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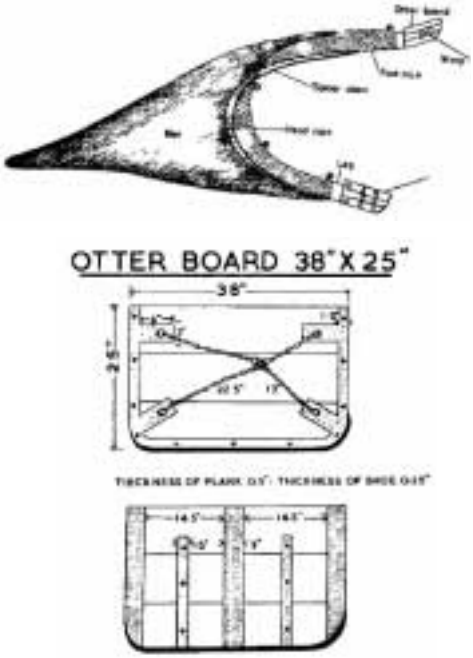


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# The history of industrial marine fisheries in Southeast Asia

by

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**and**
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# FOREWORD

Introduction of industrial fishing and more effective fishing technologies resulted in extremely rapid growth in production from wild marine fish stocks in the Southeast Asia region. This has been achieved by a process of sequentially depleting wild fish stocks within an essentially unregulated management environment so that fleets moved from one target species to another and from one area to another to sustain landings.

However, this process has now run its course because there are virtually no new unexploited fish stocks or areas remaining that fishing fleets can move to, despite recent trends of offshore fishing fleets of the region moving into the Pacific and Indian Oceans to fish for highly migratory species such as tuna.

This report provides a fascinating account of the rise and fall of different types of industrial fishing in Southeast Asia, starting with pearling and moving through phases that included trawling, purse seining, drift netting, trolling and more recently tuna longlining/poling/purse seining. This historic account of the boom and bust activities of industrial fishing highlights the need for a thorough overhaul of existing fisheries policies in the region and a move towards much more sustainable development.

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# Executive summary

Using the information in Butcher (2004)[1] and other sources, a review of the history of development of the major industrial marine fisheries in Southeast Asia has been undertaken. The production methods and fisheries considered were: (a) pearling; (b) trawling; (c) purse seining; (d) shrimp trawling; (e) tuna longlining, poling and purse seining; (f) driftnetting; (g) trolling; and (h) other industrial fishing operations, including failed types of industrial fishing. For each of these production methods and fisheries, the main features of the history of development from about 1850 to the present day are highlighted with some commentary on their current status.

In examining the history of fisheries development, the common feature is that of a boom-and-bust development where, one by one, stocks and habitats were exploited by new or improved fishing techniques to supply a rapidly increasing regional population and developing export markets. In all areas, this exploitation was done in an often uncontrolled, unregulated manner. When stocks were depleted by these new fishing methods, fleets moved on to the next area or stock. This sequential plunder also occurred across fisheres as the declining economic performance of one fishery spurred the transfer of vessels and fishers to a new, developing fishery (very often with government assistance) which in its turn also declined.

For example, trawling began with sailed-powered beam trawlers operated by Japanese fishers in the early 1990s. With the change to diesel-powered vessels in the 1930s, concerns about the status of stocks were already being made and the fleet expanded into other trawl grounds in the Philippines. Japanese fleets were also active in waters around Taiwan Province of China, the South China Sea and the Tonkin Gulf off Viet Nam. The trawling technology was exported from the Philippines to Thailand by a joint Thai-German Government initiative in the early 1960s. This was so successful that soon demersal stocks in the Gulf of Thailand were under pressure and this led to an expansion of the fleet's fishing activities to other areas in the region. This expansion of the Thai trawlers to other areas also prompted parallel industrial-scale developments in other countries, most notably Indonesia and the Malay Peninsula. This expansion has been characterized by often violent conflicts with small-scale fishers in a number of areas.

However, soon demersal catch rates were in decline in most areas and there were few if any new areas into which demersal trawling activities could be expanded and, by the 1970s, Thai vessels were being converted to (and being built for) purse seining to take small pelagic species in the Gulf of Thailand. There, the landings of these species increased by more than eight times in the first few years of the 1970s. However, like the development of trawling, both in Thailand and elsewhere, the expansion into purse seining in the region was essentially unregulated and it was not long before the small pelagic species being targeted were being either overexploited or had suffered significant price declines as a result of oversupply. By the early 1970s, this expansion of the industrialized purse seine fishery had been so dramatic that it was the dominant form of fishing in several countries, including Indonesia and the Philippines.

Declines in catch rates and also of prices of small pelagic species prompted further development and expansion, this time into tuna purse seining in the late 1970s to supply the newly-evolving regional tuna cannery capacity, most particularly that in Thailand. Tuna fishing throughout the region has since expanded in the now-familiar pattern and, by 1991, the vast majority of tuna supplied to Thai canneries came from the activities of purse seiners in the waters of other

[1] Butcher, John G. 2004. *The Closing of the Frontier: A History of the marine fisheries of Southeast Asia c.1850-2000*. Institute of Southeast Asian Studies (ISEAS), Singapore, 442 pp.

countries of the region. However, again concerns are now being expressed about the status of some regional tuna stocks.

The point was therefore reached more than a decade ago where there were very few new, underexploited areas for fleets to move to within the region and very few new types of fisheries or species that fleets could transfer to, and this remains the situation today.

The challenge for the countries of the region in the future is, therefore, for the first time to manage existing fisheries resources and their fisheries for long-term sustainability. This will require not only the introduction of enforceable management measures but a restructuring of the industry to address current overexploitation, greatly enhanced regional cooperation in fisheries enforcement, data collection and research and, most importantly, a vast improvement in the quality and quantity of regional and national fisheries statistics upon which informed management and development decisions can be made.

# I. Introduction

This summary of the history of marine fisheries in Southeast Asia traces the development of fisheries in the region from basically subsistence activities in the nineteenth century to large-scale industrial fishing in the latter part of the twentieth and early twenty-first centuries and examines the impact that this development has had on fish stocks and fishing communities in the region. The work is based substantially on the comprehensive review by Butcher (2004) although other sources have also been used as appropriate. Units of measurement have, where possible, been standardized to metric units to facilitate comparisons with current and other data, although Butcher's (2004) units for weights and measures of measurement are already quoted in metric units except where other units are referred to in a statute, law or other legal instrument. However, there are instances, particularly for the measurement of vessel tonnage, where such standardization has not been possible and these instances are highlighted and discussed as they occur.

The geographical area covered by this history is shown in Figure 1 and includes all of the countries of Southeast Asia, excluding China to the north and Australia to the south. The time period covered is approximately from the mid-nineteenth century to the present day (2005).

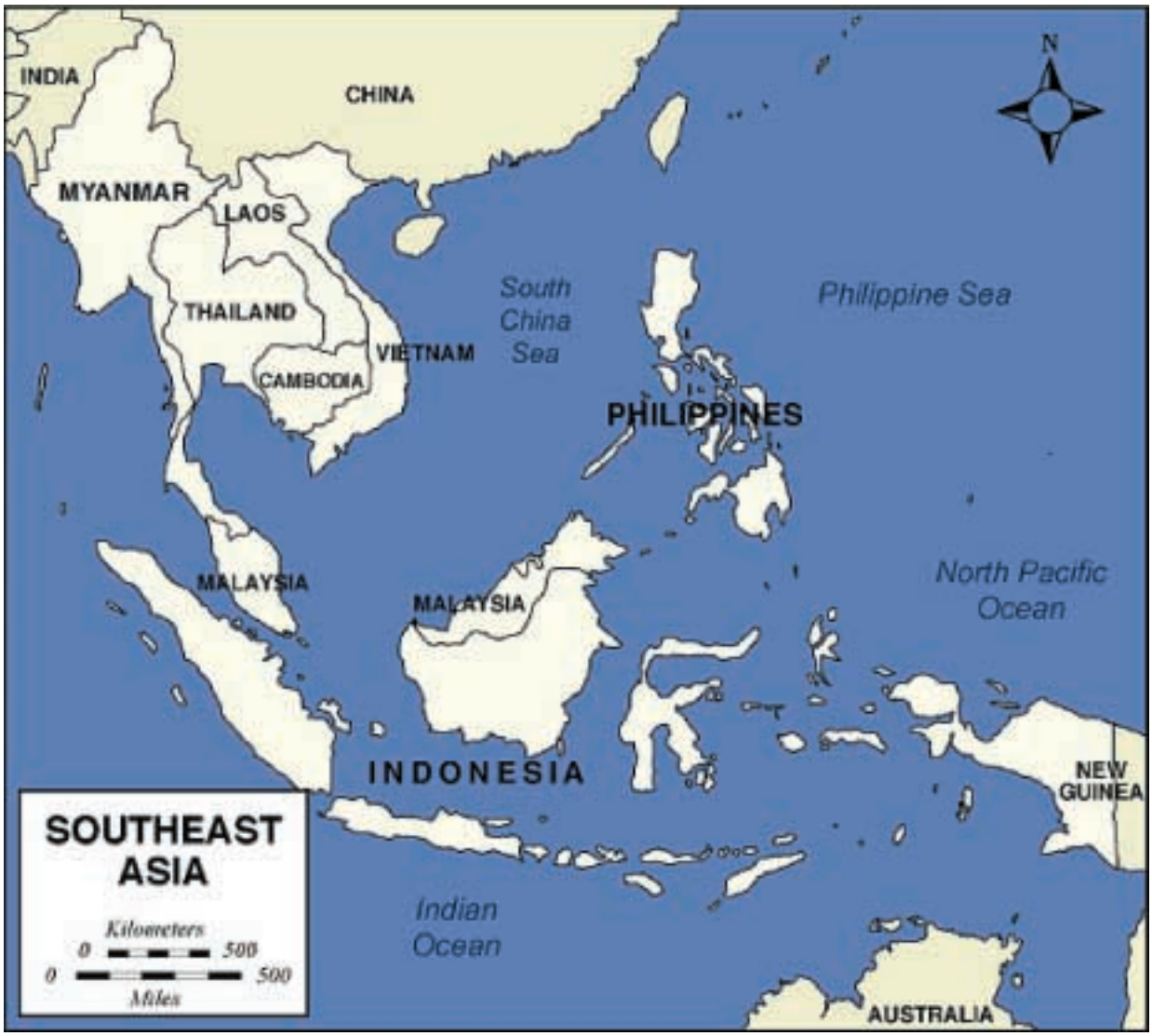



**Figure 1. Map of Southeast Asia showing the area and countries covered by this review**

Although inland and estuarine fisheries are also important in Southeast Asia, the seas of the region have been particularly important and have long provided people with a variety of fish, shrimps, squids, whales, pearl oysters, sea cucumbers and a multitude of other animals that they have collected and captured for medicine, oil, jewellery and most importantly food.

Prior to the early 1900s, the population of the whole of Southeast Asia was about 40 million with the majority of that population living in villages. The countries of the area were not yet urbanized to any great extent and therefore fishing (both marine and inland) was directed mainly at the need to supply food for these village communities. There was some limited trade (often between coastal and inland villages) and simple preservation and processing methods such as salting, drying and the manufacture of fish sauce which were developed and used to facilitate this trade. The supply of fresh, preserved or processed fish for large centralized markets, either domestic or international, was largely unknown.

As a result of this subsistence fishing by coastal villages in the nineteenth century, the region's marine fish stocks were almost certainly lightly exploited and, although no detailed surveys were carried out until after 1945, several contemporary nineteenth century records comment on both the quality and the abundance of fish in many areas and on the simple fishing methods used in marine fisheries.

Restricted by the simple fishing gear and vessels, and with abundant coastal fish resources, most fishing was undertaken in near-shore waters. When the demand for fish and other marine animals rose or the supply fell (often as a result of natural causes, such as the monsoons), it was a relatively simple matter to expand operations into new coastal fishing grounds since there were very few barriers to such expansion.

