

Chapter 2

Unsettled Seas: Towards a History of Marine Animal Populations in the Central Indo-Pacific

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Abstract A central theme of this book concerns the importance of historical perspectives for understanding the challenges that confront marine capture fisheries in the twenty-first century. This chapter explores this theme in relation to the Central Indo-Pacific, a body of water that lies at the geographic and geopolitical heart of the different case studies brought together in this volume. The Central Indo-Pacific is one of the world's principal marine biogeographic realms. It is made up of the eastern Indian and western Pacific oceans, and the seas linking the two—the South China Sea, the seas and straits of Southeast Asia, the Coral Sea, the waters separating Australia from Indonesia and Papua New Guinea, and Australia's northern continental shelf. Here, I cover a period similar to the timeframe of the book's other chapters, which extends from the late nineteenth to the early twenty-first century. This was a period of profound transformation in the marine fisheries of the Central Indo-Pacific, brought about by the intensification of established fisheries and the advent of new industrial fishing practices. My aims are two-fold: to discuss some of the challenges that confront marine environmental historians working in this region; and to describe the major patterns to the transformation of fishing during the period under review, which propelled the Central Indo-Pacific to the centre of the global expansion of marine capture fisheries.

Keywords Asia fisheries history · Oceania fisheries history · Indo-Pacific fishing history · HMAP Asia · Marine environmental history

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Catch statistics for most Central Indo-Pacific fisheries are available only from 1950 onwards, when the FAO began to collect information on fisheries production globally. These statistics point to the truly massive expansion in harvests of wild fish and other marine animals in the second half of the twentieth century. Between 1950 and 2000 the fishing fleets of Asia and Oceania, the two continental regions that border the Central Indo-Pacific, increased their recorded marine catches by 422 and 1,218% respectively, against a global average of 344% (Watson and Pauly 2013). This growth was driven by a series of innovations in fishing vessels, gears, and fish-finding technologies, which in the case of the Asia produced a 25-fold increase in effective fishing power, and by a relentless expansion of the geographic frontiers of fishing activity that moved at an average rate of 1° of latitude per year during the period 1950 to 2000 (Swartz et al. 2010). There is, however, more to the history of this expansion than is revealed by analysis of catch and effort data. The maritime peoples of South Asia, Southeast Asia and the South Pacific have strong indigenous fishing traditions, and the intensification of existing and predominantly small-scale fishing practises in response to economic and demographic growth was a major factor in the expansion in capture fisheries. The second major factor involves the advent of industrial fishing, or fishing powered by fossil fuels, which facilitated the remarkable increase in fishing power. A third and related factor lies in the increasing presence of foreign fishing fleets, particularly the Japanese, in Central Indo-Pacific seas. Together, these developments help to explain the dramatic transformation of marine capture fisheries that took place between the late nineteenth and early twentieth century (Fig. 2.1).

The Marine Environment

The hallmark of the Central Indo-Pacific is its high level of biodiversity, with the Coral Triangle, the 'global centre of marine biodiversity', at the very heart of region (Allen 2007). This rich biological diversity is a factor of the complexity of the marine environment on broad physical and ecological scales. In their global system for the regional classification of coastal and shelf areas, Spalding and his colleagues delineate 12 separate provinces and 41 distinct ecoregions within the Central Indo-Pacific biogeographic realm (Spalding et al. 2007). As this scheme suggests, the outstanding feature of this realm is the extent of its shallow coastal

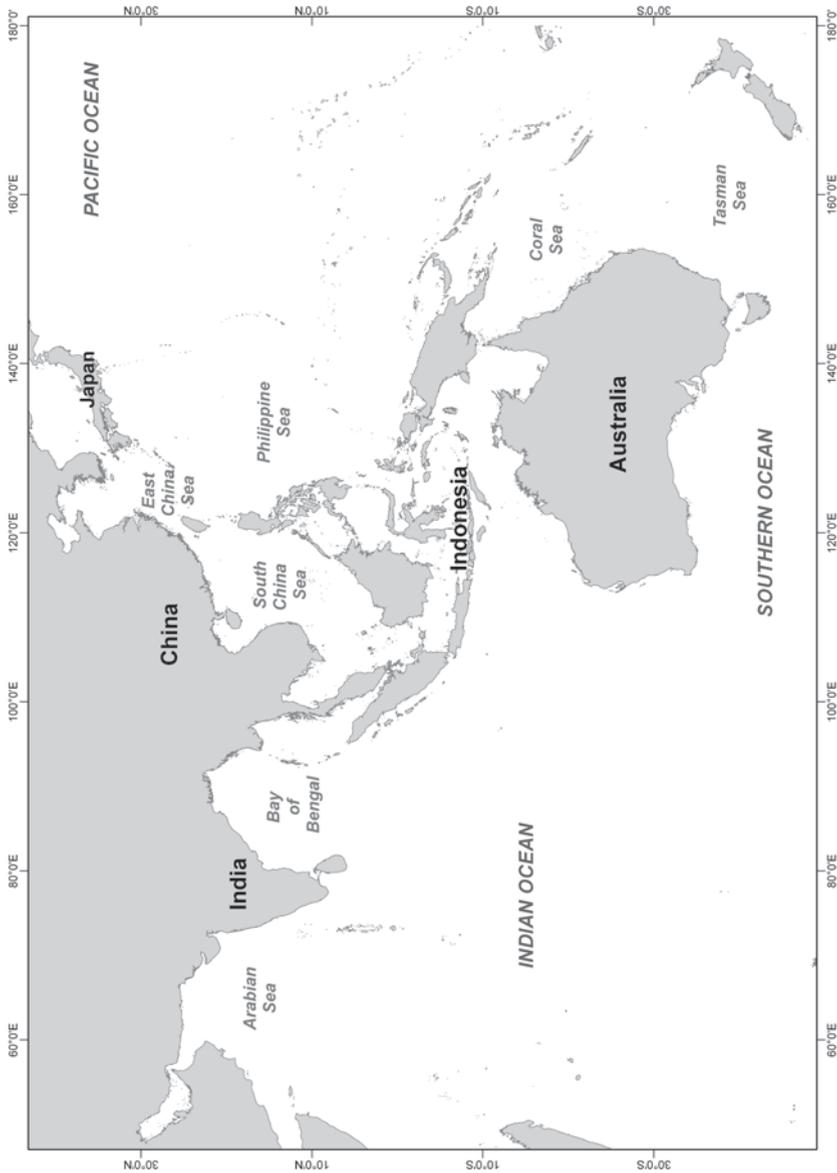


Fig. 2.1 Map of the Central Indo-Pacific

and shelf, as opposed to oceanic, waters. Two large shelf areas, which together form around one-fifth of the shelf area of the entire globe, lie at the centre of the Central Indo-Pacific. The Sunda Shelf encompasses the coastal waters of Burma, the Malacca Straits, the Gulfs of Tonkin and Thailand, the southern part of the South China

Sea, the Java Sea, and parts of the Philippines. The Sahul or Arafura Shelf is located to the south and comprises of the Timor and Arafura Seas separating Australian and Indonesia, the Gulf of Carpentaria, and Torres Strait. All of these waters are less than 200 m deep, and many parts are 50 m or less. Deeper basins are formed by the eastern parts of the Bay of Bengal and the Andaman Sea, the northern half of the South China Sea, the Sulawesi, Flores and Banda Seas, the Coral Sea, the Arafura Sea between Australia and Papua New Guinea, and the Timor Sea and Northwest Australian shelf between Australia and Indonesia. South of Java, west of Sumatra, and north and east of Papua New Guinea are narrow shelves and deep seas in close proximity to the coast. The island chains that fall within the Central Indo-Pacific, which include the Marianas Islands, the Caroline Islands, Micronesia, the Solomon Islands, Fiji, Tonga, and Vanuatu, are also characterized by narrow shelf areas and the relatively close proximity of deep oceanic waters (Longhurst 2007).

