Chapter 16
The Megaengineering of Ocean Fisheries: A Century of Expansion and Rapidly Closing Frontiers

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16.1 Introduction

The industrialization of the world's oceans (Smith, 2000, 2004a, 2004b), otherwise known as the *blue revolution*,[1] took place in a little over a century and has spread to include various economic sectors, including capture fishing.[2] Capture fishing is one of the oldest livelihoods in human existence (Von Brandt, 1984), but has recently undergone a tremendous transformation. Uneven as it has been, and taking place in fits and starts, the blue revolution has evolved from myriad centers. It has only been partly blueprinted, or engineered, and technology was only one of its components. Still the process as it has unfolded over the globe has identical features. It is to a tracing of the contours of this global event that this paper is devoted.

Most contemporary readers are aware that the revolution in fishing has now reached, or surpassed, its environmental limits. Scientists warn us that a growing proportion of world's fish stocks are overfished and depleted (FAO, 2009) and that we are fishing down the food web (Pauly, Christensen, Dalsgaard, Froese, & Torrers, 1998). The consequence, some would argue, is that by 2048 all fish stocks will have been exhausted, bringing commercial fishing to a full stop (Worm, Barbier, Beaumont, & Duffy, 2006). The collapsed cod fisheries of the Great Banks have thereby paved the way for a far greater tragedy that will unfold in the years to come. From a more positive side, the World Bank (2008) points out that, with adequate reform, the fisheries will give us access to "sunken billions" of economic benefit.

Whether the fisheries managers of today have developed appropriate toolkits to avert the ecological crisis remains to be seen. Fisheries governance is still a new concept (Kooiman, Bavinck, Jentoft, & Pullin, 2005) and still very much in its development. The new mindset, however, should not detract attention from the amplitude and forcefulness of transformation during the 20th century, nor from the fact that technical innovations regarding fishing are proceeding on a daily basis. The blue

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S.D. Brunn (ed.), *Engineering Earth*, DOI 10.1007/978-90-481-9920-4_16,

revolution, in other words, has not been terminated but continues below the water line.

The first section below sketches the blue revolution as it has taken place in fisheries around the world. It is followed by elaborations of the transformation process in two important fishing regions: the west coast of North America and Southeast Asia. In doing so, I rely on two historical works: McEvoy's (1986) study of Californian fisheries, and Butler's (2004) synthesis on history of Southeast Asian fisheries. Both regions are known for the quality of their fishing grounds as well as the productiveness of their fisheries. The Californian case illustrates the process of fisheries development which commenced around the turn of the 19th century in temperate waters, while Southeast Asian fisheries are indicative of the process which started in the tropics almost fifty years later.

Attention then shifts to the technology which underlay both blue revolutions. Special consideration is given to the "roving bandits" (Berkes, Hughes, & Steneck, 2006), viz., the distant water fleets which emerged in the 1950s and contribute in no small measure to the fishing pressure. The last section considers the impacts of industrialization and looks ahead to the near future.

16.2 Revolution in World Fisheries

Smith (2000, 2004a, 2004b) presents the transformation of world fisheries as part of a larger movement from traditional to industrial society, which commenced around 1780 in Europe but obviously has earlier roots. This societal movement possessed material, economic and social dimensions. Major technological change came to affect fisheries in the late 19th century,

> based first on the coming of steam then, early in the 20th century the internal combustion engine. These advances greatly increased accessibility to fishing grounds and the power of fishing gear. On the shore side the advent of refrigeration, the auction system, and fast and efficient rail and road transport facilitated the development of markets and thus greatly increased production.
>
> (Smith, 2000: 20)

The technical development of fisheries in Europe, North America and select other parts of the world took wing in the decades before WWII and resulted in a dramatic improvement of the efficiency of fishing operations. A similar process was initiated following the war in the newly independent countries of Asia and Africa. Governments, assisted by recently established international bodies, such as the Food and Agriculture Organization (FAO), took up the cause of fisheries modernization with fervor, following the pattern laid out earlier in the west. This implied the development of modern fisheries and the large scale construction of infrastructure such as harbors and refrigeration facilities. A whole set of other technical changes, some smaller, some larger, have occurred in parallel.

The improvement of fishing technology was based on a positive assessment of the oceans' potential, and a blind eye to its long-term limitations. McEvoy (1986)

gives the example of W.M. Chapman, a biologist who was highly influential in the development of policy for marine resources in the U.S. in the post-WWII period. Chapman, according to McEvoy (1986: 190), "firmly believed that the ocean had vast, untouched reserves of food and that U.S. entrepreneurs had a mission to develop those resources for the benefit of mankind." I have come across similar views in policy documents related to the blue revolution in India (Bavinck, 2001).

