BAY OF BENGAL LME

Bay of Bengal Large Marine Ecosystem Project

Fisheries catches for the Bay of Bengal Large Marine Ecosystem since 1950

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Fisheries catches for the Bay of Bengal Large Marine Ecosystem since 1950

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Table of Contents

Executive summary ... 3
Introduction ... 7
Results 14
- Bangladesh ... 14
- India (mainland) ... 15
- Andaman and Nicobar Islands (India) ... 16
- Indonesia ... 17
- Malaysia ... 19
- Maldives ... 20
- Myanmar ... 21
- Sri Lanka ... 23
- Thailand ... 24
- High Seas ... 25
- Bay of Bengal Large Marine Ecosystem (BOBLME) ... 26
- Export data ... 28

Discussion and Conclusions ... 29
- Bangladesh ... 29
- India (mainland) ... 29
- Andaman and Nicobar Islands (India) ... 30
- Indonesia ... 30
- Malaysia ... 31
- Maldives ... 31
- Myanmar ... 32
- Sri Lanka ... 32
- Thailand ... 33
- High Seas ... 33
- Bay of Bengal Large Marine Ecosystem (BOBLME) ... 33
- Recommendations and Conclusions ... 34
- Acknowledgements ... 36

References ... 37
Tables and Figures ... 39
Appendix I: Myanmar catch reconstruction ... 101
Appendix II: Sri Lanka catch reconstruction ... 135

Executive summary

We present marine fisheries catch data for the Bay of Bengal Large Marine Ecosystem (BOBLME) based on spatially allocated catch data from the *Sea Around Us* project's global ½ degree latitude x ½ degree longitude catch database for the BOBLME-enclosed parts of the Exclusive Economic Zones of Bangladesh, India (east coast of mainland India), the Andaman and Nicobar Islands (India), Indonesia, Malaysia (west coast of Peninsular Malaysia), the Maldives, Myanmar, Sri Lanka, and Thailand (Andaman Sea Coast), as well as the High Seas component of the BOBLME for the period 1950-2006. More recent data are currently not available at the ½ x ½ degree scale. Spatially assigned data for all countries except India (including Andaman and Nicobar Islands) were based on the FAO FishStat landings data that consist of national data reported by countries to FAO. For India, our spatially allocated data consisted of reconstructed total catches based on earlier studies of the *Sea Around Us* project. The *Sea Around Us* project's global ex-vessel price database was also used to calculate the landed value of catches taken within this area, by species, commercial group, functional group, country fishing and gear-type. Data on catches by gear are based on taxon-gear associations derived globally by the *Sea Around Us* project. In addition, total catches were reconstructed for two of the eight countries (Myanmar and Sri Lanka) for the period 1950-2008, and are presented in this report independently of spatially allocated catch data. Globally available export data are presented as quantity and value of exported products for the eight countries surrounding the Bay of Bengal.

- **Bangladesh**: Landings from the waters of Bangladesh were almost entirely reported as 'miscellaneous marine fishes'. As of the mid-1980s, hilsa shad (*Tenualosa ilisha*) are reported and comprise 40% of total landings between 1984 and 2006, with a landed value of 825 million USD. Over 99% of landings (5 billion USD landed value) were by the fleet of Bangladesh, with minor catches taken by Japanese fleets during the 1950s and 1960s. Landings were assigned mainly to gillnet gears (95%), with a landed value of 4.5 billion USD.

- **India (Mainland)**: Catches (reconstructed total catches not reported landings) in India's waters consisted of many taxa, with Indian oil sardine (*Sardinella longiceps*), drums or croakers (Sciaenidae) and penaeid shrimps being the largest individual contributors with around 6-8% of total landings each. Landed value was dominated by shrimp ('penaeid shrimps', 'natantian decapods', 'shrimps and prawns' and 'giant tiger prawns'), yielding 13.6 billion USD. Catches from the EEZ of India were taken almost exclusively by India (92% by weight, 29 billion USD landed value). Main gear was gillnets (25%), shrimp trawls (14%), mid-water trawls and bottom trawls (12% each). The landed value was highest for shrimp trawls with 14.5 billion USD.

- **Andaman and Nicobar Islands (India)**: Catches from the EEZ waters of the Andaman and Nicobar Islands were dominated by herring-like fishes (Clupeiformes), while landed value was highest for skipjack tuna (*Katsuwonus pelamis*). Catches taken from the EEZ of the Andaman and Nicobar Islands were predominantly assigned to Thai vessels which accounted for 43% of the total catch. Sri Lankan vessels and domestic (Indian) vessels accounted for 31% and 25%, respectively, over the entire time period. The landed value by fishing country was highest for Sri Lanka, which was estimated to be 54% of the total landed value for this EEZ. The majority of landings were taken by gillnet (49% by weight, 688 million USD landed value), followed by mid-water trawls and purse seines over the 1950-2006 period.

- **Indonesia**: Over half of total landings from the BOBLME portion of the Indonesian EEZ were as 'mixed group', with a major portion reported as 'miscellaneous marine fishes'. Of the individually reported species, short mackerel (*Rastrelliger brachysoma*), banana prawn (*Fenneropenaeus merguiensis*) and blood cockle (*Anadara granosa*) dominated, with 7, 6, and 5% of total landings, respectively. Note that 'mixed group' consists of many individual taxonomic entities, each contributing a relatively small amount of reported landings compared to the individually listed taxa above. Landed value was dominated by banana prawns (1.3 billion USD), *Metapenaeus* spp. (570 million USD) and giant tiger prawns (*Penaeus monodon*, 397 million USD). Indonesian fleets dominated landings (84% by weight, 4.6 billion USD), with Thai fleets responsible for 15%. The dominant gears were gillnets, bottom trawls, purse seines and shrimp trawls, accounting for 24%, 14%, 11% and 11% of landings, respectively. Shrimp trawls had the highest landed value by gear (2.4 billion USD). Note that the global taxon-gear associations used by the *Sea Around Us* project does not take into account the bottom trawl ban in Western Indonesia.

- **Malaysia**: Landings from Malaysian waters were dominated by Indo-pacific mackerels (*Rastrelliger* spp.) accounting for 19% of total landings, while landed value was highest for shrimps and prawns (3.6 billion USD). Landings in the BOBLME waters of Malaysia were mainly by Malaysian fleets (87% of total landings). Thai fishers took an increasingly larger share of landings starting in the mid 1990s, and in total were responsible for almost 13% of landings. The landed value was highest for Malaysia (15.5 billion USD). The dominant gear was gillnet, representing 30% of total landings, and a landed value of 3.1 billion USD.

- **Maldives**: Landings and landed value from the EEZ waters of the Maldives were dominated by skipjack tuna from 1950-2006 (65% of total landings, 9.2 billion USD). Fishing in the Maldives EEZ was almost exclusively by Maldivian fishers (95% by weight, 12 billion USD landed value). Based on the *Sea Around Us* project's global taxon-gear associations, landings were mainly taken by troll lines until the mid-1990s, after which pole and line became the dominate gear. The landed value by gear was highest for troll lines until the mid-

1990s, accounting for 5 billion USD over the period 1950-2006. From 1995 onward, landed values were dominated by pole and line gear, accounting for 4.2 billion USD of landed value since 1995.

- **Myanmar**: Landings from the EEZ waters of Myanmar were dominated by 'miscellaneous marine fishes' (91%), while 'Natantian decapods' (prawns and shrimp) was the most important taxonomic group, accounting for 1.1% of landings and 1.2 billion USD landed value. Myanmar fleets accounted for the majority of reported landings (86% by weight, 17 billion USD landed value), followed by Thai vessels with 14% of landings (4 billion USD). Landings were taken almost entirely by gillnet (landed value 16.5 billion USD), with a small fraction taken by mid-water trawls, bottom trawls and shrimp trawls. Reconstructed total marine fisheries catches for Myanmar were estimated to approximate 32 million tonnes from 1950 to 2008. This estimate was 9% larger than landings reported by Myanmar to the FAO. Inshore catches were found to be declining, while total reconstructed catches have leveled off or are even beginning to decline; this is in contrast to the reported landings data, which suggest continued growth in landings.

- **Sri Lanka**: The main taxa reported as landings from Sri Lankan water's were herring-like fishes (Clupeiformes), silky shark (*Carcharhinus falciformis*) and 'mackerels, tunas and bonitos' (Scombridae). The most highly valued species group was 'mackerels, tunas and bonitos' (1.4 billion USD), followed by skipjack tuna (*Katsuwonus pelamis*, 1.1 billion USD). Landings were almost exclusively taken by Sri Lanka (landed value of 5 billion USD), with less than 1% of the landings being taken by foreign fleets. A large variety of gears appears to be used in Sri Lankan waters; however, gillnets are the most used gear (28% by weight, over 1.2 billion USD landed value). Reconstructed total fisheries catches for Sri Lanka for 1950-2008 were estimated to be 18 million tonnes, which is 2 times larger than the landings officially reported by Sri Lanka to the FAO. Reconstruction accounted for subsistence catch and discards not included in official data.

- **Thailand**: Landings from the BOBLME waters of Thailand were dominated by Indo-pacific mackerels (*Rastrelliger* spp., 9%), *Sardinella* spp. (6%), bigeyes (*Priacanthus* spp., 5%) and Indian scad (*Decapterus russelli,* 4%). Landed value was dominated by penaeid shrimp with 155 million USD. Thai fleets accounted for over 99% of landings (1.2 billion USD) from the Thai BOBLME waters. The dominant gear was gillnets (40% by weight, almost 314 million USD landed value).

- **BOBLME High Seas**: The high seas accounts for 31.5% of the total BOBLME area, and the majority of high seas landings were from 1980 onward. Taxon-specific landings were dominated by skipjack tuna (*Katsuwonus pelamis*), representing approximately 5% of total high seas landings and 753 million USD of landed value. Landings from the high seas were dominated by fleets from countries bordering the Bay of Bengal, with Malaysia, Thailand, Indonesia and Sri Lanka representing 32%, 26%, 22% and 10% of total high seas landings, respectively. The landed value was highest for Malaysia (1.7 billion USD). According to the present taxon-gear associations used, landings were mainly from gillnet (74% by weight, 2.7 billion USD) and tuna longline gears (10% by weight, 2 billion USD).

- **Bay of Bengal Large Marine Ecosystem**: For the entire BOBLME, a large number of taxa, each contributing only a relatively small amount to catches (here referred to as 'mixed group') accounted for 75% of total landings. The four most important individually reported taxa were herring-like fishes (Clupeiformes), Indo-pacific mackerels (*Rastrelliger* spp.), Hilsa shad (*Tenualosa ilisha*), skipjack tuna (*Katsuwonus pelamis*) and 'drums or croakers' (Sciaenidae), each accounting for around 3% of total landings over the 1950-2006 period. The single most valuable taxon was skipjack tuna, contributing 10% to total landed value (11.6 billion USD). The majority of landings from the BOBLME were by India's fishing fleets, accounting for 27% of total landings, followed by Myanmar (24%; however, there are concerns about the accuracy of Myanmar's reported landings statistics), Malaysia (12.2%), Thailand (11.5%), Bangladesh (8.6%), Indonesia (8.5%), Sri Lanka (4.5%) and the Maldives (3.0%). Non-BOBLME countries (primarily Japan and Taiwan) represented less than 1% of total landings. Landed value was highest for India (29.6 billion USD), followed by Malaysia (17.2 billion USD), Myanmar (16.8 billion USD), Maldives (12 billion USD) and Thailand (11.4 billion USD). Landings by gear were dominated by gillnets (53% of total landings), bottom trawls (8%), mid-water trawls (7%), shrimp trawls (6%) and purse seines (5%). The landed value by gear-type was highest for gillnets (35.8 billion USD), followed by shrimp trawls (22.4 billion USD).

- **Seafood exports**: Export data were only available from 1976 onwards. Total exports by the eight countries that border the Bay of Bengal were estimated to be 60 million tonnes from 1976 to 2008, or 5 million tonnes per year. The value of these exports was estimated at 176 million USD. Thailand (29.1 million t, 89.1 million USD), Indonesia (12.8 million t, 35.5 million USD) and India (8.5 million t, 27.3 million USD) had the largest exports of marine products by quantity and value.

Introduction

Population growth, coastal development and intense resource use in the Bay of Bengal are contributing to habitat degradation and over-exploitation of fish stocks within this Large Marine Ecosystem. The consequences of a compromised marine environment to the people living in the eight countries that surround the Bay of Bengal are serious threats to food security and compromised livelihoods.

Fishing has traditionally been a key source of food and income for the people living along the Bay of Bengal. While historically, fishing may have been small-scale (Day, 1888; Butcher, 2004), today vessels range from small-scale, un-motorized artisanal crafts to large mechanized industrial trawlers, including both domestic and foreign fleets. The numerous fleets operating in the Bay of Bengal are often in competition for the same fish stocks, putting intense pressure on the marine ecosystem of this region. Distant water fleets, while adding to the pressure on fish resources, may also provide a source of much needed revenue through fishing access agreements and fees. Balancing the national food security issue of domestic use of fish resources against the potential economic benefit that may be gained from careful consideration of foreign access and export of these fish is a major management challenge fraught with risks.

A serious constraint to effective and sustainable management of fisheries within the Bay of Bengal is the large number of fish stocks whose distributions span more than a single country. Collaborative action is required in order to move towards sustainable management of such trans-boundary resources and activities. Previous attempts to manage the shared resources and mitigate the environmental degradation within the Bay of Bengal have failed due to limited institutional capacity, ineffective policies and poor implementation. A regional strategy with national support from all the countries surrounding the Bay of Bengal is necessary in order to effectively manage this Large Marine Ecosystem (LME; Sherman and Hempel, 2008).

The Bay of Bengal Large Marine Ecosystem (BOBLME) Project is a collaborative effort between the United Nations Food and Agriculture Organization (FAO) and the countries associated with the Bay of Bengal (Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Thailand, and Sri Lanka) to improve regional management of fisheries and the marine environment. The aim of the BOBLME project is to identify threats to the marine ecosystem, improve the livelihoods of coastal communities and secure food resources of the Bay of Bengal. The five major areas that are being addressed include: 1) developing a Strategic Action Plan (SAP) to protect the health and living resources of the Bay; 2) improving coastal/marine natural resource management and use; 3) improved understanding of the BOBLME environment; 4) maintenance of ecosystem health and management of pollution; and 5) developing methods for monitoring and evaluating the project, and disseminating information.

The *Sea Around Us* Project, a scientific collaboration between the University of British Columbia, Canada and the Pew Charitable Trusts, Philadelphia, has developed approaches for estimating and spatially assigning global fisheries catches, and assessing world ocean health using a set of indicators, which can be used to measure broad management performance. Building on this, as a component of the BOBLME project, the *Sea Around Us* project has analyzed fisheries catch data and computed ocean health indicators (see separate report)[1] for the Exclusive Economic Zones (EEZs) of the eight countries bordering the Bay of Bengal, as well as the High Seas area contained within the BOBLME (Figure 1).

The foundation of spatially allocated data rests initially on FAO FishStat landings data that are based on individual country reports to FAO (Watson *et al.*, 2004), which are progressively supplemented by 'reconstructed' data sets for each country (e.g., Wielgus *et al.*, 2010). Reconstructed datasets, which estimate total catches by incorporating unreported and unregulated fisheries catches, progressively replace FAO country datasets in each new round of spatial allocation of catches as undertaken by the *Sea Around Us* project. As allocations are highly resource- and time-intensive, the *Sea Around Us* project only undertakes these every few years. Hence, while presently FAO data are available up to and including 2009, the spatially allocated *Sea Around Us* catches are only available up to 2006. Furthermore, newly reconstructed data presented as part of this project (Sri Lanka and Myanmar) are not yet spatially allocated using the approach of Watson *et al.* (2004). The exception is the catch data for India, which consists of previously reconstructed catches (Bhathal, 2005; Bhathal and Pauly, 2008)

As part of this project, total marine fisheries catches were newly estimated for two Bay of Bengal Large Marine Ecosystem countries (Sri Lanka and Myanmar) using the catch reconstruction technique of Zeller *et al.* (2007), which accounts for all fisheries removals including small-scale, discarded and unreported catch, which are often missing from or under-reported in the national catch statistics provided to the FAO as the official landings for that country. Total marine fisheries catches will be estimated for the remaining five countries in the next phase of this project, should this proceed.

Using the presently allocated catch data for all eight countries' EEZs bordering the Bay of Bengal, we present landings and landed value by species, commercial group, functional group, fishing country and gear-type. Taxonomic, commercial and functional grouping identifications are based on FishBase (www.fishbase.org) and SeaLifeBase (www.sealifebase.org) and Watson *et al.* (2004), while gear-type associations were derived based on Watson *et al.* (2006a; 2006b). Where possible, we have identified catch as being from the small-scale or large-scale sectors and report available export data by country. Landed values are derived from the combination of catch data and the global ex-vessel fish price database developed and maintained by the *Sea Around Us* project (Sumaila *et al.*

[1] Kleisner and Pauly (2011) Bay of Bengal Large Marine Ecosystem Indicator Report. Report to the Bay of Bengal Large Marine Ecosystem Project, prepared by the *Sea Around Us* Project, Fisheries Centre University of British Columbia, Vancouver, Canada.

2007).

Material and methods

Catches taken within the Bay of Bengal Large Marine Ecosystem are presented here in the form of extractions from the *Sea Around Us* project's database of taxonomically disaggregated and spatially allocated global fisheries catches (Watson *et al.*, 2004). Data are presented for those portions of a country's EEZ that fall within the BOBLME area as defined in Figure (1). Catches taken in the high seas area that fall within the BOBLME area are also presented, as are total catches for the entire BOBLME area. Note that high seas, with over 31% of the area, comprises the majority of the area within the BOBLME (Table 1), followed by the EEZs of India (both mainland and Andaman and Nicobar Islands combined), Maldives and Indonesia (Table 1). Data presented here include all countries that report landings for the FAO statistical area 57 and 51 that are associated with the BOBLME and (for EEZs) that are allowed or have been observed to fish in that particular EEZ, as determined through the *Sea Around Us* project's global database of 'fishing access agreements' (www.seaaroundus.org), consisting of the updated and expanded version of an earlier FAO database, *FARISIS* (Martosubroto *et al.*, 1996). Catches are presented by weight in metric tonnes and by value in year 2000 real US$ equivalent (Sumaila *et al.*, 2007). Catches are presented by the 11 most significant individual taxonomic entities (in terms of catch volume or landed value), commercial groups, functional groups, and gear-type. Commercial and functional groups are as defined by (Watson *et al.*, 2004). Gear-type associations are based on globally derived taxon-fishing gear associations, not on catch reported by gear type (Watson *et al.*, 2006a; Watson *et al.*, 2006b). In addition to spatially allocated catches, the total reconstructed catch was estimated for two of the eight countries in the Bay of Bengal. In addition, India's reconstructed catches presented here are from the *Sea Around Us* spatially allocated database, which used India's reconstructed catch as the input data (based on Bhathal, 2005). In contrast, for Myanmar and Sri Lanka, catches are both presented as spatially allocated FAO landings and value data (from the database) and as total reconstructed catches (yet to be incorporated into the spatially allocated *Sea Around Us* catch database). For the remaining five countries (Bangladesh, Indonesia, Malaysia, Maldives and Thailand) only the spatially allocated, reported FAO landings data are available at present. Export data were obtained from the FAO trade database and presented here as total quantity and value of exported products by country.

The spatial allocation of catches that is undertaken by the *Sea Around Us* project globally uses a rule-based process of allocating catches to a global ½ degree latitude x ½ degree longitude cell grid system (i.e., about 180,000 maritime cells globally). This allocation process combines catches by taxon, country fishing and area fished (i.e., FAO statistical areas) with known ecological species distributions and fishing access information (compiled by the *Sea Around Us* project; Watson *et al.*, 2004). The result of this spatial allocation process is that catches have been assigned to smaller spatial units (cell grid) that are more meaningful in ecosystem and ecological terms. For each country, the catches taken within that country's EEZ waters (by all countries known or assumed to be fishing within these waters) are presented as the sum of the catches taken in the spatial cells that fall within the area claimed by that country as its Exclusive Economic Zone. For time periods pre-dating EEZ declarations, we assume freer access to these waters, but treat them as EEZ-equivalent waters. In this report, we have included only those cells from a country's EEZ which fall within the BOBLME area (Figure 1).

Due to the large number of taxa included in the *Sea Around Us* project catch database (globally >1500), taxa are also aggregated into two groupings. The *commercial* grouping aggregates taxa into one of 12 broad groups (i.e., anchovies, herring-like fishes, perch-like fishes, tuna and billfishes, cod-like fishes, salmons and smelts, flatfishes, scorpionfishes, sharks and rays, crustaceans, mollusks, and 'other fishes and invertebrates'). The *functional* grouping aggregates taxa based partly on taxonomy, but mostly on habitat preferences, feeding habits, and maximum size, which define what we call 'functional groups' as required for ecosystem modeling. This grouping separates fish by where they live in the water column. *Demersal* animals that live on or are closely associated with the sea bottom are separated from those that live predominately in the water column or near the water surface (e.g., *pelagic*). *Benthopelagic* taxa refer to those that live and feed near the bottom as well as in mid-water or near the surface. Habitat separation is further described by depth zones, with *bathypelagic* and *bathydemersal* taxa referring to taxa living in the 1000-4000 m depth zone. Finally, we have separated out *reef associated* taxa as well as *sharks and rays*, *flatfishes*, and a few other individual groups. Most of these functional groups are further separated into those that are under 30 cm maximum length (e.g., small herring-like species), those 30 to 90 cm, and those over 90 cm (such as tunas), except for sharks, rays and flatfishes, which are grouped into two categories (small and medium versus large). Overall, we have defined 30 functional groups (Table 2). This grouping system substantially facilitates ecological and modeling studies.

Taxa in the *Sea Around Us* Project catch database have fishing gear associations as developed by Watson *et al.* (2006a; 2006b). The majority of global catch records are associated with up to five gear types, ranked according to importance (catch tonnage) and extrapolated to cover all global catch records. The fishing gear database, developed by Watson *et al.* (2006a; 2006b), provides annual catches by these gear types since 1950. Note that the catch-by-gear associations the *Sea Around Us* project uses are not based on reported catch-by-gear as are available in a few instances for some time periods for some countries, but are globally-derived associations. As such, they do not account for local gear-specific management actions, such as the Indonesia bottom trawl ban in western Indonesian waters (Martosubroto, 1996; Buchary, 1999; Butcher, 2004). In this report, we present catches (by weight and landed value) for the major gear-types associated with catches taken within the EEZs of each of the eight countries, the high seas and the entire BOBLME area based directly on the gear definitions of Watson *et al.* (2006a; 2006b). This will allow for identification of major fishing gear-types used within the Bay of Bengal. This information, in combination with knowledge of destructive gear types and sensitive habitats will enable management decisions about gear specifications and restrictions. Given the global approach used by Watson *et al.* (2006a; 2006b), local and regional area-specific taxon-gear associations may be missed using the present approach.

Fisheries catches are also presented by landed value. The value was estimated using the ex-vessel fish price database described by Sumaila *et al*. (2007) for each taxon-country-year combination. The ex-vessel price is the price that a fisher receives when they sell their catch and often differs from the market price. Price data were assembled into a global database from a variety of available data sources and, where data were missing, a rule-based decision process was used to estimate prices (Sumaila *et al.*, 2007). The real landed value was derived using the *Sea Around Us* spatially allocated catch data, the price database and the consumer price index (CPI) for each country.

Reporting fisheries landings by weight and by landed value allows for cost-benefit analysis of different management options and assists in determining the social and economic impacts of various management strategies. However, the importance of subsistence fisheries to national economies are rarely fully captured through the predominantly commercial catch statistics. Therefore, for a proper assessment of management options, we must also look at total fisheries catches as opposed to reported landings only. Fisheries landings as reported in a country's official landing statistics often underestimate total fisheries catches. This has been shown to occur in both developed (Zeller *et al.*, 2011) and developing countries (Zeller *et al.*, 2007). In particular, small-scale fisheries have often been found to be under-represented in the reported data. This under-representation of catches in the official data leads to poor representation of this sector in policy and management decisions and ultimately the marginalization of small-scale fishers (Pauly, 2006). Discarded bycatch is another component of fisheries catch, which is often unaccounted for in the reported data (Zeller *et al.*, 2007; Zeller *et al.*, 2011). Estimating total catch using a catch reconstruction approach (*sensu* Zeller *et al.*, 2007), which includes all fisheries sectors and components, is essential to providing a comprehensive baseline to evaluate management and policy options.

Total marine fisheries catches were reconstructed and incorporated into the spatial data for India (Bhathal, 2005; Bhathal and Pauly, 2008), and newly reconstructed for Sri Lanka and Myanmar. See Appendix I and II for the reconstruction reports for Myanmar and Sri Lanka. Total catches were estimated using a six step approach (Zeller *et al.*, 2007):

1) Identification and sourcing of existing, reported catch times series, e.g., FAO and national data;
2) Identification of sectors, time periods, species, gears, etc. not covered by (1), i.e., missing catch data, via literature searches and consultations;
3) Sourcing of available alternative information sources dealing with missing data identified in (2), via extensive literature searches and consultations with local experts;
4) Development of data anchor points in time for missing data items, and their expansion to country-wide catch estimates;
5) Interpolation for time periods between data anchor points, e.g., via per capita catch rates; and

6) Estimation of final total catch times series estimates, combining reported catches (1) and interpolated, country-wide expanded missing data series (5).

Myanmar's catches were reconstructed for the period 1950-2008 (see Appendix I). Marine fisheries statistics for Myanmar were sparse, and the only available estimates were those presented in the FAO FishStat database and a few FAO documents. FAO catches were taken as the best estimate of Myanmar's marine landings. National data were then used to spatially refine catches within Myanmar's EEZ as offshore, inshore and onshore catches. To this, estimates of discarded bycatch and unreported artisanal catches were added. The Myanmar report also points at substantial over-reporting problems in recent years, suggesting a problem with the underlying data recording and reporting system (see Appendix I)

The reconstruction of Sri Lanka's catches is described in full in Appendix II. In brief, national landings data were compared to FAO landings as presented in FAO FishStat to determine the quality of data transfer. Fisheries-independent household survey data were used to compare seafood consumption to the domestic supply of seafood as inferred from trade-adjusted reported data. Estimates of unreported subsistence catches and shrimp trawl discards were added to the reported landings. National data and independent reports were used to improve the taxonomic resolution of the catch data.

India's catches were reconstructed earlier (Bhathal, 2005; Bhathal and Pauly, 2008). The catch data that resulted from this reconstruction were used to replace the FAO input data in the *Sea Around Us* Project catch allocation database for the pre-2001 period. Reconstructed data were incorporated into the database by spatially allocating catches to half degree by half degree cells (see catch allocation methods above). For this report, India's catches are presented as a single data set representing total catches taken within the portion of India's EEZ that lies within the BOBLME.

After completing catch reconstructions for all countries within the BOBLME, allocated catch data (as presented at www.seaaroundus.org) will use the reconstructed catch in place of the reported landings. In this report, we present the allocated catch for all eight countries, of which, India is the only one whose reconstructed catch data are incorporated. For the other seven countries, we present catch allocation data, which uses the reported landings as input (Watson *et al.*, 2004). In addition to these datasets, we present catch reconstructions for Myanmar and Sri Lanka (Appendix I and II). The data from these reconstructions will be incorporated in the next catch allocation over the coming years as part of the ongoing data improvements of the *Sea Around Us* project.

Results

The key findings of this study are presented in alphabetical order of country name as per the naming convention used by the *Sea Around Us* project, followed by a section on the high seas within the BOBLME, a summary for the whole BOBLME area, and a section on export of marine products.

Bangladesh

Landings from the waters of Bangladesh were estimated to be 9.5 million t over the 1950-2006 time period (424,000 t·year^{-1} since 2000; Figure 2), and consisted almost entirely of 'miscellaneous marine fishes' until the mid-1980s. As of the mid-1980s, landings were reported for several species and species groups. The main species reported were Hilsa shad (*Tenualosa ilisha*), which represented 40% of the total landings between 1984 and 2006 (over 160,000 t·year^{-1} since 2000; Figure 2). Crustaceans represented 8% of the total landings during this same period (1984-2006), with 36,500 t·year^{-1} since 2000. Overall, reported landings from the waters of Bangladesh increased steadily until the early 1980s, after which they increased rapidly throughout the rest of the time period to peak at just under 480,000 t·year^{-1} in 2006 (Figure 2). The total landed value from the waters of Bangladesh was estimated at almost 5 billion USD for the period 1950-2006, or approximately 215 million USD·year^{-1} from 2000 on (Figure 3). The main contributor to this was 'miscellaneous marine fishes' (over 100 million USD·year^{-1} since 2000), followed by Hilsa shad (47 million USD·year^{-1} since 2000) and crustaceans (38 million USD·year^{-1} since 2000, Figure 3).

Landings by commercial group were dominated by 'other fishes and invertebrates', followed by herring-like and crustaceans (Figure 4). Landed values also suggested the same pattern (Figure 5).

By functional group, landings were mainly small demersals, representing 63% of the total landings over the 1950-2006 time period (Figure 6). From 1984 to 2006, landings of medium pelagics were substantial, representing 42% of overall landings. Also increasing over the study period were landings of 'lobsters and crabs' (Figure 6). The landed value of the catch by functional group was dominated by small demersals, which represented 3.6 billion USD over the period 1950-2006, and 130 million USD·year^{-1} from 2000 on (Figure 7). Medium pelagics, 'lobsters and crabs', and large pelagics were valued at 47 million USD·year^{-1}, 38 million USD·year^{-1}, and 246,000 USD·year^{-1} from 2000 on.

Landings were almost entirely from the fleets of Bangladesh (>99% of total landings; Figure 8), with some catches taken by Japanese fleets mainly during the 1950s and 1960s. The landed value was therefore also dominated by Bangladesh, with an estimated landed value of almost 5 billion USD for the period 1950-2006, and 216,000 USD·year^{-1} from 2000 on (Figure 9).

Landings were mainly from gillnet fisheries (92% since 2000; Figure 10). The remaining landings were caught using pots (3%), traps (3%) and bottom trawls (2%). Landed value by gear was also highest for gillnets, estimated at 4.5 billion USD over the 1950-2006 time period, and around 180 million USD·year^{-1} from 2000 on (Figure 11). The remaining value was primarily from pots (12 million USD·year^{-1}), traps (12 million USD·year^{-1}) and bottom trawl gears (9.5 million USD·year^{-1}, Figure 11).

India (mainland)

Total catches in the EEZ waters of India within the Bay of Bengal (i.e., the East Coast of India) were estimated to be 32.3 million tonnes over the period 1950-2006, and 1.2 million t·year^{-1} from 2000 on (Figure 12). Miscellaneous marine fishes made up the largest portion of total landings, followed by Indian oil sardine (*Sardinella longiceps*), drums or croakers (Sciaenidae) and penaeid shrimps, each representing roughly 7-8% of total landings. Total landed value of catches in India's waters within the Bay of Bengal was estimated at 32.8 billion USD over the period 1950-2006, and over 1 billion USD·year^{-1} from 2000 on (Figure 13). Landed value was dominated by shrimp (group: 'penaeid shrimps', 'natantian decapods', 'shrimps and prawns' and 'giant tiger prawns' [*Penaeus monodon*]), which was estimated (all shrimp groups together) at 352 million USD·year^{-1} from 2000 on (Figure 13).

Catches by commercial group are dominated by perch-likes (34.5% since 2000), other fishes and invertebrates (27%), crustaceans (16%) and herring-likes (10%; Figure 14). Sharks and rays also featured as individual category, accounting for 49,000 t·year^{-1} since 2000. The value by commercial group was highest for crustaceans, whose landed value was 18 billion USD over the period 1950-2006, and over 470 million USD·year^{-1} from 2000 on (Figure 15). 'Other fishes and invertebrates' contributed the second highest landed values, estimated at 277 million USD·year^{-1} from 2000 on, while catches of perch-likes were estimated at 128 million USD·year^{-1} from 2000 on.

By functional group, landings were dominated in the earlier time periods by small pelagics, but since 2000, are dominated by small demersals, representing 38% of total landings since 2000 (Figure 16). The value by functional groups was highest for shrimps, which had an estimated landed value of 355 million USD·year^{-1} from 2000 on (Figure 17). Since the 2000, small demersals have also increased in the landed value contribution, and now account of 22% (218 million USD·year^{-1}).

Catches from the waters of India were taken almost exclusively by India (92% of total landings; Figure 18), while landings from Thai and Sri Lankan vessels represented 4.8% and 3.5%, respectively, of total landings from India's waters. The value of landings was highest for India with over 29 billion USD for the entire time period, and 937 million USD·year^{-1} from 2000 on (Figure 19).

Landings from India's EEZ were mainly from gillnets (25%), shrimp trawls (14%), mid-water trawls and bottom trawls (12% each; Figure 20). Landings from all four of these gears increased steadily from the 1970s onward, and by the early 2000s almost 75% of landings were from these gears. A substantial increase in gillnet landings occurred in the recent period (2000s). The value of landings from the Bay of Bengal portion of India's waters was highest for the shrimp trawl fishery, which was estimated at 355 million USD·year^{-1} from 2000 on (Figure 21). Gillnet landings were averaging around 265 million USD annually during the 2000s (Figure 21).

Andaman and Nicobar Islands (India)

Landings for the Andaman and Nicobar Islands EEZ waters totaled 2.0 million tonnes over the 1950-2006 time period (Figure 22). Reported landings were very low from 1950 to the mid 1970s, after which they increased substantially (see catch by country below) to a peak of just under 128,000 t·year^{-1} in 1998, followed by a rapid decline to around 56,000 t·year^{-1} in the most recent time period. The majority of landings were reported as a variety of taxa (here called 'mixed group'). Among the leading individual taxa in catch volume were herring-like fishes (Clupeiformes), followed by jacks and pompanos (Carangidae) and mackerels, tunas and bonitos (Scombridae). The total landed value within the EEZ of the Andaman and Nicobar Islands was estimated at 2.3 billion USD over the entire time period, with a peak landed value of nearly 129 million USD·year^{-1} in 1998, before landed value declined to around 83 million USD·year^{-1} by the mid 2000s (Figure 23). The individual taxon with the highest landed value was skipjack tuna (*Katsuwonus pelamis*), followed by the mackerels, tunas and bonitos (Scombridae), Yellowfin tuna (*Thunnus albacares)*, herrings (Clupeiformes), Spanish mackerel (*Scomberomorus commerson*) and several additional tuna taxa (frigate tuna, *Auxis* spp.; Kawakawa, *Euthynnus affinis;* bigeye, *Thunnus obesus*) and Penaeus shrimps (Figure 23).

By commercial grouping, perch-like fishes represented the largest individual component, followed by tuna and billfishes, crustaceans and herring-like fishes (Figure 24). In terms of landed value, tuna and billfishes contributed the most, estimated 35 million USD·year^{-1} from 2000 on(Figure 25).

Over the entire time period, landings by functional group were dominated by small demersals (Figure 26), but this group (2,100 t·year^{-1} since 2000) was replaced by other groups since 2000, with small pelagics, large pelagics, and medium pelagics accounting for 9,850 t·year^{-1}, 12,600 t·year^{-1} and 8,150 t·year^{-1}, respectively, since 2000 (Figure 26). The landed value by functional group was dominated by large pelagics, which represented 47% of the total landed value (and 41.9 million USD·year^{-1} since 2000; Figure 27), followed by small demersals (although reduced to minimal landed value since 2000), medium pelagic and small pelagic (8 million and 6 million USD·year^{-1}, respectively since 2000; Figure 27).

Fishing in the EEZ of the Andaman and Nicobar Islands was dominated by Thai vessels, accounting for 43% of catches over the entire time period, Sri Lankan vessels accounting for 31% and domestic

(Indian) vessels accounting for 25% of catches (Figure 28). The remaining landings were taken by vessels from other countries outside the Bay of Bengal area, including Japan, Taiwan, South Korea and others. Of note is the rapid appearance of Sri Lankan and Thai entities in the mid 1970s (Figure 28), which partially may be influenced by the spatio-temporal allocation rules employed by the *Sea Around Us* project for deciding when a country's fishing fleet is deemed capable of fishing in foreign waters distant from home ports (e.g., early to mid 1970s for Sri Lanka and Thailand). Furthermore, a rapid disappearance of Thai fishing from the waters of the Andaman and Nicobar Islands is illustrated for 1999 (Figure 28), driven by the termination of official fishing access agreements between Thailand and India. The landed value by fishing country was highest for Sri Lanka, which was estimated to be 54% of the total landed value for this EEZ over the full time period, and over 80% since 2000 (42 million USD·year^{-1} by 2006). This was followed by Thai fleets (although officially absent since 1999) and Indian fleets (13%, 9.5 million USD·year^{-1} since 2000), while Japanese fleets dominated the landed values prior to 1975 (Figure 29). However, Japanese fishing phased out after 1976 when India declared its EEZ.

Using the *Sea Around Us* global taxon-gear associations, the majority of landings (49%) were taken by gillnet (23% or 9,460 t·year^{-1} since 2000; Figure 30). Mid-water trawls also caught a substantial portion of total landings (8% during the 2000s). Gillnet landings also had the highest landed value, estimated at 9 million USD·year^{-1} from 2000 on (Figure 31). Longline tuna and troll line fisheries were estimated at 18.4 and 5.7 million USD·year^{-1}, respectively from 2000 on (Figure 31). Significantly, longline tuna gear overtook gillnets in terms of landed value since 2000.

Indonesia

Total landings from the BOBLME portion of the Indonesian EEZ were estimated to be 9.6 million tonnes for the 1950-2006 period, and 426,000 t·year^{-1} from 2000 on (Figure 32). Landings were dominated by a large variety of taxonomic entities (here presented as 'mixed group', as each taxon does not contribute much overall), and 'miscellaneous marine fishes' accounted for nearly 8% of total reported landings. For individually reported species, short mackerel (*Rastrelliger brachysoma*), banana prawn (*Fenneropenaeus merguiensis*) and blood cockle (*Anadara granosa*) represented 7%, 6% and 5%, respectively, of total landings. Reported landings were very low until the mid-1970s, when landings increased by almost 50,000 tonnes per year from 1976 to 1977. Given that landings within the Indonesian EEZ are dominated by Indonesian fleets (see below), this sudden change in landings in the mid 1970s may be a reflection of the quality of Indonesian statistical data for the earlier decades. The total value of landings for the 1950-2006 time period was estimated at 6.2 billion USD, and 239 million USD·year^{-1} from 2000 on (Figure 33). The landed value was dominated by shrimp, with banana prawns, estimated at 65 million USD·year^{-1} since 2000 being the single highest taxon, followed by *Metapenaeus* spp. and giant tiger prawns (*Penaeus monodon*), with 24 and 16 million USD·year^{-1} from 2000 on, respectively (Figure 33).

Landings by commercial groups were largest for perch-likes, which represented 41% of total landings. 'Other fishes and invertebrates', crustaceans and herring-likes also represented significant portions of the total landings (15%, 13% and 11%, respectively; Figure 34). The landed value by commercial group was highest for crustaceans (driven by shrimp catches), estimated at 112 million USD·year^{-1} from 2000 on (Figure 35). Perch-likes had the second highest landed value, estimated at 66.7 million USD·year^{-1} from 2000 on. The landed value of both crustaceans and perch-likes increased steadily over the time period considered (1950-2006).

Total landings by functional group were dominated by medium pelagic (18%), small pelagic (17%), small demersals (15%) and shrimp (11%; Figure 36). As expected, landed values by functional group were clearly dominated by shrimp, estimated at 105 million USD·year^{-1} from 2000 on (Figure 37).

Landings from the Bay of Bengal portion of Indonesia's EEZ were largely by Indonesian fleets (84%; Figure 38). In addition, Thailand was responsible for 15% of total landings. Japan (until the mid 1980s), South Korea, Taiwan and a few other countries made up the remaining 1% of landings The value of landings from this portion of Indonesia's EEZ was highest for Indonesian fleets with annual averages of 233 million USD·year^{-1} from 2000 on (Figure 39). Thai fishing fleets contributed 19% of landed value. Our allocation also assigned 5 million USD·year^{-1} worth of landings to Philippine vessels during the early-mid 2000s (Figure 39).

The gears responsible for the majority of landings were gillnets (24%), bottom trawls (14%), purse seines (11%), shrimp trawls (11%) and mid-water trawls (10%) (Figure 40). The landed value was clearly dominated by shrimp trawls, estimated at 105 million USD·year^{-1} from 2000 on, and gillnets, estimated at 36 million USD·year^{-1} from 2000 on (Figure 41). As noted previously, the bottom trawl ban introduced in 1980 (Martosubroto, 1996; Buchary, 1999; Butcher, 2004) in western Indonesia was not incorporated in the global taxon-gear associations used for assigning reported landings to gear type.

Malaysia

Landings from the EEZ waters of Malaysia within the Bay of Bengal were estimated to be approximately 13.3 million tonnes over the period 1950-2006, and 393,000 t·year^{-1} from 2000 on (Figure 42). The catch was dominated taxonomically by Indo-pacific mackerels (*Rastrelliger* spp.) accounting for 19% of total landings. Landings of Indo-pacific mackerels were highest from the mid-1980s onward (Figure 42). Until the early-1980s, substantial amounts of shrimp and prawns were caught also, but these landings decreased distinctly after 1983 and remained low throughout the rest of the study period (Figure 42). Interestingly, a small amount of sergestid shrimp (Sergestidae) were reported starting with the time period of decline of the shrimp and prawn landings, suggesting a possible shift in target species (Figure 42). The total value of landings from Malaysian waters over the 1950-2006 time period was estimated at 17.5 billion USD, and approximately 476 million USD·year^{-1} from 2000 on (Figure 43). By species, the landed value was highest for shrimps and prawns (3.6 billion USD, but only 18.4 million USD·year^{-1} from 2000 on), which had the highest value during the first half of the study period, whereas Indo-pacific mackerel were more highly valued during the second half of the study period (88 million USD·year^{-1} since 2000). Of note is that the potential target shift from 'shrimp and prawns' to sergestid shrimp in the early 1980s is clearly reflected in landed values, with sergestid shrimp accounting for 22.6 million USD·year^{-1} from 2000 on (Figure 43).

Catch by commercial group was dominated by perch-like fishes, which represented 44% of total landings over the entire time period considered (1950-2006). Other fishes and invertebrates made up 28% of landings, and crustaceans 13% (Figure 44). The value of landings by commercial group was highest for crustaceans followed by perch-likes (Figure 45). Over the period 1950-2006, landings of crustaceans represented 37% of total landed value, and perch-likes represented 35% (Figure 45). The landed value of perch-likes has increased over time whereas the value of crustaceans has decreased. From 2000 on, perch-like fishes contributed 221 million USD·year^{-1}, while crustaceans provided 131 million USD·year^{-1} to total landed value.

By functional groups, landings were dominated by medium pelagics, which made up 28% of total landings (Figure 46). Small demersals also represented a large portion of the total landings (23%), and dominated landings prior to the early 1980s. Small pelagics and shrimps were the next most important contributors to landings. Landed value by functional groups was highest for shrimps, estimated at 79 million USD·year^{-1} from 2000 on (Figure 47). Since the early 1980s, landings of medium pelagics have dominated landed value, representing 28% of the total landed value from 2000 on (131 million USD·year^{-1}, Figure 47).

Landings in the waters of Malaysia within the BOBLME were mainly by Malaysian fishers (87% of total landings; Figure 48). Thai fishers increasingly took a larger share of landings starting in the mid 1990s, and in total were responsible for 12.5% of landings from the BOBLME portion of the Malaysian EEZ (Figure 48). The landed value of the catch was highest for Malaysia's fleets, contributing over 344 million USD·year^{-1} since 2000 (Figure 49). Thai fleets accounted for 132 million USD·year^{-1} during the same time period, while Japanese, South Korean, Taiwanese and Ukrainian fleets fishing in these waters until the late 1970s accounted for less than 0.3% overall (Figure 49).

The majority of landings were taken by gillnet, representing 30% of total landings (Figure 50). Bottom trawls, mid-water trawls and purse seines, represented 15%, 14% and 11%, respectively, of total landings, but landings by these gears were most substantial since the 1980s (Figure 50). The landed value by gear was highest for gillnets, 18% (Figure 51). Bagnets and bottom trawls contributed the next highest landed values. Noteworthy is that landed values for the most recent time period (since 2000) are dominated by bottom trawl gear, which presently accounts for around 24% of total landed value (Figure 51).

Maldives

Reported landings from the EEZ waters of the Maldives over the period 1950-2006 were estimated at 3.4 million tonnes, and 163,000 t·year^{-1} from 2000 on (Figure 52). Skipjack tuna (*Katsuwonus pelamis*) represented the greatest portion of total landings (6%), with approximately 12,000 t·year^{-1} being landed during the 1950s and 1960s, and nearly 140,000 t·year^{-1} being reported by 2006 (Figure 52). Landings of yellowfin tuna (*Thunnus albacares*) were also substantial, representing 13% of the total catch over the 1950-2006 time period. Noteworthy is that 'sharks and rays' were the third most important taxonomic group in terms of landings (Figure 52). The total landed value was estimated at 12.4 billion USD for the period 1950-2006 and 550 million USD·year^{-1} from 2000 on (Figure 53). Landed value was dominated by skipjack tuna, with over 425 million USD·year^{-1} from 2000 on, accounting for 74% of total landed value (Figure 53). Yellowfin tuna was valued at 76 million USD·year^{-1} (14%) and frigate tunas at 16 million USD·year^{-1} (5%) since 2000, while the remaining species contributed much less to the overall landed value.

As expected, reported landings by commercial groups were dominated by tuna and billfishes, while landings of 'other fishes and invertebrates' and 'sharks and rays' were considerably smaller (Figure 54). Sharks and rays did not appear in the reported landings data until the 1960s and were most substantial during the mid-1990s to mid-2000s. The value of the landings by commercial group was accounted for almost exclusively by tuna and billfishes (98%), which were estimated at 542 million USD·year^{-1} from 2000 on (Figure 55).

In line with the above, landings by functional groups were dominated by large pelagics (82%) and to a lesser extent small demersals (8%; Figure 56). The landed value by functional group was highest for large pelagics, which represented 524 million USD·year^{-1} from 2000 on, or 92% of total landed value by functional group (Figure 57).

Landings from the Maldives EEZ were almost exclusively taken by Maldivian fishers (95% of total landings; Figure 58). The remaining 5% of landings were taken by other countries including Japan, Taiwan, Egypt, Ukraine, South Korea, Russia and Spain prior to 1976, the year the Maldives declared their EEZ. The Maldivian fleets dominated landed value, accounting for 96% or 536 million USD·year^{-1} from 2000 on (Figure 59).

Landings in the waters of the Maldives were mainly taken by troll lines until the mid-1990s, after which pole and line as well as gillnets became the dominate gear in terms of reported landings (Figure 60). Over the past two decades, tuna longlines also contributed increasingly to total landings, increasing from around 3,000-5,000 t·year^{-1} to 21,000 t·year^{-1} by 2006. However, landings by this gear are small in comparison to pole and line tuna gear, which increased from around 60 t·year^{-1} in 1950 to 100,000-140,000 t·year^{-1} by the 2000s (Figure 60). The landed value by gear was highest for troll lines until the mid-1990s, accounting for 5 billion USD over the period 1950-2006 (41%; Figure 61). From 1995 onward, landed values were dominated by pole and line gear, accounting for 77% of total landed value (Figure 61).

Myanmar

Spatially allocated reported landings

Reported landings from the EEZ waters of Myanmar for the period 1950-2006 were estimated to be 30.8 million tonnes, and 1.4 million t·year^{-1} from 2000 on (Figure 62). Landings were dominated by the 'mixed group' of taxa (93%), being predominately 'miscellaneous marine fishes' (91%). The remaining 6% of landings consisted mainly of 'natantian decapods' (i.e., mainly shrimps and prawns) accounting for 351,000 t (1.1%), Indo-Pacific mackerels (312,000 t, 1.0%), *Sardinella* spp. (284,000 t, 0.9%), Indian scad (208,000 t, 0.7%), anchovies (205,000 t, 0.6%) and bigeye (198,000 t, 0.6%; Figure 62). The total landed value from Myanmar's waters was estimated at 21 billion USD for the 1950-2006 period, and 990 million USD·year^{-1} from 2000 on (Figure 63). Natantian decapaods were the most important named taxonomic group, accounting for 1.2 billion USD over the full time period, and 73 million USD·year^{-1} from 2000 on (Figure 63).

Given the poor taxonomic differentiation of reported landings, landings by commercial grouping were dominated by 'other fishes and invertebrates', which represented 90% of total landings (Figure 64). Perch-likes represented 5% of total landings and crustaceans represented 2%. The landed value by commercial group was highest for 'other fishes and invertebrates' (Figure 65), which was estimated at 16.9 billion USD for the period 1950-2006, and 720 million USD·year^{-1} 2000 on.

By functional group, landings were mainly small demersals, which represented over 89% of total reported landings (Figure 66). Medium pelagics and shrimps represented 3.5% and 2%, respectively. The landed value by functional group was highest for small demersals, estimated at 16.4 billion USD over the 1950-2006 time period, and 683 million USD·year^{-1} from 2000 on (Figure 67). Shrimp landings from in the waters of Myanmar were valued at 150 million USD·year^{-1} from 2000 on.

The majority of reported landings (86%) in the waters of Myanmar were by Myanmar fleets (Figure 68). In addition, Thailand caught 14.3% of reported landings from the Myanmar EEZ since 1950. Similarly, landed values were dominated by Myanmar fleets, with 17 billion USD accounting for 80% of landed value based on the reported data, while Thai fleets accounted for most of the rest, i.e., 285 million USD·year^{-1} from 2000 on (Figure 69).

Landings were taken almost entirely by gillnet, with a small fraction taken by mid-water trawls, bottom trawls and shrimp trawls (Figure 70). Landed values were also highest for landings taken by gillnets, estimated at 689 million USD·year^{-1} from 2000 on (Figure 71). Shrimp trawl landings had the second highest value, estimated at 145 million USD·year^{-1} from 2000 on.

Total reconstructed catch

Reconstructing total fisheries catches for Myanmar was hampered by a dearth of information sources, and poor responses from local experts (see Appendix I for full report). Based on information available at the time of writing, reconstructed marine fisheries catches for Myanmar were estimated to be over 32 million tonnes over the 1950-2008 time period (Figure 72; Appendix I). FAO reports, on behalf of Myanmar, total landings of nearly 30 million tonnes. The discrepancy of 9% is due to an upward adjustment of statistics reported to FAO for 1950 to 2004 to account for unreported catches, and a downward adjustment to catches reported to FAO for the period 2005-2008. The downward adjustment to reported catches during this period was to account for official statistics reporting continued increases in landings despite the strong negative impact of Cyclone Nargis in 2008 (whose well documented negative impacts on the fisheries is not reflected in reported data). The dominant taxa identified in the catch reconstruction were shrimp and prawns, small pelagics (Indian mackerel, clupeids, and anchovies), croakers (Sciaenidae), carangids (jacks, horse mackerels and scads), and elasmobranchs (sharks, skates and rays; Figure 73).

Sri Lanka

Spatially allocated reported landings

Landings from the waters of Sri Lanka by all fishing countries, as presented in the *Sea Around Us* Project catch database based on the global allocation process (Watson *et al.*, 2004), totaled 2.7 million tonnes for the period 1950-2006 (Figure 74). The main species caught were herring-like fishes (Clupeiformes), silky shark (*Carcharhinus falciformis*) and 'mackerels, tunas and bonitos' (Scombridae). The total value of landings over the period 1950-2006 was estimated to be 5.2 billion USD, and 52 million USD·year^{-1} from 2000 on. The most highly valued species group was mackerels, tunas and bonitos totaling 10.2 million USD·year^{-1} from 2000 on. Skipjack tuna (*Katsuwonus pelamis*) was the second most highly valued taxon, estimated at 10.5 million USD·year^{-1} from 2000 on. Narrow-barred Spanish mackerel (*Scomberomorus commerson*) and yellowfin tuna (*Thunnus albacares*) were also substantial in value, especially during the mid-1960s to the mid-1970s (Figure 75).

Aggregated by commercial group, the dominant grouping was 'other fishes and invertebrates', followed by the fishes belonging to the 'perch-like' category and 'sharks and rays' (Figure 76). For the commercial grouping, the perch-likes had the highest overall landed value for the entire time period, estimated at almost 2.3 billion USD. For the most recent time period (since 2000), however, tuna and billfishes are valued higher, contributing 26 million USD·year^{-1} to total landed value, while perch-like fishes provide 14.4 million USD·year^{-1} to landed value. The 'other fishes and invertebrates' had an estimated landed value of 5.9 million USD·year^{-1} from 2000 on (Figure 77).

Landings by functional group were dominated by small pelagics, followed by large pelagics, large sharks and medium pelagics (Figure 78). The landed value was dominated by large pelagics, estimated at 35.8 million USD·year^{-1} from 2000 on (Figure 79).

Landings were almost exclusively taken by Sri Lanka, with less than 1% of the landings being taken by foreign fleets (Figure 80). Of the foreign vessels fishing in Sri Lankan waters, Japan had the highest share, with 20,000 t (0.8%). However, Japan only fished these waters prior to 1977, before Sri Lanka declared its EEZ. The landed value of the catch was highest for Sri Lanka, being 5 billion

USD, and 51.6 million USD·year^{-1} from 2000 on, and accounting overall for 99% of the landed value (Figure 81).

Based on the global taxon-gear associations derived by the *Sea Around Us* project, a large variety of gears appears to be used in Sri Lankan waters (Figure 82). However, the gear-type most used over the entire time period is gillnets, which represented 28% of the reported landings. Catches taken with hooks were also substantial (14%) as were purse seines (10%; Figure 82). Over the entire time period, the landed value by gear-type was highest for catches taken by gillnet, estimated at over 1.2 billion USD from 1950-2006. Since 2000, however, longline tuna gears provide the largest landed value, at 13.5 million USD·year^{-1}, while gillnets contribute around 6 million USD·year^{-1} (Figure 83). Troll lines also represent a substantial portion of the total value of landings in Sri Lankan waters, estimated at 5 million USD·year^{-1} from 2000 on.

Total reconstructed catch

Total marine fisheries catches taken by Sri Lanka in the EEZ waters of Sri Lanka were estimated for the period 1950-2008 to be almost 18 million tonnes (Figure 84; see Appendix II for full report). In contrast, reported landings, as presented by the FAO on behalf of Sri Lanka were 8.4 million tonnes. Thus, the overall reconstructed estimates of total catches were over 2 times larger than the landings officially reported by Sri Lanka to the FAO. The subsistence catch represented 40%, and discards represented 13% of the total estimated catch. The remainder of the total catch was from the artisanal (26%) and industrial (21%) sub-sectors of commercial fisheries. During the catch reconstructions, the estimate for commercial catch was almost entirely based on reported landings, while the subsistence and discards were entirely unreported components. Reconstructed catches were dominated taxonomically by pony fish (Leiognathidae), skipjack tuna (*Katsuwonus pelamis*), herrings, sardines, and anchovies (Clupeoids), jacks (Carangidae), and yellowfin tuna (*Thunnus albacares*; Figure 85).

Thailand

Landings from the EEZ waters of Thailand within the Bay of Bengal were estimated at 1.4 million tonnes over the 1950-2006 time period, and 82,500 t·year^{-1} from 2000 on (Figure 86). Indo-pacific mackerels and *Sardinella* spp. represented the largest taxonomically distinct components of reported landings, followed by bigeyes (*Priacanthus* spp.) and Indian scad (*Decapterus russelli*). Landings by these taxa represented 9%, 6%, 5% and 4%, respectively, of the total landings. The total value of landings from the Bay of Bengal portion of Thailand's EEZ was estimated at 1.2 billion USD for the 1950-2006 time period, and 67.5 million USD·year^{-1} from 2000 on (Figure 87).

Landings by commercial groups were dominated by 'other fishes and invertebrates' and perch-likes, which represented 42% and 34%, respectively, of the total landings (Figure 88). Landings of perch-like fishes increased steadily throughout the period and by the 2000s represented 45% of the total landings. The landed value by commercial groups was highest for crustaceans and 'other fishes and invertebrates' (Figure 89), estimated at 22.6 and 22.9 million USD·year^{-1} from 2000 on.

Landings by functional group in the waters of Thailand within the Bay of Bengal were dominated by small demersals, representing 36% of total landings (Figure 90). Medium pelagics represented 24%, medium demersals represented 11%, and cephalopods represented 8% of total reported landings (Figure 90). The landed value by functional group was highest for shrimps with an estimated value of 12.9 million USD·year^{-1} from 2000 on (Figure 90). The landed value for small demersals was 12.2 million USD·year^{-1} since 2000. The landed value for cephalopods and medium pelagics was also considerable, particularly in more recent decades. In the 2000s, cephalopods and medium pelagics had average annual values of 11.4 million USD·year^{-1} and 8.9 million USD·year^{-1}, respectively.

Thailand almost exclusively dominated the landings, with over 99% of landings being taken by Thai fishers (Figure 92). Japan was responsible for just over 6,000 tonnes of landings between 1952 and 1979. The landed value was highest for Thailand, with 68 million USD·year^{-1} from 2000 on (Figure 93).

The majority of landings from Thai waters within the Bay of Bengal were caught using gillnets (Figure 94). Approximately 40% of total landings were from gillnet fisheries. In the early time period (1950s-1970s), gillnets fisheries represented over 60% of the total landings, whereas in the recent period (2000s) gillnets caught less than 30% of total landings. In the recent period, mid-water trawls, bottom trawls and purse seines became much more important in terms of tonnage landed by these gears (Figure 94). The landed value by gear was highest for gillnet landings (Figure 95), accounting for 13.7 million USD·year^{-1} from 2000 on. While shrimp trawls were the second most valuable gear-type in earlier periods (Figure 95), bottom trawls overtook shrimp trawls in the 1990s, accounting for 16 and 12 million USD·year^{-1}, respectively, from 2000 on (Figure 95).

High Seas

Landings from the high seas within the Bay of Bengal Large Marine Ecosystem totaled 5.8 million tonnes (307,000 t·year^{-1} since 2000, Figure 96). Skipjack tuna, Longtail tuna (*Thunnus tonggol*) and Kawakawa dominated taxon-specific landings, each representing 5% of total high seas landings (16,000 t·year$^{-1,}$ 14,600 t·year^{-1} and 16,000 t·year^{-1}, respectively since 2000). The majority of high seas landings were from 1980 onward. The landed value taken on the high seas was estimated for the 1950-2006 time period to be 6.6 billion USD (295 million USD·year^{-1} since 2000; Figure 97). Bigeye tuna and yellowfin tuna had estimated values of 23 million USD·year^{-1} and 31.8 million USD·year^{-1}, respectively since 2000 (Figure 97).

Total landings by commercial group were dominated by 'other fishes and invertebrates', representing 65% of landings (211,000 t·year^{-1} since 2000), and 'tuna and billfishes', representing

25% of total landings (70,900 t·year^{-1} since 2000; Figure 98). By landed value, 'tuna and billfishes' were estimated at 134 million USD·year^{-1} since 2000, while 'other fishes and invertebrates' were estimated at 126 million USD·year^{-1} since 2000 (Figure 99).

Landings by functional group were highest for small demersals and large pelagics, representing 63% and 26%, respectively, of total landings (203,500 t·year^{-1} and 72,500 t·year^{-1} since 2000; Figure 100). Large pelagics were the most highly valued, estimated at 142 million USD·year^{-1} from 2000 on, while small demersals were estimated at 117 million USD·year^{-1} since 2000 (Figure 101).

Landings on the high seas were dominated by fleets from countries bordering the Bay of Bengal, with Malaysia, Thailand, Indonesia and Sri Lanka representing 32%, 26%, 22%, and 10% of total high seas landings, respectively (92,800, 97,600, 72,500 and 24,900 t·year^{-1} since 2000; Figure 102). Landings by countries from outside the BOBLME were highest for Japan and Taiwan, accounting for 3% and 1.5%, respectively. The landed value taken on the high seas was highest for Malaysia, estimated at 76 million USD·year^{-1} since 2000. Sri Lanka had the second highest landed value, estimated at 68 million USD·year^{-1} since 2000. Japanese, Thai and Indonesian fleets contributed values of 29.7, 56.9 and 30.1 million USD·year^{-1} since 2000 (Figure 103). Japanese catches from this region of the high seas seem to be continuing to decline.

Based on the taxon-gear associations derived globally by the *Sea Around Us* project, landings over the entire time period were mainly from gillnet fisheries (74%) and tuna longline fisheries (9.6%), and account for 232,000 and 27,600 t·year^{-1}, respectively since 2000 (Figure 104). It is feasible that the taxon-gear association for gillnets as applied here for the high seas area may not be fully representative for gear use in the high seas. Gillnet and tuna longline gears provided the highest landed values, estimated at 135 and 84 million USD·year^{-1} from 2000 on (Figure 105).

Bay of Bengal Large Marine Ecosystem (BOBLME)

In this section, we present data for the entire Bay of Bengal Large Marine Ecosystem (national as well as international, high seas waters combined), as defined in Figure (1). Landings from the waters of the BOBLME were estimated to be approximately 111 million tonnes over the 1950-2006 time period (4.5 million t·year^{-1} since 2000; Figure 106). While a large number of taxa, each contributing only a relatively small amount to total catches (here grouped as 'mixed group') accounted for 75% (i.e., 83 million t), the four most important individual taxa in the reported data were herring-like fishes (Clupeiformes, 71,000 t·year^{-1} since 2000), Indo-pacific mackerels (*Rastrelliger* spp., 125,000 t·year^{-1} since 2000), Hilsa shad (*Tenualosa ilisha*, 168,000 t·year^{-1} since 2000), skipjack tuna (*Katsuwonus pelamis*, 143,000 t·year^{-1} since 2000) and 'drums or croakers' (Sciaenidae, 100,000 t·year^{-1} since 2000), each accounting for around 3% of total catches over the entire time period (Figure 106). The total landed value from the Bay of Bengal LME over the 1950-2006 time period was estimated at 110 billion USD (4 billion USD·year^{-1} since 2000; Figure 107). While the assemblage of 'mixed group' accounted for the largest share of contributions (2.5 billion USD·year^{-1} since 2000), the single most valuable taxon was skipjack tuna, contributing 11% to total landed value (502 million USD·year^{-1} since 2000; Figure 107).

Aggregated by commercial groups, landings were mainly 'other fishes and invertebrates' (50% of the total landings, 2.3 million t·year^{-1} since 2000; Figure 108). Perch-likes also contributed a large portion of total landings (951,000 t·year^{-1} since 2000), becoming increasingly important through time. Landings of crustaceans and herring-likes were also substantial, with 314,000 and 352,000 t·year^{-1}, respectively, since 2000 (Figure 108). The landed value by commercial group was highest for 'other fishes and invertebrates', estimated at 1.4 billion USD·year^{-1} since 2000 (Figure 109). Landings of crustaceans were also highly valued, estimated at 985 million USD·year^{-1} since 2000. Tuna and billfishes were valued at 797 million USD·year^{-1}, while perch-likes were estimated to contribute 543 million USD·year^{-1} since 2000.

Landings by functional group were dominated by small demersals, representing 44% of total landings (2.2 million t·year^{-1} since 2000; Figure 110). Landings of medium pelagics increased considerably through the time period, but overall only represented 14% of total landings (630,000 t·year^{-1} since 2000). Small pelagics represented 9% and shrimps 7% (269,000 t·year^{-1} and 214,000 t·year^{-1}, respectively, since 2000; Figure 108). The landed value by functional group was dominated by small demersals (1.2 billion USD·year^{-1} since 2000), shrimps (722 million USD·year^{-1} since 2000) and large pelagic (837 million USD·year^{-1} since 2000; Figure 111).

The majority of landings from the Bay of Bengal LME were by India's fishing fleets, which accounted for 27.1% of total landings (1.2 million t·year^{-1} since 2000; Figure 112). Myanmar's fleets accounted for 24% of total reported landings (1.1 million t·year^{-1} since 2000). Note, however, that there are serious concerns about Myanmar's reported landings statistics for recent years (see Appendix I). These contributions are followed by Thailand (629, 000 t·year^{-1} since 2000), Bangladesh (424,000 t·year^{-1} since 2000), Indonesia (494,000 t·year^{-1} since 2000), Malaysia (361,000 t·year^{-1} since 2000), Sri Lanka (119,000 t·year^{-1} since 2000) and the Maldives (156,000 t·year^{-1} since 2000; Figure 112). Other countries from outside the Bay of Bengal (primarily Japan and Taiwan) represented less than 1% of total landings from the BOBLME. The landed value by fishing country was highest for India (946 million USD·year^{-1} since 2000), followed by Myanmar (705 million USD·year^{-1} since 2000, but see note above), Maldives (536 million USD·year^{-1} since 2000), Thailand (541 million USD·year^{-1} since 2000) and Malaysia (421 million USD·year^{-1} since 2000; Figure 113).

Landings by gear were dominated by gillnets, with 53% of total reported landings (2.6 million t·year^{-1} since 2000; Figure 114). Bottom trawl landings contributed 376, 000 t·year^{-1} since 2000, mid-water trawls 318,000 t·year^{-1} since 2000, shrimp trawls 200,000 t·year^{-1} since 2000, and purse seines 190,000 t·year^{-1} since 2000 (Figure 114). The landed value by gear-type was highest for gillnets (32.5% of total landed value), estimated to be 1.4 billion USD·year^{-1} since 2000 (Figure 115). Shrimp trawl gear contributed the second highest landed value (20.3%), estimated at 674 million USD·year^{-1}

since 2000. This was followed by bottom trawls (98 million USD·year^{-1} since 2000) and troll lines (71.8 million USD·year^{-1} since 2000). Note that for the more recent time period, the contribution from troll lines has declined substantially, while landed values from pole and line tuna gear has increased considerably. Essentially, troll line gear, which accounted for over 200 million USD·year^{-1} in the early 1990s, had declined to between 60-70 million USD·year^{-1} by the mid 2000s. In contrast, pole and line gears increased their contribution to total landed value from 6 million USD·year^{-1} in the early 1990s to over 500 million USD·year^{-1} by the mid 2000s (Figure 115). This change in gear contribution to total landed value (both gears targeting tuna) is predominantly driven by changes in gear types by the Maldives fleets (see Maldives section above).

Export data

At present, globally available export data are limited in time (starting only in 1976) and spatial assignment, and can only be reported on a per country basis. Thus, it is not possible to assign exports from the countries surrounding the Bay of Bengal to catches originating from within or outside the BOBLME waters.

Total exports of marine products by the eight countries that border the Bay of Bengal totaled 60 million tonnes over the 1976-2008 time period. The value of these exports was estimated at 176 million USD (Table 3). Thailand, Indonesia and India had the largest exports by quantity and value.

Discussion and Conclusions

The Bay of Bengal Large Marine Ecosystem (BOBLME) Project aims to improve regional management of fisheries and the marine environment by identifying threats to the marine ecosystem, improving the livelihoods of coastal communities and securing food resources of the Bay of Bengal. As a component of the larger BOBLME project, we have examined fisheries catch data as spatially allocated to the waters of the BOBLME using the global catch allocation procedure of the *Sea Around Us* project (www.seaaroundus.org). The input data into the spatial allocation procedure consists of landings data as reported by each member country to the UN Food and Agriculture Organization (FAO), with the exception of India, for which we had reconstructed total catch data based on Bhathal (2005) and Bhathal and Pauly (2008). Furthermore, as part of the present study, we reconstructed total fisheries catches, and contrasted these to reported landings data (as reported to FAO) for two of the eight countries (Sri Lanka and Myanmar). Here we discuss each country individually, highlighting major findings and issues.

Bangladesh

Bangladesh suffers some of the highest levels of poverty amongst the Bay of Bengal countries, which may explain the poor quality of fisheries data for Bangladesh. Landings in the waters of Bangladesh amounted to over 9 million tonnes over the period 1950-2006 (424,000 t·year^{-1} since 2000), the majority of which were from domestic fleets. However, in the early time period (prior to the establishment of an EEZ), Thai trawlers operated extensively in the waters of Bangladesh, and in 1980 entered into joint venture agreements allowing over 100 trawlers to operate legally within the Bangladesh EEZ (Butcher, 2004). Joint venture schemes are one way for a country to continue fishing in another country's waters without paying foreign access fees. These operations likely have minimal economic benefit to the country where the fishing occurs and comes at a high ecological cost as it depletes domestic resources mainly deemed for export.

India (mainland)

Total catches in the EEZ waters of India within the Bay of Bengal were estimated to be 32.3 million tonnes over the period 1950-2006 (1.2 million t·year^{-1} since 2000). These estimates represent total extractions from the marine environment as the spatially allocated data for India used total reconstructed catches as input data. Therefore, this estimate includes many components that are unaccounted for in the landings estimates for the other countries, such as unreported catches and discards. The largest portion of India's catch was 'miscellaneous marine fishes', with Indian oil sardine (*Sardinella longiceps*), drums or croakers (Sciaenidae) and penaeid shrimps as the largest individually represented taxa. Total landed value of catches in India's waters within the Bay of

Bengal was estimated at over 1 billion USD·year^{-1} since 2000, with shrimp catches being the most highly valued.

Andaman and Nicobar Islands (India)

The estimated landings of 2 million tonnes for the 1950-2006 time period (41,500 t·year^{-1} since 2000) from the waters of the Andaman and Nicobar Islands were mainly from Thai and Sri Lankan vessels, with domestic (Indian) vessels accounting for 25% of catches. Foreign fishing, including highly destructive and illegal dynamite fishing, is known to occur in Andaman and Nicobar waters (Rajan, 2003). Thai and Sri Lankan fleets appeared mainly in the mid 1970s in our data, which may partially be an artifact of our spatial allocation procedure, which required us to set a year for each country after which the fishing fleets of that country had developed the capacity to fish beyond their own waters, either in high seas waters or other country EEZ waters. For Sri Lanka, that year is presently set to 1976, and in this case resulted in a substantial re-allocation of Sri Lankan catches to other areas, such as the Andaman and Nicobar Islands in whose waters Sri Lankan vessels are known to be fishing. The *Sea Around Us* project hopes to refine this procedure in the future, but requests that feedback can be provided to improve this 'year' assumption. Similarly, a rapid disappearance of Thai fishing from the waters of the Andaman and Nicobar Islands in 1999 is driven by the termination of official fishing access agreements between Thailand and India.

