1957, DoF reported fisheries catches by key species groups but not by gears. Landings were limited and came almost entirely from the small-scale sector. In 1974, separation of catches by gears began, but estimates of small-scale fisheries catches are still difficult to obtain and community fishing survey data from the DoF are available only from 1998-2008. Based on these data, small-scale fisheries catches can range between 6-24% of the total catches, with an average of about 13% (Table 2).

Table 2. Estimated small-scale sector (SS) component of total reported marine catches 1998-2008.

Year	Total catches ($t*10^3$) (FAO)	Industrial catches ($t*10^3$) (logbook)	SS catches ($t*10^3$) (estimate)	% SS (estimate)
1998	2730	2403	326	13.6
1999	2746	2405	341	14.2
2000	2796	2388	408	17.1
2001	2632	2379	252	10.6
2002	2644	2447	197	8.1
2003	2651	2424	228	9.4
2004	2636	2484	152	6.1
2005	2616	2427	188	7.8
2006	2485	2152	333	15.5
2007	2079	1911	169	8.8
2008	1645	1326	319	24.1

For the earlier years prior to the establishment of the database system, we have two estimates that can be used to adjust the catches. Phasuk (1987) used statistics from the DoF to suggest that about 8.3% of the total fisheries catches within the Gulf of Thailand came from small-scale fisheries sector. Juntarashote and Chuenpagdee (1987), on the other hand, estimated small-scale fisheries catches using data from the Marine Fisheries Census conducted in 1967 and 1985. Using number of hired labor in the existing fisheries establishments as a criterion to estimate the catches of small-scale fisheries, they concluded that about 83% of the fisheries establishments in 1985 were small-scale. This proportion, they estimated, should provide 25.7% of catches. Based on this, we added 17.4% to the reported total catch of 2 million t in 1985, or about 348,000 t, making the new total of 2.3 million t. Given that this percentage fits within the range indicated in Table (2), it is reasonable to apply it to all the years prior to 1998 to account for small-scale fisheries catches that were likely to be high prior to the advancement of gear and technology and also were likely to be mostly left out of the national statistics.

Adjustment after 1998

Small-scale catches from 1998-2010 were estimated based on published reports and case studies, from which we derived a percentage of total reported catch to account for catches from the small-scale sector. Anchor points in 2002 and 2005 were established as follows: for 2005, we calculated total fishing effort as the product of average annual fishing effort ($kg \cdot fisher^{-1}$) and number of fishers. A case study of small-scale fisheries in the Gulf of Thailand provided data on catch per effort of small-scale gears including fish gillnets, crab traps, hook and line, and trammel nets (Lunn and Dearden 2006), as well as the number of fishing days per month. We used these data to calculate an average small-scale catch of 3 $t \cdot fisher^{-1} \cdot year^{-1}$ in 2002, under the assumption that fishers engage in 9.5 months of fishing per year. Annual catch was then multiplied by 94,229, the number of small-scale fishers in the peak season in 2004 (Lymer *et al.* 2010), the closest year with available data. The result was 281,165 tonnes of fish catch from the small-scale sector, which was equivalent to 11% of the total reported marine fish catch in 2002. Panjarat (2008) reported that in the mid-2000s (i.e., 2005), small-scale fisheries catches made up about 16.5% of total marine fisheries catches. For the years from 1998-2002, we added 11% of total reported catch to account for small-scale sector catches, then linearly increased this percentage to the 2005 rate of 16.5%. Thereafter we maintained the 2005 rate until 2010.

Adjustment for fish consumption

To ensure that adjusted catches were not under-estimating contribution from the small-scale sector, we computed *per capita* fish consumption to verify that small-scale production was sufficient to meet human consumption needs. Adjusted small-scale sector catch was divided by coastal population from 1950-2010 (Figure 2). Coastal population was defined as the number of people living within 100 km of the coast, and the dataset was sourced from NASA Socioeconomic Data and Applications Center (McGranahan *et al.* 2007). The results suggested that small-scale catches were under-estimated from 1950 to 1970. This is due to two reasons: Firstly,

Figure 2. Thailand's coastal population per capita consumption of fish (from reported small-scale catches, see text).

estimated coastal fish consumption increased rapidly in the mid-1960s coinciding with the emergence of industrial fishing. This is contrary to expectation, as large-scale trawlers negatively impacted small-scale catches through competition for fish and destruction of gear. At the same time, the coastal population was increasing and suggested greater pressure on small-scale fisheries which would further strain the resource base. Secondly, trade in fisheries products was already thriving at the turn of the twentieth century and there was active exchange of items such as dried fish and dried shrimp paste between Thailand, the Malay Peninsula and western Indonesia (Butcher 1996). As such, the small-scale sector was producing enough fish to satisfy coastal human consumption needs as well as external markets. We therefore assumed that coastal fish consumption rate in the 1950s and 1960s was at least equivalent to that when the industrial sector started. In 1970, when industrial fishing effort was strong, coastal fish consumption was approximately 53 kg·person^{-1}·year^{-1}; we thus applied a fish consumption rate of 50 kg·person^{-1}·year^{-1} from 1950-1969, then reverted to the unadjusted fish consumption rates from 1970-2010. Subsequently, small-scale sector fish catches from 1950-1969 were increased by the difference between 50 kg and the unadjusted consumption rate (as shown on Figure 2), multiplied by the coastal population.

Marine recreational fishing

Marine recreational fishing in Thailand occurs both along the Andaman Sea and in the Gulf of Thailand. Sport fishing operators are concentrated in the Phuket area, where the industry has been growing since at least the 1980s. Fishers on single-day guided tours typically fish in the coastal waters of nearby islands, while multi-day trips take fishers, predominantly foreigners, in search of game fish in deeper waters of the Andaman Sea. Big game fishing trips often yield catches of large fish such as marlins (Istiophoridae), tunas (Scombridae), dolphinfish (*Coryphaena hippurus*), and giant trevally (*Caranx ignobilis*), while fishers in coastal waters tend to catch demersal fishes and pelagics including rainbow runners (*Elagatis bipinnulata*), queenfish (Carangidae), king mackerel (*Scomberomorus cavalla*), barracudas (Sphyraenidae), and skipjack tuna (*Katsuwonus pelamis*). To our knowledge, no records of recreational fishing in Thailand are kept.