In the first instance these optimists appeared of course to be right. For indeed, the quantities of seafood brought to the shore increased by leaps and bound, as data from the post-WWII period illustrates (Fig. 16.1). The world's fish harvests have increased almost fivefold. For countries that engaged in the first phase of the blue revolution, growth had actually started much earlier. McEvoy (1986: 126) thus estimates that while the fishing population of California remained roughly stable in the period 1899–1925, catches increased ten times.

The revolution in fishing technology was accompanied by large scale changes in the organization of harvesting, along lines alternatively referred to as modernism, globalization or Fordism (Armitage & Johnson, 2006; Chuenpagdee et al., 2005). Fordism describes a system of production based on product standardization, decomposition of the production process, technological intensity, relatively inflexible production designs and large production volumes (Harvey, 1989, in Chuenpagdee et al., 2005). It has been applied most to industrial fisheries, and least to small scale fishing.

Meanwhile, seafood markets expanded and globalized as preservation technology and transportation improved. Delgado, Wada, Rosegrant, Meijer, and Ahmed (2003) point out that this was paralleled by rising consumer demand and a long and virtually uninterrupted increase of prices. Figure 16.2 provides an indication of price trends in the U.S., which is one of the world's major markets. The result of all these market changes is that, at the beginning of the 21st century, fish is one of the world's most traded agricultural commodities (World Bank, 2008).

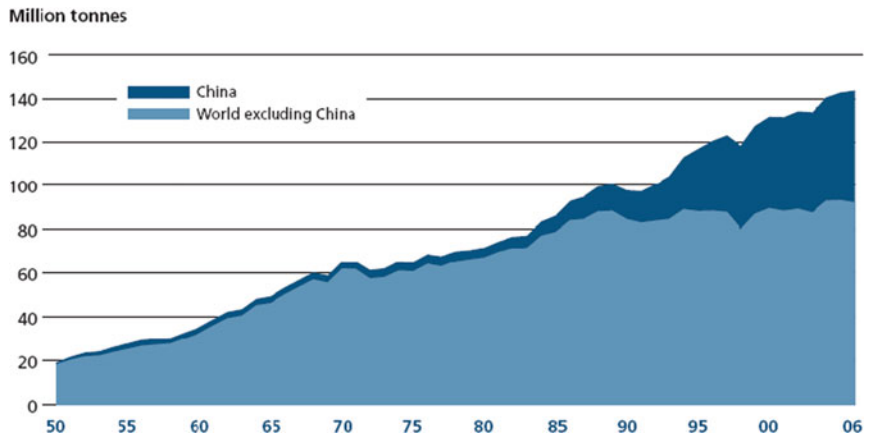

Fig. 16.1 World production capture fisheries 1950–2008. (FAO, 2009)

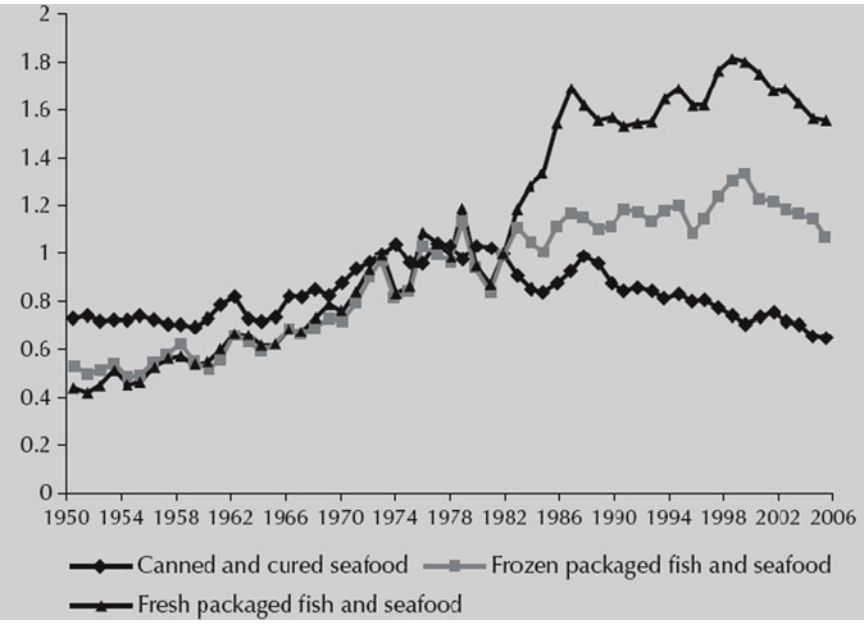

Fig. 16.2 Trends in U.S. real price indexes for fish and seafood products 1947–2006. (World Bank, 2008)