As fishing moved away from a subsistence-level activity and became increasingly oriented towards supplying more remote markets in the late 1800s and early 1900s, a spectacular growth in catches occurred (Sugiyama *et al.*, 2004). This expanding demand for marine products was created above all else by urbanization and the growth in population but also by the development of transport and marketing systems and changes in the techniques in preserving fish, shrimps and other marine life that prompted people to produce for the market.

This expansion of marine production accelerated after the Second World War as fleets were mechanized and fishing activities expanded to new areas, particularly those areas offshore that had previously been unfished or, at least, only lightly exploited. Figure 2 shows the extent of this increase in landings in the last half of the twentieth century and, particularly, how this expansion in marine landings overwhelmed production from inland waters. The expansion of marine landings in Southeast Asia has been so spectacular that two nations in the region (Thailand and Indonesia) are now among the world's top 10 fish producing nations and marine fisheries production accounts for more than 1 percent of GDP in almost all countries of the region (Sugiyama *et al.*, 2004, Table 1).

With this expansion in landings through the twentieth century came an expansion in the areas fished by national fishing fleets, a decline in the abundance of many fish stocks and, accordingly, an increase in interest at the regional, national and international level, in administering, controlling and regulating fishing activities in the region. States, and since the late 1940s, international organizations have all influenced the scale and location of fishing in the region and, until recently, fishing often took place beyond the reach and grasp of state powers.

The ability to expand landings by moving to new areas was curtailed in the latter part of the twentieth century not only by the lack of new fishing grounds to move to but also very much by this increasing interest of national Governments (and the legal obligations and powers conferred

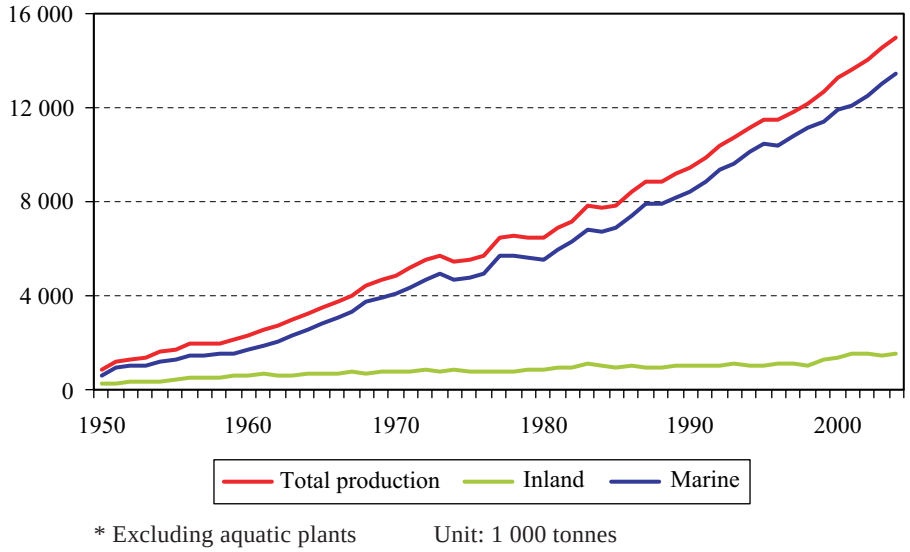



**Figure 2. Chart showing the increase in production from marine areas of Southeast Asia from 1950 to 2004**

by the UN Convention on the Law of the Sea, UNCLOS) to control fishing activities, particularly fishing by other nations' fleets, within a nation's territorial waters. Such recent attempts at regulating fisheries have not been wholly successful since they are built on a long history of a lack of government intervention and control in the marine fisheries sector. However, as Butcher (2004) points out, the era of opening of new "frontiers of fisheries has ended. The challenge now is to exploit the seas in a sustainable manner that preserves the diversity of marine life while providing the people of the region with a source of food long into the future".

In examining how the various sectors of marine fisheries in Southeast Asia have developed since the nineteenth century and how they have contributed to the overall rapid expansion of landings, the individual components that comprise the region's marine fisheries sector will be examined. These components include: (a) pearling; (b) trawling; (c) purse seining; (d) shrimp trawling; (e) tuna longlining, poling and purse seining; (f) driftnetting; (g) trolling; and (h) other industrial fishing operations, including failed types of industrial fishing.

In addition, the current state of each of these sectors and the resources upon which they rely will be examined so that an assessment can be made for each sector of the likelihood of being able to move from an expansionist mode of fishing (where landings were increased by exploiting new areas) to one of sustainability, based on existing resources.

## II. Pearling

In the nineteenth century, prior to the development of the cultured pearl industry in Japan, mother of pearl shells and pearls were some of the most valuable marine animal products of the time, and the demand for these products had been increasing rapidly in Europe and North America. In Southeast Asia, there was a thriving pearl shell and pearl industry in the early 1800s, based in the islands surrounding the Sulu and Celebes Seas which sold or bartered its products to China. So great was this trade that providing sufficient labour was a problem and therefore slave raiders were employed to capture slaves in the islands and coastal villages of the Malay Peninsula and bring them to Manila and Jolo. At the height of the trade in the 1830s, as many as 68 000 people were employed in diving for pearl shell in the area, more than the number of fishers in the whole of Java and Madura. About 730 tonnes of pearl shell was exported from Jolo

each year. The pearl shell and pearls that were not exported directly to China (either by Chinese traders or by British East India Company vessels) were sent to the market at Makassar for sale.

The pearling areas around the Sulu and Celebes Seas, the majority of which is now encompassed within the Philippines, is still by far the major producer of pearl shell and pearls (as opposed to pearls from the pearl culture industry) in the region with pearl shell production in 2002 being about 25000 tonnes or over 99 percent of total production in the region (FAO, 2004). This production is, however, about the same level as the 1960s although landings have fluctuated considerably during that time.

The early, rapid development of the pearl shell and pearl industry in the eastern islands area (which almost exclusively used Japanese and Filipino divers) quickly resulted in the more easily accessible stocks coming under pressure and, as pearl stocks in shallower waters were intensively harvested, it became necessary to find ways to harvest in deeper waters to maintain and increase supplies. In 1839 Augustus Siebe developed diving gear which was eagerly adapted by companies with sufficient capital to purchase the necessary equipment. The addition of diving equipment not only enabled divers to reach greater depths (up to approximately 54 m) than had previously been possible with free-diving, but also to increase the proportion of the year in which it was possible to collect oysters from three to nine months. The development also enabled stocks in deeper waters to be exploited and, by the late 1800s, areas in the Aru Islands, the Mergui Archipelago and the Sulu Archipelago were being fished. Faced with the high costs of the pearling operations, pearlers generally adopted the strategy of extracting as much as possible as quickly as possible and then moving on to another oyster bed. This strategy was adopted in all three of the main pearling areas.

The first area where diving equipment resulted in an increase in yields was in the Mergui Archipelago where, according to an official report by Rudmose Brown and Simpson in 1907, there was “no systematic pearling in the archipelago before 1891 when the attention of the Government was drawn to these banks by a Queensland pearler [presumably from the Torres Straits].” To manage this fishery, the Government of Burma immediately introduced a “block system” whereby the government auctioned the rights to collect pearl oysters in five “blocks” covering the richest pearling grounds. As a result of this system the mentality was adopted that it was imperative to extract as much pearl shell as possible during the year as the same company would not necessarily secure the same block the following year. Official figures indicate that yields rose dramatically from 26 tonnes in 1891/92 to 340 tonnes in 1894/95, leading to the emergence of Mergui as a boomtown. By 1900/01 the yield had fallen to 66 tonnes, and the government abolished the block system and replaced it by a system under which pearlers bought a licence for each pump they used. There was apparently no limit on the number of licences used.

During this period the accepted view was that there was little danger of overexploitation of the Mergui pearl beds as the beds were continually restocked by the offspring produced by oysters in deeper waters beyond the reach of the divers. It was argued that there was a “natural balance” between the number of divers and the quantity of shell available for, as yields fell, divers would leave and the stocks would recover. As a result it was concluded there was no need for any sort of regulation of the Mergui pearl fishery.

Pearling also expanded into the Aru Islands where Australian pearlers, using Japanese and Filipino divers, adopted diving gear in the 1870s. The richest grounds were those along the eastern side of the Islands which, after a few failed attempts at development, were developed by the Australian pearlers from Torres Strait in 1905, under a three-year concession granted by the Netherlands Indies Government. These grounds had hardly been touched by divers and, initially, catches were about twice what they were in the Torres Straits. In addition, the operations were significantly

more profitable because licence costs, labour and the cost of living were cheaper than in the Torres Straits fishery.

This Aru Island fishery quickly expanded and by 1906 there were 150 vessels working in the area, operating as a fleet with multiple diving vessels supplying a schooner which acted as a "floating station" where sorting, cleaning and packing was undertaken. In 1906, indigenous divers in the area (who, under the terms of the concession, had exclusive access to pearl shell in waters less than 5 fathoms) supplied only 13 percent of the total 950 tonnes that were taken in the area. The company operating the fleet was the world's largest producer of pearl shell and, in the same year, supplied 37 percent of mother-of-pearl shell imported into London.

However, within a few years, yields began to decline as the three year concession provided no long-term incentives for preservation of the stock and contemporary anecdotal evidence appears to indicate a reduction in catch rates per vessel of about 50 percent between 1905 and 1908. Although the concession was actually renewed several times, the company operating the fleet had withdrawn most or all of its vessels by 1916. However, this withdrawal did not end pearling activities in the Islands with the indigenous, shallow water fishery continuing and a few diving vessels operating well into the 1930s. These activities continue today from smaller, motorized vessels.

In the Sulu Archipelago, the introduction of diving technology came later and in a milder form than in other areas and, in 1914, there were 73 pearling vessels operating there, 40 of which were owned by a Japanese company and the rest by individuals of various ethnicities. Only two of the Japanese vessels had motor-driven pumps for diving. By 1930, there were only 24 vessels operating, five of which were equipped with engines and moto-driven air pumps. The Sulu Archipelago area appears to have exported about 300 tonnes of pearl shell in 1914 and, throughout its development, was distinguished by a greater reliance on indigenous fishers operating in shallow water for most of its production. Yields do not appear to have declined as precipitously as other areas where mechanized diving operations were more important, and Butcher (2004) suggests that this may have been a result of the more extensive nature of the pearl beds and the apparently less intense exploitation.

The introduction of mechanical diving technology in the late nineteenth century therefore led to a boom-and-bust development of the pearl shell beds of the region with pearl beds being sequentially depleted. Throughout this period of development, however, it is interesting to note that little concern was expressed for the long-term sustainability of the stocks since it was commonly believed that depleted adult stocks would be quickly replenished from untouched "deeper water" stocks. The decline in abundance of pearl shell helped drive an increasing demand for trochus shell and other gastropods as a substitute for pearl shell which was used in the manufacture of buttons. But, after the Second World War, it was the development of cheap plastic substitutes for button manufacture that resulted in the decline of the industry although it continues today as a small, artisanal fishery in the Philippines.

## III. Trawling

Mechanized trawling requires a vessel that is powerful enough to tow a large net through the water at a reasonable speed (typically 2-4 knots) and therefore the development of trawling did not generally take place until after the development of steam-powered vessels in the latter part of the nineteenth century, although a limited amount of beam trawling using sail-powered vessels was undertaken, including that by Japanese fishers in Manila Bay. It was at this time that the "first industrialization" of fisheries began in the British Isles. At first, steam-powered vessels were used to tow fishing boats out to fishing grounds and take catches to markets, but later the

power of steam engines was harnessed to drive fishing boats and haul in nets. The most important fishing gear at this time was the trawl net, which fishers employed to capture the abundant demersal populations of the English channel and then of the North Sea. As the fishery expanded the beam trawl, which is kept open by a beam at the entrance to the net, was quickly replaced by the otter trawl, which is kept open by the flow of water over the otter boards (or "doors") on the tow lines as the boat pulls the net through the water. In the late 1800s British trawlers moved further and further into the North Sea to maintain their catches, but fishing companies made great profits, as the income from the sale of fish to the rapidly growing market far outweighed the cost of sailing to more distant fishing grounds.