We estimated recreational fish catch by multiplying the number of recreational fishers by a typical catch rate. Due to differences between catches from big game and coastal fishing, we assumed there were two types of recreational fishers: i) coastal fishers, including paying tourists and Thais who participate for leisure; and ii) big game fishers, mainly tourists who pay for guided trips.

Coastal recreational fishing (Thais) – We started accounting for local coastal recreational catches in 1980, but recognise that domestic marine recreational fishing may not be very prominent in Thailand. A global study of marine recreation estimated a recreational fishing participation rate[2] of 18.2% in Asia (Cisneros-Montemayor and Sumaila 2010). However, it appears that a large portion of recreational fishers in Thailand tend to be tourists;[3] therefore, we halved the national participation rate to 9.1%. Further, we assumed that local recreational fishers lived by the coast and were not mired in poverty, based on the rationale that people who live under the poverty level fish for subsistence, and not for recreation. Coastal population was here also defined as population living within 100 km of the sea. We obtained data on the percentage of Thailand's population that lived under poverty (UNCTAD 2012), and assumed that this percentage was representative of the coastal population. Local recreation catch in a given year *n* from 1980-2010 was calculated as:

$$C_{local_n} = (P_{coastal} - P_{poverty})_n * T * Ct$$

Where C_{local} is local recreational catch; $P_{coastal}$ is number of people living by the coast; $P_{poverty}$ is number of people living under the poverty level; T is participation rate; and Ct is average recreational catch (kg·fisher^{-1}·year^{-1}).

The adjusted Asian participation rate of 9.1% was applied to Thailand's coastal population not living in poverty in 2010, resulting in 2,135,437 potential recreational fishers. To estimate the number of recreational fishers prior to 2010, we assumed that this number tracked the change in Thailand's annual average GDP. This assumption is reasonable, as recreational fishing is a leisure activity, hence participation can be expected to fluctuate according to the state of the economy. *Per capita* annual average GDP growth rate from 1970-2010 was obtained from the United Nations Conference on Trade and Development database (UNCTAD 2012). Due to a lack of Thailand-specific data, we used the recreational catch rate from a reconstruction of Malaysia's marine recreation sector (7 kg·fisher^{-1}·year^{-1}; Louise Teh and Lydia Teh, unpublished data), a country which shares similar fisheries characteristics with Thailand, and kept this rate constant from 1980-2010.

Coastal recreational fishing (tourists) – We started accounting for tourist recreational catches in 1990, the start of the decade when tourism rapidly expanded in Thailand (Kontogeorgopoulos 1998). Tourist recreational catch was added to the local component to compute total coastal recreational catch. The portion of recreational catch from tourists was estimated by multiplying the number of coastal tourist fishers by a tourist recreational catch rate. Coastal fishing trips are single day events and the number of participants varies according to boat size, with some chartered boats able to carry a maximum of 4 clients while others can carry 8 to 15.

We conservatively assumed 4 clients per coastal fishing boat trip, based on written reports and photographs of such trips posted on the Internet. Reports by participants also indicated there was competition among recreational fishing boats to see who had the largest catch when the boats returned to port, which suggested that on any one day a fair number of the operators had their boats out at sea. We assumed that in 2007, there were at least as many

[2] Participation rate as defined in Cisneros-Montemayor and Sumaila (2010) is the number of anglers in a country as a percentage of that country's population

[3] http://phuket.thaivisa.com/fishing-in-phuket/

coastal fishing operators in Thailand as there were big game fishing operators, although it is likely that there are a higher numbers of the former (the number of big game fishing operators is documented below). We further assumed that coastal fishing operators ran 5 fishing trips per trip week during the peak months of November to March, and the number of fishing trips dropped by 50% during the non-peak months. In total, 21,120 coastal fishing trips were taken by tourists in Thailand in 2007, with an average of 4 tourists per trip.

Using the number of coastal tourist fishers in 2007 as an anchor point, we then assumed that the arrival of this population mirrored the trend of tourist arrivals in Phuket from 1990-2010. We obtained data on tourist arrivals for the periods 1989-2005[4] and 2008-2010;[5] linear interpolation was used to fill gap years.

Catches were highly variable, ranging from no fish to 40 tunas,[6] which we identified as small to mid-sized kawakawa (*Euthynnus affinis*), caught by 7 participants on one trip. Based on their size, we estimated this particular catch to be in the range of 20 – 30 kg. Due to lack of further data, we arbitrarily set a conservative catch rate of 3 kg·fisher^{-1}·trip^{-1} for tourist recreational fishers, and maintained this catch rate from 1990-2010.

Big game fishing – Although Thais undoubtedly engage in big game fishing, we made the conservative assumption that participation in this activity was by foreign tourists only. This was based on the general impression from exploring the websites of several big game fishing operators in Thailand,[7] where pictured clients are predominantly non-Thai. The majority of big game fishing charters are based in Phuket, with fishing destinations in the Andaman Sea, while the Gulf of Thailand appears to be less popular.

Based on trip reports in 2007/2008 of a sport fishing operator,[8] we estimated that on average 3 multi-day big game fishing trips per operator are taken during the high fishing season from November to March, with each trip having an average of 2.67 clients. We assumed that client numbers dropped to 50% of the high season level during the off peak season. The total number of big game fishing operators in 2007 on the Andaman coast was estimated to be 14, based on an internet search of companies that offer the services in the Phuket area. However, anecdotal evidence suggested this number may be as high as 30;[9] we thus used an average of 22 big game fishing operators on the Andaman Coast. We assumed that there were half as many big game fishing operators on the Gulf of Thailand coast, such that the total number of big game fishing operators in Thailand was conservatively estimated to be 33. In total, these operators guided 2,115 big game fishers in 2007. We assumed that the number of big game fishers in Thailand from 1990-2010 matched the change in tourist arrivals to Phuket, as described above.