Economically speaking, the 20th century can therefore be typified as the "golden age" not only for Southeast Asian fisheries (Butler, 2004: 292), but for fisheries worldwide. Rather than being associated with poverty (Béné, 2003), fisheries have been a source of great economic wealth, attracting fortune-seekers of various type and capacities.

But in every transformation of such proportions, there are winners and losers, and fisheries has seen its share of social differentiation. The biggest loser is of course the environment: many fisheries are currently believed to be severely overexploited (Fig. 16.3).

Fisheries are variously classified. Johnson, Bavinck, and Veitayaki (2005; see also Johnson, 2006) make a thoughtful review of the literature, suggesting a division into small-scale, industrial, and intermediate fisheries. Each of these fishing types in principle exploits different parts of oceanic space; small scale fishers relying on inshore waters, small industrial fishermen on offshore areas, and industrial vessels on distant waters. The regular incidence of conflict between fishermen of various technology types points out, however, that there are spatial areas of overlap and contestation (Bavinck, 2005; Platteau, 1989).

FAO (2007) calculates that the world fishing fleet currently consists of approximately 4 million vessels, one third of which are decked.[3] Most of the other two-thirds are presumably small scale craft. The decked vessels, of various types, tonnage and power, are generally motorized, while this is the case with only a third

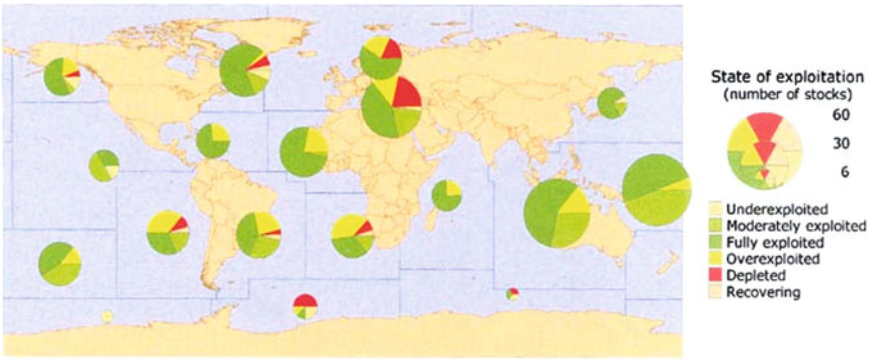

Fig. 16.3 State of world marine fishery resources. (Source: FAO, 2005)

of the undecked vessels. Trawlers are estimated to make up approximately 40% of the aggregate tonnage of the world fishing fleet (Valdemarsen, 2001: 636).

All these fishing vessels are operated by approximately 35 million full-time fishermen, the large majority of whom live in Asia and in Africa (FAO, 2007). Statistics demonstrate that while the number of capture fishers in Europe and North America is declining, their numbers continue to increase steadily in other parts of the world (FAO, 1999).

Contrary to popular assumption, oceanic space is not evenly fished. This is partly a result of physical and ecological characteristics, and partly because of human geography and technological reach. Biomass is generally concentrated along continental shelves; locations of oceanic upwelling constitute particularly fertile fishing grounds. Historically, however, these could not all be effectively fished. It was only as technology developed that fishing effort expanded geographically.

Smith (1994, 1991) provides a typology of fishing regions in relation to urbanization, and distinguishes three types of seas: urban seas, rural seas and wilderness seas, each with its own set of uses. The first adjoin large ports and built-up areas: here fishing competes with many other intense uses of sea space. Rural seas are characterized by less intensive and slightly different use patterns, while wilderness seas are sparsely used at all. Although Smith makes no mention hereof in his discussion of this typology, it coincides more or less with the regions or dimensions of contemporary oceanic law: urban seas are located in territorial waters (<12 nautical miles), rural seas with the Exclusive Economic Zone (<200 nautical miles), and wilderness seas with the high seas in between (Fig. 16.4).

