COD CATCHES ON A FISHING BOAT OFF THE LOFOTEN ISLANDS, NORWAY
(PHOTO: GETTY IMAGES)

OVERFISHING

AND OTHER THREATS TO AQUATIC LIVING RESOURCES

The international community cannot achieve the Millennium Development Goal of hunger eradication without improving fisheries management. Almost two-thirds of the GIWA regional teams predicted that the effects of unsustainable fishing practices would increase in severity in their region by 2020. Overfishing was identified as the priority concern in many parts of East Asia and Australia & the Pacific Islands. Virtually all of the mega-regions determined that the overexploitation of fish and other aquatic living resources, and the use of destructive fishing practices are major concerns. By contrast, excessive by-catch and discards were only determined to be critical at the mega-regional level in South America and Southeast Asia. Excessive fishing effort and the employment of destructive fishing practices are attributed to a complex web of root causes, including the common pool nature of fisheries resources, poverty, insufficient knowledge regarding the status of the fisheries, inappropriate subsidies, a lack of appropriate incentives and weak enforcement of fisheries regulations.

Today, the fisheries industry employs over 200 million people and exploits virtually all international waters. The achievement of the Millennium Development Goal (MDG) to eradicate hunger will be partly dependent on the ability of the fisheries and their ecosystems to supply animal protein to the populations of most developing countries. However, there is widespread concern over the sustainability of the fisheries. The Food and Agriculture Organization reports that 52% of the world's marine fish stocks are fully exploited, 16% are overexploited and 7% are depleted (FAO 2005). Furthermore, many of the ecosystems that support critical fisheries are degraded.

GIWA assessed the sustainability of international fisheries (Box 15) by targeting the following issues: (i) overexploitation; (ii) excessive by-catch and discards; (iii) destructive fishing practices; (iv) decreased viability of stocks through pollution and disease; and (v) impact on biological and genetic diversity.

BOX 15. TRANSBOUNDARY FISHERIES

GIWA uses the following characteristics to define international fisheries:

- River basins, lakes, and marine ecosystems that are divided by political borders which do not match the distribution and migratory patterns of fish stocks;
- Fleets operating in the Exclusive Economic Zone (EEZ) of foreign countries;
- Two or more countries disputing the location of their respective EEZs;
- Consumers buying fish caught in another country's EEZ;
- Fleets fishing on the high seas, which are international commons (the high seas were not assessed by GIWA).

Global situation and trends

- Overfishing and other threats to aquatic living resources were assessed as the priority concern in over one-fifth of the GIWA regions/sub-systems.
- Almost 60% of the GIWA regional teams assessed overexploitation as severe. In nearly every lake and Large Marine Ecosystem (LME) assessed by GIWA, several fish stocks are overexploited.
- Overfishing is primarily caused by the excessive fishing effort of industrial fishing fleets, but small-scale fishers also overexploit nearshore fish stocks.
- Excessive by-catch and discards exacerbate overfishing and can threaten endangered species; trawling fisheries in the North Atlantic and in numerous tropical regions typically have significant by-catch.
- In three-quarters of GIWA regions/sub-systems, destructive fishing practices are degrading habitats and communities that support fisheries.