The average big game catch per client was estimated through photographs of game fish posted on the internet and anecdotal reports. Trip reports from a sport fishing operator[10] provided quantitative and qualitative descriptions of clients' catches, from which we approximated catch composition. Photographs of clients' catches further allowed us to estimate the weight of game fishes from their size. Based on 3 trip reports, we set the average catch per big game fisher to 60 kg·fisher^{-1}·trip^{-1}, and maintained this catch rate from 1990-2010. We assumed this catch to be retained, with no catch-and-release occurring.

Species composition

Species compositions of unreported industrial and small-scale catches were assumed to resemble that of reported landings. At 44%, the category 'marine fishes nei' comprised the largest category of total reported landings from 1950-2010. This category captured all low value fish, likely including juveniles of commercially important species and/or very low valued small sized fish. To create a more detailed species profile of 'marine fishes nei', we used data from sampling surveys which provided the composition of so-called 'trash' fish and low-value fish caught in the Gulf of Thailand in 1966 and 1999 (APFIC 2007). The data lists were sorted and the top 10 species that together accounted for at least 60% of total composition were selected to represent 'marine fishes nei' (Table 3). This same composition was applied to the taxonomic breakdown of fish discards.

Table 3. Major species of so-called 'trash' and low value fish caught in the Gulf of Thailand in 1966 and 1999.

Taxon	Percentage of total catch	
	1966‡	1999‡
Nemipteridae	30.6	26.8
Synodontidae	15.7	14.2
Leiognathidae	13.6	20.2
Cynoglossidae	10.9	10.0
Platycephalidae	10.8	10.0
Sciaenidae	9.5	8.9
Carangidae	8.9	10.0

‡ Base data sourced from APFIC (2007). Species composition values are scaled up to 100%.

Catches from the recreational fishing sector were allocated to two composition groups–big game fishing and coastal fishing. Big game fishing catch composition was estimated based on trip reports as described under 'Recreational fishing'. We assumed that coastal recreational fish catches comprised the groups 'Scombridae', 'demersal fishes', 'Carangidae', and 'Sphyraenidae', whereby 'demersal fishes' included Serranidae, Lutjanidae, Holocentridae, Lethrinidae and Dasyatidae. To determine catch weights, we started by allocating equal weighting to each of the four groups. Due to the frequency by which tunas and mackerels were pictured and reportedly caught on day fishing trips in the Phuket area[2], we doubled the weighting of 'Scombridae'. We also doubled the weighting of 'demersal fishes' as these fishes were likely more common within coastal waters (Table 4).

[4] 1989-2005 tourist arrivals to Phuket as reported in http://www.phuketland.com/phuket_links/touristinfo.htm

[5] As reported in http://www.c9hotelworks.com/press-best-year-ever-for-phuket-tourism-arrivals.htm

[6] As reported by a participant on a single day Phuket fishing trip, see http://www.tripadvisor.com/ShowUserReviews-g1389361-d1873466-r126026076-Phuket_Fishing_Charters-Chalong_Phuket.html#REVIEWS

[7] Example of deep sea fishing operator websites: Andaman Fishing Adventures http://www.andaman-fishing-adventures.com/ ; Phuket Fishing Charters http://www.phuketfishingcharters.com/about-us.php; Siam Lady Yachting http://www.samui-yacht-boat.com/sportfishing.php.

[8] www.fishing-khaolak.com/reports/index.html

[9] http://megafishingthailand.com/guided-fishing-in-thailand/deep-sea-fishing-gulf-of-thailand-koh-chang-koh-kut/

[10] www.fishing-khaolak.com/reports/index.html

Sector breakdown

Reported marine fish catches were allocated to either the industrial or small-scale sector. All catches from 1950 to 1961, the year otter trawls were introduced in Thailand (Butcher 1999), were considered to be small-scale. In 1966, trawl catches reportedly made up about 57% of reported landings (Butcher 1999). Thus, starting from 0% in 1961, we linearly increased the industrial portion of reported marine landings to 57% in 1966, with the difference being allocated to the small-scale sector. From this anchor point, we used linear interpolation to fill in data gaps until reaching 88% in 1998, the year data distinguishing reported landings between the industrial and small-scale sectors became available.

Table 4. Marine recreational catch composition.

Big game fishing Family	%	Coastal fishing Family	%
Scombridae	48	Scombridae	33
Istiophoridae	43	Demersals‡	33
Coryphaenidae	5	Carangidae	17
Carangidae	3	Sphyraenidae	17
Sphyraenidae	2	—	—

‡ Demersals include Serranidae, Lutjanidae, Holocentridae, Lethrinidae and Dasyatidae.

Within the small-scale sector, we differentiated catches from subsistence and artisanal fishers. Subsistence fishers catch fish primarily for their own or family-consumption (or some local barter), while artisanal fishers catch fish with the primary intention of selling all or the majority of the catch. The proportion of artisanal fishers was based on a series of fisheries inventory surveys in the late 1960s and 1970s (Panayotou and Jetanavanich 1987). The earliest data point was from 1967, when 'subsistence' fishing households made up about 70% of total fishing households (Panayotou and Jetanavanich 1987). It should be noted that 'subsistence' was defined as fishing households with 2 or fewer 'employees', as opposed to 'enterprise' households that had 3 or more employees. We assumed that this distinction was made to reflect the economic status of fishing households, whereby those with fewer employees were possibly deemed to be poorer and more likely to be operating at a subsistence level. We maintained the 1967 proportion of subsistence fishers in all years from 1950 to 1967. Further data points from the same source were available for the years 1969, 1970, 1973 and 1976- these were 70%, 74%, 67% and 63% respectively. Data gaps between these years were filled by linear interpolation. We were unable to locate further breakdowns on the subsistence fishing component. However, it is reasonable to assume that given the economic and infrastructure developments that occurred throughout Southeast Asia in the past 20-30 years, the majority of fishers today participate in the market economy, hence can be considered to be artisanal. A catch reconstruction of Malaysia's marine fisheries found a 20% subsistence component in the small-scale sector in 2008 (Louise Teh and Lydia Teh, unpublished data). In the absence of other data, we applied this rate to Thailand for 2008 and held it constant through to 2010, and filled in data gaps using linear interpolation from the 1976 anchor point of 63%.