The profitability of steam trawlers and their ability to land large amounts of food to feed the growing urban populations of Europe planted the idea in the minds of a few entrepreneurs and officials that trawling might prove just as successful in the Southeast Asian waters. The first person to consider the possibility of capturing demersal fish in Southeast Asian waters by means of a trawler was apparently a Captain Eddie, the captain of a steamship. During discussions with British officials in 1894 Captain Eddie proposed that he be granted a monopoly on trawling in the waters around Penang and off the coasts of Perak and Selangor for two to four years and that he would pay the government a certain sum for the privilege. Eddie had experimented with a trawl net and had apparently had very good results, but he dumped his catch before returning to port and said he would not reveal where he had fished or what he had caught or order a steam trawler from England until the Government agreed to his request. The areas for which he had requested to be granted a monopoly had great potential for trawl fishing, but because they had so little information to go on and they were in any case reluctant to grant a monopoly, officials refused Eddie's request and no one took up his idea of trawling in this area for many years.

The design of trawl nets in Southeast Asia may have some precedence in the fixed nets, known as *payang*, that were used off the coasts of Java and Madura and the Malay Peninsula in the nineteenth century to catch small and medium-sized pelagic fish. These nets were similar in design to a trawl net, with wings and a "cod end" and the upper part of the net supported by floats and the lower edge secured with weights. Similarly, fishers in the Philippines used a pair-trawl type net design, locally known as *sapyaw*, to also catch pelagic species. These nets, however, were not towed nets but fixed or lift nets. Therefore, perhaps their greatest importance in the development of trawling that was to come in the future was to provide the net making skills and familiar net patterns for manufacturing towed trawl nets.

The first attempt in the region at surveying demersal fish stocks and testing demersal trawling as a method of capture was made in 1907 when the Netherlands Indies Government refitted a steam barge, the *Gier*, to undertake surveys in the Java Sea and nearby areas using a small otter trawl. The trials that were undertaken were hampered by operational difficulties such as the net often becoming stuck in the soft mud and large cup sponges clogging the net. Despite these difficulties, some areas with good potential were identified by the end of the trials in 1911 and the conclusions of the survey were generally optimistic. In the report to the Government, which recommended a more commercially-orientated survey, it was emphasized that the *Gier* was not designed as a trawler since it used a small net and the vessel concentrated on surveying a number of areas rather than concentrating on the areas that were found to have high fish abundance. Despite these recommendations, no follow-up surveys were undertaken and, in fact, the Government actually reduced its commitment to fisheries surveys and research.

Other similar trawl surveys were being undertaken at about the same time, including the *Golden Crown*, which surveyed the Arakan coast of Burma in 1908–09 and later, under new ownership, surveyed the waters off the Straits Settlements, the *Albatross*, a steam beam trawler belonging to the U.S. Bureau of Fisheries, which surveyed demersal resources in the Philippines in 1907–08

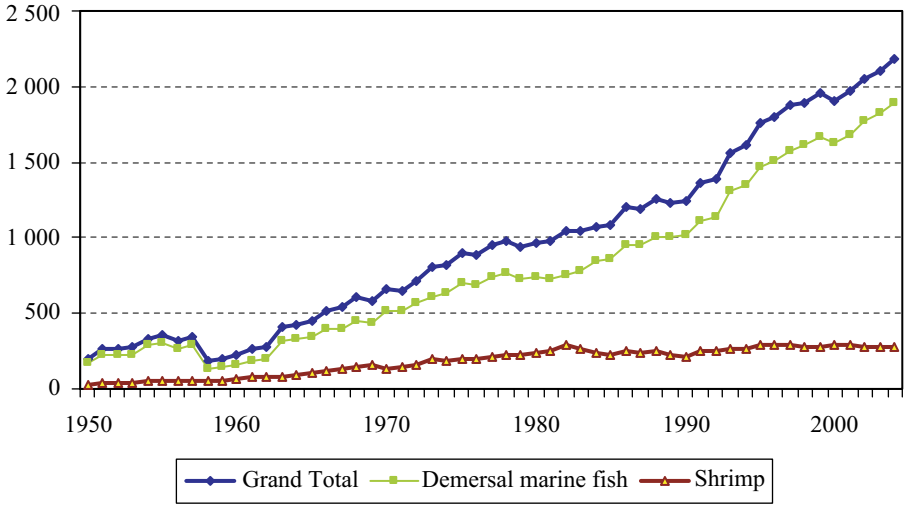
and the steam trawler *Tongkol*, which surveyed possible trawling grounds in the Straits of Malacca and the South China Sea in 1926–27. None of these surveys proved encouraging enough for further surveys or commercialization to be undertaken although, interestingly, all suggested that the use of otter trawls and other "modern" fishing methods operated from small motor trawlers in inshore areas and landing on a daily basis may have some potential rather than the larger, European-type trawlers in offshore areas. This recommendation had a cultural and commercial focus as well as being a response to the abundance of fish found. Local markets preferred their fish fresh rather than frozen and prices in local markets were not high, which made it difficult to operate large trawlers profitably.

As noted earlier, Japanese fishers had been operating beam trawls from sail-powered vessels in Manila Bay since about 1900 and, in the late 1920s, this fishery began to expand as the fishing companies operating there introduced diesel-powered vessels. By the early 1930s, virtually all of the beam trawlers had diesel engines and the trawlers had extended their operations well beyond Manila Bay. This expansion of activities prompted one of the first suggestions that trawling was adversely affecting other fisheries when Filipino fishers in San Miguel Bay complained to the President of the Philippines that the Japanese trawlers were reducing fish stocks, a claim that was supported by subsequent research. However, trawling activities in San Miguel Bay continued and, by 1980, 89 trawlers of various sizes were operating there. However, by this time, demersal stocks in the area, and other trawl grounds in the Philippines, had been depleted (in 1980, estimates of trawlable biomass in San Miguel Bay were only 1600 tonnes, about 20 percent of what the estimate was in 1948) and trawl operations had become economically marginal. No further significant growth of the industrial trawl fishery therefore occurred although trawling from dugouts, using very small nets, expanded gradually from the 1950s onwards and helped in maintaining a small trawl fishery for demersal species in the Philippines, which continues today.

Japanese fishing companies were also active in developing offshore pair- and otter-trawl fisheries in the 1930s in other areas of Southeast Asia, particularly in the waters around Taiwan, the South China Sea and off the coast of Viet Nam, including the Gulf of Tonkin where between 1935 and 1937 these trawlers caught an average of 11000 tonnes per year , mainly of species such as yellowback bream (*Taius tumifrons*) and other bream species. In addition, Japanese trawlers operated as far south as Sarawak and were also based in Singapore, apparently fishing in areas as far south as the northwest coast of Australia.

In contrast to most other fishing activities in the region at the time, these Japanese trawlers did not land their catches in the countries where they were taken but, rather, landed the frozen product to markets in Japan and Taiwan. These Japanese trawlers, together with Japanese operations in the Philippines constituted, therefore, the main trawling activities in Southeast Asia by the late 1930s since none of the surveys by European Governments or entrepreneurs had resulted in a viable trawl fishery using European-type trawlers.

Following the Second World War, demersal fish landings in the region recovered quickly to pre-war levels, despite the problems of the limited supply of vessels, fishing gear and other equipment. By 1950, demersal fish landings had reached around 166000 tonnes (in addition to some 43000 tonnes of shrimp) of which perhaps half came from trawling activities. These landings then increased rapidly, reaching about 1.7 million tonnes by 2002 in addition to about 600000 tonnes of shrimp. Although data on landings by fishing methods has not been consistently collected in the region, by far the majority of this increase in demersal landings has come from the expansion of trawling activities for demersal fish species, with the rate of increase having accelerated a little in the period after 1990 (Figure 3).




Unit: 1 000 tonnes

**Figure 3. Landings of demersal marine fish and shrimp species in Southeast Asian countries, 1950–2002 (source: FAO Fisheries Statistics)**

This increase in landings from trawling activities resulted from a number of developments in different countries. Japanese pair-trawling expertise was used to successfully develop both fish and shrimp trawl fisheries in the Gulf of Thailand in 1959 and, in 1961, a joint German–Thai Government initiative to introduce small-scale, inshore trawling in Thailand was hugely successful with the number of trawlers operating in Thailand increasing from 99 in 1960 to 2700 in 1966. Catches from these vessels correspondingly increased from around 59 000 to 36 000 tonnes (representing about 57 percent of total Thai landings and about 64 percent of total regional demersal landings) during the same period. Interestingly, these large increases in landings, particularly for species not suitable for human consumption (which represented about 40 percent of total trawl landings), helped support and develop ancillary industries such as pelletized feed and duck production. Without a market for these so called "trash" fish, the profitability of this fledgling industry would have been a lot less than it otherwise was.

As the number of trawl vessels in the Gulf of Thailand increased rapidly and catch rates (and profits) declined, the fleet looked for other opportunities. Thai trawlers moved further afield and, by 1974, had begun fishing on the west coast of Viet Nam, Burma, Sarawak, the east coast of Malaysia and Java. The number of Thai-registered trawlers continued to grow with the exploitation of these new fishing grounds and, by 1977, had reached 6300 with landings from these vessels totalling some 1.1 million tonnes.

The impact in the region of trawling by Thai vessels was profound. In Malaysia, despite a government rejection in 1958 of trawling as a potential direction for the fishing industry, trawling accounted for 48 percent of total landings of 440000 tonnes by 1974. The introduction of inshore trawling as a fishing method in the Straits of Malacca occurred in the early 1960s and was a direct result of the development and success of the Thai trawl industry although it is uncertain whether the initial impetus was provided by Thai trawlers operating in Malay waters or Malay operators visiting Thailand to learn trawling. As a result of this osmosis, the techniques and net design for otter trawling used in the Straits of Malacca was identical to that developed by the German–Thai fisheries project and used by the Thai vessels. The introduction of trawling to the Straits of Malacca was, however, fraught with conflict and violence with other fishers, particularly since the trawlers essentially ignored a ban on trawling operations within 12 miles of the coast and in waters less than 15 fathoms.

As the industry followed the development pattern of the Thai trawl industry, and the fishery was essentially unregulated, the number of vessels increased rapidly and catch rates declined. On the east coast of the Malay Peninsula, catch rates fell from 520 to 160 kg/hour between 1970 and 1981 while in the northern part of the Straits of Malacca, catch rates fell from 130 to 55 kg/hour during the same period. In both areas, Thai trawlers as well as Malay vessels contributed to the depletion of fish populations.

The success of the initial development of trawling in the Straits of Malacca prompted the development in 1966, by Chinese fishers based in Bagan Si Api Api, of a similar trawl fishery on the western shores of the Straits, in Indonesia. With supporting government investment incentives, the industry expanded rapidly, driven by investment by Japanese fishing companies and, from the start, targeted shrimp for the Japanese market (see Section V below) although significant quantities of demersal fish were also taken. However, unlike Thailand, there was not an immediate market for this "trash" fish and much of it was dumped at sea after sorting out the shrimp and valuable edible fish species. In 1969, the Government stipulated that foreign companies operating in the industry had to enter into a joint venture arrangement with local companies and, again, it was the Japanese companies that provided the capital for these joint ventures with local companies providing labour, capital and political connections. This development of a large trawl industry in Indonesia had profoundly transformed the Indonesian fishing industry in a few years.

Supporting infrastructure of freezing and cold storage facilities, harbours etc. followed the development of the fishery and, by the end of 1976, foreign investment in the Indonesian shrimp fishery totalled US$46 million with 51 cold storage facilities being operational. Exports of frozen shrimp increased from around 5600 tonnes in 1969 to over 35000 tonnes in 1979.