With advances in the development of fishing technology, the wilderness zone of the oceans has rapidly been pushed back. Pauly, Alder, Bennett, and Christensen (2003) point out the geographic and depth expansion of fisheries since 1950 and extrapolate the trend to 2050. They note:

> Over the past 50 years, fisheries targeting benthic and bentho-pelagic organisms have covered the shelves surrounding continents and islands down to 200 m, with increasing inroads below 1000 m, whereas fisheries targeting oceanic tuna, billfishes, and their relatives

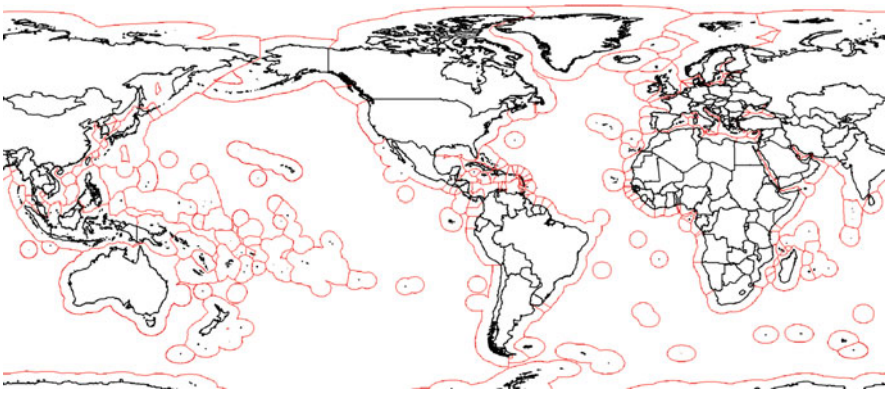

Fig. 16.4 Exclusive economic zones of the world. (Source: Wikipedia)

> covered the world ocean by the early 1980s. . . . With satellite positioning and seafloor-imaging systems, we will deplete deep slopes, canyons, seamounts and deep-ocean ridges of local accumulations of . . . bottom fishes.
>
> (Pauly et al., 2003: 1359–1360).

The following sections describe how the variegated processes associated with fishing industrialization have impacted two important fishing regions.

16.3 Blue Revolution in California

Arthur F. McEvoy's monumental study (1986) traces the history of California fisheries from 1850 to 1980, considering the interaction between three elements: ecology, technology and production, and law. He divides this time period into three eras, the first dealing with the foundation of commercial fisheries (1850–1910), the second exploring the industrial frontier (1910–1950), and the third featuring decline and enclosure (1950–1980). We are concerned here mainly with the second phase, viz., the inauguration and industrialization of the fisheries.

It is worthwhile, however, noting the basis upon which industrialization in California took place. Following contemporary scientific understanding, McEvoy describes the Californian marine ecology as essentially "lush and varied" (1986:6) and "some of the most valuable fisheries in the world" (1986: xi). Prior to European and Asian immigration into the coastal region, the First Nation population had operated a rich salmon fishery for subsistence purposes. With the arrival of poor immigrants from New England, China and Europe, notably Portugal and Italy, however, this population declined rapidly and the now commercialized fisheries were almost totally usurped (1986: 66). Ethnic specialization took place, and, at the start of the industrial era,

> The fishing industry . . . consisted of a number of disaggregated sectors, each with its own techniques and markets and all of them transplanted to California from somewhere else.
>
> (1986: 69)

Common to fisheries in this time period was that it concentrated on the inshore zone, which was consequently rapidly depleted.

The Second Industrial Revolution and the discovery of oil, however, soon changed the sector thoroughly. Key to this transformation "was the successful application of fossil fuels to fishing and the gradual modification of vessels and gear for work on the open ocean" (1986: 126). This was accompanied by the development of new processing methods – such as canning, and the production of fish meal – and large, new markets (1986: 124). Three new fisheries developed: an open-sea troll fishery for salmon, a high-seas tuna fishery, and a sardine, or pilchard fishery.

The industrialized sardine fishery is the most interesting of the three, showing the steepest ascent and, later, the biggest decline too. It developed so quickly, and with so little regulation, that, by the 1930s, this fishery was probably the most intensive in the world, making California the prime fishing state in the country. The crash, which came at the end of WWII, however, was catastrophic (1986: 154), and the sardine fishery never recovered. Nor did many other fish stocks. In reaction, many fishing businesses shifted their activities to other waters. Thus, a distant water tuna fisheries soon developed, as did investments in the Peruvian anchovies fishery (which collapsed in the 1970s).