Across these seas there is considerable variation in terms of tides, currents, and salinity. The Central Indo-Pacific lacks the vast upwellings of cold and nutrient-rich waters of the kind that sustain fisheries in the North Atlantic and off the coasts of California and Chile. Instead, the climatic variations associated with the monsoon, a system of alternating winds and rainfall active either side of the equator, profoundly influences surface currents and the flow of freshwater into the sea, which in turn affects the salinity and turbidity of the water at different times of the year. As the monsoon varies seasonally according to the El Niño-Southern Oscillation (ENSO), caused by prolonged differences in water temperatures between the tropical eastern and tropical western Pacific Ocean, localised and regional oceanographic conditions can vary considerably from year to year. Areas of localised upwellings, such as the eastern part of the Banda Sea, the existence of nutrient-rich river discharges and estuarine systems, and the high biomass of coral reefs, mangrove forests and seagrass meadows, all of which occur extensively in these waters, are the main drivers of biological productivity across the Indo-Pacific as a whole. The deeper basins and oceanic waters are very different from the coastal and shelf areas, being marked by significantly lower levels of primary productivity. Yet these waters nonetheless support large populations of tuna, billfish and other pelagic fishes, a factor that has been attributed to the simplified conditions for breeding and foraging behaviour that result from the highly stratified water column that exists in these waters (Longhurst 2007).

Many States of the Sea: Marine Environmental History in the Central Indo-Pacific

The History of Marine Animal Populations (HMAP) initiative proposes two general principles in relation to the study of past patterns of diversity and abundance in the marine environment and the historic impact of humans on marine populations. The first concerns data sources. Human fishing activity has historically been concentrated in coastal and near-shore environments or, in other words, in that part of the

sea that is most accessible to people. Such areas constitute the ‘the human edges’ of the ocean, and represent the areas where historical records are most abundant and hence where knowledge of past interactions with the marine environment are most likely to be recoverable (Holm et al. 2010). The second principle concerns methodology. Research in marine environmental history and historical marine ecology required a fundamentally interdisciplinary approach that draws on history, archaeology, marine science, and ecology. These principles underpin some of HMAP’s main insights, which are to clarify both the potential and pathways for recovering knowledge of oceans past and to sharpen understanding of what is likely to always remain beyond the reach of human understanding (Holm 2003; Holm et al. 2010). HMAP’s principles are also universal, applying to all the world’s seas across time. Yet the Central Indo-Pacific region is not as straightforward a prospect for marine environmental historians as the seas of Europe and North America, a situation that helps to explain why Asia and Oceania have yet to attract the same level of attention as the extensively studied and better understood marine animal populations of the northern hemisphere. In this section I discuss some of the reasons why marine environmental history presents such a challenge in the Central Indo-Pacific.

In the first instance, an important distinction needs to be made between histories of general sea fishing, or fishing that yields food for human consumption, and high-value fisheries linked to long-distance trade networks, such as whaling, pearling, trepang or beche-de-mer fisheries, and fisheries for tortoiseshell, trochus, cowries, and chank. Whereas the former have tended to be neglected, the latter fisheries have been the subject of a number of detailed studies including several studies undertaken from a historical-ecological approach (e.g. Schwerdtner Mánez 2010; Schwerdtner Mánez and Ferse 2010; Anderson et al. 2011). Whaling, pearling and trepang fishing in particular share similar historical characteristics. In essence these relate to a comparatively early entry into global trading networks and the methodical exploitation of marine resources by large and mobile fishing fleets, linked to the demand for high-value commodities in markets often located at considerable distance from the seas where such resources are exploited: the market for whale oil and other whale products in Europe and North America; for trepang and other marine exotica in China; for pearls in Persia, India, China and Europe, and for mother of pearl in Europe and North America. By virtue of their link to global trading networks these industries produce more extensive historical records, often accessible in European archives, which helps to explain why a more extensive historiography exists (Boomgaard 2005). By contrast, there is little historical literature relating to the history of general sea fishing. John Butcher’s *The Closing of the Frontier* (2004), a history of the marine fisheries of Southeast Asia between the mid-nineteenth and early twenty-first centuries, is the outstanding exception to this general neglect. Three factors in particular combine to make the marine fisheries of the Central Indo-Pacific such a challenging prospect: one relates to the nature of the marine environment; a second relates to the nature of human society; and a third relates to the broader history of human society in this part of the world.

The rich biodiversity of the Central Indo-Pacific is reflected in the variety of species that have been harvested across time for human consumption. These warm

tropical and subtropical waters provide a habitat for many tens of thousands of species of worms, corals, crustaceans, molluscs, echinoderms, fish, reptiles and marine mammals, which along with phytoplankton, algae, seagrasses and detritus form complex ecosystems that are, even today, at best only partially understood (Butcher 2005). This means that we are dealing with many hundreds of, if not several thousand, exploited species, ranging from whales and dugongs, to turtles, to fish of every size, to shellfish collected by hand along the shoreline. There are two important consequences that arise from this high level of diversity. The first is that most fisheries tend to be multi-species rather than single-species, where fishers readily switch target species, location and even gears in response to weather conditions or the vagaries of fish behaviour in order to obtain an adequate catch on any given day. This is a feature common to most tropical fisheries, and it makes it difficult or even impossible to determine the composition of catches across time (Allsopp 1977). The second consequence of high biodiversity relates to the problem of naming. A wealth of indigenous names for the same or similar species once existed across this extended region, and although many of these names are still used, a great many are only poorly recorded in the present and many others are now rarely used and may not have been recorded at all. The converse of this problem is the tendency for Europeans and speakers of European languages to refer to many different species by simple generic names. ‘Snapper’, a name that applies to over a 100 species in the Lutjanidae family of fishes, is perhaps the extreme example of this tendency, although other common names such as ‘shark’, ‘mackerel’ and ‘tuna’ have also been applied in the past to a range of species that may not even occupy similar ecological strata nor bear more than a superficial resemblance to the Northern Hemisphere fishes after which they are named (Fig. 2.2).

Secondly, in relation to human society, it must be noted that the coastal peoples of South Asia, Southeast Asia, the South Pacific Islands, and northern Australia possess a wide diversity of social and political systems, cultures, and languages. This has certainly been the case in the past, and remains true today. In terms of fishing, this translates into an almost bewildering array of fishing techniques and technologies across time. Of equal significance is the characteristic that most fishing communities share in common across this region. Fisherfolk are traditionally amongst the most socially marginal members of society. The vast majority of traditional fishers across Asia and the Pacific have historically been illiterate peoples, and part of communities that lie at the very margins or even beyond the authority of centralised states, at least on a practical basis (Firth 1966; Reeves et al. 1988; Pearson 2003). This creates a problem in terms of historical records, insofar as they simply don’t exist for many fisheries across the region before the second half of the twentieth century (Butcher 2004). Furthermore, extensive areas of the Central Indo-Pacific are highly vulnerable to natural disasters such as typhoons or tsunamis or to the activities of pirates and slave raiders, which may cause discontinuities or silences to appear in the historical records that do exist.

The third challenge relates to history, or rather, to the periodization and chronology of Central Indo-Pacific fisheries. Models that explain changes in fisheries across time propose three principal phases of development, moving from ‘Aboriginal’

Fig. 2.2 JW Lewin, *Fish Catch at Dawes Point* (Sydney Harbour, 1813). Reproduced by permission of the Art Gallery of South Australia



or subsistence exploitation of coastal and near-shore environments using simple technologies, to ‘Colonial’ fisheries involving systematic resource exploitation within the frameworks of developing market economies, to the ‘Global’ era where marine resources exploitation is incorporated into global patterns of consumption and trade (Jackson et al. 2001). Another approach involves looking at the nature of data sources. The documentary sources for marine environmental history can be divided amongst three chronological categories: a ‘historical’ period that covers an extended era when archival and other records are mainly unscientific or otherwise unsophisticated; a ‘proto-statistical’ period, which covers the period from the mid-nineteenth century when port, customs and other similar records become abundant; and a ‘statistical’ period, which begins around 1900 with the collection of the first national or regional data on catches (Holm et al. 2001). Neither of these approaches fit comfortably with the pattern of historical change in Central Indo-Pacific fisheries, where the development of general fisheries cannot be so easily divided into neat chronological divisions. This is because the transition from indigenous to colonial to global fisheries in Southeast Asia, South Asia, and Pacific is strongly confounded across space and time, or in other words, it tends to take place in different places at different times (Jackson et al. 2001). Instead, one of the defining features of the twentieth century is the transformation and intensification of artisanal or small-scale fisheries alongside, and sometimes in competition with, the development of new kinds of industrial and globalised fishing, a situation that continues in some places even today.