Indonesia

Total landings from the Bay of Bengal LME portion of the Indonesian EEZ were estimated to be 9.6 million tonnes (426,000 t·year^{-1} from 2000 on). Landings were dominated by a large variety of taxonomic entities, presented here as 'mixed group', as each taxon does not contribute much on its own. Of the individually reported species, short mackerel (*Rastrelliger brachysoma*), banana prawn (*Fenneropenaeus merguiensis*) and blood cockle (*Anadara granosa*) each represented 5-7% of the total landings. Reported landings were very low until the mid-1970s, when landings nearly doubled between 1976 and 1977. Given that landings within the Indonesian EEZ are dominated by Indonesian fleets, this sudden change in landings in the mid 1970s may be a reflection of the quality of Indonesian statistical data for the earlier decades. However, this sudden increase may also have been the result of the rapid introduction of trawlers between 1966 and 1971, which in the Straits of Malacca increased from 8 to 830 vessels (Butcher, 2004). The construction of numerous fish processing plants and improved freezing capacity has also been linked to the increase in catches and exports seen during the 1970s (Butcher, 2004). Although dominated by Indonesian vessels, Thai vessels were responsible for 15% of landings and accounted for 19% of the value of landings from Indonesian waters. Numerous joint-venture operations were established between Indonesia and Japan during the late 1960s in response to a government regulation that restricted access by foreign vessels to its waters unless they entered into a joint venture with an Indonesian company (Butcher, 2004). This may also explain the increase in landings observed in the 1970s. A catch reconstruction would help address these questions and resolve whether this substantial increase in landings is due to reporting issues or an increase in fishing activity.

While it is known that the Indonesian government instituted a formal trawl ban in 1980 (Martosubroto *et al.*, 1996; Buchary, 1999), a decrease in catch taken by trawl nets is not observed in the *Sea Around Us* data, as such national management information is not incorporated in the globally derived gear associations (Watson *et al.*, 2006a; Watson *et al.*, 2006b).

Malaysia

Landings from Malaysian waters were dominated by Malaysian vessels, with an increasing number of landings from Thai vessels, from the 1990s onward. Overall, the dominant species landed from Malaysian waters was the Indo-pacific mackerel. In the early time period, shrimp and prawn landings were substantial, but decreased dramatically after 1983 and remained low throughout the rest of the study period. During the mid-1960s, there was an increase in demand for shrimp (primarily from the Japanese market) and during this same time period a surge in trawlers was seen, largely promoted through government regulations which specified a minimum vessel size (Butcher, 2004). Intensive trawling in the Straits of Malacca quickly caused a decrease in catch rates, suggesting that depletion was taking place as early as the mid-1970s (Butcher, 2004). Thai trawlers are thought to be partly responsible for the depletion of fish in the Malaysian EEZ during this period (Butcher, 2004). This may also explain the appearance of sergestid shrimp (Sergestidae) in the landings data around this time, which suggests a shift in target species.

Maldives

Landings from the waters of the Maldives over the period 1950-2006 were estimated at 3.4 million tonnes (163,000 t·year^{-1} from 2000 on). Skipjack tuna (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*) were the most important individually reported taxa, with 'sharks and rays' as the third most important taxonomic group in terms of landings. The total landed value was also dominated by skipjack and yellowfin tuna. Landings were mainly taken by troll lines until the mid-1990s, after which pole and line and gillnets became the dominate gear in terms of reported landings.

Myanmar

Spatially allocated catches for Myanmar amounted to 30.8 million tonnes over the 1950-2006 time period (1.4 million t·year^{-1} from 2000 on), 86% of these from domestic fleets. Reported landings were very poorly differentiated taxonomically, with 90% of landings reported as 'miscellaneous marine fishes'.

Total reconstructed catches for Myanmar for the period 1950-2008, which included reported and unreported catches as well as discards, were 9% larger than the reported landings data provided by Myanmar to the global community via FAO. The catch reconstruction has raised concerns about likely over-reporting of Myanmar's offshore catches in recent years, an issues which was partially addressed in the current reconstruction report by a downward adjustment to account for a decrease in catches associated with Cyclone Nargis in 2008 (see Appendix I). The reconstruction also improved the taxonomic resolution of the catch data.

Sri Lanka

Landings allocated to the waters of Sri Lanka were estimated to be 2.7 million tonnes over the 1950-2006 time period (29,000 t·year^{-1} from 2000 on), dominated taxonomically by herring-like fishes (Clupeiformes), silky shark (*Carcharhinus falciformis*) and 'mackerels, tunas and bonitos' (Scombridae). The decline in landings from Sri Lanka's EEZ after 1976 could potentially be an artifact of the *Sea Around Us* project's spatial allocation procedures, which presently assume that Sri Lankan fleets were capable of fishing in non-domestic waters only after 1976, resulting in the allocation assigning Sri Lankan reported landings to other EEZs (see e.g., Andaman and Nicobar Islands above) if access agreements exist or fishing was known to happen. The magnitude and rapid change as illustrated here is unlikely to be realistic, and this allocation issue will need to be addressed in future years through improvements in spatial allocation approaches and using spatially restricted reconstructed catches that are limited to Sri Lanka's EEZ waters.

Reconstructed catches (accounting for unreported catches mainly from the subsistence sector and discarded bycatch associated with shrimp trawl fisheries) for Sri Lanka from 1950-2008 were 2 times larger than the reported landings data provided by Sri Lanka to the global community via FAO.

Thailand

Landings from the waters of Thailand are estimated to be 1.4 million tonnes over the 1950-2006 time period (82,500 t·year^{-1} since 2000). The method used by the *Sea Around Us* project to spatially allocate FAO area catches to specific EEZ areas using fishing access observations and agreements may have allocated disproportionately large reported landings by Thai vessels to EEZ waters other than Thailand's. Thai fishers have access to a large number of EEZs and High Seas waters, both throughout the BOBLME as well as throughout the rest of the Indo-Pacific. This results in Thailand's own EEZ waters becoming a relatively small percentage of all areas accessible to Thai fleets, resulting in lower allocations of reported catches to Thai waters. This needs further investigations but can only be properly addressed through catch reconstructions, which will allow the determination of catches that can be locked within Thailand's EEZ, and not made available to general allocation within FAO areas.

High Seas

Fisheries landings from the high seas were estimated to be 5.8 million tonnes from 1950-2006 (307,000 t·year^{-1} since 2000), representing 5.3% of total landings from the Bay of Bengal LME over the study period. Landings were dominated by Malaysian, Thai and Indonesian vessels, which together represented over 85% of average annual landings since 2000. The value of landings was also highest for these vessels in the recent period (since 2000).

Bay of Bengal Large Marine Ecosystem (BOBLME)

Over the period 1950-2006, landings from the Bay of Bengal were over 110 million tonnes (4.5 million t·year^{-1} from 2000 on), with a landed value of 110 billion USD (4 billion USD·year^{-1} from 2000 on). India was responsible for the largest component (28%) of total landings by fishing country. Myanmar's landings represented 24% of total landings. However, the official landings statistics of Myanmar are questionable, and seem to be over-reported for recent years (see Appendix I). Unfortunately, a substantial percentage of reported landings are not assigned to a specific taxon by reporting countries, but are reported as 'miscellaneous marine fishes' or other miscellaneous categories, which is a highly uninformative accounting practice that needs to be addressed. At a time when the region is trying to move towards ecosystem-based fisheries management, or at least consider ecosystem implications as part of resource management, better ecological (i.e., taxonomic) as well as holistic (i.e., regular and comprehensive accounting or estimating unreported landings and discards) accounting of fisheries catches is urgently required.

Based on those landings that were better accounted for taxonomically, herring-like fishes (Clupeiformes), Indo-pacific mackerels (*Rastrelliger* spp.) and Hilsa shad (*Tenualosa ilisha*) dominated reported landings data, while tuna (skipjack and yellowfin) and shrimp dominated in terms of landed value.

Based on the globally derived taxon-gear associations used by the *Sea Around Us* project (Watson *et al.*, 2006a; Watson *et al.*, 2006b), over half of all landings from the BOBLME were caught by gillnets. In part, this may be an artifact of the global taxon-gear association methodology, which relies heavily on data on gears used to catch major commercial species.

Recommendations and Conclusions

Constraints to effective management in the Bay of Bengal include weak institutional capacity at national levels, insufficient budgetary and resource commitments to monitoring and enforcement, and lack of community stakeholder consultation and empowerment. Policies have been largely ineffective in addressing the issues which are affecting the health of the Bay of Bengal marine environment. Despite the large number of international, regional and sub-regional bodies and programs operating in the Bay, none have a clear mandate, geographical scope and/or capacity to support a regional initiative that would effectively address the issues confronting the coastal communities of the Bay of Bengal. The countries surrounding the Bay of Bengal face many more challenges than simply the management of their marine resources. Socio-economic constraints pose as major challenges in many of these countries, particularly Bangladesh, where poverty and weak governance are prevalent and have resulted in fisheries management considerations being secondary to meeting basic needs. While each of the Bay of Bengal countries faces its own unique set of socio-economic and political challenges, their dependence on coastal resources is universal. The sustainable use of fisheries resources is therefore critical to maintaining and improving the livelihoods and food security of the Bay of Bengal's coastal population.

While historically fisheries management focused on the commercial aspects of this industry, today the focus has shifted toward ecosystem-based considerations, and needs to shift further towards food security considerations. This shift from reporting only what is landed to estimating total marine extractions from the ecosystem requires a more comprehensive approach. Here, we use the examples of Sri Lanka and Myanmar to highlight the difference between the reported landings (i.e., the 'official data') and total catches, illustrating the need for improved accounting of fisheries catches in the Bay of Bengal. The reconstruction approach presented here includes estimates of unreported or under-reported commercial catch, non-commercial (i.e., subsistence) catch and discarded bycatch, which are traditionally not accounted for in fisheries statistics. Yet, these components have been found in many countries to comprise a substantial portion of the total catch (e.g., Butcher, 2004; Zeller *et al.*, 2006; Zeller *et al.*, 2007). If the two countries whose catches are reconstructed here were assumed to be representative of the discrepancy between reported landings and total catches, a more realistic estimate of total extractions within the Bay of Bengal would need to be revised upwards. More significant than the actual tonnages being missed in the reported data are the implications for the sectors being missed, namely small-scale fisheries that often heavily rely on fisheries for fundamental food security and livelihoods (Pauly, 2006). Not correctly accounting for these sectors only adds to the marginalization of the poorest and most resource dependent members of society (Pauly, 2006). If management and policy decisions are made using only these 'under-estimated' landings data, policy frameworks aimed at protecting ecosystems, livelihoods and food security within the Bay of Bengal may become questionable. For the Bay of Bengal ecosystem to provide a more sustainable natural resource base for the peoples living around the BOBLME, more comprehensive estimates of total fisheries extractions for the whole Bay of Bengal are urgently needed.

Estimating total fisheries extractions can be done using relatively straightforward techniques, which are not highly prohibitive to even the most resource-limited countries. A combination of regular creel and household surveys conducted every 2-5 years can be used to estimate total domestic demand and supply, as well as small-scale fisheries in countries lacking the financial and human resources to conduct annual surveys or ongoing catch data collections (Zeller *et al.*, 2007). This would be a large improvement over the current situation where no data are collected for many of the small-scale sectors. Roving creel surveys conducted on a non-annual basis are an effective method for monitoring fisheries and acquiring catch and effort data where effort is dispersed over a large area (Brouwer *et al.*, 1997).

Subsistence fisheries estimates are rarely included in fisheries catch data, yet play a fundamental role in the food security of coastal communities and countries. Many countries conduct household surveys to estimate a range of socio-economic indicators. *Per capita* seafood consumption rates are often included in these surveys and can easily be used in combination with population data to estimate a country's seafood demand. A slight adjustment to the questionnaire used in these surveys could help determine the amount of fresh, as opposed to processed and likely imported, fish that is consumed. A simple comparison between the amount of fresh fish consumed and the reported supply of fish caught (adjusted for imports and exports) can be used to estimate unreported domestic catch. This offers a low cost approach to estimating a largely overlooked fisheries sub-sector, which is fundamental to meeting a country's seafood consumption demand.

Discarded bycatch represents another fisheries component that is largely overlooked in fisheries statistics. While this fisheries component may be perceived as having little economic significance, it does have profound ecological relevance. Discarded bycatch is a fisheries-related mortality which is therefore considered an extraction from the marine environment. Kelleher (2005) suggests that discarding is generally low in this region with the exception of shrimp and trawl fisheries in Bangladesh and Myanmar. Shrimp trawl fisheries have some of the highest discard rates and are known to have significant ecosystem impacts (Kelleher, 2005). The magnitude of these impacts needs to be estimated in order for the appropriate management strategies to be applied. This can be done by conducting localized studies where onboard observers estimate the amount and type of discarded bycatch. These case-studies can then be scaled up to a country-wide or regional level using effort data or by calculating a catch to discard ratio.

Another constraint to improved accounting of fisheries catches is the practice of trans-shipment. Countries such as Sri Lanka often transfer their catch at sea to foreign vessels, which then land their catch elsewhere. This results in under-estimated catches by Sri Lanka in their own waters. This practice needs to be addressed on a global scale as this problem is widespread and involves both domestic and distant water fleets and their catches.

Given the challenges and constraints each country faces in successfully implementing a sustainable fisheries management strategy, it is the role of the BOBLME Project and its partners (e.g., FAO) to engage with governments, NGOs and coastal communities in the Bay of Bengal and to implement the above operational recommendations. As part of the world's move towards ecosystem-based management of marine resources, the BOBLME Project is the necessary driver for achieving this goal within the Bay of Bengal region.

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Tables and Figures

Table 1. Surface area and percentage area of each country's EEZ, as well as the High Seas area within the Bay of Bengal Large Marine Ecosystem area as defined here. Source: *Sea Around Us* project www.seaaroundus.org

Spatial entity	Area (km^2)	%
Bangladesh	78,538	1.3
Myanmar	520,262	8.3
Sri Lanka	530,684	8.5
India (mainland)	666,600	10.7
India (Andaman and Nicobar)	659,912	10.6
Indonesia	719,300	11.5
Malaysia	68,747	1.1
Maldives	916,189	14.7
Thailand	118,600	1.9
High Seas	1,972,168	31.5
BOBLME	6,251,000	100.0

Table 2: Functional groups as defined by the *Sea Around Us* project for catch reporting and ecosystem modeling.

Small Pelagics (<30 cm)
Medium Pelagics (30 - 90 cm)
Large Pelagics (>=90 cm)
Small Demersals (<30 cm)
Medium Demersals (30 - 90 cm)
Large Demersals (>=90 cm)
Small Bathypelagics (<30 cm)
Medium Bathypelagics (30 - 90 cm)
Large Bathypelagics (>=90 cm)
Small Bathydemersals (<30 cm)
Medium Bathydemersals (30 - 90 cm)
Large Bathydemersals (>=90 cm)
Small Benthopelagics (<30 cm)
Medium Benthopelagics (30 - 90 cm)
Large Benthopelagics (>=90 cm)
Small Reef associated fish (<30 cm)
Medium Reef associated fish (30 - 90 cm)
Large Reef associated fish (>=90 cm)
Small to Medium Sharks (<90 cm)
Large Sharks (>=90 cm)
Small to Medium Rays (<90 cm)
Large Rays (>=90 cm)
Small to Medium Flatfishes (<90 cm)
Large Flatfishes (>=90 cm)
Cephalopods
Shrimps
Lobsters, crabs
Jellyfish
Other demersal invertebrates
Krill
Other taxa

Table 3. Total exports (quantity and value) by country bordering the Bay of Bengal, summed for the 1976-2008 time period. Exports cannot be assigned to Bay of Bengal waters. Data source: FAO FishStat Trade data.

Country	Export quantity (tonnes)	Export value (USD)
Bangladesh	1,086,387	7,524,415

India	8,534,436	27,312,772
Indonesia	12,774,144	35,541,179
Malaysia	5,396,666	9,043,943
Maldives	1,122,582	1,347,664
Myanmar	2,617,972	4,084,100
Sri Lanka	264,799	1,893,163
Thailand	29,053,711	89,068,597
Total	60,850,697	175,815,833

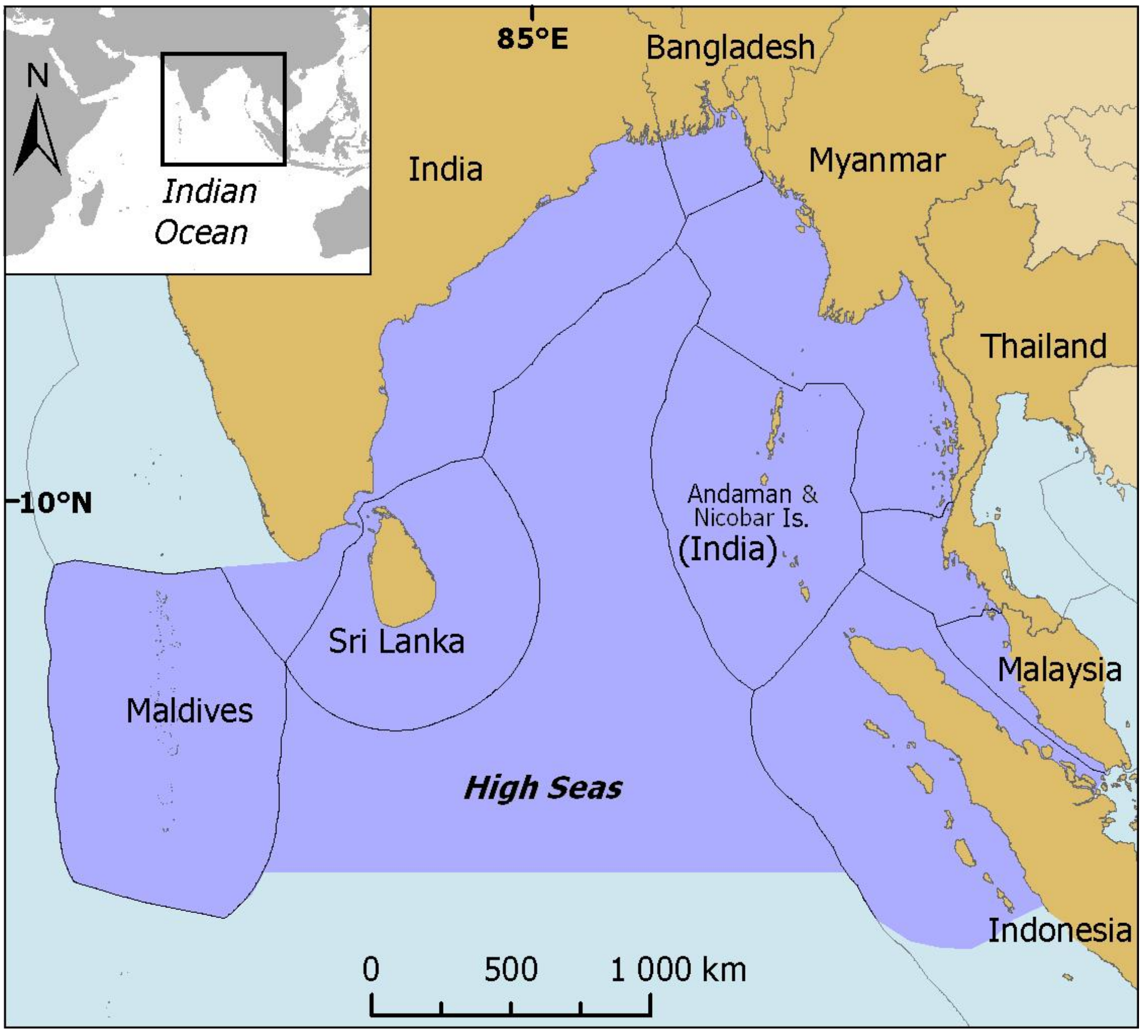

Figure 1. Map of the Bay of Bengal Large Marine Ecosystem (shaded region), including the eight countries, their EEZs, and the high seas area that lie within this area.

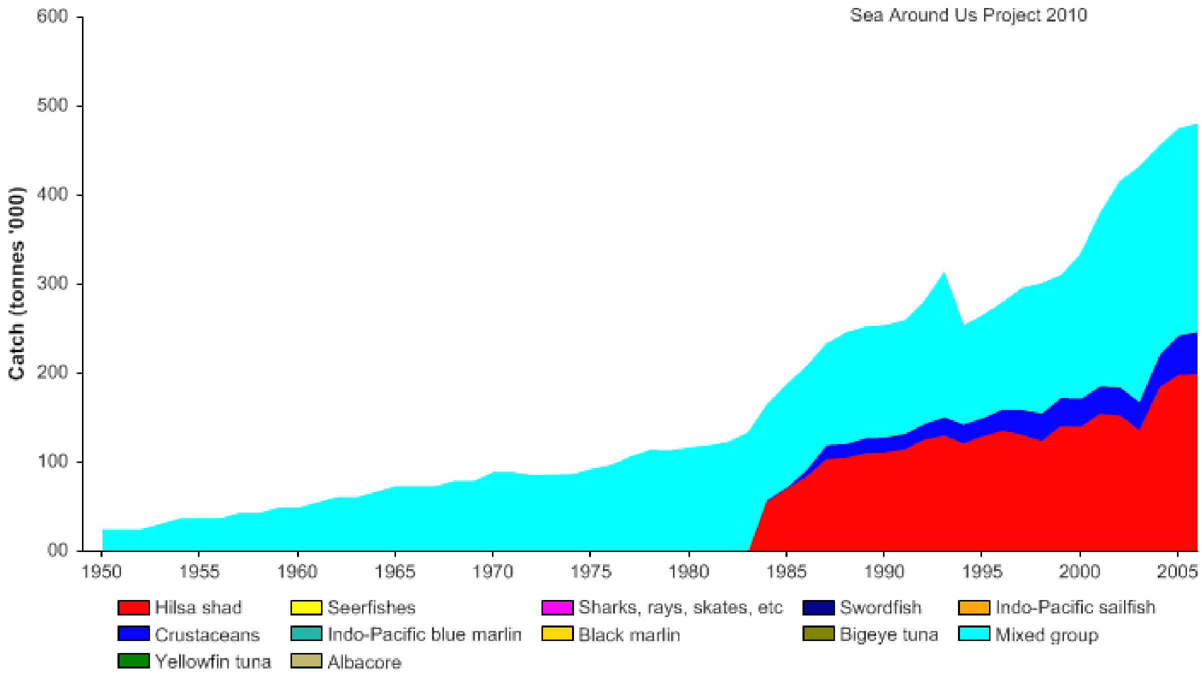

Figure 2: Landings by species in the EEZ of Bangladesh, 1950-2006.

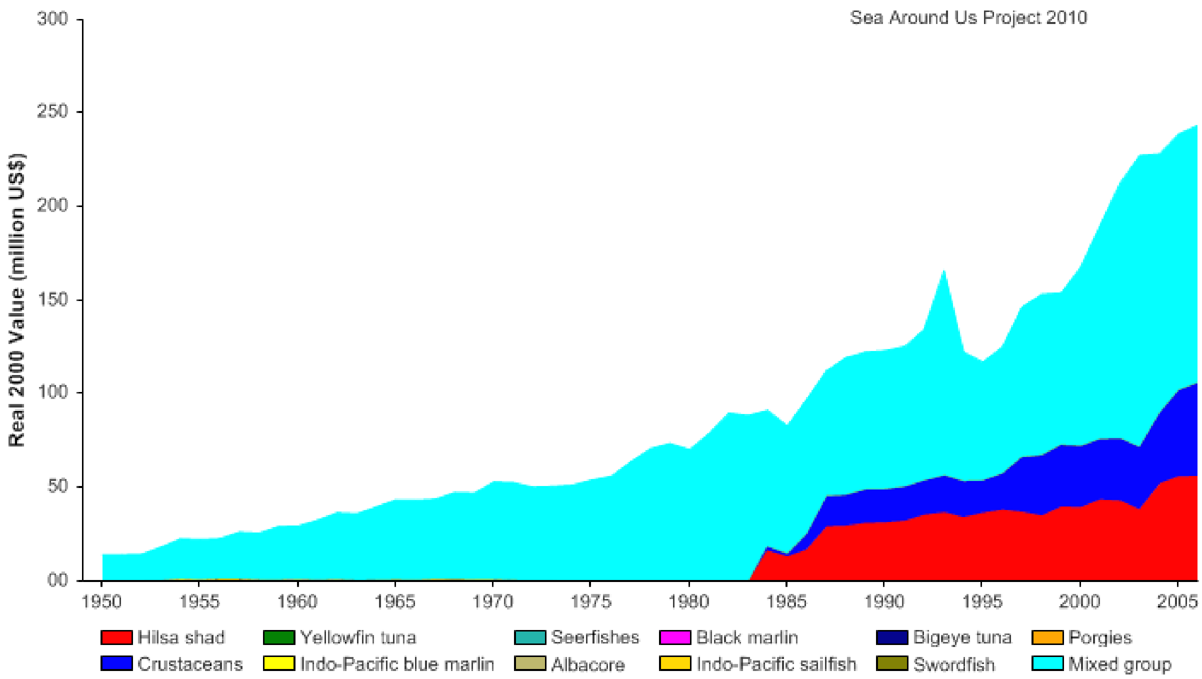

Figure 3: Real 2000 value (US$) by species in the EEZ of Bangladesh, 1950-2006.

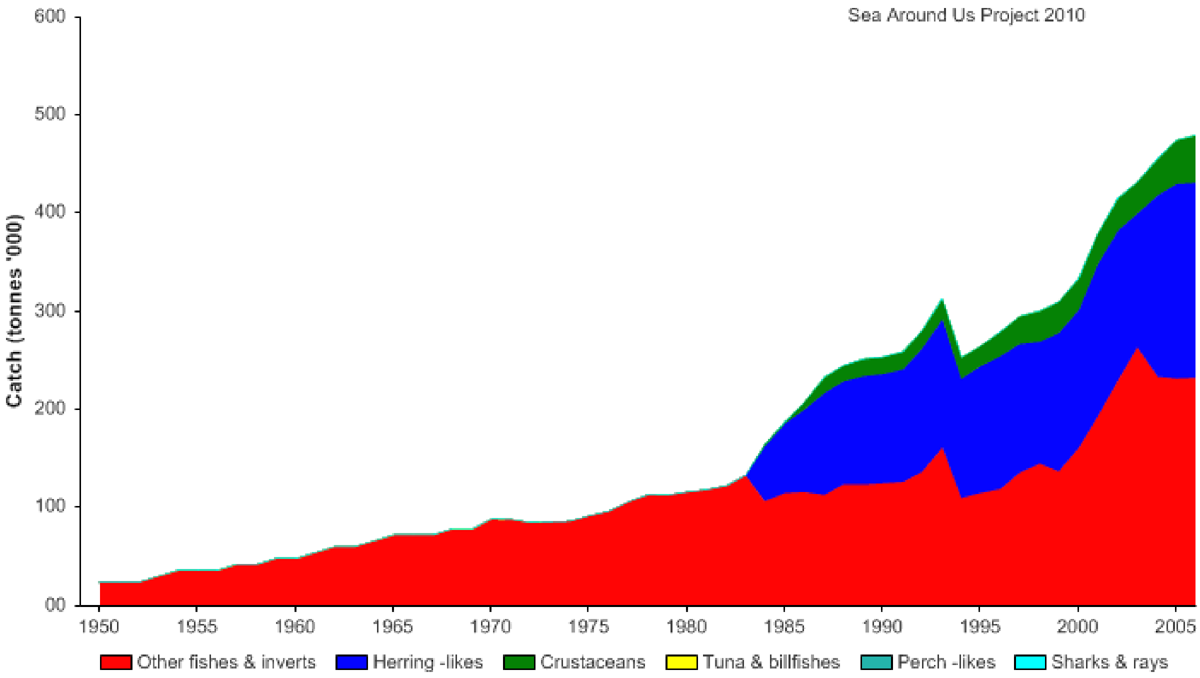

Figure 4: Landings by commercial group in the EEZ of Bangladesh, 1950-2006.

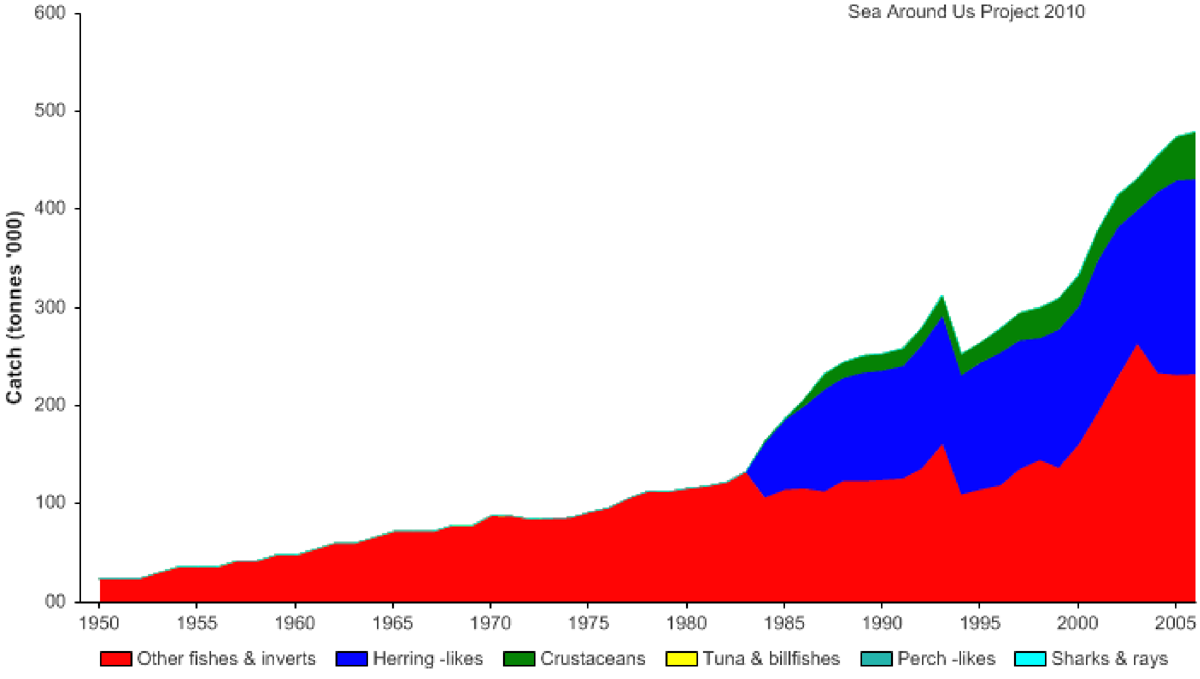

Figure 5: Real 2000 value (US$) by commercial group in the EEZ of Bangladesh, 1950-2006.

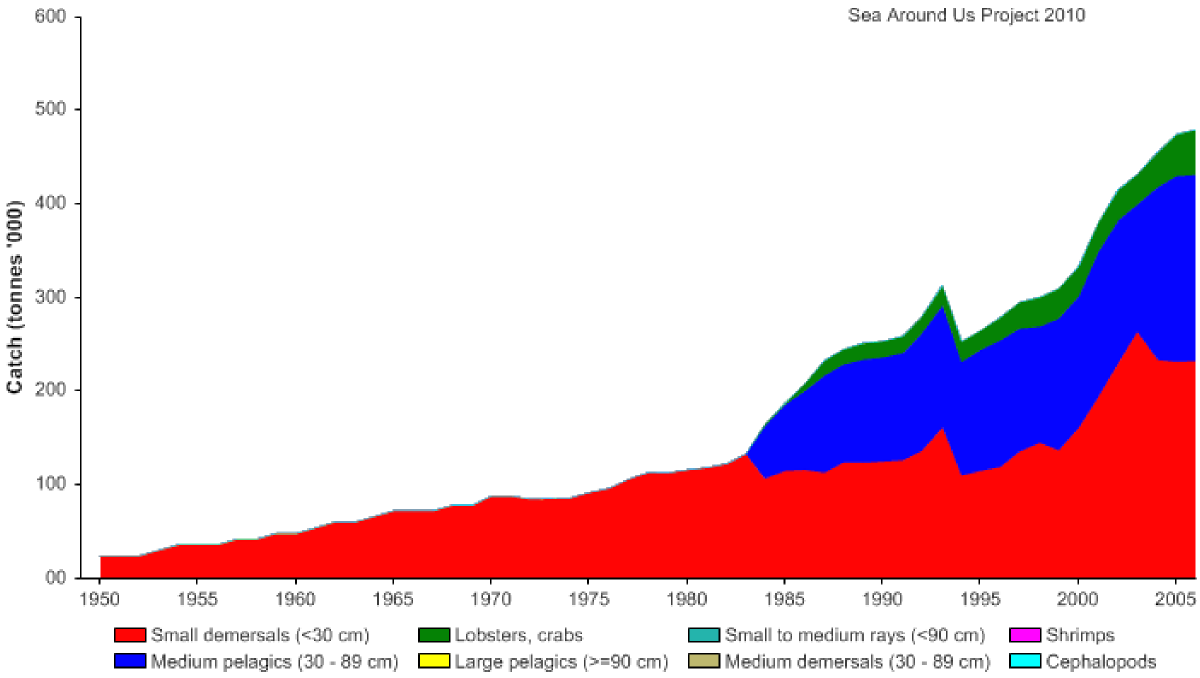

Figure 6: Landings by functional group in the EEZ of Bangladesh, 1950-2006.

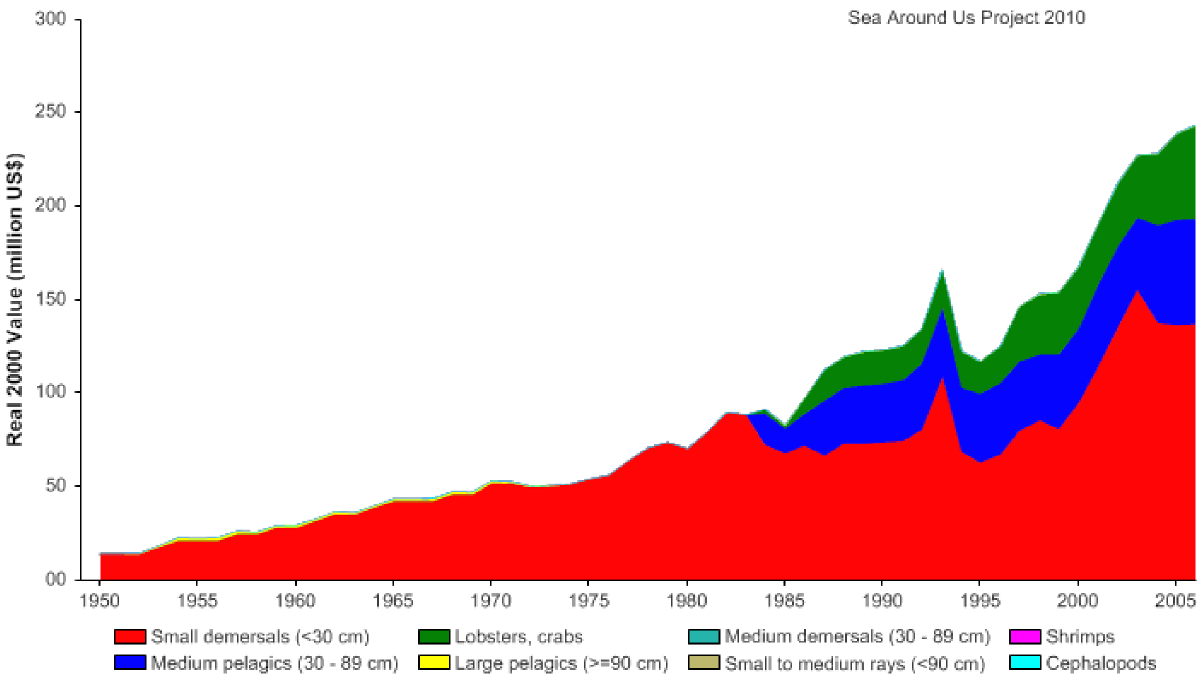

Figure 7: Real 2000 value (US$) by functional group in the EEZ of Bangladesh, 1950-2006.

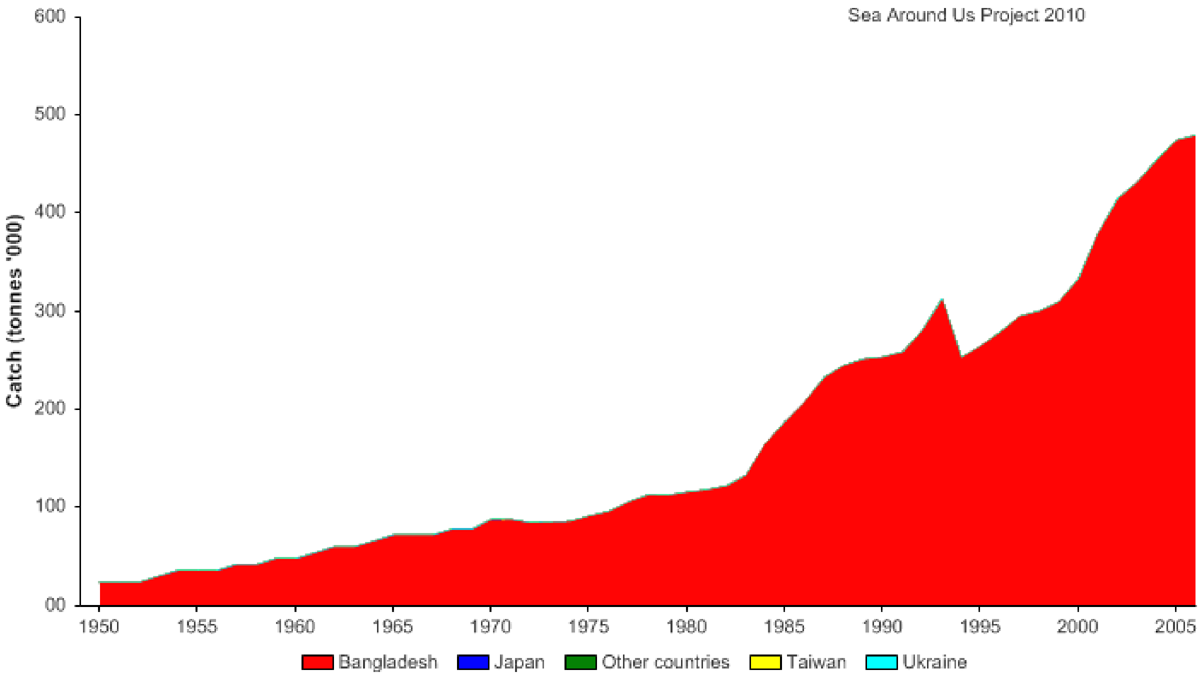

Figure 8: Landings by fishing country in the EEZ of Bangladesh, 1950-2006.

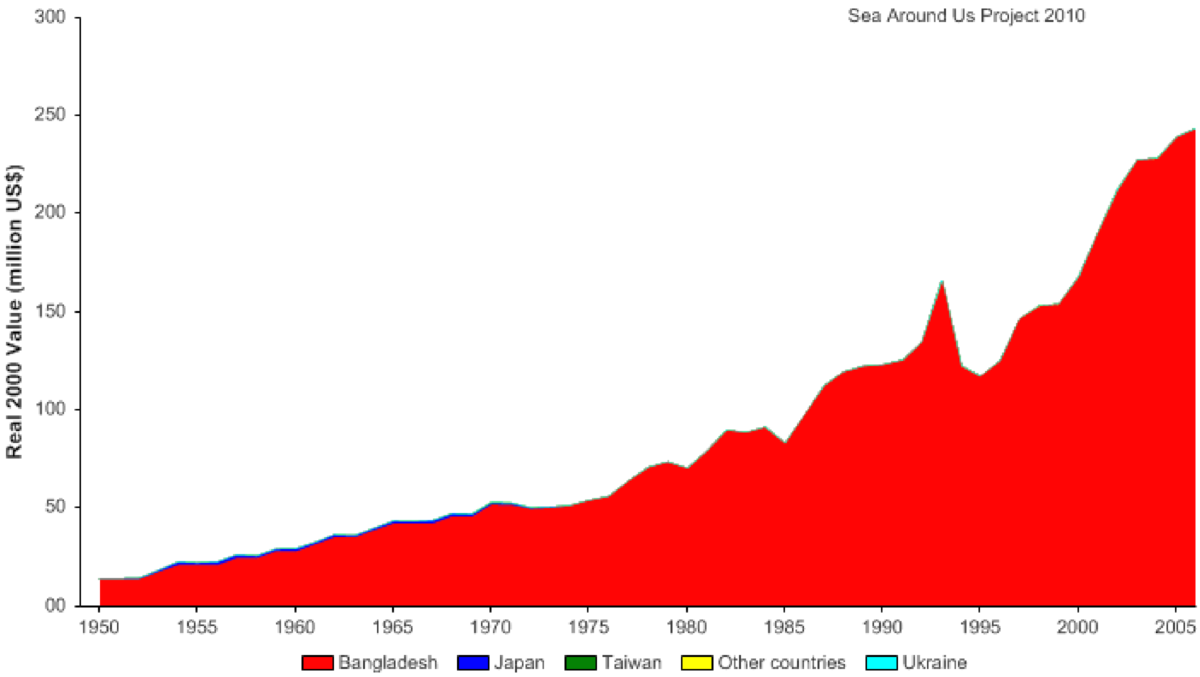

Figure 9: Real 2000 value (US$) by fishing country in the EEZ of Bangladesh, 1950-2006.

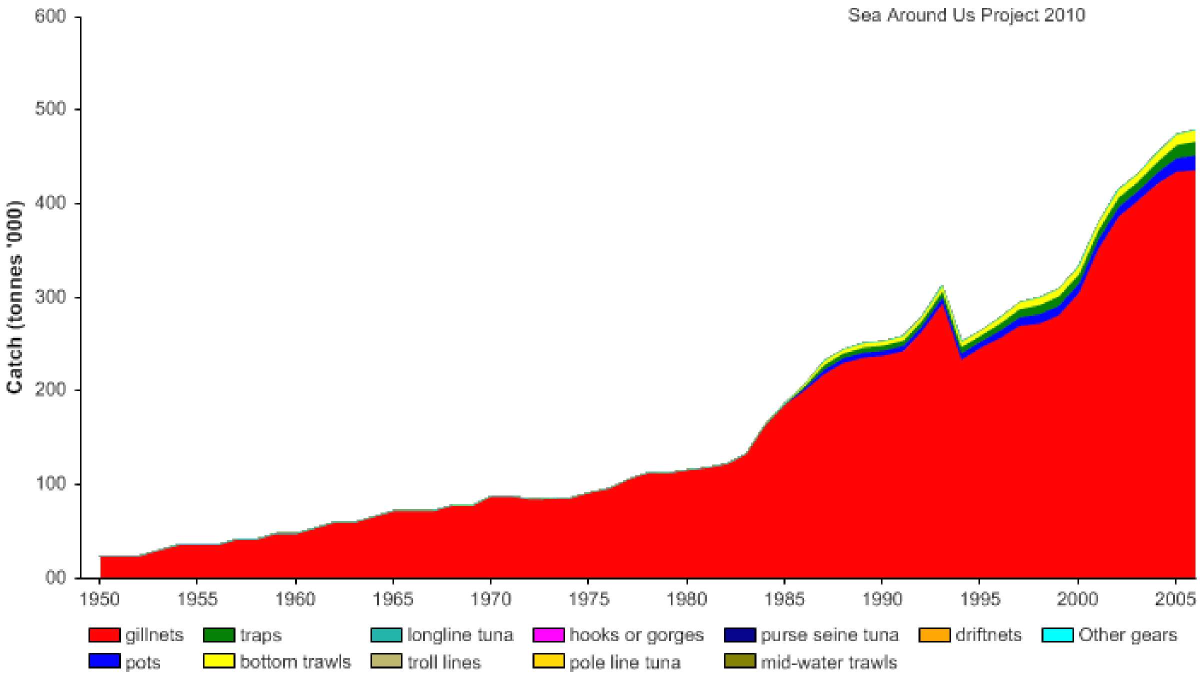

Figure 10: Landings by gear in the EEZ of Bangladesh, 1950-2006.

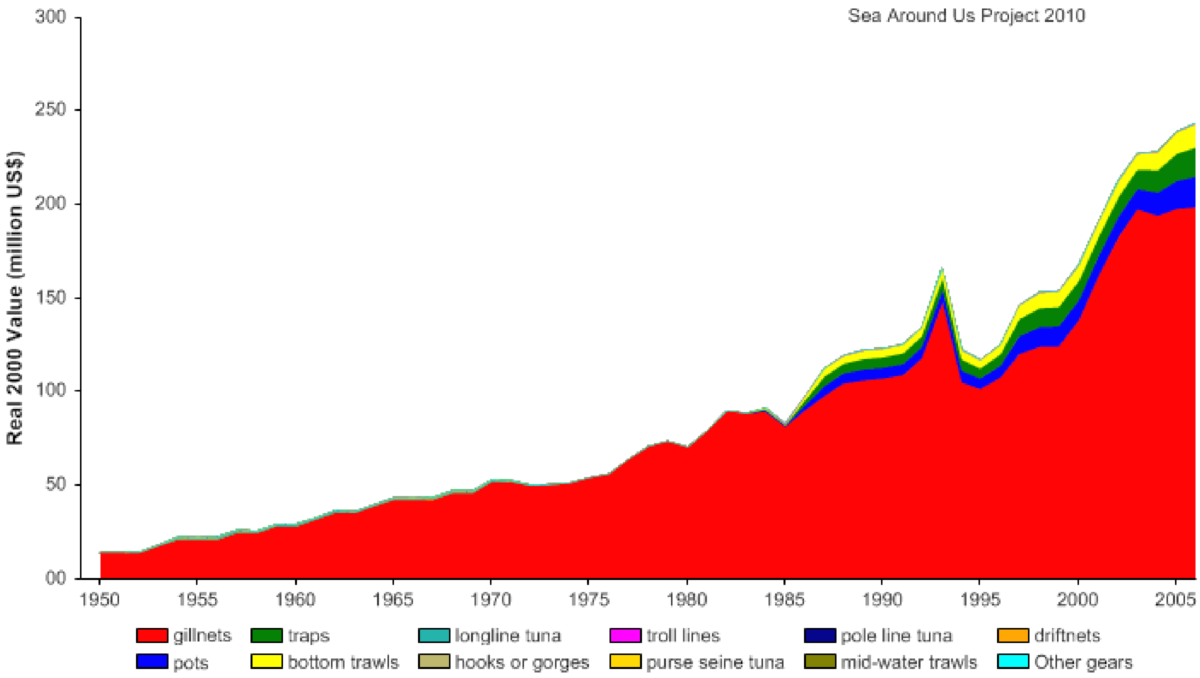

Figure 11: Real 2000 value (US$) by gear in the EEZ of Bangladesh, 1950-2006.

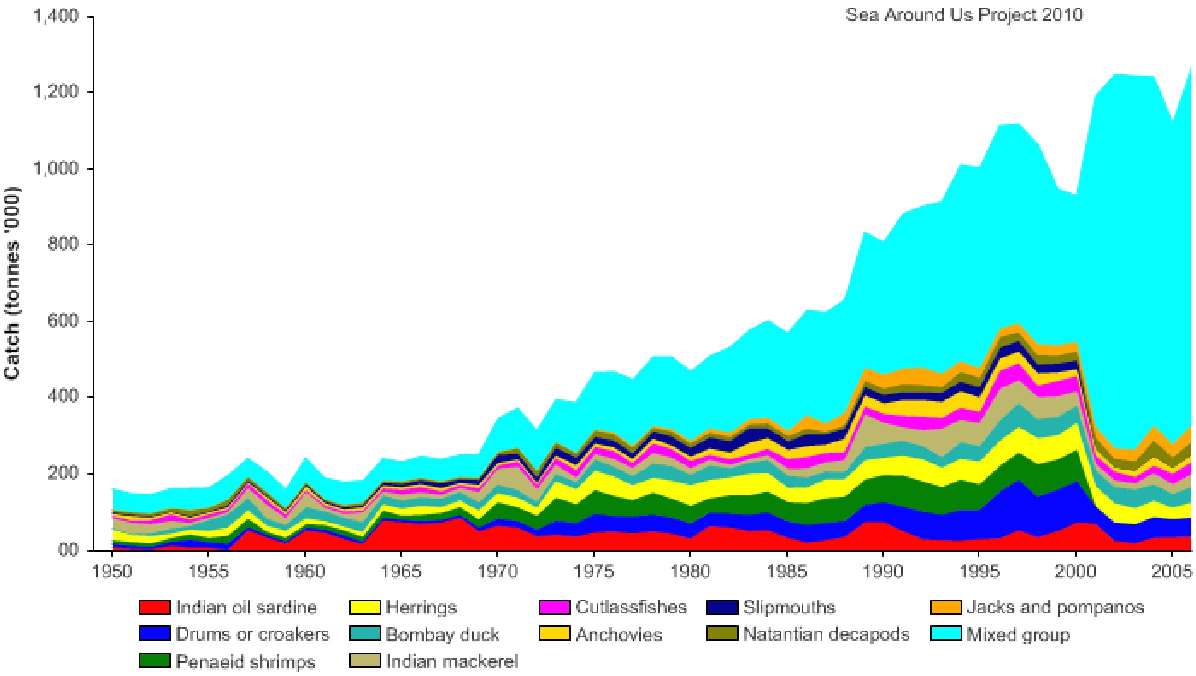

Figure 12: Landings by species in the EEZ of India, 1950-2006.

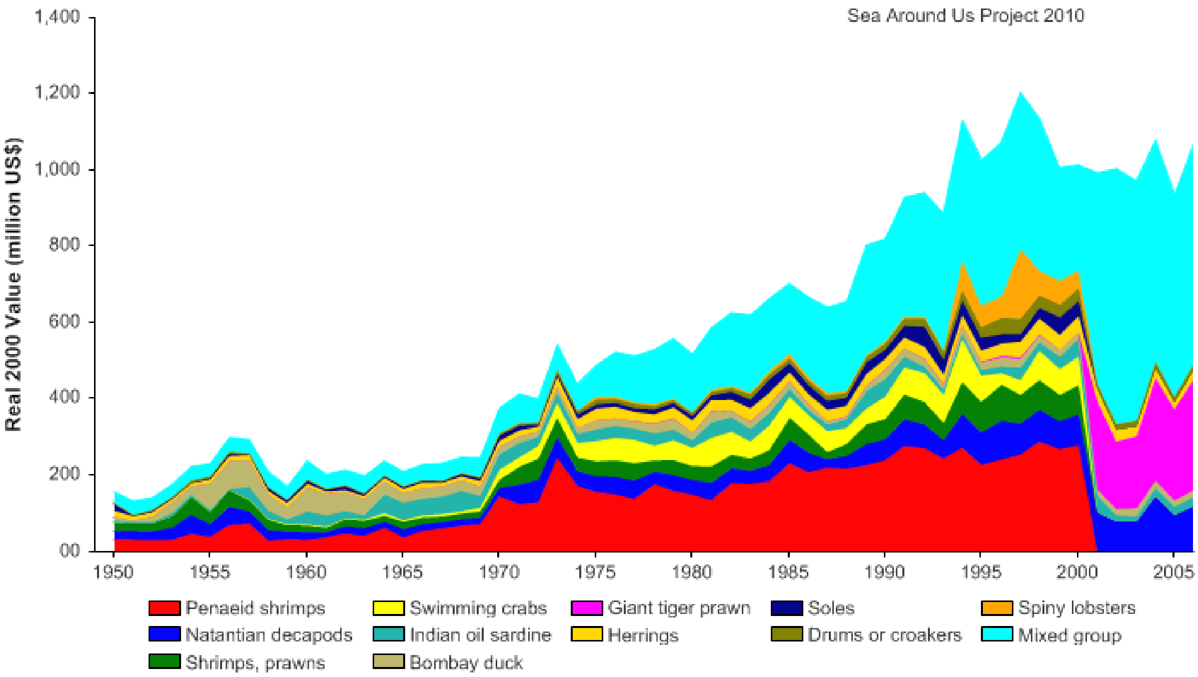

Figure 13: Real 2000 value (US$) by species in the EEZ of India, 1950-2006.

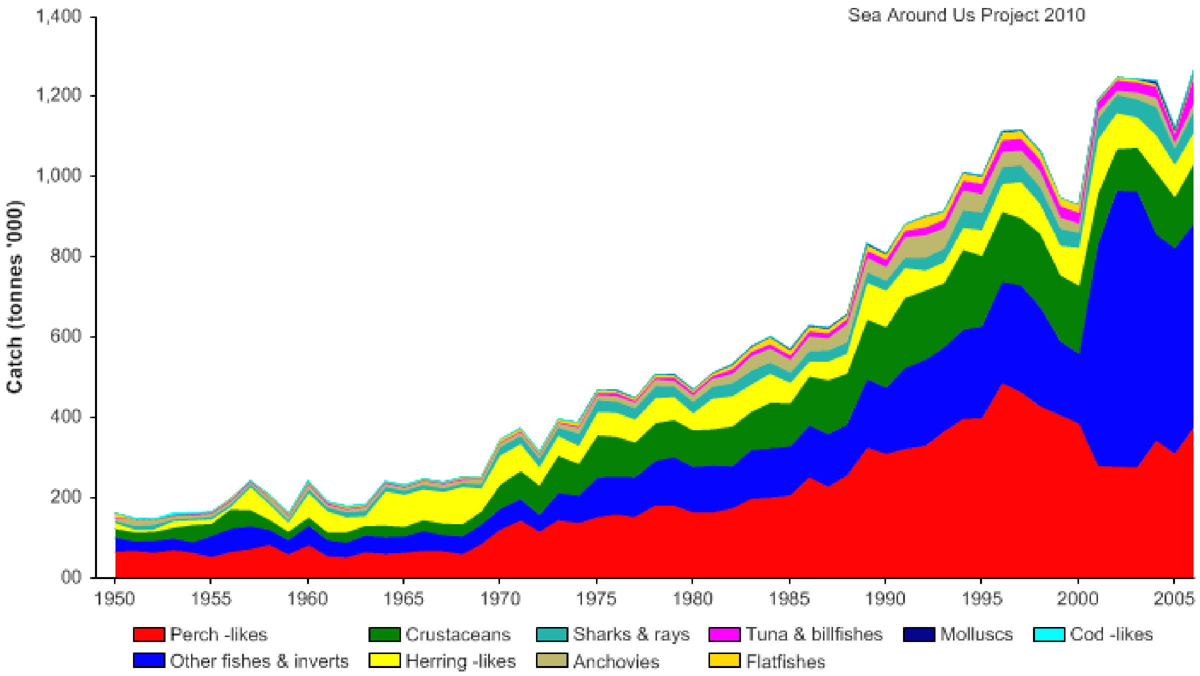

Figure 14: Landings by commercial group in the EEZ of India, 1950-2006.

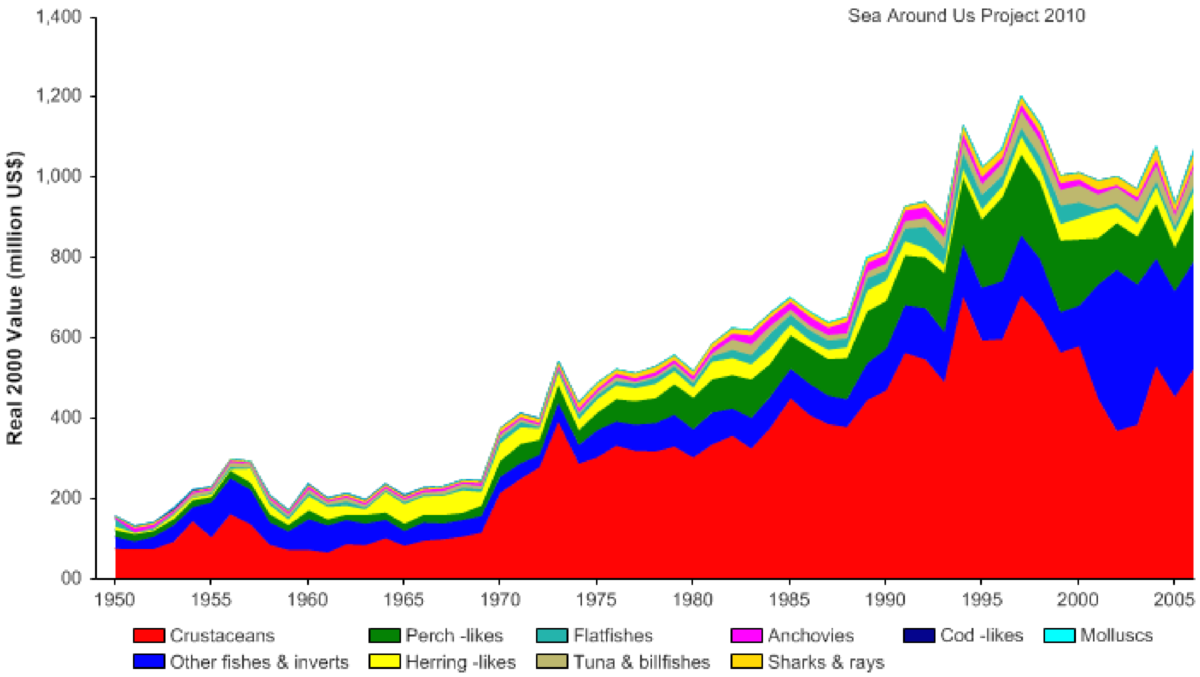

Figure 15: Real 2000 value (US$) by commercial group in the EEZ of India, 1950-2006.

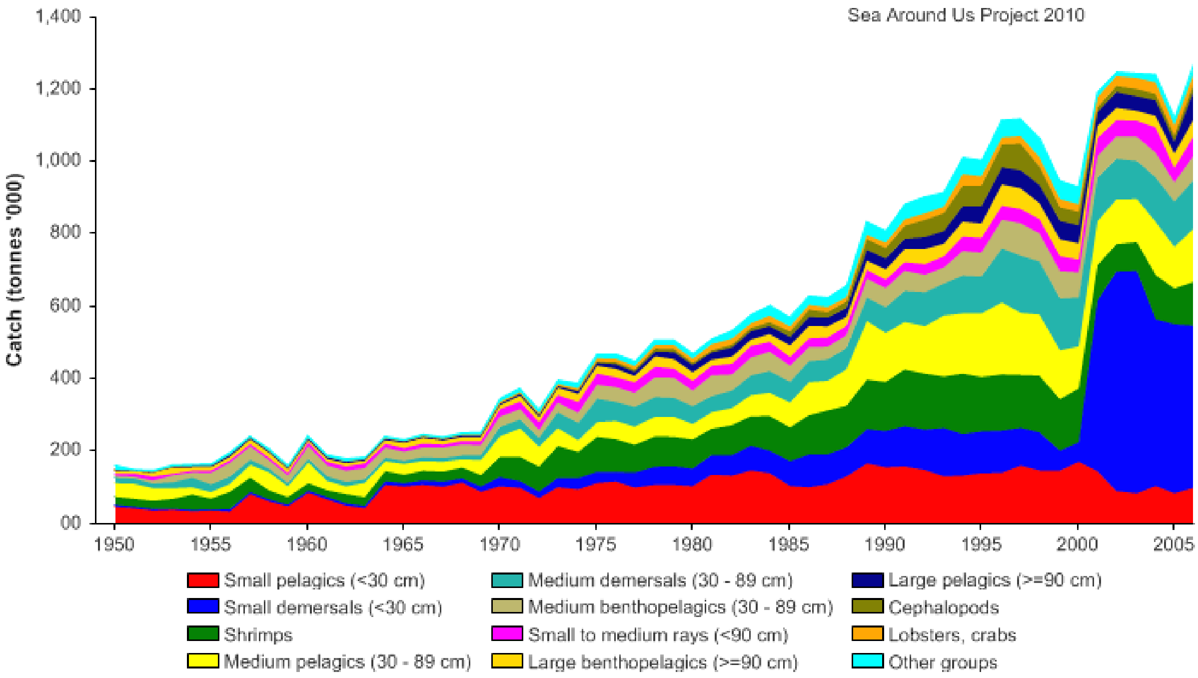

Figure 16: Landings by functional group in the EEZ of India, 1950-2006.

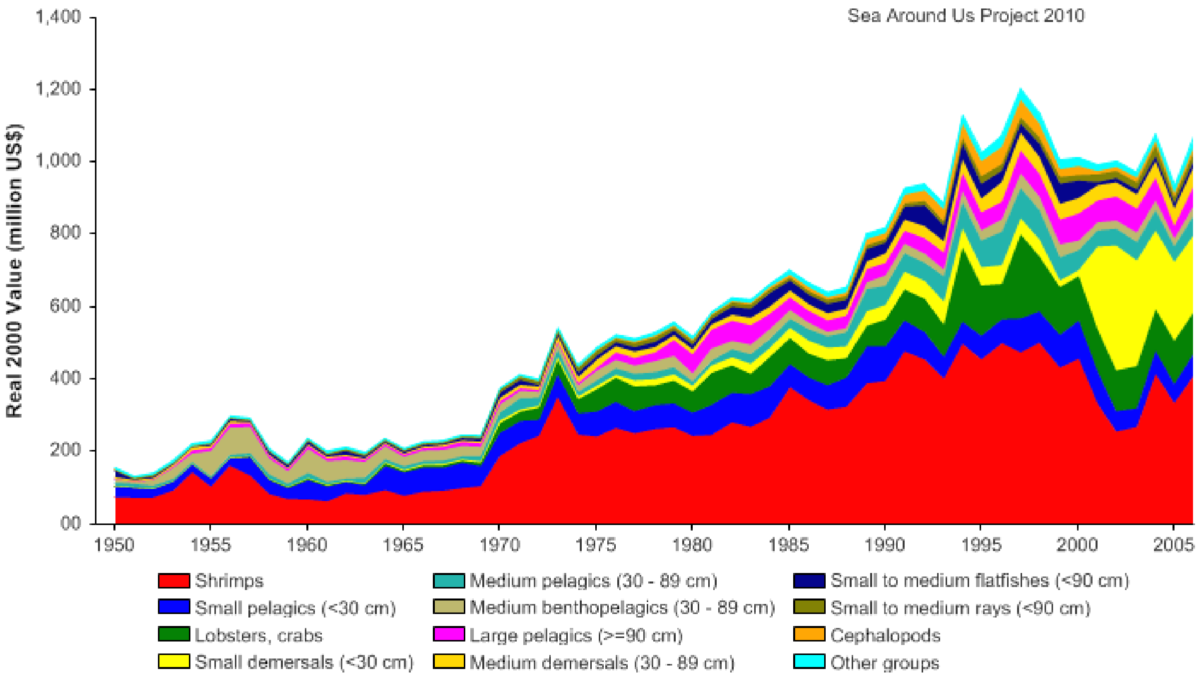

Figure 17: Real 2000 value (US$) by functional group in the EEZ of India, 1950-2006.

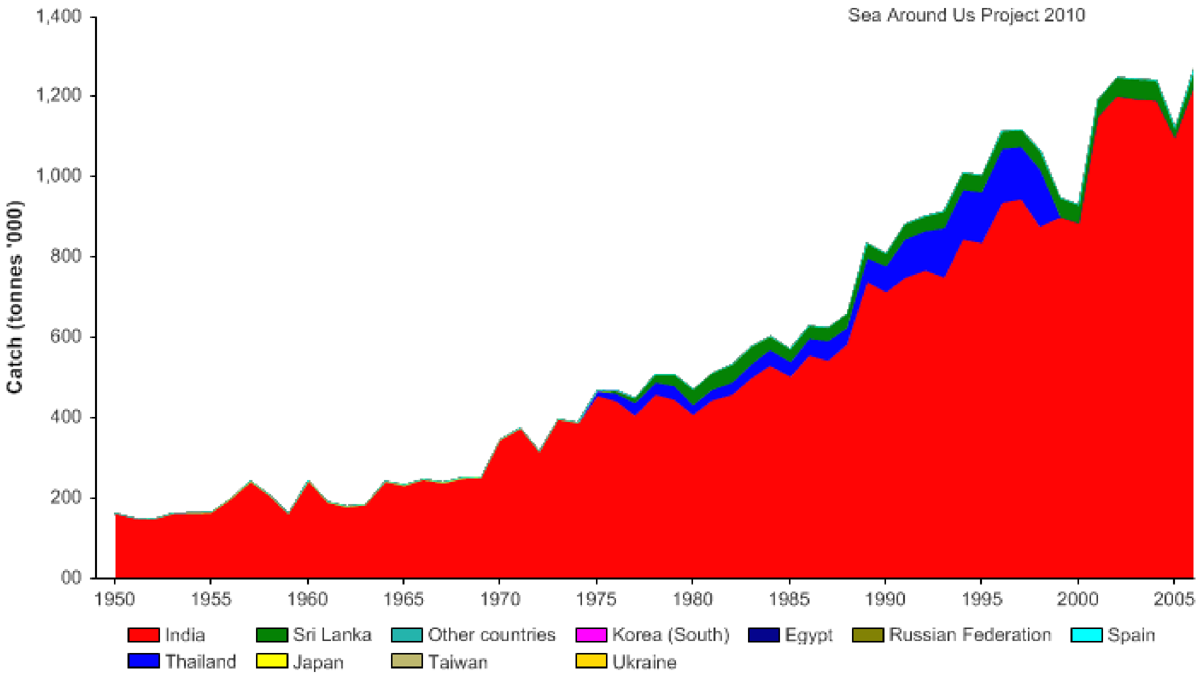

Figure 18: Landings by fishing country in the EEZ of India, 1950-2006.

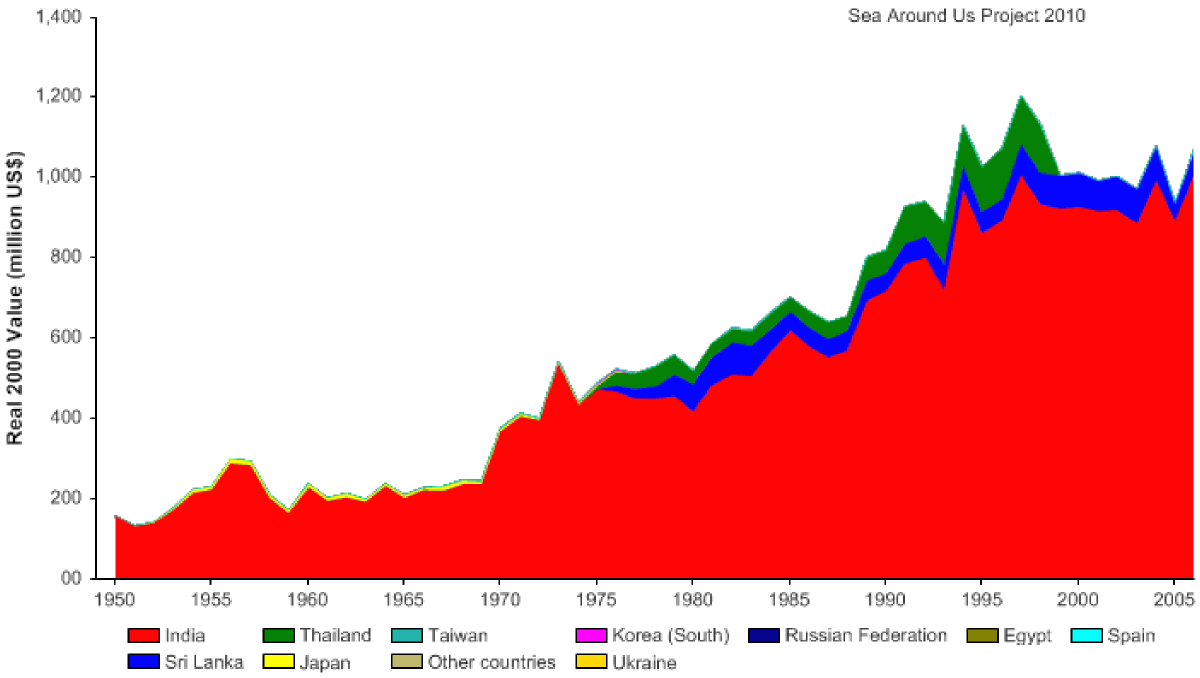

Figure 19: Real 2000 value (US$) by fishing country in the EEZ of India, 1950-2006.

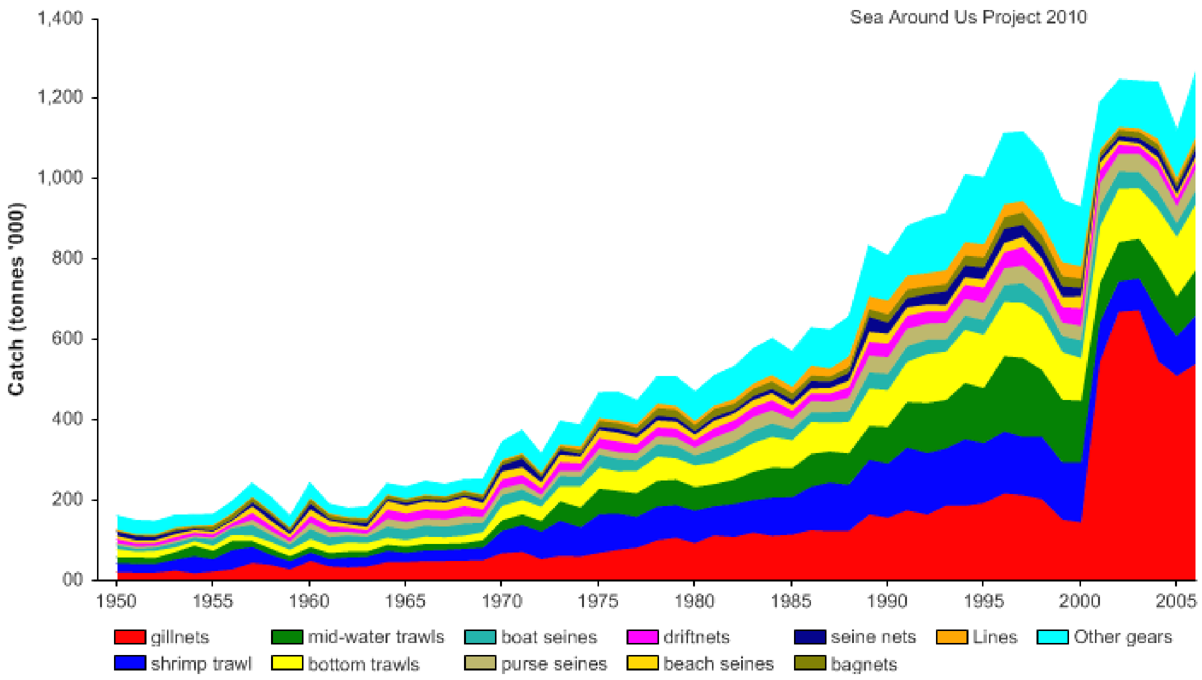

Figure 20: Landings by gear in the EEZ of India, 1950-2006.