Looking back over the history of Californian fisheries, McEvoy argues,

> the commercial harvest left in its wake a trail of devastation. By their end, both the quantity and the diversity of life in the current had fallen to unprecedentedly low levels. The destruction was both cyclical and cumulative, the different sectors of the industry depleting their resources, colonizing new ones, and depleting them in turn without altering significantly their essential characteristics or patterns of behavior.
>
> (1986: 251)

This pattern of environmental wastage, was, in McEvoy's estimation, furthered by the specific condition of the legal system.

> Throughout most of its history, U.S. law worked in service to the private economy to dissolve whatever barriers either the ecology of the resources themselves or the efforts of some fishers to stabilize their relations with the fish might place in the way of sustained expansion.
>
> (1986: 253)

Thankfully, this is not the end of the story. McEvoy concludes his analysis on a more positive note, pointing out the "tectonic changes in public attitudes" (1986: 255), which have taken place since the 1970s, and the new focus on conservation.

16.4 Blue Revolution in Asia

John Butcher (2004) writes the history of marine fisheries in Southeast Asia in the period 1850–2000. The industrialization of fisheries in this region coincides largely with a time phase he entitles "the great fish race," which commenced after WWII and lasted into the 1960s and 1970s. This period of rapid expansion, however, was rooted in earlier developments.

In the mid-eighteenth century, Southeast Asia, which encompasses the contemporary nation states of Indonesia, Philippines, Malaysia and Singapore, and Thailand possessed a thriving fisheries and a strong tradition of fish consumption. Butcher points out a "vigorous trade" in seafood products (Butcher, 2004: 37, 51) and "a huge variety of fishing gears" (2004: 41). However, most of the fishing took place close to shore, and "focused both ecologically and geographically on but a small proportion of the sea" (2004: 57). Fishers relied on passive fishing gears, as well as wind and muscle power.

By 1930 catches had probably increased by a factor of three (2004: 71), and demand was growing. Butcher argues that this early increase of fish production was, however, barely accompanied by technological innovation. Rather he suggests that:

> The great bulk of fish captured in Southeast Asian waters was still caught with fishing gears and vessels that differed little except sometimes in size from those being operated in the mid-1800s.
>
> (2004: 72)

Instead of exploiting more distant waters and other ecological strata, fishermen had moved along coastlines into inshore areas that had been barely fished before (2004: 121), and generally intensified their fishing efforts. Technological change was becoming visible at the horizon. Borrowing technologies from Europe and North America, Japanese fishermen had started motorized trawling operations in Southeast Asia, and Chinese fishermen introduced purse seines for the harvest of pelagics such as Indian mackerel. These activities extended fishing into new ecological strata and geographical zones. Butcher is unequivocal, however, about the overall picture: "On the eve of the Pacific War vast sections of the sea were hardly touched by fishing" (2004: 165).

The "great fish race," which commenced after WWII and the independence of previously colonized nations, brought about vast change. The ethos of these new states was "development," and fisheries was one of the foci of attention (2004: 170–171). Technology played a crucial role in realizing an upsurge in catches.

> We can list the technological changes that took place one by one – motorization, devices to detect fish, new fishing gears, nets made of synthetic fibers, the greater use of ice, the construction of cold storage facilities, improved land transport, and so on – but it was the combination of various changes that brought about the rapid rise in catches.
>
> (2004: 174)

The Philippines was the first country in the region to take off. But it was Thailand that soon became the biggest player. Supported by German fisheries experts, trawling developed in Thailand in a big way from 1960 onwards.[4] The Gulf of Thailand, the initial location of fishing, soon became overfished. Rather than resulting in a downsizing of the fleet, the declining catch rates, however, prompted government to provide incentives for the construction of larger boats, and thereby "set off a great diaspora of Thai trawlers" (2004: 198) to other waters in Southeast Asia. Meanwhile purse seining for pelagic species also developed rapidly.

Trawling and purse seining were the basic elements of fisheries industrialization in other Asian countries too. As these activities spread, two varieties of conflict exacerbated. First, the incidence of conflict with small scale fishermen increased dramatically, a result of the fact that "because of the size and power of their vessels the operators of trawlers and purse seiners could easily destroy any small nets or boats that happened to get in their way" (2004: 229). In addition, small-scale fishermen felt that their livelihoods were being undermined (Figs. 16.5 and 16.6). The second conflict occurred between governments, trying to protect "their" marine resources from the incursions of foreign fleets. These included industrial vessels from Japan, Taiwan and Korea.