Within this context a few simple conclusions can be reached. Broadly speaking, the size and structure of any marine animal population in the Central Indo-Pacific at any given moment is an outcome of three factors: ‘natural’ factors, or long-term and cyclical environmental changes; the nature and intensity of human predation; and human modification of the environment, including pollution and habitat destruction. As a general rule, the second and third of these factors become

significantly more important causes of change in population size and structure during the era of 'industrial fishing', or fishing that is powered by fossil fuels, an era that dawned with the introduction of steam trawlers to the North Sea in the 1880s and the subsequent spread of new kinds of fishing vessels and gears to other parts of the world (Cushing 1988; Roberts 2007). During the 'Great Acceleration' of industrial fishing after the Second World War (WWII) this nexus involving human fishing pressure and habitat modification as drivers of ecosystem change intensifies (Holm 2013), although the relative impact of different causal factors and the links or synergies between them remain poorly understood, and even in the late twentieth century it was generally only the most important commercial species that tended to attract any significant level of scientific attention (Cowen et al. 2007; Roberts 2012). The implications are straightforward. Although in an ideal scenario historians would write about the environment using the same analytical categories and concepts as ecosystem modellers so as to yield the fullest insights that a historical perspective can offer, this is often impossible for the vast majority of Central Indo-Pacific fisheries.

Instead, it is possible only to speak in terms of generalisations and basic principles. What can be said with confidence is that, as time has gone by, more and more marine animals have come within the reach of humans trying to catch them, and that humans have developed the power to catch particular animals over more and more of their range. This has meant that wild populations have ever-smaller refuges that are free of fishing pressure, or as Callum Roberts has written, that increasingly fish have 'no place left to hide' (Roberts 2007). This in turn creates the potential for more and more populations collapsing, but collapse has not been inevitable, since the impact of fishing is also related to the life history characteristics of a particular species. How vulnerable animals are to fishing pressure depends on a range of factors, although the species most vulnerable to overfishing typically possess one or more of the following characteristics: they are commercially valuable; have small population sizes; are easily caught due to their size, habits of feeding or breeding or regular movement through particular areas; attain reproductive capacity at a relatively late age; produce relatively few offspring; are confined to a narrow ecological niche; or are not highly mobile (Butcher 2005). The selectivity of fishing gears is also crucial. Gears such as harpoons, handlines, and small nets such as beach seines are highly selective and unlikely to directly impact on non-targeted species in any significant way. On the other hand, advanced techniques have the potential to be highly destructive. Industrial fishing has been estimated to reduce ecosystem biomass by an estimated average of 80% within the first 15 years of exploitation (Myers and Worm 2003). Modern purse seines are capable of taking entire shoals of schooling pelagic fishes, and are implicated in the by-catch of species such as dolphins and turtles. Longlines can devastate long-lived populations of large ocean predators and also record high levels of by-catch for non-target species including seabirds. Trawling is perhaps the most destructive practise of all through the indiscriminate capture of non-target species and the often devastating impact on benthic species of corals and sponges wherever demersal trawls are used (Butcher 2004). In other words, the impact of human harvesting activity on marine animal population should not be

considered solely in relation to targeted species. Rather, the full impact of fishing practises must be taken into account, in terms of by-catch and habitat destruction, wherever the nature of historical records allows.

The Transformation of Marine Fisheries in the Central Indo-Pacific

Fish has always been a staple foodstuff of the island and coastal populations of South and Southeast Asia, northern Australia and the Pacific, but despite this, there are relatively few examples of long-distance or bulk trade in fish for human consumption in the period before the mid-nineteenth century. This can be explained by the difficulties in preserving fish in large quantities in tropical climates, the limitations on fast and efficient transport in the age of sail, and most importantly of all, by the ability of traditional fisheries to meet local needs from resources located in coastal and near-shore waters. The trade in dried and salted fish from the Persian Gulf and other parts of the western Indian Ocean to India, and trade in pastes and sauces made from fermented and salted fishes like shrimp paste or *belacan* in Southeast Asia, are among the main examples that can be highlighted (Reeves et al. 1988; Butcher 2004). Yet even these fisheries relied on simple methods such as stakes or hand-drawn nets, and employed small open vessels such as canoes or skiffs. Technological changes did occur during the nineteenth century, as with the adoption of metals for making fish hooks in the South Pacific Islands and the diffusion of beach seining from India to Sri Lanka (O'Meara et al. 2011; Paulin 2011). Most marine fisheries, however, remained characteristically small-scale and directed principally at meeting subsistence needs or localised demand, and across the Central Indo-Pacific as a whole, there remained a great diversity of practises and techniques employed by indigenous and artisanal fishers. As a result fishing pressure tended to affect the marine environment only on a localised scale, and there are few cases of systematic depletions of entire species through the demands of human consumption in the Central Indo-Pacific. The decline of dugong populations in Southeast Asian waters is one of the few examples that have been documented for this period (Butcher 2004).

John Butcher's *The Closing of the Frontier* (2004) describes the processes by which this situation was fundamentally altered in the Southeast Asian context by the expansion of marine capture fisheries that began in the second half of the nineteenth century. There are three broad and overlapping phases to this expansion, made up of an initial phase that witnessed the advent of industrial fishing practises and an intensification of established fishing practises to meet growing demand for fish as a staple foodstuff; a second phase, the 'great fish race', which begins after the WWII and involves the rapid expansion of industrial fisheries across the region; and a third period, the 'closing of the frontier', which coincides with the creation of exclusive economic zones (EEZs) by Southeast Asian nations, the exploitation of the last remaining commercially viable fish populations, and stagnating or declining harvests

as the limits to growth are reached. Butcher's main themes are the geographic and bathymetric extensions of the 'frontiers' of fishing that results from the intensification of established fisheries and the introduction of new and more powerful fishing gears, and the typical boom-bust pattern of fishing industries that sees the opening of a new fishing grounds leading inevitably to the decline of exploited stocks and a subsequent movement to more distant or deeper waters in search of untapped populations (Butcher 2004). To a large extent, these same processes played out across the Central Indo-Pacific as a whole during the late nineteenth and twentieth centuries. The remainder of this chapter outlines a brief history of marine fisheries, using a similar three-phase framework to make sense of the profound change in the nature, scale and extent of the human impact on the marine environment that has taken place during the last 150 years.

State, Economy, and Technology: The Origins of Intensive and Industrial Fisheries

In the 1800s it was common to find explorers and naturalists expressing their astonishment at the rich and varied marine life of the Central Indo-Pacific seas. For example, Alfred Russel Wallace wrote of Ambon harbour in the Indonesian archipelago that 'there is perhaps no place in the world richer in marine productions, corals, shell and fishes' (Wallace 1869). As the nineteenth century progresses, the literature on the sea and its products begins to take on a different character, where the prospects for the commercial development of fisheries is increasingly the focus of discussion. Francis Day, an ichthyologist who served as Inspector General of Fisheries in India and Burma during the 1870s, was one of the pioneers of this style of writing about the marine environment. His landmark *Report on the sea fish and fisheries of India and Burma* (1873), a work that also contains numerous references to the diversity and abundance of Indo-Pacific marine life, dealt extensively with the existing artisanal fisheries of British India and outlined a range of measures by which production might be expanded and new fisheries developed (Day 1873). More fisheries experts soon followed in other parts of the region. An early report on the fisheries of the Dutch East Indies was completed by colonial authorities in 1882 (Butcher 2004). In the late 1880s and early 1890s the English marine biologist William Saville-Kent travelled extensively through the Australian colonies as an advisor on fisheries development, including extended visits to two colonies with waters extending north of the Tropic of Capricorn, Queensland (1889–1892) and Western Australia (1893–1895); the marine fisheries of north-west Australia, he suggested in 1896, 'presents an inexhaustible field for future enterprise' (Saville-Kent 1896; Harrison 1997). The United States government commissioned a survey by the fisheries expert A.B. Alexander in the South Pacific Islands in 1899–1900 (Alexander 1902). Underlying each of these assessments, there lay a growing conviction that fish had the potential to become a major item of capitalist production and trade.