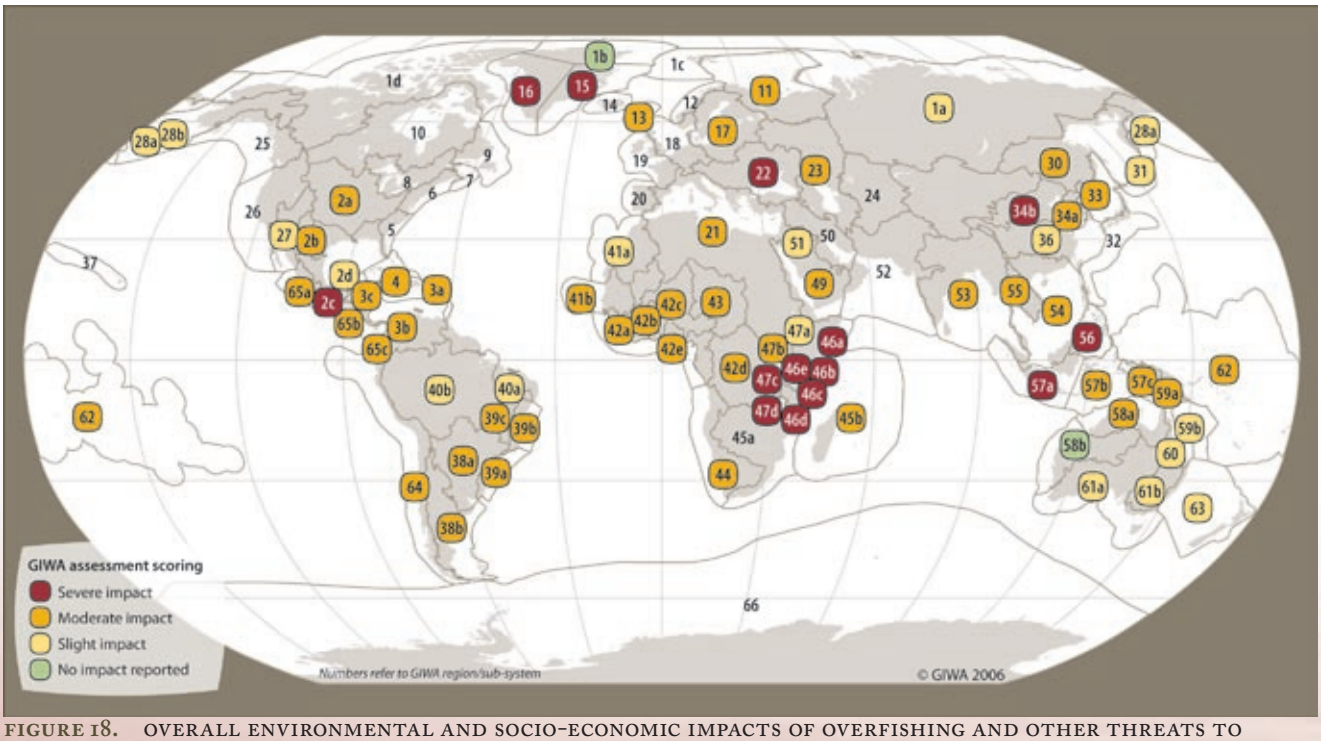


FIGURE 18. OVERALL ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF OVERFISHING AND OTHER THREATS TO AQUATIC LIVING RESOURCES