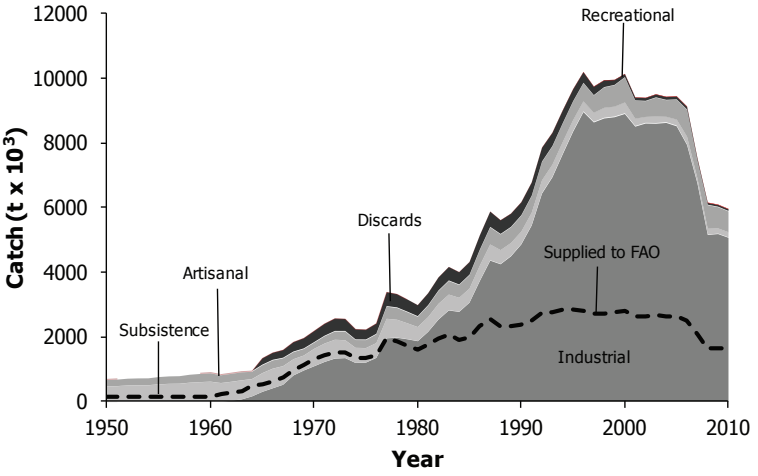

Figure 3. Reconstructed catches (within and outside of the Thai EEZ) showing contribution of different sectors.

Results

Thailand's reconstructed catch totalled 266 million t from 1950-2010. This estimate was 2.8 times that of total marine landings of 95 million t that were reported to FAO in the same period. The industrial sector made up 83% of total reconstructed catch, of which 5% were discards, while the small-scale sectors (artisanal and subsistence) comprised 17% and marine recreational catch totalled less than 1% (Figure 3). Unreported catches totalled just over 170 million t, of which the industrial, artisanal, and subsistence IUU sectors contributed 133, 12 and 11 million t respectively. Furthermore, discards accounted for 13 million t of unreported catches, while another 0.3 million t came from the recreational fishing sector. The interval with greatest disparity between reported and unreported catches was during 1950-1970, during which total reconstructed catches reached almost 3 times that of reported catches in some years.

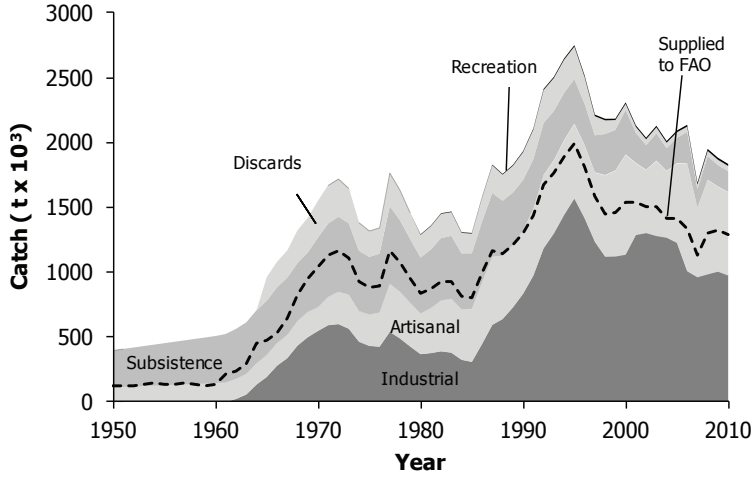

Figure 4. Reconstructed catches (within the Thai EEZ) showing contribution of different sectors.

Reported marine landings totalling 65 million t came from the Thai EEZ, while reported landings from outside Thailand's EEZ amounted to 30 million t in the period 1950-2010. Of reported marine landings from within the Thai EEZ, the industrial, artisanal, and subsistence sectors contributed 44, 10, and 11 million t respectively (Figure 4). Unreported catches within the Thai EEZ totalled 24 million t, while unreported industrial catches and discards from outside the Thai EEZ totalled 147 million t.

Catch composition evolved from a mix of near-shore demersal fishes, invertebrates, and pelagic species such as Indian mackerel in the 1950s, to being increasingly made up of demersals in the mid-1960s and early 1970s at the height of the trawling expansion (Figures 5-7). Demersals peaked in 1972 when they comprised over 70% of marine landings; thereafter, the proportion of pelagics and cephalopods increased while demersals declined. The proportion of crustaceans remained fairly consistent averaging around 7%, forming a small but valuable component of marine catches. Low-value fishes such as Nemipteridae, Leiognathidae, and Synodontidae contributed most to total catch composition from 1950-2010.

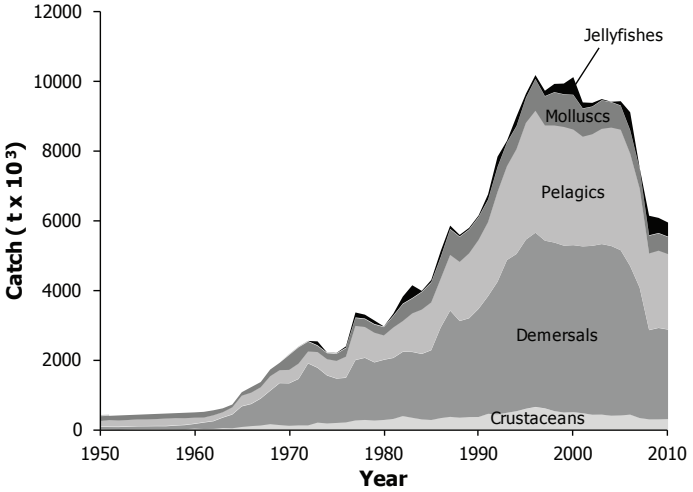

Figure 5. Reconstructed catches (within and outside of the Thai EEZ) broken down by major fish groups.