The basis for these optimistic appraisals lay in the advance of European colonial states. During the second half of the nineteenth century imperial powers strengthened their control across an increasingly wide area, beginning with the formation of the British Raj in 1857. The British in the Straits Settlements and Australia, the Dutch in the East Indies, the French in Indo-China, the Spanish and later the Americans in the Philippines, and the Germans in New Guinea and the Pacific, all extended or consolidated their overseas empires, so that by the early twentieth century most of the region fell within the boundaries of one or another colonial power. State expansion and the consolidation of political power was accompanied by, if not propelled by, rapid economic and demographic growth. This led to increasing demand for fish as a staple food, especially in the growing urban markets of cities and towns and amongst the sizeable labouring populations of the mines and plantations located across the different colonies. Technology offered solutions to the problem of meeting this growing demand. Steamships, faster and with larger cargo capacities than sailing vessels, were able to supply salt cheaply to fishing grounds to allow catches to be preserved and transport catches to major markets at economical rates. Railways offered a means to transport fish in bulk quantities to inland cities and towns and cities inland. And the advent of steam trawling promised to greatly expand catches, both by increasing harvest in established fishing grounds and opening up potentially rich fishing grounds in deeper waters offshore (Cushing 1988; Reeves et al. 1996).

These factors combined to lead many colonial governments to support experimental fisheries surveys designed to locate new grounds and test new fishing gears. In British India steam trawlers were trialled on several occasions, including the *Golden Crown* in the Bay of Bengal in 1908–1909, the *William Carrick* off Bombay in 1921–1922, and the *Lady Goschen* along the Madras coast in 1927–1930 (Reeves et al. 1996). The United States government followed Alexander's survey of pelagic resources in the South Pacific in the steamer *Albatross* during 1899–1900 with a survey of demersal fisheries in the Philippines in the same vessel during 1907–1909. In the Dutch East Indies, the steamer *Gier* was engaged for trawl surveys in the Java Sea in 1910–1911. Other surveys included the French vessel *de Lanessan* off the southeast coast of Vietnam in 1925, and the steamer *Tongkol* in the Straits of Malacca and the South China Sea on behalf of the government of British Malaya in 1926–1927 (Butcher 2004). The Australian government supported a number of surveys by the custom-built trawler *Endeavour* during the early 1900s, although these did not extend into northern waters nor were they continued after the loss of this trawler in 1914 (Roughley 1966).

From a historical perspective, these trawl surveys provide valuable baselines for marine environments that would later be transformed by fishing. At the time, however, little came in terms of new fishing enterprises. This was partly because trawlers, which had relatively high capital costs, could not yet compete with established fisheries based in shallower coastal and nearshore waters, where abundant fish stocks were located, and partly because knowledge of the location of suitable trawling grounds and of the best gear and techniques to employ had not yet built up amongst fishers (Reeves et al. 1996). There was, however, one important exception:

the Japanese. During the first four decades of the twentieth century, the Japanese led the way in pioneering new fishing technologies in the regions. Japanese beam trawlers, powered initially by sail, began operating in the Philippines during the late 1890s, encouraged by a state policy that provided training and subsidies to the commercial fishing sector in order to boost the supply of fish to the rapidly growing working class in the nation's new industrial centres. Diesel-powered vessels, capable of towing much larger nets, were introduced to these waters in the 1920s, and by the early 1930s a fleet of at least 70 was operating in the Philippines (Butcher 2004). Another major catalyst for expansion occurred after the First World War, when Japan secured control over Germany's Pacific Island possessions north of the equator. During the 1920s, following a systematic survey of marine resources in these waters, pole-and-line fisheries targeting tuna and skipjack and exported as a canned product directly to Japan were established in the Celebes Sea, at Ambon, and at Palau in Micronesia. Additional surveys of tuna stocks extending through Southeast Asia and into the Indian Ocean were undertaken during the 1930s (Butcher 2004; Barclay, this volume).

Other fisheries spread from waters close to Japan into the Central Indo-Pacific during this period. Motorized pair trawlers moved into the waters off Taiwan and from here into the South China Sea and the Tonkin Gulf in the 1920s, and by the 1930s large otter trawlers were also fishing in these waters. One trawler, the 473-t *Shinko Maru*, was based at Singapore in the 1930s and, equipped with a freezer, was able to range as far afield as the Northwest Australian shelf (Butcher 2004). The Japanese practise of netting reef fishes like fusiliers using a long encircling net called the *muro ami* also spread widely during these years. *Muro ami* fishers, employing large and well organised teams of divers equipped with carrier boats and smaller fishing boats, drove fish into traps formed by these nets at the edges of coral reefs, working from reef to reef as each was depleted in turn. They spread southward through the Philippines and the South China Sea in the 1920s and 1930s, eventually basing several operations in Singapore and Batavia and operating widely in the Indonesian archipelago. Singapore was also a principal base for motorized driftnetting and trolling operations, two fisheries that, much like trawling and *muro ami* fishing, were established by Japanese fishers during the 1920s and spread out in 1930s across the waters of Southeast Asia (Butcher 2004; Morgan and Staples 2006).

Alongside these initiatives there are comparatively few examples of major technological change in Central Indo-Pacific fisheries. Chinese fishers based at Singapore introduced purse seines to the Straits of Malacca in the early 1900s, employing these nets initially from sail-powered junks before transitioning to motored vessels in the latter 1930s. At Batavia the quantity of fish landed by motorized vessels doubled between 1935 and 1938, mainly through the adoption of engines aboard boats employing the *paying*, a large sack-like net, in conjunction with *rumpon*, a form of fish aggregating device consisting of palm fronds suspended from a float, in the Java Sea. In the 1930s, Filipino fishers developed an operation known as a *lawag*, which involved the use of a powered boat and a number of canoes or smaller vessels equipped with lamps to increase the power of the *sapyaw*, or round haul seine,

by attracting fish with the lights and trapping them with the net (Butcher 2004). For the most part, however, marine fisheries remained characteristically small-scale and basic in method even into the 1920s and 1930s. What did occur was simply an intensification of such fisheries. Examples of this include the proliferation of fish stakes and other fixed gears in Southeast Asian waters, greater use of simple beach seines, gillnets and purse seines from vast fleets of small canoes and other open boats in India, and higher catches of demersal fishes through the use of hook-and-line across the Central Indo-Pacific (Butcher 2004; Hornell 2004). Much of this catch was for the trade in salted fish. Access to cheap salt, to means of transport to markets, and to established trading networks helps to explain regional variations in the intensity of fishing. It also meant that expansion was by no means uniform. For example, whereas marine fisheries in Madras expanded due to the creation of fish curing yards and fishing industries based at Singapore also grew through the influence of efficient transport and marketing networks, other places, such as Burma, actually witnessed a local decline in marine fisheries due to the availability of cheap imported fish (Butcher 2004; Reeves et al., this volume).

In this way, demand for fish as a staple food was met during the first half of the twentieth century. Per capita consumption of fish probably did not increase dramatically, as it was to after 1950, but because of population growth across South and Southeast Asia and the growing quantities of fish exported to places like Japan a much larger quantity of fish was being taken from the Central Indo-Pacific as a whole. In the absence of statistical data for most fisheries the size of the increase cannot be calculated precisely, but a tripling of the marine catch between 1900 and the late 1930s is a reasonable estimate (see Butcher 2005). Just as significantly, fishers had pioneered new types of fisheries such as trawling and purse seining, and as a consequence, were reaching into new ecological strata and into more remote waters. Vast sections of sea were as yet hardly touched by fishing, including most of Bay of Bengal outside of coastal fisheries, much of the Banda, Arafura, and Andaman Seas outside of indigenous fisheries, and much of the northern Australian coastline apart from small and sporadic fisheries for turtle and dugong and limited indigenous and subsistence fisheries in coastal waters. This was however set to change after 1950, through an expansion in capture fisheries that eventually left few parts of the Central Indo-Pacific untouched by commercial fishing pressure.