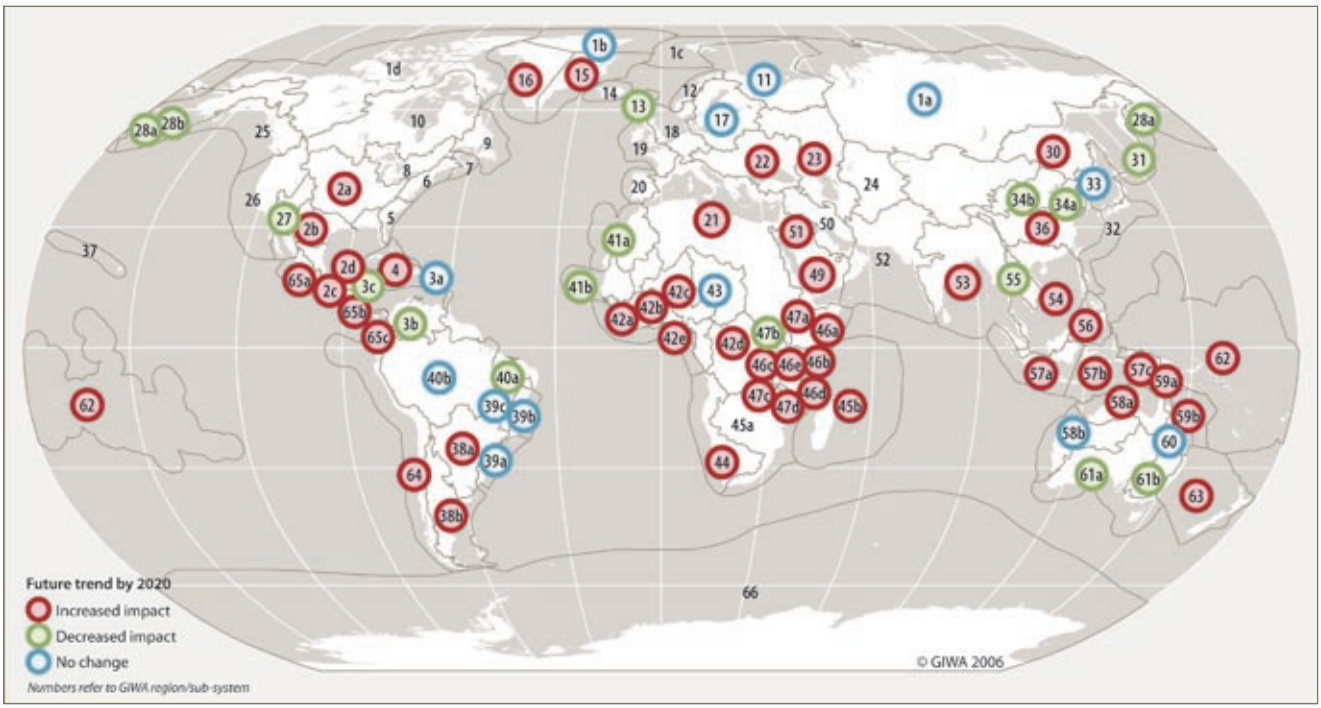


FIGURE 19. FUTURE ENVIRONMENTAL TRENDS OF OVERFISHING AND OTHER THREATS TO AQUATIC LIVING RESOURCES

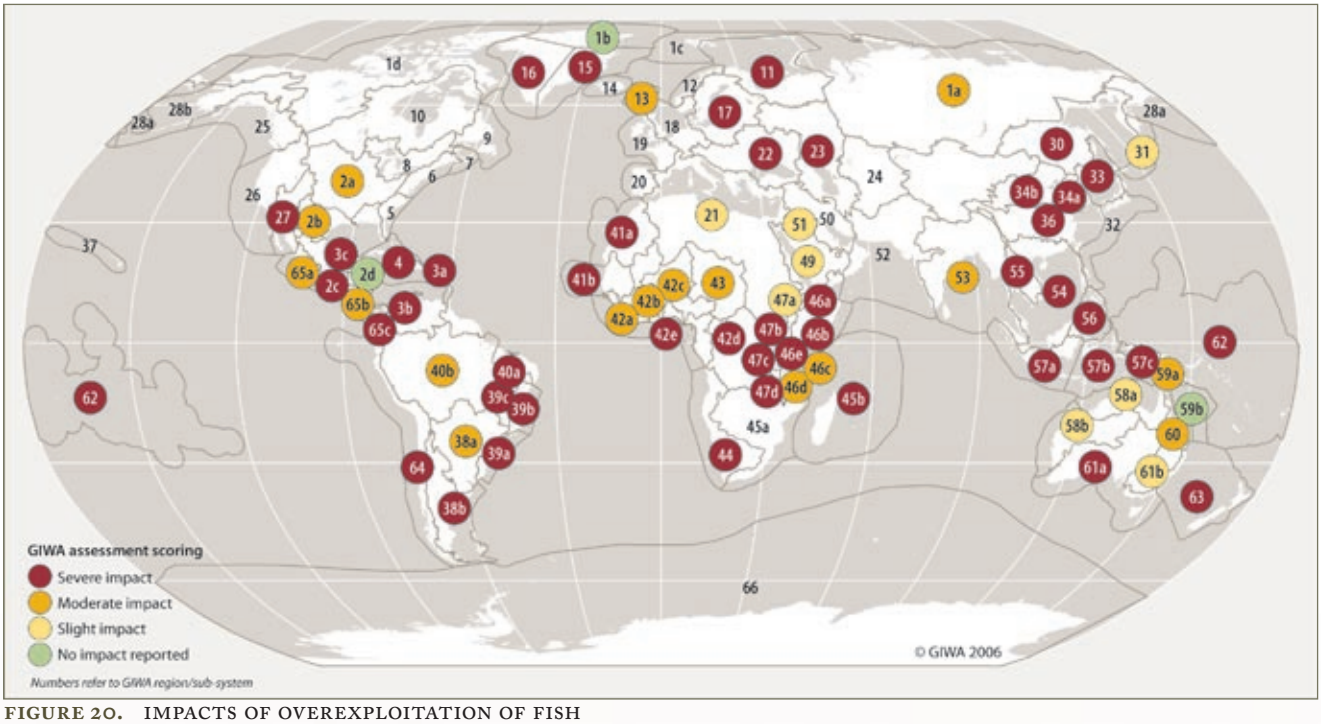


FIGURE 20. IMPACTS OF OVEREXPLOITATION OF FISH

- Aquaculture is the fastest growing animal-based food-producing sector, particularly in developing countries. However, the widespread environmental and social drawbacks of the industry need to be addressed.
- Although the majority of the GIWA regional teams predicted that the impact of overfishing and other threats to aquatic living resources would increase in severity, the situation in over 20% of GIWA regions/sub-systems is expected to improve by 2020 following the adoption of sustainable management practices (Figure 19).

ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS

Overexploitation

Overexploitation occurs when fish and other living resources are caught at a rate which exceeds the maximum harvest that allows the population to be maintained by reproduction. Overexploitation of fish was assessed as severe in more regions than any other environmental issue evaluated by GIWA. It is a geographically widespread problem, affecting most LMEs and many lakes, including the East African Rift Valley Lakes/47b,c,d.

Overexploitation firstly affects large, slow-growing predatory fish, such as cod, halibut and grouper, and high-value invertebrates, such as shrimp, lobster and large shellfish. In many GIWA regions the depletion of large predators has led to 'fishing down the food web', whereby the average catch composition is gradually replaced by short-lived, fast-growing, plankton-eating