Discussion

Statistics on Thai fisheries have been compiled since the early 1950s. A major improvement in data collection and reporting occurred in 1998 with the creation of the Information Technology Center within the Department of Fisheries, which brought about the introduction of logbook systems and the annual fishing community surveys for small-scale fisheries. The logbook survey, in particular, includes information about fishing grounds, making it possible to differentiate catches from within and outside Thai waters. Given the interest of Thai fishing fleets, particularly trawlers, for operating in neighbouring and other countries' waters, either with or without formal agreements, it is important to estimate the amount of IUU catches from outside the Thai EEZ. As it turns out, 81% of total unreported catches from this reconstruction originated from the industrial sector. The most frequently fished EEZs are those of Indonesia and Myanmar (Lymer *et al.* 2010). In 2006, between 1,000 and 2,000 Thai boats were estimated to operate in Indonesian fishing grounds in the South China Sea and Arafura Sea, most of whose catches were not reported to the DoF because they fished under private sector agreements. In contrast, only 349 Thai fishing vessels with agreements to fish in the Indonesian EEZ were officially known to DoF (Lymer *et al.* 2010). As such, the 2.7 factor of unreported to reported industrial catch estimated in this reconstruction is not unduly high and may even err on the conservative side.

In the case of small-scale fisheries, the report by Juntarashote and Chuenpagdee (1987) provides reasonable estimates for adjusting catches from this sector, supplementing those reported in the fishing community surveys. These estimates were, however, conservative, as in both cases (i.e., logbooks and community surveys), they resulted from sampling surveys (not a total population) and were not raised to total population. We addressed this by conducting the coastal fish consumption analysis, which assessed whether small-scale catches were sufficient to meet human nutrition needs.

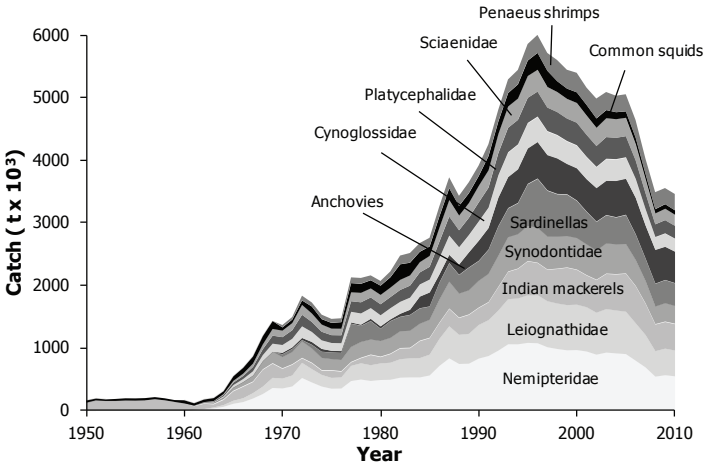

Figure 6. Top species that comprise close to 60% of reconstructed marine catches within the Thai EEZ from 1950-2010 (within and outside of the Thai EEZ.

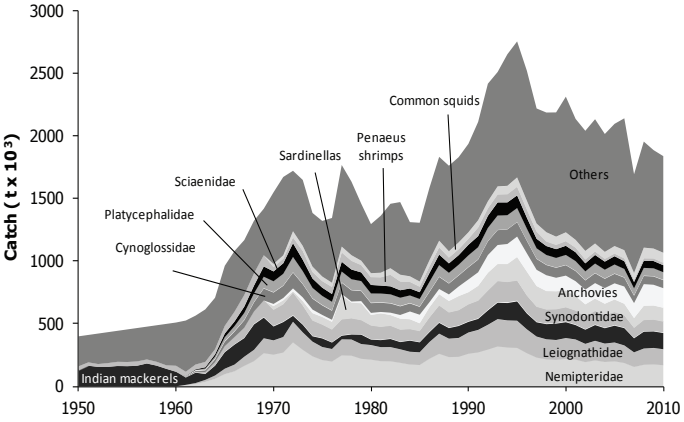

Figure 7. Top species that comprise close to 60% of reconstructed marine catches within the Thai EEZ from 1950-2010.

To our knowledge, this reconstruction presents the first estimate of marine recreational fish catches in Thailand. As recreational fishing is not regulated in Thailand, there was little data to guide our analysis and we had to rely on broad assumptions and popular media sources to generate a catch estimate. Consequently, marine recreational fish catch results should be viewed cautiously. Internet websites indicated that tourists made up a large proportion of recreational fishing in Thailand; however, our analysis suggested that tourists' catch amounted to only about 1% of total estimated recreational catch of 292,000 t from 1980-2010, in part because we only started accounting for tourist catch in 1990. The reconstruction also indicated that big game fishing in the Andaman Sea tends to favour pelagic species such as marlins and dolphin fish, which are not usually targeted by commercial fishing.

Efforts by the Catch Certification Coordination Centre are definitely a step in the right direction, but Thailand has a long way to go in combating IUU fishing. The revision of the 1947 Thai Fisheries Act is underway, along with the revised master plan for fisheries management, which together should help improve the overall management and governance system.

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Data pertaining to landings within and outside Thailand's EEZ and to small-scale fisheries were provided by Dr. Ratana Chuenpagdee, Memorial University, through collaboration with the Thai Department of Fisheries and key informants. This is a contribution of *Sea Around Us*, a scientific collaboration between the University of British Columbia and The Pew Charitable Trusts.

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Appendix Table A1. Catches by gear (%) from within (GoT and IO) and outside (AB and CDE) the Thai EEZ. Thai fishing vessels report catches from the Western Central Pacific (GoT and AB) and Indian Ocean (IO and CDE). Source - Thai DoF logbook surveys.