However, already by 1970–71, trawlers were having to move to new fishing grounds as catch rates declined in areas such as the Straits of Malacca. In 1971, 50 trawlers moved from Sumatra to the north coast of Java because of dwindling catch rates; trawlers moved for the first time to the south coast of Irian Jaya and a Japanese company moved its entire operations to east Kalimantan. Soon, however, these new areas also experienced dwindling catch rates: catch rates in the Arafura Sea approximately halved between 1973 and 1976, and total landings decreased in the area even though the number of trawlers had increased by over 30 percent. In 1980, it was reported that the size of shrimp in the Straits of Malacca, south and east Kalimantan, Cilacap and the Arafura Sea "had decreased tremendously". By the late 1970s, there were no more new areas to which the fleet could move and so, after reaching a peak of some 132000 tonnes in 1979, total landings of shrimp from Indonesia began to decline, partly a result of a ban on large trawlers implemented in 1980/81 (see below). It was to be another decade before Indonesian shrimp landings again reached that level of production.

Impacts of the trawl fishery were also felt in the declining abundance of demersal fish species in the areas where trawlers operated (particularly the Arafura Sea), made even more critical by the common habit of dumping "trash" fish at sea rather than landing and utilizing them, as was the case in Thailand. This led to several violent clashes between traditional fishers and trawlers and, between 1964 and 1976, according to official records, 62 vessels were sunk and 34 fishers killed in clashes between trawlers and inshore fishers.

In 1980, in response to these increasingly violent clashes and continuing complaints from inshore fishers, industrialized trawling was banned in all waters surrounding Java and Bali and in 1981 this ban was extended to the waters surrounding Sumatra. Trawling was still permitted in other areas, including the Arafura Sea where a requirement for the installation of by-catch reduction devices was also implemented, although probably not effectively enforced. Both shrimp and fish stocks recovered quickly as a result of the ban (the density of demersal fish in the Straits of

Malacca, for example, more than doubled from 1.2 tonnes/km$^2$ to 3 tonnes//km$^2$ between 1983 and 1985) and, with government assistance, small-scale fishers moved to fill the void left by the trawlers. In some areas, the number of small motorized vessels more than doubled in the early 1980s and total shrimp landings rebounded to pre-1980 levels by the late 1980s.

However, the ban on industrialized trawling was, like regulations controlling mesh sizes etc. in areas such as the Arafura Sea, never fully effective and, by the early 1990s, there was a resurgence of trawling, with many vessels operating illegally and also many being "licensed" by local authorities despite the supposed ban. In 1996, small-scale fishers in Jakarta claimed that more than 200 industrialized trawlers were operating within a kilometre of the coast and, inevitably, violent clashes between small-scale fishers and trawlers once again became common. By the mid-to-late 1990s, the trawl ban had ceased to be effective (except in areas where small-scale fishers were able to enforce it themselves by violence) and landings of shrimp and demersal fish species again increased, reaching over 280000 tonnes by 2002.

In other countries of the region, as well as Indonesia, the declaration of national Exclusive Economic Zones (EEZ) under the UN Law of the Sea Convention (UNCLOS) during the 1980s had a profound impact on the development of trawling activities in the region. Much of the waters that had previously been international waters (and in which Thai trawlers in particular had operated) now came under the jurisdiction of one or other of the countries of the region. The largest EEZs were those of the archipelago states of Indonesia and the Philippines. According to UNCLOS, the fishing fleets of those countries which had traditionally fished in the EEZ of another country should continue to be given access to those waters so long as the coastal state lacked the capacity to exploit the fisheries resources within its EEZ.

This prompted a flurry of development of national fishing industries and the setting of conditions for foreign access to demersal resources, particularly in those states such as Indonesia which had a huge EEZ, and terms of access for foreign fishing vessels became a useful bargaining chip in other diplomatic negotiations. These conditions often included a requirement to land the catch in the coastal state (which impacted the reporting of national landings statistics), employment of local labour and payment of access fees. However, in Indonesia, the enforcement of the conditions of foreign vessel access was again difficult as local authorities issued "permits" and lacked the required resources such as patrol vessels to effectively monitor foreign fishing activity.

Of the countries in the region, it was the Thai trawlers that had the capacity to fish extensively in other countries' EEZs and they continued to do this, often illegally, following the declaration of EEZs. Thai vessels operating within the EEZ of other countries often simply entered the EEZ without permission to seek fish. This led to numerous arrests of Thai trawlers in Viet Nam, Burma, Philippines, Indonesia and Malaysia but these arrests were only a tiny proportion of the Thai fleet which, in any case, had invested in faster vessels, detection equipment and weapons so as to avoid arrest. Many violent clashes occurred between national fishers and Thai trawlers in Burma, Viet Nam, Indonesia and other countries through the 1980s and 1990s in response to these illegal activities. Catches were most often shipped directly to Thailand or other markets by transport vessels and were not landed in the coastal state.

During the late 1990s, Thailand began to enter into joint venture arrangements with a few countries to allow their fleet to operate legally in other countries' EEZs. Such arrangements were entered into with Indonesia and Myanmar within the region and with other countries around the Indian Ocean rim. However, illegal fishing in foreign waters continued to be common and was exacerbated by the inability of Thai authorities to control the number of vessels in its own national waters, thereby providing incentives for these vessels to look further afield for their catches.

Despite early attempts at developing a trawl industry in the first few decades of the twentieth century, the history of industrialized trawling in Southeast Asia has therefore been one of unregulated, sequential expansion beginning initially with the development of the Thai trawl industry in the early 1960s. The successful expansion of the Thai trawlers to other areas within the region prompted parallel industrial-scale developments in other countries, most notably Indonesia and the Malay Peninsula although this expansion has been characterized by often violent conflicts with small-scale fishers in a number of areas. Throughout its development, landings of demersal fish and shrimp from industrial trawling activities have been dominated by three countries: Indonesia, Thailand and Malaysia, with these countries contributing 73 percent of total regional shrimp landings in 2002 and 80 percent of total regional demersal fish landings (FAO, 2004).

As Butcher (2004) notes, the development of trawling in the region occurred by the sequential exploitation of new areas with vessels maintaining and increasing landings by moving to new areas as stocks were depleted. Such sequential depletion has also impacted significantly on traditional fishers, often resulting in violent clashes as demersal stocks have, in many areas, been effectively transferred from small-scale fishers to the industrial trawl fleet. Attempts at regulating and controlling this industrial trawl development, where it occurred, were universally weak and ineffective.

In the 1970s, with the declaration by most countries of Exclusive Economic Zones through the UNCLOS process, the existing trawler fleet (which was mainly of Thai vessels) continued to operate and expand into other countries' EEZs while several national governments looked at ways of developing their own national fleets. With Thai authorities unable to control the number of vessels in their own waters, the Thai fleet has not only continued to expand but has also looked for opportunities beyond their own waters. This has led to a major issue of illegal fishing activities in many countries of the region, which has proved difficult to control.

Despite, or perhaps because of, this essentially unregulated development of industrial trawling in the region, landings of demersal fish and shrimp species have increased dramatically and are currently in excess of 1.7 million tonnes of demersal fish and 600 000 tonnes of shrimp (Figure 3). Although detailed statistics are often not available, most of the increases in these shrimp and demersal fish landings have come from the activities of industrial trawling, except in the Philippines where small-scale fisheries dominate and where demersal fish and shrimp landings have only increased marginally over the past three decades. In 1950, prior to the development of industrial trawling, the Philippines was the major contributor to demersal fish landings in the region, accounting for 76 percent of total regional demersal fish landings. By 2002, its contribution had shrunk to less than 20 percent (FAO, 2004).

With no more new fishing areas for the trawlers to exploit, the challenge for the region for the future is to not only bring illegal fishing under control but, in parallel with this, to develop and implement strategies that will limit the region's industrial trawl fleet to levels which will ensure long-term, sustainable demersal resources.

## IV. Push netting

Industrial push netting developed from traditional, small hand-operated push-nets and small boat-operated nets (dugouts, rafts and sailing boats) in the region. Fishing with traditional push-nets involves scooping or seining, usually along the bottom or just off the bottom in relatively shallow waters in estuarine areas, mangrove creeks, shallow bays and littoral areas. A bag net connected to poles is pushed forward through the water by hand to catch coastal marine animals such as shrimp, crabs and fish. Traditional push-net fishing operations of different scales

are reported from Indonesia, Malaysia, Myanmar, the Philippines, Singapore and Thailand. The most visible push-net fisheries in the region are those off the Gulf of Thailand covering the Thai and the northern Malaysia (Terengganu) coastlines.

In the wake of fishery industrialization, some push-net fisheries have developed beyond the non-motorized or hand-held operations and, since 1970, the efficiency of this traditional equipment has increased by using motors rather than manpower (in the Manila Bay, Philippines [Silvestre *et al.*, 1987] and Gulf of Thailand [Nagalaksana, 1987]). This change allowed for push-net fishing farther from the shore and a larger sized net. Push nets are non-selective and it is believed that motorized push-net fishing boats are causing the deterioration of marine animal resources and the coastal ecology in shallow, near-shore areas.

In Thailand, the Department of Fisheries imposed a 3 km near-shore fishery limit to exclude trawling and push netting but the number of push-net boats has increased and there have been warnings from many local communities regarding push-net fishing boats operating illegally within the 3 km near-shore limit. The rapid development of the commercial trawling and purse seining fleet resulted in economic hardships for small-scale, coastal fishers who became less competitive, forcing them into these illegal fishing activities, which is particularly damaging to the resource because of the high percentage of juvenile shrimp and fish species captured with this gear (Nagalaksana, 1987). Controlling push-net activities in the near-shore zone has proven difficult (Suvapepun, 1996). The use of artificial reefs in these shallow waters has been recommended as a means to deter both push-net fishing and trawling (Pramokchutima and Vadhanakul, 1987).

In Thailand, a total of 354 push-net fishing boats were registered in 1970, the first year of registration. In 1974 there were 740 registered push netters with a length of between 14 and 18 m (out of a total fleet of 3241 vessels, representing 22 percent of fishing vessels) operating mainly on the Gulf of Thailand seaboard (Everett, 1974). In 1984, a total number of 16006 fishing boats were registered to the Department of Fisheries of which 960 were push netters. (Pramokchutima and Vadhanakul, 1987). By 1989, the number of boats had increased to 1907. A census of marine fishing in 1995 counted about 4000 push-net boats, of which 1142 were lar ge boats, and noted a trend toward even more such boats. Large boat push-net poles are about 28 to 44 m long with a net mesh size of between 0.5 and 1.5 cm. The push-net poles of small push-net boats are 6 to 15 m long, with approximately the same size of net mesh as large push-net boats. Push-net boats are still operating in many areas such as Prachuapkhirikhan, Chumpon, Suratthani and Pattani provinces and in some extreme cases the legs of the push-net have been extended to allow push netting in deeper waters beyond the near-shore zone up to depths of around 30 m.

Push-net boats harvest both large and small marine animals. In Thailand, those with economic importance such as shrimp make up about 40 to 45 percent of the total catch; the balance, some 60 percent which are classified together as trash fish, include juveniles of economic marine animals such as sardines, spider crabs and drum fish. These juvenile economic fish constitute some 65 to 70 percent of the trash fish total. The remaining 30 to 35 percent are true trash fish. It has been estimated that in one year the total push-net harvest from boats of all sizes is 26289 tonnes, of which 15–16 percent are lar ge shrimp, 8–9 percent are spider crabs, 7 percent are fish, 4–5 percent are squid/cuttlefish, and the balance a mixture of other species.