The Great Acceleration: Post-WWII Intensification and Expansion

The Second World War devastated fishing industries across the Central Indo-Pacific. From the Southwest Pacific to Burma the war resulted in the destruction of boats and other equipment, brought a halt to the import of materials such as twine, nets, hooks and salt necessary to sustain fishing operations, disrupted transport and marketing networks, and reduced demand for fish. As a result, many important stocks had a brief reprieve from fishing pressure. But as soon as the war ended most marine fisheries were re-established, the first stage in a process that led not only to the restoration of pre-war harvests but also to a massive increase in catches across the

Central Indo-Pacific.¹ Across the region people looked to the sea with a similar set of objectives: as a source of food and a guarantee of food security for fast growing populations; as a source of employment and means of improving the welfare for coastal communities; and as a potential source of income through the development of export industries. The great expansion in marine capture harvests that took place during the post-war decades largely came about through an intensification of processes initiated earlier in the twentieth century, involving state commitment to fisheries development, a broader context of substantial and sustained demographic growth, economic modernisation, and a series of technological innovations that enabled the intensification of established fisheries, the development of new fisheries, and the movement of fishing activity into remoter and deeper seas. Compared to the pre-WWII period, however, developments between the late 1940s and 1970s were on an entirely different scale.

Southeast Asia was once again at the forefront of these changes. Beginning with the Philippines, and then followed by British Malaya (later Malaysia), Thailand, and Indonesia, fishing industries revived and quickly reached pre-war rates of production, before the massive and unprecedented surge in catches that took place during the 1950s and 1960s. This expansion was supported through a range of national programmes designed to boost fisheries production, many of which relied upon foreign aid in the form of education and training, technical assistance, and funding or loans to build ports and facilities for storing and processing catches. In South Asia a boom in fisheries exploitation also began in the 1950s, and in time the results as expressed through national production statistics were equally spectacular. India implemented the first in what became a succession of national 5-year plans designed to boost capture fisheries in 1951, the start of a process that had been dubbed the ‘Blue Revolution’ because its ideals, aims and outcomes all resemble the ‘Green Revolution’ in agricultural of the post-war era (Bavinck 2001). The focus of the ‘Blue Revolution’ shifted over time, from modernising fishing enterprises and supporting the development of ports and other infrastructure, to supporting the development of export fisheries and promoting deep-sea fishing. Sri Lanka’s government followed a similar programme in the 1960s and 1970s (Bathal 2005; O’Meara et al. 2011). Pacific Island nations also moved to develop their fishery resources after the war, often with the support of the United States or other foreign governments, or in conjunction with the Japanese fishing companies that returned to these seas to fish for tuna in increasing numbers after the early 1950s (Gillet 2007; Barclay, this volume).

The return of Japanese fishers to the Pacific Islands highlights the important contribution of foreign nations to the expansion of marine fisheries across the Central Indo-Pacific. This contribution took a number of forms. The post-war decades witnessed ever-growing demand for the region’s seafood in developed nations, principally Japan, the United States, and parts of western Europe, which encouraged investment in boats and gear across the region. Transfer of technology from developed to developing nations in the region was also crucial. Fishing vessels of

¹ Butcher labels this post-WWII period as ‘the Great Fish Race’; Holm, writing on the North Atlantic, uses the phrase ‘the Great Acceleration’ (Butcher 2004; Holm 2013).

all kinds were increasingly likely to be powered by engines, and thus able to reach fishing grounds quickly and spend more time actually fishing, and to travel more readily to remoter or deeper waters to exploit stocks that had previously attracted little or no fishing pressure. Fish-finding technologies, led by the echo-sounder, were adopted for the first time during these decades. Ice began to be used more frequently both at sea and on land, enabling catches to be easily preserved and providing a more marketable commodity to consumers. Nylon and other synthetic fibres replaced cotton and hemp in fishing nets and lines, making fishing gears stronger, more durable and less visible to fish, and allowing for the use of nets that were much larger, and lines that were much longer, than those widely used in earlier times (Butcher 2004).

Differences in the priorities of state development and the timing and magnitude of export market growth help to explain regional variations in capture production increases during the 1950s, 1960s, and 1970s. Civil conflicts and foreign wars held back the development of fisheries in some areas, as in Vietnam and Cambodia in the 1960s and 1970s, Bangladesh in the 1970s, and Sri Lanka in the 1980s. Across the Central Indo-Pacific as whole, however, similar processes of intensification of established fisheries and the extension of these fisheries into new areas, in the emergence and expansion of new industrial fisheries, and in levels of foreign fishing can all be observed during this period. Four developments in particular highlight these changes that swept widely across Central Indo-Pacific fisheries in the post-WWII period: a massive expansion in trawling for small demersal fishes and shrimp; the rapid growth in the use of different types of purse seines to catch tunas as well as smaller pelagic species; the spread of longlining; and the mechanization and modernization of small-scale fisheries. Each was characterized by a broadly similar pattern of movement, spreading outwards from waters close to major ports and markets to increasingly remote seas in the search for new or less heavily exploited stocks of fish.

In the Philippines, beam trawlers began operating shortly after WWII ended, along similar lines to the operations undertaken by the Japanese in the 1930s. More powerful otter trawls and the larger boats required to pull such gear through the water appeared by the late 1940s and became increasingly common in the 1950s, initially in Manila Bay, and later in San Miguel Bay and the Visayan and Samar Seas, as new grounds were sought to replace depleted grounds close to ports and supply ever-growing domestic markets with fresh fish. The most spectacular expansion in trawling, however, took place in Thailand. Aided by foreign aid programmes designed to introduce inshore trawling, the number of registered Thai trawlers rose from 99 to 2,700 between 1960 and 1966. Most of the catch was used for domestic consumption, although 'trash fish', which represented as much as 40% of an average catch, came to be processed as fish meal and animal feed, thus making the industry profitable (Butcher 2004). An outward spread of trawling brought about by sharply falling catch rates in the more heavily fished waters occurred, and in the late 1960s Thai trawlers moved increasingly from the inshore waters of the west and north of the Gulf of Thailand towards the west coast of Vietnam, into the Mergui Archipelago on the coast of Burma, and into the waters of the Indonesian archipelago.

By the late 1970s more than half of Thailand's recorded catch came from beyond its own territorial waters. In Malaysia and Indonesia, trawling operations spread through the Straits of Malacca and thence along the coasts of Sumatra, Java and Borneo between the late 1960s and early 1970s, eventually reaching as far afield as Irian Jaya and the Arafura Sea (Butcher 2002, 2004).

Trawling, particularly for paneid shrimps, developed elsewhere as a major export industry during this period. In Australia, lucrative trawl fisheries for shrimp, scallops and demersal fishes were established during the late 1950s and 1960s at Shark Bay, Exmouth Gulf and Nikol Bay in Western Australia, at Moreton Bay and along the northern New South Wales and southern and central Queensland coasts, and in the Gulf of Carpentaria in the continent's north, alongside the expansion of lobster, trawl and net fisheries in the continent's temperate southern waters (Williams and Stewart 1993). Australian companies contributed to the development of shrimp trawling in Papua New Guinea during the 1970s. Off Australia's Northwest, Japanese and Taiwanese trawlers fished for snappers and other demersal species during the 1960s and 1970s (Gillet 2007). In India, trawling for shrimp and small demersals began at Kerala in the early 1960s, and, as in Southeast Asia, it spread rapidly in the late 1960s and 1970s as the profitability of trawl fisheries attracted increasing investment and government support. As in other parts of the Central Indo-Pacific, the main market was the United States, followed by Europe. Trawling eventually emerged as the single most important sector of the Indian fisheries, accounting for around 50% of the nation's total catch (Bathal 2005; Bavinck 2001).

The seemingly ubiquitous spread of trawling in the Central Indo-Pacific has a counterpart in the growth of tuna fisheries after WWII. Tuna fishing was an industry particularly affected by the war, and although the industry revived somewhat belatedly owing to the restrictions placed on the movement of Japanese vessels in the immediate post-war years, the lifting of these restrictions in 1952 sparked the first stages of an expansion that carried on through throughout the second half of the twentieth century. Purse seining was the mainstay of this expansion. Large nylon nets and power blocks to haul such nets, initially introduced by American fishers operating in the eastern Pacific, were rapidly adopted by Japanese vessels operating in Southeast Asian and Pacific waters in the 1960s (Gillet 2007). Other innovations followed. The development of ultra-low freezing, which maintained catches in better condition, assisted in the expansion of the distant-water fleets of Japan and Taiwan. From about 1975 tuna fishers in the Philippines and Indonesia began to fish with the aid of floating lures, or *payaw*, a type of FAD that was particularly effective in lifting catch rates for skipjack and yellowfin tunas. Pole-and-line and trolling, more suited to smaller-scale operators, also expanded in these years, helping to maintain the increasing marine capture harvests of Indonesia, the Philippines and Thailand in the 1970s and 1980s (Butcher 2004). During the 1970s Japanese fishing companies took to the extensive employment of longlines, including deep-water longlines that reached down into parts of the water columns inhabited by species such as bigeye tuna. This fishing method, which typically employed a number of catching boats attached to a large and well-equipped mothership, was directed at supplying the high-value sashimi tuna increasingly favoured by affluent Japanese

consumers. Southern and Pacific Bluefin tuna were also exploited heavily by long-line vessels in this period. Longlining operations on a similar industrial scale were also developed by Taiwanese and Filipino fishing companies during the 1970s. The Japanese were also influential in supporting the expansion of land-based pole-and-line fishing in Southeast Asia and Pacific Islands in the 1960s and 1970s, often in partnership with local fishers and fishing companies based in Indonesia and the Pacific Islands, who generally provided labour both at sea and in the canneries that processed the catch for export overseas (Morgan and Staples 2006; Butcher 2004).