	OT < 14	OT 14-18	OT 19-25	OT > 25	PT < 14	PT 14-18	PT > 18	BT	PS	AN-PS	MK-DGN	MK-EGN	PuNET	BAMBOO	TOTAL CATCH ($t \times 10^3$)
1998															
%GoT	95	74	32	0	100	100	90	100	60	100	98	100	100	100	968
%AB	5	26	68	100	0	0	10	0	40	0	2	0	0	0	570
%IO	72	23	0	0	100	19	100	0	61	100	100	100	100	0	306
%CDE	28	77	100	100	0	81	0	0	39	0	0	0	0	0	560
1999															
%GoT	95	88	27	0	100	94	85	100	60	100	70	100	100	100	949
%AB	5	12	73	100	0	6	15	0	40	0	30	0	0	0	717
%IO	98	25	7	0	100	19	100	0	76	100	96	100	100	0	333
%CDE	2	75	93	100	0	81	0	0	24	0	4	0	0	0	407
2000															
%GoT	90	78	28	0	100	94	70	100	61	100	58	100	100	100	949
%AB	10	22	72	100	0	6	30	0	39	0	42	0	0	0	755
%IO	100	40	16	0	100	58	100	0	100	100	100	100	100	0	369
%CDE	0	60	84	100	0	42	0	0	0	0	0	0	0	0	314
2001															
%GoT	99	83	31	0	100	95	98	100	62	100	55	100	100	100	981
%AB	1	17	69	100	0	5	2	0	38	0	45	0	0	0	704
%IO	100	47	36	0	100	100	100	0	100	100	100	100	100	0	411
%CDE	0	53	64	100	0	0	0	0	0	0	0	0	0	0	283
2002															
%GoT	100	82	32	0	0	94	98	100	59	100	67	100	100	100	967
%AB	0	18	68	100	0	6	2	0	41	0	33	0	0	0	746
%IO	100	42	35	0	100	100	100	0	100	100	100	100	100	0	421
%CDE	0	58	65	100	0	0	0	0	0	0	0	0	0	0	312
2003															
%GoT	100	78	32	0	0	94	98	100	63	100	62	100	100	100	1007
%AB	0	22	68	100	0	6	2	0	37	0	38	0	0	0	712
%IO	100	44	29	0	100	100	100	0	100	100	98	100	100	0	372
%CDE	0	56	71	100	0	0	0	0	0	0	2	0	0	0	333
2004															
%GoT	100	75	30	0	0	94	97	100	61	100	82	100	100	100	978
%AB	0	25	70	100	0	6	3	0	39	0	18	0	0	0	704
%IO	100	33	22	0	100	100	55	0	100	100	100	100	100	0	359
%CDE	0	67	78	100	0	0	45	0	0	0	0	0	0	0	442
2005															
%GoT	100	73	30	0	0	100	100	100	61	100	100	100	100	100	975
%AB	0	27	70	100	0	0	0	0	39	0	0	0	0	0	692
%IO	100	23	22	0	0	100	76	0	100	100	100	100	100	0	339
%CDE	0	77	78	100	0	0	24	0	0	0	0	0	0	0	421
2006															
%GoT	100	76	35	0	0	100	100	100	60	100	91	100	100	100	868
%AB	0	24	65	100	0	0	0	0	40	0	9	0	0	0	587
%IO	100	23	17	0	0	100	65	0	100	100	100	100	100	0	294
%CDE	0	77	83	100	0	0	35	0	0	0	0	0	0	0	404
2007															
%GoT	100	80	33	0	0	100	100	100	60	100	100	100	100	100	784
%AB	0	20	67	100	0	0	0	0	40	0	0	0	0	0	541
%IO	100	34	15	0	0	100	70	0	96	100	100	0	100	0	255
%CDE	0	66	85	100	0	0	30	0	4	0	0	0	0	0	331
2008															
%GoT	100	89	64	100	0	100	100	100	95	100	100	100	100	100	789
%AB	0	11	36	0	0	0	0	0	5	0	0	0	0	0	72
%IO	100	56	28	0	0	100	67	0	90	100	100	0	100	0	262
%CDE	0	44	72	100	0	0	33	0	10	0	0	0	0	0	203
2009															
%GoT	100	89	70	100	0	100	100	100	94	100	100	100	100	100	816
%AB	0	11	30	0	0	0	0	0	6	0	0	0	0	0	69
%IO	100	59	34	4	0	100	70	0	82	100	100	100	100	0	286
%CDE	0	41	66	96	0	0	30	0	18	0	0	0	0	0	203

GoT = Thai water (Gulf of Thailand)
AB = Outside Thai EEZ (Western Central Pacific)
IO = Thai wter (Indian Ocean)
CDE = Outside Thai EEZ (Indian Ocean)

OT = Otter board trawl
PT = Pair trawl
BT = Beam trawl
PS = Purse seine

AN-PS = Anchovy purse seine
MK-DGN = Mackerel drift gill net
MK-EGN = Mackerel encircling gill net
Pu-NET = Push net

BAMBOO = Bamboo stake trap

Appendix Table A2. FAO landings vs. reconstructed total catch (in tonnes), and catch by sector with discards shown separately for Thailand, 1950-2010.