fish and invertebrates at lower trophic levels, as the predatory fish populations succumb to intensive fishing effort (Pauly et al. 1998). The Argentinean hake (*Merluccius hubbsi*), for example, was the species principally targeted in the South Atlantic Drainage System (Patagonian Shelf/38b). After years of overfishing, hake stocks finally collapsed in 1997, whilst stocks of the short-lived and fast-growing Anchoita (*Engraulis anchoita*) tripled over the same period. The collapse caused extensive unemployment in the fishing industry, severely impacted fish processing plants and reduced export revenues.

In the Caribbean Small Islands region (Caribbean Sea/3a), fisheries production escalated to unsustainable levels, from 9 000 tonnes in 1950 to 60 000 tonnes in 2000 (Figure 21). Many commercial species are currently at risk as a result of overexploitation and a loss of critical habitats for fish and shellfish reproduction, such as mangroves, seagrass beds and reefs.

It is often difficult to determine the degree to which fish stocks are depleted as a result of overexploitation or climatic variability. For example, the cod stocks of the Greenland Seas are sensitive to changes in water temperature, and have subsequently declined over the last 30 years (East Greenland Shelf/15 and West Greenland Shelf/16). According to Sherman (2003), climate is the key controlling factor of fishing yields in about half of the world's LMEs. However, overexploitation exacerbates the effects of climate variability, such as in the major upwelling areas of the Benguela Current/44, Canary Current/41 and Humboldt Current/64 (Box 16).