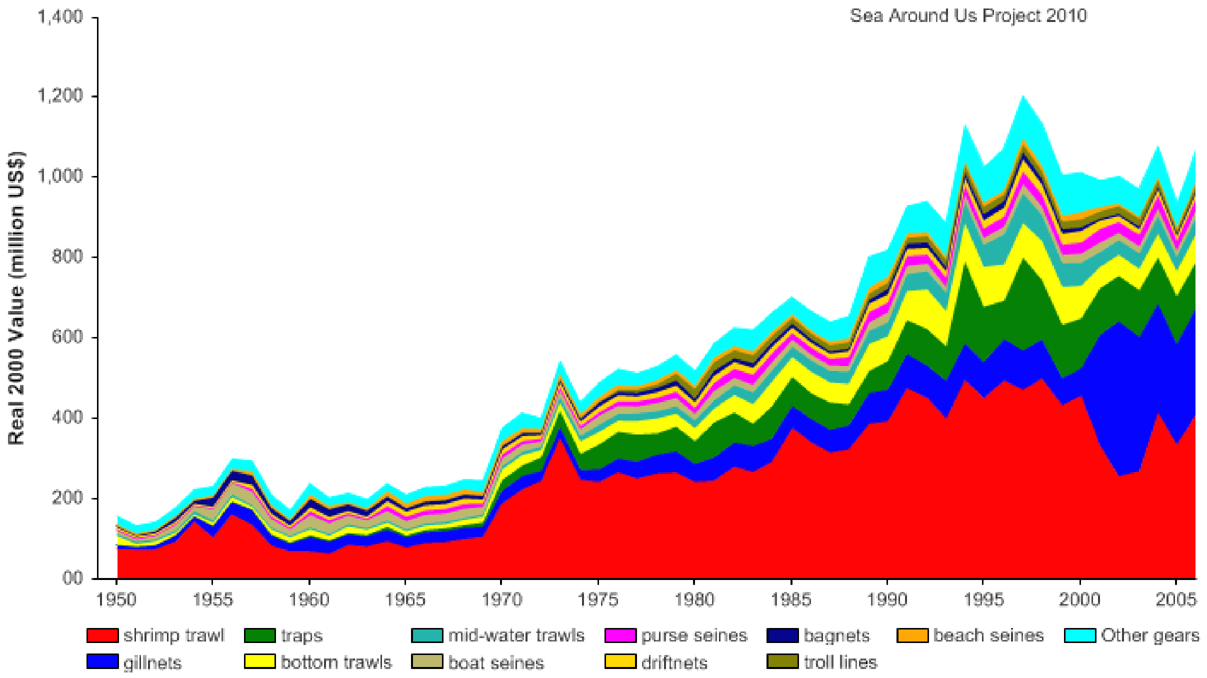

Figure 21: Real 2000 value (US$) by gear in the EEZ of India, 1950-2006.

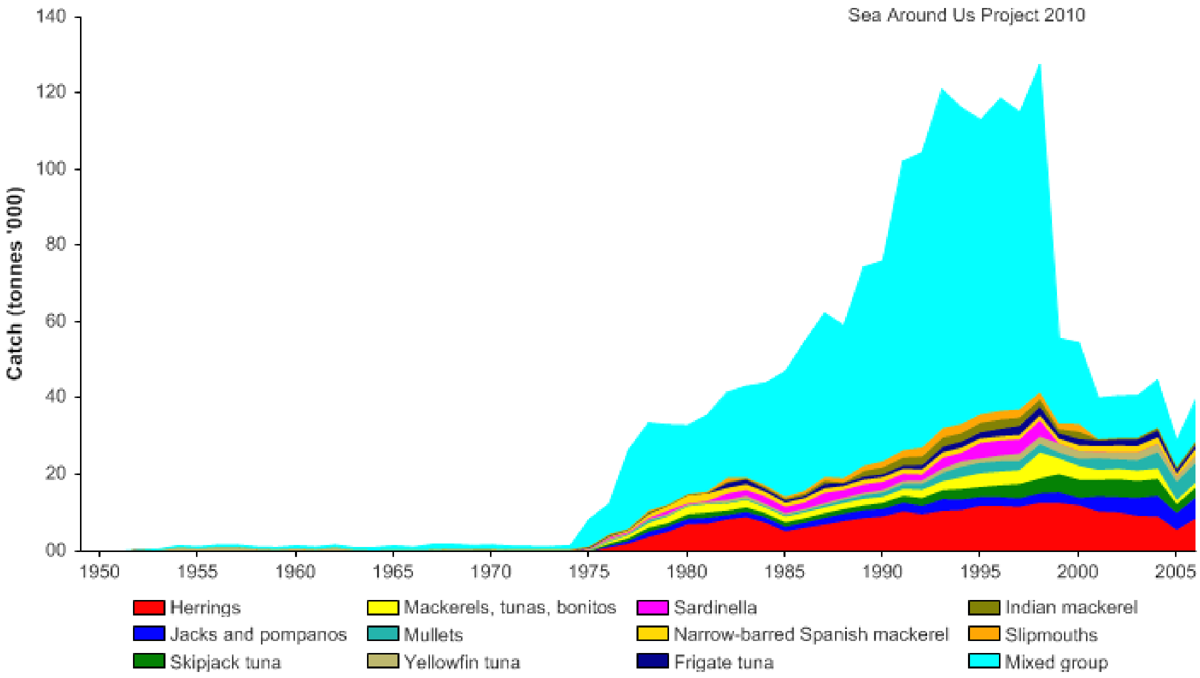

Figure 22: Landings by species in the EEZ of the Andaman and Nicobar Islands, 1950-2006.

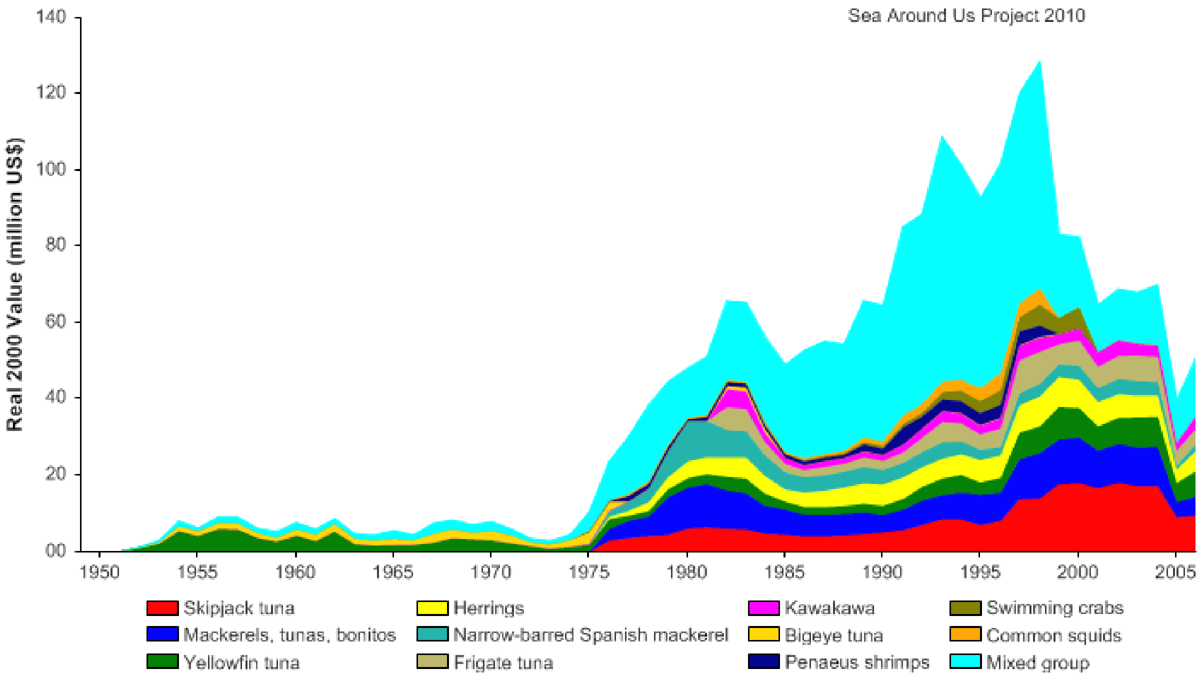

Figure 23: Real 2000 value (US$) by species in the EEZ of the Andaman and Nicobar Islands, 1950-2006.

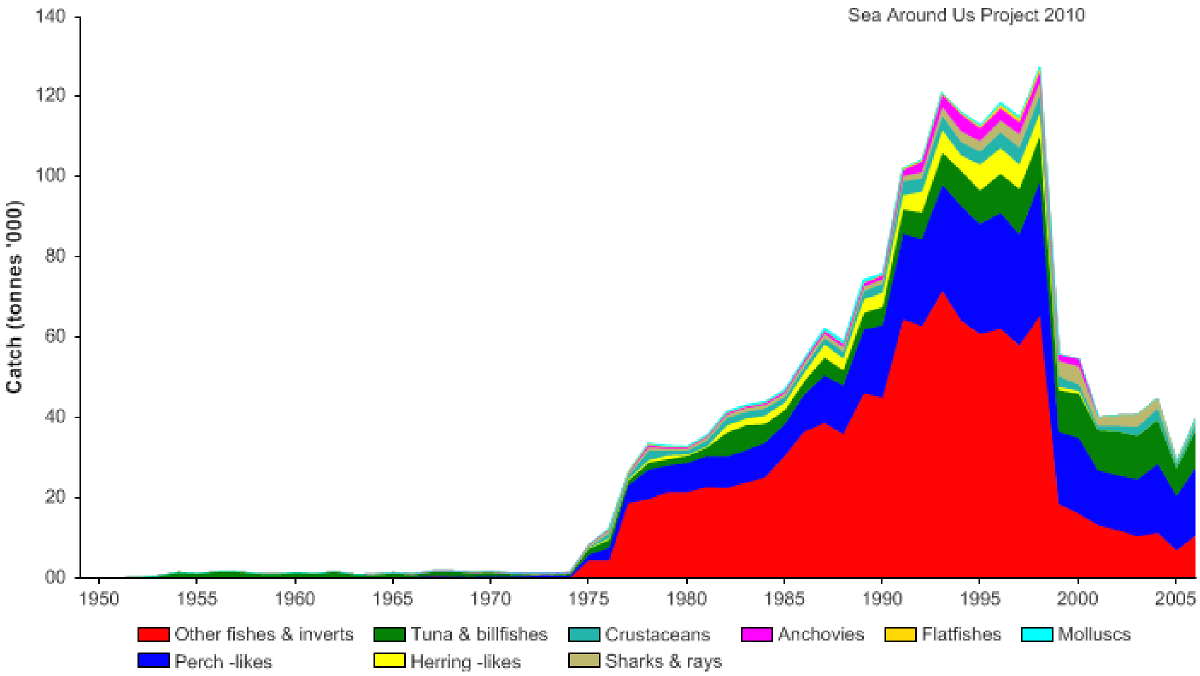

Figure 24: Landings by commercial group in the EEZ of the Andaman and Nicobar Islands, 1950-2006.

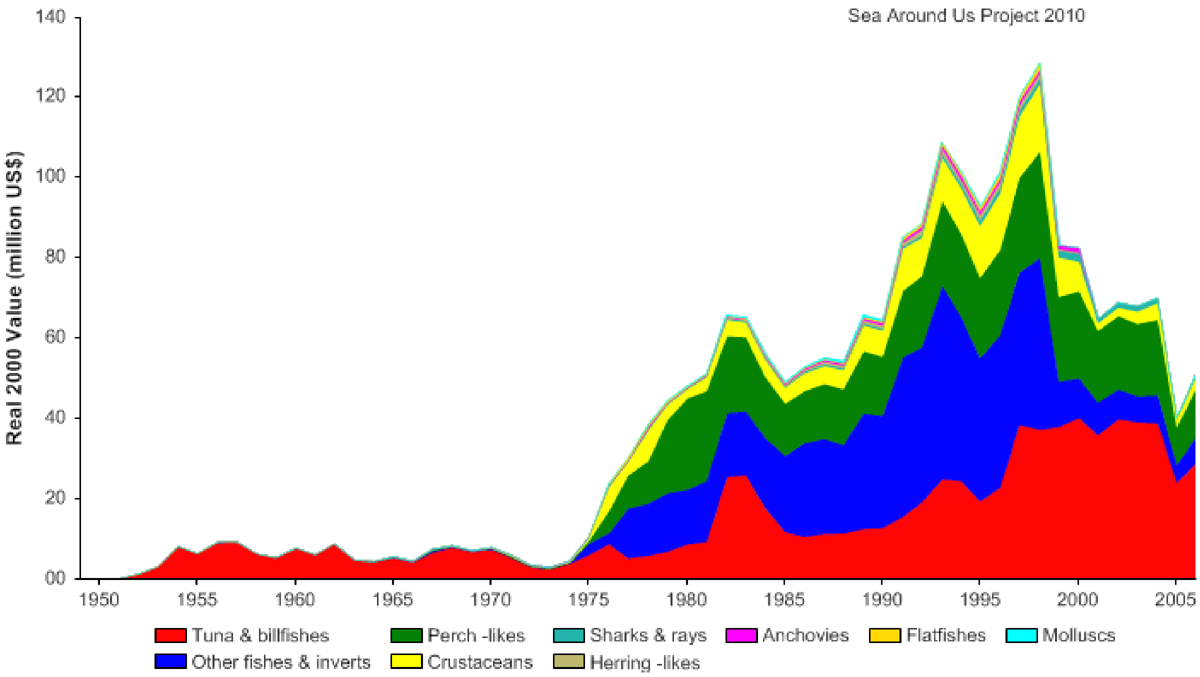

Figure 25: Real 2000 value (US$) by commercial group in the EEZ of the Andaman and Nicobar Islands, 1950-2006.

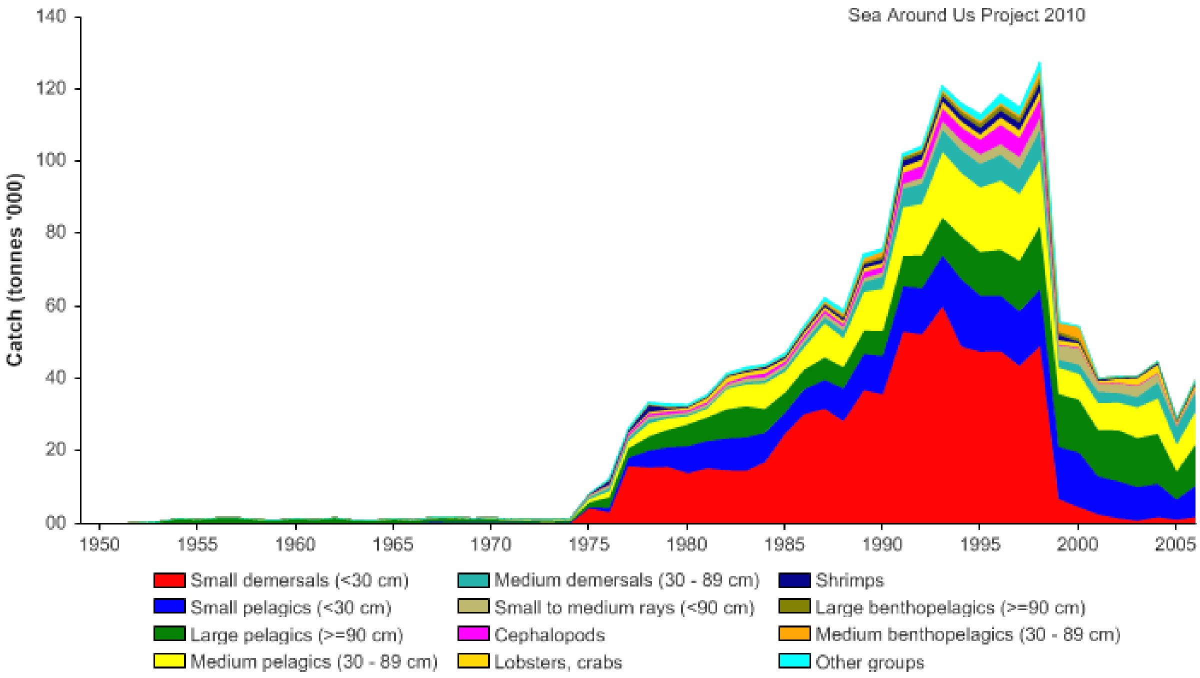

Figure 26: Landings by functional group in the EEZ of the Andaman and Nicobar Islands, 1950-2006.

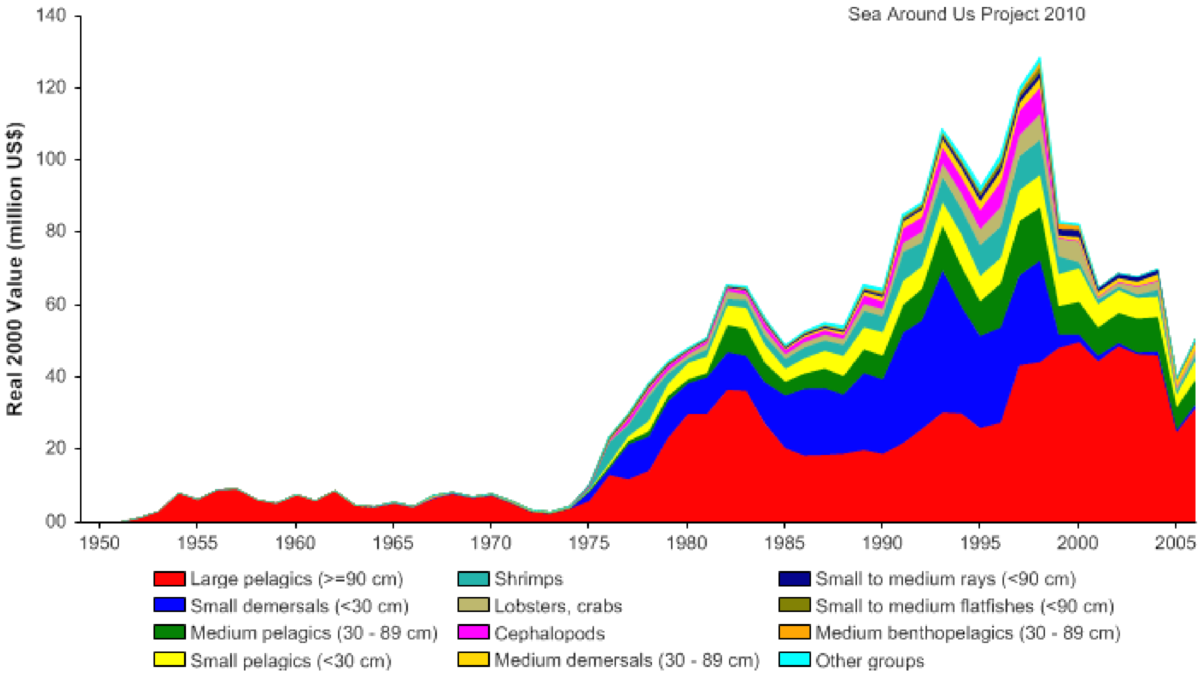

Figure 27: Real 2000 value (US$) by functional group in the EEZ of the Andaman and Nicobar Islands, 1950-2006.

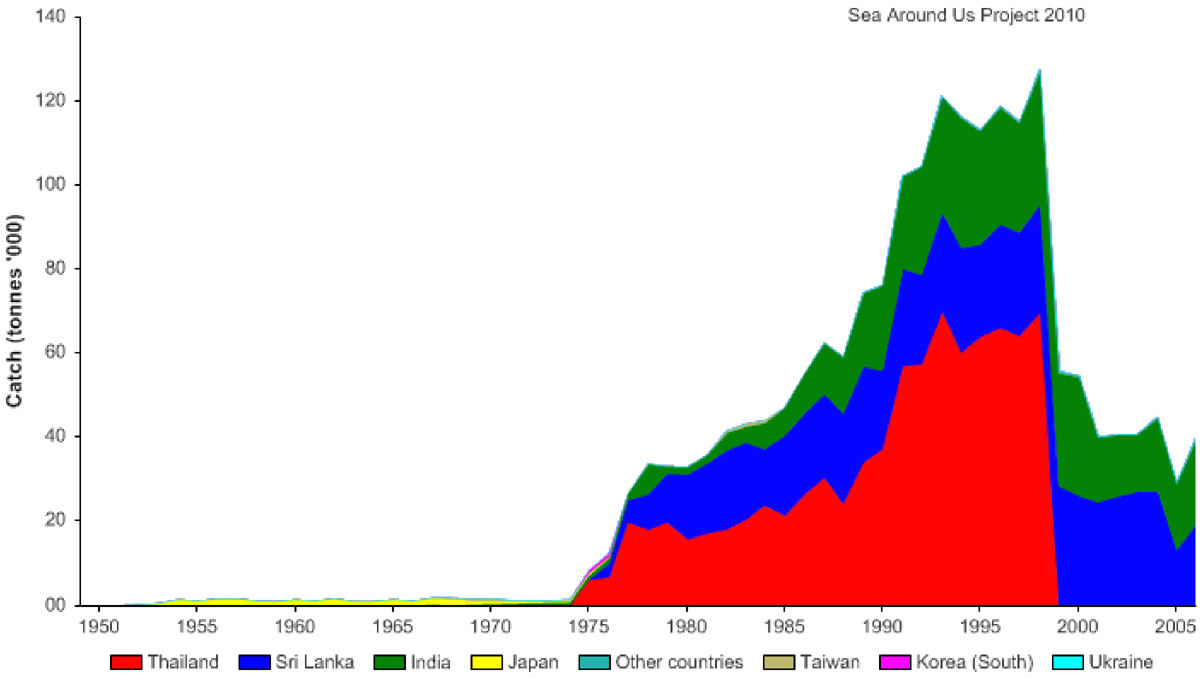

Figure 28: Landings by fishing country in the EEZ of the Andaman and Nicobar Islands, 1950-2006.

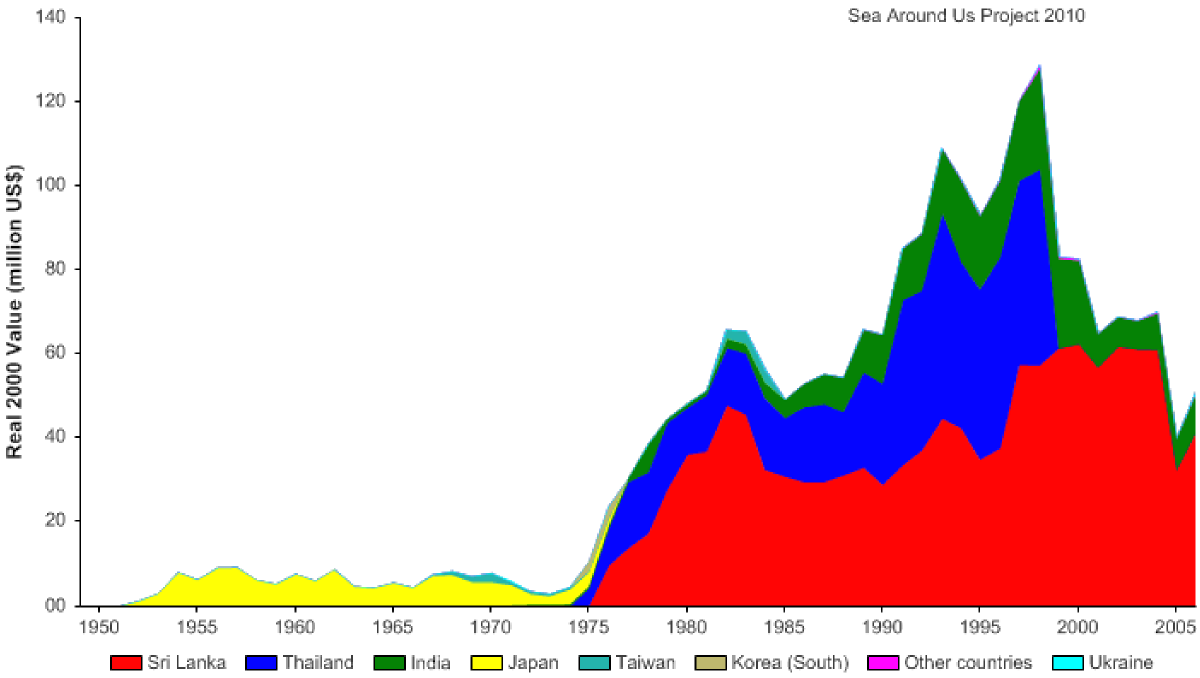

Figure 29: Real 2000 value (US$) by fishing country in the EEZ of the Andaman and Nicobar Islands, 1950-2006.

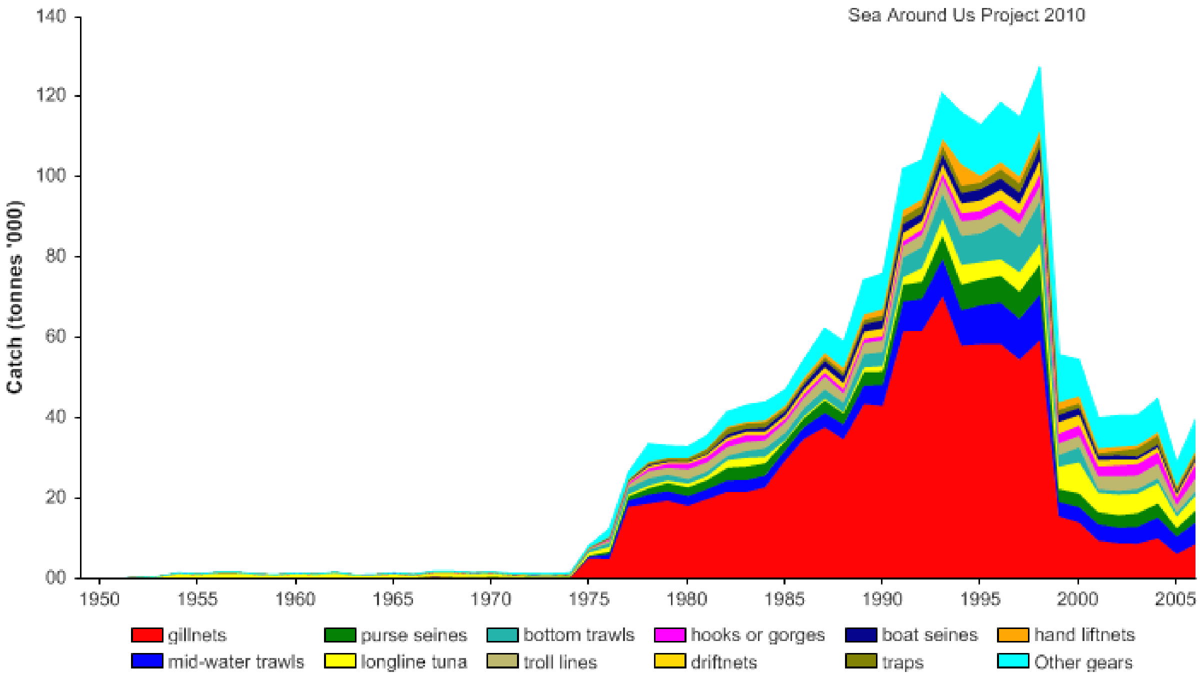

Figure 30: Landings by gear in the EEZ of the Andaman and Nicobar Islands, 1950-2006.

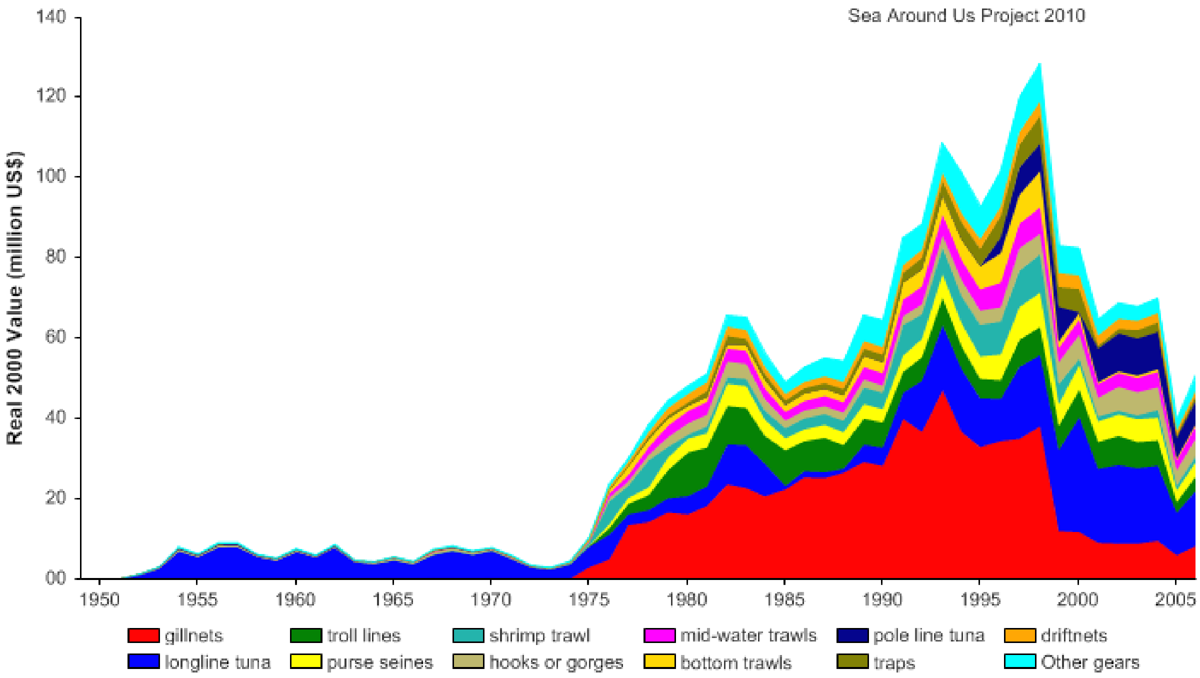

Figure 31: Real 2000 value (US$) by gear in the EEZ of the Andaman and Nicobar Islands, 1950-2006.

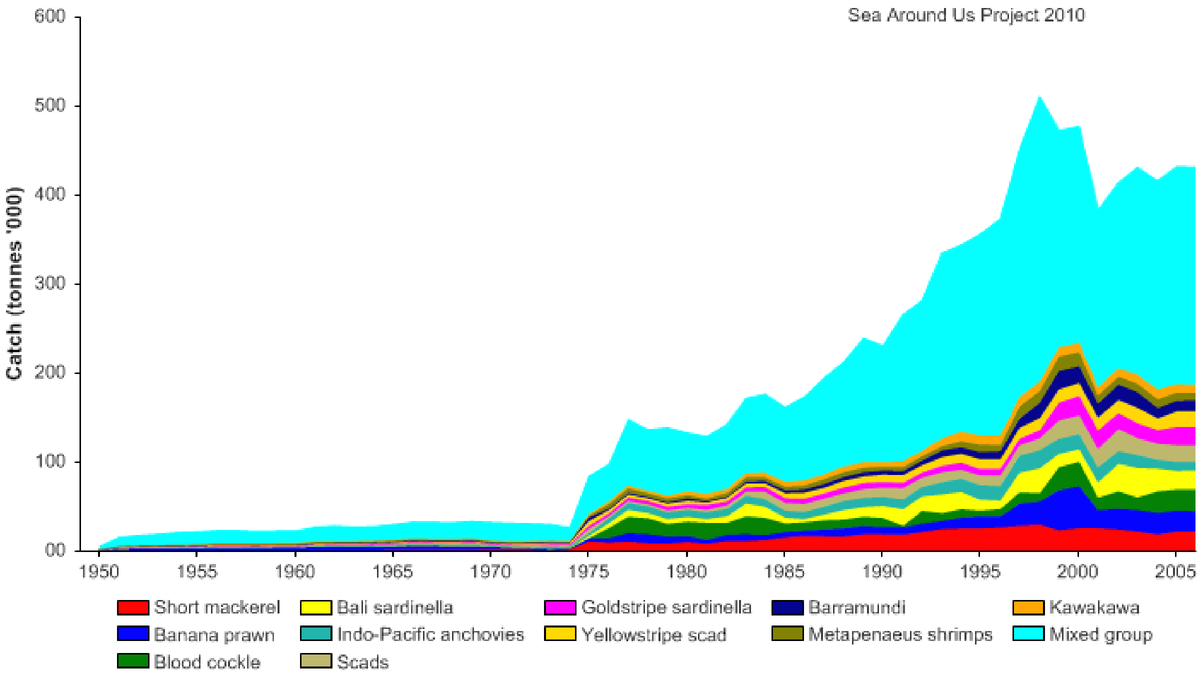

Figure 32: Landings by species in the Bay of Bengal portion of Indonesia's EEZ, 1950-2006.

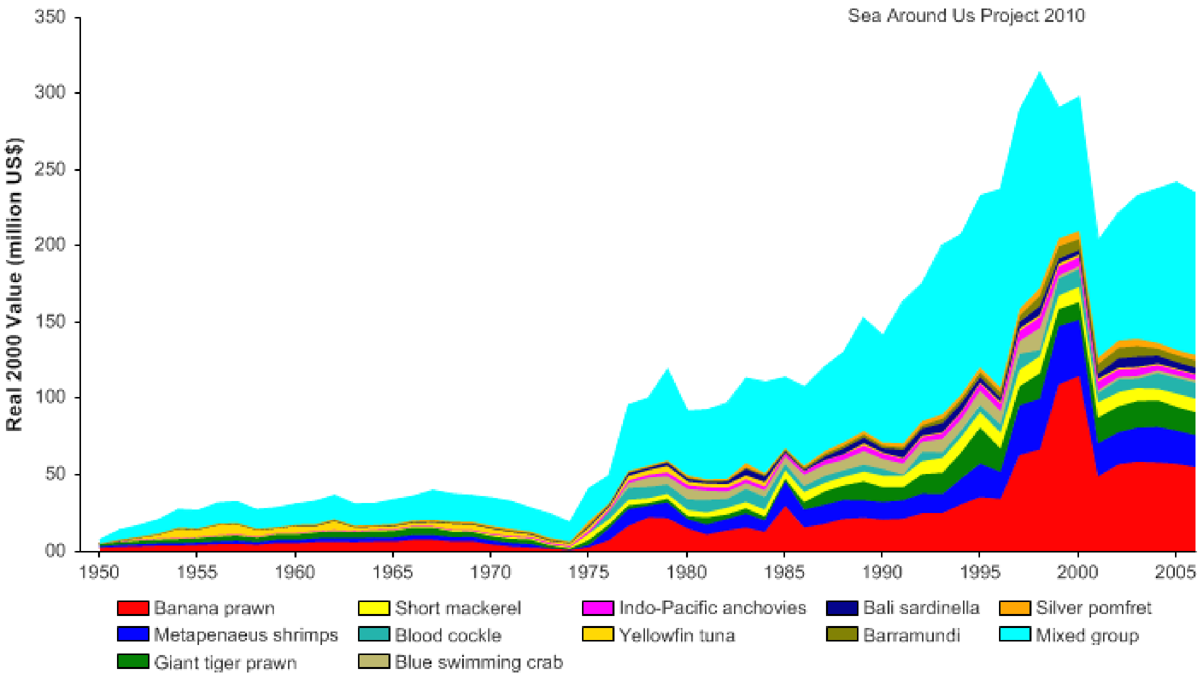

Figure 33: Real 2000 value (US$) by species in the Bay of Bengal portion of Indonesia's EEZ, 1950-2006.

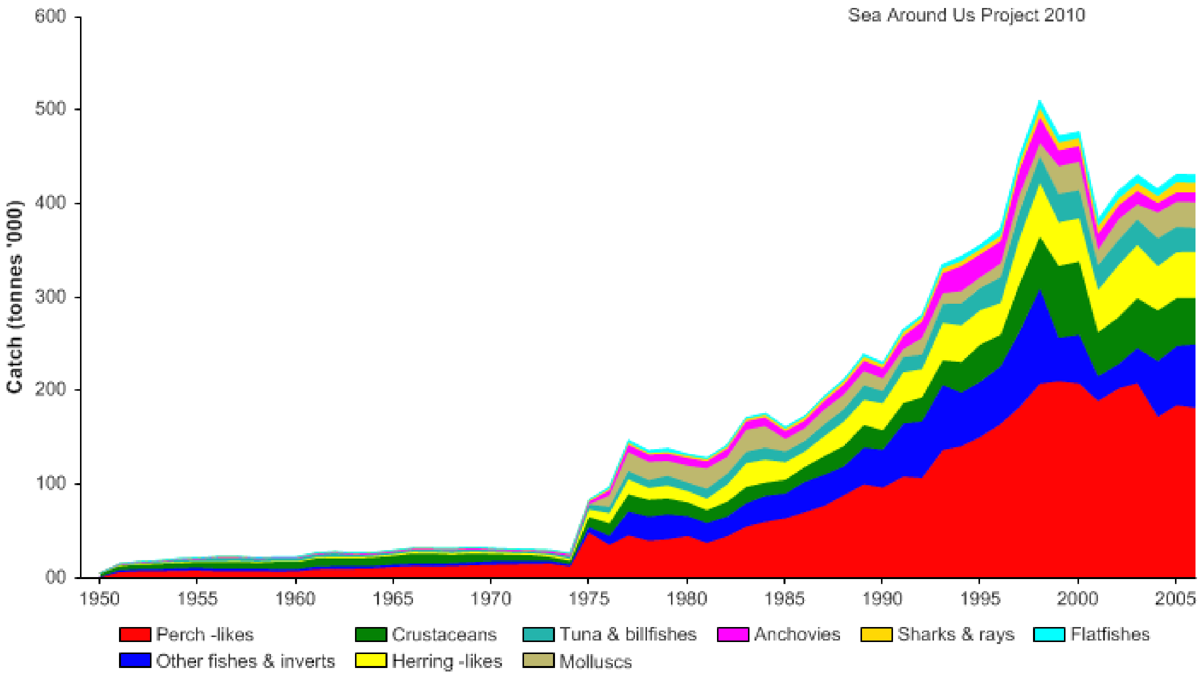

Figure 34: Landings by commercial group in the Bay of Bengal portion of Indonesia's EEZ, 1950-2006.

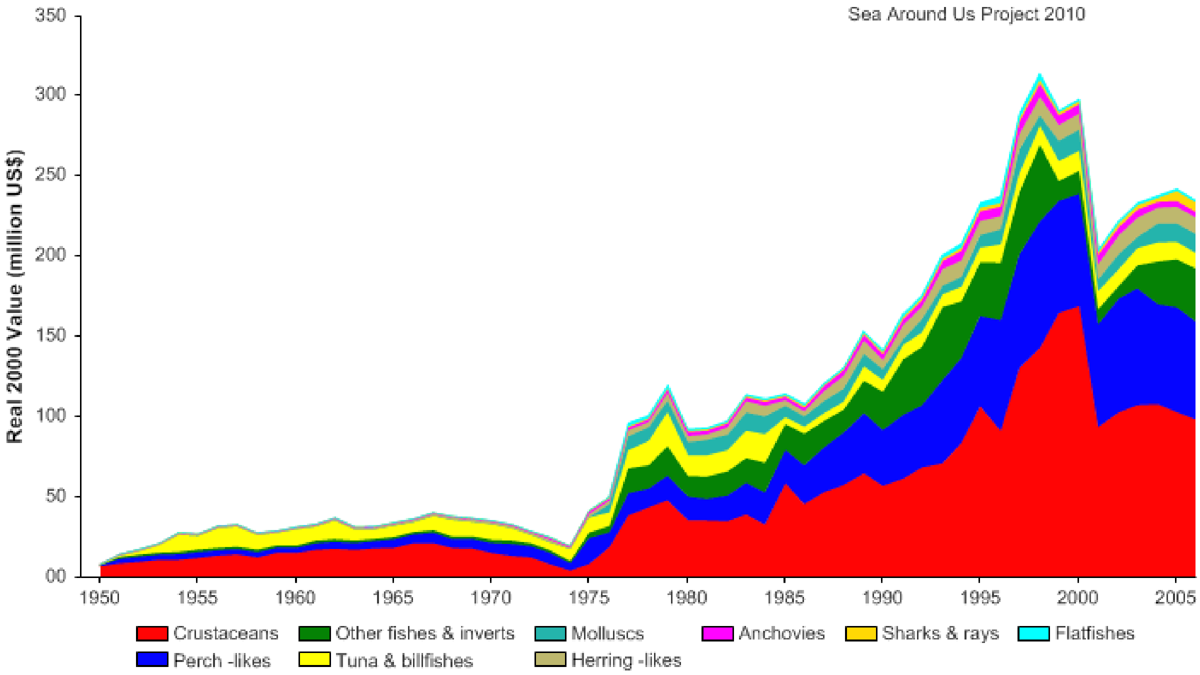

Figure 35: Real 2000 value (US$) by commercial group in the Bay of Bengal portion of Indonesia's EEZ, 1950-2006.

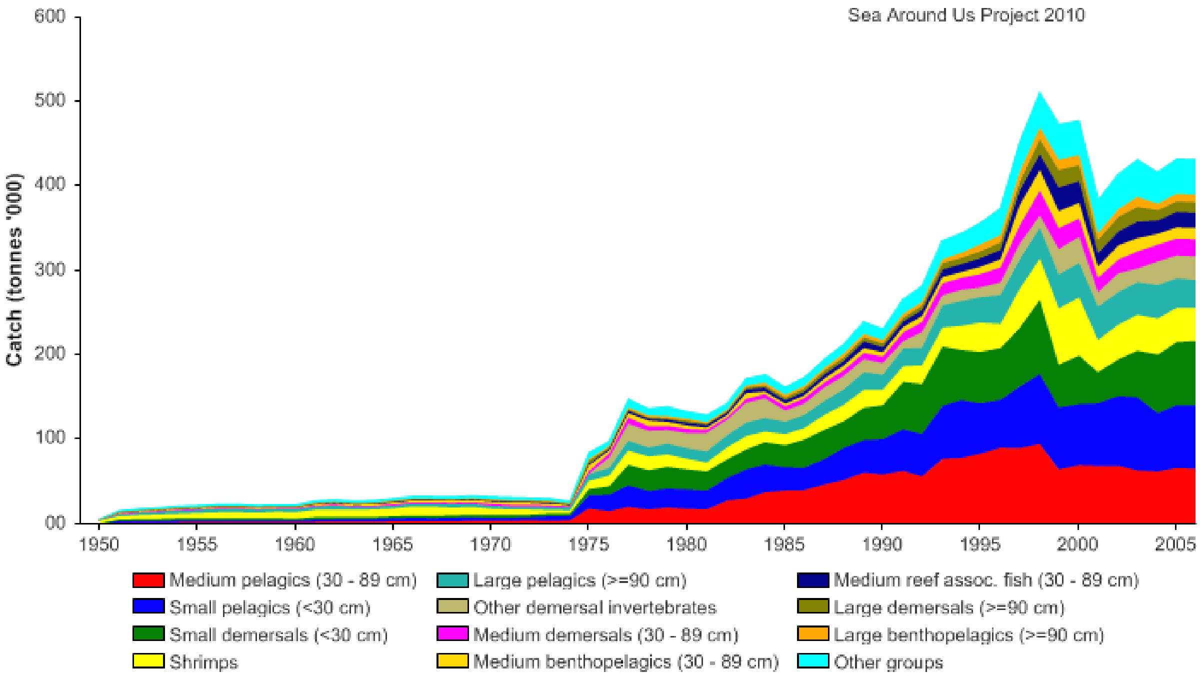

Figure 36: Landings by functional group in the Bay of Bengal portion of Indonesia's EEZ, 1950-2006.

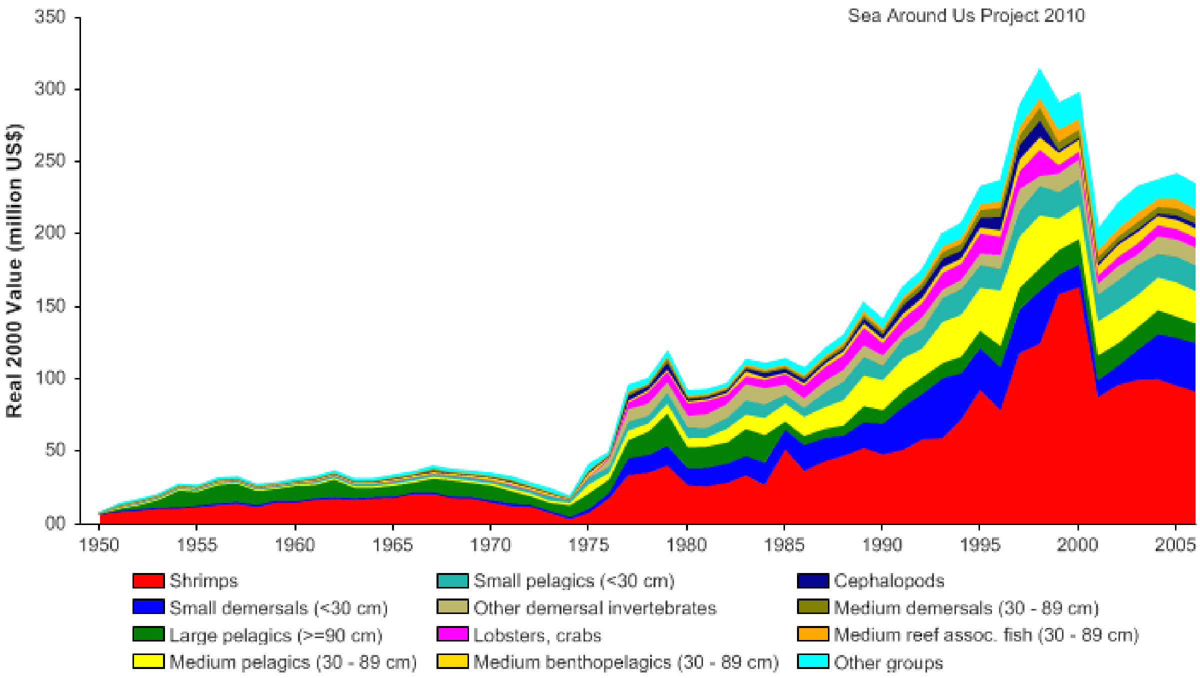

Figure 37: Real 2000 value (US$) by functional group in the Bay of Bengal portion of Indonesia's EEZ, 1950-2006.

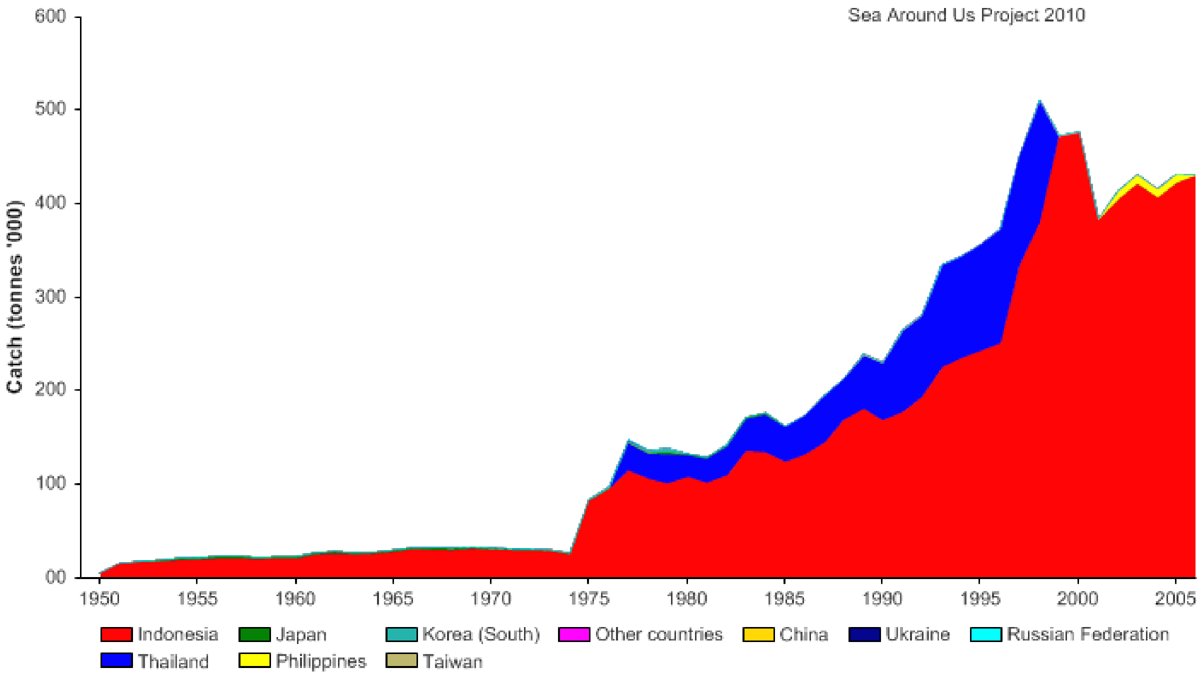

Figure 38: Landings by fishing country in the Bay of Bengal portion of Indonesia's EEZ, 1950-2006.

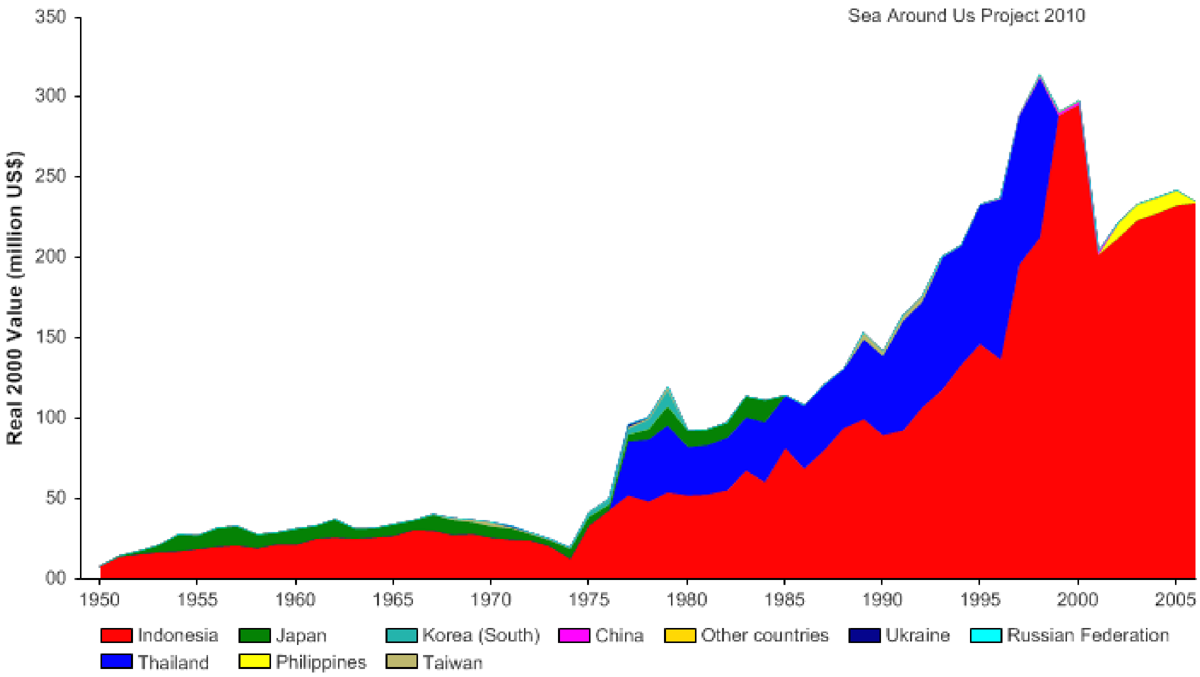

Figure 39: Real 2000 value (US$) by fishing country in the Bay of Bengal portion of Indonesia's EEZ, 1950-2006.

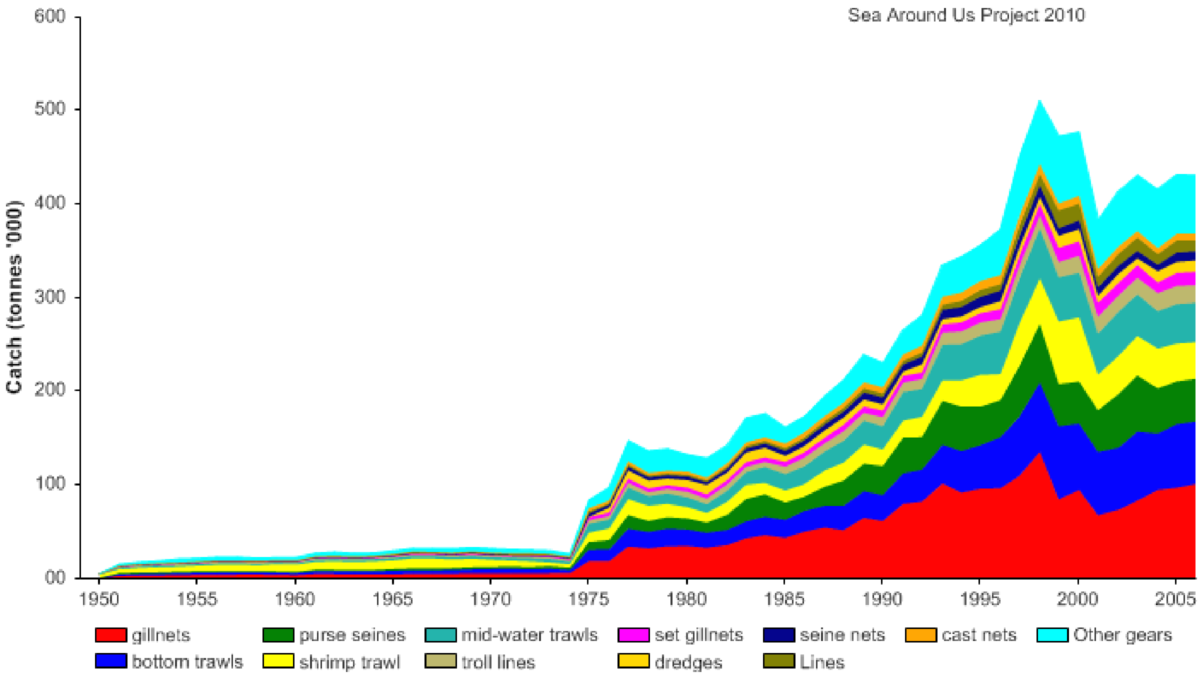

Figure 40: Landings by gear in the Bay of Bengal portion of Indonesia's EEZ, 1950-2006.

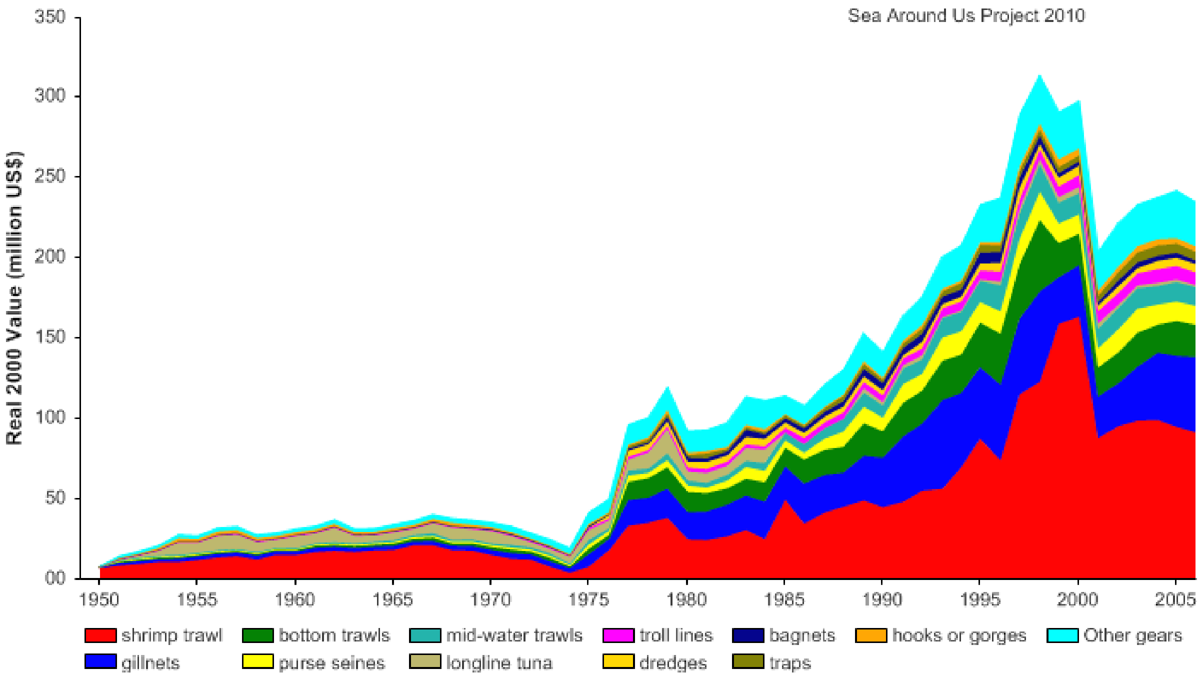

Figure 41: Real 2000 value (US$) by gear in the Bay of Bengal portion of Indonesia's EEZ, 1950-2006.

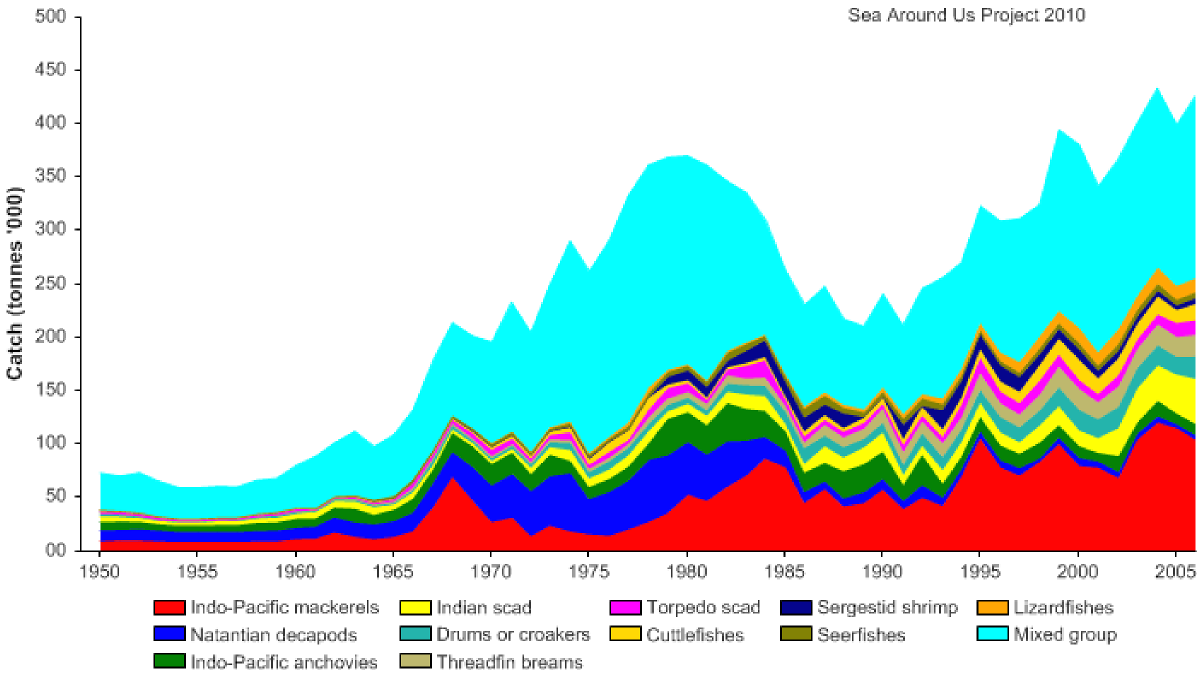

Figure 42: Landings by species in the Bay of Bengal portion of Malaysia's EEZ, 1950-2006.

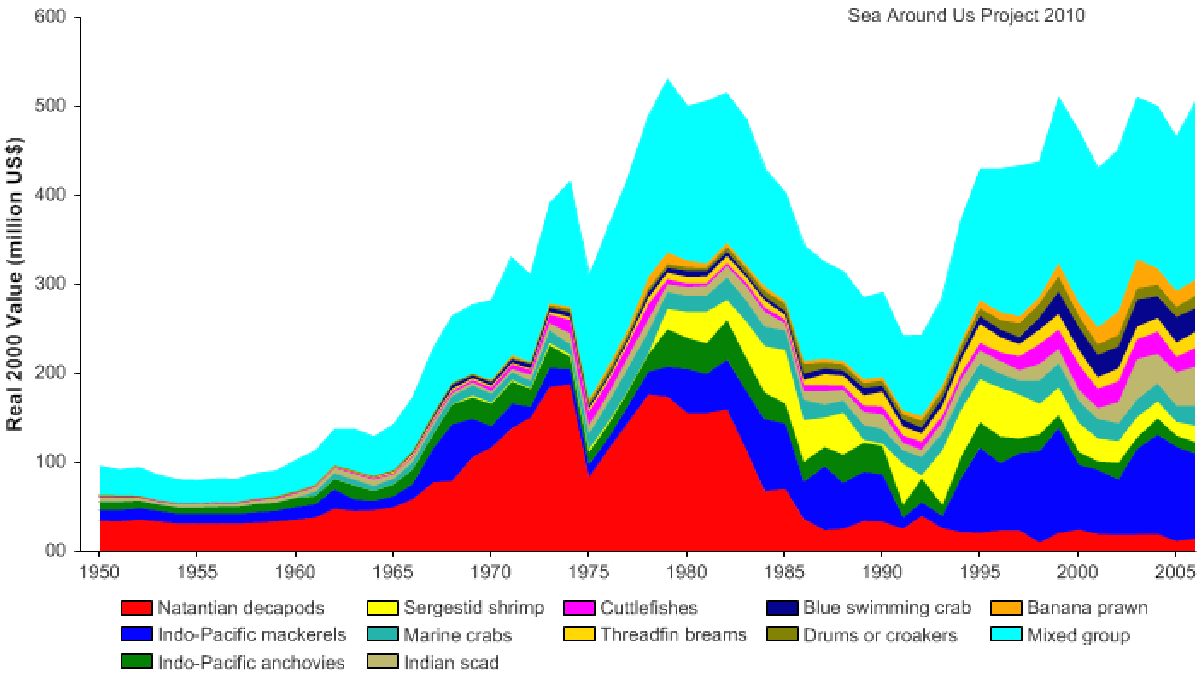

Figure 43: Real 2000 value (US$) by species in the Bay of Bengal portion of Malaysia's EEZ, 1950-2006.

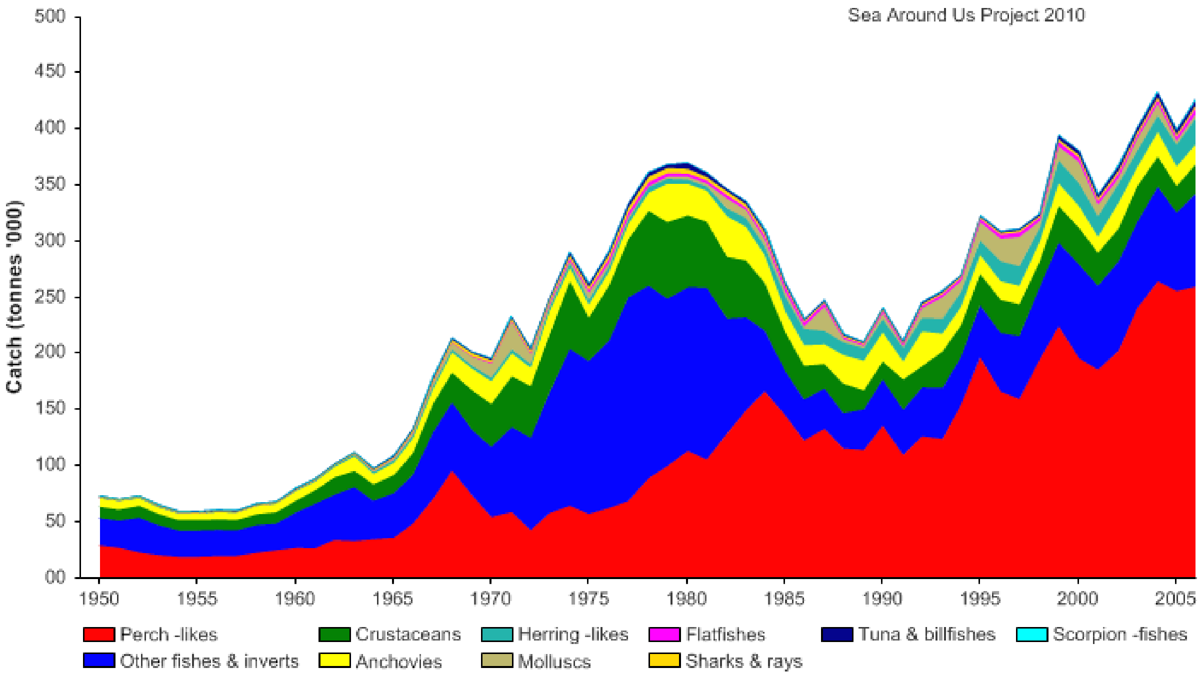

Figure 44: Landings by commercial group in the Bay of Bengal portion of Malaysia's EEZ, 1950-2006.

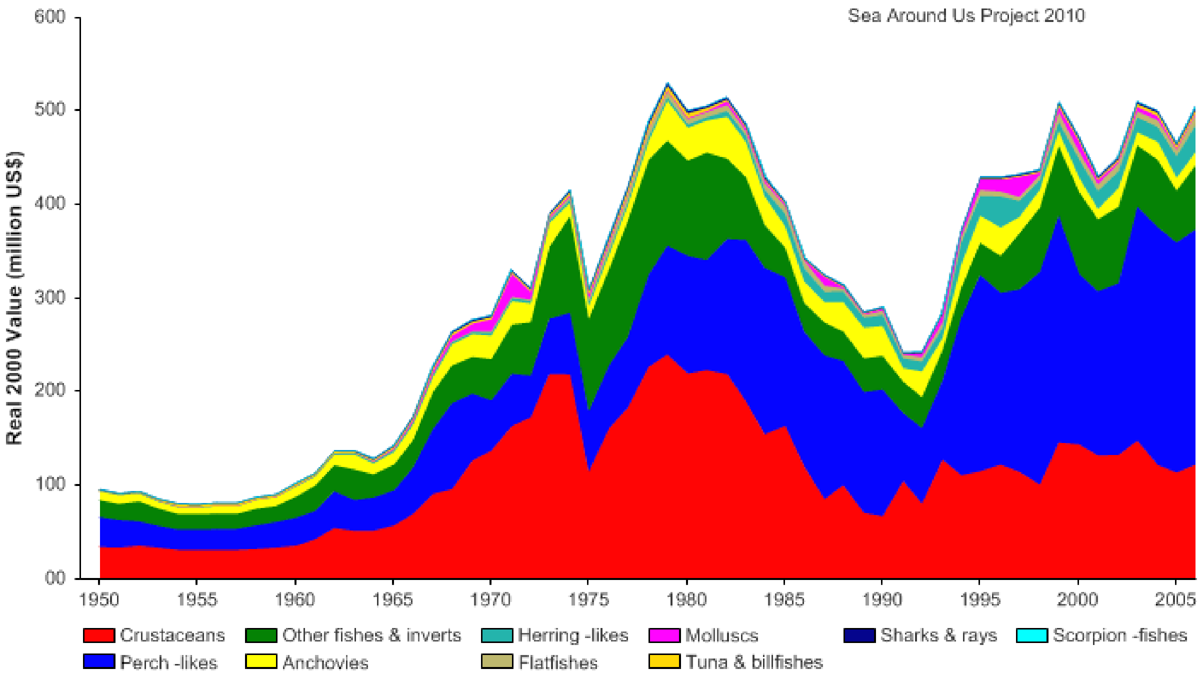

Figure 45: Real 2000 value (US$) by commercial group in the Bay of Bengal portion of Malaysia's EEZ, 1950-2006.

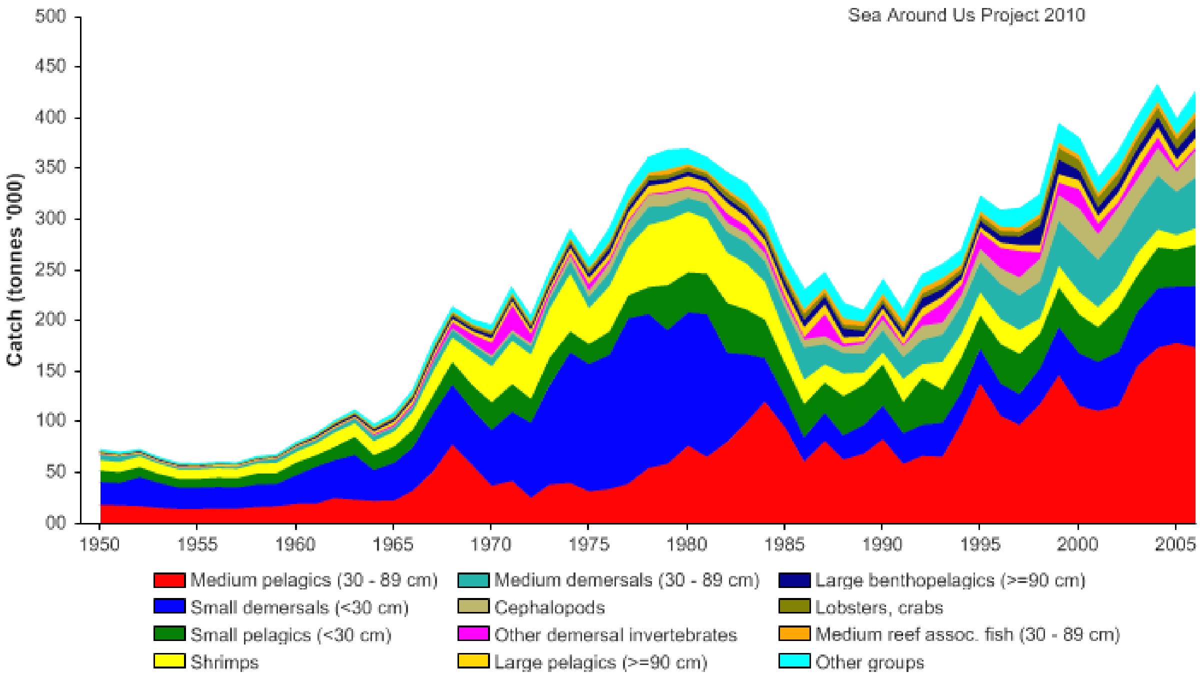

Figure 46: Landings by functional group in the Bay of Bengal portion of Malaysia's EEZ, 1950-2006.