Year	FAO landings	Reconstructed total catch	Industrial	Artisanal	Subsistence	Recreational	Discard
1950	121,000	402,000	-	119,000	283,000	-	-
1951	127,300	413,000	-	122,000	291,000	-	-
1952	122,250	424,000	-	125,000	299,000	-	-
1953	133,400	435,000	-	128,000	307,000	-	-
1954	150,200	446,000	-	132,000	314,000	-	-
1955	135,600	457,000	-	135,000	322,000	-	-
1956	136,800	468,000	-	138,000	330,000	-	-
1957	150,200	479,000	-	141,000	338,000	-	-
1958	130,600	490,000	-	145,000	345,000	-	-
1959	128,500	501,000	-	148,000	353,000	-	-
1960	130,800	512,000	-	151,000	361,000	-	-
1961	209,521	528,000	-	156,000	372,000	-	-
1962	246,263	571,000	27,600	160,000	383,000	-	-
1963	301,364	626,000	66,600	165,000	395,000	-	-
1964	466,101	729,000	153,000	170,000	406,000	-	-
1965	493,580	988,000	214,900	174,000	417,000	-	181,000
1966	560,681	1,109,000	305,000	179,000	428,000	-	197,000
1967	682,519	1,207,000	374,200	184,000	439,000	-	210,000
1968	886,767	1,381,000	489,900	194,000	445,000	-	252,000
1969	1,027,412	1,493,000	571,900	198,000	456,000	-	267,000
1970	1,136,152	1,641,000	637,000	187,000	534,000	-	283,000
1971	1,239,356	1,782,000	699,800	221,000	564,000	-	296,000
1972	1,295,825	1,855,000	731,300	252,000	577,000	-	295,000
1973	1,260,135	1,797,000	710,300	266,000	548,000	-	273,000
1974	1,074,923	1,528,000	604,800	240,000	462,000	-	221,000
1975	1,040,875	1,475,000	584,100	245,000	443,000	-	202,000
1976	1,070,923	1,520,000	598,900	267,000	452,000	-	202,000
1977	1,422,321	2,022,000	791,900	373,000	597,000	-	260,000
1978	1,324,439	1,886,000	738,100	363,000	549,000	-	236,000
1979	1,189,862	1,698,000	663,400	340,000	487,000	-	206,000
1980	1,060,276	1,521,000	591,100	317,000	430,000	3,950	179,000
1981	1,121,249	1,613,000	624,600	351,000	450,000	4,060	184,000
1982	1,206,415	1,741,000	671,100	395,000	480,000	4,220	191,000
1983	1,223,483	1,773,000	679,200	419,000	483,000	4,360	188,000
1984	1,094,679	1,595,000	605,800	393,000	429,000	4,520	162,000
1985	1,094,368	1,603,000	603,200	412,000	427,000	4,700	156,000
1986	1,301,382	1,897,000	757,400	477,000	468,000	4,830	189,000
1987	1,479,952	2,145,000	904,800	528,000	490,000	5,010	218,000
1988	1,402,369	2,022,000	896,600	485,000	427,000	5,410	208,000
1989	1,439,581	2,063,000	958,700	483,000	403,000	6,100	213,000
1990	1,509,152	2,148,000	1,043,300	490,000	387,000	6,880	221,000
1991	1,634,062	2,309,000	1,169,100	513,000	384,000	7,610	236,000
1992	1,861,492	2,609,000	1,374,400	564,000	400,000	8,250	262,000
1993	1,928,154	2,679,000	1,465,600	564,000	378,000	8,910	263,000
1994	2,035,890	2,801,000	1,589,500	574,000	363,000	9,630	265,000
1995	2,117,929	2,883,000	1,695,100	574,000	343,000	10,490	260,000
1996	1,945,734	2,661,000	1,555,600	562,000	317,000	11,440	215,000
1997	1,727,854	2,365,000	1,379,000	534,000	284,000	12,030	156,000
1998	1,600,246	2,342,000	1,273,900	628,000	315,000	11,770	113,000
1999	1,621,974	2,349,000	1,281,300	661,000	312,000	10,610	83,000
2000	1,726,350	2,498,000	1,318,800	771,000	342,000	10,990	55,000
2001	1,644,439	2,242,000	1,392,400	554,000	230,000	11,430	54,000
2002	1,585,454	2,128,000	1,388,400	486,000	189,000	11,570	53,000
2003	1,606,293	2,233,000	1,378,700	578,000	211,000	12,080	53,000
2004	1,488,909	2,087,000	1,337,200	513,000	174,000	12,890	50,000
2005	1,495,630	2,178,000	1,308,100	612,000	194,000	13,470	51,000
2006	1,480,044	2,281,000	1,150,700	826,000	242,000	13,990	49,000
2007	1,201,604	1,767,000	1,033,900	533,000	145,000	14,620	40,000
2008	1,362,248	2,015,000	1,044,800	725,000	181,000	15,290	48,000
2009	1,390,040	1,952,000	1,069,000	655,000	164,000	15,550	48,000
2010	1,353,232	1,904,000	1,039,300	642,000	161,000	15,180	47,000

Appendix Table A3. Reconstructed total catch (in tonnes) by major taxonomic groups for Thailand, 1950-2010. 'Others' contain 74 additional taxonomic categories.