By 1980 the frontier of fishing in Southeast Asia was closing. Although the demand for fish products continued to grow, and prices remained high, most ecological strata were now heavily fished. Butcher describes the transition as follows:

> During the 1960s great populations of fish lay untapped ready to be exploited when existing populations were depleted. By the late 1990s fishers were capturing virtually the full range of harvestable fish, crustaceans, mollusks, and holothurians in all ecological strata through the sea within and around Southeast Asia.
>
> (2004: 288)

In spite of increasing fishing effort, total catches had stabilized. Investors who earlier had targeted capture fishing, now started to seek more profitable investment venues, such as in aquaculture.

Fig. 16.5 Small-scale fishermen in South India. (Source: Author)

Fig. 16.6 Fleets of small industrialized vessels in South India. (Source: Author)

16.5 The Role of Technology

Although the modernized fisheries of California and Southeast Asia differ in many respects, including the periodization of their blue revolutions, they possess a strikingly similar technological base. The likeness of their harvesting technologies follows from the emulation, adaptation and promotion of successful innovations in other fishing regions, that is, a "globalization of production" which intensified in the course of the 20th century (cf. Thorpe & Bennett, 2001).

We noted above the important role of mechanical propulsion, which was introduced to fishing in the late 19th century and was accompanied by the use of new boat-building materials. Although smaller fishing vessels in the present day are often still made of wood, boat yards now often utilize fiberglass reinforced polyester (FRP) for their construction, while steel is preferred for larger vessels. Developments in engine and fiber technology, hydraulics, electronics and refrigeration also impacted vessel design significantly.

Ancillary equipment too has made a big difference. Fish finders, which emerged from naval technologies designed and tested in WWII for the detection of submarines, are, writes Valdemarsen (2001: 643), "the non-gear development that has influenced the efficiency of fishing operation most." In western countries almost all contemporary fishing vessels are now equipped with navigational and fish finding devices, and this technology is spreading fast to other parts of the world. All these technologies have assisted in exploring new fishing grounds, locating and catching target species, processing and preserving catches, and transporting them to market centers.

Turning to gear, Valdemarsen draws attention to another key moment, the introduction of synthetic fibers, which took place since 1950.

> When reviewing the outgoing century for events, that have had substantial impact on the development of fishing technologies and practices besides the large scale motorization of the fleet, it is difficult to find anything that overshadows the introduction of synthetic fibers in fishing gears, which can be dated to around 1950.
>
> (2001: 641)

Synthetic fibers are not only lighter than, for example, cotton and hemp (allowing fishers to take along more nets at one time), but are much stronger too. The increased strength of netting material, Valdemarsen (ibid.) argues, formed a condition for subsequent innovations. The introduction of transparent monofilament nylon also reduced the visibility of nets and contributed greatly to catch performance. Søndergaard (2006) and Martinussen (2006) have described the momentous changes which occurred parallel to the transition from natural to synthetic fibers in Scandinavia in the period following WWII.

A small set of gear types has had an important impact on the fishing industry in the 20th century. Two fishing techniques, trawling and purseseining, stand at the heart of the industrialization effort.[5] Building upon earlier fishing methods, neither of these techniques was strictly new. Changing conditions, however, prompted a process of innovation, which propelled these methods to the forefront of the technical revolution.

Trawling emerged out of earlier experiences with towed bagnets (Von Brandt, 1984) and is an active fishing method.[6] The proliferation of bottom trawl technology followed the development of engine-power which occurred, as we have seen, from the late 19th century onward. "Since then," Valdemarsen (2001: 641) writes, bottom trawling "has developed to become the most important fishing method to exploit high value fish and shrimp resources living on or in the vicinity of the bottom."

Over time trawl gear has undergone many developments, which has made it suitable for new terrains, depths, and target species. It is widely used to catch shrimp, flatfish and even some roundfish species. With the exhaustion of more accessible fishing grounds, however, trawl fishermen sought to extend their range.

> The trend in recent years has been towards fishing in worse and worse bottom conditions as well as going into deeper and deeper waters, where bottom conditions often are known to be fairly rough. Trawling in such areas has been made possible not least with the development of rougher bottom gears for protection of the more sensitive netting parts.
>
> (Valdemarsen, 2001: 642)

Here again, technology had come to fishermen's assistance in order to maintain catch levels and incomes.