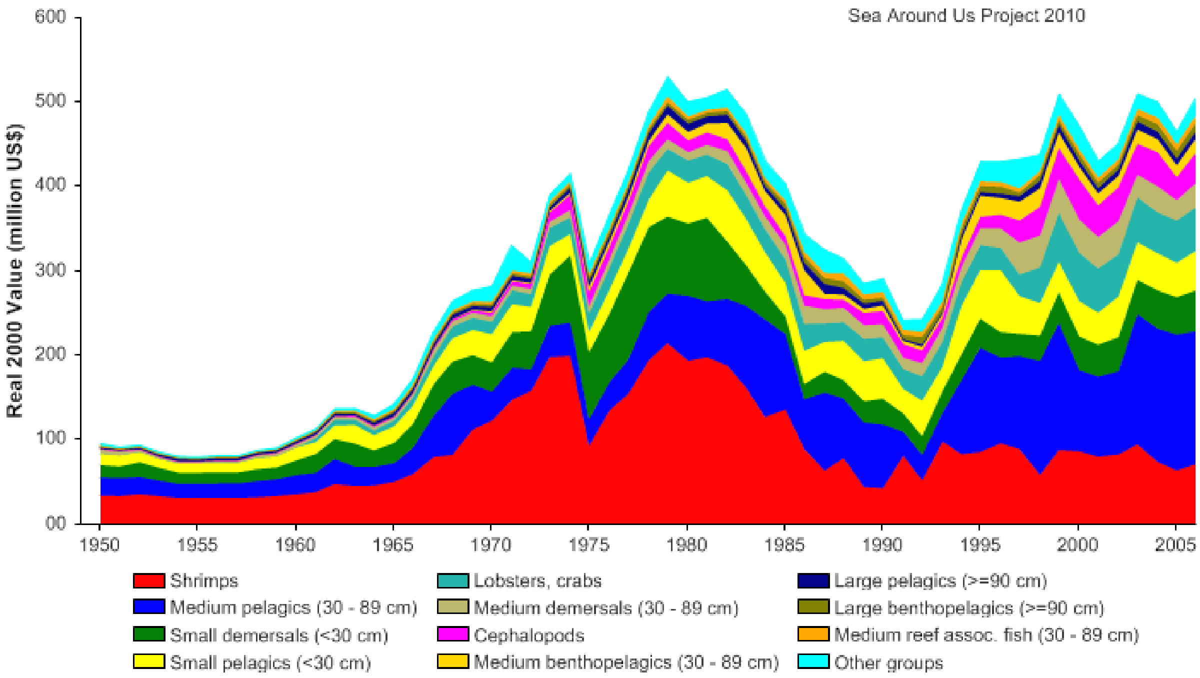

Figure 47: Real 2000 value (US$) by functional group in the Bay of Bengal portion of Malaysia's EEZ, 1950-2006.

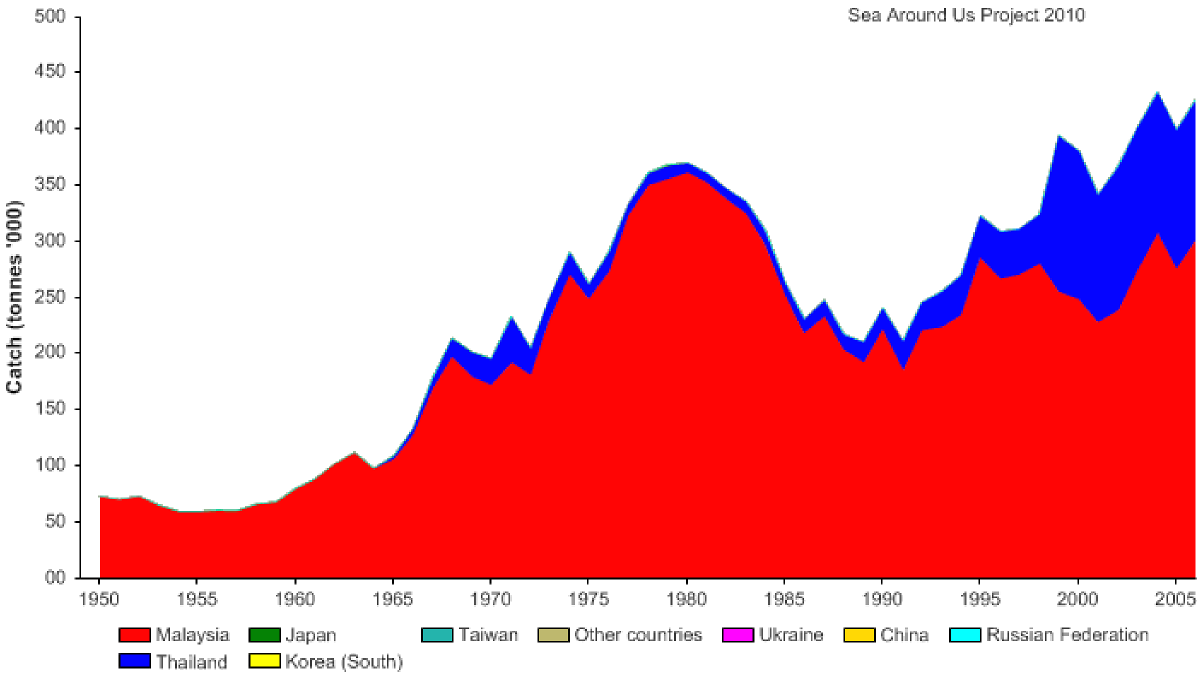

Figure 48: Landings by fishing country in the Bay of Bengal portion of Malaysia's EEZ, 1950-2006.

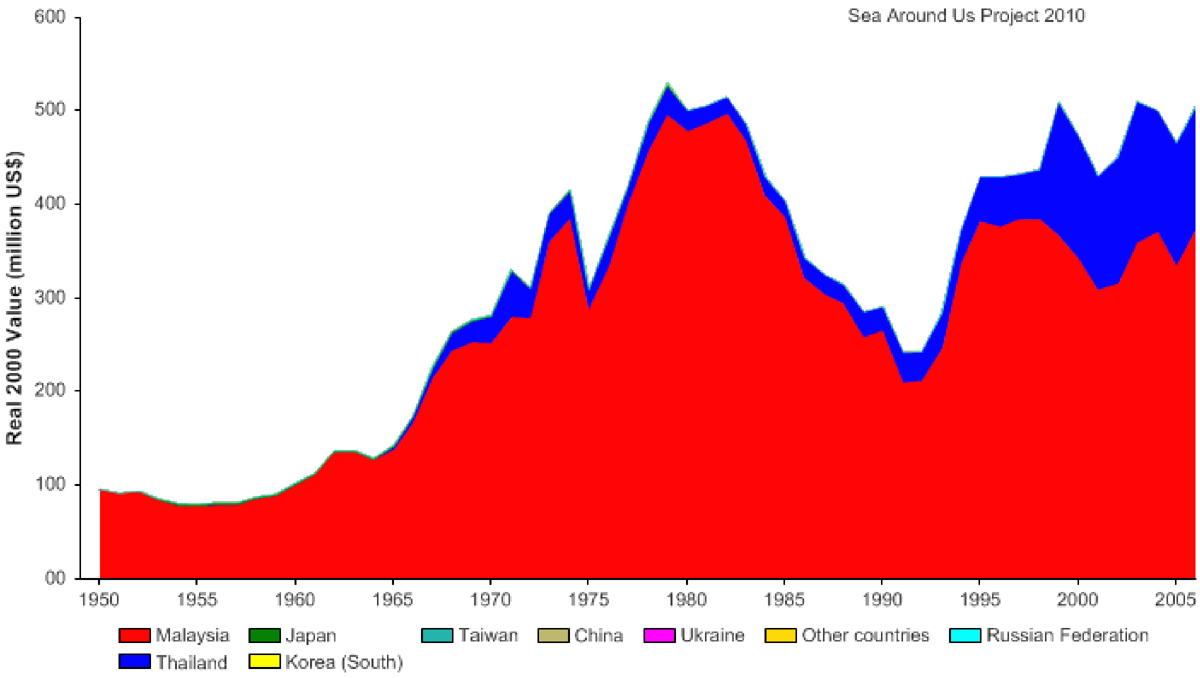

Figure 49: Real 2000 value (US$) by fishing country in the Bay of Bengal portion of Malaysia's EEZ, 1950-2006.

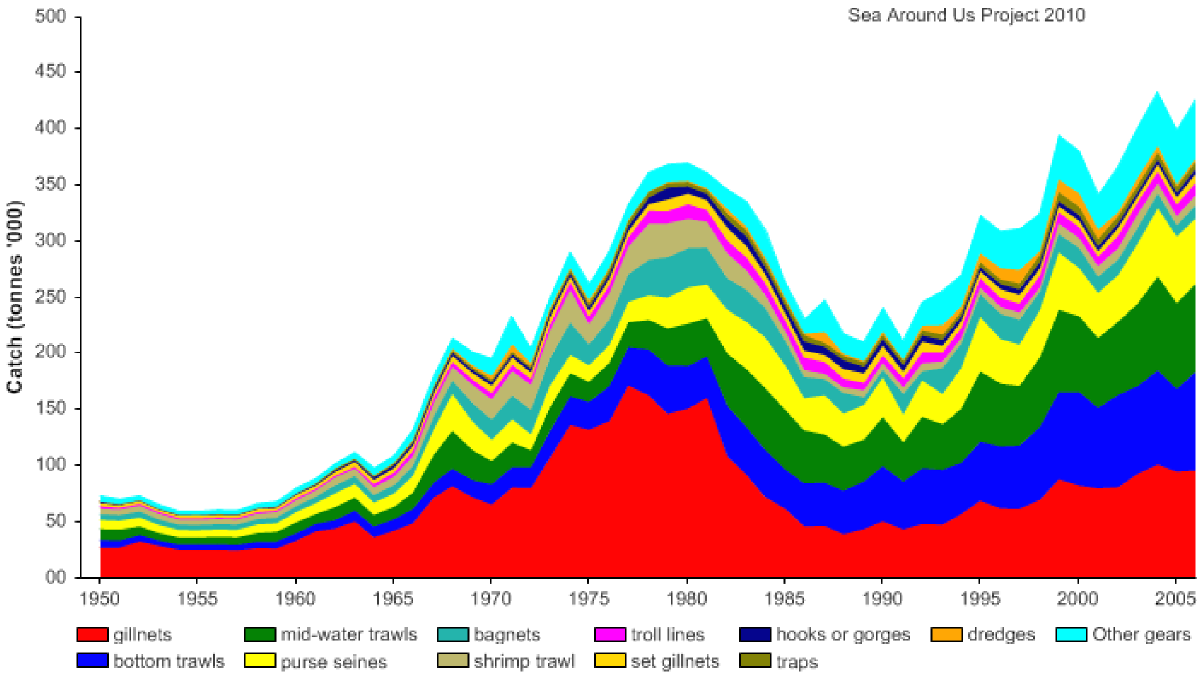

Figure 50: Landings by gear in the Bay of Bengal portion of Malaysia's EEZ, 1950-2006.

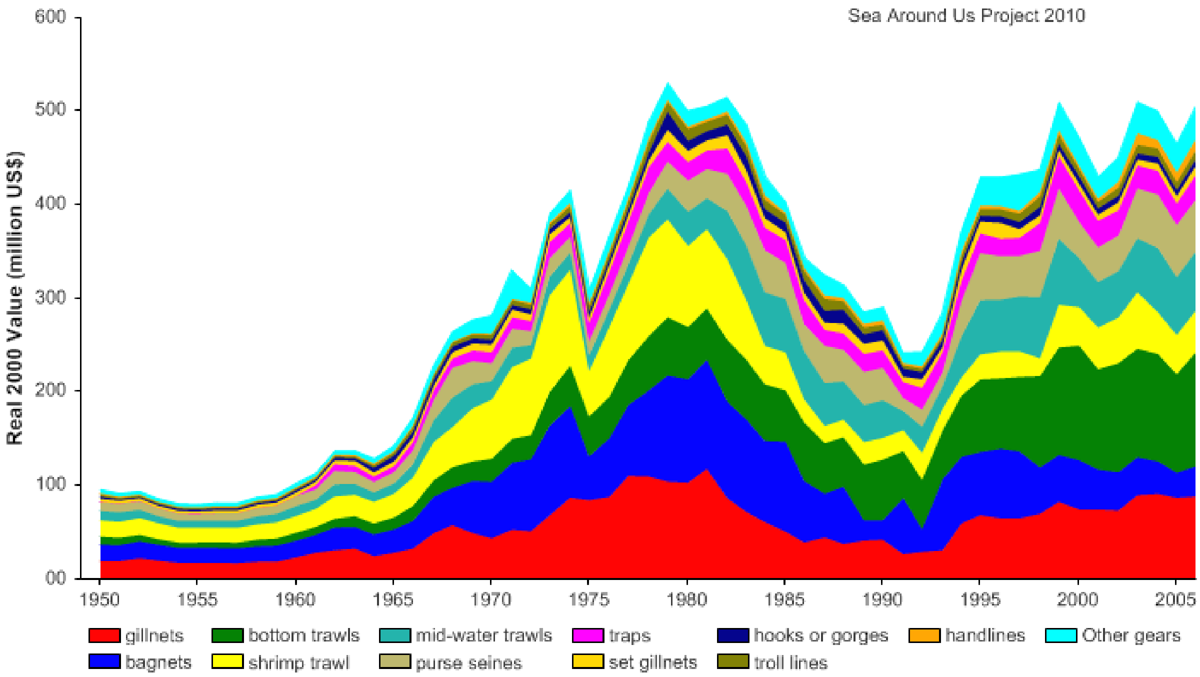

Figure 51: Real 2000 value (US$) by gear in the Bay of Bengal portion of Malaysia's EEZ, 1950-2006.

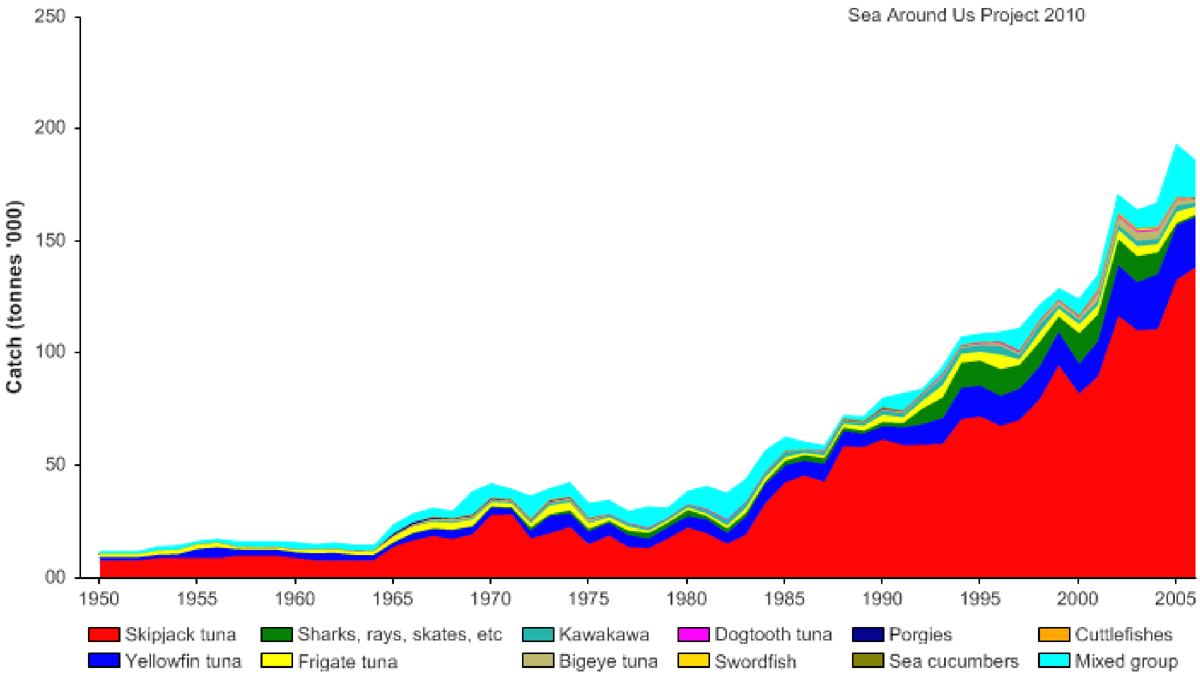

Figure 52: Landings by species in the EZZ of the Maldives, 1950-2006.

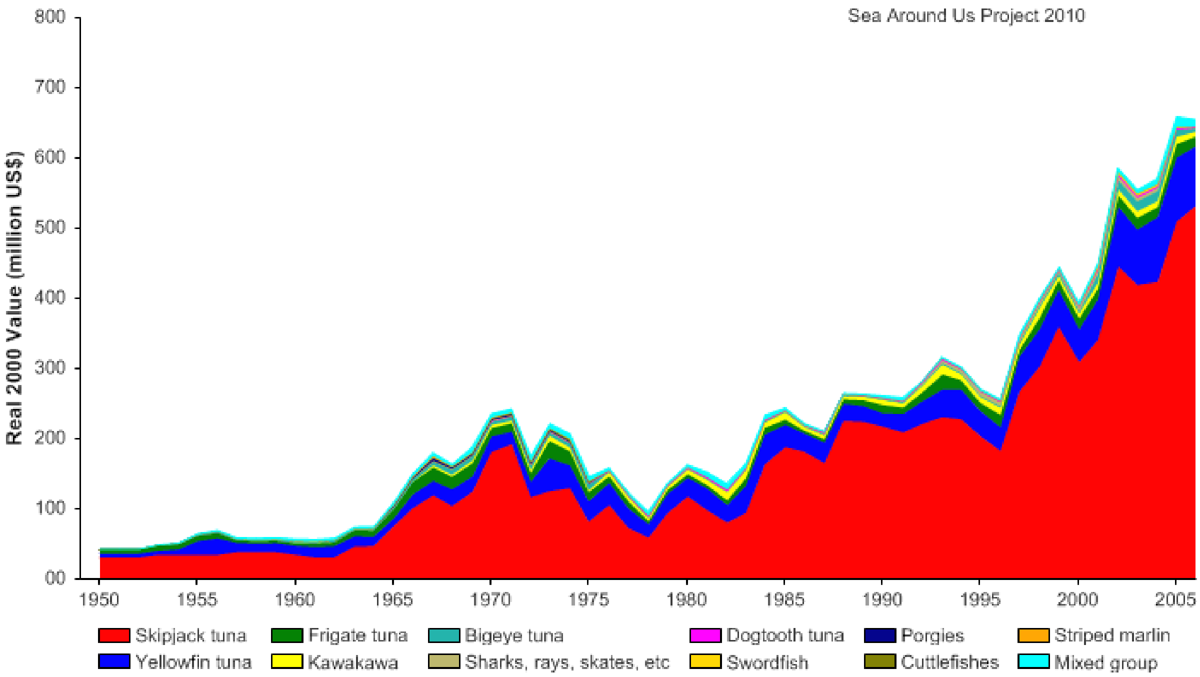

Figure 53: Real 2000 value (US$) by species in the EZZ of the Maldives, 1950-2006.

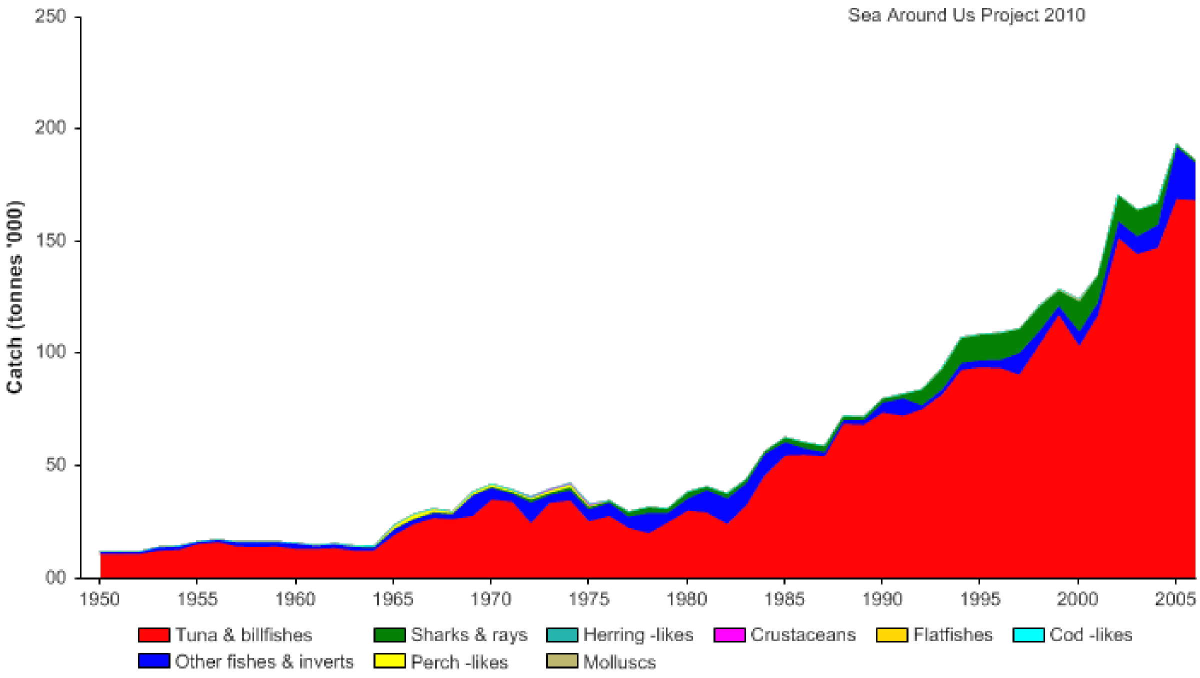

Figure 54: Landings by commercial group in the EZZ of the Maldives, 1950-2006.

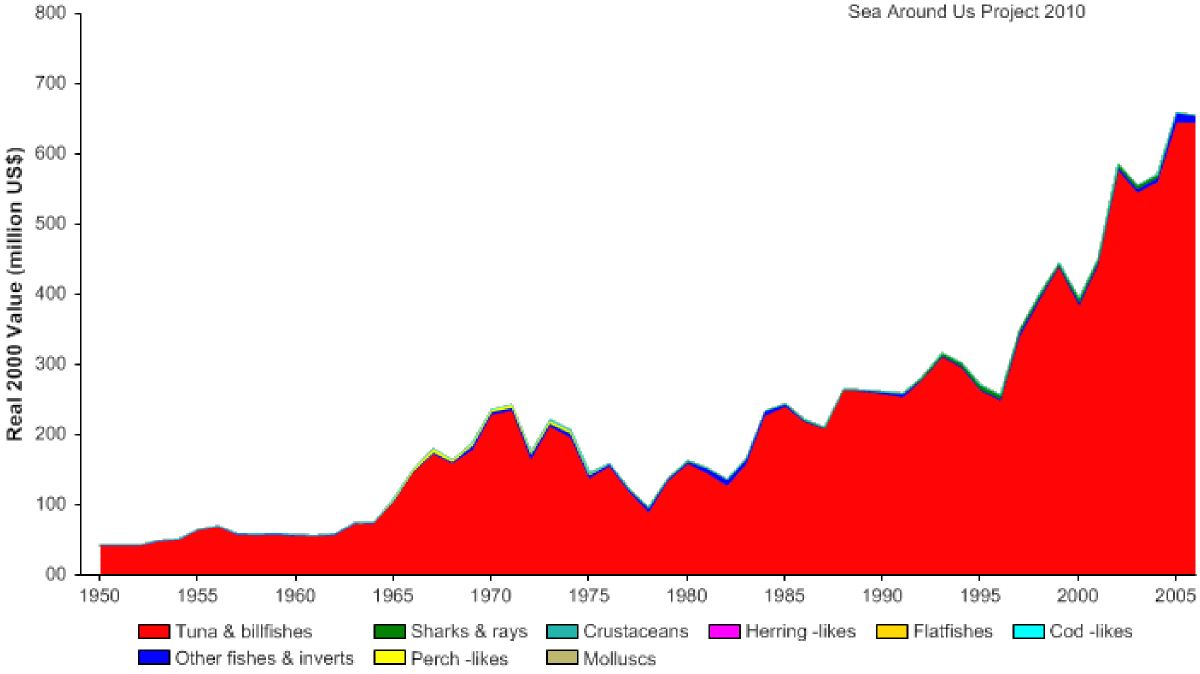

Figure 55: Real 2000 value (US$) by commercial group in the EZZ of the Maldives, 1950-2006.

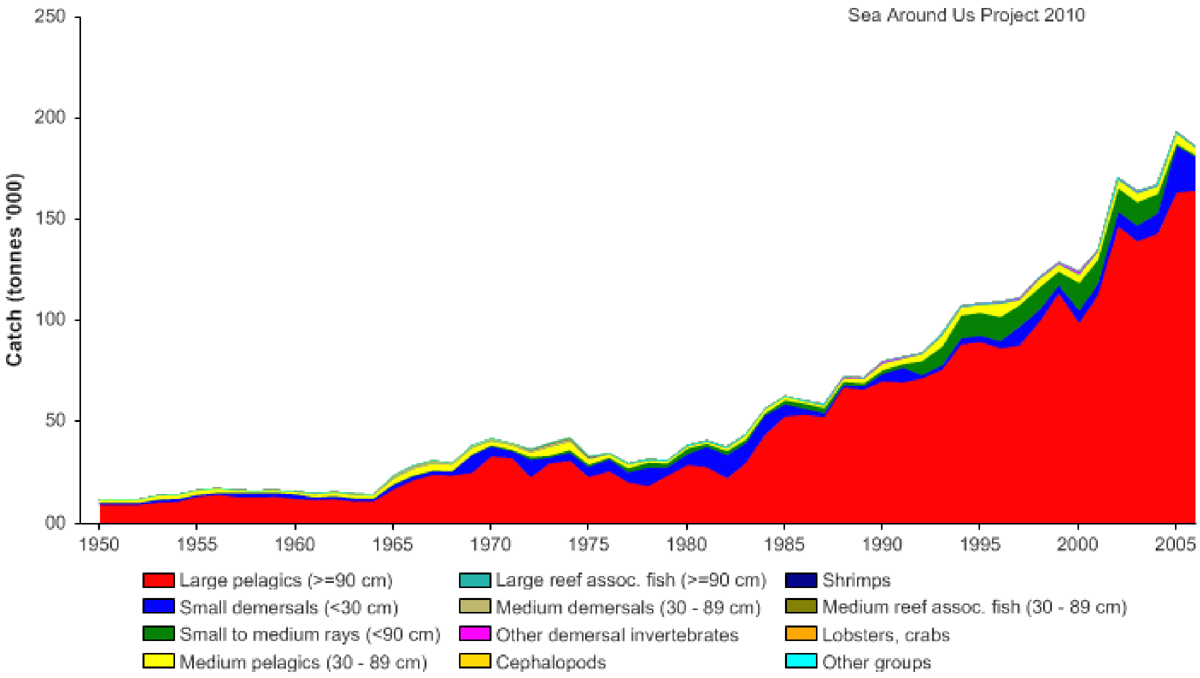

Figure 56: Landings by functional group in the EZZ of the Maldives, 1950-2006.

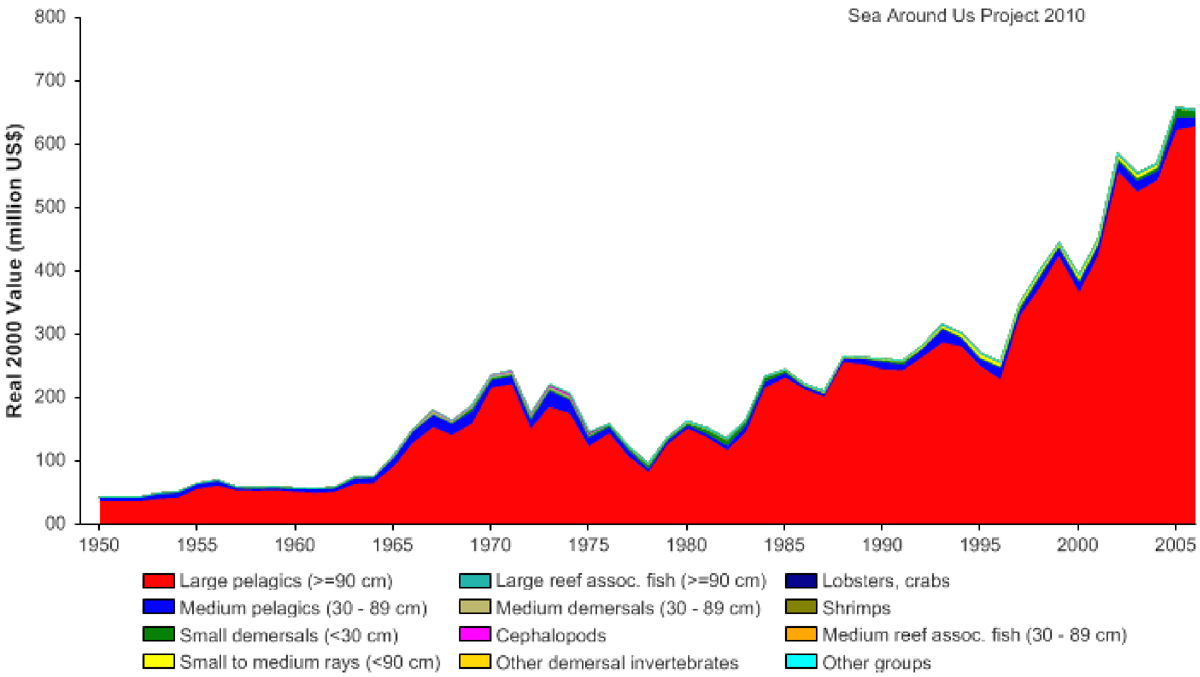

Figure 57: Real 2000 value (US$) by functional group in the EZZ of the Maldives, 1950-2006.

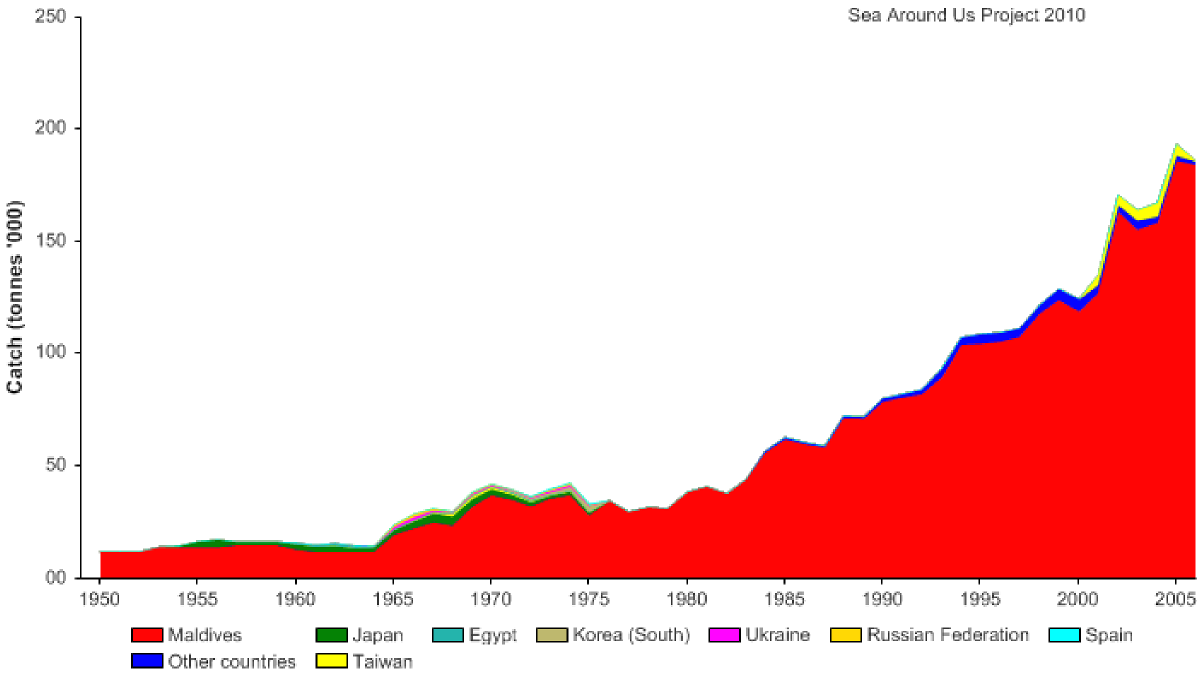

Figure 58: Landings by fishing country in the EZZ of the Maldives, 1950-2006.

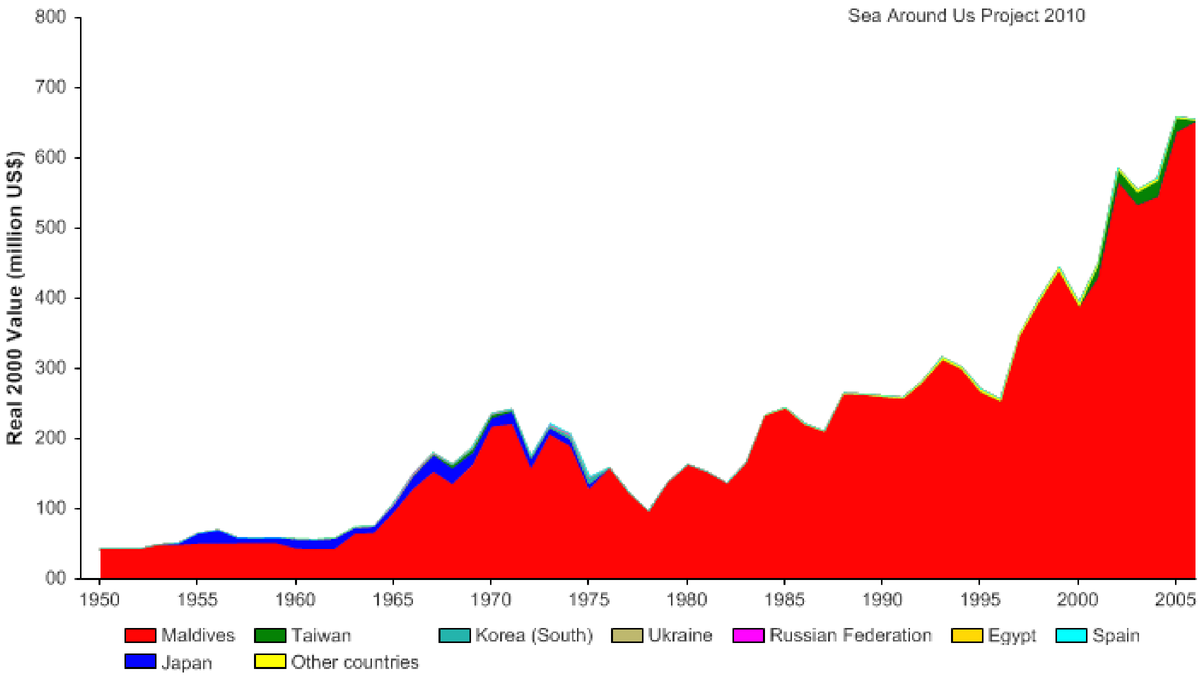

Figure 59: Real 2000 value (US$) by fishing country in the EZZ of the Maldives, 1950-2006.

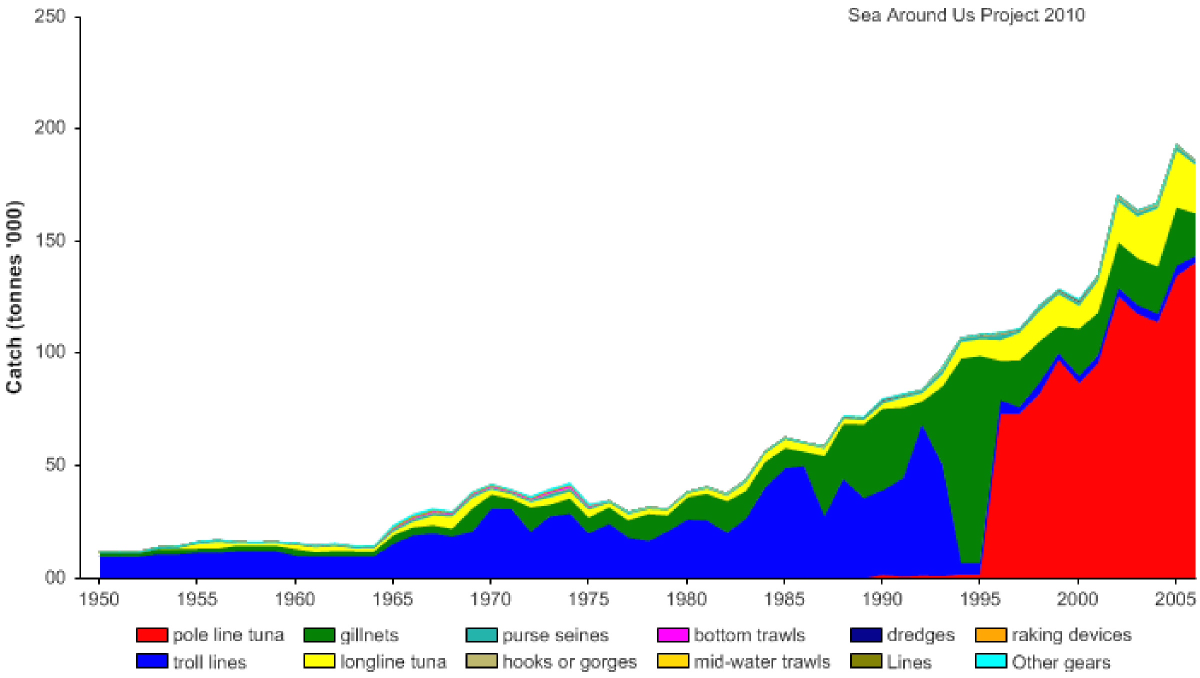

Figure 60: Landings by gear in the EZZ of the Maldives, 1950-2006.

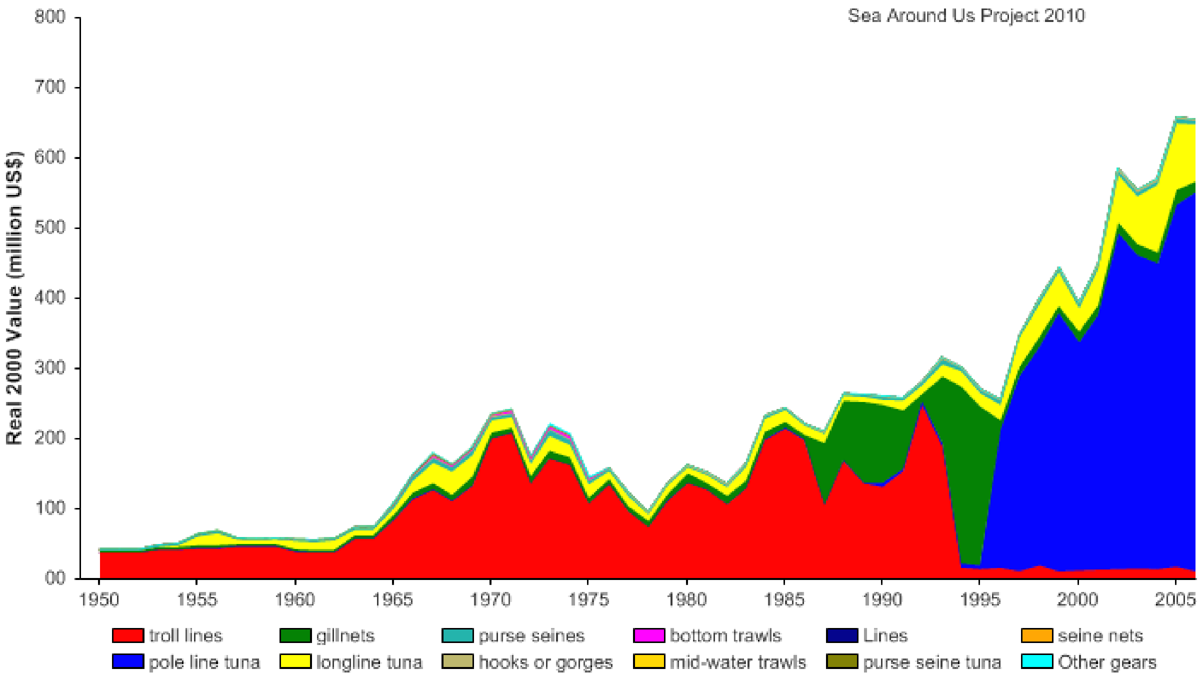

Figure 61: Real 2000 value (US$) by gear in the EZZ of the Maldives, 1950-2006.

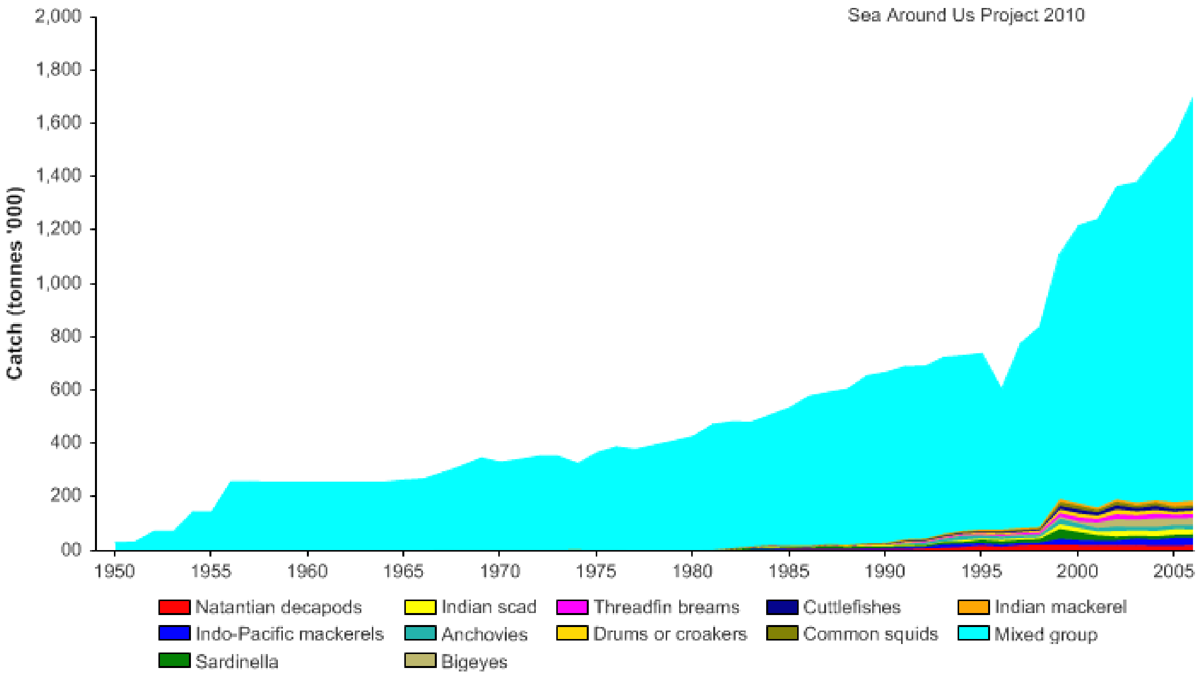

Figure 62: Landings by species in the EZZ of Myanmar, 1950-2006.

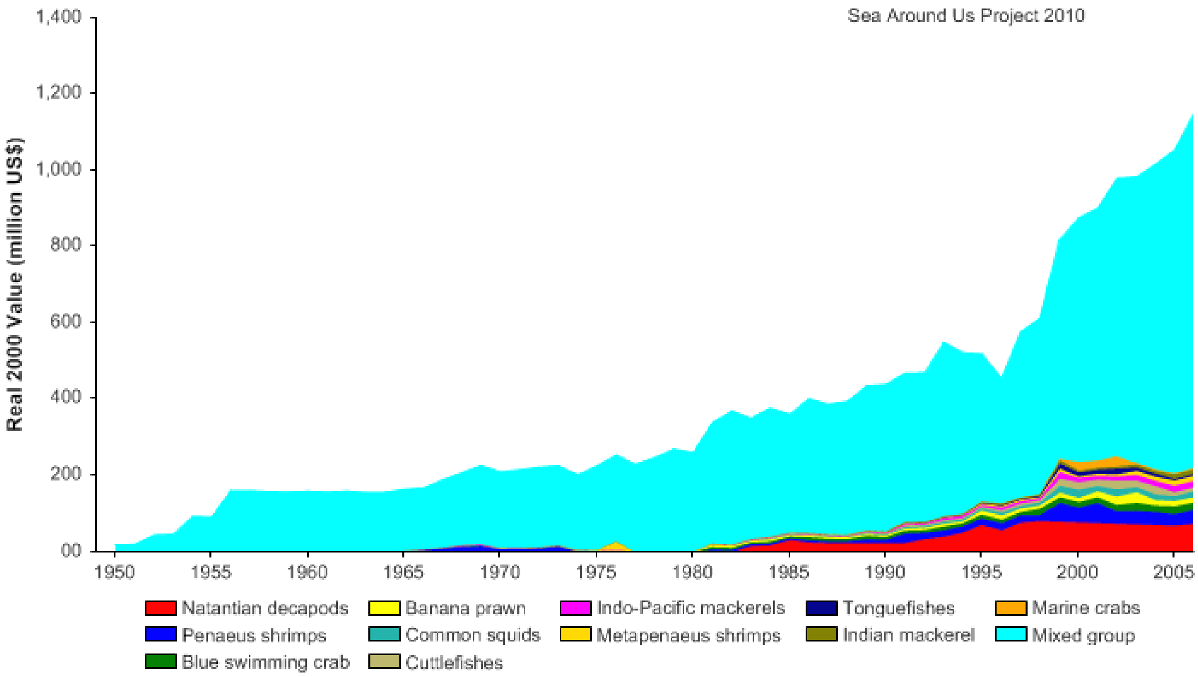

Figure 63: Real 2000 value (US$) by species in the EZZ of Myanmar, 1950-2006.

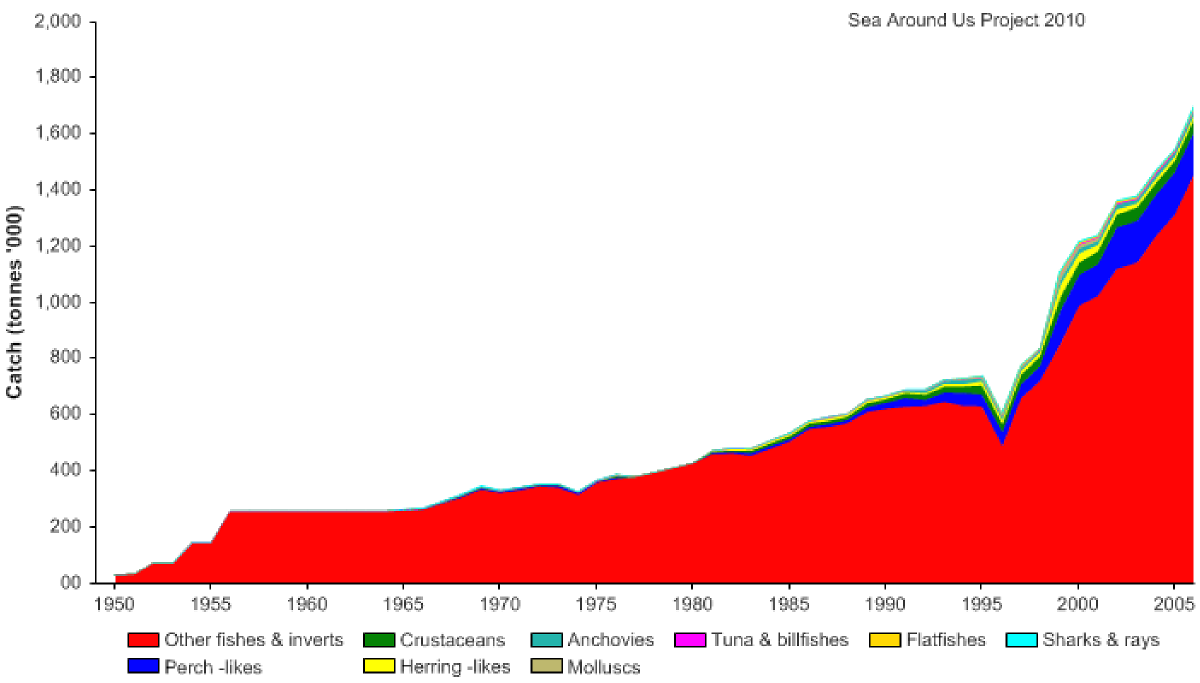

Figure 64: Landings by commercial group in the EZZ of Myanmar, 1950-2006.

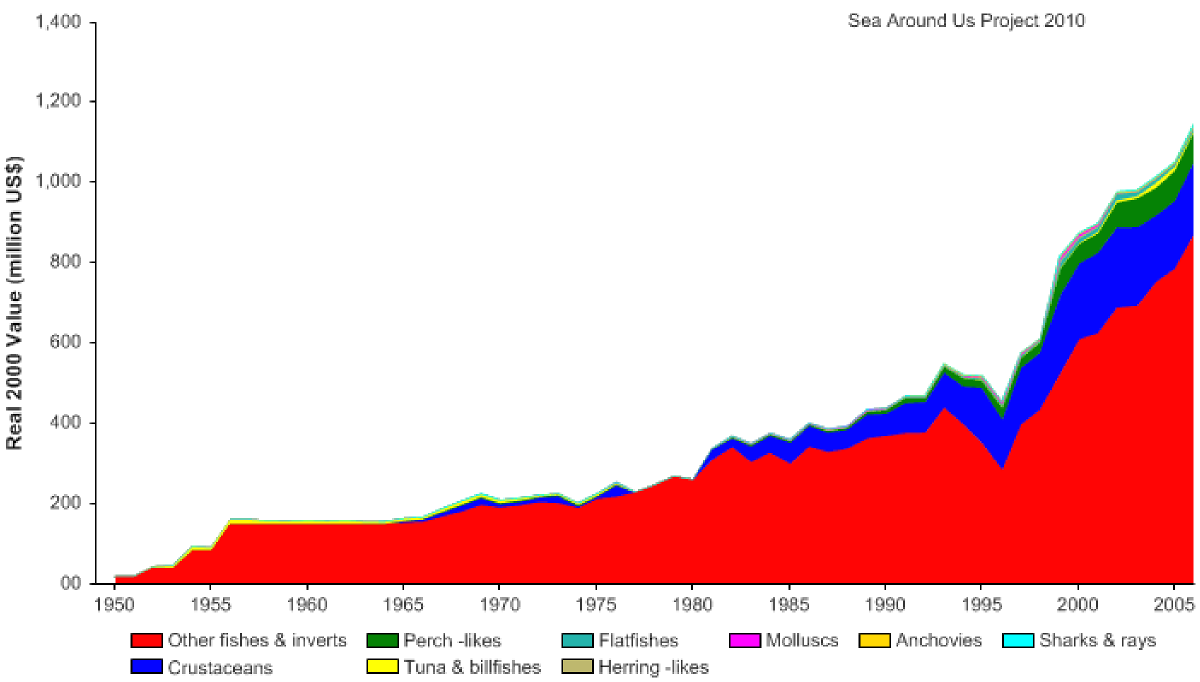

Figure 65: Real 2000 value (US$) by commercial group in the EZZ of Myanmar, 1950-2006.

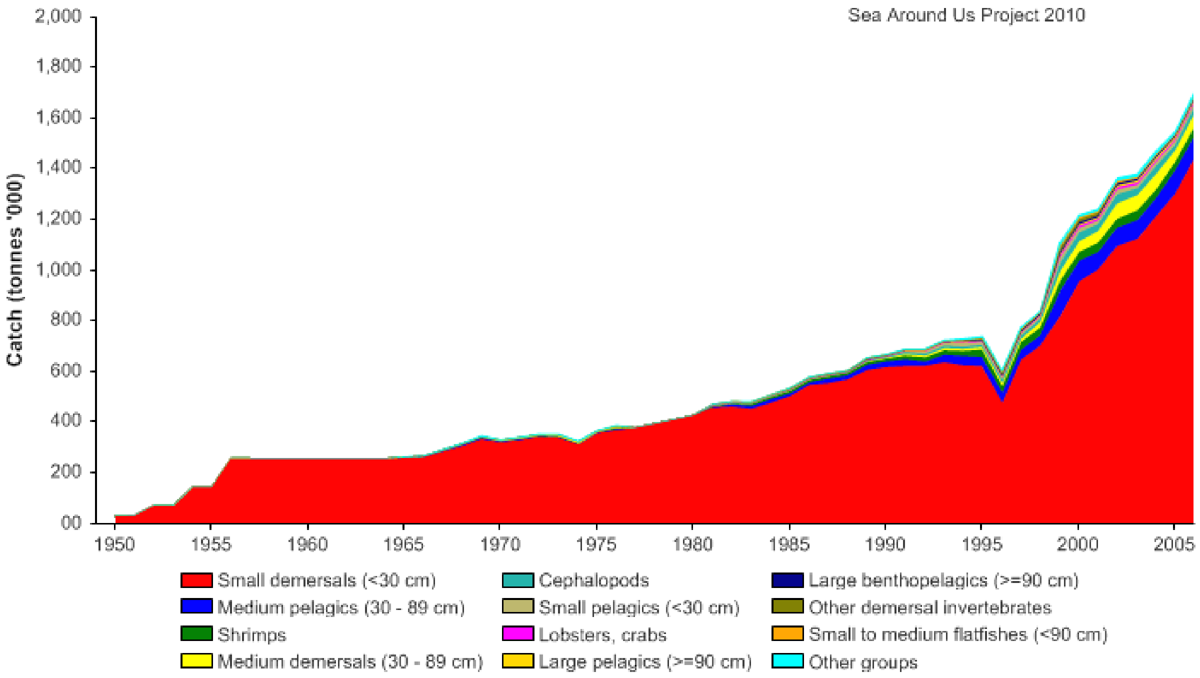

Figure 66: Landings by functional group in the EZZ of Myanmar, 1950-2006.

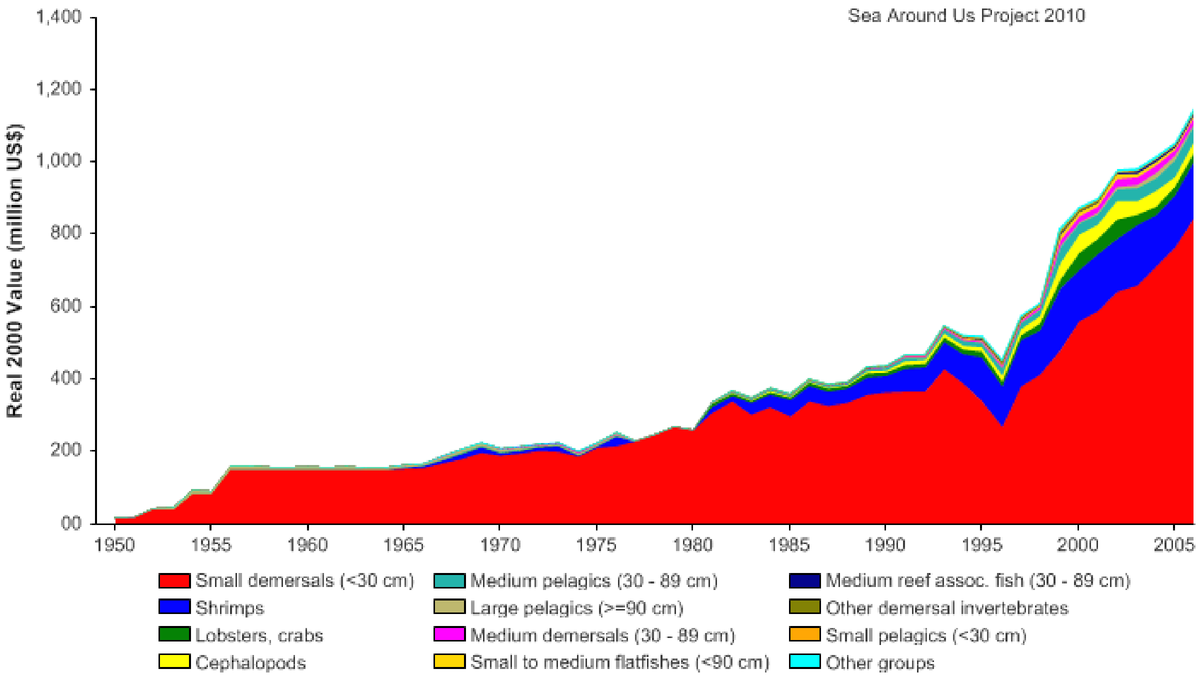

Figure 67: Real 2000 value (US$) by functional group in the EZZ of Myanmar, 1950-2006.

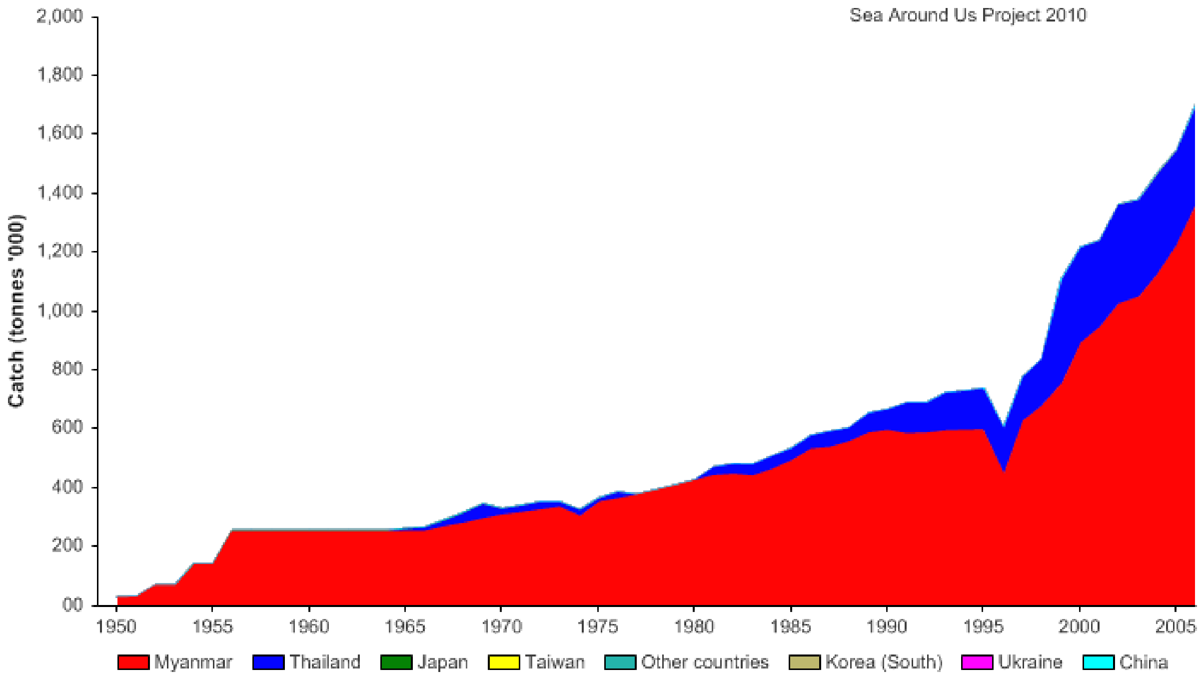

Figure 68: Landings by fishing country in the EZZ of Myanmar, 1950-2006.

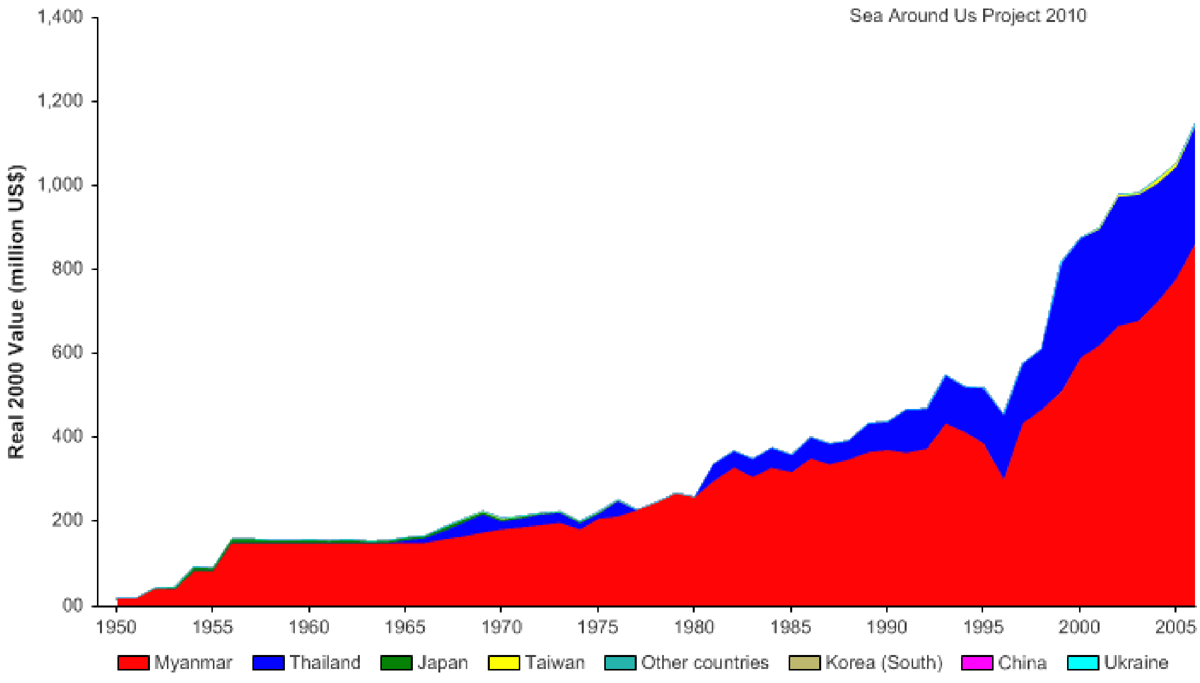

Figure 69: Real 2000 value (US$) by fishing country in the EZZ of Myanmar, 1950-2006.

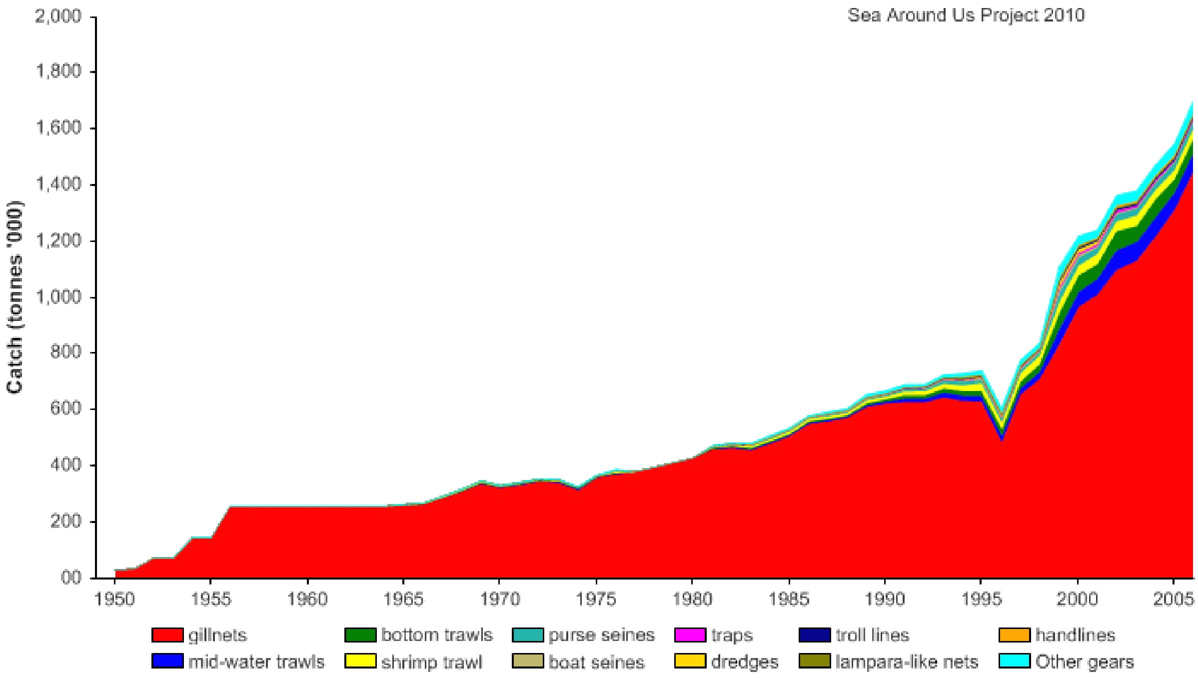

Figure 70: Landings by gear in the EZZ of Myanmar, 1950-2006.

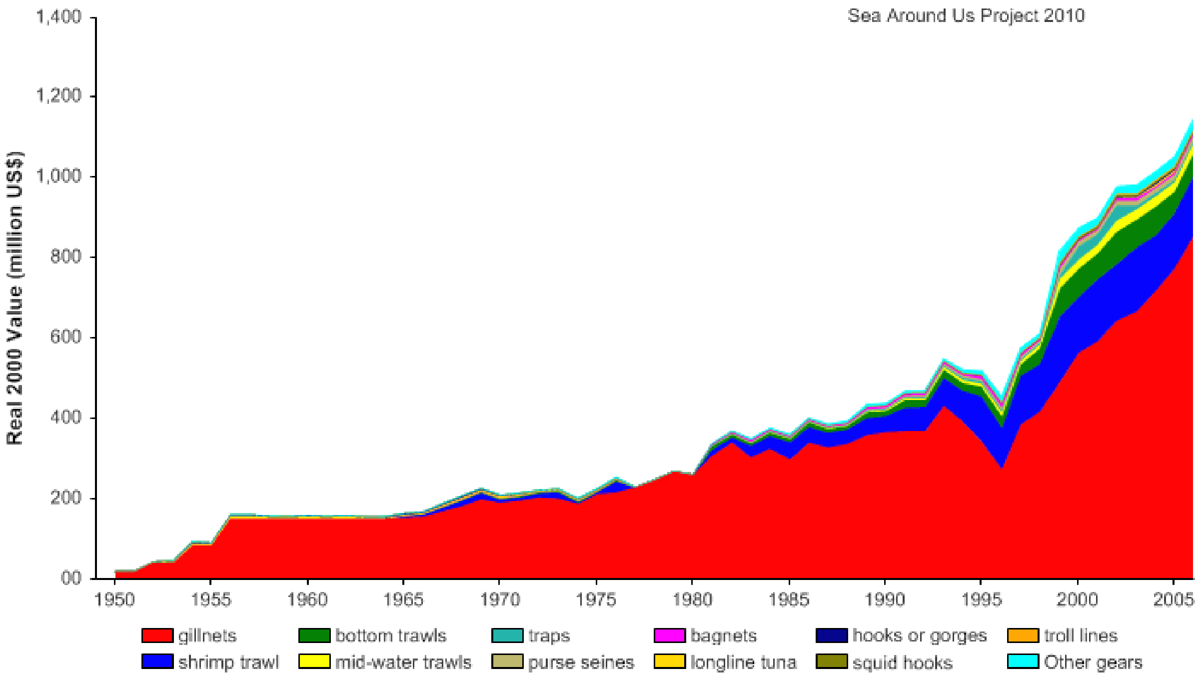

Figure 71: Real 2000 value (US$) by gear in the EZZ of Myanmar, 1950-2006.

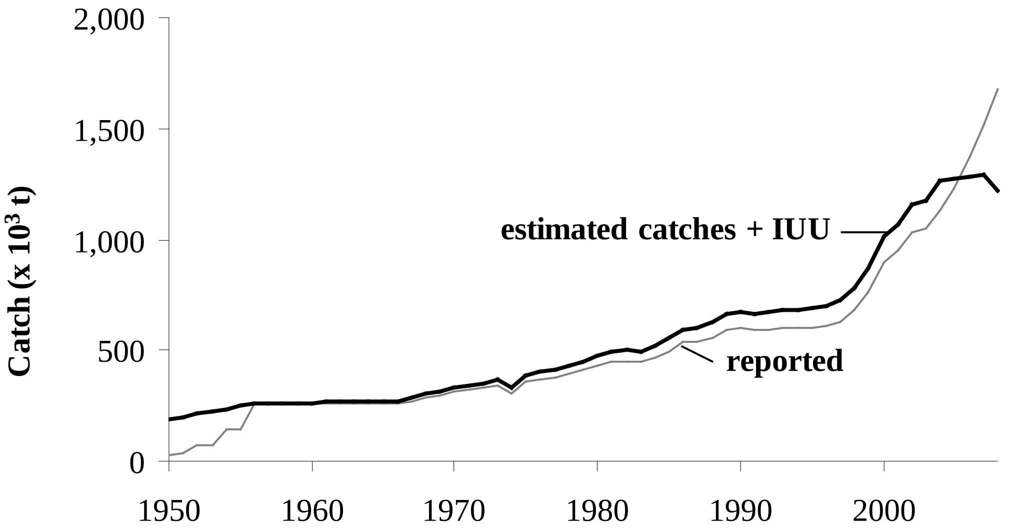

Figure 72: Reported landings (as presented by FAO on behalf of Myanmar) versus reconstructed (reported + IUU).