Purse seines are also effective in capturing smaller pelagic fishes such as mackerels and sardines, and with abundant stocks of such fishes occurring across the Central Indo-Pacific, this too developed as an important part of the post-WWII expansion of marine fisheries. Declining demersal stocks caused by the excesses of trawling contributed to the rise of this fishery. Trawl vessels were readily adaptable to the use of smaller seines and other towed nets, and with purse seining requiring less engine power and hence fuel than trawling, numbers of vessels in Thailand, Indonesia and the Philippines made this transition during the second half of the 1960s. This process resumed after the oil price shock of 1973. According to one source, the total pelagic catch in the Gulf of Thailand increased 63,000–480,000 t between 1971 and 1977 (Butcher 2004). Purse seining for small pelagic fishes began along the west coast of India in the late 1970s (Bathal 2005).

To a large extent the expansion of small pelagic fisheries reflected a wider modernisation of the small-scale fishing sector. This was also the case in relation to the expansion of driftnet, gillnet, and dropline (bottom longline) and handline fisheries. Replacement of traditional vessels with relatively inexpensive fibreglass and other kinds of small vessels, the adoption of inboard engines and the installation of ice-boxes or freezers, and the use of synthetic nets in place of cotton or hemp all contributed to the expansion in net and line fisheries across the region. Driftnetting in the Straits of Malacca and along the east coast of the Malay Peninsula was one of the first fisheries to benefit from engines and synthetic nets; one report from 1958 credited the introduction of nylon drift nets in the Straits of Malacca with a doubling of catches (Butcher 2004). In time small-scale fishers in the Philippines, Vietnam and Indonesia also began to adopt these technologies, although the process was slower in the beginning and the uptake less rapid than, for example, fisheries based at Singapore. Other developments were however embraced, such as the spread of motorized trolling in Southeast Asian waters in the 1950s and 1960s, the greater use of powered boats to support a massive expansion of *muro ami* fishing, and greater numbers of powered boats and electric lights employed in *lawag* and *basnigan* (or bag-net) fishing operations (Butcher 2004). Nylon nets and lines began to be used in India and Sri Lanka's small-scale fisheries from around the late-1950s, and although motorization in the small-scale sector did not begin on a large scale until the early 1980s, the use of gillnets in particular became increasingly important in place of beach seining amongst artisanal fishers (Devaraj and Vivekanandan 1999; O'Meara et al. 2011). Powered vessels and synthetic nets and lines also became more common as well amongst small-scale operators in Australia's north-western and north-eastern waters in the 1950s and 1960s, along with other techniques such

as the use of steel traps to catch schooling snappers and other demersal fishes (Hayson 2001).

The significance of this kind of modernisation, which took a multitude of forms, cannot be underestimated. It meant that small-scale fishers across the Central Indo-Pacific were able to increase their fishing power and reach further beyond the more heavily fished coastal waters and, by so doing, maintain or increase catches in the face of competition from trawling and other industrial fisheries and declining yields from traditional inshore stocks. In this way the small-scale sector, by virtue of the sheer numbers of fishers that fell into this category, was able to remain the dominant fishing sector in terms of its contribution to total national catch, especially in heavily populated countries with large coastal populations such as the Philippines and Indonesia.

How to measure the impact of this expansion? FAO statistics show that between 1950 and 1980 nominal marine fish landings increased by factors of three in Japan and India, four in Australia, Malaysia, and Bangladesh, five in Sri Lanka, six in the Philippines and Papua New Guinea, more than ten in Thailand and Burma, and several Pacific Island nations, and, most spectacularly, 20 in Indonesia. The vital point is that this boom took place across virtually the entire Central Indo-Pacific, excluding waters more than 200 m deep. By 1980 few areas remained untouched by industrial fisheries, and large stretches of coastal and nearshore waters were now subjected to intensive fishing pressure from industrial and small-scale fishing alike. Stock declines were now a common occurrence. Purse seines are capable of capturing an entire school of fish, and while the sheer profusion of pelagic species meant that stocks could sustain even enormous increases in fishing pressure, in places like the Java Sea sharp declines in catch rates for small pelagic fishes occurred during the 1980s (McElroy 1991). Analyses of longline hooking rates show sharp declines for larger predator species after only a few years of fishing effort (Myers and Worm 2003). The same can be said in relation to driftnets and gillnets in more intensively-fished areas. Some practises could be particularly destructive on a localised scale, such as *muro ami* fishing or the use of explosives to catch demersal reef fishes, a technique that had been common in Philippines and other parts of Southeast Asia and the Pacific in the immediate post-WWII years (Butcher 2004).

Nothing, however, compared to the destructive impact of trawling. In San Miguel Bay in the Philippines, the trawlable biomass or quantity of fish and shrimps accessible to trawlers fell at a rate of around 5% a year from 8,900 t in 1948 to 1,600 t in 1980 (Butcher 2004). On the Northwest Australian shelf, intensive trawling by Taiwanese pair trawlers resulted by-catch of sponges falling from around 500 kg an hour to only a few kg per hour between 1972 and the mid-1980s, evidence of the devastating impact of trawling on the benthic environment (Sainsbury et al. 1992). In the Gulf of Thailand a trawler could catch about 230 kg of fish per hour in 1963, but by 1967 catch rates had fallen to around half that figure; it is estimated that the Gulf lost 60% of its large finfish, shark and skate populations in the first 5 years of industrial trawling, although catches of squids, shrimps and other smaller species rose during the 1960s as a result of the removal of predator species. In fact, the Gulf of Thailand has come to be recognised as a prime example of 'fishing down the food

web', or the systematic depletion of high trophic level species and the progressive shift of fishing effort to lower trophic levels (Butcher 2004; Christensen 1998). Similar patterns have been observed in other areas subjected to intensive industrial fishing (e.g. Bathal and Pauly 2008), although few areas have yet rivalled the Gulf of Thailand in terms of the extent to which industrial and intensive fishing in the 1960s and 1970s was responsible for fundamental change in the marine environment.

Closing the Frontier: Towards a New Ocean, 1980s–2010s

The principle of the 'Tragedy of the Commons' posits that individuals acting out of self-interest will inevitably deplete a finite resource held in common ownership due to the lack of any inherent mechanism to encourage conservation for the common good. It is a powerful tool for explaining depletion of marine fisheries, where nation-states take the place of individuals and the world's oceans represent a global commons. In the late 1960s and 1970s there were increasing signs that such a scenario was playing out across the Central Indo-Pacific. Clashes between small-scale fishers and trawlers, arising from competition over dwindling inshore stocks, the destructive impact of trawling, and lax enforcement of regulations designed to protect small-scale fishers, occurred on several occasions: in the Straits of Malacca, along the shores of Thailand and Burma facing the Andaman Sea, along the east coast of Sumatra and off both the north and south coasts of Java, in the Indian states of Kerala, Madras, and Tamil Nadu; and in many other places in between (Butcher 2004; Bavinck 2001; Rumley 2009). After years of conflict and illegal trawling, the Indonesian government banned trawlers from the waters surrounding Java and Bali, before extending the ban to include Sumatra in 1981 (Butcher 2004). Such conflicts were a sign that a turning point had been reached in the history of the region's fisheries. The spectacular spatial expansion of fishing effort and the prolonged growth of marine capture harvests that had marked the post-WWII decades were drawing to a close, and fishing nations were becoming more assertive in their claims to jurisdiction over marine resources. By the early 1980s the commons was effectively closed across the Central Indo-Pacific, the cycle of boom-bust that had propelled the spatial expansion of fishing effort was drawing to a close, and a new phase in the history of marine capture fisheries was beginning (Fig. 2.3).