In spite of its popularity among industrial fishers, bottom trawling has recently come under severe criticism, however, for two important reasons. First, bottom trawling has been demonstrated to negatively impact the benthic environment, and thereby the ecosystem of many marine species (FAO, 2004; Pauly et al., 2002).[7] Secondly, bottom trawling results in important bycatches of non-target species, which are subsequently discarded (FAO, 2004). This practice is regarded

as extremely wasteful. New technical innovations are therefore directed toward adapting trawl practice and reducing both negative impacts.

A fundamentally different type of trawling, aimed at so-called pelagic species such as sardine, herring, whiting, or Pollack, came about mid-way the 20th century (cf. Von Brandt, 1984: 262ff). Pelagic trawls currently might have a mouth area of 15,000 m^2 (161,458 sq ft) – a 60 fold increase in catching volume from the first designs. This type of fishing has become very important in the North Pacific and the North Atlantic. The development of pelagic trawl fishing, Valdemarsen (2001) argues:

> Has been possible, not least because of the mechanized handling of the trawl with large and powerful net drums, introduction of refrigerated sea water (RSW) to store large amounts of fish in bulk and the fish pump, which can rapidly take onboard large quantities of fish from a codend. Catches might often exceed 100 tonne in many fisheries.
>
> (Valdemarsen: 645)

The second technique which revolutionized industrial fishing in the twentieth century was purse seining. This technique relies on using a wall of net to encircle a shoal of pelagic fish at the surface, subsequently closing the net at the bottom in order to prevent the shoal from escaping (Von Brandt, 1984: 301–304). Valdemarsen (2001: 645) argues that modern purse seining depends on two developments that occurred in the 1950s: the introduction of synthetic fibers and the power block for hauling the net. Both of these innovations made it possible to enlarge the scale of fishing operations. The improvement of fish detection technology has contributed greatly to the efficiency of purse seines, so much in fact, that several important fish stocks became heavily overfished in the 1960s and 1970s.

Like trawlers, purse seiners are specialized fishing units, often demanding a relatively large crew (15–25) for handling the net. The method is regarded as relatively "clean" in the sense that bycatches of other than target species can often be avoided. This is not always the case, however. The environmental movement has, for example, decried the entrapment of dolphins along with tuna, and demanded remedial measures. The main "problem" of modern purseseining, however, is its ruthless efficiency, viz., utilized together with fish-finding devices, pelagic fish schools have little chance to go undetected and escape.

16.6 Distant Water Fleets

Factory ships, or distant water fleets, as they are sometimes called, epitomize the technological innovation process that has taken place in capture fishing most forcefully (cf. Berkes et al., 2006). Although in earlier days too fishermen had engaged in fishing at long distances from their homes, such as on the cod banks off North America, but the scale of these efforts were limited. Between the 1950s and the 1970s, however, nations scrambled to develop large distant water fleets that roamed the Atlantic and Northeast Pacific as well as other promising fishing grounds,

making use of the most up to date technology as well as the gear types described above. McGoodwin (1990) describes the breathtaking scale of these vessels:

> The ships were huge, some exceeding 300 ft (91.4 m) in length and 4,000 gross tons. Many were capable of bringing in as much as 500 tons of fish in a single haul and of processing over 250 tons a day. Because of their formidable capitalization requirements – a purchase price of several millions of dollars and daily operating expenses in excess of $20,000 – they were usually underwritten by giant corporations and heavily subsidized by national governments. . .Because of their processing capacity, the ships could stay at sea longer than any fishing vessels had ever been able to before – sometimes for a year or more. Each was a floating factory, and the fleet itself a kind of roving industrial complex, where even the by-catches of untargeted species and the scrap from the on-board processing operations were reduced to fish meal.
>
> (1990: 101)

The main operators of distant water fishing fleets in the post-WWII time period were the Soviet Union (now the Russian Federation), and Japan, who together accounted for more than half the total catches (WWF, 1998: 17). Other big players included – in descending order of importance – Spain, the Republic of Korea, Poland, Taiwan, Portugal, Germany, France and Ukraine. Following the fish where they were to be found, distant water fleets sometimes ventured closer into coastal waters. There they came into conflict with local authorities and fishermen. Thorpe and Bennett (2001: 145) describe what they consider in this regard as a process of "ocean colonialism" in Latin America. Others discuss such conflicts in Africa (Alder & Sumaila, 2004), and Southeast Asia (Butler, 2004).