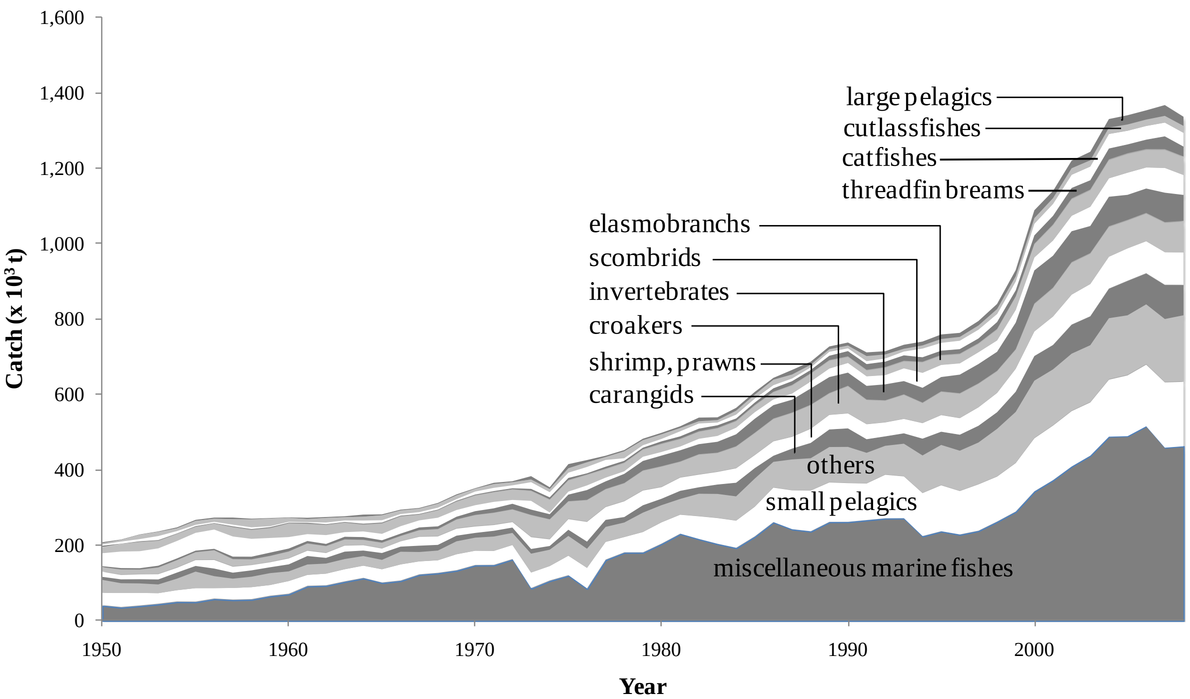

Figure 73: Total reconstructed catch for Myanmar, 1950-2008 by species

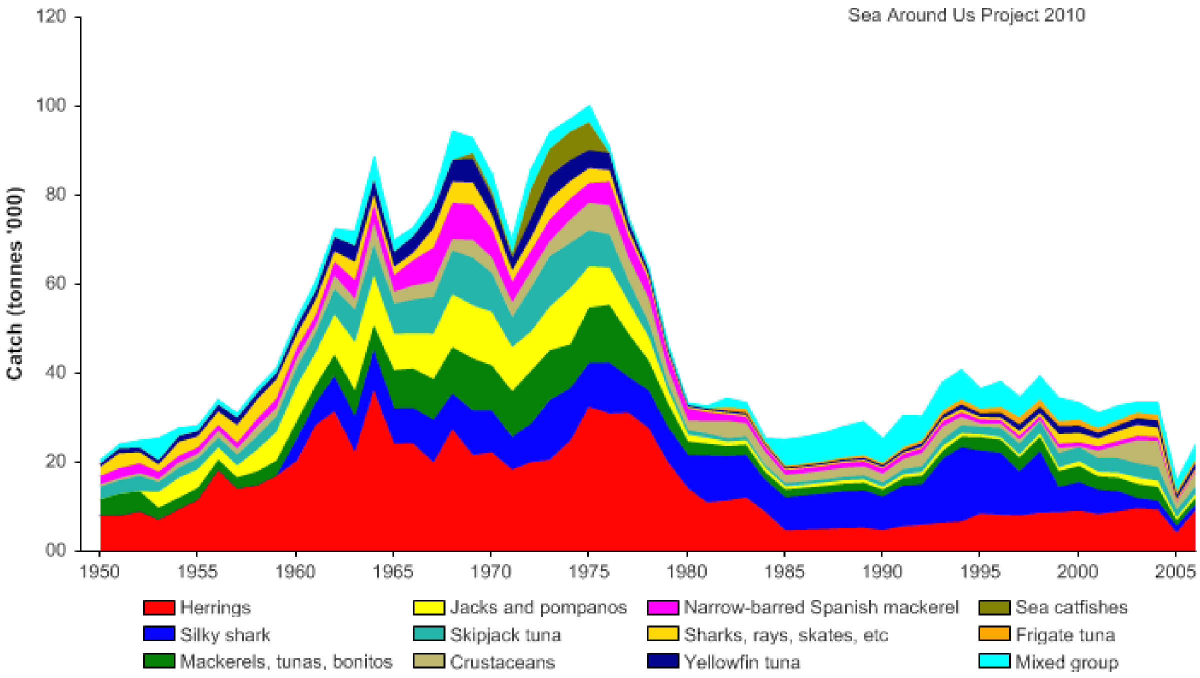

Figure 74: Landings by species in Sri Lanka's EZZ, 1950-2006.

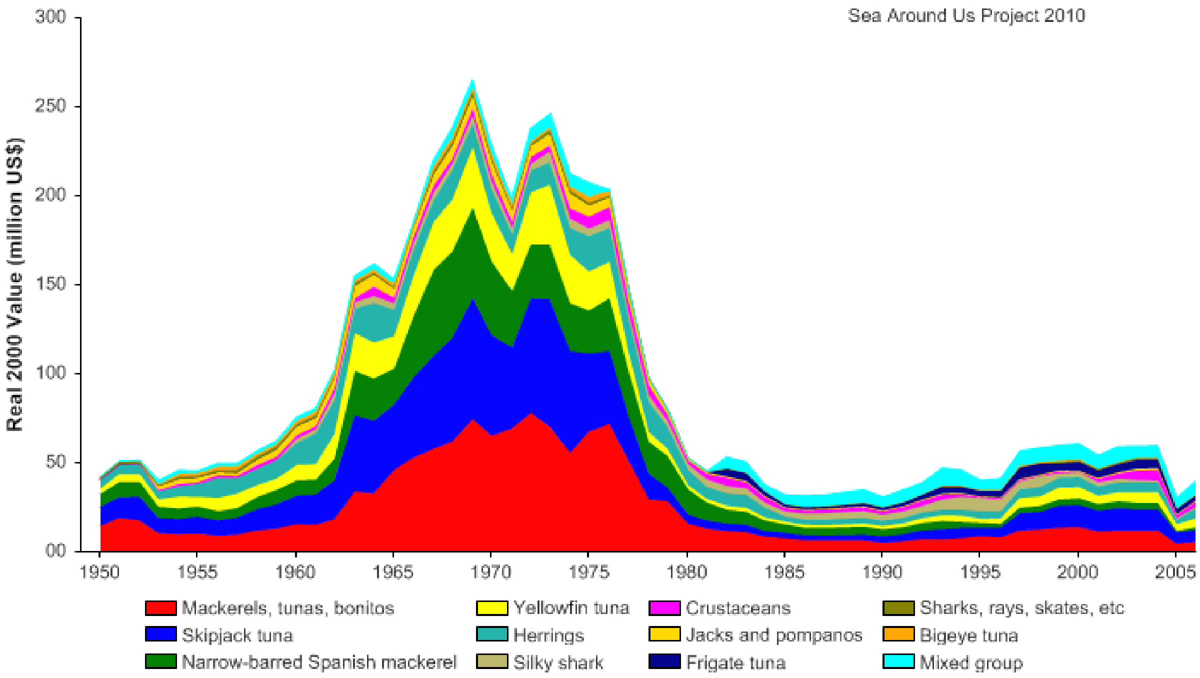

Figure 75: Real 2000 value (US$) by species in Sri Lanka's EZZ, 1950-2006.

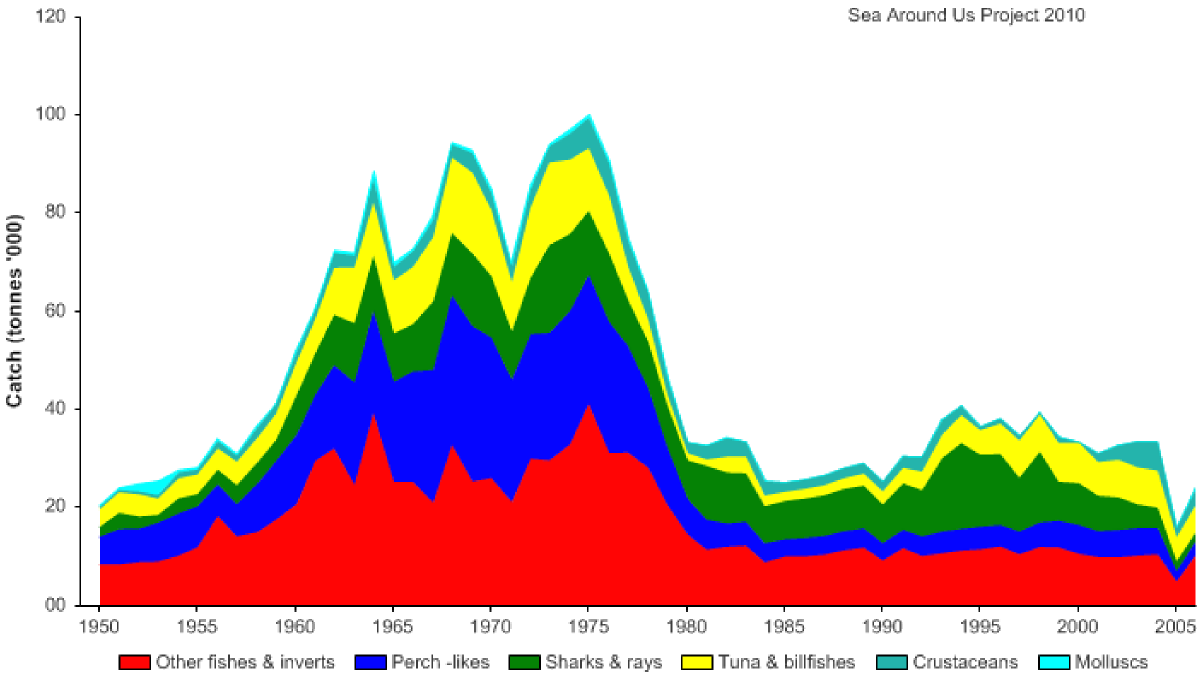

Figure 76: Landings by commercial group in Sri Lanka's EZZ, 1950-2006.

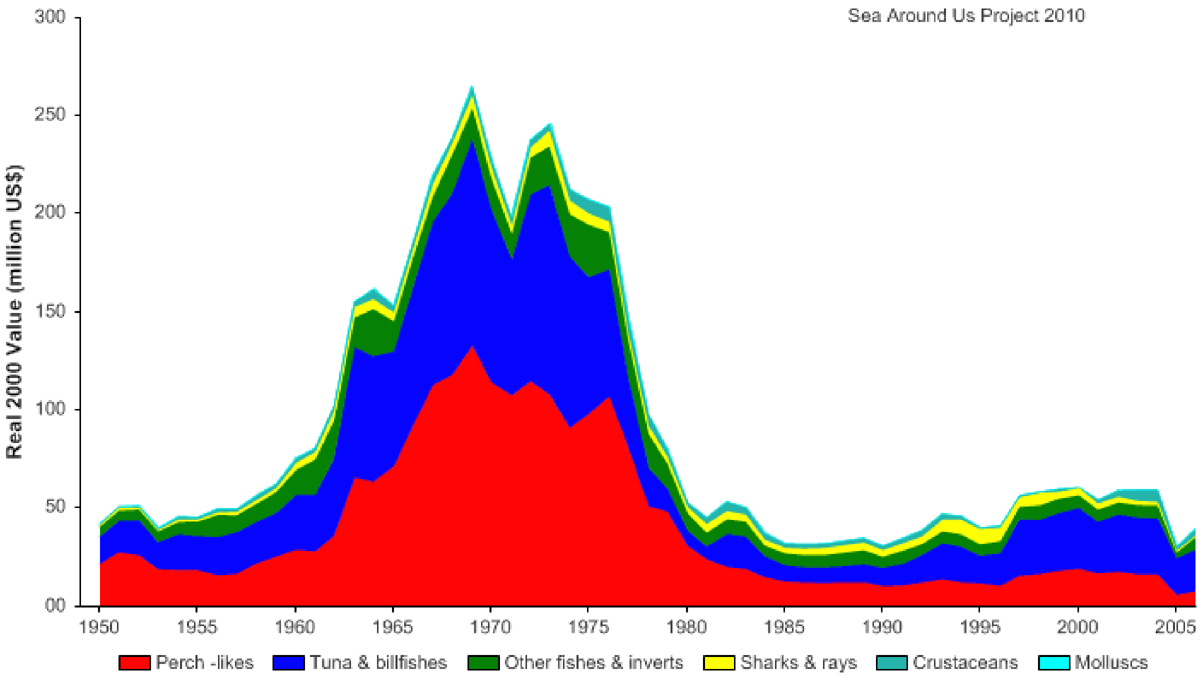

Figure 77: Real 2000 value (US$) by commercial group in Sri Lanka's EZZ, 1950-2006.

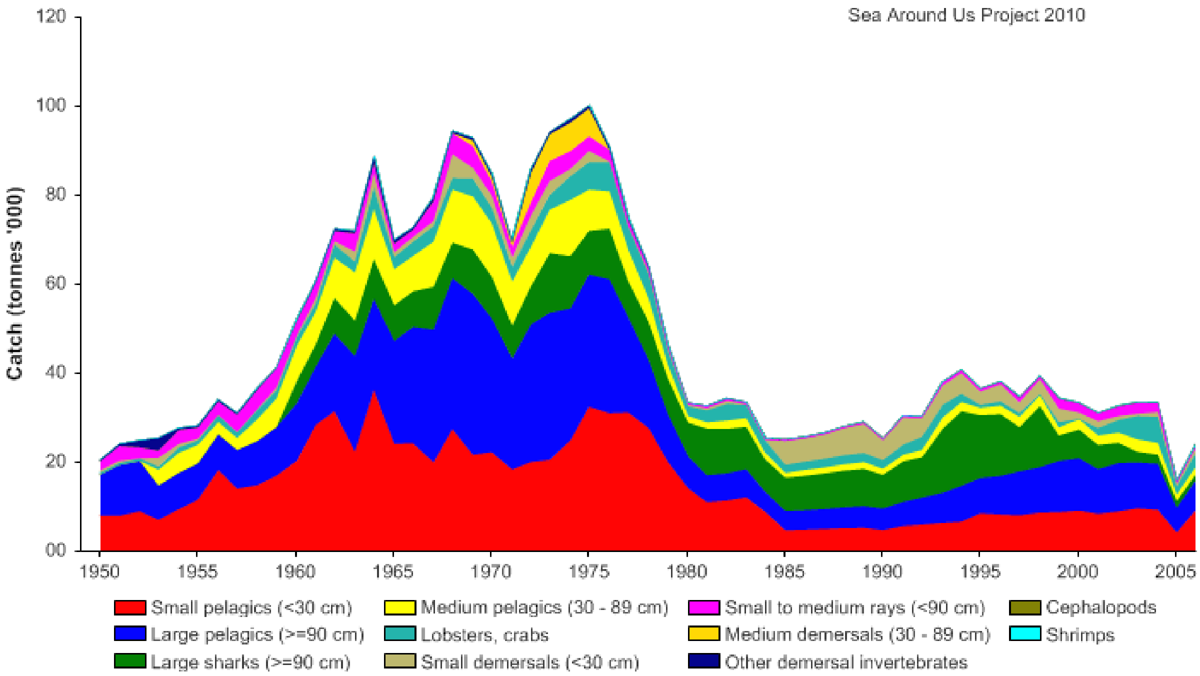

Figure 78: Landings by functional group in Sri Lanka's EZZ, 1950-2006.

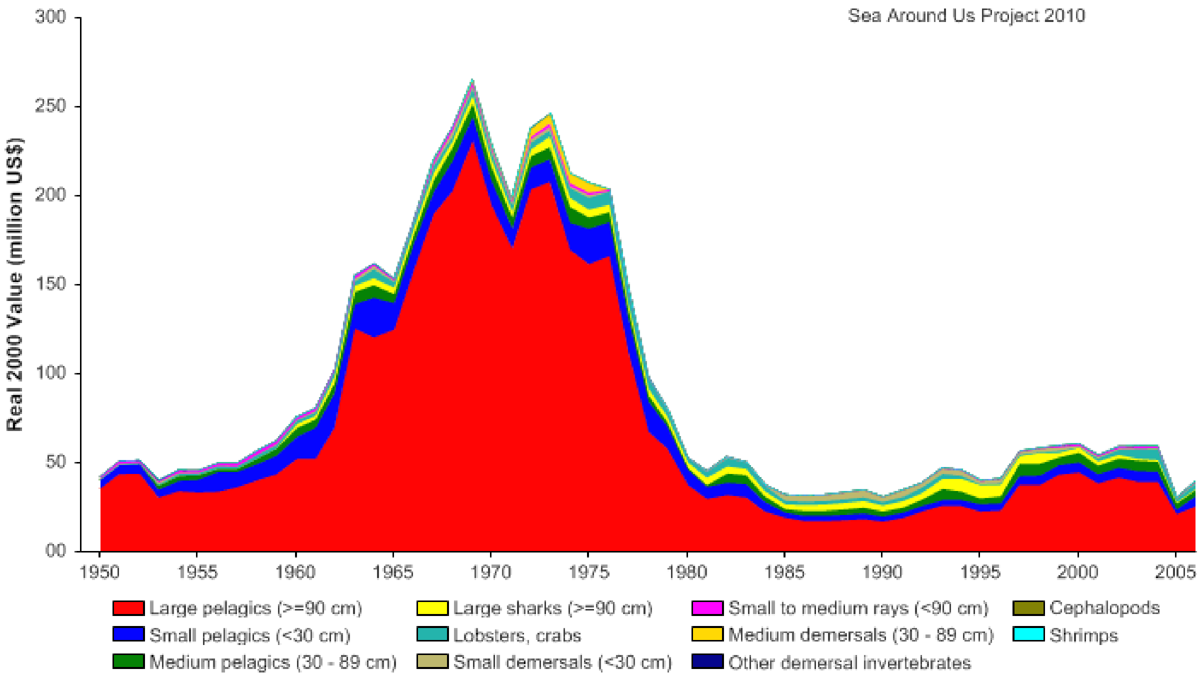

Figure 79: Real 2000 value (US$) by functional group in Sri Lanka's EZZ, 1950-2006.

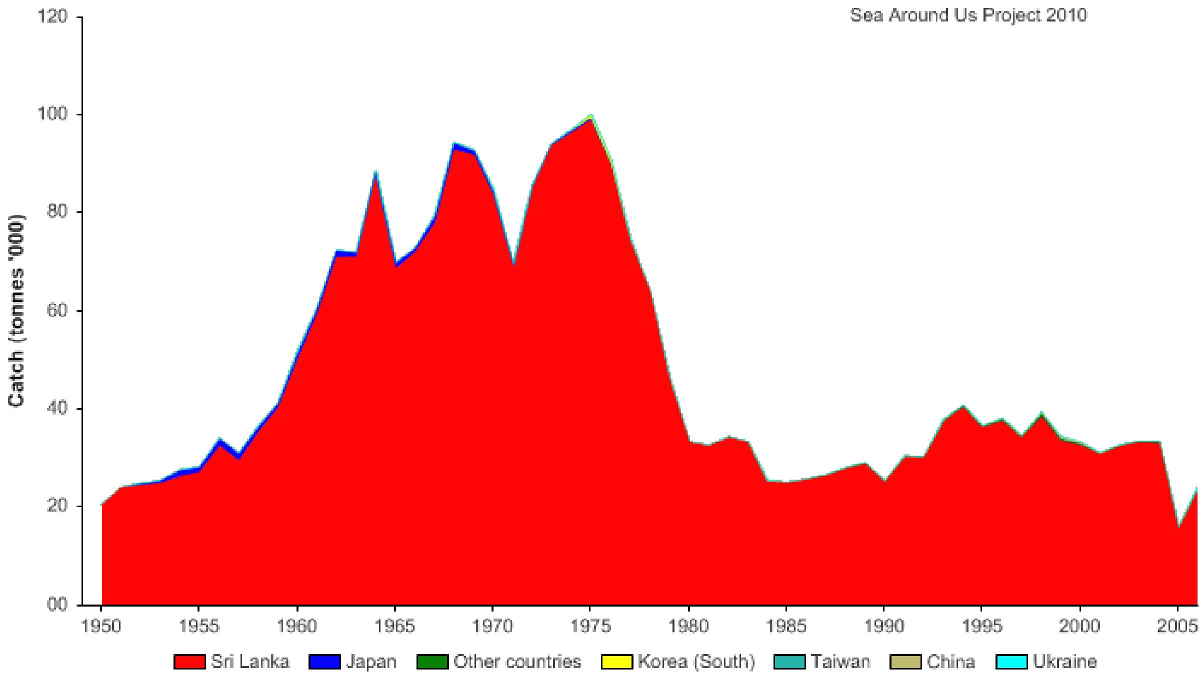

Figure 80: Landings by fishing country in Sri Lanka's EZZ, 1950-2006.

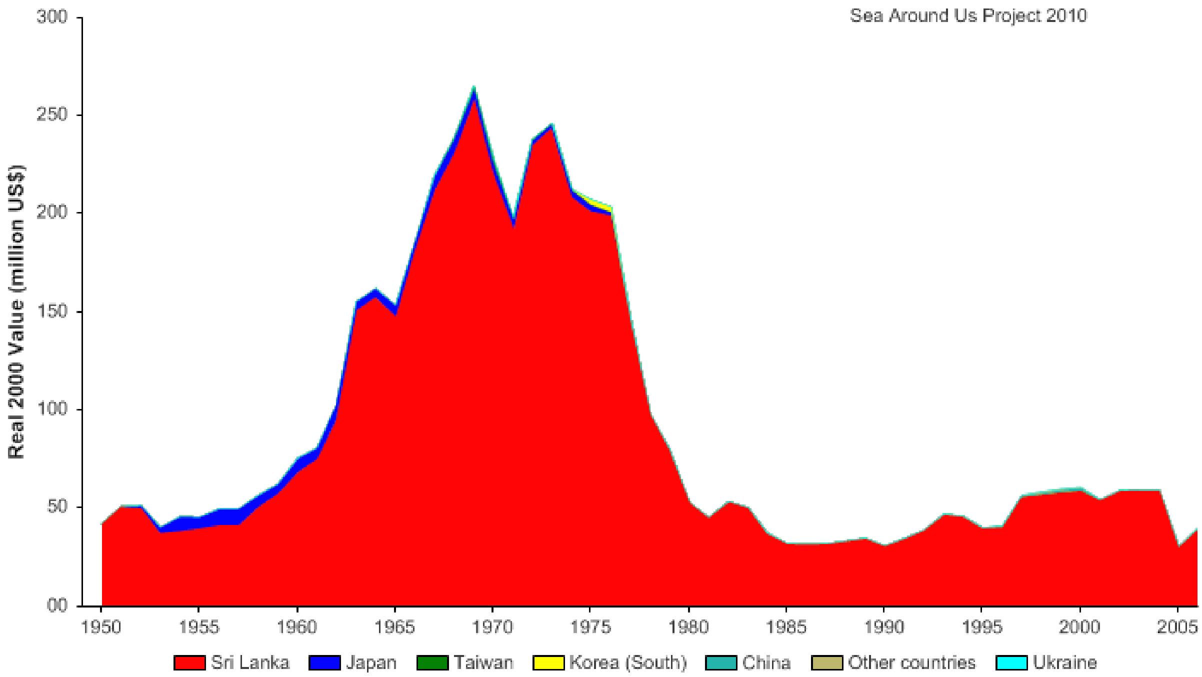

Figure 81: Real 2000 value (US$) by fishing country in Sri Lanka's EZZ, 1950-2006.

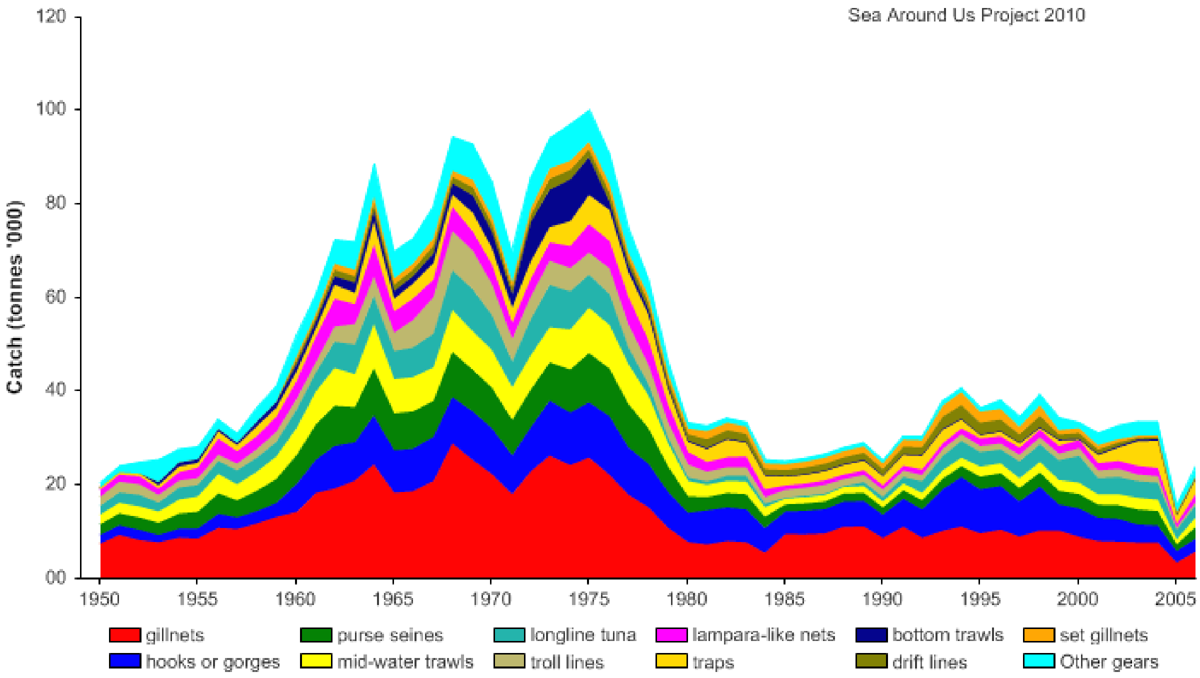

Figure 82: Landings by gear in Sri Lanka's EZZ, 1950-2006.

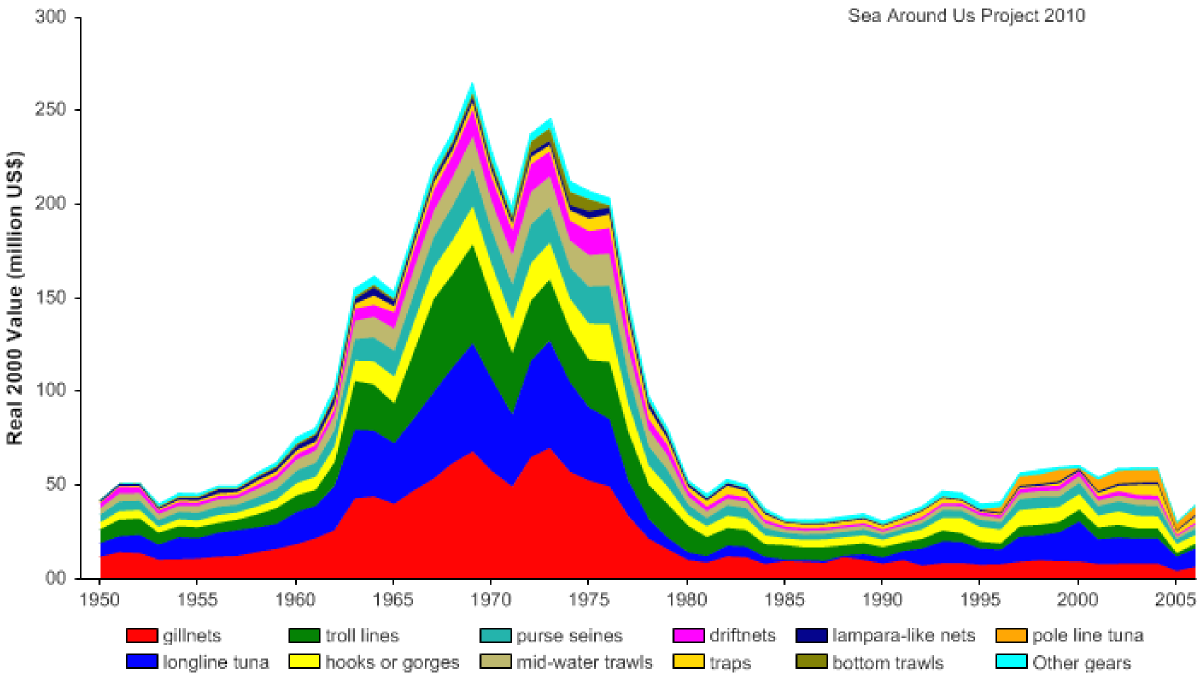

Figure 83: Real 2000 value (US$) by gear in Sri Lanka's EZZ, 1950-2006.

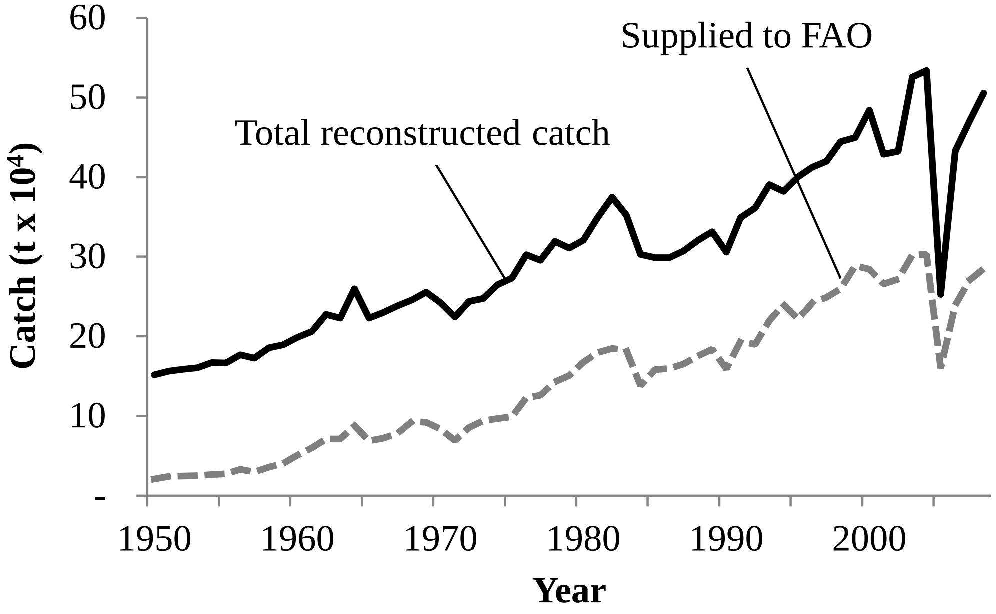

Figure 84: Reported landings vs. total reconstructed catch, 1950-2008

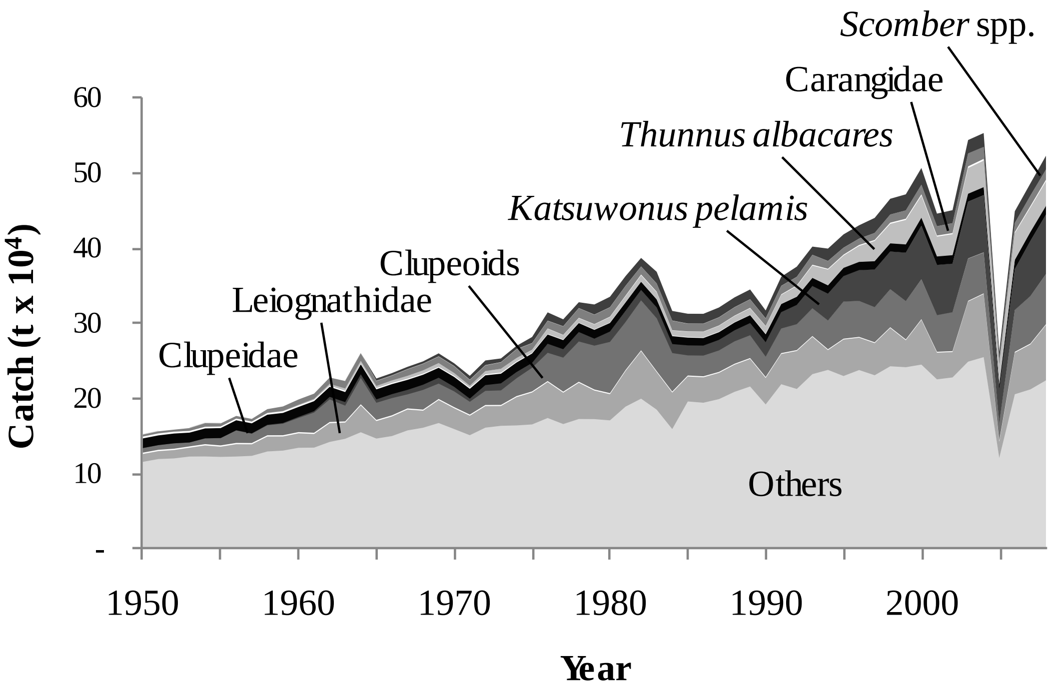

Figure 85: Total reconstructed catch by species, 1950-2008.

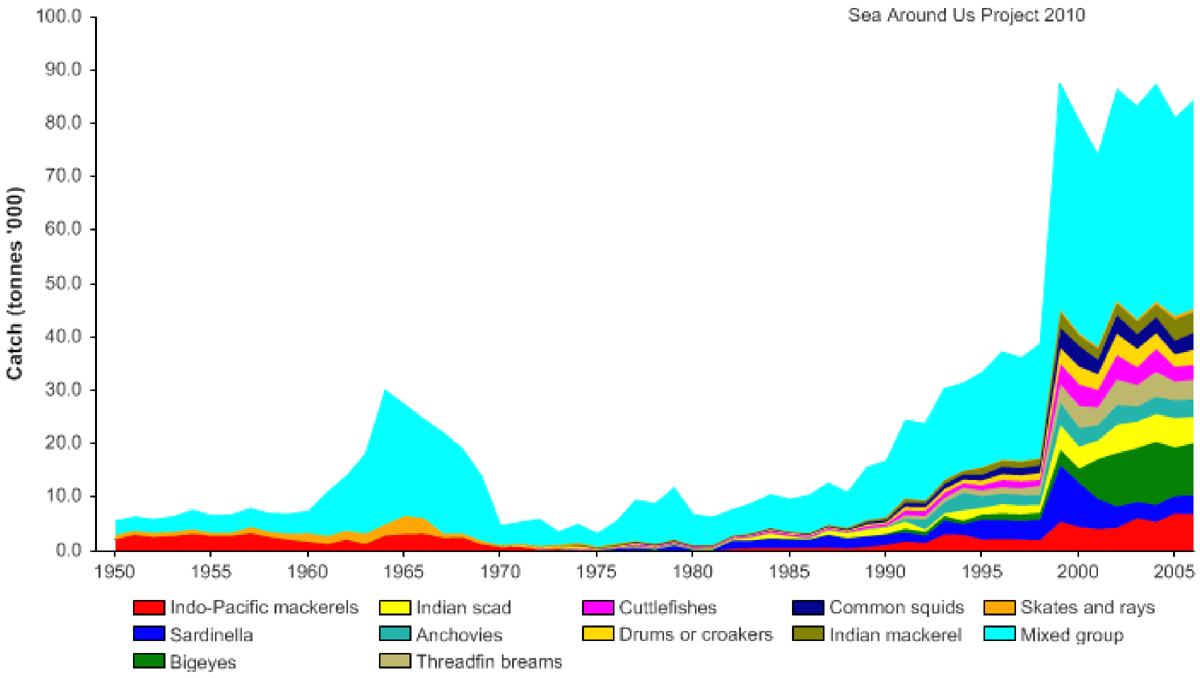

Figure 86: Landings by species in the Bay of Bengal portion of Thailand's EZZ, 1950-2006.

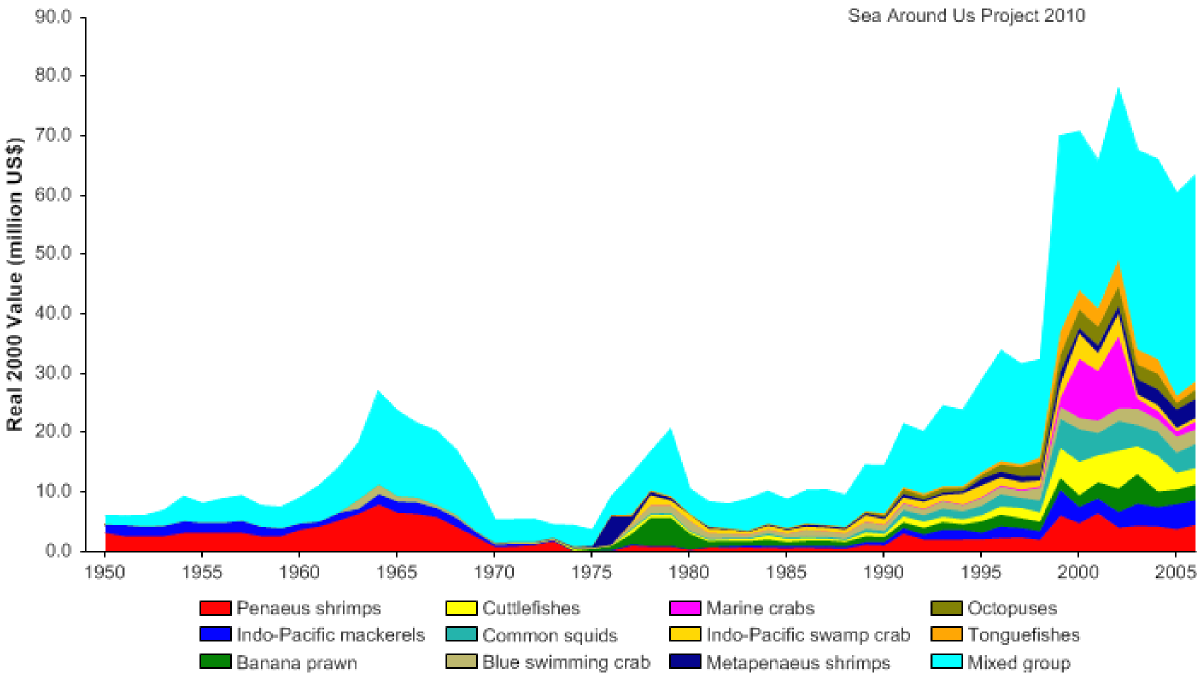

Figure 87: Real 2000 value (US$) by species in the Bay of Bengal portion of Thailand's EZZ, 1950-2006.

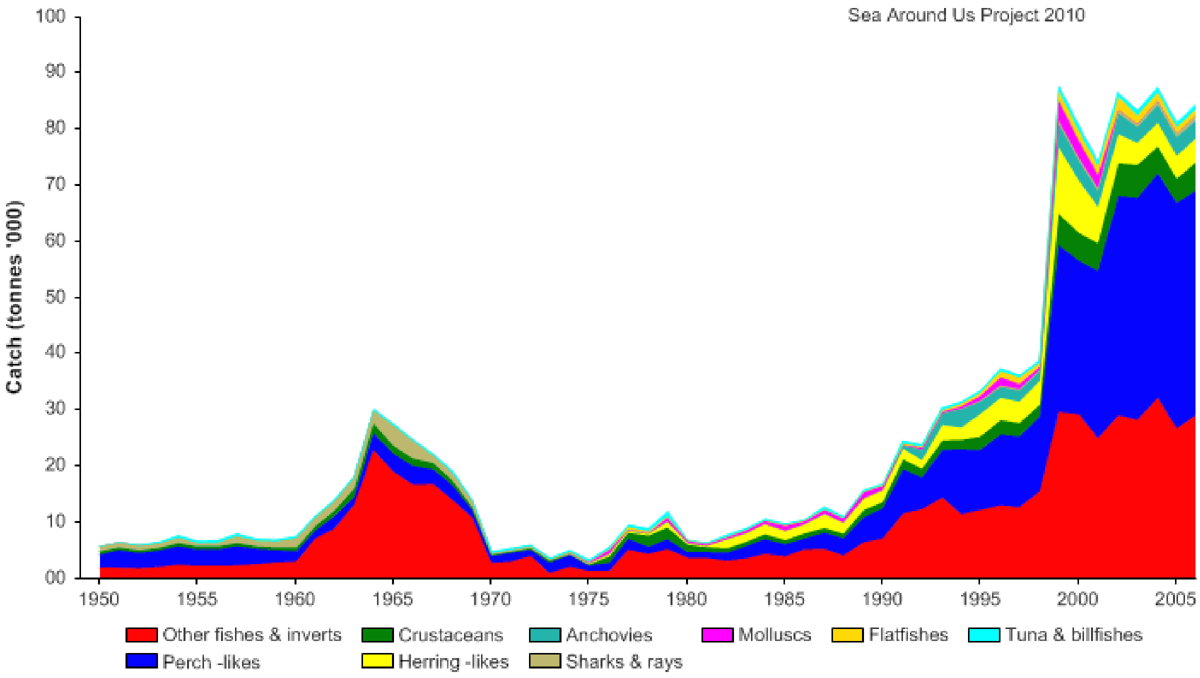

Figure 88: Landings by commercial group in the Bay of Bengal portion of Thailand's EZZ, 1950-2006.

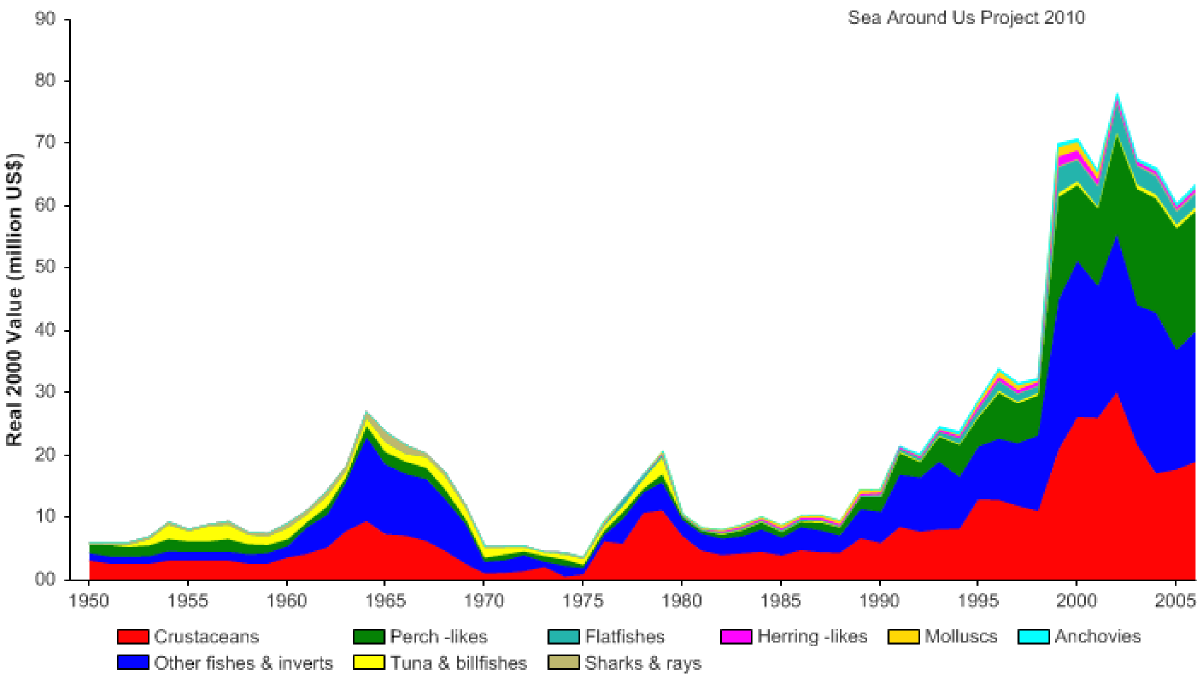

Figure 89: Real 2000 value (US$) by commercial group in the Bay of Bengal portion of Thailand's EZZ, 1950-2006.

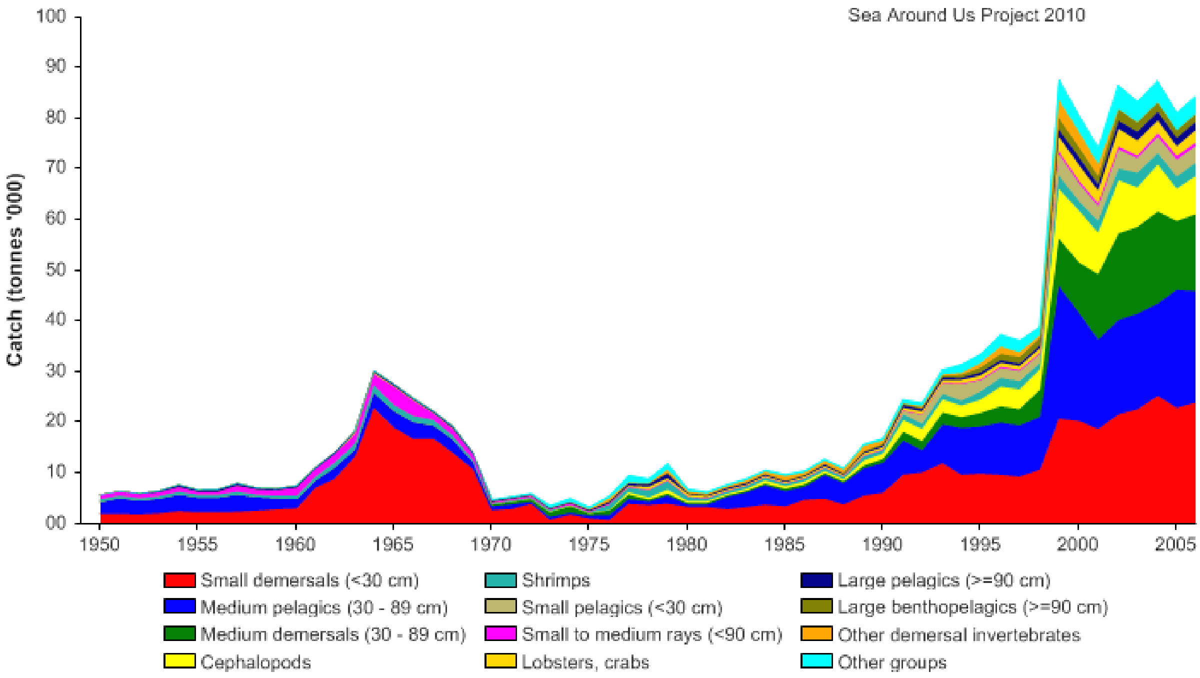

Figure 90: Landings by functional group in the Bay of Bengal portion of Thailand's EZZ, 1950-2006.

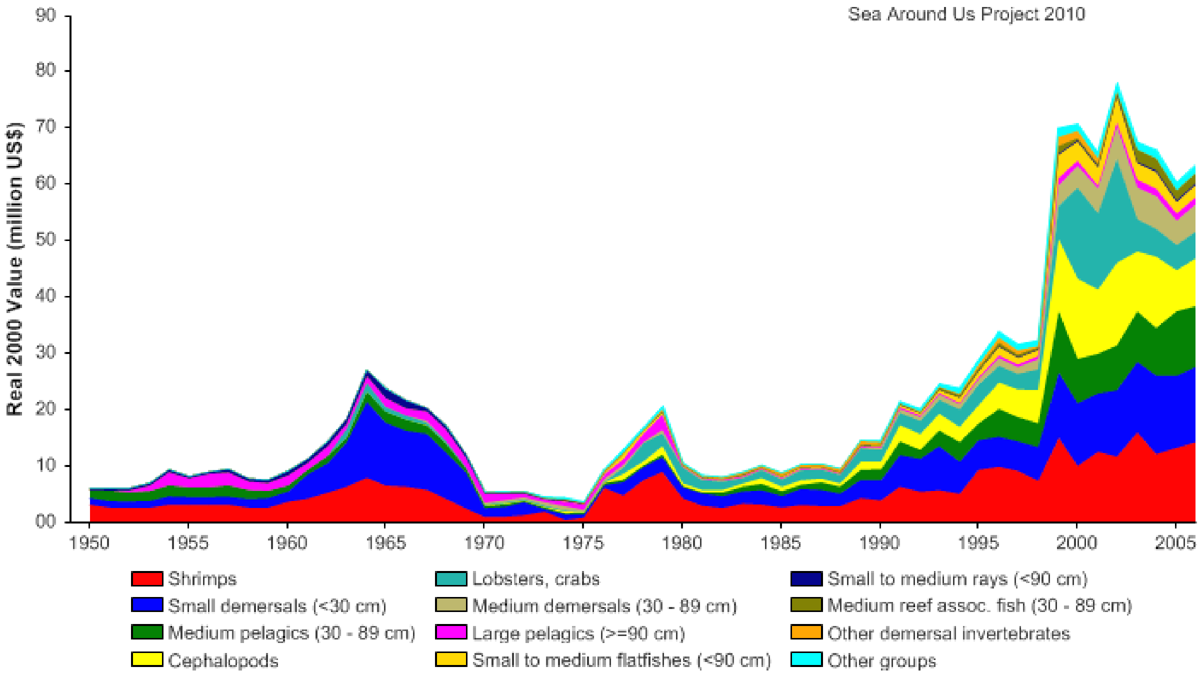

Figure 91: Real 2000 value (US$) by functional group in the Bay of Bengal portion of Thailand's EZZ, 1950-2006.

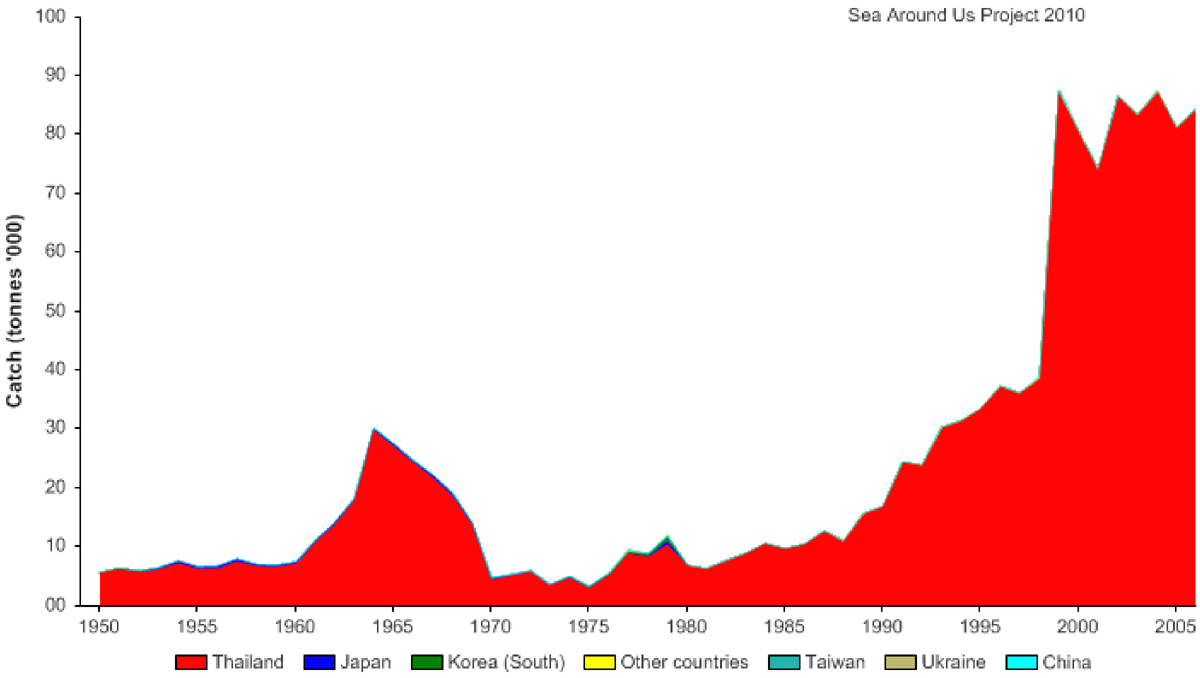

Figure 92: Landings by fishing country in the Bay of Bengal portion of Thailand's EZZ, 1950-2006.

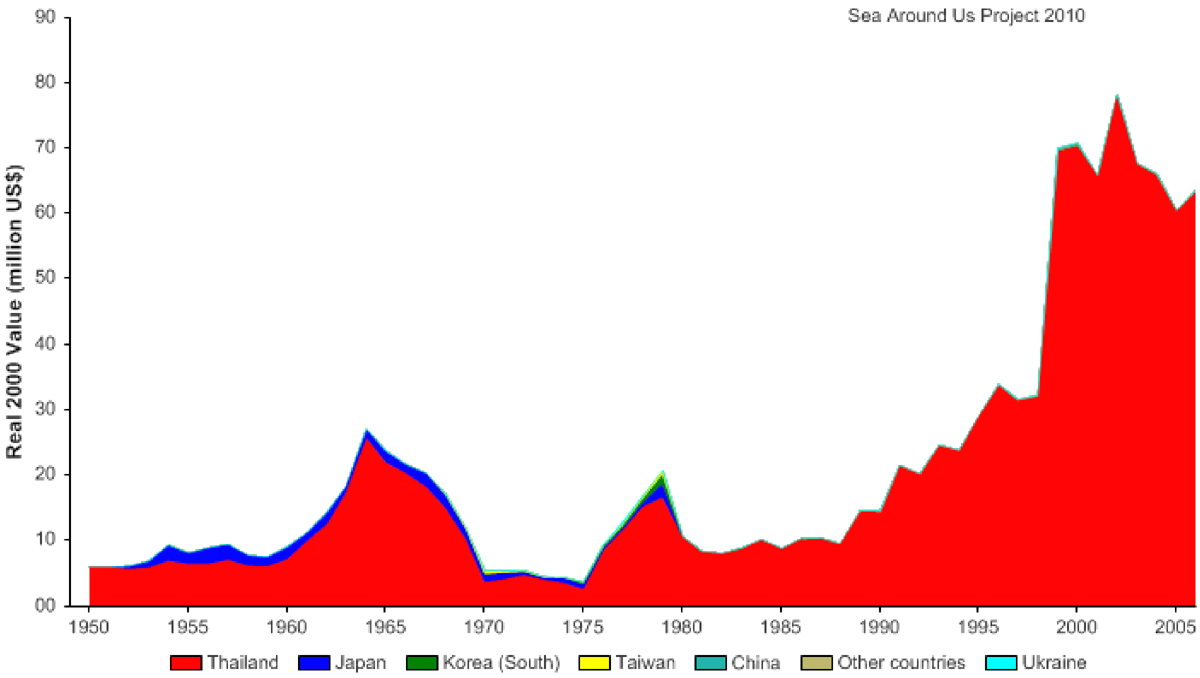

Figure 93: Real 2000 value (US$) by fishing country in the Bay of Bengal portion of Thailand's EZZ, 1950-2006.

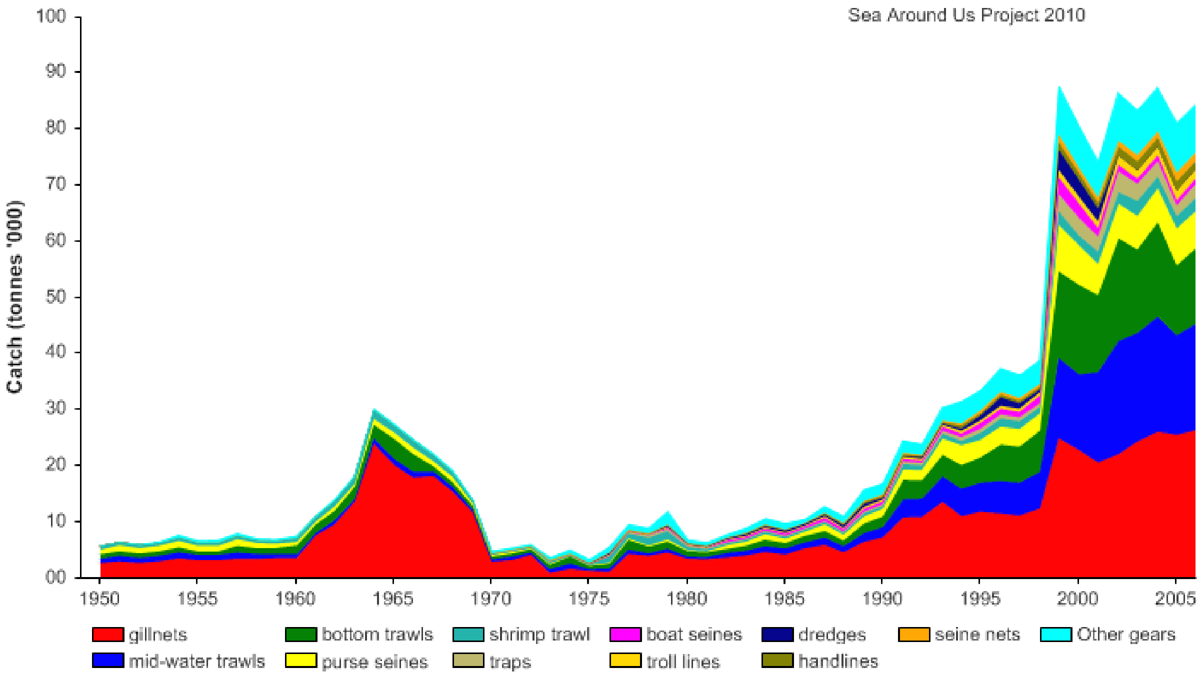

Figure 94: Landings by gear in the Bay of Bengal portion of Thailand's EZZ, 1950-2006

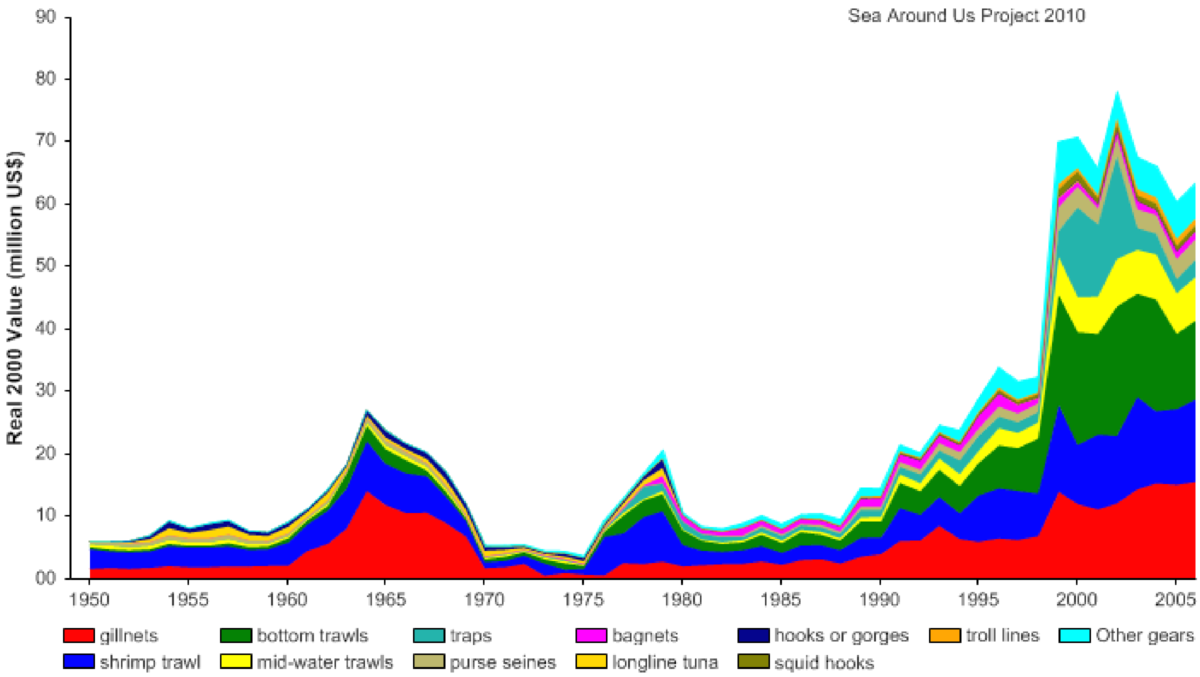

Figure 95: Real 2000 value (US$) by gear in the Bay of Bengal portion of Thailand's EZZ, 1950-2006

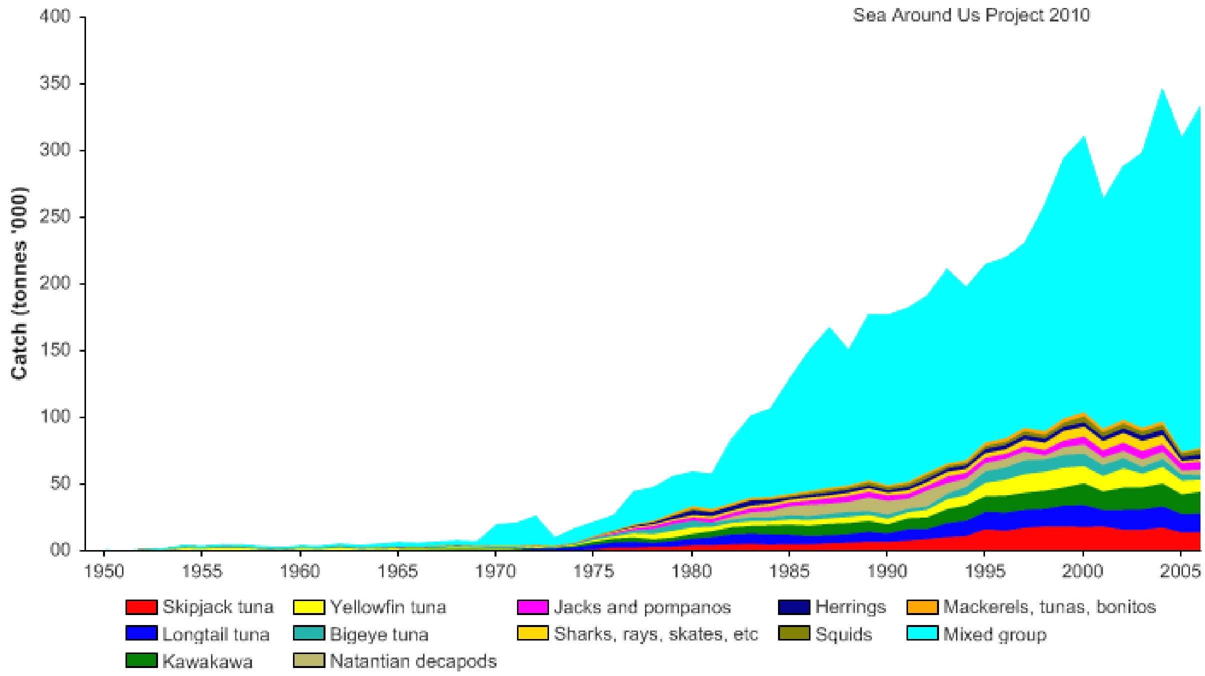

Figure 96: Landings by species in the High Seas area of the Bay of Bengal, 1950-2006.

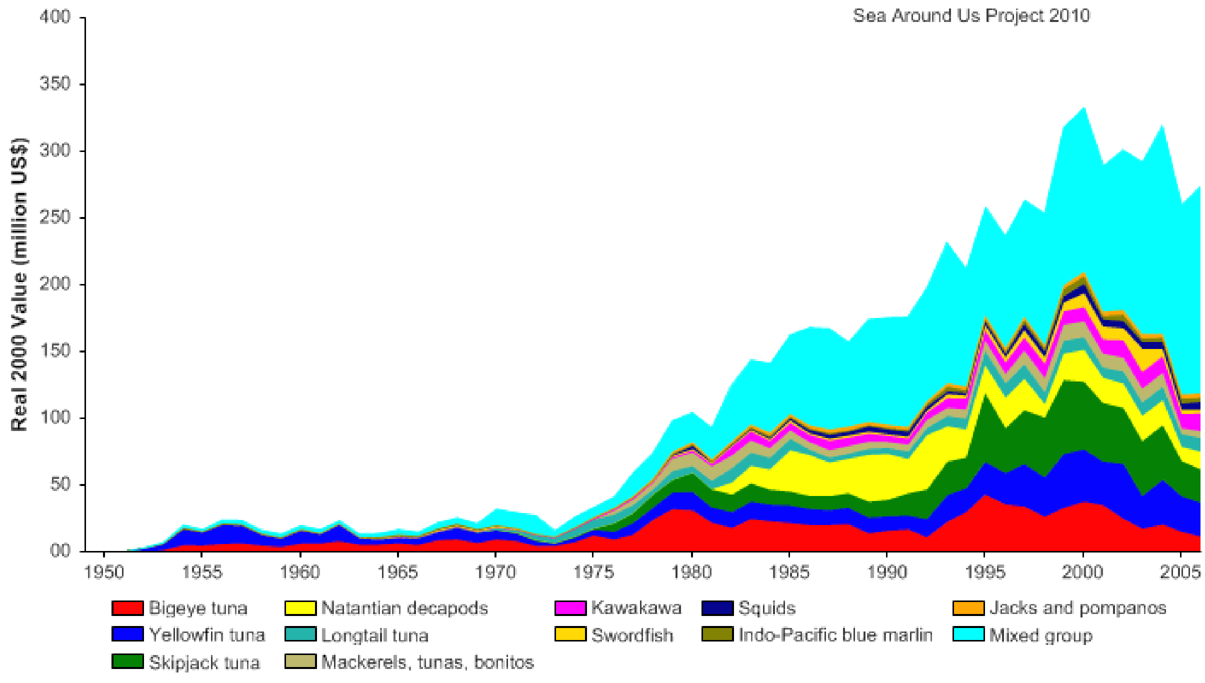

Figure 97: Real 2000 value (US$) by species in the High Seas area of the Bay of Bengal, 1950-2006.

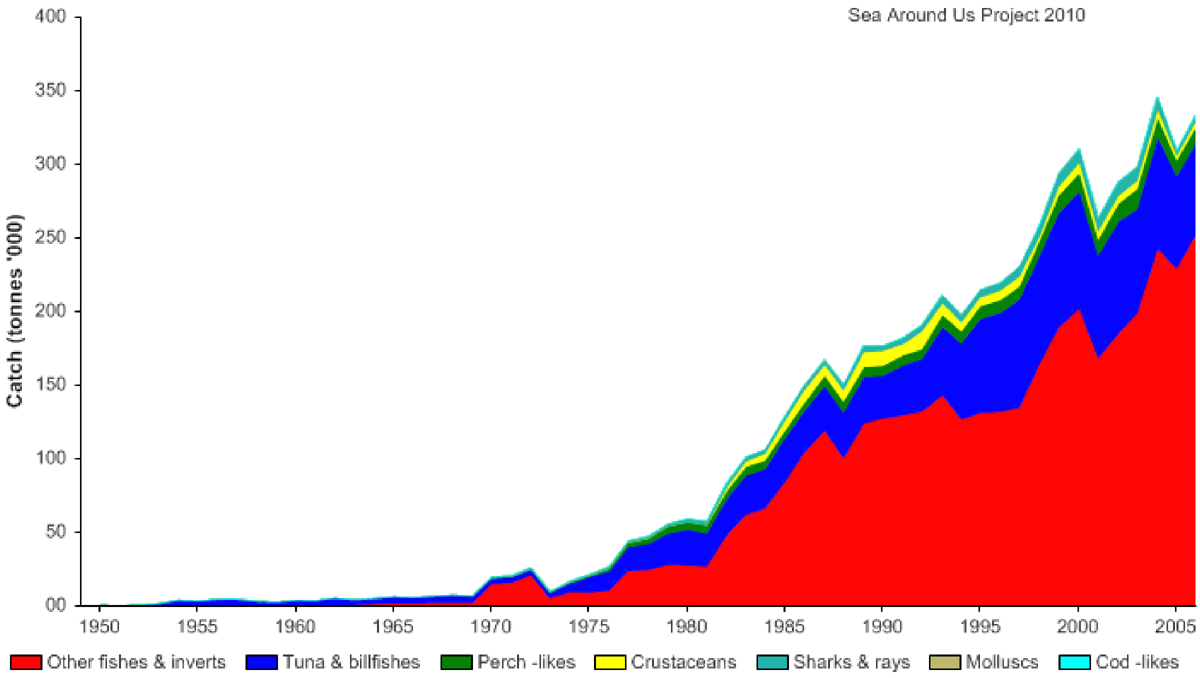

Figure 98: Landings by commercial group in the High Seas area of the Bay of Bengal, 1950-2006.

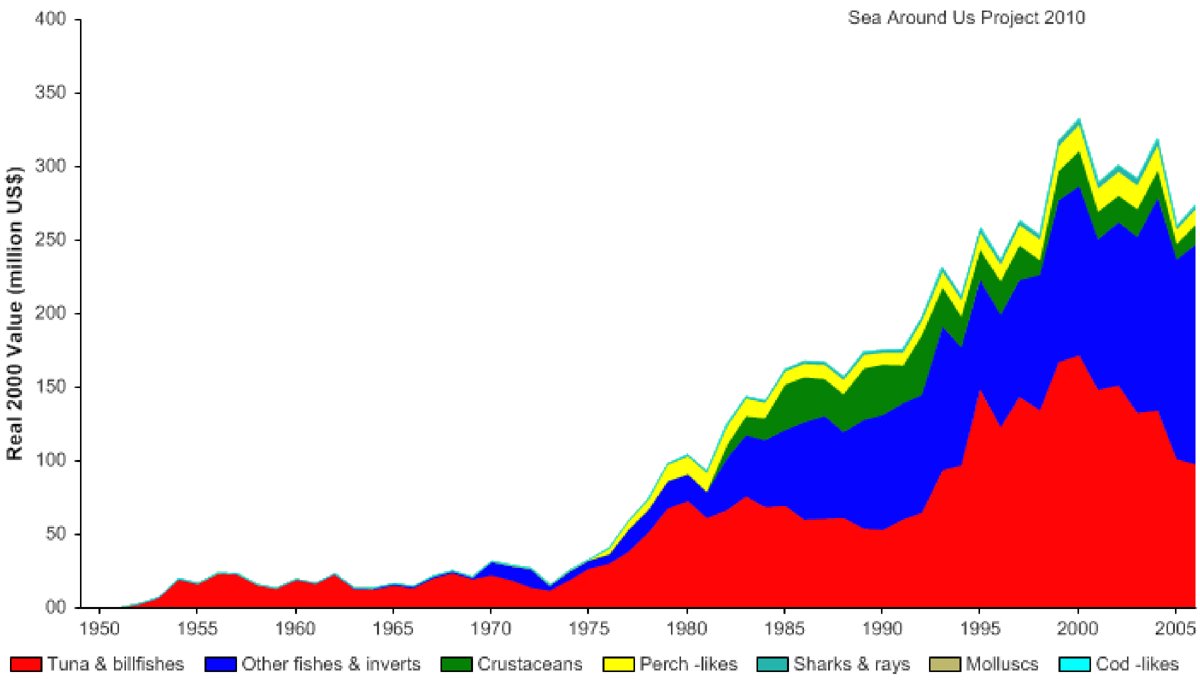

Figure 99: Real 2000 value (US$) by commercial group in the High Seas area of the Bay of Bengal, 1950-2006.