Claims to ownership of marine animal populations in offshore waters were progressively strengthened during the post-WWII period. Until 1950 the widely accepted principle was that states could legitimately claim exclusive ownership over waters extending up to three nautical miles from the coast. In 1952 the Australian government unilaterally rejected this principle by claiming ownership of benthic resources to edge of the continental shelf, an act designed to prevent Japanese pearling from re-establishing operations off the northern and northwestern coasts after WWII. In 1957 Indonesia declared itself to be an archipelagic state and lay claim to all waters existing within 12 miles of baselines drawn around the entire archipelago, and this act that was repeated by the Philippines in 1961. Twelve-mile ter-

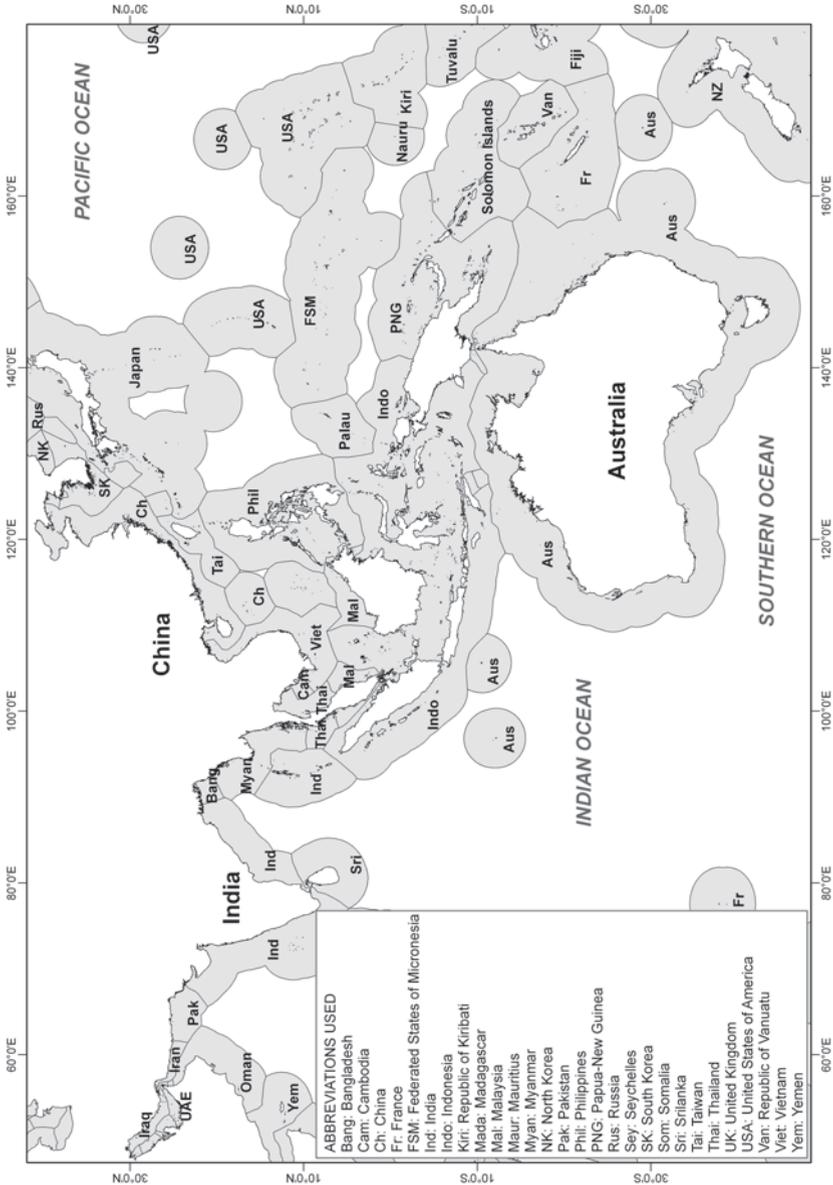


Fig. 2.3 Map of the Central Indo-Pacific showing EEZs

ritorial seas were declared by most of other coastal states in South Asia, Southeast Asia, the Pacific and Australia during the late 1960s (Butcher 2004; Campbell and Wilson 1993). New maritime boundaries also began to be negotiated. Australia and Indonesia agreed to a division spanning the Timor Sea in 1973. This was followed

by the attempted expulsion of Indonesian fishers from Australian territorial waters and, in 1979, to an Australian claim to a 200 mile exclusive fishing zone. These claims were formalised by the Third United Nations Conference on the Law of the Sea (UNCLOS III) in 1982 (Campbell and Wilson 1993). Much of the Central Indo-Pacific thereafter fell within the EEZ of one coastal state or another, leaving only the open Indian and Pacific oceans outside of any national jurisdiction.

By the mid-1980s the Philippines, Thailand, Indonesia, Malaysia and India were among the top 12 fishing nations in the world, in terms of size of the reported marine catches, whilst Japan, Taiwan and China were also ranked amongst the world's top fishing nations and taking a large share of their catch from the Central Indo-Pacific. Catches continued to expand for a time, driven by rising catches of tuna and in the few other remaining fisheries that could sustain large-scale expansions, and by the drive to attain maximum exploitation rates in established fishing sectors; these developments are described in more detail below. Amongst most countries, however, marine catches began to stagnate and even decline. In some cases, such as Australia's tropical trawl and demersal line and net fisheries, expansion was curtailed through management strategies such as quota restrictions, closed seasons, and license limitations designed to restrict catches to levels deemed to be sustainable in the long-term (Williams and Stewart 1993). However, across much of the Central Indo-Pacific, the end to growth was the inevitable result of the decreasing number and size of new and untouched fish stocks to exploit. To put it another way, growth began to push up against the biological productivity of the sea itself, a situation that was most pronounced in the coastal and near-shore waters that had been the focus of the post-WWII expansion in capture fisheries. Yet across the region nations remained committed to earning revenue and supporting coastal communities from the marine environment, and demographic and economic growth continued across Asia and the Pacific. These factors combined to create challenges of reducing over-capacity and protecting the livelihoods of small-scale fishers which emerged, alongside the problems of declining stocks, habitat loss and marine pollution, as some of the most pressing problems in Central Indo-Pacific fisheries in the final decades of the twentieth century. The other major problem from a governance perspective was the spread of Illegal, Unreported and Unregulated (IUU) fishing, particularly in relation to high-value species, an outcome of weak enforcement of regulations, high market prices, and the growing competition for scarce fishery resources (Agnew et al. 2009)

Tuna held out the most potential for maintaining growth at a similar rate to the decades prior to the 1980s. Initially, market factors including high fuel prices and lower demand for canned and sashimi tuna in the major markets of Japan, the United States and Europe brought about a decline in investment in tuna fishing and therefore in fishing effort, but generally favourable conditions beginning in the early-1980s drove expansion across the Central Indo-Pacific. Indonesia and the Philippines together accounted for the bulk of the Southeast Asian tuna catch, and Japan and Taiwan continued to fish for tuna in the waters of these and other Southeast Asian countries, but during the 1980s stocks in the main tuna fishing grounds began to decline through the widespread employment of *payaw* and other FADs and the in-

creasing use of more efficient purse seines in competition with the more traditional pole-and-line, trolling, and smaller scale purse seine and longline methods (Butcher 2004; Morgan and Staples 2006). Declining stocks encouraged movement eastward into the tropical and subtropical waters of the Pacific, where foreign distant-water fleets and fledgling joint-venture operations between Pacific Island states and developed nations also began to increase during the 1980s and 1990s. Chinese and Taiwanese longliners became more active in these waters, alongside the large and modern purse seine fleets of Japan and the United States, and the smaller pole-and-line fleets acquired by nations such as Samoa, Fiji, New Caledonia and the Solomon Islands. Catches of the main species (skipjack, yellowfin, bigeye, albacore) tripled in the Western and Central Pacific in the 20 years after 1980 (see chapters by Chen and Barclay, this volume). Taiwanese and Japanese longliners also pushed deeper into the Indian Ocean in the 1980s and 1990s in search of bigeye and Southern Bluefin tuna for the lucrative sashimi market, increasingly using the deep-water lines that reached down to depths that had once provided a haven for these species. Another major development, and one that pointed towards the fishing practises of the future, was the capture of juvenile tunas in the wild to be raised in large mobile sea cages for sale at a later stage (Gillet 2007).