## V. Purse seining

Although simple purse seining for pelagic species had been carried out in the region since the nineteenth century, the impetus for the development of an industrial-scale purse seine industry was, perversely, often the serial declines in a number of areas of demersal fish species which were taken by trawl fishing, which has been discussed above. In many cases, which will be further elaborated below, declining demersal fish stocks stimulated the search for new fisheries and, with mechanized vessels available, purse seining of pelagic fisheries was an obvious choice.

In the nineteenth century, various surrounding nets came to be used like purse seines, with the ability to close the lower end of the net by pulling a rope that passed through lead rings hanging from the lower edge of the net. Such nets were used, for example, in the Mollucas to catch a variety of pelagic fish and were often used in conjunction with fish aggregating devices, locally known as *rumpon*. In Cebu, fishers modified traditional floating nets to act as purse seines and these were extensively used by the 1930s to take flying fish. In the Philippines, a traditional purse-shaped net known as *sapyaw* was used prior to the 1920s to take large quantities of *Sardinella* although this net did not have a closing mechanism and needed to be positioned beneath the fish school, rather than surrounding them. After the 1920s, some operators in the Philippines adopted a net locally known as a *kubkuban* which was a small purse seine net (240 m long, 20 to 40 m deep and with a very large mesh) operated from a single large double-outrigger vessel. Because of the large mesh, larger pelagics such as mackerel were targeted.

By the early 1900s, sail-powered Chinese junks based on Hainan Island and on the Chinese mainland were operating purse seine nets (as well as trawl nets) in the Gulf of Tonkin. In 1910, between 600 and 700 such junks paid for a fishing permit at Cac Ba Island and many others were apparently fishing illegally. Butcher (2004) estimates that these vessels took 20000–25000 tonnes of prepared fish back to their home ports annually . Similar vessels (operated by Chinese from Hainan and each supported by three smaller tenders) were later used to develop purse seining in the Gulf of Thailand and also for Indian mackerel in Malayan waters in the Straits of Malacca during the 1930s, using nets that were about 310 m long, 50 m deep and with a 1.27 cm. Contemporary records show that catches varied enormously, and ranged from about 300 kg to 12 tonnes in a single haul.

A dramatic development occurred in the Straits of Malacca fishery in 1937 with the introduction of motorized vessels in place of the sail-powered junks. As a result of this development, landings of Indian mackerel at Pangkor increased dramatically, rising from 860 tonnes in 1931 to 5700 tonnes in 1938. The success of the venture stimulated local Malays to also begin purse seining, although the nets they used had larger mesh sizes than those of the Chinese purse seiners to enable them to be handled from their existing vessels. This resulted in landings of larger size mackerel, including, it is presumed, of Spanish mackerel.

Although developments of these traditional fishing methods resulted in increased landings, the increases were modest when compared with the dramatic increase in demand for fish and fish products, the increase in production from both aquaculture and from the developing trawling industry, and the increase in imports of fish products.

By the late 1960s, however, there were emerging problems with the large number of trawlers that were operating in areas such as the Gulf of Thailand and vessels were looking for new trawl grounds in the region. Drastic declines in trawl catch rates in the Gulf of Thailand and soaring oil prices prompted fishers to either modify existing vessels or have new vessels built for taking pelagic species, instead of trawl species. There were large stocks of pelagic species in the Gulf (particularly Indian mackerel) and methods such as purse seining required much less fuel than

trawling. The total pelagic catch in the Gulf of Thailand therefore increased dramatically from 63000 tonnes in 1971 to 480000 tonnes in 1977, a result not only of an increasing number of purse seine vessels but also because of the use of light lures and the move to new fishing areas within the Gulf. This latter factor resulted in the landing of species such as scads and sardines that previously had not been a significant part of the pelagic catch.

Also, during the 1970s and early 1980s, the Government of Thailand promoted the development of a canning industry by encouraging foreign investment. The first tuna cannery was established in 1972 as a joint venture between an Australian company (Safcol Holdings) and Thai and Hong Kong investors and by 1983 there were 30–35 canneries in operation. This demand for tuna from the canneries led to purse seine vessels targeting the abundant stock of small tuna such as longtail (*Thunnus tongil*), kawakawa (*Euthynnus affinis*) and frigate (*Auxis thazard*) tuna. However, the fleet by 1991 had to rely on tuna catches from foreign waters (including Malaysia and the Natuna Islands) since the stocks in the Gulf of Thailand had diminished significantly. The development of the canning, particularly tuna canning, industry in Thailand during the 1980s (which made Thailand the world's largest exporter of fish products by 1989, with 51 percent of global exports) was so rapid that canning capacity outstripped the ability of the fleet to supply raw product. This resulted not only in the Thai purse seine fleet seeking additional supplies in other waters of Southeast Asia, but, perhaps more importantly, also led to a rapid rise in the imports of frozen raw tuna, and other fish, for their canneries. By 1991, 79 percent of the 630000 tonnes of tuna that was canned in Thailand was derived from imported raw product. This demand for raw tuna for the Thai canneries therefore helped, in large part, to drive the development of tuna industries in other countries of the region, particularly the Philippines. The vast majority of this imported tuna originated from purse seine operations throughout the region, and, although a small quantity of tuna from pole-and-line and longline vessels was supplied to the Thai canneries, much of the tuna from these fisheries increasingly went to the Japanese sashimi market (see Section VI below).

As the fishery in the Gulf of Thailand developed without significant regulation, overexploitation of some pelagic fish species in the Gulf became evident and total landings in the Gulf fell steadily to 290000 tonnes in 1980.

In Indonesia, the development of the purse seine fishery was also influenced by the development, and subsequent problems with, the industrial trawl fishery. Although landings of pelagic species had been increasing substantially since the early 1900s (reaching 154000 tonnes by 1950 and 620000 tonnes by 1978 as both Chinese and Indonesian-owned purse seine vessels supplied newly built canneries and became the dominant fishing gear in Indonesia), the ban on trawl fishing in the 1980s accelerated the development of the purse seine fishery, particularly in the Java Sea. The Government, when banning trawling in the western part of the country, provided financial incentives for vessels to convert to purse seining, with the result that the number of purse seiners increased from an average of 810 during the period 1975–79 to 2100 in 1984–87. At this time, the larger purse seiners extended their operations into the eastern part of the Java Sea, with the result that landings by the Java Sea purse seine fleet increased from 49000 tonnes in 1975–79 to 140000 tonnes in 1984–87. After 1985, total landings (as well as annual landings per vessel) fell significantly, a result of overexploitation of the major species, particularly the small pelagics. Fortunately, the price of these fish increased at this time which enabled the purse seine fleet not only to survive economically but also expand to new areas in the southern part of the Makassar Strait and the waters between the Malay Peninsula and Borneo. The purse seiners also improved their technology, using light to attract fish and hence increase their efficiency. However, by 1995, total catches of pelagic species in the Java Sea had stagnated at around 150000 tonnes, roughly the same level as the early 1980s.

The catch by industrial purse seine vessels accelerated again after 1995, reaching 8 percent of the total marine catch of Indonesia by 1997 (FAO, 2000) as the vessels continued the expansion of their area of operations into the eastern areas of Indonesia, a process that had begun in the 1980s. In total, small-scale purse seine operations and industrial purse seine vessels together contributed approximately 17.6 percent of total marine production in Indonesia in 1997 (FAO, 2000) with the majority of this still coming from the small-scale sector, which continues to dominate the industry. However, the larger industrial purse seine vessels contribute much more in terms of value of the catch than the small-scale sector because they focus on high-value species such as tuna and other large pelagics whereas the small-scale fishers concentrate on inshore small pelagics in the western part of the country.

This expansion of industrial purse seiners into eastern Indonesian waters has been supported by the increased development of infrastructure such as tuna canneries and ports which also provide services to foreign fishing vessels. Purse seine vessels in the west of Indonesia fish for small pelagic species and are concentrated primarily in the Java Sea, South China Sea, Malacca Strait and Mollucas Sea. In general, these seiners range from 10 to 30Gross Registered Tonnage (GRT)[2], although in the last decade larger ones have been built, exceeding 100GR T. Purse seine vessels operating in the east of the country tend to be larger vessels, in excess of 100 GRT.

During the late 1970s, Japanese purse seiners were also expanding their operations in Southeast Asia and, in 1980, at least 14 vessels were operating off the north coast of Irian Jaya and Papua New Guinea, each taking about 15 tonnes of fish per day. As part of this operation, the Japanese vessels also captured large quantities of tuna in and around Indonesian waters.

In the Philippines, the traditional *kubkuban* purse seine net, in use since the 1920s, has continued to be used by small-scale, inshore fishers to take mackerel. In addition, in the 1950s, large-scale purse seining was introduced to the Philippines, probably by American tuna seiners operating in the eastern Pacific. The introduction included the use of nylon nets and power blocks for hauling the net. As the new fishing method was taken up enthusiastically, with trawlers being converted to seiners and secondhand Japanese purse seine vessels being imported, the move to purse seining was further supported by government incentives and assistance from a United Nations Special Fund project in importing nylon nets and other equipment.

At first, the increasing number of purse seine vessels (there were already 48 operating by 1966) targeted small pelagic species but, because of the large quantities of fish being landed and the lack of onshore processing facilities to handle the catch, prices collapsed in the late 1960s. With this price collapse, together with warnings that increasing fishing on small pelagic species may lead to a reduction in the quantity of fish available, vessels began to turn their attention to tuna. By 1975, purse seining for tuna in the Philippines had increased dramatically, aided by the development of fish aggregating devices, locally called *payaw*, around which the purse seiners as well as handline fishers operated. The *payaw* is particularly effective for aggregating skipjack and yellowfin tuna. Recorded tuna landings in the Philippines exploded from about 23 000 tonnes in 1973 to 220000 tonnes in 1977 although statistics are imprecise because of factors such as unrecorded foreign catches and the practice of Filipino vessels selling their catch to foreign vessels at sea.

Since the late 1970s, catches from tuna purse seining in the waters of the Philippines have increased only slowly, with recorded landings reaching about 300000 tonnes by 1997 and 400000 tonnes by 2002. However , during this time, Filipino operators of tuna purse seiners have expanded their operations considerably to other areas in the Indian and Pacific Oceans and these

[2] GRT is a measure of the capacity of the vessel below the main deck and differs from weight measures of vessels, such as displacement tonnage. See footnote 3 for details of the units of measurement for vessels.

increases in recorded landings partly reflect this expanded fishing area as well as the targeting of other, smaller tuna species. Purse seining remains, however, the most common form of commercial fishing gear in the Philippines with 61 percent of operators using this gear, 15.7 percent using ring-nets and 12.4 percent using bag nets (FAO, 2005a). By contrast, only 3.7 percent of small-scale fishers use the small traditional purse seine or *kubkuban.* The purse seines, ringnets and handlines usually account for over 80 percent of the annual tuna catch, with nearly half the commercial tuna catch in 1995 taken by purse seine.

In addition to tuna, commercial purse seiners target small pelagic species, particularly roundscad, sardines and Indian mackerel. Together, these small pelagic species accounted for 47 percent by weight of overall commercial landings in 2003 (FAO, 2005a) from all gear types with tunas comprising the remainder. However, the proportion derived only from purse seine operations has not been reported. Because of their lower value, the small pelagic species comprise a much smaller proportion by value of the total commercial catch.

The shift in emphasis in a number of countries such as Indonesia and the Philippines in the 1960s and 1970s from demersal trawling to purse seining of small pelagics and, later, tuna, has also prompted other countries of the region to examine purse seining. In Viet Nam, some purse seining was undertaken early in the twentieth century by Chinese junks operating in the Gulf of Tonkin, as noted above. However, Viet Nam has not developed its own offshore purse seine fleet to any great extent although small purse seine vessels have, for some decades, taken small pelagic species in inshore waters. Although the inshore fishery is dominated by small trawlers, the offshore fleet of some 20000 vessels includes only about 100 vessels (with engines of 400–500 horsepower) which have the capacity for deep-sea fishing. This fleet comprises either trawlers or purse seiners. Trawlers are used in waters 35–80 m deep in southeastern waters, whereas purse seiners fish pelagic species in deep waters, mainly off the central region. The estimated percentage of the total catch from major types of fishing gear (FAO, 2005b) are; trawling 30 percent, purse seine 26 percent, gillnet 18 percent, lift net 5 percent, longline 6 percent and others (fixed net, push-net etc.) 15 percent. However, the development of offshore fisheries (including purse seining for tuna) has been vigorously promoted by the Government and has been included in a recent long-term strategic plan for the fisheries sector (FAO/Fishcode, 2004).