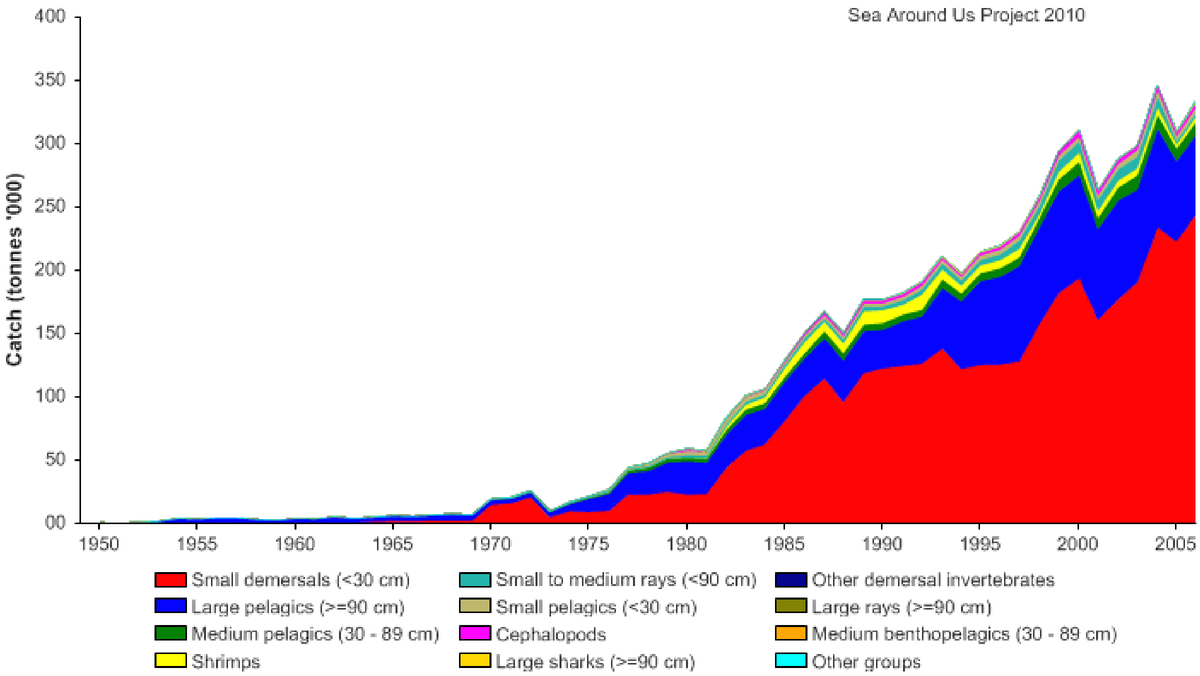

Figure 100: Landings by functional group in the High Seas area of the Bay of Bengal, 1950-2006.

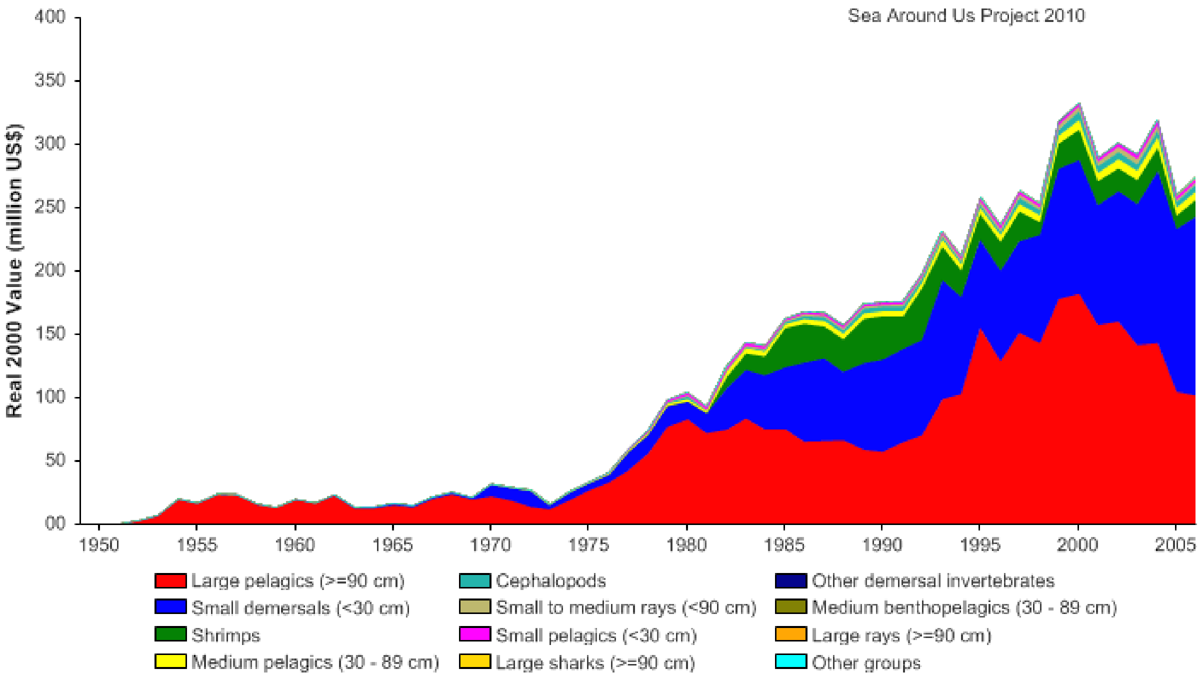

Figure 101: Real 2000 value (US$) by functional group in the High Seas area of the Bay of Bengal, 1950-2006.

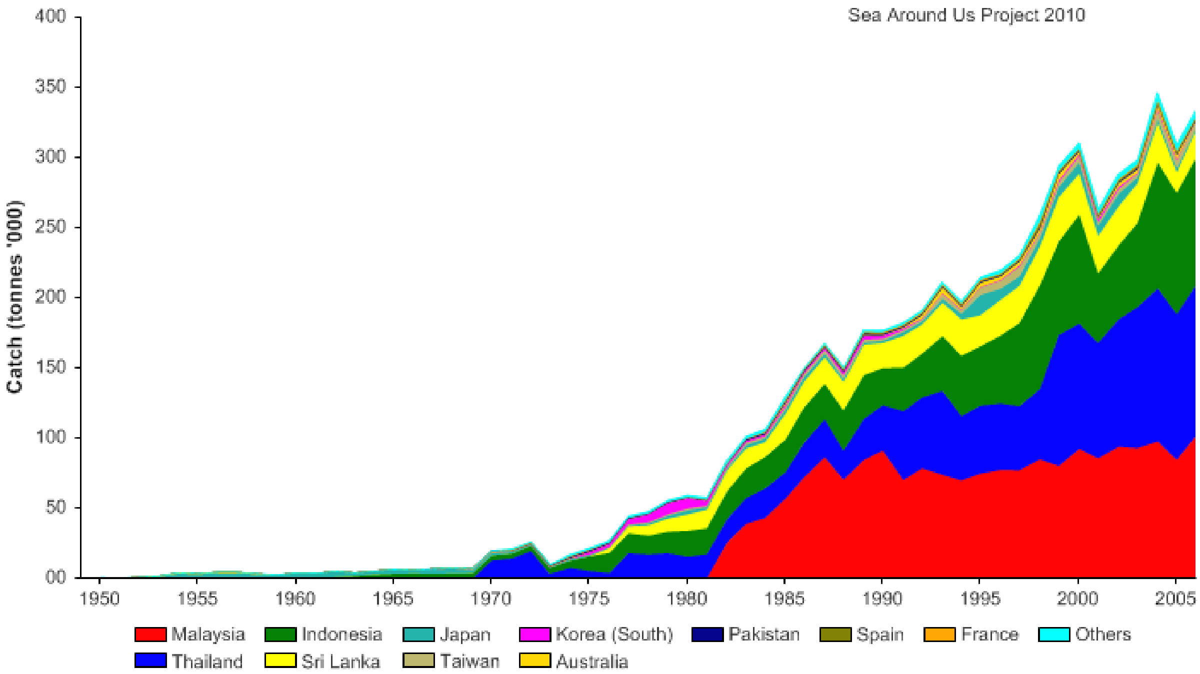

Figure 102: Landings by fishing country in the High Seas area of the Bay of Bengal, 1950-2006.

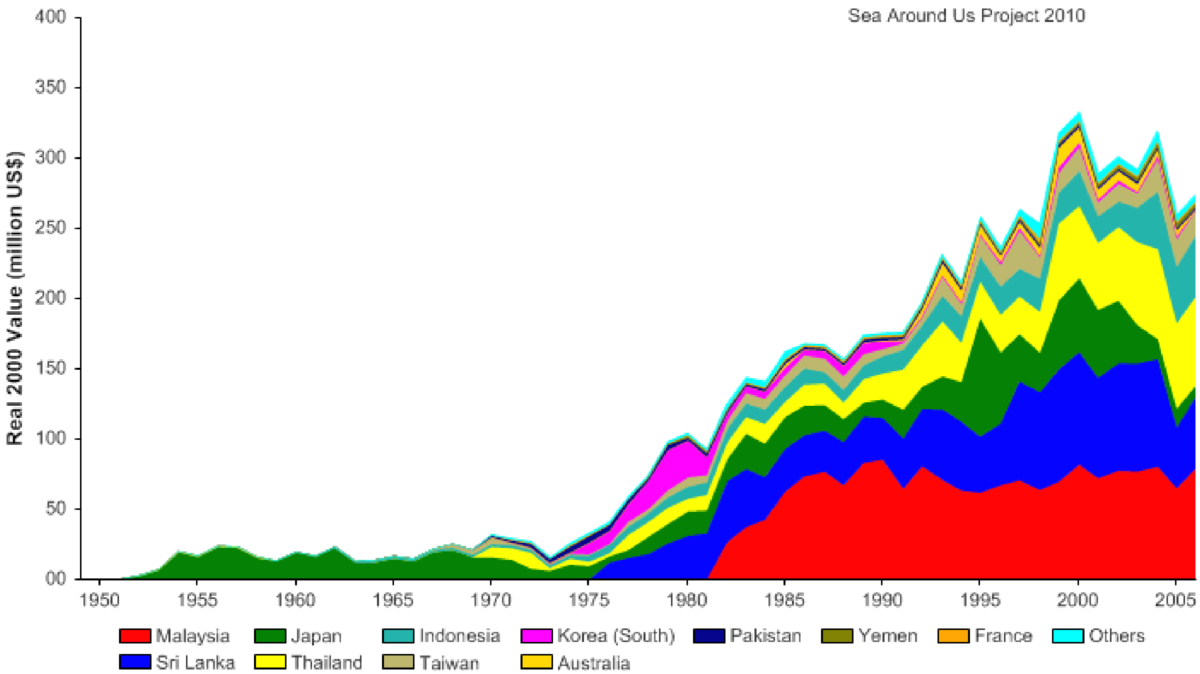

Figure 103: Real 2000 value (US$) by fishing country in the High Seas area of the Bay of Bengal, 1950-2006.

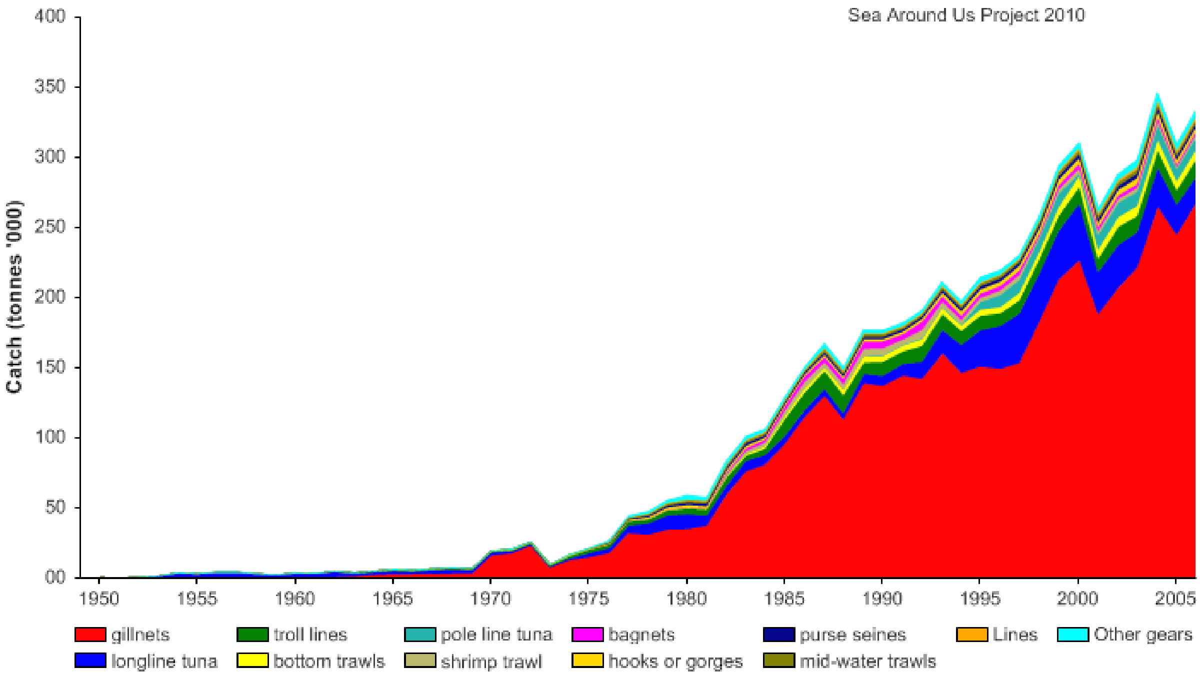

Figure 104: Landings by gear in the High Seas area of the Bay of Bengal, 1950-2006.

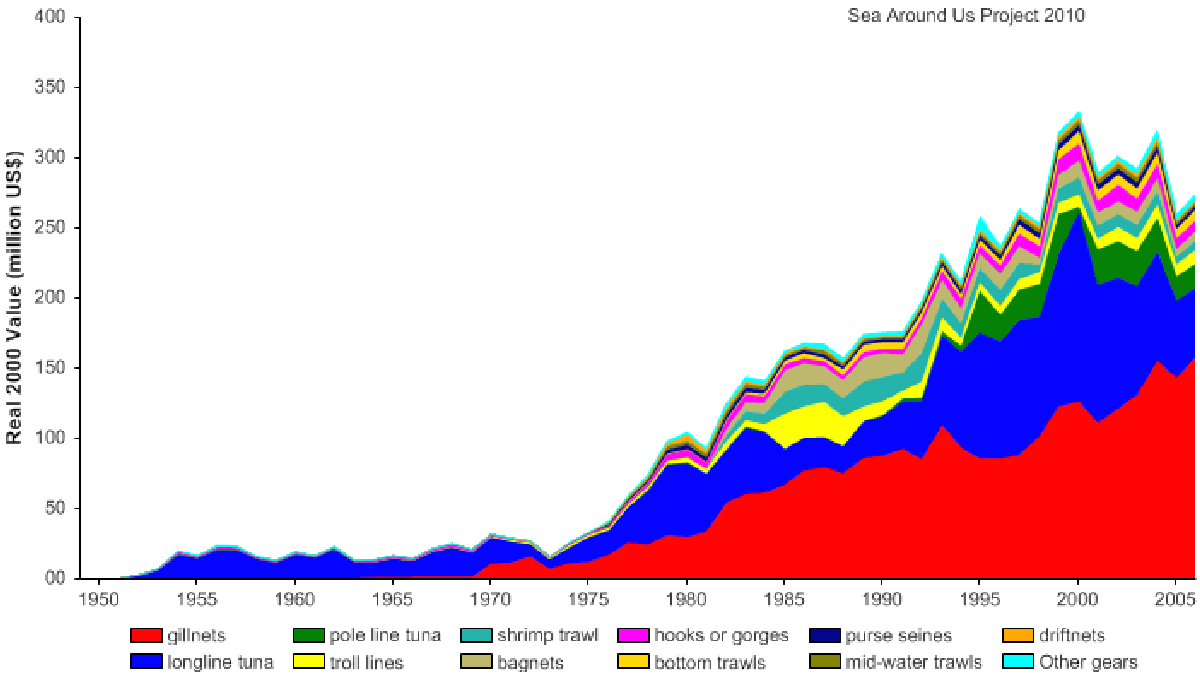

Figure 105: Real 2000 value (US$) by gear in the High Seas area of the Bay of Bengal, 1950-2006.

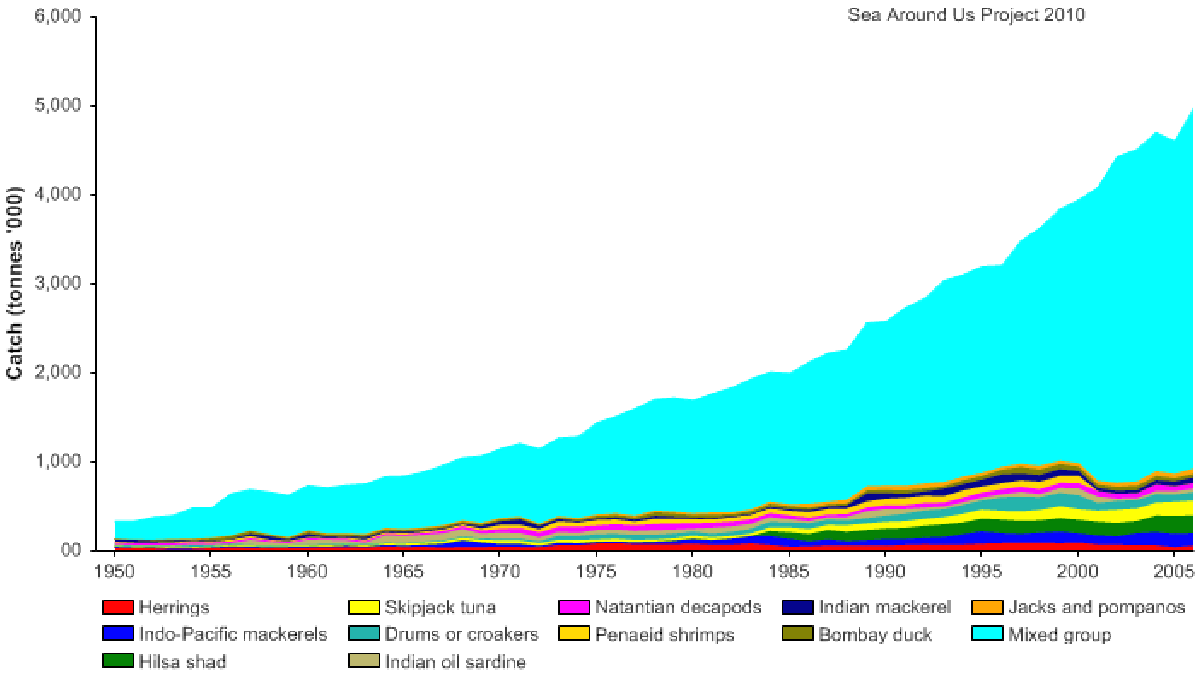

Figure 106: Landings by species in the Bay of Bengal Large Marine Ecosystem, 1950-2006.

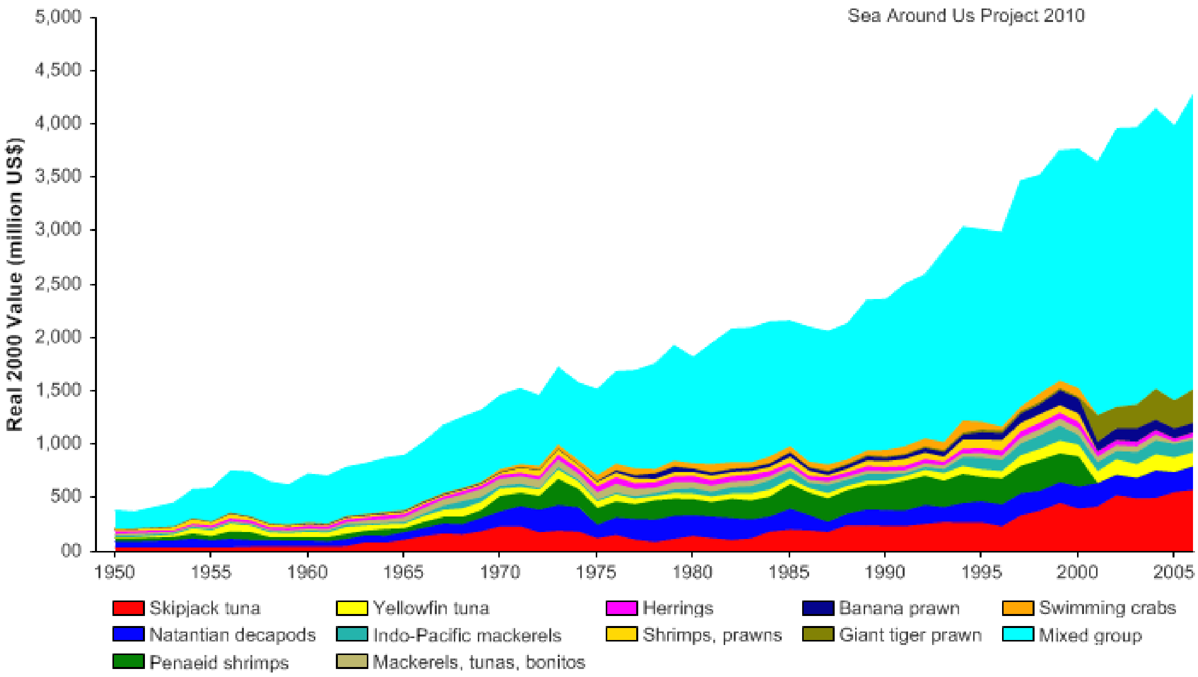

Figure 107: Real 2000 value (US$) by species in the Bay of Bengal Large Marine Ecosystem, 1950-2006.

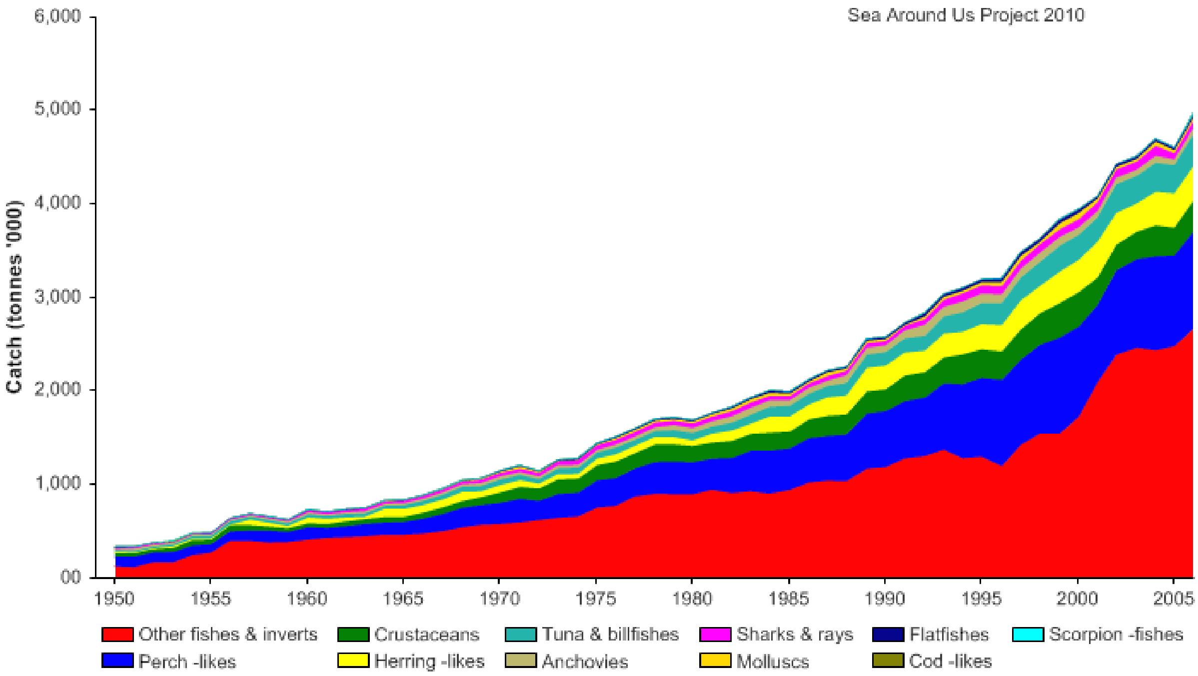

Figure 108: Landings by commercial group in the Bay of Bengal Large Marine Ecosystem, 1950-2006.

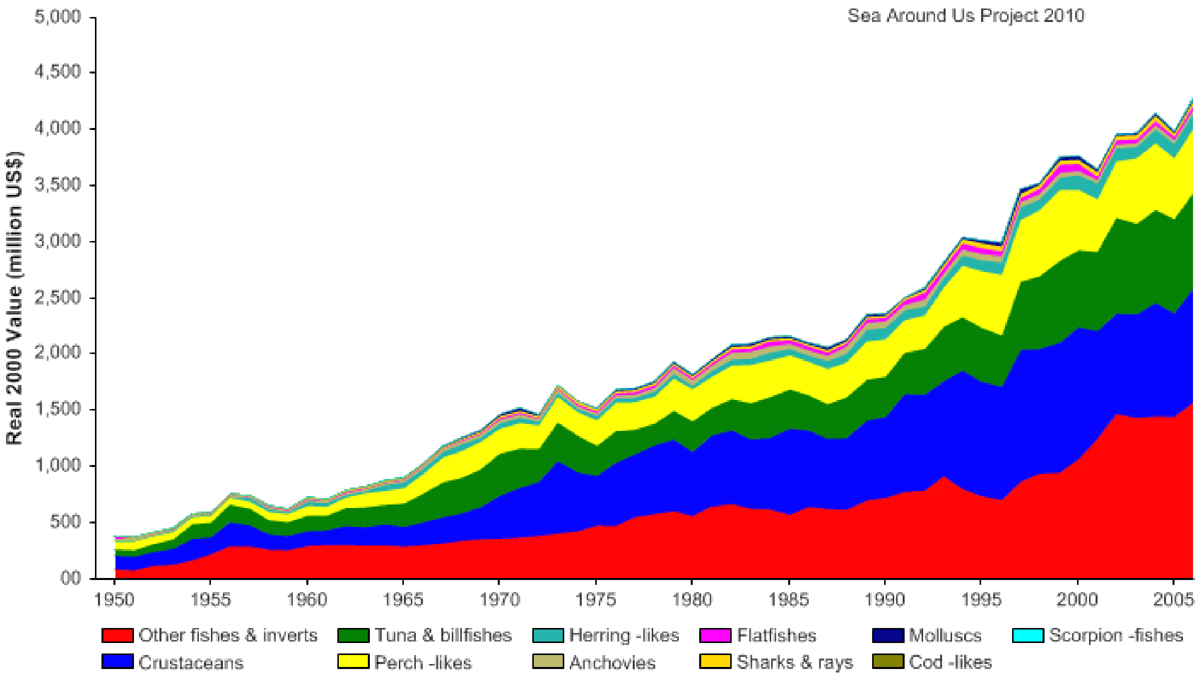

Figure 109: Real 2000 value (US$) by commercial group in the Bay of Bengal Large Marine Ecosystem, 1950-2006.

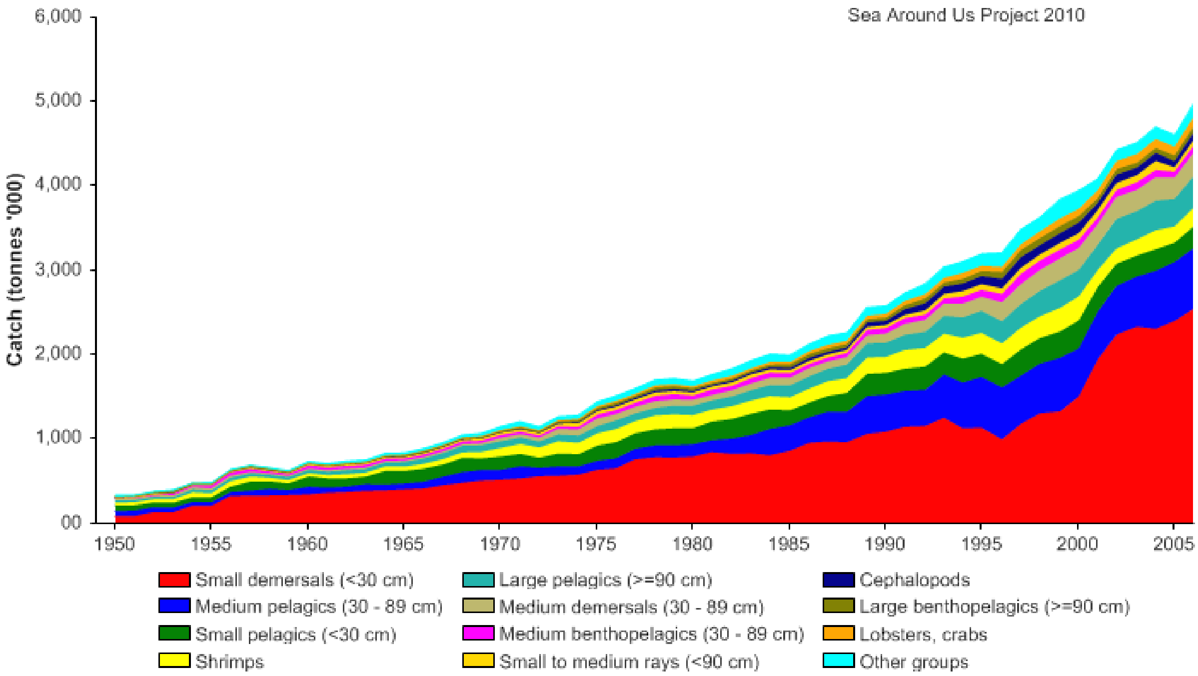

Figure 110: Landings by functional group in the Bay of Bengal Large Marine Ecosystem, 1950-2006.

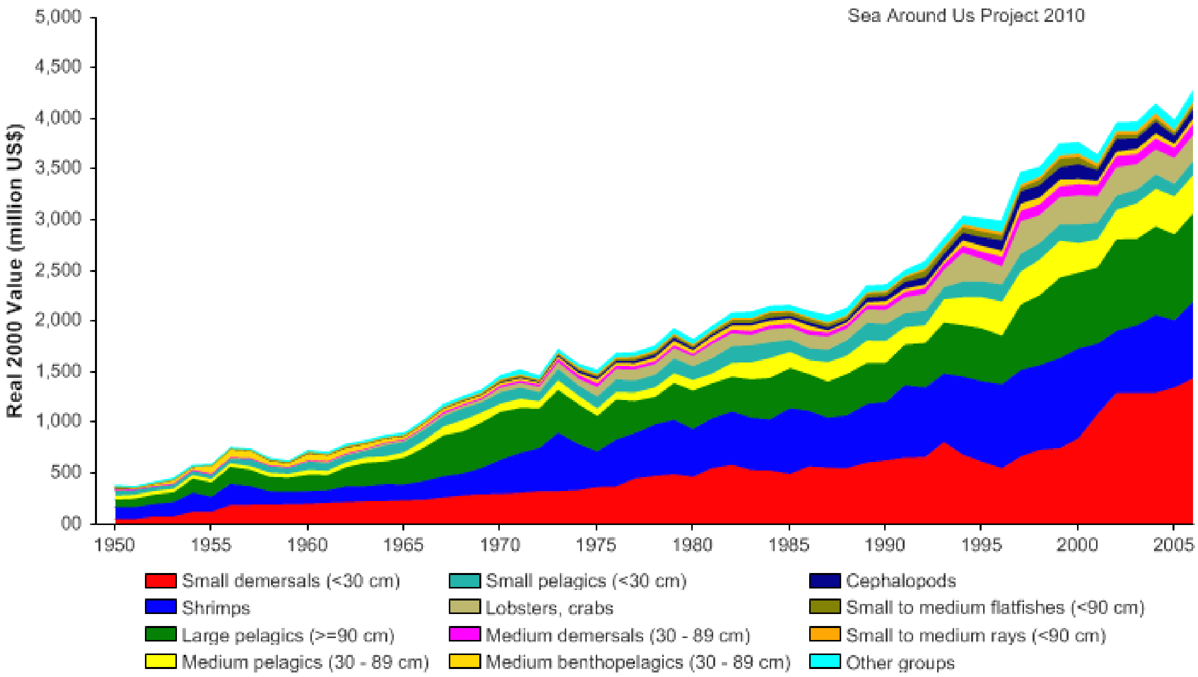

Figure 111: Real 2000 value (US$) by functional group in the Bay of Bengal Large Marine Ecosystem, 1950-2006.

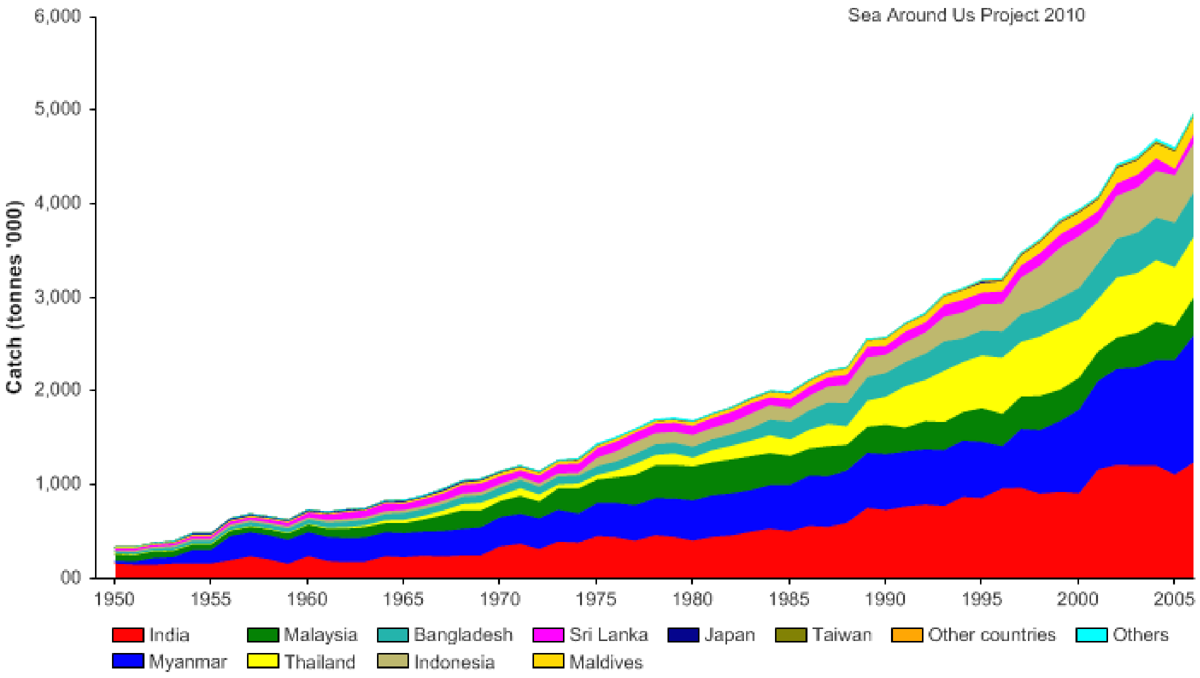

Figure 112: Landings by fishing country in the Bay of Bengal Large Marine Ecosystem, 1950-2006.

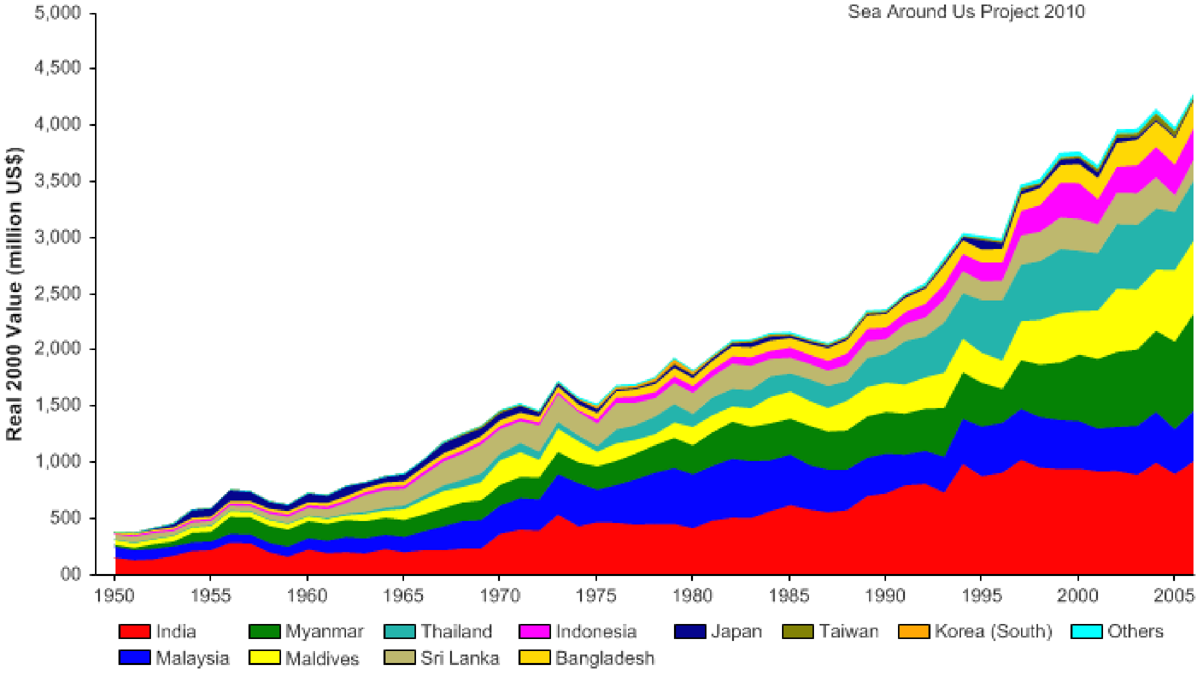

Figure 113: Real 2000 value (US$) by fishing country in the Bay of Bengal Large Marine Ecosystem, 1950-2006.

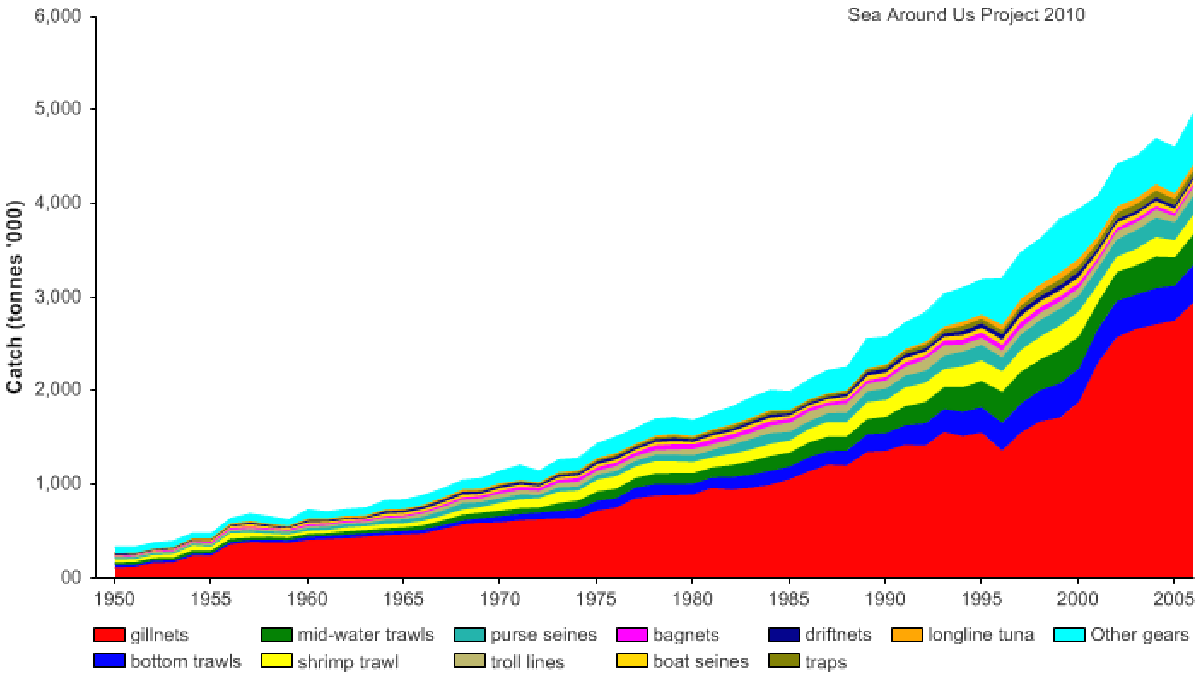

Figure 114: Landings by gear in the Bay of Bengal Large Marine Ecosystem, 1950-2006.

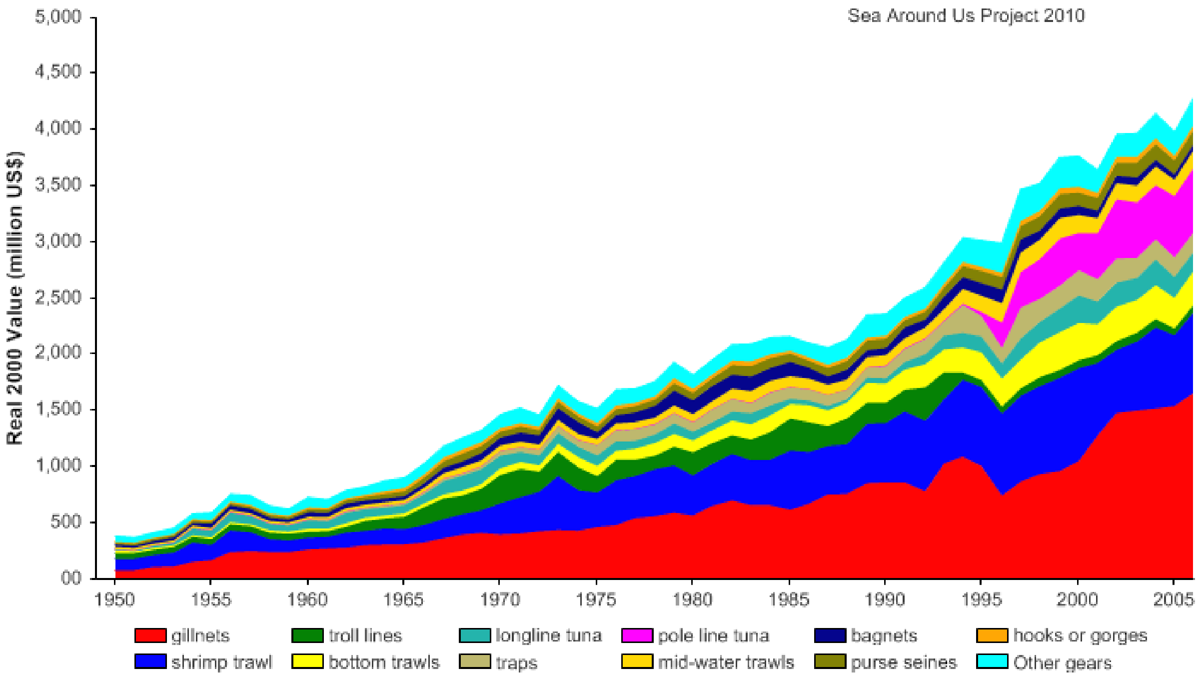

Figure 115: Real 2000 value (US$) by gear in the Bay of Bengal Large Marine Ecosystem, 1950-2006.

Appendix I: Myanmar catch reconstruction

MYANMAR'S MARINE CAPTURE FISHERIES 1950-2008: EXPANSION FROM THE COAST TO THE DEEP WATERS

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ABSTRACT

The Bay of Bengal Large Marine Ecosystem is bordered by eight countries of over 400 million people who are dependent upon the marine resources for their food, livelihood and security. Thus, fisheries catch baselines are important to improve the management of the Bay of Bengal marine environment and its fisheries since rapid population growth, high dependence on resources, and increased land use has resulted in the overexploitation of fish stocks and habitat degradation, and has led to considerable uncertainty as to whether the ecosystem will be able to support the livelihoods of the coastal populations in the future. Marine fisheries catches reported to the FAO by Myanmar reflect the landings and not the actual catches and this has consequences for the sustainable use of the marine resources. Here, we present estimates of components of illegal, unreported, and unregulated catches (IUU), and add them to the statistics reported to FAO for 1950 to 2004 to estimate total catches. For the period 2005-2008, we make downward adjustments to those reported to FAO prior to accounting for IUU. Downward adjustments are made to reported catches during this period because official statistics report increases despite the strong negative impact that Cyclone Nargis had on the people and fisheries in 2008, which suggests deficiencies in the national reporting system. We locate catches in time and space within the EEZ of Myanmar to detail the spatial expansion of the fisheries. Total catches were estimated to have increased from over 200,000 t·year^{-1} in the 1950s to 1.3 million tonnes in 2008. From 1950 to 2008, cumulative total catches were estimated to be 32 million tonnes, 9% higher than reported, while our estimate of total catches from 2005-2008 are approximately 700,000 tonnes less than landings reported to FAO during the same time. The growth seen in Myanmar's fisheries since the late-1990s originated from catches taken in the offshore areas, whereas, since the early 2000s, a decline of catches occurred in the inshore fisheries, which operate within 12 nm from shore.

INTRODUCTION

Myanmar, formerly known as Burma, is located on the eastern shores of the Bay of Bengal Large Marine Ecosystem. The Bay of Bengal Large Marine Ecosystem (BOBLME), which is comprised of part or all of the EEZ waters of: Bangladesh, India, Indonesia, Malaysia, the Maldives, Myanmar, Sri Lanka, and Thailand, and the High Seas waters faces many challenges with respect to fisheries management. Over 400 million people in this region are dependent on coastal and marine resources for their food, livelihood and security. Rapid population growth, high dependence on resources, and increased land use has resulted in the overexploitation of fish stocks and habitat degradation, and has led to considerable uncertainty as to whether the ecosystem will be able to support the livelihoods of the coastal populations in the future. Most of the Bay of Bengal's resources are shared by two or more countries and therefore trans-boundary or multi-country collaboration is required to ensure their sustainable management and conservation.

Myanmar is bordered by Bangladesh to the north and by Thailand to the south. Similar to other countries surrounding the Bay of Bengal, the life of its peoples and its fisheries are shaped seasonally by the monsoons and occasionally by cyclones. Fish represent the main source of protein for the population, and they are also important economically as a source of foreign currency (Aung, 1996). Myanmar has several major rivers and a relatively long coastline, which can be straightforwardly subdivided into three coastal zones, i.e., the Rakhine Coastal Zone in the north, the Deltaic Coastal Zone in the centre, and the Tanintharyi Coastal Zone in the south (Lay, 1997; Pe, 2004; Figure 1). The continental shelf of Myanmar is approximately 230,000 km^2 and the Exclusive Economic Zone

(EEZ), which was declared in 1977 (Aung, 1996), is approximately 535,000 km² (Figure 1). Concurrent with the establishment of the EEZ, the Myanmar government also established a 12-mile territorial sea and a 24-mile contiguous zone.

The three coastal zones mentioned above are used for fisheries management purposes as well. The four fishing zones of Myanmar are extensions of the coastal zones with the Deltaic zone being split into two fisheries zones, 'Ayeyarwady' and 'Mon' (Pe, 2004). The national management of marine fisheries considers these four fishing zones along with distance from shore to spatially define fisheries. Fisheries catches taken within the fishing zones of the EEZ were formerly described as onshore, inshore, or offshore. However, during the mid-1990s, the national fisheries agency changed the reporting structure and now catches are reported as 'inshore' and 'offshore' (Pe, 2004).

The Rakhine Coastal Zone has two distinct seafloor types. The northernmost areas are shallow and deltaic due to the large volumes of sediments deposited from river outflows originating from Bangladesh, whereas the southern areas of this zone are relatively rocky (Pe, 2004). The monsoons and the associated river runoff cause inter-annual values of salinity to fluctuate between 18 and 34 psu[2] (Pe, 2004).

The Deltaic Coastal Zone is also heavily influenced by the outflow of rivers, including the Ayeyarwady River, which is estimated to deposit 250 million tons of sediments annually (Pe, 2004). This sediment load, combined with the loads of two other large rivers, the Thanlwin and Sittaung, advance the land into the sea in the Gulf of Mottama, and also served to create the largest shelf area within Myanmar (Pe, 2004). The former capital of Yangon (earlier 'Rangoon'), the most populated city in Myanmar, is situated in this area.

Figure 1. Map showing the location of Myanmar in the Bay of Bengal, and three coastal areas defined for the present study

The Tanintharyi Coastal Zone borders Thailand to the south and includes the Myeik Archipelago and a portion of the Andaman Sea. The seas surrounding the Myeik Archipelago contain about 800 islands, with coral reefs surrounding the outer, and mangroves and sea grass beds the inner islands (Pe, 2004). The Myeik Archipelago is home to the 'sea gypsies', a cultural group who have traditionally lived at sea in this region. These people relied on the sea for meeting their daily needs and have a unique adaptation to their eyes, which enables them to have superior underwater vision (Gislén *et al.*, 2003). Currently, foreign vessels are not allowed to operate in the southernmost fishing grounds (Ministry of Livestock and Fisheries, 2006).

The fisheries zones vary in the importance of their fisheries resources and catches. The Rakhine coast is important in terms of penaeid shrimps (FAO, 2004), but declines in shrimp catches have led to increased targeting of anchovy (Okamoto, 2009). Purse seines target anchovy in shallow waters and catches are mostly comprised of the genus *Stolephorus* (FAO, 2004). In 2003, total production from aquaculture, inland, and marine fisheries in the Ayeyarwady accounted for 36% of Myanmar's fish and prawn production, while the Tanintharyi coast accounted for 35% of the production of fish and prawns in 2003, with most originating from marine waters (Boutry, 2008).

[2] Practical Salinity Units, equivalent to parts per thousand.

The inshore fisheries operate from the lowest tide level to a depth of 15 m (Pe, 2004) and are conducted with boats less than 9 m using passive fishing gears with engines up to 12 horsepower (Ministry of Livestock and Fisheries, 2006), although some trawling does occur in inshore waters for penaeid shrimp (FAO, 2004). Offshore fisheries, which occur at depths greater than 15 m, use active gears and vessels over 9 m in length and engines with over 12 hp (Ministry of Livestock and Fisheries, 2006). The offshore fisheries zone is divided into 30 x 30 nautical mile blocks (*i.e.*, ½ x ½ degree) to form 144 'fishing grounds' (Pe, 2004).

With the government moving in the late 1980s from a centrally planned economy to one more market-based, policies were implemented to attract foreign investment in various sectors of the economy, including fisheries (Aung, 1996). Fishing rights were extended to some foreign fishing vessels and foreign joint venture enterprises were formed, giving them access to the EEZ, but not the territorial sea (Ministry of Livestock and Fisheries, 2006). In 1989, with the passing of the Law Relating to the Fishing Right of Foreign Vessels, offshore fishing rights were leased to companies from Thailand, Malaysia, the Republic of Korea, and Singapore (Than 1992, in Bhaskaran and Fahey, 1998).

Under Myanmar's Marine Fisheries Law, which was enacted in 1990, artisanal fishers are given priority to fish in all zones (Pe, 2004). Laws enacted that provided rights to foreign vessels in 1989, prior to those of Myanmar nationals (in 1990) led to confrontation between artisanal fishers and foreign vessels when foreign vessels encroached into inshore areas (Soe, 2008). Local large-scale vessels are allowed to operate within territorial waters, reflecting the fact that the banning of trawling within 5 miles of the Rakhine and Tanintharyi Coastal Region and within 10 miles within the Ayeyarwady Coastal Region has not been successful (Pe, 2004). Despite improvements in the laws regulating fisheries activities beginning in the late-1980s, the Department of Fisheries concedes that unauthorized fishing activities are extensive (Aung and Oo, 1999).

Fisheries inspectors in each state, division, district and township are responsible for ensuring that fishing vessels are operating under the terms of Myanmar's laws. Thirteen checkpoints are used to inspect vessels on the way to and from fishing grounds (Aung and Oo, 1999), and the national marine fishery statistics distinguish landings from inshore and offshore areas, and their ex-vessel value (Soe, 2008). National fisheries statistics reported to international agencies are separated into aquaculture production and catches from inland and marine fisheries, but the latter lack taxonomic breakdown.

Until the early 1960s, there was little coastal fishing, and imports, mostly of dried fish, were needed to meet consumer demand (Soe, 2008). There are various reasons for this, notably a preference for freshwater fishes, a lack of infrastructure (transport, provision of salt) and limited investments (Butcher, 2004). The role of moneylenders, who lent fishers capital to invest in equipment, has also been described as contributing to the low output of marine fisheries, both in the early 1900s as well as after World War II (Maxwell 1904, in Butcher, 2004; Khin, 1948). Khin (1948) suggested that the indebtedness of fishers to moneylenders resulted in fisheries being confined to inshore areas because the boats and gear were of poor quality.

In 1962, with the establishment of a socialist government, the People's Pearl and Fisheries Board was formed to develop marine fisheries (Soe, 2008). At this time, motorized craft began to replace sails and canoes, and new fishing gears were introduced. During the 1970s, several international agencies, including FAO, assisted in increasing fishing capacity and in expanding the cold storage infrastructure. However, in the early 1980s, Myanmar's economy began to falter and the government invited foreign investments to stimulate its economy (Soe, 2008). Since the mid-1980s, government policy has emphasized the development of fisheries and aquaculture, with the stated aims to meet the nutritional needs of the population and to promote fishery exports as a means to earn foreign exchange (Ministry of Livestock and Fisheries, 2006).

Although taxonomically disaggregated catches are lacking, there are signs that the marine fisheries in Myanmar may have begun to be overexploited. Notably, catch per unit effort (CPUE) of shrimp in the northern Rakhine coast fell from 32 $kg \cdot hour^{-1}$ during 1989-1991 to a mean of 11 $kg \cdot hour^{-1}$ for the 1997-2003 period (Pe, 2004). Also, analysis of fishing logs from vessels in the 80-100 gross tonnage (GT) class, which yielded a mean catch rate of 200 $kg \cdot hour^{-1}$ in 1982 in the Ayeyarwady Delta area, suggested that these vessels could fill their hold in about two weeks, whereas it took them over four weeks to fill holds one and half decades later, implying a 50% drop in catch rates (Aung 2000, in Pe, 2004).

There are also signs of overfishing of some specific species, such as pomfret (*Pampus* spp.), Indian threadfin (*Polynemus* spp.), and Hilsa (*Tenualosa ilisha*), which are both top export earners, and important food fish (Pe, 2004). In 1991, catches of silver pomfret (*Pampus argenteus*) were dominated by specimens 35 cm in length, but in 1995, this had decreased to 30 cm (Pe, 2004). The decline in the dominant length at capture of 14% represents a decline of about 36% in weight[3], a sign of growth overfishing (Pauly, 1988).

Hilsa is an anadromous species and in Myanmar waters, there are two distinct populations. One is located along the Rakhine coast, undergoes migrations to Bangladesh and India, and appears not to be extensively exploited (Pe, 2004). The other Hilsa population is located in the southern area of Myanmar, and is targeted using purse seines and encircling gill nets. Over a ten year period (1991-2000), catches from this population declined from 106,000 $t \cdot year^{-1}$ to 42,000 $t \cdot year^{-1}$, and at the local markets Hilsa, which used to average over one kilogram per fish, fell to an average of approximately 175 g (Aung 2001 in Pe, 2004). This represents a change in average total length from approximately 39 cm to 22 cm[4], and suggests both growth and recruitment overfishing, given that the length at maturity is between 21 and 38 cm (www.fishbase.org). Indeed, the study of length-weight relationships for Hilsa from 1968-1970 concentrated on fish of length 35 to 38 cm because these were the most frequent sizes in commercial landings at that time (FAO, 1971).

Besides various investigations into the biology and population dynamics of important fish species (Druzhinin, 1970; Druzhinin and Tin Tin Myint, 1970; Pauly and Sann Aung, 1984), there have been studies on the biomass levels of pelagic and demersal fishes present in Myanmar's waters (Druzhinin and Phone Hlaing, 1972; Pauly *et al.*, 1984). Trawl surveys indicated that the biomass of demersal fish over the continental shelf (down to 200 m depth) is similar along the three coastal zones. During 1981-1983, estimated demersal biomass for the continental shelf was about 785,000 tonnes, averaging about 262,000 tonnes in each of the three coastal zones (Pe, 2004). This total demersal fish biomass led to estimates of 'maximum sustainable yield' of about 1.05 million tonnes (Pe, 2004), but this was revised downwards by 33% in 1999 (Soe, 2008). Hydro-acoustic surveys of pelagic species during 1979 and 1980 revealed a large difference in biomass levels between the three coastal areas. Pelagic fish biomass was estimated to average 175,000 tonnes, 505,000 tonnes, and 295,000 tonnes for the Rakhine coast, Ayeyarwady Delta, and the Tanintharyi coast, respectively (Pe, 2004). More recently, deep sea fisheries surveys, extending beyond 200 m depth, have been undertaken with the cooperation of the Southeast Asian Fisheries Development Center (Oo, 2009), which can be expected to impact on the estimates of catch potential.

There have been several attempts by FAO to suggest to Myanmar the development of an adequate statistical reporting structure for marine fisheries catches (see e.g., Pauly, 1984). Myanmar's reported catches to FAO are comprised of "miscellaneous marine fishes" from 1950 to the present, "miscellaneous marine shrimps and prawns" from 1983 to the present and "jellyfishes" since 1995 (FAO, 2010). Unfortunately, this precludes the quantitative description of catch diversity, the computation of indicators such as the marine trophic index (Pauly and Watson, 2005), the analysis of stock dynamics, and the detailed analysis of the expansion of fisheries into unexploited fishing areas, as could be performed through the examination of the species composition of the catches.

In response to the concern of the health of the Bay of Bengal, the Bay of Bengal Large Marine Ecosystem (BOBLME) Project (www.boblme.org) was launched as a collaborative effort between the United Nations Food and Agriculture Organization (FAO) and the countries associated with the Bay of Bengal (Maldives, India, Sri Lanka, Bangladesh, Myanmar, Thailand, Indonesia and Malaysia) to improve the management of the Bay of Bengal marine environment and its fisheries. The purpose of the BOBLME Project is to establish a baseline for sustainable use of fisheries resources within the region and to promote the development and implementation of regional and sub-regional collaborative approaches to common and/or shared issues affecting the health and status of the BOBLME. In this context and in an effort to improve fisheries management capability and

[3] Calculated using the weight-length relationship from Fishbase (Froese and Pauly, 2010): $W = aL^b$, with a = 0.0423 and b = 2.929 (Mustafa, 1999).

[4] Calculated using the weight-length relationship from Fishbase (Froese and Pauly, 2010): $W = aL^b$, with a = 0.0135 and b = 3.077 (Nurul Amin *et al.*, 2002).

performance, the catch reconstruction for Myanmar will provide valuable baseline information on total marine fisheries extractions since 1950, crucial to meeting this mandate. What we attempt below is therefore a reconstruction of the aggregate marine catch of Myanmar from 1950 to 2008 by depth zone (and/or distance offshore), to obtain, if indirectly, a view of the dynamics of the fisheries within the EEZ of Myanmar through time.

METHODS

Myanmar's marine fishery statistics were available from FAO for the years 1950-2008 (FAO, 2010). Other independent reports of fisheries catches are lacking for Myanmar, and alternative FAO documents (e.g., FAO, 1971) that describe the fisheries of Myanmar essentially report the same amounts. Therefore, we use the catches presented in the FAO database as the best estimates of landings, and use national reported data to spatially allocate these catches within Myanmar's EEZ. We also include estimates of Illegal, Unreported, and Unregulated (IUU) catches. Here, estimates of IUU consist of unreported catches in the form of discards from the large-scale commercial and artisanal sectors, and from unreported catches from the artisanal sector that do not form part of the national statistics.

All estimated fisheries catch data are defined spatially within Myanmar's EEZ and by fishing sector, including the discards assessed for the large-scale commercial sector. We estimated catches taken in the offshore, inshore and onshore areas from 1950-2008 by starting with the data reported to FAO. These are then combined with nationally reported data, to generate a time series of national fisheries catches in each area. Then, we estimated offshore catches, subtracted them from total reported catches and assigned the remainder to inshore and onshore areas. The partitioning of inshore and onshore catches was estimated using a ratio-driven approach, and inshore catches were then split between the artisanal and large-scale subsectors. We adopted this method to account for changes in government reporting procedures (see 'Small-scale artisanal data' below). We also account for the effects of Cyclone Nargis in 2008 since we deem it unlikely that the reported catch increase in 2008 was possible after this cyclone devastated much of the infrastructure in the Ayeyarwady division and caused a significant loss of human life in May 2008.

We compare the catch per unit area over time with the rates observed in Bangladesh, the eastern states of India, and Thailand, all of which also border the Bay of Bengal. Given the downward estimate of MSY in 1999 to approximately 704,000 t this comparison is made to check whether the recent increases in marine catches fall within the range reported from neighbouring countries. We also use taxonomic data from the eastern states of India and those reported for Thailand in the Eastern Indian Ocean to infer on the taxonomic composition of catches taken in Myanmar waters.

We also analyze data concerning *per capita* consumption rates to assess the extent of unreported catches. Apparent *per capita* consumption rates are compared to *per capita* consumption rates from two earlier studies to determine whether it reflects the actual consumption of marine resources. Apparent *per capita* consumption rates are determined from landings and net trade (after removing products not used for human consumption) and human population, i.e., we used the relationship *per capita* consumption = (total catch + net trade)/population).

Human population data

The human population data for Myanmar were combined with reported catches and net trade to determine *per capita* rates. These rates were then compared to actual consumption rates reported in two different studies (Soe, 2008; Okamoto, 2009; see below). Human population estimates for the start of each decade are reported by the United Nations (2009). Linear interpolations between reported population estimates were used in order to create a yearly time series of population between 1950 and 2008. The population grew from about 17 million in 1950 to approximately 50 million in 2008 (Figure 2).

Large-scale commercial fisheries data

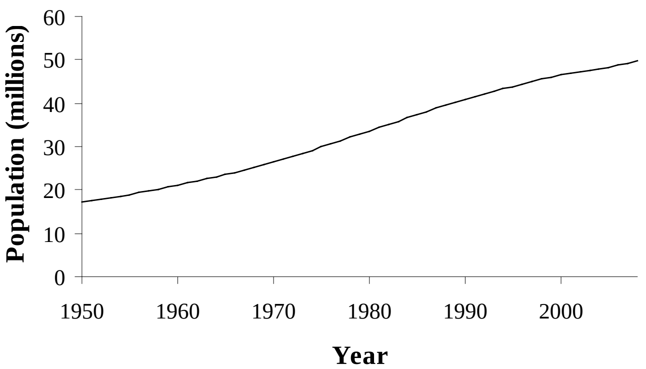

Figure 2: Human population of Myanmar from 1950-2008.

Catch statistics reported on behalf of Myanmar are available from the FAO Fisheries and Aquaculture Department for the period 1950-2008 (FAO, 2010). We assume that the reported data represent both the large-scale commercial fisheries and the small-scale artisanal fisheries. We consider that in the early period (1950-1970), large-scale commercial fisheries were carried out by trawl, purse seine, and drift-net in inshore areas (FAO, 1970). Some trawlers began operating in 1953, but large-scale commercial operations took off only in the 1980s. Estimates of catches by the large-scale fleet are made for both the offshore waters and for their contributions to inshore catches.

<u>Offshore</u>

Offshore catches are taken by the large-scale commercial fleet, and we considered these to have started only in 1970, when overseas agencies helped develop cold storage facilities and increase fishing capacity. Data concerning offshore catches are deemed reliable for 1973-1981, and offshore fisheries during this time changed from contributing 22.8% to total reported catches in 1973 to 26.8% in 1981. Consequently, we assumed that offshore catches were non-existent until 1970, set offshore catches equal to zero in 1969 and interpolated to the first nationally reported catch data from offshore areas in 1973. Between 1973 and 1981, we used the reported totals, with interpolations for two years with missing values.

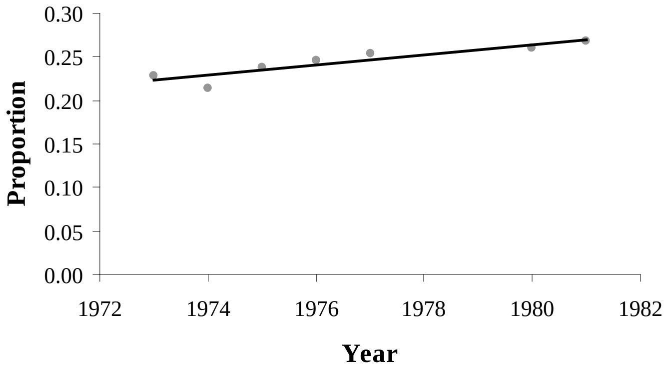

Figure 3: Trend in the proportion of offshore catches to total catches from 1973-1981.

We assumed that growth in the offshore areas continued after 1981, brought about by the opening up of the economy to foreign investments. We use the trend of the proportion of offshore catches to total reported catches from 1973 to 1981 to estimate the growth in offshore fisheries until 1989 (Figure 3). The estimated rate of growth (0.006 per year) increased the fraction of offshore catches to total catch from 0.26 in 1982 to 0.30 in 1989. After 1989, we consider that there was a greater rate of growth in the fishery as a result of directed investment, and we set the offshore contribution to total catches to 0.63 in 2004, which results in increases of approximately $0.02 \cdot year^{-1}$. The proportion of offshore catches has been set to 0.63 in nationally reported statistics between 1995 and 2006, but we believe that this constant value is erroneous for two reasons: 1) it would require the onshore and inshore catches to be smaller during 1995-1999 than were reported between 1973 and 1981 (despite an approximate 50% increase in population) and; 2) it suggests that production levels still increased in 2008 after Cyclone Nargis. We therefore use the rate of $0.02 \cdot year^{-1}$ to estimate the proportion of catches taken in offshore areas after 2004, which results in offshore catches comprising almost 72% of catches in 2008.

Table 1. Estimated and reported onshore and inshore catches, the onshore to inshore ratio for reported data, and the large-scale catches taken from inshore. Numbers in *italics* are estimated, dashes (-) indicate years when catches were estimated by linear interpolation.

Year	Onshore catch (t)	Inshore catch (t)	Ratio	Large-scale from inshore (t)
1950	*19,275*	11,825	*1.6300*	0
1951	*20,284*	*12,716*	*1.6030*	*0*
1952	*43,888*	*28,112*	*1.5760*	*0*
1953	*43,521*	*28,479*	*1.5491*	*32*
1954	*86,307*	*57,693*	*1.5221*	384
1955	*85,572*	*58,428*	*1.4951*	384
1956-1972	-	-	-	-
1973	131,11	129,884	1.0095	*29,618*
1974	131,13	110,542	1.1862	*23,692*
1975	132,44	138,020	0.9596	*32,909*
1976	133,76	143,183	0.9342	*35,189*
1977	135,10	148,600	0.9092	*37,600*
1978-1979	-	-	-	-

1980	149,019	168,196	0.8860	*43,763*
1981	154,690	171,423	0.9024	*45,936*

Inshore

Table 2. Proportion of offshore catches to the total reported catches for 1950 to 1981. Numbers in *italics* are estimated and dashes (-) indicate years when estimates were done by linear interpolation.

Year	Offshore	Proportion of total reported catch
1950-1969	*0*	*0*
1970	*19,275*	*0.062*
1971	*38,549*	*0.121*
1972	*57,824*	*0.176*
1973	77,009	0.228
1974	65,928	0.214
1975	84,679	0.238
1976	90,242	0.246
1977	96,100	0.253
1978-1979	-	-
1980	111,565	0.260
1981	119,377	0.268

From 1953-1955, the Japanese trawling vessel, *Taiyo Maru No. 11*, operated within Burmese waters, landing 800 tonnes in the 25 months (*i.e.*, 32 t·month^{-1}) of operations (Ba Kyaw, 1955). Besides trawl surveys, there is no record of commercial trawling operations again until the *Linzin* began trawling in the Myeik archipelago between 1964 and 1969, at depths less than 60 meters. In 1969, 3 more trawlers were added to the fleet (FAO, 1971). An FAO expert, A.D. Druzhinin (FAO, 1970) commented that one of the most important commercial fish species caught at the time was the Indo-Pacific king mackerel (*Scomberomorus guttatus*), which was targeted using drift nets, while a purse seine fishery targeting the Indian mackerel (*Rastrelliger* spp.) was developing in the mid-1960s in the Myeik area as well (FAO, 1971).

In order to create a time-series of estimated large-scale commercial catches in inshore areas, we assume that the catches made by the *Taiyo Maru No. 11* represent the start of large-scale commercial catches in inshore areas. Thus, we set catches in 1955 to 384 t, the estimated catch of the *Linzin* for that year. Data concerning the contributions of the large-scale commercial fleet to inshore catches are lacking after 1955, and so we set the proportion of inshore catches taken by the large-scale fleet t0 0.228 - the same proportion the offshore catches contributed to the total reported catches for 1973. Therefore, we interpolate linearly between the estimated catch in 1955 (384 t), and the derived estimate for 1973 of around 29,600 t (Table 1). Between 1973 and 1981, we used the reported offshore catch, converted them to fractions of reported total catches, and used these fractions to estimate catches taken by this sector from inshore waters. After 1981, we fixed the proportion to 0.268, i.e., the value in 1981 (Table 2).

Table 3. Spatially reported fisheries catch data for Myanmar. Ratios of onshore to inshore catch for years between 1973 and 1994, the last year when catches are reported from both areas. After 1994, nationally reported catches are either from the offshore or inshore areas only. Dashes (-) indicate years of missing data.

Year	Offshore (t)	Onshore (t)	Inshore (t)	Ratio	Source
1973	77,009	131,118	129,884	0.502	Sivasubrumaniam (1985)
1974	65,928	131,130	110,542	0.543	Sivasubrumaniam (1985)
1975	84,679	132,441	138,020	0.490	Sivasubrumaniam (1985)
1976	90,242	133,766	143,183	0.483	Sivasubrumaniam (1985)
1977	96,100	135,100	148,600	0.476	Sivasubrumaniam (1985)
1978-1979	-	-	-	-	-
1980	111,565	149,019	168,196	0.470	Sivasubrumaniam (1985)
1981	119,377	154,690	171,423	0.474	Sivasubrumaniam (1985)
1982	69,272	155,253	226,045	0.407	Sivasubrumaniam (1985)
1983	68,762	152,323	223,595	0.405	Sivasubrumaniam (1985)
1984-1985	-	-	-	-	-
1986	61,197	184,672	289,289	0.390	Sivasubrumaniam (1985)
1987-1990	-	-	-	-	-
1991	71,849	206,055	310,081	0.399	Aung (1996)

1992	70,896	207,887	311,480	0.400	Aung (1996)
1993	78,505	207,813	311,319	0.400	Aung (1996)
1994	74,797	209,192	315,887	0.398	Aung (1996)
1995	382,000	n/a	222,000	n/a	Baskharan & Fahey (1998)
1996	382,033	n/a	224,367	n/a	Central Statistics Organization (2008)
1997	398,000	n/a	234,000	n/a	Central Statistics Organization (2008)
1998	429,000	n/a	252,000	n/a	Central Statistics Organization (2008)
1999	479,000	n/a	281,000	n/a	Central Statistics Organization (2008)
2000	564,853	n/a	331,739	n/a	Central Statistics Organization (2008)
2001	586,864	n/a	344,666	n/a	Central Statistics Organization (2008)
2002	648,165	n/a	380,669	n/a	Central Statistics Organization (2008)
2003	663,442	n/a	389,640	n/a	Central Statistics Organization (2008)
2004	712,942	n/a	418,713	n/a	Central Statistics Organization (2008)
2005	773,617	n/a	454,348	n/a	Central Statistics Organization (2008)
2006	866,148	n/a	508,691	n/a	Central Statistics Organization (2008)

Small-scale artisanal data

Catches of marine fish were predominantly made by small-scale (or ‘artisanal’) fishers in the onshore and inshore areas until the 1970s, but it is only in the 1970s that catches began to be defined spatially. We consider catches reported as ‘onshore’ as being taken solely by the artisanal fleet, and catches reported as ‘inshore’ as being caught by both the artisanal and large-scale fleets.