Trawling offered less scope for expansion. Shrimp fisheries had benefitted from rising prices during the late 1970s, but declining yields from wild stocks and the development of shrimp farming on a large scale (see Pokrant, this volume) curbed the industry's expansion during the 1980s. The incorporation of coastal and near-shore waters within EEZs also hampered trawling, particularly the activities of the sizeable Thai trawling fleet. During the 1980s and 1990s illegal fishing was carried out extensively in the surrounding waters of Malaysia, Indonesia and Burma, but the development of more effective surveillance and regulatory systems led increasingly to the implementation of joint-venture and licensing arrangements that allowed foreign fishing vessels to operate within the zones of these countries and as far afield as Vietnam, Bangladesh and Australia during the late 1980s and 1990s (Butcher 2004; Williams 2007). Deep water trawling at depths between 50 and 100 m, where abundant stocks of demersal fishes such as snappers could still be obtained, became more common across the region in the 1990s and 2000s, encouraged in cases like India and Sri Lanka by government support for such deep-sea fishing ventures. But trawling remained a controversial practise, strongly opposed by small-scale fishers and subject to increasingly strict management conditions and high license fees. Bans on foreign trawling were imposed, not only in Indonesia, but also in India, Bangladesh, Burma, and Australia in the late 1980s and 1990s, although illegal fishing continued in some areas such as Indonesia's Arafura Sea (Butcher 2004; Bathal 2005). During the 2000s Thai trawlers were fishing as far afield as the western Indian Ocean in the waters of Oman, Somalia and Madagascar in the western region of the Indian Ocean.

In many respects the situation with tuna and trawl fisheries reflects the wider development of industrial fisheries after 1980. Large and mobile fleets were becoming more common, operating under license in a particular country's EEZ, often on a short-term basis as a quota was filled, a stock declined to the point

where it was no longer viable to fish it, or market factors such as fuel prices and demand for seafood made a particular fishery uneconomical. Technological innovations continued to be deployed in an effort to increase fishing efficiency, not just in terms of gears such as deep-water trawls and longlines, but also through fish-finding aids such as side-scanning sonar and GPS (Anticamara et al. 2011). Overfishing was a constant threat, partly as a result of weak governance arrangements that were in turn a legacy of the largely unrestrained expansion of earlier decades, and partly due to overcapacity in industrial fleets. The common theme across the Central Indo-Pacific was the full exploitation of marine resources wherever a commercial profit could be made and fishing rights could be obtained. One indication of this tendency was an expansion in invertebrate fisheries targeting squids, crabs and other crustaceans. Another was the push into waters that lay beyond the Central Indo-Pacific proper. The open seas in the Pacific and Indian oceans, outside of EEZs and hitherto avoided due to remoteness and low productivity, began to attract more fishing effort during the 1980s. For larger factory fleets, the final frontier for expansion lay in the Southern Ocean, which also began attracting increasing fishing activity in the 1980s and 1990s (Anticamara et al. 2011; Watson et al. 2012; Swartz et al. 2010). The other major development was the growth of aquaculture in coastal areas.

Small-scale fisheries also moved inexorably towards full exploitation of available resources. This was the case across of a multitude of sectors. Bans on trawling benefitted small-scale fishers operating in coastal and near-shore waters by removing industrial-scale competition, and stocks of demersal fishes recovered in many areas following these bans, only to be exploited by gillnets, dropnets, droplines, handlines and other relatively basic methods employed by such small-scale fishers supplying fish to ever-growing regional populations. Small pelagic fisheries also continued to expand, where scope for expansion existed, in concert with rising domestic demand. Coral reefs offered such scope, which was met in a number of ways. Across Southeast Asia demersal reef fish continued to be targeted by *muro ami* fishing and its variants, and by net and line fisheries, including by new fleets of deep-water demersal longlines operating in waters unsuitable for trawling, and small vessels that made use of GPS and sonar to target spawning aggregations. Cyanide began to be used more widely to stun and capture reef fishes. Important new markets developed in the form of the live fish trade favoured by increasingly wealthy consumers in cities like Honk Kong and Singapore, and by the live aquarium trade in small reef fishes (Butcher 2004). The rise of a middle class in Hong Kong and mainland China also contributed to the growing demand for shark fin that led to a boom in elasmobranch fisheries in Indonesia and other countries and, in time, to the decimation of shark populations (see Tull, this volume), and to a revival in trepang fishing in Southeast Asian and parts of the Pacific. Specialised or niche fisheries also developed and spread. Landings of cephalods expanded rapidly in many countries in the 1980s and 1990s as small-scale operators made greater use of electric lights and small casting or lifting nets to capture squids, which were actually prolific in many areas due to the overfishing of larger predator species. Other fishers targeted giant clams, lobsters, crabs, or different kinds of mollusc or

crustaceans, often for consumption in distant markets (Butcher 2004; Gillet 2007). In this way the global trade in fishery products, a major factor in the expansion of tuna fishing and trawling, reached down into the small-scale sector. Towards the end of the twentieth century a third sector of fisheries also appeared in the Indo-Pacific in the form of recreational fishing, an increasingly important factor in fisheries exploitation of parts of the northwest and northeast Australian coastline.

It is important to point out that population declines in response to fishing pressure are not irreversible, and indeed, many important commercial stocks stabilised and even began to recover during the 2000s in response to improved management arrangements. This reflected a growing commitment to rebuilding regional fisheries expressed in international forums such as an Association of Southeast Asian Nations special meeting on fisheries in 2001 and the World Summit on Sustainable Development in 2002 (Butcher 2004). The nations of Oceania, which include Australia and the Pacific Island countries, have tended to perform better in measures of management effectiveness than the nations of Asia, although the benefits of restoring biomass in depleted ecosystems in order to sustain long-term exploitation is a widely-shared goal, and poorly-performing nations now receive greater international assistance to achieve sustainability in fisheries (Worm et al. 2009; Mora et al. 2009; Worm and Branch 2012). However, despite these positive signs, the outlook for marine animal populations in the Central Indo-Pacific is a vision of life in a very different ocean. Even in sustainably-managed fisheries, the impact of intensive fishing pressure is such that targeted populations now possess life history characteristics and population dynamics that are far removed from 'pristine' or unfished populations, and in this sense, can be viewed as fundamentally 'new' species (Longhurst 2007). An increasing proportion of wild capture fisheries is now processed and used as feed in ocean fish farms. The synergistic effects of fishing pressure also changes trophic structure within ecosystems, where higher-order predators are less abundant and short-lived species such as shrimps, squids and jellyfish are more prolific as both predators and competitors for food sources are removed through human harvesting (Butcher 2004). Marine pollution, habitat loss through the destruction of mangroves, seagrass beds and coral reefs, the spread of invasive species, and the onset of climate change caused by global warming combine to exacerbate the impact of fishing, reducing the productivity of marine environments and posing serious threats to the maintenance of biodiversity in the twenty-first century (Roberts 2012).

Conclusion: Challenges and Opportunities

The Asian tsunami of 2004 was the biggest single shock to the marine fisheries of the Central Indo-Pacific since WWII. Small-scale fishers in India, Sri Lanka, Thailand and Indonesia were devastated. Much like the restoration of fishing capacity in the late 1940s, fleets were quickly rebuilt in the wake of this disaster. In the 2000s, however, there was no longer the vast and largely untouched wealth of ma-

rine resources that had existed in the 1950s and 1960s; the frontier for expansion of industrial and intensive fisheries had closed. Viewed from a long-term perspective, the expansion of marine capture fisheries in the Central Indo-Pacific is remarkable both on account of its rapidity, developing over the course of just over a century and concentrated in the three decades between 1950 and 1980, and its pervasiveness, extending across virtually the entire body of water bordered by the Asian subcontinent, northern Australia, the western Pacific, and the East China Sea, and reaching into the open Indian and Pacific oceans. Within this area marine animal populations had been fundamentally transformed by fishing pressure, perhaps for all time. The period between the late nineteenth and the early twentieth century was truly an era of unsettled seas.

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