The Law of the Sea, which was adopted in 1982 and ratified a little more than a decade later, forced distant water fishing nations to either relocate their activities to

Fig. 16.7 The Atlantic Dawn – the world's largest factory ship. (Source: www.valderhaug.no)

the high seas, or to negotiate with coastal states about fishing rights. Coinciding as it did with the leveling off of catches, these circumstances contributed to the scrapping of most of the largest factory ships (McGoodwin, 1990: 103) and an overall reduction in the size of these fleets. Factory ships operating in distant seas are still about, however (Fig. 16.7). Although many of them operate quite legally, others have submerged to become part of the worrying contingent of Illegal, Unreported and Unregulated Fishing (IUU), otherwise known as fish piracy (OECD, 2004).

16.7 Conclusion

In the previous pages I have described the industrialization of capture fishing that took place during the 20th century in parallel to other social and economic changes. This process possessed two distinct phases, the first of which centered in the developed world and took off in the period before WWII. The second occurred in developing countries during the second half of the century. Existing fisheries underwent substantial change – hence the term blue revolution – in both instances, and new fisheries came about. Technology played a far-reaching role.

The impact of technological change in fisheries has been manifold. From a global perspective, the blue revolution has on the one hand resulted in an enormous increase of fish harvests, and an improvement of food security. Millions of people are still employed in the sector; most of them live in low income countries where alternative employment opportunities are scarce. The globalization of markets and the increase of fish prices has thus contributed to economic wealth, while the World Bank argues that, if we act responsibly, many "sunken billions" are available in future.

All these achievements, however, have come at a price. Marine biologists warn us that the enormous increase in technological efficiency has had catastrophic effects on the marine environment. Fish stocks that were previously shielded from predation because of human ignorance or inability, are now buckling under the strain of ever increasing effort. There is therefore a clamor for better governance. The problem is, however, as Chuenpagdee et al. (2005: 27) have suggested, that "new driving forces have developed, surpassing the capacity of the old management systems and putting new pressures on the natural and social systems."

But the 20th century also contains the seeds of what may later be recognized as a new era. The Law of the Sea, which gives coastal states responsibility for the world's most valuable fishing grounds, constituted the first milestone herein. It has already been supplemented by agreements with regard to high seas fisheries and so-called straddling stocks. The second milestone is the realization, under the guidance of FAO, of an international Code of Conduct for Responsible Fishing (1995). Although implementation is still voluntary, this code is highly influential in directing the course of national and international governance efforts. All over the world, governments are increasing their control over fisheries, and imposing new rules and regulations. One of the most fundamental of these is the inauguration of new property right regimes, such as individual transferable quotas, in capture fishing.

What have all these changes meant for fishers and their communities? In Europe and North America, the fishing population has declined substantially in size during the 20th century, many old-timers disappearing into other economic avenues. The introduction of new property arrangements has limited entry to the fisheries, and may be affecting the life and long term viability of fishing communities (Lowe & Carothers, 2008).

The situation in other parts of the world, such as Asia and Africa, is quite different. Although fish stocks there too are under obvious pressure, the number of fishermen is generally increasing, particularly in the small-scale sector. The fact that alternative employment avenues are scarce and fishermen's skill sets are limited, contributes to this state of affairs. Meanwhile conflicts between groups of fishermen, as well as between fishermen and other coastal and marine users, appear to be on the increase.

Acknowledgement I am grateful to Stan Brunn for his suggestions to improve this chapter. Eva-Maria van Straaten helped to trace relevant material.

Notes

1. Bailey (1985) coined the term "blue revolution" to refer to technological developments in tropical fisheries (cf. McGoodwin, 1990). As this process did not differ fundamentally from the one, which took place earlier in temperate zones, I use it as a generic term.
2. Capture fishing stands opposed to culture fishing, otherwise known as fish farming or aquaculture. In this paper the term "fishing" refers only to the former activity.
3. FAO (2009: 26–27) points out the fallacy of statistics with regard to the number of fishing vessels in the world and urges that these figures are no more than indicative of global trends.
4. The number of trawlers is indicative of the popularity of trawling in Thailand. Trawlers increased from 99 in 1960 to 2700 in 1966, and 6300 in 1977 (Butcher, 2004: 195, 199).
5. Industrial fishing vessels make most use of these techniques. Innovations with regard to gill nets have been more important for small-scale fisheries, which rely more on passive fishing methods.
6. Active fishing methods are those in which the fisherman drags or pulls a gear in pursuit of his target species. Passive fishing gears are those in which the gear is stationed in one position and it is the target species that entangles itself.
7. Thus Pauly et al. (2002: 691) compare bottom trawling to the clear cutting of forests in order to hunt deer.

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