Catches are defined spatially in this manner for most years between 1973 and 1986 (Sivasubramaniam, 1985) and for 1991-1994 (Aung, 1996); however we deem the spatial allocation of catches to be only reliable from 1973-1981, due to erratic change in the data reported spatially for 1982 and 1995[5]. Also, from 1996 on, the reported contribution of inshore and offshore catches to the annual total marine capture fishery is fixed at 37% and 63%, respectively (Table 3).

In order to define catches by the two sectors in the inshore areas, we created a time-series of ratios of onshore to inshore catches from 1973 to 1981. A small decline is noticed in this ratio, and we use the equation of the trend line to estimate the fraction of catches taken in onshore areas in 1950 (Figure 4). Conveniently, it estimates that onshore catches were approximately 62% of fishery catches in 1950, and we therefore set inshore catches as 38%. From 1982 onwards, we used the average ratio (0.472) from 1980 and 1981 to estimate the amount of catches taken from onshore areas (Table 1). We also consider that catches reported to FAO in the first six years (1950-1955) are underreported. Thus, we estimate the 1950 catch by combining the human population for that year with the *per capita* consumption rate from 1967 to estimate catches in 1950, and then interpolate to the year 1956. The 1967 *per capita* rate was chosen because it appears to be the first year of actual reported data. Reported catches between 1956 and 1966 are a constant 257,000 t·year^{-1}. We view these constant catches as unlikely, but retain them for lack of a better alternative.

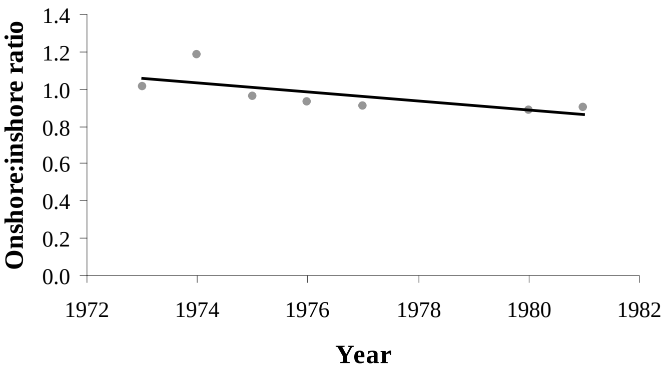

Figure 4: Decreasing trend in the onshore to inshore reported catch ratio.

[5] In 1982, the ratio of onshore to inshore catches dropped dramatically, as do the offshore catches. In 1995, when the reporting structure changed to inshore and offshore areas only, there was also a 5-fold increase in offshore catches and drop of about 33% in inshore catches.

IUU data

Unreported catches are viewed here as consisting of subsistence catches and discards from large-scale commercial fishing operations. Subsistence catches are considered to be the retained catches used for personal use from the artisanal sector and catches that do not form part of the commercial small-scale reporting system. Discards, a part of the catch that is not landed, are estimated by applying discard rates to our estimates of large-scale commercial and artisanal fisheries.

Per capita consumption rates

We compared apparent *per capita* consumption rates with consumption rates from two independent studies (Soe, 2008; Okamoto, 2009) to determine if there are unreported catches. Apparent *per capita* consumption rates were derived using the catch data presented by FAO, the net trade determined from the fisheries commodities and trade database maintained by the FAO Fisheries and Aquaculture Department, and the human population data.

Soe (2008) compares a nationally reported *per capita* consumption rate derived from monthly food consumption surveys of meat and fish in 2001 and found that the actual *per capita* consumption rate was 15.12 kg. This consumption rate consisted of 11.52 kg of fresh fish and crustaceans, and of 3.6 kg of processed products. We converted the processed products using a conversion factor of 2.36, derived from a simple average for fish paste, salted anchovy, other fish fillet, and sardine (FAO, 2002-2011). These product types are the largest contributors to imports in the commodities and trade database, and we assume they are also reflective of locally available processed products. This conversion leads to a *per capita* consumption rate of 20.0 kg, in comparison to the apparent *per capita* rate of 17.2 kg.

Okamoto (2009) compared the amount of catch and the outflow of fishery products over a one-year period from December 2004 to November 2005 in Thandwe township, situated along the Rakhine coast with a human population of approximately 140,000. The total fisheries catch in Thandwe Township was reported to be 6,349 tonnes and the total outflow of fisheries product was estimated to be approximately 2,800 t. Thus, the difference between the catch and the outflow (~3,100 t) was locally consumed. This difference translates to a *per capita* rate of 23.2 kg in 2005 in comparison to the apparent *per capita* consumption rate of 22.4 kg.

To account for the unreported catches from the discrepancy between the apparent versus estimated actual consumption rates, we use the average *per capita* difference of 1.8 kg·year^{-1} from Soe (2008) and Okamoto (2009) as being representative of the 2000s. Going backwards in time, we set 1955 to zero and interpolate to the year 2000. Unreported catches in each year are estimated from the estimated human population and the estimated unreported *per capita* rate.

Discards

We use data from Kelleher (2005) to estimate discards by the large-scale commercial fleet operating in both the inshore and offshore areas, and for the artisanal fleet. Kelleher (2005) reports a trawl discard rate of 7.5%, and in the reporting year 2002-2003, trawl catches were estimated to take more than 40% of the marine landings. Therefore, we convert the last year of catches by the *Linzin* to a proportion of the total catch, and interpolate from the 1955 proportion to the year 2000, which we set at 0.41 and maintain until 2008. For the remaining catches taken by other gears in the large-scale sector, and for the artisanal sector, we use a discard rate of 1 % (Kelleher, 2005).

Effects of Cyclone Nargis

Cyclone Nargis was a category 3 cyclone that caused the worst natural disaster in Myanmar's history. The cyclone made landfall in the Ayeyarwady division, but also affected the Yangon division, and killed an estimated 140,000 people (Anon., 2008b). An estimated 7.5 million people live in these two areas, and approximately 2.5 million people were severely affected by the cyclone. The high winds and resulting storm surge in this low lying area caused damage to fisheries infrastructure and to fishing equipment such as boats and nets. Thus, post-harvest capacity was also severely affected and it was estimated that in some areas the income earned by fishing had fallen by half after the cyclone (Anon., 2008a). The lower availability of fish in the diet as a result of the cyclone is reflected in dietary changes--the proportion of households consuming fish and eggs, the main sources of protein and fat, dropped approximately 25 % (Anon., 2008a).

A natural disaster of this magnitude that caused such devastation should be reflected in the corresponding national statistics, but they are not. Rather, fisheries catches for 2008 are reported to have increased by over 10 per cent from 2007. Further, from 2005-2007 catches are reported to have increased, on average, by 10 % per year, as compared to an average of 6 % per year over the previous four year period (2001-2004). These increases result in apparent *per capita* marine fish consumption rates increasing from 19.0 kg·person^{-1}·year^{-1} to 26.5 kg·person^{-1}·year^{-1} from 2004 to 2008.

The inability of national statistics to capture the effect of Cyclone Nargis on the fisheries capture production also leads to past catch statistics also being considered doubtful. Thus, we consider that since 2004, marine fisheries catches only increased slightly, and declined in 2008, in contrast to reported statistics. We increase catches from 2004 by the human population growth rate until 2007 (~0.8 % per year), and then estimate the decline in catches caused by Cyclone Nargis. To account for the effects of the cyclone, we assume that there was a 25 % reduction in household consumption for the 7.5 million people affected by the cyclone and this reduced consumption reflects losses in marine catches from 2007 levels and adjust catches downwards.

Taxonomic assignment of catches

A taxonomic description of catches is lacking and therefore we interpolate data from the eastern states of India and those of Thailand to assign catches to taxa for Myanmar. Both India and Thailand have fisheries catches described rather well taxonomically and we categorize the reported taxa from the two countries into taxonomically related groups. For each year and both countries, we calculate the fraction that each taxonomic group contributes to reported total catches. We then calculate an average from the two fractions in each year and normalize these fractions to one. Finally, we apply the calculated average fraction for each taxonomic group to Myanmar's total catch to estimate catches by taxa for each year.

RESULTS

FAO reports, on behalf of Myanmar, total landings of 29.8 million tonnes. By comparison from 1950-2008, our total catch estimate comprised of reported landings, downward adjustments to reported landings for 2005-2008, unreported catches and discards, is just over 32.4 million tonnes (Figure 5). Large-scale commercial fisheries account for 42% of the total estimated catch since 1950, even though they were of minor importance until the 1980s. As determined here, the catches in the inshore waters are declining, and the growth in fisheries landings occurs only in offshore areas.

Offshore catches

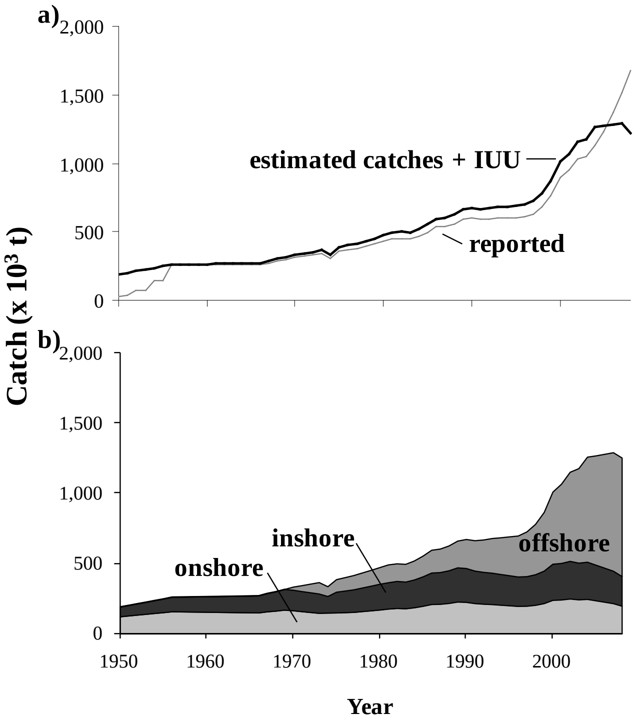

Figure 5: a) Comparison between the data reported to FAO and estimated catches (including downward adjustment for 2005-2008; see text for details) with IUU components included; and b) the catches taken in spatial areas of Myanmar.

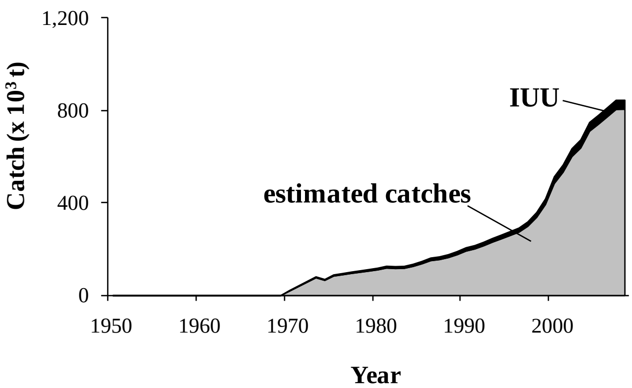

Figure 6: Estimated catches and IUU components in the offshore area.

Total catches taken in the offshore waters by Myanmar's large-scale fleet were estimated to be approximately 11.5 million tonnes from 1950-2008. Large-scale commercial fisheries in offshore waters were estimated to have increased from approximately 22,000 t·year^{-1} in 1970 to almost 847,000 t·year^{-1} in 2008. There has been a dramatic change in catch levels since 1995 in this area, from an estimate of approximately 278,000 t·year^{-1} in 1995 to 847,000 t·year^{-1} in 2008, with an annual rate of change averaging approximately 10%. Discards were also estimated to have increased from approximately 3,000 t·year^{-1} in 1970 to approximately 38,000 t·year^{-1} in 2008 (Figure 6). Catches increased from on average 0.18 t·km^{-2}·year^{-1} in the offshore waters during the 1970s to an average of 1.6 t·km^{-2}·year^{-1} from 2000 to 2008.

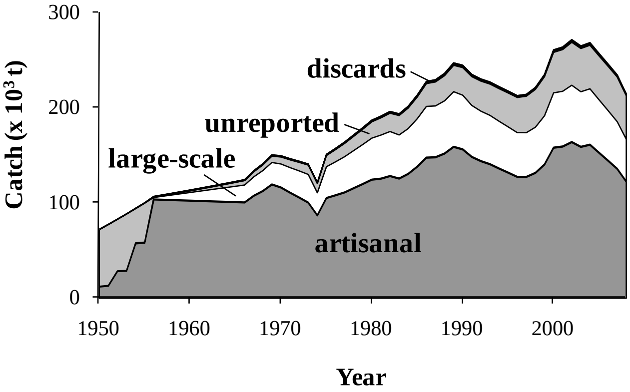

Figure 7: Estimated catches and IUU components in the inshore areas.

Inshore catches

Total inshore catches were estimated to be approximately 10.4 million tonnes from 1950-2008. Inshore catches are dominated by the artisanal fleet, which accounted for an average of over 90% of the total catches taken from inshore waters between 1950 and 1969. From 1970 to the present, the artisanal fleet accounted for an average of 78% of the total catches taken in the inshore area, i.e., approximately 8.4 million tonnes from 1950-2008 (Figure 7). Inshore catches increased from about 72,000 t·year^{-1} in 1950, and averaged approximately 175,000 t·year^{-1} from 1986-1999. Inshore catches were estimated to have peaked in 2002 at 211,000 tonnes, before declining to 169,000 t·year^{-1} in 2008. The large-scale fleet operating in inshore areas contributes less, at just over 2 million tonnes from 1953-2008. We estimate that catches by the large-scale fleet operating in inshore areas increased from 384 t·year^{-1} in 1955 with two peaks of approximately 60,000 t·year^{-1} in 1989 and 2002. Catches decline from 2002 and are estimated to be 45,000 t·year^{-1} in 2008.

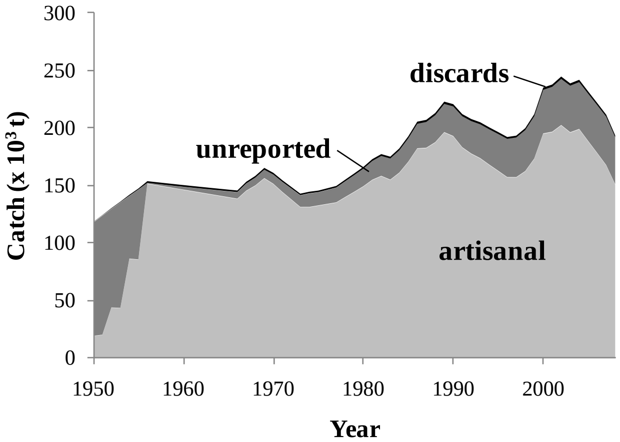

Figure 8: Estimated catches and IUU components from the onshore areas.

Unreported catches are only estimated for the artisanal sector, and from 1950 to 2008 they were estimated to be over 1.4 million tonnes. During 1950-1955, unreported catches were estimated to average about 53,000 t·year^{-1}, but then declined. Starting in 1956, unreported catches were estimated to be only 308 t, but they have increased steadily, and are now estimated to be about 46,000 t·year^{-1}. Discards were estimated to be almost 102,000 tonnes from 1950-2008, and increased from 118 t·year^{-1} in 1950, and are currently estimated to be approximately 1,700 t·year^{-1}. The breakdown of discards between the artisanal and large-scale sector follows the same pattern as catches.

Onshore catches

Onshore catches are taken solely by artisanal fishers, and from 1950-2008

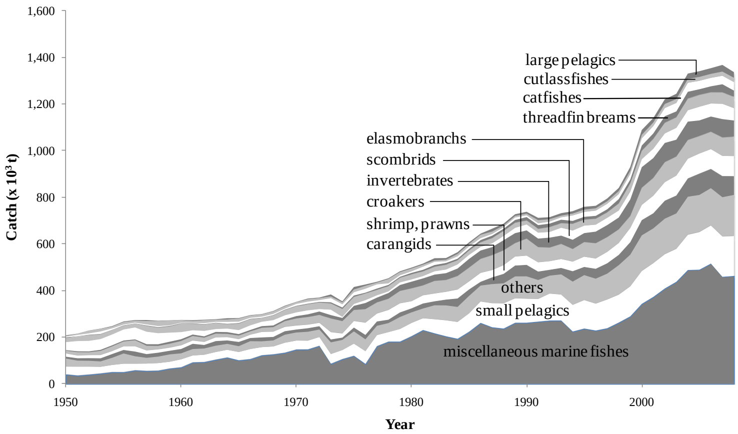

Figure 9: Taxonomic breakdown assigned to the estimated catches in Myanmar using taxonomic information from the eastern states of India and Thailand.

total catches were estimated to be over 10 million tonnes (Figure 8). Total catches were estimated to be approximately 117,000 t·year^{-1} in 1950, peaked at about 245,000 t·year^{-1} before declining to approximately 214,000 t·year^{-1} in 2008. Unreported catches were substantial between 1950 and 1955, averaging approximately 82,000 t·year^{-1}. In 1956, the unreported catches were estimated to be about 400 t·year^{-1} and have steadily increased to about 41,000 t·year^{-1} since 2002. Discards were almost 88,000 t over the entire time period. In 1950, we estimate discards contribute about 200 t·year^{-1} to total onshore catches, peaked at about 2,000 t·year^{-1} in 2002 and are currently about 1,500 t·year^{-1}.

Taxonomic disaggregation of catches

Using data from the eastern states of India and from Thailand we disaggregated the three reported taxonomic groupings into 40 taxa (Figure 9). The 40 taxa comprise 9 species, 4 genera, 20 families and 7 taxa that are at lower taxonomic resolution (e.g., miscellaneous taxa, orders or classes). Miscellaneous marine fish accounts for 99% of the taxa reported to FAO since 1950, whereas our estimated catch by taxa reduces this group to 35 % on average. Important taxa include shrimp and prawns, small pelagics (Indian mackerel, clupeids, and anchovies), croakers (Sciaenidae), carangids (jacks, horse mackerels and scads), and elasmobranchs (sharks, skates and rays). Catches by taxa from 1950-2008 are presented in Appendix A1.

Catch per unit area

The sharp increases reported since the late-1990s has led to the questioning of the validity of the catch reported to FAO. Estimated catches taken from the onshore and inshore waters of Myanmar were added, and expressed as catch per unit area for inshore areas, defined here as those catches taken within 12 nm from shore. The inshore area was estimated to be approximately 85,000 km^2. Inshore catches averaged 2.8 t·km^{-2}·year^{-1} during the 1950s, and increased to 5.7 t·km^{-2}·year^{-1} from 2000 to 2008 (Table 4). The increasing trend of catch per unit area of EEZ is credible, in that such a trend also occurs off Bangladesh, the eastern states of India and Thailand. Moreover, Myanmar's current catch per area of EEZ is neatly bracketed between the high values for Thailand and the low values for eastern India (Table 4).

Table 4. Myanmar's estimated total catch by its current management areas and, for comparison, those from the EEZ area of the eastern states of India[1] bordering the Bay of Bengal, Bangladesh, and Thailand[2]. Data for 2000s is until 2008 (Myanmar) and until 2006 (India, Bangladesh, and Thailand).

Decade	Inshore (t·km^{-2})	Offshore (t·km^{-2})	EEZ (t·km^{-2})	EEZ (t·km^{-2}; India)	EEZ (t·km^{-2}; Bangladesh)	EEZ (t·km^{-2}; Thailand)
1950s	2.8	n/a	0.45	0.27	0.43	0.06
1960s	3.2	n/a	0.53	0.34	0.84	0.28
1970s	3.6	0.18	0.73	0.61	1.20	0.95
1980s	4.7	0.34	1.10	0.80	2.70	2.70
1990s	5.0	0.65	1.40	1.30	3.60	6.40
2000s	5.7	1.60	2.30	1.70	5.40	6.70

[1]catch data from Bhathal and Pauly (2008); [2]catch data from FAO.

DISCUSSION

The catches from capture fisheries are estimated to be approximately 9% larger than those reported to FAO by Myanmar from 1950 to 2008. This is due to the inclusion of IUU catches in the form of unreported catches and discards. The catches estimated here would be larger if data concerning the illegal and large-scale unreported catches were to be included in our assessment of IUU activity.

We have attempted to account for the spatial expansion of fisheries within the EEZ of Myanmar, and estimated that 67% of catches currently originate from offshore waters, and this is the only area generating catch increases. These increases are probably due to the expansion of the fleet into deeper water areas, as suggested by the recent surveys undertaken at depths greater than 200 m. Observations of overfishing of some species that are important for local consumption and the loss of mangrove habitat may support our claim that catches taken from the inshore and onshore areas are declining, at least in the last decade.

We compared the spatial catch rates over time with those of two neighbouring countries on the Bay of Bengal, in order to approximately assess whether our estimates were realistic. The outcome was encouraging, in that estimated catch per area in Myanmar was bracketed by the corresponding estimate from these two neighbouring countries.

There does appear to be considerable improvements in the statistical reporting procedures, especially in comparison to the earliest time periods. However, much of this knowledge is not shared with the international community. Catches by area may need to be re-assessed, given that they have been fixed at the same percentage for a decade. Some independent reports offer details on the taxonomic breakdown of the catch, which presently is not available on a per species basis. Ensuring that such taxonomic breakdown becomes available is of the highest priority if the status of Myanmar fisheries is to be assessed.

ACKNOWLEDGEMENTS

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APPENDIX A

Table A1. Estimated fisheries catch (tonnes) by taxon for Myanmar's EEZ from 1950-2008.

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Anguilliformes	428	Ariidae	4,235
1951	Anguilliformes	523	Ariidae	6,178
1952	Anguilliformes	507	Ariidae	6,501
1953	Anguilliformes	637	Ariidae	11,009
1954	Anguilliformes	631	Ariidae	6,939
1955	Anguilliformes	594	Ariidae	4,319
1956	Anguilliformes	386	Ariidae	4,055
1957	Anguilliformes	720	Ariidae	5,222
1958	Anguilliformes	839	Ariidae	5,400
1959	Anguilliformes	1,359	Ariidae	3,470
1960	Anguilliformes	1,200	Ariidae	3,122
1961	Anguilliformes	3,660	Ariidae	2,806
1962	Anguilliformes	3,570	Ariidae	5,150
1963	Anguilliformes	3,994	Ariidae	4,752
1964	Anguilliformes	757	Ariidae	8,797
1965	Anguilliformes	1,520	Ariidae	6,711
1966	Anguilliformes	830	Ariidae	5,050
1967	Anguilliformes	974	Ariidae	5,449
1968	Anguilliformes	1,730	Ariidae	5,747
1969	Anguilliformes	1,759	Ariidae	4,949
1970	Anguilliformes	2,581	Ariidae	8,350
1971	Anguilliformes	1,572	Ariidae	8,933
1972	Anguilliformes	789	Ariidae	8,110
1973	Anguilliformes	1,725	Ariidae	17,823
1974	Anguilliformes	3,040	Ariidae	13,865
1975	Anguilliformes	5,206	Ariidae	14,134
1976	Anguilliformes	3,194	Ariidae	17,065
1977	Anguilliformes	1,793	Ariidae	17,177
1978	Anguilliformes	2,290	Ariidae	7,055
1979	Anguilliformes	2,017	Ariidae	6,765
1980	Anguilliformes	937	Ariidae	6,711
1981	Anguilliformes	1,032	Ariidae	12,969
1982	Anguilliformes	610	Ariidae	13,037
1983	Anguilliformes	454	Ariidae	7,402
1984	Anguilliformes	733	Ariidae	10,034
1985	Anguilliformes	993	Ariidae	10,123
1986	Anguilliformes	1,111	Ariidae	8,186
1987	Anguilliformes	730	Ariidae	7,147
1988	Anguilliformes	1,086	Ariidae	6,782
1989	Anguilliformes	1,297	Ariidae	9,972
1990	Anguilliformes	1,405	Ariidae	7,230
1991	Anguilliformes	1,788	Ariidae	7,580
1992	Anguilliformes	1,948	Ariidae	8,175
1993	Anguilliformes	1,845	Ariidae	9,740
1994	Anguilliformes	2,296	Ariidae	21,270
1995	Anguilliformes	1,833	Ariidae	19,227
1996	Anguilliformes	2,393	Ariidae	20,597
1997	Anguilliformes	2,596	Ariidae	21,382
1998	Anguilliformes	6,172	Ariidae	19,632
1999	Anguilliformes	9,061	Ariidae	21,538
2000	Anguilliformes	5,269	Ariidae	27,926
2001	Anguilliformes	8,573	Ariidae	28,684
2002	Anguilliformes	9,234	Ariidae	31,625
2003	Anguilliformes	9,526	Ariidae	33,939
2004	Anguilliformes	10,078	Ariidae	34,916
2005	Anguilliformes	10,358	Ariidae	32,602
2006	Anguilliformes	10,290	Ariidae	32,702
2007	Anguilliformes	10,536	Ariidae	32,661
2008	Anguilliformes	9,996	Ariidae	33,782

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Auxis	926	Carangidae	8,097
1951	Auxis	306	Carangidae	10,290
1952	Auxis	300	Carangidae	11,117

1953	Auxis	406	Carangidae	13,023
1954	Auxis	841	Carangidae	16,175
1955	Auxis	922	Carangidae	14,831
1956	Auxis	1,021	Carangidae	19,663
1957	Auxis	1,479	Carangidae	14,654
1958	Auxis	660	Carangidae	16,023
1959	Auxis	409	Carangidae	14,381
1960	Auxis	363	Carangidae	17,075
1961	Auxis	1,165	Carangidae	21,654
1962	Auxis	881	Carangidae	12,800
1963	Auxis	847	Carangidae	18,334
1964	Auxis	1,986	Carangidae	13,418
1965	Auxis	821	Carangidae	17,397
1966	Auxis	686	Carangidae	13,277
1967	Auxis	590	Carangidae	15,629
1968	Auxis	722	Carangidae	13,157
1969	Auxis	880	Carangidae	14,057
1970	Auxis	462	Carangidae	11,157
1971	Auxis	1,048	Carangidae	13,429
1972	Auxis	812	Carangidae	12,242
1973	Auxis	3,498	Carangidae	10,140
1974	Auxis	1,528	Carangidae	8,747
1975	Auxis	4,201	Carangidae	13,964
1976	Auxis	1,952	Carangidae	15,815
1977	Auxis	616	Carangidae	16,970
1978	Auxis	854	Carangidae	12,264
1979	Auxis	130	Carangidae	15,916
1980	Auxis	91	Carangidae	13,544
1981	Auxis	222	Carangidae	19,238
1982	Auxis	1,160	Carangidae	14,944
1983	Auxis	541	Carangidae	22,953
1984	Auxis	652	Carangidae	31,637
1985	Auxis	1,456	Carangidae	25,990
1986	Auxis	806	Carangidae	14,672
1987	Auxis	5,134	Carangidae	27,202
1988	Auxis	1,591	Carangidae	39,588
1989	Auxis	1,390	Carangidae	43,384
1990	Auxis	898	Carangidae	45,336
1991	Auxis	748	Carangidae	33,258
1992	Auxis	890	Carangidae	22,434
1993	Auxis	536	Carangidae	24,452
1994	Auxis	468	Carangidae	39,185
1995	Auxis	640	Carangidae	30,450
1996	Auxis	511	Carangidae	37,119
1997	Auxis	516	Carangidae	38,006
1998	Auxis	524	Carangidae	37,500
1999	Auxis	292	Carangidae	44,064
2000	Auxis	752	Carangidae	54,938
2001	Auxis	778	Carangidae	54,103
2002	Auxis	673	Carangidae	65,391
2003	Auxis	931	Carangidae	64,644
2004	Auxis	956	Carangidae	65,504
2005	Auxis	1,303	Carangidae	78,381
2006	Auxis	1,159	Carangidae	69,221
2007	Auxis	1,520	Carangidae	77,309
2008	Auxis	1,236	Carangidae	67,414

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Cephalopoda	26	Chirocentrus	2,490
1951	Cephalopoda	32	Chirocentrus	958
1952	Cephalopoda	33	Chirocentrus	1,376
1953	Cephalopoda	38	Chirocentrus	2,021
1954	Cephalopoda	43	Chirocentrus	4,456
1955	Cephalopoda	40	Chirocentrus	2,874
1956	Cephalopoda	42	Chirocentrus	2,566
1957	Cephalopoda	63	Chirocentrus	4,257

1958	Cephalopoda	49	Chirocentrus	3,231
1959	Cephalopoda	54	Chirocentrus	3,058
1960	Cephalopoda	41	Chirocentrus	3,379
1961	Cephalopoda	25	Chirocentrus	4,185
1962	Cephalopoda	33	Chirocentrus	6,605
1963	Cephalopoda	64	Chirocentrus	5,076
1964	Cephalopoda	136	Chirocentrus	4,076
1965	Cephalopoda	152	Chirocentrus	4,475
1966	Cephalopoda	256	Chirocentrus	3,876
1967	Cephalopoda	208	Chirocentrus	4,861
1968	Cephalopoda	370	Chirocentrus	6,238
1969	Cephalopoda	490	Chirocentrus	4,731
1970	Cephalopoda	1,225	Chirocentrus	4,074
1971	Cephalopoda	1,126	Chirocentrus	3,370
1972	Cephalopoda	785	Chirocentrus	3,443
1973	Cephalopoda	1,773	Chirocentrus	4,145
1974	Cephalopoda	3,173	Chirocentrus	2,176
1975	Cephalopoda	5,174	Chirocentrus	2,640
1976	Cephalopoda	3,697	Chirocentrus	2,347
1977	Cephalopoda	9,283	Chirocentrus	3,203
1978	Cephalopoda	9,124	Chirocentrus	3,324
1979	Cephalopoda	9,738	Chirocentrus	3,730
1980	Cephalopoda	9,829	Chirocentrus	4,129
1981	Cephalopoda	9,513	Chirocentrus	3,418
1982	Cephalopoda	8,616	Chirocentrus	3,086
1983	Cephalopoda	9,667	Chirocentrus	3,272
1984	Cephalopoda	14,348	Chirocentrus	2,848
1985	Cephalopoda	14,388	Chirocentrus	2,781
1986	Cephalopoda	13,124	Chirocentrus	3,192
1987	Cephalopoda	11,722	Chirocentrus	3,614
1988	Cephalopoda	13,098	Chirocentrus	3,928
1989	Cephalopoda	17,798	Chirocentrus	4,922
1990	Cephalopoda	17,842	Chirocentrus	4,975
1991	Cephalopoda	22,886	Chirocentrus	4,490
1992	Cephalopoda	28,170	Chirocentrus	3,939
1993	Cephalopoda	21,503	Chirocentrus	4,075
1994	Cephalopoda	28,117	Chirocentrus	6,643
1995	Cephalopoda	27,609	Chirocentrus	7,102
1996	Cephalopoda	33,370	Chirocentrus	8,413
1997	Cephalopoda	34,414	Chirocentrus	8,805
1998	Cephalopoda	29,888	Chirocentrus	10,028
1999	Cephalopoda	35,723	Chirocentrus	10,933
2000	Cephalopoda	47,076	Chirocentrus	9,997
2001	Cephalopoda	45,011	Chirocentrus	12,353
2002	Cephalopoda	51,733	Chirocentrus	14,035
2003	Cephalopoda	41,796	Chirocentrus	13,176
2004	Cephalopoda	49,163	Chirocentrus	14,203
2005	Cephalopoda	37,918	Chirocentrus	13,190
2006	Cephalopoda	36,154	Chirocentrus	12,907
2007	Cephalopoda	47,330	Chirocentrus	13,660
2008	Cephalopoda	39,873	Chirocentrus	14,196

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Clupeidae	10,189	Cynoglossidae	144
1951	Clupeidae	12,605	Cynoglossidae	163
1952	Clupeidae	10,651	Cynoglossidae	257
1953	Clupeidae	15,801	Cynoglossidae	54
1954	Clupeidae	18,305	Cynoglossidae	470
1955	Clupeidae	18,957	Cynoglossidae	848
1956	Clupeidae	23,786	Cynoglossidae	135
1957	Clupeidae	18,124	Cynoglossidae	529
1958	Clupeidae	13,217	Cynoglossidae	260
1959	Clupeidae	14,787	Cynoglossidae	662
1960	Clupeidae	16,500	Cynoglossidae	1,003
1961	Clupeidae	17,170	Cynoglossidae	1,543
1962	Clupeidae	16,381	Cynoglossidae	1,380

1963	Clupeidae	14,424	Cynoglossidae	809
1964	Clupeidae	12,220	Cynoglossidae	1,431
1965	Clupeidae	13,520	Cynoglossidae	1,008
1966	Clupeidae	12,464	Cynoglossidae	857
1967	Clupeidae	15,695	Cynoglossidae	1,086
1968	Clupeidae	17,518	Cynoglossidae	1,076
1969	Clupeidae	22,567	Cynoglossidae	787
1970	Clupeidae	28,471	Cynoglossidae	1,009
1971	Clupeidae	30,694	Cynoglossidae	1,097
1972	Clupeidae	31,825	Cynoglossidae	1,070
1973	Clupeidae	56,656	Cynoglossidae	1,261
1974	Clupeidae	50,895	Cynoglossidae	1,381
1975	Clupeidae	45,402	Cynoglossidae	1,058
1976	Clupeidae	56,025	Cynoglossidae	2,516
1977	Clupeidae	45,568	Cynoglossidae	3,141
1978	Clupeidae	46,101	Cynoglossidae	3,106
1979	Clupeidae	50,926	Cynoglossidae	3,711
1980	Clupeidae	53,169	Cynoglossidae	2,889
1981	Clupeidae	40,618	Cynoglossidae	2,673
1982	Clupeidae	51,910	Cynoglossidae	3,097
1983	Clupeidae	48,769	Cynoglossidae	3,320
1984	Clupeidae	56,216	Cynoglossidae	2,437
1985	Clupeidae	57,210	Cynoglossidae	3,097
1986	Clupeidae	58,205	Cynoglossidae	3,320
1987	Clupeidae	62,247	Cynoglossidae	2,622
1988	Clupeidae	61,795	Cynoglossidae	2,979
1989	Clupeidae	55,813	Cynoglossidae	3,552
1990	Clupeidae	71,125	Cynoglossidae	3,847
1991	Clupeidae	63,067	Cynoglossidae	4,256
1992	Clupeidae	56,476	Cynoglossidae	3,880
1993	Clupeidae	62,901	Cynoglossidae	3,492
1994	Clupeidae	52,310	Cynoglossidae	3,153
1995	Clupeidae	60,741	Cynoglossidae	4,444
1996	Clupeidae	63,629	Cynoglossidae	6,350
1997	Clupeidae	61,224	Cynoglossidae	7,006
1998	Clupeidae	56,396	Cynoglossidae	7,655
1999	Clupeidae	49,774	Cynoglossidae	8,137
2000	Clupeidae	71,651	Cynoglossidae	9,810
2001	Clupeidae	74,178	Cynoglossidae	11,255
2002	Clupeidae	83,603	Cynoglossidae	13,511
2003	Clupeidae	79,682	Cynoglossidae	9,992
2004	Clupeidae	78,486	Cynoglossidae	10,341
2005	Clupeidae	73,301	Cynoglossidae	7,993
2006	Clupeidae	72,825	Cynoglossidae	8,228
2007	Clupeidae	77,356	Cynoglossidae	9,179
2008	Clupeidae	81,384	Cynoglossidae	11,025

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Elasmobrnachii	14,973	Engraulidae	8,536
1951	Elasmobrnachii	19,205	Engraulidae	19,756
1952	Elasmobrnachii	23,878	Engraulidae	14,420
1953	Elasmobrnachii	19,599	Engraulidae	11,727
1954	Elasmobrnachii	17,768	Engraulidae	12,809
1955	Elasmobrnachii	15,016	Engraulidae	10,713
1956	Elasmobrnachii	15,076	Engraulidae	9,701
1957	Elasmobrnachii	24,094	Engraulidae	11,247
1958	Elasmobrnachii	23,216	Engraulidae	18,626
1959	Elasmobrnachii	25,626	Engraulidae	13,999
1960	Elasmobrnachii	35,207	Engraulidae	16,427
1961	Elasmobrnachii	26,075	Engraulidae	11,283
1962	Elasmobrnachii	26,360	Engraulidae	11,518
1963	Elasmobrnachii	24,275	Engraulidae	12,865
1964	Elasmobrnachii	17,449	Engraulidae	10,844
1965	Elasmobrnachii	27,025	Engraulidae	15,134
1966	Elasmobrnachii	24,970	Engraulidae	11,212
1967	Elasmobrnachii	14,390	Engraulidae	13,267

1968	Elasmobrnachii	18,863	Engraulidae	10,547
1969	Elasmobrnachii	21,379	Engraulidae	15,230
1970	Elasmobrnachii	25,034	Engraulidae	11,118
1971	Elasmobrnachii	25,001	Engraulidae	7,235
1972	Elasmobrnachii	27,000	Engraulidae	8,028
1973	Elasmobrnachii	25,693	Engraulidae	11,158
1974	Elasmobrnachii	33,293	Engraulidae	11,017
1975	Elasmobrnachii	29,170	Engraulidae	9,728
1976	Elasmobrnachii	27,474	Engraulidae	12,355
1977	Elasmobrnachii	22,154	Engraulidae	14,771
1978	Elasmobrnachii	21,441	Engraulidae	13,294
1979	Elasmobrnachii	18,297	Engraulidae	13,604
1980	Elasmobrnachii	20,602	Engraulidae	16,989
1981	Elasmobrnachii	19,024	Engraulidae	17,140
1982	Elasmobrnachii	18,020	Engraulidae	12,042
1983	Elasmobrnachii	19,417	Engraulidae	12,971
1984	Elasmobrnachii	16,710	Engraulidae	16,008
1985	Elasmobrnachii	17,242	Engraulidae	15,227
1986	Elasmobrnachii	18,458	Engraulidae	21,699
1987	Elasmobrnachii	20,909	Engraulidae	22,227
1988	Elasmobrnachii	20,002	Engraulidae	25,924
1989	Elasmobrnachii	20,491	Engraulidae	17,454
1990	Elasmobrnachii	15,665	Engraulidae	18,268
1991	Elasmobrnachii	15,224	Engraulidae	26,947
1992	Elasmobrnachii	19,504	Engraulidae	36,486
1993	Elasmobrnachii	18,097	Engraulidae	31,339
1994	Elasmobrnachii	27,386	Engraulidae	35,230
1995	Elasmobrnachii	24,243	Engraulidae	25,037
1996	Elasmobrnachii	23,768	Engraulidae	22,090
1997	Elasmobrnachii	21,755	Engraulidae	23,234
1998	Elasmobrnachii	28,377	Engraulidae	24,174
1999	Elasmobrnachii	33,887	Engraulidae	27,099
2000	Elasmobrnachii	33,852	Engraulidae	28,682
2001	Elasmobrnachii	39,837	Engraulidae	29,506
2002	Elasmobrnachii	43,198	Engraulidae	33,760
2003	Elasmobrnachii	43,008	Engraulidae	29,500
2004	Elasmobrnachii	47,469	Engraulidae	32,887
2005	Elasmobrnachii	48,773	Engraulidae	33,927
2006	Elasmobrnachii	45,920	Engraulidae	38,449
2007	Elasmobrnachii	46,753	Engraulidae	42,651
2008	Elasmobrnachii	46,134	Engraulidae	37,342

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	*Euthynnus affinis*	1,417	Istiophoridae	103
1951	*Euthynnus affinis*	398	Istiophoridae	112
1952	*Euthynnus affinis*	361	Istiophoridae	107
1953	*Euthynnus affinis*	511	Istiophoridae	136
1954	*Euthynnus affinis*	1,272	Istiophoridae	130
1955	*Euthynnus affinis*	1,416	Istiophoridae	130
1956	*Euthynnus affinis*	1,561	Istiophoridae	111
1957	*Euthynnus affinis*	2,210	Istiophoridae	153
1958	*Euthynnus affinis*	954	Istiophoridae	125
1959	*Euthynnus affinis*	560	Istiophoridae	143
1960	*Euthynnus affinis*	481	Istiophoridae	122
1961	*Euthynnus affinis*	1,739	Istiophoridae	109
1962	*Euthynnus affinis*	946	Istiophoridae	120
1963	*Euthynnus affinis*	1,128	Istiophoridae	118
1964	*Euthynnus affinis*	2,804	Istiophoridae	108
1965	*Euthynnus affinis*	1,169	Istiophoridae	115
1966	*Euthynnus affinis*	928	Istiophoridae	99
1967	*Euthynnus affinis*	819	Istiophoridae	108
1968	*Euthynnus affinis*	947	Istiophoridae	108
1969	*Euthynnus affinis*	1,306	Istiophoridae	102
1970	*Euthynnus affinis*	674	Istiophoridae	88
1971	*Euthynnus affinis*	1,434	Istiophoridae	92
1972	*Euthynnus affinis*	1,145	Istiophoridae	98

1973	*Euthynnus affinis*	3,528	Istiophoridae	90
1974	*Euthynnus affinis*	2,029	Istiophoridae	72
1975	*Euthynnus affinis*	4,546	Istiophoridae	70
1976	*Euthynnus affinis*	2,725	Istiophoridae	73
1977	*Euthynnus affinis*	1,986	Istiophoridae	93
1978	*Euthynnus affinis*	1,457	Istiophoridae	94
1979	*Euthynnus affinis*	1,401	Istiophoridae	86
1980	*Euthynnus affinis*	1,852	Istiophoridae	548
1981	*Euthynnus affinis*	1,942	Istiophoridae	176
1982	*Euthynnus affinis*	2,509	Istiophoridae	246
1983	*Euthynnus affinis*	1,231	Istiophoridae	192
1984	*Euthynnus affinis*	1,618	Istiophoridae	171
1985	*Euthynnus affinis*	2,479	Istiophoridae	306
1986	*Euthynnus affinis*	1,667	Istiophoridae	299
1987	*Euthynnus affinis*	5,182	Istiophoridae	102
1988	*Euthynnus affinis*	4,305	Istiophoridae	206
1989	*Euthynnus affinis*	3,690	Istiophoridae	178
1990	*Euthynnus affinis*	5,280	Istiophoridae	139
1991	*Euthynnus affinis*	5,608	Istiophoridae	125
1992	*Euthynnus affinis*	5,508	Istiophoridae	257
1993	*Euthynnus affinis*	3,980	Istiophoridae	354
1994	*Euthynnus affinis*	4,014	Istiophoridae	340
1995	*Euthynnus affinis*	4,984	Istiophoridae	270
1996	*Euthynnus affinis*	4,118	Istiophoridae	225
1997	*Euthynnus affinis*	4,402	Istiophoridae	188
1998	*Euthynnus affinis*	4,745	Istiophoridae	140
1999	*Euthynnus affinis*	4,535	Istiophoridae	442
2000	*Euthynnus affinis*	7,131	Istiophoridae	422
2001	*Euthynnus affinis*	7,480	Istiophoridae	389
2002	*Euthynnus affinis*	7,048	Istiophoridae	435
2003	*Euthynnus affinis*	8,699	Istiophoridae	452
2004	*Euthynnus affinis*	9,068	Istiophoridae	477
2005	*Euthynnus affinis*	11,234	Istiophoridae	480
2006	*Euthynnus affinis*	10,384	Istiophoridae	488
2007	*Euthynnus affinis*	12,614	Istiophoridae	491
2008	*Euthynnus affinis*	10,760	Istiophoridae	471

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	*Katsuwonus pelamis*	8	*Lactarius lactarius*	2,052
1951	*Katsuwonus pelamis*	5	*Lactarius lactarius*	2,209
1952	*Katsuwonus pelamis*	5	*Lactarius lactarius*	2,237
1953	*Katsuwonus pelamis*	6	*Lactarius lactarius*	2,531
1954	*Katsuwonus pelamis*	8	*Lactarius lactarius*	3,272
1955	*Katsuwonus pelamis*	8	*Lactarius lactarius*	3,555
1956	*Katsuwonus pelamis*	10	*Lactarius lactarius*	4,452
1957	*Katsuwonus pelamis*	13	*Lactarius lactarius*	4,114
1958	*Katsuwonus pelamis*	7	*Lactarius lactarius*	11,175
1959	*Katsuwonus pelamis*	6	*Lactarius lactarius*	9,735
1960	*Katsuwonus pelamis*	5	*Lactarius lactarius*	5,564
1961	*Katsuwonus pelamis*	12	*Lactarius lactarius*	5,218
1962	*Katsuwonus pelamis*	20	*Lactarius lactarius*	4,634
1963	*Katsuwonus pelamis*	15	*Lactarius lactarius*	4,632
1964	*Katsuwonus pelamis*	25	*Lactarius lactarius*	3,646
1965	*Katsuwonus pelamis*	13	*Lactarius lactarius*	3,040
1966	*Katsuwonus pelamis*	13	*Lactarius lactarius*	1,953
1967	*Katsuwonus pelamis*	10	*Lactarius lactarius*	2,316
1968	*Katsuwonus pelamis*	14	*Lactarius lactarius*	2,006
1969	*Katsuwonus pelamis*	12	*Lactarius lactarius*	1,522
1970	*Katsuwonus pelamis*	8	*Lactarius lactarius*	1,695
1971	*Katsuwonus pelamis*	13	*Lactarius lactarius*	1,295
1972	*Katsuwonus pelamis*	14	*Lactarius lactarius*	2,429
1973	*Katsuwonus pelamis*	9	*Lactarius lactarius*	2,959
1974	*Katsuwonus pelamis*	14	*Lactarius lactarius*	1,707
1975	*Katsuwonus pelamis*	14	*Lactarius lactarius*	2,827
1976	*Katsuwonus pelamis*	15	*Lactarius lactarius*	1,883
1977	*Katsuwonus pelamis*	33	*Lactarius lactarius*	1,499

1978	*Katsuwonus pelamis*	102	*Lactarius lactarius*	1,148
1979	*Katsuwonus pelamis*	36	*Lactarius lactarius*	1,292
1980	*Katsuwonus pelamis*	39	*Lactarius lactarius*	1,447
1981	*Katsuwonus pelamis*	30	*Lactarius lactarius*	1,238
1982	*Katsuwonus pelamis*	19	*Lactarius lactarius*	1,003
1983	*Katsuwonus pelamis*	93	*Lactarius lactarius*	835
1984	*Katsuwonus pelamis*	122	*Lactarius lactarius*	919
1985	*Katsuwonus pelamis*	113	*Lactarius lactarius*	919
1986	*Katsuwonus pelamis*	115	*Lactarius lactarius*	794
1987	*Katsuwonus pelamis*	144	*Lactarius lactarius*	1,046
1988	*Katsuwonus pelamis*	163	*Lactarius lactarius*	1,053
1989	*Katsuwonus pelamis*	167	*Lactarius lactarius*	439
1990	*Katsuwonus pelamis*	165	*Lactarius lactarius*	917
1991	*Katsuwonus pelamis*	100	*Lactarius lactarius*	557
1992	*Katsuwonus pelamis*	283	*Lactarius lactarius*	655
1993	*Katsuwonus pelamis*	3,501	*Lactarius lactarius*	471
1994	*Katsuwonus pelamis*	2,854	*Lactarius lactarius*	1,634
1995	*Katsuwonus pelamis*	2,847	*Lactarius lactarius*	1,721
1996	*Katsuwonus pelamis*	2,858	*Lactarius lactarius*	1,105
1997	*Katsuwonus pelamis*	2,948	*Lactarius lactarius*	1,002
1998	*Katsuwonus pelamis*	3,317	*Lactarius lactarius*	1,020
1999	*Katsuwonus pelamis*	3,865	*Lactarius lactarius*	1,579
2000	*Katsuwonus pelamis*	4,511	*Lactarius lactarius*	1,388
2001	*Katsuwonus pelamis*	4,265	*Lactarius lactarius*	1,605
2002	*Katsuwonus pelamis*	4,516	*Lactarius lactarius*	1,731
2003	*Katsuwonus pelamis*	4,552	*Lactarius lactarius*	1,778
2004	*Katsuwonus pelamis*	4,772	*Lactarius lactarius*	1,900
2005	*Katsuwonus pelamis*	4,728	*Lactarius lactarius*	1,920
2006	*Katsuwonus pelamis*	5,093	*Lactarius lactarius*	1,940
2007	*Katsuwonus pelamis*	5,942	*Lactarius lactarius*	1,953
2008	*Katsuwonus pelamis*	4,822	*Lactarius lactarius*	1,886

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Lutjanidae	3,318	Miscellaneous marine fishes	39,613
1951	Lutjanidae	418	Miscellaneous marine fishes	34,706
1952	Lutjanidae	973	Miscellaneous marine fishes	38,764
1953	Lutjanidae	967	Miscellaneous marine fishes	43,503
1954	Lutjanidae	899	Miscellaneous marine fishes	49,398
1955	Lutjanidae	964	Miscellaneous marine fishes	49,020
1956	Lutjanidae	941	Miscellaneous marine fishes	57,296
1957	Lutjanidae	1,236	Miscellaneous marine fishes	54,450
1958	Lutjanidae	1,355	Miscellaneous marine fishes	55,672
1959	Lutjanidae	1,732	Miscellaneous marine fishes	64,577
1960	Lutjanidae	1,357	Miscellaneous marine fishes	69,839
1961	Lutjanidae	2,239	Miscellaneous marine fishes	90,648
1962	Lutjanidae	947	Miscellaneous marine fishes	92,074
1963	Lutjanidae	1,210	Miscellaneous marine fishes	102,718
1964	Lutjanidae	1,154	Miscellaneous marine fishes	111,691
1965	Lutjanidae	1,174	Miscellaneous marine fishes	99,652
1966	Lutjanidae	1,416	Miscellaneous marine fishes	105,021
1967	Lutjanidae	1,159	Miscellaneous marine fishes	121,206
1968	Lutjanidae	1,236	Miscellaneous marine fishes	125,230
1969	Lutjanidae	1,625	Miscellaneous marine fishes	132,389
1970	Lutjanidae	1,503	Miscellaneous marine fishes	146,136
1971	Lutjanidae	1,466	Miscellaneous marine fishes	146,473
1972	Lutjanidae	1,502	Miscellaneous marine fishes	161,895
1973	Lutjanidae	3,188	Miscellaneous marine fishes	84,884
1974	Lutjanidae	2,996	Miscellaneous marine fishes	104,932
1975	Lutjanidae	1,847	Miscellaneous marine fishes	119,061
1976	Lutjanidae	628	Miscellaneous marine fishes	83,737
1977	Lutjanidae	1,542	Miscellaneous marine fishes	159,764
1978	Lutjanidae	1,092	Miscellaneous marine fishes	178,954
1979	Lutjanidae	1,736	Miscellaneous marine fishes	178,815
1980	Lutjanidae	1,572	Miscellaneous marine fishes	202,352
1981	Lutjanidae	1,464	Miscellaneous marine fishes	228,697
1982	Lutjanidae	1,609	Miscellaneous marine fishes	214,547

1983	Lutjanidae	2,547	Miscellaneous marine fishes	201,702
1984	Lutjanidae	2,184	Miscellaneous marine fishes	191,534
1985	Lutjanidae	2,631	Miscellaneous marine fishes	221,568
1986	Lutjanidae	1,489	Miscellaneous marine fishes	259,304
1987	Lutjanidae	1,997	Miscellaneous marine fishes	240,870
1988	Lutjanidae	2,437	Miscellaneous marine fishes	235,229
1989	Lutjanidae	1,823	Miscellaneous marine fishes	259,899
1990	Lutjanidae	1,628	Miscellaneous marine fishes	259,967
1991	Lutjanidae	2,145	Miscellaneous marine fishes	264,429
1992	Lutjanidae	1,960	Miscellaneous marine fishes	269,253
1993	Lutjanidae	3,406	Miscellaneous marine fishes	269,725
1994	Lutjanidae	3,910	Miscellaneous marine fishes	222,559
1995	Lutjanidae	3,329	Miscellaneous marine fishes	234,890
1996	Lutjanidae	3,618	Miscellaneous marine fishes	225,777
1997	Lutjanidae	3,600	Miscellaneous marine fishes	235,582
1998	Lutjanidae	3,500	Miscellaneous marine fishes	259,685
1999	Lutjanidae	4,650	Miscellaneous marine fishes	286,235
2000	Lutjanidae	4,918	Miscellaneous marine fishes	339,360
2001	Lutjanidae	6,052	Miscellaneous marine fishes	368,617
2002	Lutjanidae	6,963	Miscellaneous marine fishes	404,029
2003	Lutjanidae	8,554	Miscellaneous marine fishes	433,936
2004	Lutjanidae	8,780	Miscellaneous marine fishes	484,125
2005	Lutjanidae	8,021	Miscellaneous marine fishes	486,423
2006	Lutjanidae	7,623	Miscellaneous marine fishes	512,537
2007	Lutjanidae	7,796	Miscellaneous marine fishes	455,533
2008	Lutjanidae	7,323	Miscellaneous marine fishes	458,482

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Miscellaneous marine molluscs	2,753	Mugilidae	7,963
1951	Miscellaneous marine molluscs	3,825	Mugilidae	7,583
1952	Miscellaneous marine molluscs	3,783	Mugilidae	2,684
1953	Miscellaneous marine molluscs	4,752	Mugilidae	3,445
1954	Miscellaneous marine molluscs	4,752	Mugilidae	6,842
1955	Miscellaneous marine molluscs	4,170	Mugilidae	16,395
1956	Miscellaneous marine molluscs	3,917	Mugilidae	7,537
1957	Miscellaneous marine molluscs	5,776	Mugilidae	2,579
1958	Miscellaneous marine molluscs	4,903	Mugilidae	1,657
1959	Miscellaneous marine molluscs	5,425	Mugilidae	4,675
1960	Miscellaneous marine molluscs	4,452	Mugilidae	2,217
1961	Miscellaneous marine molluscs	3,968	Mugilidae	1,910
1962	Miscellaneous marine molluscs	4,265	Mugilidae	1,101
1963	Miscellaneous marine molluscs	4,251	Mugilidae	367
1964	Miscellaneous marine molluscs	3,726	Mugilidae	191
1965	Miscellaneous marine molluscs	4,102	Mugilidae	771
1966	Miscellaneous marine molluscs	3,419	Mugilidae	876
1967	Miscellaneous marine molluscs	3,756	Mugilidae	280
1968	Miscellaneous marine molluscs	3,723	Mugilidae	398
1969	Miscellaneous marine molluscs	3,506	Mugilidae	427
1970	Miscellaneous marine molluscs	5,213	Mugilidae	513
1971	Miscellaneous marine molluscs	5,002	Mugilidae	375
1972	Miscellaneous marine molluscs	5,553	Mugilidae	1,001
1973	Miscellaneous marine molluscs	4,698	Mugilidae	354
1974	Miscellaneous marine molluscs	5,018	Mugilidae	297
1975	Miscellaneous marine molluscs	4,217	Mugilidae	366
1976	Miscellaneous marine molluscs	12,861	Mugilidae	734
1977	Miscellaneous marine molluscs	564	Mugilidae	1,195
1978	Miscellaneous marine molluscs	635	Mugilidae	2,516
1979	Miscellaneous marine molluscs	6,216	Mugilidae	1,045
1980	Miscellaneous marine molluscs	4,353	Mugilidae	1,127
1981	Miscellaneous marine molluscs	5,786	Mugilidae	1,021
1982	Miscellaneous marine molluscs	4,746	Mugilidae	1,922
1983	Miscellaneous marine molluscs	8,655	Mugilidae	1,804
1984	Miscellaneous marine molluscs	6,443	Mugilidae	1,497
1985	Miscellaneous marine molluscs	11,651	Mugilidae	2,175
1986	Miscellaneous marine molluscs	10,150	Mugilidae	1,233
1987	Miscellaneous marine molluscs	11,257	Mugilidae	1,644

1988	Miscellaneous marine molluscs	17,422	Mugilidae	3,352
1989	Miscellaneous marine molluscs	12,285	Mugilidae	2,431
1990	Miscellaneous marine molluscs	5,724	Mugilidae	2,098
1991	Miscellaneous marine molluscs	70	Mugilidae	3,094
1992	Miscellaneous marine molluscs	2,018	Mugilidae	2,246
1993	Miscellaneous marine molluscs	1,078	Mugilidae	2,207
1994	Miscellaneous marine molluscs	2,362	Mugilidae	4,985
1995	Miscellaneous marine molluscs	4,367	Mugilidae	3,934
1996	Miscellaneous marine molluscs	7,195	Mugilidae	4,819
1997	Miscellaneous marine molluscs	5,061	Mugilidae	5,697
1998	Miscellaneous marine molluscs	2,965	Mugilidae	10,601
1999	Miscellaneous marine molluscs	14,734	Mugilidae	12,455
2000	Miscellaneous marine molluscs	15,534	Mugilidae	11,646
2001	Miscellaneous marine molluscs	13,569	Mugilidae	15,250
2002	Miscellaneous marine molluscs	828	Mugilidae	15,851
2003	Miscellaneous marine molluscs	875	Mugilidae	16,189
2004	Miscellaneous marine molluscs	910	Mugilidae	15,559
2005	Miscellaneous marine molluscs	715	Mugilidae	15,542
2006	Miscellaneous marine molluscs	739	Mugilidae	15,701
2007	Miscellaneous marine molluscs	695	Mugilidae	16,859
2008	Miscellaneous marine molluscs	760	Mugilidae	16,124

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Nemipteridae	3,771	Palinuridae	16
1951	Nemipteridae	724	Palinuridae	15
1952	Nemipteridae	1,335	Palinuridae	13
1953	Nemipteridae	1,307	Palinuridae	19
1954	Nemipteridae	1,037	Palinuridae	13
1955	Nemipteridae	1,559	Palinuridae	14
1956	Nemipteridae	1,069	Palinuridae	17
1957	Nemipteridae	1,639	Palinuridae	83
1958	Nemipteridae	1,576	Palinuridae	200
1959	Nemipteridae	1,912	Palinuridae	295
1960	Nemipteridae	1,718	Palinuridae	307
1961	Nemipteridae	2,667	Palinuridae	158
1962	Nemipteridae	1,296	Palinuridae	88
1963	Nemipteridae	1,536	Palinuridae	216
1964	Nemipteridae	1,801	Palinuridae	286
1965	Nemipteridae	1,778	Palinuridae	132
1966	Nemipteridae	1,748	Palinuridae	158
1967	Nemipteridae	1,467	Palinuridae	254
1968	Nemipteridae	1,454	Palinuridae	198
1969	Nemipteridae	1,939	Palinuridae	260
1970	Nemipteridae	1,921	Palinuridae	399
1971	Nemipteridae	2,246	Palinuridae	544
1972	Nemipteridae	2,594	Palinuridae	718
1973	Nemipteridae	4,662	Palinuridae	738
1974	Nemipteridae	5,576	Palinuridae	538
1975	Nemipteridae	5,614	Palinuridae	414
1976	Nemipteridae	3,142	Palinuridae	417
1977	Nemipteridae	5,313	Palinuridae	372
1978	Nemipteridae	4,837	Palinuridae	603
1979	Nemipteridae	4,231	Palinuridae	401
1980	Nemipteridae	5,989	Palinuridae	170
1981	Nemipteridae	6,381	Palinuridae	320
1982	Nemipteridae	7,344	Palinuridae	322
1983	Nemipteridae	7,147	Palinuridae	268
1984	Nemipteridae	6,220	Palinuridae	454
1985	Nemipteridae	6,758	Palinuridae	481
1986	Nemipteridae	9,210	Palinuridae	369
1987	Nemipteridae	10,205	Palinuridae	438
1988	Nemipteridae	9,004	Palinuridae	155
1989	Nemipteridae	11,685	Palinuridae	221
1990	Nemipteridae	14,024	Palinuridae	391
1991	Nemipteridae	15,451	Palinuridae	317
1992	Nemipteridae	14,542	Palinuridae	392

1993	Nemipteridae	14,549	Palinuridae	333
1994	Nemipteridae	12,129	Palinuridae	415
1995	Nemipteridae	11,687	Palinuridae	564
1996	Nemipteridae	12,032	Palinuridae	659
1997	Nemipteridae	12,820	Palinuridae	729
1998	Nemipteridae	18,285	Palinuridae	1,041
1999	Nemipteridae	15,754	Palinuridae	885
2000	Nemipteridae	22,074	Palinuridae	1,028
2001	Nemipteridae	22,816	Palinuridae	1,129
2002	Nemipteridae	27,517	Palinuridae	1,375
2003	Nemipteridae	24,479	Palinuridae	1,659
2004	Nemipteridae	28,538	Palinuridae	1,722
2005	Nemipteridae	23,264	Palinuridae	1,681
2006	Nemipteridae	24,852	Palinuridae	1,760
2007	Nemipteridae	33,834	Palinuridae	1,742
2008	Nemipteridae	26,178	Palinuridae	1,844

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	*Pampus argenteus*	684	*Parastromateus niger*	1,226
1951	*Pampus argenteus*	647	*Parastromateus niger*	1,179
1952	*Pampus argenteus*	779	*Parastromateus niger*	1,286
1953	*Pampus argenteus*	873	*Parastromateus niger*	1,565
1954	*Pampus argenteus*	576	*Parastromateus niger*	1,135
1955	*Pampus argenteus*	828	*Parastromateus niger*	1,350
1956	*Pampus argenteus*	1,008	*Parastromateus niger*	1,702
1957	*Pampus argenteus*	1,589	*Parastromateus niger*	2,442
1958	*Pampus argenteus*	1,521	*Parastromateus niger*	2,076
1959	*Pampus argenteus*	1,339	*Parastromateus niger*	2,382
1960	*Pampus argenteus*	1,617	*Parastromateus niger*	2,648
1961	*Pampus argenteus*	1,110	*Parastromateus niger*	1,812
1962	*Pampus argenteus*	2,030	*Parastromateus niger*	3,325
1963	*Pampus argenteus*	1,466	*Parastromateus niger*	2,351
1964	*Pampus argenteus*	1,494	*Parastromateus niger*	2,241
1965	*Pampus argenteus*	1,372	*Parastromateus niger*	1,812
1966	*Pampus argenteus*	866	*Parastromateus niger*	1,270
1967	*Pampus argenteus*	1,578	*Parastromateus niger*	2,086
1968	*Pampus argenteus*	2,011	*Parastromateus niger*	2,903
1969	*Pampus argenteus*	1,292	*Parastromateus niger*	1,818
1970	*Pampus argenteus*	1,697	*Parastromateus niger*	2,301
1971	*Pampus argenteus*	2,232	*Parastromateus niger*	2,640
1972	*Pampus argenteus*	2,144	*Parastromateus niger*	2,793
1973	*Pampus argenteus*	10,180	*Parastromateus niger*	3,295
1974	*Pampus argenteus*	3,882	*Parastromateus niger*	2,134
1975	*Pampus argenteus*	5,048	*Parastromateus niger*	3,274
1976	*Pampus argenteus*	7,252	*Parastromateus niger*	3,942
1977	*Pampus argenteus*	2,116	*Parastromateus niger*	2,321
1978	*Pampus argenteus*	4,723	*Parastromateus niger*	3,002
1979	*Pampus argenteus*	7,282	*Parastromateus niger*	4,171
1980	*Pampus argenteus*	6,392	*Parastromateus niger*	4,020
1981	*Pampus argenteus*	4,924	*Parastromateus niger*	2,740
1982	*Pampus argenteus*	5,390	*Parastromateus niger*	2,598
1983	*Pampus argenteus*	6,618	*Parastromateus niger*	2,348
1984	*Pampus argenteus*	5,031	*Parastromateus niger*	4,924
1985	*Pampus argenteus*	3,749	*Parastromateus niger*	2,079
1986	*Pampus argenteus*	4,488	*Parastromateus niger*	1,679
1987	*Pampus argenteus*	4,230	*Parastromateus niger*	1,668
1988	*Pampus argenteus*	4,832	*Parastromateus niger*	1,073
1989	*Pampus argenteus*	7,427	*Parastromateus niger*	3,129
1990	*Pampus argenteus*	7,234	*Parastromateus niger*	3,703
1991	*Pampus argenteus*	5,708	*Parastromateus niger*	2,808
1992	*Pampus argenteus*	4,968	*Parastromateus niger*	2,664
1993	*Pampus argenteus*	7,048	*Parastromateus niger*	3,093
1994	*Pampus argenteus*	11,594	*Parastromateus niger*	5,400
1995	*Pampus argenteus*	9,358	*Parastromateus niger*	4,592
1996	*Pampus argenteus*	8,871	*Parastromateus niger*	5,137
1997	*Pampus argenteus*	9,733	*Parastromateus niger*	6,091

1998	*Pampus argenteus*	12,180	*Parastromateus niger*	6,279
1999	*Pampus argenteus*	12,417	*Parastromateus niger*	9,041
2000	*Pampus argenteus*	13,209	*Parastromateus niger*	9,587
2001	*Pampus argenteus*	15,300	*Parastromateus niger*	9,617
2002	*Pampus argenteus*	16,471	*Parastromateus niger*	10,403
2003	*Pampus argenteus*	17,126	*Parastromateus niger*	11,016
2004	*Pampus argenteus*	18,304	*Parastromateus niger*	11,741
2005	*Pampus argenteus*	18,848	*Parastromateus niger*	11,983
2006	*Pampus argenteus*	19,030	*Parastromateus niger*	11,962
2007	*Pampus argenteus*	19,089	*Parastromateus niger*	12,206
2008	*Pampus argenteus*	18,248	*Parastromateus niger*	11,897

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Penaeidae	11,939	Plotosidae	343
1951	Penaeidae	10,401	Plotosidae	501
1952	Penaeidae	11,645	Plotosidae	527
1953	Penaeidae	12,490	Plotosidae	892
1954	Penaeidae	11,366	Plotosidae	562
1955	Penaeidae	13,996	Plotosidae	350
1956	Penaeidae	20,476	Plotosidae	329
1957	Penaeidae	12,066	Plotosidae	423
1958	Penaeidae	10,371	Plotosidae	438
1959	Penaeidae	11,469	Plotosidae	281
1960	Penaeidae	13,761	Plotosidae	253
1961	Penaeidae	11,861	Plotosidae	227
1962	Penaeidae	12,263	Plotosidae	417
1963	Penaeidae	14,545	Plotosidae	385
1964	Penaeidae	12,396	Plotosidae	713
1965	Penaeidae	11,204	Plotosidae	544
1966	Penaeidae	13,063	Plotosidae	409
1967	Penaeidae	21,010	Plotosidae	442
1968	Penaeidae	21,383	Plotosidae	466
1969	Penaeidae	16,249	Plotosidae	401
1970	Penaeidae	13,615	Plotosidae	677
1971	Penaeidae	14,444	Plotosidae	763
1972	Penaeidae	12,897	Plotosidae	714
1973	Penaeidae	27,708	Plotosidae	980
1974	Penaeidae	12,905	Plotosidae	842
1975	Penaeidae	20,138	Plotosidae	877
1976	Penaeidae	45,567	Plotosidae	781
1977	Penaeidae	25,991	Plotosidae	1,600
1978	Penaeidae	37,401	Plotosidae	762
1979	Penaeidae	33,072	Plotosidae	724
1980	Penaeidae	22,170	Plotosidae	679
1981	Penaeidae	28,925	Plotosidae	1,326
1982	Penaeidae	25,722	Plotosidae	1,437
1983	Penaeidae	24,338	Plotosidae	779
1984	Penaeidae	27,416	Plotosidae	1,082
1985	Penaeidae	27,210	Plotosidae	1,107
1986	Penaeidae	31,806	Plotosidae	912
1987	Penaeidae	26,289	Plotosidae	800
1988	Penaeidae	29,964	Plotosidae	756
1989	Penaeidae	31,499	Plotosidae	1,114
1990	Penaeidae	33,093	Plotosidae	806
1991	Penaeidae	32,630	Plotosidae	847
1992	Penaeidae	30,821	Plotosidae	913
1993	Penaeidae	31,671	Plotosidae	1,052
1994	Penaeidae	25,286	Plotosidae	2,386
1995	Penaeidae	28,824	Plotosidae	2,157
1996	Penaeidae	25,202	Plotosidae	2,232
1997	Penaeidae	31,705	Plotosidae	2,336
1998	Penaeidae	34,784	Plotosidae	2,033
1999	Penaeidae	44,829	Plotosidae	2,187
2000	Penaeidae	46,379	Plotosidae	3,000
2001	Penaeidae	54,745	Plotosidae	2,879
2002	Penaeidae	55,734	Plotosidae	3,090

2003	Penaeidae	61,586	Plotosidae	3,257
2004	Penaeidae	59,184	Plotosidae	3,394
2005	Penaeidae	60,396	Plotosidae	3,523
2006	Penaeidae	60,072	Plotosidae	3,501
2007	Penaeidae	61,290	Plotosidae	3,631
2008	Penaeidae	59,793	Plotosidae	3,397

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Polynemidae	289	Portunidae	86
1951	Polynemidae	355	Portunidae	82
1952	Polynemidae	554	Portunidae	79
1953	Polynemidae	820	Portunidae	110
1954	Polynemidae	1,230	Portunidae	72
1955	Polynemidae	413	Portunidae	95
1956	Polynemidae	853	Portunidae	153
1957	Polynemidae	538	Portunidae	973
1958	Polynemidae	817	Portunidae	2,214
1959	Polynemidae	773	Portunidae	3,301
1960	Polynemidae	1,003	Portunidae	3,254
1961	Polynemidae	910	Portunidae	2,722
1962	Polynemidae	1,088	Portunidae	1,615
1963	Polynemidae	1,557	Portunidae	2,956
1964	Polynemidae	947	Portunidae	3,551
1965	Polynemidae	1,048	Portunidae	2,339
1966	Polynemidae	868	Portunidae	2,691
1967	Polynemidae	972	Portunidae	3,389
1968	Polynemidae	1,351	Portunidae	3,382
1969	Polynemidae	1,864	Portunidae	3,441
1970	Polynemidae	2,584	Portunidae	3,802
1971	Polynemidae	3,394	Portunidae	5,434
1972	Polynemidae	3,198	Portunidae	8,255
1973	Polynemidae	6,518	Portunidae	7,611
1974	Polynemidae	6,178	Portunidae	5,345
1975	Polynemidae	3,414	Portunidae	8,445
1976	Polynemidae	2,348	Portunidae	9,732
1977	Polynemidae	1,983	Portunidae	10,812
1978	Polynemidae	2,227	Portunidae	14,709
1979	Polynemidae	2,245	Portunidae	9,602
1980	Polynemidae	2,479	Portunidae	14,797
1981	Polynemidae	1,602	Portunidae	14,974
1982	Polynemidae	1,820	Portunidae	13,928
1983	Polynemidae	1,066	Portunidae	11,250
1984	Polynemidae	1,770	Portunidae	11,515
1985	Polynemidae	1,905	Portunidae	11,686
1986	Polynemidae	1,706	Portunidae	13,074
1987	Polynemidae	1,581	Portunidae	11,864
1988	Polynemidae	1,887	Portunidae	13,654
1989	Polynemidae	2,745	Portunidae	13,322
1990	Polynemidae	2,621	Portunidae	12,124
1991	Polynemidae	2,504	Portunidae	14,310
1992	Polynemidae	2,602	Portunidae	12,922
1993	Polynemidae	1,893	Portunidae	13,540
1994	Polynemidae	5,137	Portunidae	9,625
1995	Polynemidae	4,021	Portunidae	6,688
1996	Polynemidae	4,081	Portunidae	9,210
1997	Polynemidae	4,226	Portunidae	12,065
1998	Polynemidae	5,256	Portunidae	17,734
1999	Polynemidae	11,575	Portunidae	20,272
2000	Polynemidae	12,579	Portunidae	25,551
2001	Polynemidae	11,582	Portunidae	26,268
2002	Polynemidae	12,493	Portunidae	29,339
2003	Polynemidae	13,082	Portunidae	29,325
2004	Polynemidae	13,761	Portunidae	28,366
2005	Polynemidae	14,350	Portunidae	28,332
2006	Polynemidae	14,105	Portunidae	28,258
2007	Polynemidae	14,182	Portunidae	30,425