The expansion of purse seining by Thai vessels in particular also impacted the waters of Cambodia. Although Cambodia has a traditional, small-scale purse seine fishery, which operates in inshore waters to take Indian mackerel and anchovies (FAO, 2005c) together with small quantities of tuna, it has not developed a national industrial-scale purse seine fleet. Foreign purse seine operations in the waters of Cambodia, using industrial scale vessels, has, however, long taken place, often by Thai and Japanese vessels and this currently includes illegal operations. No data are available on the number of vessels involved or their catches.

While small-scale purse seine fisheries have a long tradition in many countries of the region, the development of industrialized purse seine fisheries in Southeast Asia accelerated following the initial decline in demersal fish stocks in the late 1960s. This development led to a search for new fisheries and, most importantly, for employment for the vessels and crew that were engaged in demersal trawling. Subsequent support of the boatbuilding industry in several countries and the increase in oil price in the 1970s also added to the attractiveness of vessels moving into the purse seine fishery.

With the decline in small pelagic stocks and reduced prices, the purse seine vessels turned their attention to tuna fishing in the early 1970s, particularly in the Philippines where this development was assisted by the use of fish aggregating devices. In addition, most of the purse seine fleets

expanded out of their national waters in search of tuna (and also, to a lesser extent, small pelagic species) and it was this expansion and the move to tuna fishing that supported continued expansion both of the purse seine fleet and their catches. However, since the purse seine fleets were operating both inside and outside their national waters (both legally and illegally) and landing their catch in various places, the statistics on landings, the place of capture and the number of vessels operating are notoriously unreliable.

While the expansion of the tuna fisheries (and, to a lesser extent, small pelagics) is still occurring in some areas, and countries such as Viet Nam are still looking to expand their industrial purse seine fleet, most stocks of small and large pelagic species within the national waters of countries of the region are considered to have reached their peak production. Examining the region's large-scale marine ecosystems (LMEs), Sugiyama *et al.* (2004) concluded that small pelagic stocks in the region had either peaked or were fluctuating in all areas except within the Sulu-Celebes Sea, the Indonesian Sea and the South China Sea LMEs where they were still increasing while large pelagics had either peaked or were fluctuating in all areas except the South China Sea LME. They also noted that the small and large pelagic resources in all areas generally had peaked after the demersal stocks, which is consistent with the known development of the trawl and purse seine fisheries in the region.

In the Philippines, recent studies on pelagic fisheries indicate overfishing and declining catch per unit effort (CPUE). Exceptions are in lightly fished areas in waters off Palawan, parts of the country's Pacific coast and some parts of Mindanao. Such findings are supported by an observed change in species composition, i.e. anchovies have partially replaced sardines, scads and mackerels in the catch, an indication of gradual stock collapse (Green *et al.*, 2003).

Like the demersal resources, the potential for expanding landings of small and large pelagic species by purse seining in the region therefore appears limited and the challenge for national governments is to move to long-term control and management of their existing fishing fleets. There are some encouraging signs that this is happening. Several countries (e.g. Viet Nam and the Philippines) have recently introduced new fisheries laws and, in the Philippines, the Government has made a significant policy shift by introducing joint management mechanisms of the fisheries sector, involving both the central government and the municipalities, and the fishers, through Fisheries and Aquatic Resources Management Councils.

However, much remains to be done in bringing long-term, sustainable management to purse seine operations in the region.

## VI. Shrimp trawling

The development of shrimp trawling in the region paralleled the development of demersal fish trawling and, in many areas, shrimp were taken as a by-catch to demersal fishing. However, in Indonesia, the development of trawling in the 1960s was, from the beginning, specifically targeted at catching shrimp and Gulf of Mexico-type shrimp nets, rather than demersal fish trawls, were used.

The increasing interest in shrimp in the Indonesian trawl fishery, as well as in other areas, coincided with a growing demand for shrimp in Japan. It is therefore not surprising that Japanese companies were involved in the development of the Indonesian shrimp fishery, initially by themselves and, after 1969, as partners in joint venture arrangements with Indonesian fishing companies. Between 1967 and 1971, one wholly owned Japanese company and about 10 joint ventures began operating shrimp trawlers in the Straits of Malacca, the waters off Kalimantan and the Arafura Sea.

Supported by Japanese capital investment, these joint ventures were vertically integrated undertakings, operating a range of trawlers which delivered the catch to their own freezing and cold storage facilities and exporting the product. Exports of frozen shrimp from Indonesia rose from 5600 tonnes in 1969 (valued at US$873000) to 35000 tonnes in 1979, valued at over US$200 million. As the prices paid for shrimp increased substantially and additional freezing and cold storage facilities were added, landings and exports continued to increase dramatically as small-scale fishers and independent trawlers sold their product to the cold storage and export companies, and vessels travelled further to find new fishing grounds.

During the 1980s, the declaration of Exclusive Economic Zones also had a profound impact on shrimp trawling in the region. Countries with extensive EEZs were able to continue to expand their shrimp trawling operations (supported by onshore cold storage facilities and onboard freezing) while countries with smaller EEZs had greater difficulty in accessing shrimp grounds beyond their own EEZ. Because of this, the shrimp catches of Indonesia (FAO, 2004) continued to increase throughout the 1980s and 1990s (rising from 117000 tonnes in 1980 to 288000 tonnes in 2002) while those of Malaysia stagnated, declining from 84000 to 76000 tonnes during the same period.

As the price of shrimp increased dramatically in the late 1960s and early 1970s, trawl fisheries that had been established in other countries, particularly Thailand and Malaysia (see Section III above), targeted areas where good shrimp catches could be taken, although they continued catching and landing demersal fish. For example, between 1965 and 1972, the proportion by weight of shrimp to demersal fish landed in Malaysia increased from 38 to 59 percent and in Thailand it increased from 54 to 71 percent (FAO, 2004). However, shrimp stocks in most areas were soon under pressure and the focus returned to demersal fish species, particularly since the price of shrimp started to decline with the introduction in the early 1970s of shrimp culture in the region and its subsequent explosive growth over the next two decades. In Thailand, for example, the proportion by weight of shrimp to demersal fish in the landings declined from 71 percent in 1972 to 35 percent in 1992 (FAO, 2004; see also Figure 3).

In 2002, 73 percent of total regional shrimp landings of about 623 000 tonnes came from just three countries: Indonesia, Thailand and Malaysia — a similar percentage (72 percent) to that from the same three countries in 1970. However, in 2002, Indonesia's landings had increased to 287 990 tonnes or about 46 percent of total regional landings compared with only 50 200 tonnes or 22 percent of regional landings in 1970. By contrast, Malaysia's share of total regional landings fell from 22 percent in 1970 to 12 percent in 2002, as landings there increased only slightly over the 32 year period.

With the possible exception of Indonesia, shrimp trawling in the region is inextricably linked to a more general, multi-species demersal trawl industry that takes fish, shrimp and other species. Its development and future direction therefore very much depends on the relative prices for shrimp and other species of the demersal trawl catch (and their relative abundance) since these relative prices will, in large part, determine the species that are targeted by trawl vessels. In this regard, the development of shrimp aquaculture in the region, and in other parts of the world, is a major factor since it has led to a long-term decline in world shrimp prices. These declining shrimp prices have probably eased the pressure on shrimp stocks and, throughout the region, shrimp now comprise a smaller proportion of demersal catches than at any other time (see Figure 3). Whether this is a result of fewer shrimp, because of overexploitation or habitat degradation, or an active targeting of other species, it is not possible to judge from the little data and analyses that are available.

## VII. Tuna longlining, poling and purse seining

As noted in Section IV above, purse seining activities in the region, although initially targeting small pelagic species, had, by the early 1980s, begun to target various tuna species and also expanded their operations to the eastern part of Indonesia, the coasts of Irian Jaya and further afield. Initially, Japanese purse seine vessels led this expansion although vessels from the Philippines and Indonesia quickly followed.

The taking of tuna in the area, however, was a traditional fishery practice in many countries. In the nineteenth century, trawl-shaped nets (locally called *payang*), trolling using lures made from feathers and longlining (locally called *rawai*) were all common fishing methods in the western islands area of Indonesia, Singapore and Malaya (Butcher, 2004) and took not only small tuna species but also other large pelagics and, in the case of longlining, demersal species such as sharks and rays. In the Mollucas, pole-and-line fishing for skipjack tuna was also a common fishing method and involved the use of live bait and barbless hooks with a piece of feather as a lure. By the early 1900s, Japanese fishing vessels had begun fishing in a number of countries of Southeast Asia. Japanese trollers, driftnetters and *muro ami* (a net for specifically taking fusiliers, family *Caesionidae*) fishers had established themselves in Singapore by the 1920s and, in the 1930s were taking, in addition to fusiliers, shad, small sharks and other species, both skipjack tuna (*Katsuwonus pelamis*) and bigeye tuna (*Thunnus obesus*) by trolling. Although the catches of these species were not large (about 100 tonnes were landed in 1932), the development is significant in that it introduced deepwater trolling for these species to the region.

The Japanese were also active in developing the pole-and-line fishery for skipjack tuna (although, as noted above, there was a traditional pole-and-line fishery for tuna in the Mollucas), which was mainly caught for the Japanese market and formed part of a broader skipjack pole-and-line fishery that extended beyond Southeast Asia into the Pacific coast of Japan and the western Pacific Ocean. Beginning in about 1910 the Japanese started developing bases in the region, and by the 1930s they had them established in a number of countries including at Ambon, Manado, Ternato, Davao, Zamboanga, Si Amil Island and Aertembaga. These bases were used as receiving, processing and exporting depots and produced not only dried tuna stick (known to the Japanese as *kasuobushi*) but also canned product. The pole-and-line technique used was similar to that used in the Mollucas and involved bamboo poles, live bait and barbless hooks. However, the Japanese also introduced the technique of spraying water on the sea surface, giving the illusion of even more small fish.

While accurate statistics on this fishery are scarce, one company based at Zamboanga landed 1100 tonnes of skipjack and 260 tonnes of immature yellowfin tuna in 1938, with the fleet fishing over a wide area that included the Sulu Sea, Moro Gulf, Celebes Sea and the Davao Gulf. The pole-and-line fishery seems to have been favourably received and, as one researcher in the Philippines commented in 1940 (quoted by Butcher, 2004, p.158), the pole-and-line fishery is "not conducive to depleting the tuna fishing grounds" although the use of purse seines for catching tuna "should be discouraged as much as possible in Philippines tuna grounds since the purse seine was far less selective in what it caught than the pole and line".

During this period, the Japanese were also exploring the development of a deep water longline fishery for tuna and, by 1932, had factory ships operating in Sumatran waters that processed and canned yellowfin tuna on board for the Japanese market. By 1941, the Japanese had conducted longlining activities in the South China, Sulu, Celebes, Mollucas and Banda Seas as well as the Pacific Ocean between New Guinea and Mindanao and the Indian Ocean.

In the year after the Second World War, Japanese activity in tuna fishing in Southeast Asia declined dramatically. However, the potential of tuna stocks in the region was well recognized. In 1950, in recognition of the virtually unexploited status of tuna in the Philippines, a company began operating longliners that had been brought from Taiwan. However, the venture failed. By 1970, however, companies that operated freezing and processing plants began supplying fishers with small vessels and hand troll lines to take large yellowfin tuna for export to Japan. By the late 1970s, the fishers based at General Santos City were landing about 40 tonnes of yellowfin tuna per day.