Year	Cynoglossidae	Engraulidae	Leiognathidae	Nemipteridae	Penaeus	Platycephalidae	Sardinella	Sciaenidae	Scombridae	Synodontidae	Loliginidae	Others
1950	-	33,100	-	-	33,200	-	-	-	-	-	-	336,000
1951	-	32,300	-	-	28,500	-	-	-	-	-	-	352,000
1952	-	33,300	-	-	24,400	-	-	-	-	-	-	366,000
1953	-	34,800	-	-	31,600	-	-	-	-	-	-	368,000
1954	-	37,600	-	-	35,000	-	-	-	-	-	-	373,000
1955	-	39,200	-	-	35,000	-	-	-	-	-	-	383,000
1956	-	40,300	-	-	35,900	-	-	-	-	-	-	392,000
1957	-	38,700	-	-	33,800	-	-	-	-	-	-	406,000
1958	-	49,600	-	-	32,300	-	-	-	-	-	-	408,000
1959	-	58,500	-	-	29,600	-	-	-	-	-	-	413,000
1960	-	62,600	-	-	49,700	-	-	-	-	-	-	400,000
1961	-	82,800	4,000	8,000	36,500	2,800	-	2,400	-	4,100	-	385,000
1962	6,400	83,600	8,000	18,000	41,000	6,400	-	5,600	-	9,200	-	393,000
1963	12,800	97,600	16,000	36,000	45,700	12,700	-	11,100	-	18,500	-	376,000
1964	21,800	107,000	27,000	61,000	43,600	21,700	-	18,900	-	31,500	-	395,000
1965	38,700	127,100	49,000	109,000	53,000	38,600	-	33,700	-	56,100	-	482,000
1966	48,800	106,700	61,000	137,000	67,800	48,600	-	42,500	-	70,700	-	525,000
1967	65,500	92,200	83,000	185,000	81,200	65,300	-	57,100	-	94,900	-	484,000
1968	83,000	68,000	105,000	234,000	85,500	82,600	-	72,300	-	120,200	-	531,000
1969	107,600	39,200	136,000	303,000	79,500	107,200	-	93,700	-	155,900	-	472,000
1970	109,700	15,000	138,000	324,000	31,400	109,300	27,900	108,500	-	159,000	22,800	596,000
1971	117,700	16,300	151,000	347,000	33,600	117,200	30,200	116,500	-	170,300	24,700	658,000
1972	145,600	20,900	190,000	431,000	43,000	145,100	11,700	146,200	-	210,600	45,900	465,000
1973	129,500	27,200	168,000	372,000	66,600	125,500	34,400	129,100	-	182,000	37,600	525,000
1974	108,900	27,000	142,000	312,000	50,400	104,600	57,000	109,100	-	151,500	41,100	424,000
1975	99,400	15,500	130,000	282,000	52,000	93,900	60,700	95,100	-	136,000	36,100	474,000
1976	96,900	16,100	128,000	270,000	56,700	91,000	62,000	88,800	-	131,700	33,600	544,000
1977	124,000	10,600	167,000	343,000	75,800	116,300	193,400	116,700	-	168,100	47,200	661,000
1978	121,300	9,100	166,000	339,000	71,700	114,000	128,200	113,400	-	164,700	45,900	612,000
1979	109,200	17,400	153,000	304,000	61,500	102,800	139,300	99,600	-	148,300	36,400	527,000
1980	103,600	17,000	148,000	288,000	66,100	98,300	88,400	95,700	1,270	141,800	33,400	440,000
1981	101,700	11,800	146,000	281,000	70,200	95,300	114,100	94,600	1,300	137,300	39,200	521,000
1982	102,600	19,500	151,000	282,000	99,700	96,900	92,700	93,800	1,350	139,500	56,000	607,000
1983	98,100	31,300	147,000	269,000	76,600	92,800	96,100	89,900	1,400	133,500	58,900	679,000
1984	90,300	67,200	138,000	248,000	58,900	85,800	87,500	84,000	1,450	123,300	49,500	562,000
1985	89,600	75,200	139,000	245,000	50,200	84,700	70,500	83,100	1,500	121,500	46,200	598,000
1986	111,700	43,600	176,000	311,000	59,500	106,000	89,500	104,100	1,550	152,000	52,700	690,000
1987	128,000	43,700	207,000	361,000	61,600	122,300	96,200	117,700	1,600	175,200	57,000	776,000
1988	115,200	53,700	188,000	322,000	49,400	109,300	95,800	106,900	1,730	156,500	52,000	773,000
1989	115,500	77,000	190,000	325,000	49,500	109,100	115,100	108,400	1,950	156,000	55,400	762,000
1990	124,500	100,700	208,000	346,000	48,700	117,700	98,000	115,800	2,210	168,200	52,300	768,000
1991	128,400	105,800	219,000	371,000	68,600	121,900	117,300	124,700	2,440	174,100	57,800	821,000
1992	138,600	136,400	240,000	414,000	59,100	131,800	139,500	132,000	2,650	188,000	55,300	974,000
1993	147,100	144,600	259,000	445,000	61,800	139,900	133,200	141,300	2,860	199,300	63,100	945,000
1994	146,300	151,800	256,000	437,000	63,400	136,700	138,600	137,900	3,090	194,600	64,700	1,074,000
1995	146,500	154,300	256,000	450,000	66,400	134,600	180,100	140,800	3,370	191,400	71,800	1,092,000
1996	130,200	140,400	226,000	393,000	64,300	117,100	186,300	129,200	3,680	166,300	68,700	1,040,000
1997	112,900	128,100	197,000	342,000	58,200	100,500	165,100	113,200	3,870	142,700	64,300	942,000
1998	106,300	127,700	185,000	328,000	38,500	93,100	150,900	109,600	3,780	132,100	75,500	995,000
1999	102,500	110,600	181,000	317,000	37,000	89,800	150,100	109,400	3,420	127,200	68,300	1,056,000
2000	106,400	124,400	185,000	336,000	40,500	92,100	142,600	116,200	3,540	130,500	75,000	1,149,000
2001	99,200	120,300	175,000	321,000	39,100	87,000	120,000	114,000	3,680	123,200	64,100	979,000
2002	93,200	118,400	158,000	305,000	32,600	78,600	100,600	109,800	3,730	111,300	69,900	950,000
2003	94,800	125,600	170,000	318,000	29,500	84,300	102,100	114,000	3,890	119,400	65,800	1,011,000
2004	86,500	125,400	158,000	291,000	23,800	78,300	92,100	108,300	4,160	110,900	56,500	957,000
2005	86,400	129,600	162,000	300,000	22,700	80,500	103,500	111,500	4,330	114,000	61,300	1,006,000
2006	83,800	142,200	155,000	294,000	25,000	77,200	98,700	111,600	4,500	109,400	68,700	1,116,000
2007	67,600	120,400	126,000	244,000	19,500	62,600	80,600	91,600	4,700	88,700	55,300	810,000
2008	74,400	171,900	139,000	233,000	21,100	69,200	115,100	93,500	4,910	98,000	85,900	913,000
2009	75,400	165,300	142,000	237,000	22,400	70,400	114,200	93,100	5,000	99,700	79,500	853,000
2010	73,100	156,200	137,000	230,000	21,500	68,100	111,900	91,000	4,880	96,500	80,600	838,000