2008	Polynemidae	13,713	Portunidae	28,374

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	*Psettodes erumei*	265	*Rastrelliger kanagurta*	3,007
1951	*Psettodes erumei*	296	*Rastrelliger kanagurta*	2,138
1952	*Psettodes erumei*	283	*Rastrelliger kanagurta*	1,116
1953	*Psettodes erumei*	370	*Rastrelliger kanagurta*	976
1954	*Psettodes erumei*	369	*Rastrelliger kanagurta*	520
1955	*Psettodes erumei*	346	*Rastrelliger kanagurta*	1,220
1956	*Psettodes erumei*	303	*Rastrelliger kanagurta*	1,500
1957	*Psettodes erumei*	416	*Rastrelliger kanagurta*	2,250
1958	*Psettodes erumei*	340	*Rastrelliger kanagurta*	547
1959	*Psettodes erumei*	389	*Rastrelliger kanagurta*	1,280
1960	*Psettodes erumei*	333	*Rastrelliger kanagurta*	2,781
1961	*Psettodes erumei*	303	*Rastrelliger kanagurta*	4,390
1962	*Psettodes erumei*	336	*Rastrelliger kanagurta*	2,610
1963	*Psettodes erumei*	320	*Rastrelliger kanagurta*	3,001
1964	*Psettodes erumei*	291	*Rastrelliger kanagurta*	2,948
1965	*Psettodes erumei*	313	*Rastrelliger kanagurta*	1,448
1966	*Psettodes erumei*	269	*Rastrelliger kanagurta*	2,240
1967	*Psettodes erumei*	290	*Rastrelliger kanagurta*	3,398
1968	*Psettodes erumei*	297	*Rastrelliger kanagurta*	2,815
1969	*Psettodes erumei*	277	*Rastrelliger kanagurta*	2,296
1970	*Psettodes erumei*	377	*Rastrelliger kanagurta*	3,182
1971	*Psettodes erumei*	371	*Rastrelliger kanagurta*	2,855
1972	*Psettodes erumei*	391	*Rastrelliger kanagurta*	9,175
1973	*Psettodes erumei*	360	*Rastrelliger kanagurta*	6,853
1974	*Psettodes erumei*	297	*Rastrelliger kanagurta*	6,221
1975	*Psettodes erumei*	253	*Rastrelliger kanagurta*	9,500
1976	*Psettodes erumei*	841	*Rastrelliger kanagurta*	13,341
1977	*Psettodes erumei*	1,254	*Rastrelliger kanagurta*	5,833
1978	*Psettodes erumei*	710	*Rastrelliger kanagurta*	4,481
1979	*Psettodes erumei*	436	*Rastrelliger kanagurta*	5,607
1980	*Psettodes erumei*	308	*Rastrelliger kanagurta*	8,050
1981	*Psettodes erumei*	500	*Rastrelliger kanagurta*	4,864
1982	*Psettodes erumei*	446	*Rastrelliger kanagurta*	4,768
1983	*Psettodes erumei*	332	*Rastrelliger kanagurta*	7,351
1984	*Psettodes erumei*	330	*Rastrelliger kanagurta*	7,554
1985	*Psettodes erumei*	722	*Rastrelliger kanagurta*	7,310
1986	*Psettodes erumei*	678	*Rastrelliger kanagurta*	17,996
1987	*Psettodes erumei*	579	*Rastrelliger kanagurta*	16,156
1988	*Psettodes erumei*	618	*Rastrelliger kanagurta*	17,228
1989	*Psettodes erumei*	597	*Rastrelliger kanagurta*	15,488
1990	*Psettodes erumei*	1,235	*Rastrelliger kanagurta*	14,019
1991	*Psettodes erumei*	904	*Rastrelliger kanagurta*	17,349
1992	*Psettodes erumei*	455	*Rastrelliger kanagurta*	29,024
1993	*Psettodes erumei*	792	*Rastrelliger kanagurta*	22,803
1994	*Psettodes erumei*	1,455	*Rastrelliger kanagurta*	16,154
1995	*Psettodes erumei*	1,533	*Rastrelliger kanagurta*	21,372
1996	*Psettodes erumei*	2,852	*Rastrelliger kanagurta*	18,092
1997	*Psettodes erumei*	3,156	*Rastrelliger kanagurta*	21,841
1998	*Psettodes erumei*	1,550	*Rastrelliger kanagurta*	25,095
1999	*Psettodes erumei*	1,539	*Rastrelliger kanagurta*	25,535
2000	*Psettodes erumei*	2,060	*Rastrelliger kanagurta*	23,434
2001	*Psettodes erumei*	1,848	*Rastrelliger kanagurta*	29,907
2002	*Psettodes erumei*	1,996	*Rastrelliger kanagurta*	30,581
2003	*Psettodes erumei*	2,758	*Rastrelliger kanagurta*	32,592
2004	*Psettodes erumei*	2,826	*Rastrelliger kanagurta*	33,553
2005	*Psettodes erumei*	3,794	*Rastrelliger kanagurta*	42,657
2006	*Psettodes erumei*	3,885	*Rastrelliger kanagurta*	38,921
2007	*Psettodes erumei*	3,700	*Rastrelliger kanagurta*	41,055
2008	*Psettodes erumei*	3,434	*Rastrelliger kanagurta*	36,526

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Sciaenidae	3,840	Scomberomorus	31,873
1951	Sciaenidae	3,706	Scomberomorus	41,434
1952	Sciaenidae	3,797	Scomberomorus	42,632
1953	Sciaenidae	3,517	Scomberomorus	43,863
1954	Sciaenidae	3,847	Scomberomorus	43,696
1955	Sciaenidae	3,272	Scomberomorus	45,156
1956	Sciaenidae	3,630	Scomberomorus	48,735
1957	Sciaenidae	5,256	Scomberomorus	49,449
1958	Sciaenidae	3,949	Scomberomorus	44,734
1959	Sciaenidae	3,565	Scomberomorus	36,517
1960	Sciaenidae	3,390	Scomberomorus	28,273
1961	Sciaenidae	5,240	Scomberomorus	14,161
1962	Sciaenidae	6,452	Scomberomorus	18,130
1963	Sciaenidae	4,515	Scomberomorus	8,914
1964	Sciaenidae	4,438	Scomberomorus	11,808
1965	Sciaenidae	4,014	Scomberomorus	14,293
1966	Sciaenidae	4,036	Scomberomorus	16,848
1967	Sciaenidae	4,293	Scomberomorus	15,614
1968	Sciaenidae	4,220	Scomberomorus	19,799
1969	Sciaenidae	3,884	Scomberomorus	15,056
1970	Sciaenidae	4,150	Scomberomorus	12,783
1971	Sciaenidae	5,409	Scomberomorus	12,843
1972	Sciaenidae	6,954	Scomberomorus	4,396
1973	Sciaenidae	8,481	Scomberomorus	15,808
1974	Sciaenidae	4,726	Scomberomorus	872
1975	Sciaenidae	4,688	Scomberomorus	4,387
1976	Sciaenidae	6,984	Scomberomorus	6,263
1977	Sciaenidae	6,932	Scomberomorus	3,917
1978	Sciaenidae	5,552	Scomberomorus	2,255
1979	Sciaenidae	8,020	Scomberomorus	3,919
1980	Sciaenidae	8,280	Scomberomorus	2,184
1981	Sciaenidae	8,610	Scomberomorus	2,204
1982	Sciaenidae	7,416	Scomberomorus	7,587
1983	Sciaenidae	6,243	Scomberomorus	10,040
1984	Sciaenidae	7,347	Scomberomorus	10,860
1985	Sciaenidae	6,447	Scomberomorus	11,504
1986	Sciaenidae	6,230	Scomberomorus	9,741
1987	Sciaenidae	6,631	Scomberomorus	10,232
1988	Sciaenidae	8,054	Scomberomorus	10,823
1989	Sciaenidae	9,296	Scomberomorus	13,760
1990	Sciaenidae	7,736	Scomberomorus	18,314
1991	Sciaenidae	7,206	Scomberomorus	18,568
1992	Sciaenidae	8,791	Scomberomorus	16,004
1993	Sciaenidae	8,031	Scomberomorus	26,272
1994	Sciaenidae	12,323	Scomberomorus	27,792
1995	Sciaenidae	13,582	Scomberomorus	18,878
1996	Sciaenidae	11,706	Scomberomorus	18,417
1997	Sciaenidae	12,241	Scomberomorus	19,235
1998	Sciaenidae	11,865	Scomberomorus	18,355
1999	Sciaenidae	13,005	Scomberomorus	20,796
2000	Sciaenidae	13,049	Scomberomorus	21,203
2001	Sciaenidae	16,018	Scomberomorus	23,996
2002	Sciaenidae	18,177	Scomberomorus	22,440
2003	Sciaenidae	18,652	Scomberomorus	32,035
2004	Sciaenidae	19,785	Scomberomorus	28,808
2005	Sciaenidae	20,563	Scomberomorus	37,909
2006	Sciaenidae	21,187	Scomberomorus	34,389
2007	Sciaenidae	23,287	Scomberomorus	42,161
2008	Sciaenidae	20,843	Scomberomorus	31,652

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Scombridae	1,391	Serranidae	1,417
1951	Scombridae	124	Serranidae	1,095
1952	Scombridae	359	Serranidae	1,093
1953	Scombridae	362	Serranidae	1,368

1954	Scombridae	365	Serranidae	1,169
1955	Scombridae	323	Serranidae	1,407
1956	Scombridae	382	Serranidae	2,229
1957	Scombridae	469	Serranidae	3,565
1958	Scombridae	562	Serranidae	3,387
1959	Scombridae	712	Serranidae	1,524
1960	Scombridae	532	Serranidae	1,583
1961	Scombridae	915	Serranidae	1,976
1962	Scombridae	357	Serranidae	500
1963	Scombridae	480	Serranidae	1,178
1964	Scombridae	406	Serranidae	1,460
1965	Scombridae	425	Serranidae	500
1966	Scombridae	576	Serranidae	755
1967	Scombridae	464	Serranidae	2,312
1968	Scombridae	513	Serranidae	835
1969	Scombridae	684	Serranidae	2,085
1970	Scombridae	624	Serranidae	3,287
1971	Scombridae	687	Serranidae	649
1972	Scombridae	790	Serranidae	1,308
1973	Scombridae	540	Serranidae	3,309
1974	Scombridae	672	Serranidae	4,400
1975	Scombridae	726	Serranidae	7,662
1976	Scombridae	501	Serranidae	6,121
1977	Scombridae	988	Serranidae	7,312
1978	Scombridae	1,141	Serranidae	3,669
1979	Scombridae	748	Serranidae	5,235
1980	Scombridae	854	Serranidae	7,750
1981	Scombridae	816	Serranidae	5,328
1982	Scombridae	1,893	Serranidae	5,911
1983	Scombridae	1,779	Serranidae	7,859
1984	Scombridae	1,837	Serranidae	9,780
1985	Scombridae	2,870	Serranidae	6,158
1986	Scombridae	2,021	Serranidae	5,200
1987	Scombridae	2,024	Serranidae	3,281
1988	Scombridae	2,252	Serranidae	5,348
1989	Scombridae	1,599	Serranidae	4,632
1990	Scombridae	1,675	Serranidae	4,885
1991	Scombridae	4,176	Serranidae	4,237
1992	Scombridae	2,929	Serranidae	4,101
1993	Scombridae	3,761	Serranidae	3,955
1994	Scombridae	2,298	Serranidae	13,296
1995	Scombridae	2,369	Serranidae	12,944
1996	Scombridae	2,030	Serranidae	16,799
1997	Scombridae	2,067	Serranidae	15,459
1998	Scombridae	2,577	Serranidae	14,829
1999	Scombridae	2,232	Serranidae	13,925
2000	Scombridae	2,739	Serranidae	16,406
2001	Scombridae	2,816	Serranidae	18,115
2002	Scombridae	4,112	Serranidae	20,524
2003	Scombridae	3,481	Serranidae	20,947
2004	Scombridae	4,089	Serranidae	22,283
2005	Scombridae	3,944	Serranidae	22,944
2006	Scombridae	3,652	Serranidae	22,375
2007	Scombridae	4,398	Serranidae	22,516
2008	Scombridae	3,767	Serranidae	22,245

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Shrimp, prawns	175	Sphyraenidae	9
1951	Shrimp, prawns	239	Sphyraenidae	8
1952	Shrimp, prawns	1,295	Sphyraenidae	7
1953	Shrimp, prawns	585	Sphyraenidae	11
1954	Shrimp, prawns	4,760	Sphyraenidae	6
1955	Shrimp, prawns	512	Sphyraenidae	7
1956	Shrimp, prawns	3,057	Sphyraenidae	9
1957	Shrimp, prawns	892	Sphyraenidae	46
1958	Shrimp, prawns	1,134	Sphyraenidae	120

1959	Shrimp, prawns	1,352	Sphyraenidae	175
1960	Shrimp, prawns	1,460	Sphyraenidae	187
1961	Shrimp, prawns	2,301	Sphyraenidae	70
1962	Shrimp, prawns	2,351	Sphyraenidae	36
1963	Shrimp, prawns	2,300	Sphyraenidae	115
1964	Shrimp, prawns	2,045	Sphyraenidae	89
1965	Shrimp, prawns	2,149	Sphyraenidae	25
1966	Shrimp, prawns	1,188	Sphyraenidae	40
1967	Shrimp, prawns	3,031	Sphyraenidae	67
1968	Shrimp, prawns	1,995	Sphyraenidae	49
1969	Shrimp, prawns	2,976	Sphyraenidae	72
1970	Shrimp, prawns	2,305	Sphyraenidae	79
1971	Shrimp, prawns	1,775	Sphyraenidae	111
1972	Shrimp, prawns	1,961	Sphyraenidae	200
1973	Shrimp, prawns	1,361	Sphyraenidae	162
1974	Shrimp, prawns	2,046	Sphyraenidae	208
1975	Shrimp, prawns	2,404	Sphyraenidae	184
1976	Shrimp, prawns	1,250	Sphyraenidae	170
1977	Shrimp, prawns	2,005	Sphyraenidae	288
1978	Shrimp, prawns	2,171	Sphyraenidae	262
1979	Shrimp, prawns	2,122	Sphyraenidae	334
1980	Shrimp, prawns	2,073	Sphyraenidae	558
1981	Shrimp, prawns	2,174	Sphyraenidae	536
1982	Shrimp, prawns	2,464	Sphyraenidae	1,600
1983	Shrimp, prawns	2,318	Sphyraenidae	949
1984	Shrimp, prawns	2,697	Sphyraenidae	805
1985	Shrimp, prawns	2,536	Sphyraenidae	677
1986	Shrimp, prawns	2,835	Sphyraenidae	939
1987	Shrimp, prawns	3,059	Sphyraenidae	1,445
1988	Shrimp, prawns	3,780	Sphyraenidae	1,760
1989	Shrimp, prawns	4,268	Sphyraenidae	2,203
1990	Shrimp, prawns	5,425	Sphyraenidae	1,400
1991	Shrimp, prawns	5,703	Sphyraenidae	2,568
1992	Shrimp, prawns	5,367	Sphyraenidae	1,790
1993	Shrimp, prawns	4,935	Sphyraenidae	2,369
1994	Shrimp, prawns	4,052	Sphyraenidae	2,332
1995	Shrimp, prawns	4,687	Sphyraenidae	1,916
1996	Shrimp, prawns	5,587	Sphyraenidae	1,401
1997	Shrimp, prawns	5,784	Sphyraenidae	1,143
1998	Shrimp, prawns	6,359	Sphyraenidae	791
1999	Shrimp, prawns	8,011	Sphyraenidae	1,223
2000	Shrimp, prawns	8,375	Sphyraenidae	1,501
2001	Shrimp, prawns	7,986	Sphyraenidae	1,532
2002	Shrimp, prawns	9,552	Sphyraenidae	2,050
2003	Shrimp, prawns	7,375	Sphyraenidae	1,990
2004	Shrimp, prawns	8,158	Sphyraenidae	2,099
2005	Shrimp, prawns	6,568	Sphyraenidae	1,917
2006	Shrimp, prawns	6,441	Sphyraenidae	1,814
2007	Shrimp, prawns	6,693	Sphyraenidae	1,803
2008	Shrimp, prawns	9,008	Sphyraenidae	2,871

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Stomoatopoda	483	Synodontidae	198
1951	Stomoatopoda	150	Synodontidae	76
1952	Stomoatopoda	343	Synodontidae	50
1953	Stomoatopoda	713	Synodontidae	84
1954	Stomoatopoda	1,010	Synodontidae	176
1955	Stomoatopoda	529	Synodontidae	192
1956	Stomoatopoda	583	Synodontidae	229
1957	Stomoatopoda	469	Synodontidae	291
1958	Stomoatopoda	420	Synodontidae	130
1959	Stomoatopoda	793	Synodontidae	94
1960	Stomoatopoda	807	Synodontidae	80
1961	Stomoatopoda	1,353	Synodontidae	254
1962	Stomoatopoda	1,632	Synodontidae	320
1963	Stomoatopoda	937	Synodontidae	299

1964	Stomoatopoda	1,438	Synodontidae	522
1965	Stomoatopoda	515	Synodontidae	265
1966	Stomoatopoda	803	Synodontidae	217
1967	Stomoatopoda	2,235	Synodontidae	157
1968	Stomoatopoda	1,902	Synodontidae	204
1969	Stomoatopoda	3,130	Synodontidae	196
1970	Stomoatopoda	2,622	Synodontidae	104
1971	Stomoatopoda	2,776	Synodontidae	185
1972	Stomoatopoda	2,559	Synodontidae	191
1973	Stomoatopoda	5,203	Synodontidae	101
1974	Stomoatopoda	4,787	Synodontidae	237
1975	Stomoatopoda	1,863	Synodontidae	242
1976	Stomoatopoda	7,069	Synodontidae	290
1977	Stomoatopoda	3,708	Synodontidae	435
1978	Stomoatopoda	2,230	Synodontidae	396
1979	Stomoatopoda	2,768	Synodontidae	392
1980	Stomoatopoda	2,290	Synodontidae	529
1981	Stomoatopoda	3,103	Synodontidae	553
1982	Stomoatopoda	3,332	Synodontidae	260
1983	Stomoatopoda	2,625	Synodontidae	48
1984	Stomoatopoda	3,049	Synodontidae	270
1985	Stomoatopoda	4,199	Synodontidae	554
1986	Stomoatopoda	4,255	Synodontidae	505
1987	Stomoatopoda	4,854	Synodontidae	220
1988	Stomoatopoda	4,552	Synodontidae	408
1989	Stomoatopoda	5,308	Synodontidae	547
1990	Stomoatopoda	7,089	Synodontidae	662
1991	Stomoatopoda	7,410	Synodontidae	435
1992	Stomoatopoda	8,365	Synodontidae	412
1993	Stomoatopoda	8,362	Synodontidae	635
1994	Stomoatopoda	7,375	Synodontidae	1,342
1995	Stomoatopoda	6,673	Synodontidae	1,473
1996	Stomoatopoda	5,923	Synodontidae	1,455
1997	Stomoatopoda	5,030	Synodontidae	2,168
1998	Stomoatopoda	18,228	Synodontidae	3,226
1999	Stomoatopoda	7,968	Synodontidae	3,332
2000	Stomoatopoda	12,679	Synodontidae	4,151
2001	Stomoatopoda	5,790	Synodontidae	4,064
2002	Stomoatopoda	5,851	Synodontidae	4,143
2003	Stomoatopoda	6,372	Synodontidae	4,331
2004	Stomoatopoda	9,180	Synodontidae	4,539
2005	Stomoatopoda	4,723	Synodontidae	4,577
2006	Stomoatopoda	4,384	Synodontidae	4,715
2007	Stomoatopoda	7,240	Synodontidae	5,240
2008	Stomoatopoda	10,159	Synodontidae	4,537

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Thunnus	61	*Thunnus tonggol*	3,058
1951	Thunnus	81	*Thunnus tonggol*	4,223
1952	Thunnus	80	*Thunnus tonggol*	11,240
1953	Thunnus	100	*Thunnus tonggol*	10,756
1954	Thunnus	100	*Thunnus tonggol*	7,086
1955	Thunnus	90	*Thunnus tonggol*	10,231
1956	Thunnus	83	*Thunnus tonggol*	8,135
1957	Thunnus	123	*Thunnus tonggol*	14,364
1958	Thunnus	104	*Thunnus tonggol*	20,786
1959	Thunnus	116	*Thunnus tonggol*	19,979
1960	Thunnus	94	*Thunnus tonggol*	10,472
1961	Thunnus	83	*Thunnus tonggol*	7,907
1962	Thunnus	131	*Thunnus tonggol*	11,978
1963	Thunnus	110	*Thunnus tonggol*	8,585
1964	Thunnus	116	*Thunnus tonggol*	9,997
1965	Thunnus	86	*Thunnus tonggol*	12,891
1966	Thunnus	72	*Thunnus tonggol*	9,473
1967	Thunnus	79	*Thunnus tonggol*	9,232
1968	Thunnus	78	*Thunnus tonggol*	10,335

1969	Thunnus	74	*Thunnus tonggol*	10,049
1970	Thunnus	65	*Thunnus tonggol*	7,585
1971	Thunnus	441	*Thunnus tonggol*	10,162
1972	Thunnus	343	*Thunnus tonggol*	8,386
1973	Thunnus	1,534	*Thunnus tonggol*	7,259
1974	Thunnus	659	*Thunnus tonggol*	8,442
1975	Thunnus	1,837	*Thunnus tonggol*	11,909
1976	Thunnus	844	*Thunnus tonggol*	12,429
1977	Thunnus	260	*Thunnus tonggol*	7,919
1978	Thunnus	369	*Thunnus tonggol*	18,506
1979	Thunnus	1,667	*Thunnus tonggol*	13,691
1980	Thunnus	859	*Thunnus tonggol*	12,527
1981	Thunnus	1,566	*Thunnus tonggol*	9,157
1982	Thunnus	5,336	*Thunnus tonggol*	6,436
1983	Thunnus	5,162	*Thunnus tonggol*	6,919
1984	Thunnus	4,578	*Thunnus tonggol*	10,824
1985	Thunnus	2,069	*Thunnus tonggol*	11,192
1986	Thunnus	1,384	*Thunnus tonggol*	15,125
1987	Thunnus	1,251	*Thunnus tonggol*	11,277
1988	Thunnus	1,301	*Thunnus tonggol*	7,879
1989	Thunnus	1,225	*Thunnus tonggol*	7,802
1990	Thunnus	773	*Thunnus tonggol*	8,273
1991	Thunnus	2,695	*Thunnus tonggol*	14,273
1992	Thunnus	1,155	*Thunnus tonggol*	11,429
1993	Thunnus	1,529	*Thunnus tonggol*	8,183
1994	Thunnus	1,109	*Thunnus tonggol*	9,269
1995	Thunnus	1,734	*Thunnus tonggol*	11,019
1996	Thunnus	1,404	*Thunnus tonggol*	10,980
1997	Thunnus	1,533	*Thunnus tonggol*	12,030
1998	Thunnus	1,460	*Thunnus tonggol*	14,087
1999	Thunnus	3,419	*Thunnus tonggol*	15,143
2000	Thunnus	3,592	*Thunnus tonggol*	16,382
2001	Thunnus	1,660	*Thunnus tonggol*	16,967
2002	Thunnus	3,039	*Thunnus tonggol*	19,158
2003	Thunnus	3,350	*Thunnus tonggol*	18,426
2004	Thunnus	2,684	*Thunnus tonggol*	18,859
2005	Thunnus	1,953	*Thunnus tonggol*	18,701
2006	Thunnus	2,429	*Thunnus tonggol*	19,009
2007	Thunnus	2,534	*Thunnus tonggol*	19,929
2008	Thunnus	2,100	*Thunnus tonggol*	20,427

Table A1 (continued).

Year	Taxon	Estimated catch	Taxon	Estimated catch
1950	Trichiuridae	10	*Xiphias gladius*	18,536
1951	Trichiuridae	11	*Xiphias gladius*	14,437
1952	Trichiuridae	10	*Xiphias gladius*	16,335
1953	Trichiuridae	13	*Xiphias gladius*	13,078
1954	Trichiuridae	13	*Xiphias gladius*	11,873
1955	Trichiuridae	12	*Xiphias gladius*	20,537
1956	Trichiuridae	11	*Xiphias gladius*	13,571
1957	Trichiuridae	15	*Xiphias gladius*	12,825
1958	Trichiuridae	12	*Xiphias gladius*	9,114
1959	Trichiuridae	14	*Xiphias gladius*	9,851
1960	Trichiuridae	12	*Xiphias gladius*	10,725
1961	Trichiuridae	10	*Xiphias gladius*	8,746
1962	Trichiuridae	12	*Xiphias gladius*	9,800
1963	Trichiuridae	11	*Xiphias gladius*	10,902
1964	Trichiuridae	10	*Xiphias gladius*	14,146
1965	Trichiuridae	11	*Xiphias gladius*	13,720
1966	Trichiuridae	10	*Xiphias gladius*	25,040
1967	Trichiuridae	10	*Xiphias gladius*	12,616
1968	Trichiuridae	10	*Xiphias gladius*	13,427
1969	Trichiuridae	10	*Xiphias gladius*	19,835
1970	Trichiuridae	8	*Xiphias gladius*	19,193
1971	Trichiuridae	9	*Xiphias gladius*	23,248
1972	Trichiuridae	9	*Xiphias gladius*	16,343
1973	Trichiuridae	9	*Xiphias gladius*	18,752

1974	Trichiuridae	7	*Xiphias gladius*	18,515
1975	Trichiuridae	7	*Xiphias gladius*	29,595
1976	Trichiuridae	7	*Xiphias gladius*	26,003
1977	Trichiuridae	9	*Xiphias gladius*	22,604
1978	Trichiuridae	9	*Xiphias gladius*	19,076
1979	Trichiuridae	8	*Xiphias gladius*	30,417
1980	Trichiuridae	26	*Xiphias gladius*	26,814
1981	Trichiuridae	8	*Xiphias gladius*	24,638
1982	Trichiuridae	11	*Xiphias gladius*	39,922
1983	Trichiuridae	11	*Xiphias gladius*	44,216
1984	Trichiuridae	17	*Xiphias gladius*	45,170
1985	Trichiuridae	28	*Xiphias gladius*	52,715
1986	Trichiuridae	26	*Xiphias gladius*	48,264
1987	Trichiuridae	26	*Xiphias gladius*	60,793
1988	Trichiuridae	25	*Xiphias gladius*	60,509
1989	Trichiuridae	12	*Xiphias gladius*	66,430
1990	Trichiuridae	18	*Xiphias gladius*	65,080
1991	Trichiuridae	6	*Xiphias gladius*	47,793
1992	Trichiuridae	12	*Xiphias gladius*	45,700
1993	Trichiuridae	20	*Xiphias gladius*	52,395
1994	Trichiuridae	14	*Xiphias gladius*	55,654
1995	Trichiuridae	37	*Xiphias gladius*	67,853
1996	Trichiuridae	14	*Xiphias gladius*	65,756
1997	Trichiuridae	13	*Xiphias gladius*	68,065
1998	Trichiuridae	33	*Xiphias gladius*	58,954
1999	Trichiuridae	123	*Xiphias gladius*	63,931
2000	Trichiuridae	39	*Xiphias gladius*	77,458
2001	Trichiuridae	63	*Xiphias gladius*	71,618
2002	Trichiuridae	65	*Xiphias gladius*	67,111
2003	Trichiuridae	73	*Xiphias gladius*	65,025
2004	Trichiuridae	72	*Xiphias gladius*	69,763
2005	Trichiuridae	72	*Xiphias gladius*	70,909
2006	Trichiuridae	73	*Xiphias gladius*	72,550
2007	Trichiuridae	74	*Xiphias gladius*	75,159
2008	Trichiuridae	72	*Xiphias gladius*	81,967

Appendix II: Sri Lanka catch reconstruction

RECONSTRUCTION OF SRI LANKA'S FISHERIES CATCHES: 1950-2008

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ABSTRACT

Sri Lanka has a long history of reliance on the sea for the nutritional and economic well-being of its people. Fishing has long been an important industry and while detailed fishing records exist dating back to the early 1900s, they are incomplete. In this study, we estimated total marine fisheries catches for the 1950-2008 time period by accounting for all fisheries sub-sectors and components and compared this to the reported landings as provided to FAO. Our total reconstructed catch which included commercial and subsistence catches, and discarded bycatch was estimated at almost 18 million tonnes over the 1950-2008 time period. This estimate was over 2 times larger than the total landings reported by Sri Lanka to the FAO. The majority of this discrepancy was due to catches from the subsistence sector and discarded bycatch associated with shrimp trawl fisheries. Improved monitoring of and record-keeping for these fisheries components is crucial to the long term management of Sri Lanka's fisheries and to maintaining livelihoods and food security of the Sri Lankan people.

INTRODUCTION

The Democratic Socialist Republic of Sri Lanka is an island country southeast of India within the Bay of Bengal (Figure 1). The climate is tropical with seasonal monsoon and cyclones, but no upwelling. In 2009, the population was 20 million (Anon, 2009) with 32 percent living in coastal areas (UNEP, 2001). The Sri Lankan Exclusivity Economic Zone (EEZ) lies within FAO statistical area 57 (FAO, 2011).

The island was colonized by the Portuguese and the Dutch, but most influentially by the British. Sri Lanka or "Ceylon" as it was known prior to 1972 was a strategic military and trade link between West Asia and Southeast Asia. It acquired independence from the British Empire as the Dominion of Ceylon in 1948, just after World War II. In 1972, Ceylon became a republic and the name was changed back to the pre-colonial name: Sri Lanka (De Silva, 1981).

Attempts to record fisheries data in Sri Lanka may have begun during British rule; however, a rigorous island wide attempt to estimate total landings did not start until after independence. Since 1910, general fisheries information was recorded by the resident marine biologist as part of an annual fisheries administration report. These reports included descriptions of traditional fisheries, destructive practices, fisheries regulations, results of test fisheries, policy changes, and financial record keeping; yet, information regarding landings on the island was incomplete (Pearson, 1911; 1922). By the 1930s, the importance of quantifying total landings was recognized, and by the 1940s, efforts to quantify landings were well underway with the appointment of 12 fisheries inspectors (FIs) within 20 fisheries districts. In the early 1950s, the number of FIs was increased to 24. The first comprehensive annual report of total landings was published in 1952 by the Department of Fisheries (DOF); the reports were, from then on, published annually (reviewed in Sivasubramaniam, 1997).

Records of landings in the 1950s focused mainly on the traditional practice of beach seining as it accounted for approximately 40% of total landings (Canagaratnam and Medcof, 1956). The use of the large beach seine, *madella*, began in the mid to late 1800s and continued to be the most commonly used traditional fishing techniques throughout the twentieth century (Alexander, 1977). Gillnetting began in the 195os, and eventually took over as the most widespread fishing method for small-scale fishers. Incidents of illegal dynamite fishing and fish poisoning were also reported. The DOF showed great interest at this time in test fisheries, with special attention to experimental dredging for pearl and windowpane oysters, as well as trawler surveys (Sivalingam, 1961).

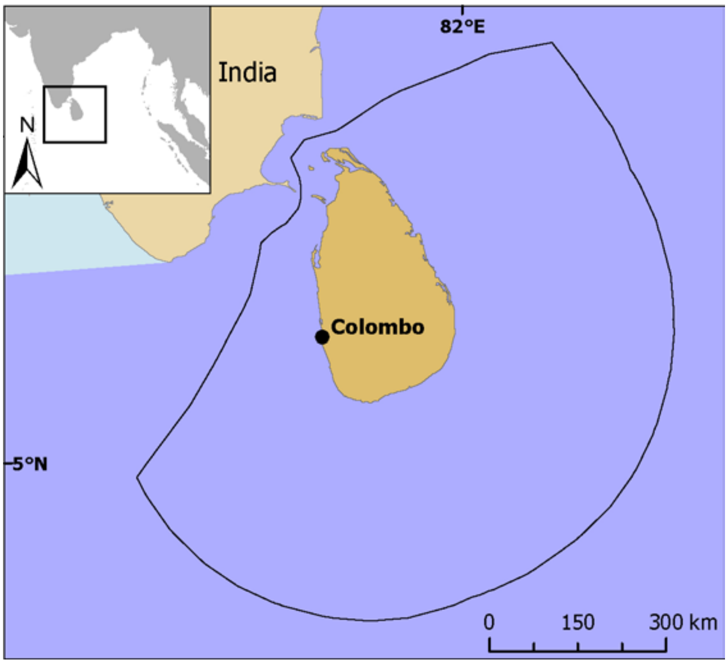

Figure 1. Map of Sri Lanka in the Bay of Bengal.

Artisanal and traditional fisheries in the 1950s could not meet the island's domestic demand for marine fish. To meet this demand, markets were supplemented with cheap imports of predominantly dried fish products from Pakistan, Japan, and India. Sri Lanka was not a large exporter of marine fish with the exception of a small market in Thailand and Singapore for shark fins, sea cucumbers and ornamental shells called chanks (*Turbinella pyrum*). Domestic marine fish production and export capacity were limited by poor infrastructure, most importantly the lack of ice and salt at landing sites, and inefficiencies attributed to the traditional nature of the fishery. In an attempt to improve upon traditional methods, the DOF imported nylon nets and implemented the development of a craft motorization program (Canagaratnam and Medcof, 1956). Subsidies for 11,000 outboard motors and the introduction of 17-23 foot fibre-reinforced plastic (FRP) boats were credited for the subsequent high annual growth rate of Sri Lanka's fisheries that lasted until the beginning of civil war in 1983 (FAO, 1989). In the last few decades, there has been an effort to augment pelagic fisheries though government assistance to increase the number of multiday vessels capable of fishing offshore and international waters.

With the aid of the FAO, statistical methods again improved in the 1970s with the removal of the position of statistical officer and the appointment of an additional 143 FIs, while a new sampling system was also adopted that utilized landing centers as primary sampling units, and boats as secondary sampling units. In 1981, the National Aquatic Resources Research and Development Agency (NARA) was established with the mandate to improve research and development, with an emphasis to better understand tuna biology and catch statistics by way of a collaborative effort with the Indo-Pacific Tuna Programme (IPTP), the Bay of Bengal Programme (BOBP), the Food and Agricultural Organization (FAO) and the Asian Development Bank (ADB) (Dayaratne and Maldeniya, 1996). Gillnetting, a practice that had become popular in the 1960s, continued as a favorite of Sri Lankan fishers and by the 1970s was accountable for 60% of reported fisheries catches.

Shortly after the establishment of NARA, civil war broke out between the Liberation Tigers of Tamil Eelam (LTTE) and the Government of Sri Lanka (GoSL). The effect of the war on fisheries was considerable, especially in the north where restrictions (e.g., a ban on outboard motors greater than 40 hp, Maldeniya, 1997b) on fishers were put in place to prevent fuel and weapons from being illegally brought from India by the LTTE. Additionally, the conflict led to the destruction of boats, gear, and infrastructure which included ice making facilities and highways important for fish transport to distant markets (Silucaithsam and Stokke, 2006). The northern fishing grounds, once responsible for producing over 40% of the country's reported landings, were the most productive and accessible fishing grounds in Sri Lanka due to the presence of a large continental shelf and a trawlable bottom (Engvall *et al.*, 1977).

The 1990's saw an increase in reported landings due to improvements in the security situation in some areas of the north and the expansion of the fishing fleet offshore and internationally. By the 1990s, government officials recognized coastal resources were fully exploited, and efforts were shifted to expanding the potential of deep sea fisheries by providing boat and equipment subsidies (Mallikage, 2001). For billfish, this was attributed to improvements in gear and the expansion of fisheries into offshore and deep sea areas (Maldeniya *et al.*, 1996).

Methods for improvement of catch statistics have been made in the 2000s, but overall they remained the same since the changes made in 1981. The demand for marine fish has remained high, with a catch that was insufficient to meet demand. Despite the increase in multiday fishing vessels and other larger craft a large component of the marine fishing fleet continues to consist of small FRP boats with outboard motors as well as non-motorized traditional craft (FAO, 2006). The tsunami in December 2004 seriously affected 90% of the fishing community through losses of boats, fishing nets, housing, and lives. Eighty percent of fishing villages were completely destroyed, along with 12-14 fishing harbors (ITDG, 2005). Post-tsunami efforts to rebuild fisheries have resulted in an overabundance of fishing boats in some areas raising concerns for overfishing (Jayasuriya *et al.*, 2005).

With the end of the civil war in 20o9, efforts to increase fisheries production in the north were a high priority for the DOF. Growing domestic demand for seafood and the potential for substantial earnings from seafood exports appear to be the driving force behind current fisheries policy, with plans to double marine fisheries production in the future. Apart from increasing landings, offshore fisheries have been identified as a more viable source of high value export oriented species such as tuna. The lack of adequate offshore fishing capacity has been seen as a major obstacle to fisheries expansion, and there have been initiatives to allow commercial fishing by foreign vessels in exchange for royalties and limited fish landings in order to increase domestic fish supply (Anon., 2010).

The increasing pressure on fisheries has not been limited to the waters surrounding Sri Lanka. Other countries with part or all of their EEZ within the Bay of Bengal Large Marine Ecosystem (BOBLME) include Bangladesh, India, Indonesia, Malaysia, the Maldives, Myanmar, and Thailand. Over 400 million people in this region are dependent on coastal and marine resources for their food, livelihood and security. Rapid population growth, high dependence on resources, and increased land use has resulted in the overexploitation of fish stocks and habitat degradation, and has led to considerable uncertainty as to whether the ecosystem will be able to support the livelihoods of the coastal populations in the future. Most of the Bay of Bengal's resources are shared by two or more countries and therefore trans-boundary or multi-country collaboration is required to ensure their sustainable management and conservation.

In response to this, the Bay of Bengal Large Marine Ecosystem (BOBLME) Project (www.boblme.org) was launched as a collaborative effort between the United Nations Food and Agriculture Organization (FAO) and the countries associated with the Bay of Bengal (Maldives, India, Sri Lanka, Bangladesh, Myanmar, Thailand, Indonesia and Malaysia) to improve the management of the Bay of Bengal marine environment and its fisheries. The purpose of the BOBLME Project is to establish a baseline for sustainable use of fisheries resources within the region and to promote the development and implementation of regional and sub-regional collaborative approaches to common and/or shared issues affecting the health and status of the BOBLME. In this context and in an effort to improve fisheries management capability and performance, the catch reconstruction for Sri Lanka/Myanmar will provide valuable baseline information on total marine fisheries extractions since 1950, crucial to meeting this mandate.

In accordance with this mandate, the goal of this study was to more accurately quantify total marine fisheries catches, by taking into account all fisheries sub-sectors and components, including subsistence catch and discarded bycatch. Efforts focused on small-scale subsistence fisheries, which are often not considered when collecting fisheries statistics although, they can constitute a large portion of actual catches (Zeller *et al.*, 2007). The importance of fisheries to the livelihoods of Sri Lankan's, particularly coastal dwellers, requires a more comprehensive estimate and accounting of the true magnitude of fisheries extractions.

METHODS

Total marine fisheries catches were estimated using information obtained from national reports, independent studies, local experts and grey literature. Landings data presented by the FAO on behalf of Sri Lanka were compared to national landings data, and household surveys were used to estimate total demand for domestic seafood as compared to local supply. We also estimated discarded bycatch for the shrimp trawl and tuna longline fisheries. In this report we refer to 'landings' as the amount of fish caught, brought to shore and recorded, while 'catch' refers to the total amount of fish caught, and includes Illegal, Unreported and Unregulated (IUU) catches and discarded bycatch.

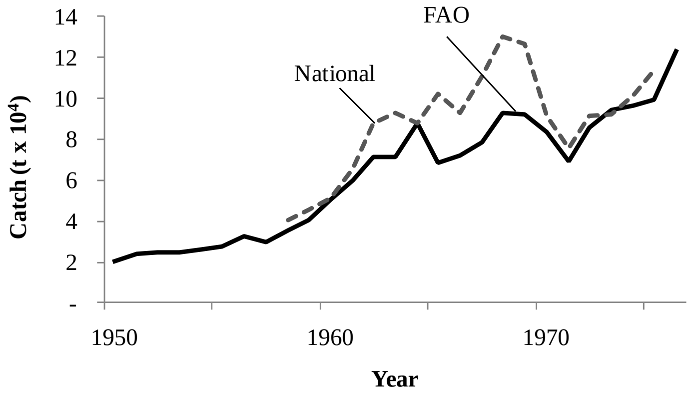

Figure 3: Comparison of landings data as presented by FAO and the national data source, indicating the statistical error in the national data, and its correction in data presented by FAO on behalf of Sri Lanka.

Population

Human population data were obtained for the 1950-1959 period from Populstat (www.populstat.info) and for the 1960-2008 time period from the World Bank (Anon, 2009). Population estimates were used to derive *per capita* marine supply and subsistence catch rates. The population of Sri Lanka has increased steadily from 7 million in 1950 to over 20 million in 2008 (Figure 2).

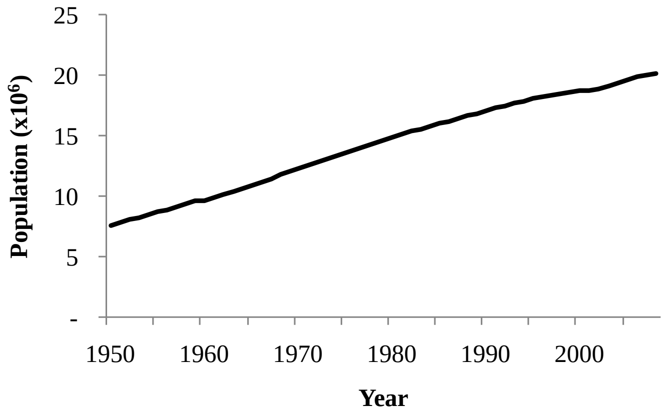

Figure 2: Human population trend for Sri Lanka. Data source: www.populstat.info and World Bank (Anon, 2009).

Commercial Fisheries

Total commercial landings for Sri Lanka were available in nationally published reports as well as by the FAO; however, the national data contained a statistical error causing landings to be high for years prior to 1970 (Pathirana, 1972); landings reported to FAO and obtained from FAO FishStat were lower than nationally reported landings prior to 1970 (Figure 3). Therefore, it was assumed that the statistical error in the national data was accounted for and corrected in landings presented in FAO's FishStat. Landings presented by the FAO were also more complete from 1980-1990, where national landings data were sparse. FAO data for crustaceans were compared to prawn and lobster landings presented by NARA. For the 1994-2002 time period, prawn and lobster landings were used in place of the FAO's 'miscellaneous marine crustaceans' grouping, as they were deemed to be a better representation of total crustacean catches (Figure 5). Marine crab fisheries, although known to occur in Sri Lanka, were assumed to be contained within a new, but smaller miscellaneous crustaceans category as no data was available to determine catch. With the exception of the amendment to crustaceans landings, the remainder of the FAO data was considered a good representation of commercial fisheries landings, both for the artisanal and industrial sectors. These landings were used as a baseline, to which we added components not accounted for in the officially reported data. Noteworthy are two non-fishery related events which are correlated with a noticeable decrease in landings over the time period considered; the beginning of the civil war in 1983 and the tsunami which occurred on December 26th, 2004.

Discards

Shrimp trawl fisheries are typically associated with considerable bycatch, which can either be landed or discarded at sea. A study in the late 1970s estimated bycatch associated with the shrimp fishery in two of Sri Lanka's main shrimp trawling grounds, Jaffna and Mannar (Subasinghe, 1981). The study provided estimates for both the landed and discarded components of the bycatch. Subasinghe (1981) presents discard rates for both areas, which gave an average rate of 10.2 kg of discards per kg of shrimp landed for 1979 (Discard rates for Mannar and Jaffina were 8.92 and 11.48 kg discarded per kg landed, respectively). These two regions were responsible for 60% of the commercial production of shrimp that year (Subasinghe, 1981; Saila, 1983). Therefore, we assumed that this discard rate was representative of Sri Lanka's shrimp trawl fisheries and applied the rate of 10.2 kg discards per kg of shrimp landed across the entire time period. Discards may have been even higher in earlier time periods due to greater benthic biomass and/or less storage capacity on vessels for non-target species; however, to remain conservative we held the discard rate constant back in time to 1950. For the recent time period, we carried the 1979 discard rate forward, unaltered, to 2008. This same study reported that over 80% of the discarded catch was ponyfish (Leiognathidae); we considered the remainder to be miscellaneous demersal fishes and miscellaneous sharks.

Depending on the type of gear used, bycatch is also of concern for tuna fisheries. The majority of tuna catches in Sri Lanka are skipjack tuna (*Katsuwonus pelamis*), representing roughly 60% of tuna catches and yellowfin tuna (*Thunnus albacares*), representing approximately 20% of the tuna catches. Tuna are predominantly caught using gillnets, although, longlines are becoming increasingly popular for catches aimed at the export market (Maldeniya, 1997b). Kelleher (2005) estimates discards by tuna longline in Sri Lankan waters to be 0.05%. Given that this was a very low discard rate, and given that we were unable to determine the portion of the tuna catch taken by longline, we did not estimate this component of the bycatch. As for bycatch associated with the tuna gillnet fisheries, information was also quite sparse. Due to the size of the nets used, incidental catch in the tuna gillnet fishery is mainly seerfish, billfish and shark. Given that these are marketable species, we assumed that the majority of the non-targeted catch for the tuna gillnet fishery was retained and that this portion of the catch was accounted for in the landings data.

Table 1. Estimated seafood consumption rates derived from Department of Census and Statistics 2007 Household Income and Expenditure Survey.

Year	*Per capita* demand (kg·person^{-1}·year^{-1})
1981	19.39
1986	18.24
1991	14.64
2002	19.86
2005	24.12
2007	24.12

Subsistence Fisheries

We assumed that the subsistence component of small-scale fisheries was unaccounted for in the reported data. To estimate this component of the total catch, we calculated the island-wide marine seafood demand using *per capita* consumption data from the 2007 Department of Census and Statistics Household Income and Expenditure survey (Anon, 2007); and compared this to the reported (commercial) landings presented by the FAO. We considered the difference between the supply of marine products for human consumption and the demand for seafood to be the subsistence catch.

The supply of marine products available for consumption by the local population was estimated as the commercial landings (FAO data) adjusted for imports and exports (W. Swartz, unpublished data, UBC Fisheries Centre). These adjusted landings were then converted to *per capita* supply rates using human population data.

To estimate marine demand, the *per capita* marine fish consumption was obtained from the 2007 Sri Lanka Department of Census and Statistics Household Income and Expenditure survey (HIES). A detailed breakdown of *per capita* consumption of marine products was available for 2007 only. The *per capita* consumption of fish, which included aquaculture and freshwater products, was summarized in the 2007 survey for the years: 1981, 1986, 1991, 2002, and 2005. In order to remove aquaculture and freshwater consumption and calculate marine consumption, we assumed that the ratio of freshwater and aquaculture consumption to marine fish consumption remained the same over the entire survey period. This assumption resulted in a conservative estimate of *per capita* marine consumption as aquaculture and freshwater fish consumption have likely increased since the 1980s. However, in order to remain conservative, the amounts removed were assumed to be proportional to those in 2007. Conversion factors provided by the FAO for Indonesia (FAO, 2000) were used to convert product weight from the 2007 HIES into live weight. The resulting *per capita* seafood consumption rates for 1981, 1986 and 2007 were used as anchor points to derive a complete time series of consumption rates for the 1950-2008 study period (Table 1). We did not use the 1991 and 2002 estimates of *per capita* consumption since these points exactly matched FAO reported landings when they were multiplied by the human population. These points were likely estimates of *per caput* consumption (reported landings divided by the population) and hence left out of the analysis. We assumed that the consumption rate in 1950 was the same as that in the 1980s and therefore carried the 1981 rate of 19.39 kg·person^{-1}·year^{-1} back, unaltered to 1950. The 2007 estimate was carried forward to 2008. Years between anchor points were interpolated linearly. Finally, we subtracted the *per capita* marine supply (FAO landings adjusted for imports and exports) from the total *per capita* seafood demand to determine the *per capita* subsistence catch rate. Human population data were then used to convert *per capita* subsistence catch rates into total subsistence catch amounts. This calculation was not done for 2005 as although the 2005 consumption estimate was thought to be reasonable, the reported landings were low due to the tsunami, which was likely the result of both fewer catches and poor reporting. The subsistence catch rate for the year following the tsunami (2005) was estimated by linear interpolation between the 2004 and 2006 subsistence catch rates and then was reduced by the same percent decline in catch (42%) as reported by the FAO for landings between the years 2004 and 2005. It is possible that subsistence was underestimated for anchor points following the beginning of civil conflict in 1983 as it is unlikely surveys included regions at war. The 2007 HIES states that Trincomalee and the Northern Province, known for high marine productivity and possibly higher *per capita* consumption, were not sampled in 2007 due to active conflict in these areas; consequently, it is likely the *per capita* consumption and hence the subsistence catch estimates are conservative.

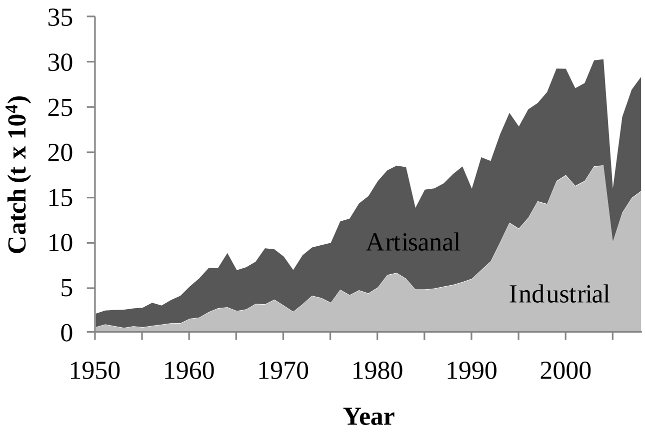

Figure 4: Total commercial fisheries catches for Sri Lanka, separated by industrial and artisanal fisheries, 1950-2008.

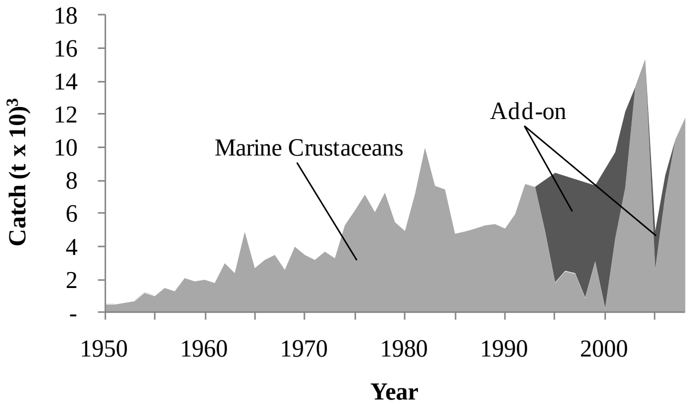

Figure 5: Reported landings of marine crustaceans (dark colour) and the additional estimated catches during the 1990s and early 2000s.

Subsistence catches were assumed to be composed of small pelagic species (50%), demersal species (40%) and invertebrates such as crabs and cephalopods (10%). The small pelagic species caught were mainly Clupeids and Scombrids, with the most common species being *Sardinella gibbosa*, *S. albella*, *Amblygaster sirm*, *A. clupeoides*, *Rastrelliger kanagurta*, and *Auxis thazard*. Demersal species catches were mainly represented by Lethrinidae, Carangidae, Myliobatidae, Sciaenidae, Haemulidae, Leiognathidae, and Acanthuridae. (Canagaratnam and Medcof, 1956; Maldeniya, 1997a; MFAR, 2008). Industrial and artisanal catches were also improved for FAO reported "crustaceans nei" utilizing assumptions based on Jayawardane *et al.* (2003). The species breakdowns for lobster and sea cucumbers were also improved based on local expert opinion. (N. Perera, pers. comm., Linnaeus University)

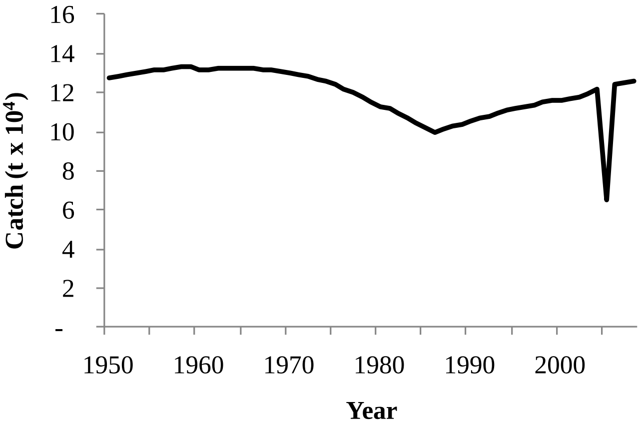

Figure 6: Reconstructed total subsistence catches for Sri Lanka, 1950-2008.

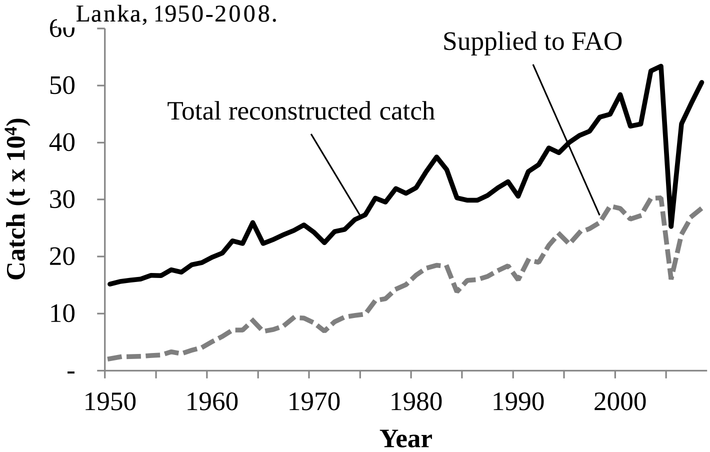

Figure 7: Total reconstructed catches compared to the data submitted by Sri Lanka to FAO, 1950-2008.

Other IUU components

While catches of sea cucumbers and sharks are reported in the official landings data, they are likely under-estimates. Unreported catches of sea cucumbers and sharks are common in Sri Lankan waters; however, data on these were not readily available. Although we were unable to account for this unreported component as part of the reconstructed catch, it should be noted that IUU fishing is known to occur in Sri Lanka and should be further investigated (P. Ganapathiraju, pers. comm., UBC Fisheries Centre).

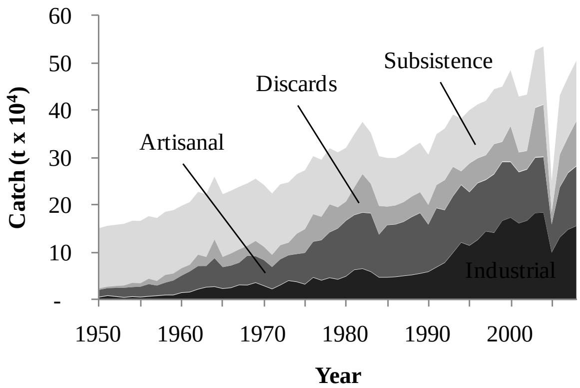

Figure 8: Total reconstructed catches for Sri Lanka by component or fisheries sector, 1950-2008.

RESULTS

Commercial Fisheries

Total marine fisheries catches by the commercial sector (artisanal and industrial) were estimated to be 8.5 million tonnes over the 1950-2007 time period (Figure 8). Catches in 1950 were approximately 20,000 tonnes·year^{-1} and increased steadily to over 300, 000 tonnes·year^{-1} in 2004. This was followed by a substantial decrease in catches to around 15,000 tonnes in 2005, the year after the tsunami devastated Sri Lanka. Total commercial catches were composed of small- (artisanal) and large-scale (industrial) sectors, which represented 55% and 44%, respectively of the total commercial catch. The total commercial catch included over 50,000 tonnes of additional crustaceans, which were not represented in the reported landings as presented by FAO (Figure 5). Catches of marine crustaceans were estimated to be 320,000 tonnes for the period 1950-2008. These were mainly shrimp (75%) and lobster (9%), with the remainder being miscellaneous marine crustaceans. Discards associated with the shrimp trawl fishery were estimated over the study period to be approximately 2.4 million tonnes (Figure 6).

Subsistence Fisheries

Total catches by the subsistence sector were estimated to be over 7 million tonnes from 1950-2008 (Figure 8). Subsistence catches remained relatively stable over the entire study period with an average annual catch of around 120,000 t·year^{-1} (Figure 8). A decrease in subsistence catches was observed for the late 1970s and early 1980s, but they increased again after that.

Total reconstructed catch

The total reconstructed catch of marine fisheries in Sri Lanka was estimated to be almost 18 million tonnes over the 1950-2008 time period (Figure 7). This estimate of total catches was 2.13 times larger than the landings officially reported by Sri Lanka to the FAO. Reported landings, as presented by the FAO on behalf of Sri Lanka were 8.4 million tonnes. The subsistence catch represented 40% and discards represented 13% of the total estimated catch (Figure 8). The remainder of the total catch was from the artisanal (26%) and industrial (21%) sub-sectors of commercial fisheries. The estimate for commercial catch was almost entirely based on reported landings, while the subsistence and discards were entirely unreported components. Major contributing taxa in the reconstructed catch included of pony fish (Leiognathidae), skipjack tuna (*Katsuwonus pelamis*), herrings, sardines, and anchovies (Clupeoids), jacks (Carangidae), and yellowfin tuna (*Thunnus albacares*; Figure 9).

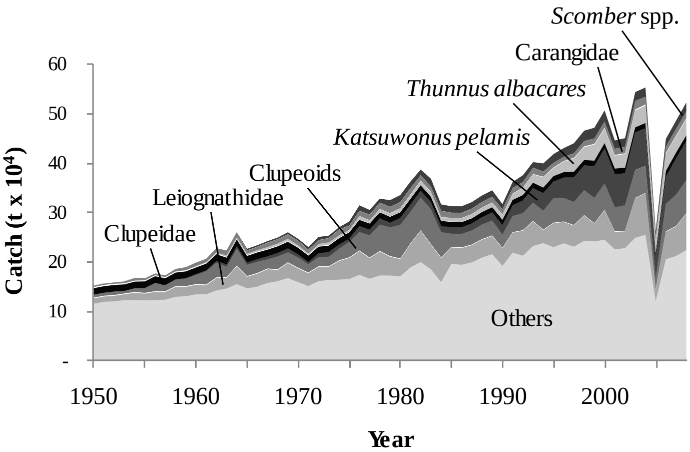

Figure 9: Total reconstructed catches with main taxa caught. All other taxa (88 total) were grouped into 'Others' category.

DISCUSSION

Total marine fisheries catches for Sri Lanka were estimated to be approximately 18 million tonnes over the 1950-2008 time period. This estimate was over 2 times larger than the landings reported by Sri Lanka to the FAO, which was approximately 8.4 million tonnes. This large discrepancy indicates a clear need for improvements in the collection and reporting of fisheries statistics in Sri Lanka. Our investigation into the fisheries of Sri Lanka revealed that information on subsistence fisheries, discarded bycatch and other IUU components was quite limited, even though these fisheries components contributed substantially to overall marine fisheries catches. Subsistence fisheries catches were the largest unreported component of the catch, and represented 40% of the total reconstructed catch.

Discards from the shrimp trawl fishery were also a substantial contributor (13%) to the total catch, and was unaccounted for in the official data. The high rate of discarding in Sri Lankan shrimp trawl fisheries has been attributed to the lack of cold storage facilities on multi-day boats. Economically important species are often stored while other less valuable species are discarded. However, the majority of the bycatch consists of low-valued species of Leiognathidae, which are typically discarded (Subasinghe, 1981). Tuna longline fisheries, on the other hand, have a much lower discard rate (0.05%) according to Kelleher (2005). This low rate of discarding is thought to be due to fishers targeting and landing multiple species of high economic importance, thus reducing the amount of discarded fish (Kelleher, 2005). Beach seining in the early period (1950s) was reported to have few discards, with the exception of jellyfish which were known to seasonally clog nets (Canagaratnam and Medcof, 1956).

The year following the tsunami, reported landings were significantly lower, even though seafood consumption remained constant. Although DOF offices were badly damaged by the tsunami and efforts were directed into emergency measures rather than accounting for landings, it is likely catches also decreased, especially in small-scale and subsistence fisheries as they sustained a large amount of damage. An assessment of the impacts of the tsunami on coastal fishers suggested that fishing pressure may have initially decreased in 2005, but then increased to pre-tsunami levels caused by excessive replacement gear and vessels donated to local fishers as part of the relief effort (De Silva and Yamao, 2007).

Illegal, Unreported and Unregulated (IUU) fisheries are known to occur in Sri Lankan waters. For example, the transshipments of shark fins caught in Sri Lanka's EEZ occur regularly. Most Sri Lankan vessels lack adequate refrigeration capacity and will therefore trade sacks of shark fins to foreign vessels at sea, which allows them to empty their hold and continue fishing while at sea. Such catches are not included in any reporting mechanism. Sri Lankan vessels also participate in the poaching of sharks and sea cucumbers, which are caught illegally outside of Sri Lanka's EEZ in the waters of Somalia, Madagascar, and the Seychelles, and are then landed in Sri Lanka. These catches are reported as domestic landings, but this is not necessarily the case (P. Ganapathiraju, pers. comm., UBC Fisheries Centre). Additionally, foreign vessels, in particular Indian vessels, engage in illegal fishing within Sri Lanka's EEZ and these catches are not reported for Sri Lanka.

Previous attempts to estimate the potential sustainable yield in Sri Lankan waters suggested harvest rates of 250,000 $t \cdot year^{-1}$, with around 80,000 t allocated to demersal species catches and 170,000 t for pelagic species (FAO, 1989). Our reconstructed catches indicate that this level was likely surpassed as far back as 1974. In this study we highlighted the lack of proper accounting for total fisheries catches, which in the case of the subsistence sector accounted for almost half of the domestic marine food supply. Without a realistic estimate of what is being extracted, fisheries are likely to be mismanaged and possibly overexploited. Although human and financial resources may not be available to establish and maintain in depth monitoring programs, regular surveys conducted every few years have been found to be very effective in estimating subsistence and small-scale catch in other developing countries (Brouwer *et al.*, 1997; Zeller *et al.*, 2006).

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Appendix Table 1. Table of values presenting FAO reported landings and the reconstructed catch as shown in Figure 7.

Year	FAO reported landings (t)	Total reconstructed catch (t)
1950	20,622	151,813
1951	24,103	156,210
1952	24,709	158,421
1953	25,016	160,496
1954	26,433	166,998
1955	27,265	166,716
1956	32,702	176,616
1957	29,638	172,670
1958	35,737	185,640
1959	40,434	189,190
1960	50,775	198,438
1961	59,717	206,182
1962	71,137	227,544
1963	71,256	222,926
1964	87,796	259,676
1965	68,836	222,888
1966	72,083	230,049
1967	78,225	238,398
1968	93,080	245,640
1969	91,936	255,295
1970	83,855	242,466
1971	69,074	224,345
1972	85,438	243,631
1973	93,972	247,627
1974	96,608	264,940
1975	99,110	273,005
1976	122,870	302,695
1977	126,000	295,302
1978	142,768	319,436
1979	150,934	310,821
1980	167,594	320,543
1981	179,398	348,908
1982	184,664	374,713
1983	183,005	352,116
1984	137,909	302,847
1985	158,065	298,884
1986	159,437	298,798
1987	164,998	307,197
1988	175,347	320,621
1989	183,773	331,133
1990	159,173	305,788
1991	193,989	349,006
1992	189,939	360,916
1993	219,447	390,223
1994	240,307	381,993
1995	222,170	399,668
1996	242,031	411,686
1997	248,790	419,199
1998	259,746	443,709
1999	288,301	449,153
2000	284,314	483,307
2001	265,749	428,117
2002	271,927	432,235
2003	302,082	524,880
2004	303,168	533,482
2005	160,142	251,821
2006	239,292	432,512
2007	270,176	468,803
2008	285,028	503,501

Appendix Table 2. Table of values presenting major taxa of reconstructed total catch. Clupeoids include herrings, sardines, and anchovies.

Year	Leiognathidae	Clupeoids	*Katsuwonus pelamis*	Clupeidae	*Thunnus albacares*	Carangidae	*Scomber* spp.	Others
1950	10,457	8,000	771	12,715	774	2,543	0	116,553
1951	10,511	8,000	890	12,807	1,150	2,561	0	120,290
1952	11,125	9,000	807	12,887	903	2,577	0	121,122
1953	11,748	7,100	723	12,983	655	3,697	0	123,591
1954	14,638	9,500	720	13,087	606	4,717	0	123,730
1955	13,537	11,600	717	13,137	557	4,027	0	123,140
1956	16,390	18,300	981	13,180	720	3,436	0	123,609
1957	15,303	14,100	1,245	13,253	883	3,351	0	124,536
1958	19,852	14,900	1,410	13,294	970	4,859	0	130,356
1959	18,749	17,000	1,576	13,341	1,055	5,968	0	131,502
1960	19,200	20,400	2,063	13,151	1,347	7,030	0	135,247
1961	18,094	28,400	2,551	13,192	1,639	6,838	0	135,467
1962	24,895	31,500	3,960	13,217	2,493	8,443	0	143,036
1963	21,509	22,400	5,369	13,228	3,348	9,846	0	147,226
1964	35,647	36,300	5,227	13,230	3,222	10,146	0	155,905
1965	23,203	24,200	5,084	13,224	3,096	6,545	3000	147,536
1966	26,023	24,300	5,830	13,212	3,515	6,342	3000	150,828
1967	27,706	20,000	6,576	13,190	3,931	8,638	3000	158,357
1968	22,596	27,500	7,448	13,156	4,416	8,631	3000	161,893
1969	30,482	21,700	8,322	13,105	4,901	8,621	4000	168,164
1970	27,612	22,300	6,554	13,034	3,841	9,007	3600	160,118
1971	25,861	18,400	4,785	12,942	2,783	7,588	5100	151,986
1972	28,621	20,100	8,250	12,830	4,266	7,566	6200	161,997
1973	26,281	20,600	9,919	12,700	5,244	8,440	4900	164,443
1974	37,502	24,900	8,792	12,552	4,610	11,610	4300	164,974
1975	42,447	32,530	6,937	12,387	3,771	8,637	7994	166,294
1976	47,751	38,541	12,392	12,207	6,908	10,076	11018	174,819
1977	41,644	46,278	11,583	12,010	5,806	11,192	9179	166,788
1978	48,182	54,412	12,933	11,795	5,915	12,717	7747	173,482
1979	37,957	59,276	9,692	11,557	6,555	12,440	13388	173,344
1980	34,769	69,061	14,117	11,296	7,304	12,307	13888	171,689
1981	47,292	64,479	15,196	11,151	8,068	12,796	12906	189,926
1982	63,048	66,764	14,172	10,935	8,682	10,579	11302	200,533
1983	49,864	70,971	14,649	10,705	9,264	10,726	15518	185,937
1984	48,481	52,153	12,348	10,465	6,694	12,594	12773	160,112
1985	33,183	27,682	13,699	10,217	7,160	10,139	13000	196,803
1986	33,794	28,471	13,697	9,962	7,416	10,319	13000	195,139
1987	34,848	29,460	14,442	10,108	7,785	10,638	13000	199,916
1988	36,061	30,608	15,004	10,255	8,089	11,003	13000	209,601
1989	36,590	31,064	16,500	10,400	8,727	11,165	13000	216,687
1990	35,154	27,958	19,495	10,543	9,929	9,831	10500	192,878
1991	40,141	33,426	21,990	10,683	11,934	11,112	12000	219,721
1992	50,504	35,097	25,786	10,820	14,185	11,112	13557	213,413
1993	49,542	37,379	29,692	10,951	16,478	13,068	10854	233,113
1994	26,277	38,870	35,755	11,075	21,045	10,215	16450	238,756
1995	48,498	49,785	33,915	11,190	16,499	9,148	17642	230,633
1996	42,941	48,221	41,000	11,296	21,308	8,347	17700	238,573
1997	42,681	47,200	50,012	11,393	27,094	9,179	20000	231,641
1998	50,824	50,800	50,124	11,481	26,122	10,796	20900	243,562
1999	35,840	51,370	64,316	11,562	32,767	10,992	21350	242,307
2000	59,392	53,250	70,957	11,636	29,512	12,777	22180	245,783
2001	35,461	49,270	66,692	11,698	26,522	12,290	16760	226,183
2002	33,768	52,310	64,425	11,786	28,085	13,117	17250	228,743
2003	79,929	56,390	75,146	11,954	34,425	17,331	17760	249,705
2004	83,900	54,410	75,795	12,146	35,512	16,009	18440	255,711
2005	21,620	24,870	44,938	6,489	24,887	7,248	9680	121,769
2006	55,219	56,230	54,341	12,433	35,842	12,057	15570	206,391
2007	59,779	63,520	73,240	12,524	32,998	13,885	16290	212,857
2008	73,544	66,890	78,860	12,618	33,027	13,684	18260	224,878

Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand are working together through the Bay of Bengal Large Marine Ecosystem (BOBLME) Project and to lay the foundations for a coordinated programme of action designed to improve the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries.

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