A major development in the tuna fishery in the Philippines came in 1975 with the development of a fish aggregating device, locally known as a *payaw*. This floating fish lure was used by both the purse seiners (described in Section IV) who targeted skipjack and juvenile yellowfin tuna and by the hand-line fishers who targeted large yellowfin and bigeye tuna. This combination of purse seine and hand-line catches brought about a spectacular increase in tuna catches in the Philippines, which rose from 23000 tonnes in 1973 to 220000 tonnes in 1977.

By the early 1950s, however, Japanese vessels had begun to return to longlining and pole-and-line fishing for tuna, including in waters around Indonesia and the Philippines, as well as the Indian and Pacific Oceans. The catching vessels were supported by mother ships, taking their catch directly back to Japan. The nature of this fishery meant that landings statistics for tuna in the region are certainly underestimated with the extent of underestimation being related to the extent of this type of foreign fishing.

The Japanese longliners involved with mothership operations varied in size from 20–50 tonnes to over 200 tonnes but, according to a 1963 report, were typically 100–200 GRT[3] . These longliners targeted yellowfin tuna but also took significant quantities of bigeye tuna and operated initially in the western areas of the Banda, Celebes and Mollucas Seas (which were international waters in the 1950s) but quickly spread their operations westwards into the Indian Ocean. In 1968, and in response to Indonesia's territorial seas claims, Indonesia and Japan signed the Banda Sea Agreement which provided access for Japanese tuna longliners to areas of the Banda Sea and to Indonesian ports for payment of an annual fee. This Agreement lasted until 1975, when the Indonesian Government attempted to establish its own tuna longlining company, Perikan Samodra Besar (PSB), although this company then entered into a new agreement with the Japanese to allow continued access to the tuna fishing areas in the Banda Sea, but under much stricter conditions than before.

With a move away from canned tuna and towards sashimi product in the 1970s, the Japanese longline fleet in Southeast Asia declined as longliners began targeting species such as southern bluefin tuna in the Indian Ocean and the vessels remaining in Southeast Asia shifted their emphasis away from yellowfin to species that were more suitable for sashimi product, such as bigeye tuna. In the Banda Sea area, yellowfin tuna comprised about 75 percent of total tuna catches in 1974, but by 1980 bigeye tuna made up 50–75 percent of the catch. The better targeting of bigeye tuna was achieved by changing the method of longlining from surface to deep longlines, set at 100–300 m below the surface. This development of "deep longlining" therefore extended the area available for fishing deeper into the water column and led to continued expansion of landings throughout the region during the 1980s.

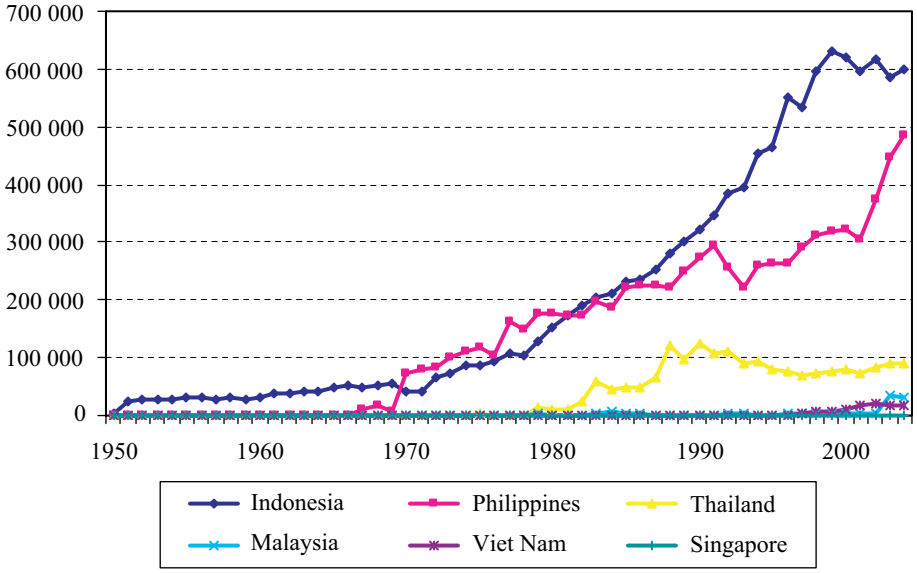
[3] Butcher (2004) notes that the original sources for this information quote both "tons" and Gross Tonnage (GT) for the size of vessels. It is presumed that "tons" refers to displacement tonnage and that GT refers to the vessel's capacity, including the area above the top deck. This is different to, and usually greater than, GRT which refers to the vessel's capacity, excluding the area above the top deck. No conversion to a standardized unit of measurement of vessel size has been attempted, or is possible without knowing the detailed design of the vessels.

The Japanese pole-and-line fishery has always been more important in the areas around the Philippines and the eastern seas of Southeast Asia than around the western areas and, in 1970, their main area of operation was the Philippines and the northern tip of Borneo. Because of their reliance on live, small baitfish (which are generally found in inshore waters), the pole-and-line vessels are not able to fish in areas remote from land. This reliance on land-based operations also meant that Japanese pole-and-line vessels, unlike purse seine vessels or longliners, could not operate without close relationships with the coastal states and therefore, Japanese operations in places like the eastern areas of Indonesia and the Philippines were more often under joint-venture arrangements.

However, by the mid-to-late 1970s, Japan was taking steps to replace its pole-and-line vessels with purse seiners, which were proving a much more efficient and profitable method of taking tuna. This also coincided with the Japanese longliners move from canned product to sashimi product (and the consequent shift in targeted species) and increased fishing by Japanese vessels in the Indian Ocean. These two developments resulted in an overall decline of Japanese tuna fishing activity in Southeast Asian waters and allowed the fledgling pole-and-line and longline industries in countries such as Indonesia and the Philippines to further develop. As noted above, purse seining and trolling, using the *payaw* fish aggregating device, developed rapidly in the Philippines after 1975 and by 1980 in Indonesia the PSB company, established in 1975, was operating seventeen 111 GRT[4] tuna longline vessels off Bali and Sumatra although they had reverted to targeting yellowfin tuna by sub-surface longlines rather than bigeye tuna with deep longlines. Three pole-and-line tuna companies were also formed and operated 29 vessels off Irian Jaya (in areas where the Japanese had formally fished) by the early 1980s. At that time, the Government of Indonesia was anxious to support a local tuna industry and supported these, and other, tuna longlining and pole-and-line companies financially, enabling them to expand their operations during the 1990s.

In 2002, Indonesia and the Philippines were the dominant tuna fishing nations in the region, accounting for more than 85 percent of regional tuna landings (Figure 4). While the majority of these came from purse seining (see Section IV above), trolling, pole-and-line and longline vessels were major contributors to tuna landings, and were particularly important in the small-scale fisheries of both countries. The statistics on tuna landings for the region shown in Figure 4 are, however, highly questionable because of the nature of the tuna industry and the nature of the national reporting systems. For example, tuna taken in the Philippines by Japanese vessels and landed in Japan are unlikely to appear in the national statistics of the Philippines and, likewise, tuna taken by Thai vessels in Indonesia are likely to appear in the national statistics of Thailand, not Indonesia. These issues need to be taken into account when considering tuna landing and production statistics for the region, although the overall upward trend in landings for the region may not be influenced as much by these factors.

[4] GRT measurements were used in the original report quoted by Butcher (2004). See footnote 3 regarding units of measurement for fishing vessel capacity.




Unit: tonnes

**Figure 4. Landings of tuna (all species) by all methods by country in Southeast Asia, 1950–2002**

## VIII. Driftnetting

Driftnetting has a long history in Southeast Asia, with the nets originally being made from coconut or ramie fibre imported from China. In areas such as the Straits of Malacca, Borneo, the Mollucas and Java, the landings from driftnets probably accounted for the majority of the catch in some areas during the nineteenth century. The traditional use of such nets were to set them in the evening and haul them in the morning with catches consisting of species such as shad, Spanish mackerel, wolf herring and small sharks, depending on the area fished and the mesh size of the net. The fishery in these early years was undertaken exclusively by small-scale fishers operating nets that were typically 110–400 m in length.

However, by the late 1920s, Japanese fishers based in Singapore had begun using driftnets in the Straits of Malacca and, by the early 1930s, there were two Japanese companies specializing in driftnetting there. These fishers undertook driftnetting on a much larger scale than the Malays and Chinese fishing in the Straits, using a 25 tonne vessel[5] with a 50 horsepower engine to tow several smaller sail-powered fishing vessels from Singapore. Each of these smaller vessels operated nets that were some 900 m long and the catch was iced and returned to Singapore on a regular basis by a transport vessel. The fishing vessels therefore were able to stay fishing for long periods of time without returning to port. Catch rates were about 90 kg per vessel per day, compared with the Chinese and Malay vessels' catches of about 9 kg per day. In 1932, the Japanese driftnetters landed 1400 tonnes of fish, mainly of Spanish mackerel, wolf herring, small sharks and shad, which comprised some 13 percent of total landings in Singapore.

By the end of the Second World War, the Japanese driftnetters, like other Japanese fishing fleets, no longer operated in the Straits of Malacca. However, their methods of using motorized vessels to tow smaller vessels to the fishing grounds and to transport the catch to market were soon adopted by local fishers. By the 1950s, outboard motors were becoming readily available and one of their first uses was to power existing craft that were used for driftnetting, particularly in

[5] The original report quoted by Butcher (2004) uses "tons" as a measure for vessel size and this presumably refers to displacement tonnage. No conversion to a standardized measure of vessel size is possible. See footnote 3 on issues relating to the measurement of vessel size.

the Straits of Malacca and the Malay Peninsula. The pace of mechanization of fishing vessels, and the impact that this had, cannot be overestimated – in 1947, about 1 percent of vessels in the Malay Peninsula were mechanized while by 1965, 55 percent of vessels had engines.

This increasing mechanization not only allowed catches to be transported from the fishing grounds to the market but also allowed vessels to follow fish schools, thus extending the area which was fished. At the same time, nylon nets began to replace the traditional fibre or cotton nets and, in 1958, it was noted that "drift net catches in the Malacca Straits have doubled with the replacement of cotton by synthetic fibre resulting in an increased supply of Tenggiri [Spanish mackerel] and Parang [wolf herring] to the west coast markets" (Anon, 1958).

In Indonesia, driftnetting for the same species as taken on the Malay Peninsula had also had a long history and the Japanese driftnetters based in Singapore in the 1930s also operated near the east coast of Sumatra within the Straits of Malacca. Indonesian fishers, however, continued to use small nets and sail-powered craft both on the east and west coast of Sumatra, Java and Borneo and the contribution to total catches from driftnetting remained small. In the 1950s, the number of vessels and fishers in Indonesia began to increase dramatically, from 80000 vessels in 1951 to 200000 in 1961, an increase of 120000. However , much of this increase was in non-motorised, traditional craft, which increased by 115000 vessels.

In contrast to the 55 percent of the fishing fleet in Malaya that was motorized by 1965, in Indonesia only 1.4 percent of the fleet was motorized by 1967 (Butcher, 2004, adapted from his table 6.6). Driftnet fishing in Indonesia, therefore, continued using traditional small nets and sail-powered craft, although the number of such craft evidently increased substantially during the 1950s and 1960s. When motorization of the fleet came to Indonesia in the late 1960s, it spurred the development of the trawl fishery (see Section III) but was adopted more slowly by other sectors such as the driftnet fishers. As a result, the importance of the driftnet fishery in Indonesia declined as a percentage of total landings as the landings from the trawl fishery increased rapidly.