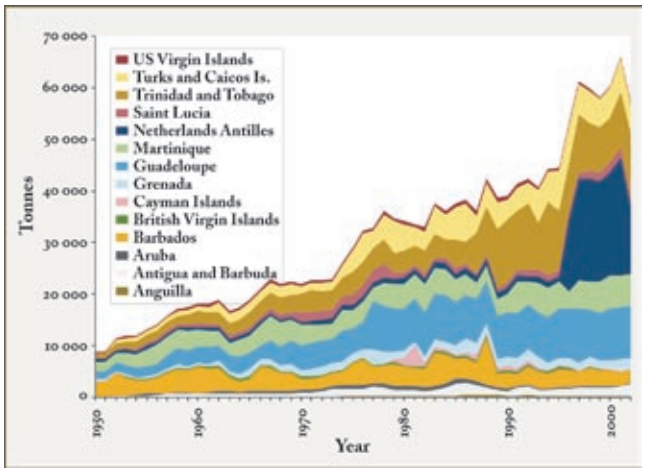


FIGURE 21. TOTAL CAPTURE OF FISH, CRUSTACEANS AND MOLLUSKS IN THE CARIBBEAN SEA/SMALL ISLANDS SUB-SYSTEM
(SOURCE: FAO FISHSTAT 2003)

The affect of overfishing on the trophic structure of fish communities is exemplified in the Barents Sea/11. In the 1980s, overfishing and natural fluctuations drastically depleted Capelin (*Mallotus villosus*) stocks. Cod (*Gadus morhua*), the most commercially important fish in the Barents Sea, preys mainly on Capelin. The subsequent lack of prey and continued overfishing of cod itself reduced the cod spawning stock biomass, and catches declined to 20% of their highest levels. Although cod stocks were restored during the early

BOX 16. CLIMATE VARIABILITY AND FISHERIES: THE EL NIÑO SOUTHERN OSCILLATION (ENSO)

Fish biomass and catches are strongly linked to climatic variability, particularly in high latitude and upwelling Large Marine Ecosystems (LMEs).

Many studies have explored the relationship between fisheries, climate, and climate modes. The latter are dynamic patterns of climate variability, such as the El Niño Southern Oscillation (ENSO). ENSO dominates the inter-annual climatic variability of the southern Pacific Ocean and influences global climate. Several ecosystem responses to the ENSO affect the fisheries. In the Humboldt Current/64 LME, cold nutrient-rich upwelling ceases in El Niño years. The consequences are dramatic, including reduced primary production, the collapse of the anchovy fisheries and the migration of jack mackerel (*Trachurus murphyi*) to inshore waters where they are subjected to high predation.

BOX 17. SOCIO-ECONOMIC IMPACTS OF THE UNSUSTAINABLE EXPLOITATION OF FISH: CASE OF THE SOUTH CHINA SEA

The GIWA assessment of the South China Sea/54, which includes the EEZs of nine countries, highlights the range and severity of the socio-economic effects of overfishing. Throughout the region, the reduction and collapse of the fisheries has led to a widespread loss of income and employment.

In many areas, particularly around the Philippines and Indonesia, fish are mostly exported causing local fish consumption to decline by a third. This has contributed to the malnutrition of many children. In coastal communities, alternative livelihoods are rarely available. Injuries and deaths from blast fishing and diving are common. Conflicts provoked as a result of declining fish stocks are frequent among local fishing groups, and with foreign fishers.

It is estimated that fishing effort will need to drop by 50% to restore many fisheries to sustainable levels, particularly near urban areas. The major deficit in wild-caught fish production is expected to lead to increased aquaculture to meet growing demand (see Box 18).