After the trawl ban imposed by Indonesia in 1980 and 1981 in western parts of the country (see Section III), there was a rapid recovery in inshore demersal and pelagic fish stocks, despite the trawl ban being only partly effective. At the same time, the Government provided easy credit for the building of new vessels and imposed no restrictions on other forms of fishing, apart from trawling. This resulted in both an upgrading and mechanization of vessels (the number of motors about doubling during the early 1980s and the number of fishers increasing by a third) and an increase in both the number of motorized and non-motorised vessels. Although it is not known how the driftnet fishery was impacted by such changes, it seems reasonable to assume that driftnet fishers also took advantage of this situation to upgrade vessels and fishing gear so they could better target the increased abundance of fish in inshore waters.

In 1998, the number of fishing vessels in Indonesia had reached about 334000 (F AO, 2000) with 57 percent of them still without motors. Most of these were involved in small-scale traditional and subsistence fishing and, in 1998, this small-scale sector contributed 94.6 percent of total marine landings of 3.27 million tonnes (FAO, 2000, but total landings data apparently show a typographical error and therefore have been corrected in accordance with FAO, 2004). The purse seine fishery (17.64 percent), lift net fishery (8.26 percent), trammel net (5.02 percent) and the skipjack and yellowfin tuna pole-and-line fishery (3.08 percent) were the most important fisheries with driftnetting remaining a very minor component of overall landings.

Driftnet fishing also remains the preserve of small-scale fishers in most other countries of the region. In the Philippines, small-scale (or "Municipal") fishers took about 922000 tonnes of fish

in 2003 (Anon, 2005a), which represented about 45 percent of total landings. Although the most common fishing method used by these Municipal fisheries is hook and line, a fixed or floating gillnet contributed around 45.5 percent of total Municipal small pelagic landings in 1995 (Zaragosa *et al.*, 2004). Small pelagic species are by far the most important component of the Municipal landings and these are also caught by other fishing methods (Zaragosa *et al.*, 2004) such as hook-and-line (15.3 percent of total Municipal landings), ringnet (11.5 percent), beach seine (8.3 percent), purse seine (3.7 percent), fish corral (2.9 percent) and bag net (2.9 percent).

In Viet Nam, fixed and floating gillnets are also significant contributors to the landings from the inshore small-scale sector, with 18 percent of total landings in 2003 coming from these nets (FAO, 2005b). However, no distinction is made in the landings data between the types of net although at least some of these gillnets are operated as small driftnets. Drift gillnetting is, and always has been, more important in the northern parts of Viet Nam (including Ha Long Bay and the Gulf of Tonkin) than in the south although current statistical data (Anon, 2005b) does not allow the separation of landings and other data by fishing method.

## IX. Trolling

Trolling was a well established fishing method in many areas of Southeast Asia (particularly the Straits of Malacca, the Philippines and the western islands of Indonesia) by the nineteenth century with unbaited hooks, and a lure made from chicken feathers being towed behind sail-powered vessels to take small tunas and Spanish mackerel.

Like driftnetting (see Section VII), the Japanese that who were based in Singapore from the 1920s transformed the way in which trolling was conducted in the region and, in the 1930s, were taking both skipjack tuna (*Katsuwonus pelamis*) and bigeye tuna (*Thunnus obesus*) by trolling. Although the catches of these species were not large when compared with the driftnet fishery discussed in Section VII (about 100 tonnes were landed by trolling in 1932), the development is significant in that it appears that it introduced deepwater trolling for these species to the region. Skipjack inhabit deep coastal and oceanic water while bigeye tuna seldom appear at the surface, but are abundant at thermocline depths and therefore the landing of quantities of these species would indicate that the Japanese trollers had developed techniques to fish in deep offshore waters. In 1932, it was reported that these fishers, using motorized vessels, were working in areas remote from Singapore as far as the Anambas and Natuna Islands, the northern entrance to the Straits of Malacca, the Mergui Archipelago and the coasts of Borneo.

With the cessation of the activities of the Japanese troll fishers after the Second World War, trolling in the Straits of Malacca and other areas reverted to the operations of small, local, sail-powered vessels and further development of this sector was intimately tied to the rate of mechanization of the small-scale fishing fleet. As discussed in Section VII, in Malaysia and also in Singapore, this mechanization occurred rapidly during the 1950s and 1960s whereas in Indonesia and the Philippines, it occurred more slowly. As a result, a return to the use of mechanized vessels for trolling, and the exploitation of waters remote from the vessel's home base, pioneered by the Japanese, occurred more quickly in Malaysia and Singapore than in other countries. Malaysia and Singapore, therefore, were able to sustain a small dedicated troll fishery, mainly for tuna, whereas in other areas trolling was often undertaken by small-scale fishers as an additional activity (often as they made their way to and from fishing grounds) to demersal hand-lining, gillnetting and other methods. In no area, however, was trolling a dominant activity.

In the Philippines, the development in 1975 of a fish aggregating device, locally known as a *payaw*, impacted significantly not only on the purse seine industry (see Section IV) but also on fishers who were taking tuna by hand-trolling. The tuna *payaw* (see Section IV) was a larger

version of a similar lure that inshore fishers had traditionally used for small pelagic species, except the tuna *payaw* was placed between 35 and 110 km offshore, about 11 km apart from each other and in waters up to 3000 m deep. The rafts were "harvested" every 5 or 6 days. The cooperation between the two groups of fishers was significant with trollers and hand-line fishers targeting the larger tuna species that were attracted by the smaller prey fish but which swam at depths out of reach of the purse seine net. The hand-line and troll fishers watched over the *payaw* in return for the privilege of fishing there. This combination of purse seine and hand-line catches brought about a spectacular increase in tuna catches in the Philippines, which rose from 23000 tonnes in 1973 to 220000 tonnes in 1977.

Apart from this positive interaction between purse seine and troll fishers, the development of the tuna purse seine industry in the region (and, to a lesser extent, the pole-and-line fishery) also impacted negatively on vessels that were using trolling to take tunas. As the appetite of Thailand's tuna canneries grew through the 1980s and the Thai purse seine fleet moved into new waters to meet the demand of the canneries, the total catch by the Thai fleet of small tuna species suitable for canning jumped from 20000 tonnes in 1981 to 170000 tonnes in 1992, but then, as they ran out of new areas to exploit, the catch began to decline. One of the impacts of this intensified fishing on small tunas by the Thai trawlers was that catches by Malaysian trollers operating off the east coast of the Malaysian Peninsula collapsed.

Trolling, like driftnetting, remains primarily an activity of the small-scale fisheries sector in Southeast Asia, particularly in Indonesia, Malaysia and the Philippines. However, unlike driftnetting, trolling for tuna and other pelagic species is generally undertaken as an adjunct, and often opportunistic, activity to other fishing operations. Because of this, and because of its relative small importance in most areas, statistics specific to this fishery are usually not available.

## X. Other industrial fishing operations, including failed types of industrial fishing

While much of the large-scale industrial fishing technology in the region, such as purse seining and trawling, has been introduced by expansion from other areas of existing fishing methods, there are a number of large-scale production technologies that have developed from existing techniques used by small-scale fishers. Perhaps the most important of these is the technology of fixed stake nets used in various parts of the region, and particularly the *muro ami* net that was first introduced by Japanese fishers to Manila and Singapore in 1919 and later into Batavia in 1925. These nets, which were portable fixed nets secured to coral reefs, were used to take fusiliers (Family *Caesionidae*) around the reef areas and quickly became so important that, for example, between 27 and 42 percent of all fish landings in Singapore between 1931 and 1938 were fusiliers from *muro ami* nets. Similar developments occurred in Batavia (where, in the period 1935–38, 25 percent of all fish sales were fusiliers from *muro ami* fishing) and in the Philippines where a single *muro ami* team typically landed 70–80 tonnes of fish per month in the late 1930s.

The technique, however, was so effective that it not only quickly resulted in declines of the stocks of reef fish but also impacted severely on the coral reefs where the nets were used. This was particularly so during the period 1945–1960 where the technique was used on a vastly increased scale in the Philippines with mother vessels, large nets and very large teams of divers and fishers being used to serially deplete coral reef areas in the region. However, by the 1980s there was an increasing concern about not only the heavy fishing pressure on coral reef fish stocks, but also on the physical damage that was being done to coral reefs in the Philippines and the South China Sea and the employment of children in the dangerous work of diving.

The technique was first banned in the late 1980s in the Philippines but later permitted using a modified *moru ami* net (called *pa-aling* fishing) which did lesser damage to the coral reefs. However, the technique was finally banned under Section 92 of the new Philippines Fisheries Code in 1998 because of the continued destruction of coral reefs and a study which concluded that stocks of reef fish, particularly on isolated reefs in the South China Sea, had been severely depleted.

In the transition from subsistence fishing using traditional techniques to the development of industrial fishing techniques to supply a rapidly increasing regional population, there were a number of other ventures that were tried but were not successful. Some of these, such as the attempted introduction of diving bell technology into the pearl shell industry in the 1870s, failed because they were inappropriate technologies while others (such as the early attempts at demersal trawling and purse seining for small pelagics) failed because they were pioneering attempts at introducing new industrial fishing methods and therefore, although failing, provided the experience for others to later successfully introduce similar technology. Throughout the history of fishing in the region, fishers in Southeast Asia have been characterized by their ingenuity in developing innovative ways of catching fish using local materials or materials available at the time. For example, items such as marine engines and munitions were abundant after the Second World War and were used to power fishing vessels and, particularly in the Philippines, to capture fish using explosives. However, this tradition of innovation has often been restricted to small-scale fishers where the costs of experimenting with innovation were minimal.

Innovation in the industrial fishing sector has also been entrepreneurial and opportunistic (and often assisted by government financial incentives) rather than the result of any detailed analysis of the long-term risks and rewards of investment in the fishing industry. Some of these government financial incentives were spectacularly successful (such as the promotion of a fish canning industry in Thailand in the 1970s) while others were less so. In several instances, development of new fisheries production methods occurred rapidly despite government policies, such as in Malaysia where, despite a government rejection in 1958 of trawling as a potential direction for the fishing industry, trawling accounted for 48 percent of total landings of 440000 tonnes by 1974. However , the common factor that unites both successful and unsuccessful government intervention and incentives for investment has been the often scant regard that has been paid to the capacity of the fisheries resource to support the proposed development. The region is littered with examples ranging from national government support for the unregulated development of the trawl industry in Thailand and Indonesia in the 1960s to the support, up to 1998, of large-scale *moru ami* fishing discussed above.

## XI. Conclusions

The study by Butcher (2004) highlights the boom-and-bust nature of development of industrial marine fisheries in the region over the past century or so as, one by one, stocks and habitats were exploited in an often uncontrolled, unregulated manner and, when these were depleted, the fleet moved on to the next area or stock. This sequential plunder also occurred across fisheries as the declining economic performance of one fishery spurred the transfer of vessels and fishers to a new, developing fishery (very often with government assistance) which in its turn also declined. However, the point was reached in about the 1980s where there were very few new, underexploited areas for fleets to move to within the region and very few new types of fisheries that fleets could transfer to. This remains the situation in the region today.

This boom-and-bust nature of development of industrial fishing has severely impacted on the small-scale fisheries in the region, which still account for the vast majority of landings (up to

94 percent of total landings for example, in Indonesia) and this led in the past, and continues to lead to, violent clashes between industrial and small-scale fishers.

Another issue highlighted by the analysis of Butcher (2004) is the poor state of even basic statistics on landings, fishing methods and fishing effort. This lack of statistics from the past has made the analysis by Butcher (2004) on the development of fisheries in the region very difficult and often reliant on isolated, qualitative information which, nevertheless, Butcher has assembled from an impressive range of sources. There has never been and there remain today virtually no statistics that are collected on a regional basis (an important gap since many stocks cross national boundaries and are fished by fleets from a number of nations) and there is no consistent regional approach to the type and methodology of statistics collection. In addition, most national statistics are poor both in the extent of their coverage and precision. The basic data upon which to assess the impact of fishing on fish stocks and to make informed fisheries development and management decisions was, therefore, never collected in the past and this important gap in knowledge remains today.

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