(SOURCE: SOUTH CHINA SEA/54)

to mid-1990s, intense fishing during the late 1990s depleted stocks again. At the end of the 1980s, 75 000 people were employed in the fisheries sector in northwest Russia, but this figure had dropped to only 30 000 a decade later. Coastal settlements experienced food insecurity, further unemployment and reduced income in other sectors of the regional economy.

Nearshore stocks are also increasingly overexploited by artisanal fishers. The number of artisanal fishermen in India is unsustainable, having increased by 300% over the past 20 years (Bay of Bengal/57). Artisanal fishing communities are particularly vulnerable to the impacts of overfishing. In the Guinea Current/42 region, 60% of landings are made by artisanal fishers, and since a downturn in fisheries production, unemployment has increased and conflict has been provoked between artisanal fishers and commercial trawlers. In the adjacent Canary Current/41 region, overfishing has led to 80% unemployment in the Senegalese fisheries sector.

Overexploitation of living resources affects many sectors of the economy. In the Bahamas (Caribbean Islands/4), as in many SIDS and other regions dependent on coastal resources, the fisheries are critical for economic development, tourism and food security. The exploitation of living resources for export results in local communities losing their best source of protein. The decline in the nutritional value of the local diet leads to protein deficiency.

The effects of destructive fishing practices and overfishing are also evident in many freshwater systems. Fish account for 25-40% of total animal protein supply in the Lake Tanganyika Basin. Rapid population growth and poor management of the resource has reduced per capita fish consumption in Malawi by over 40%, leading to malnutrition in some areas. Destructive fishing activities and overfishing put a substantial proportion of those employed in Lake Malawi's commercial fisheries (nearly 290 000) at risk. In Lake Tanganyika, overfishing and destructive fishing practices have led to large-scale unemployment following the collapse of Burundi's industrial fishing fleet in the early 1990s.

Excessive by-catch and discards

By-catch refers to the incidental capture of non-target fish, invertebrates, marine mammals, sea turtles, and seabirds, as well as under-sized specimens of target species. But discards refer to undesired by-catch thrown overboard; the survival rate of most species discarded is extremely low. In many of the regions assessed by GIWA, excessive by-catch accompany overexploitation.

By-catch changes the age structure of fish populations, disrupts food webs and threatens endangered species. In the transboundary waters of many tropical and subtropical GIWA regions, by-catch, particularly from shrimp trawling (see figure 22), was assessed as having severe environmental impacts. In the Somali Coastal Current and South African waters, the ratio of prawns to by-catch is 1:7 and 1:4 for trawlers, respectively. By-catch of endangered species is also a concern, particularly in the Pacific Islands/62 and Somali Coastal Current/46.

By-catch and discards can have serious socio-economic implications. In the Sea of Okhotsk/30, fleets discarded large quantities of juvenile pollock during the 1990s, which destabilised the age structure of the stock. The volume of pollock catches have subsequently declined by one-third over the last 10 years. In 2000, fishing companies lost revenues in excess of 100 million USD.

FIGURE 22. BY-CATCH FROM SHRIMP TRAWLING IN THE GULF OF MEXICO
(PHOTO: MINDEN PICTURES)

Discards also create major transboundary problems if the discards from one fishery include species which are valuable to another. For example, foreign fishers dominate offshore fishing in the Somali Coastal Current/46 region, and discard significant amounts of edible by-catch. When rotting fish carcasses are carried shoreward, local fishermen complain that foreigners are destroying their fisheries.

Destructive fishing practices

Destructive fishing methods, including bottom trawling, blast fishing, fishing with poisons, muro-ami nets, and several other locally employed fishing methods, significantly degrade aquatic habitats. Almost three-quarters of GIWA regional teams reported that destructive fishing practices cause moderate to severe impacts (Figure 23).

Although bottom trawling was originally developed for use in deepwater in the North Atlantic, it is now also employed when fishing shallow seagrass beds in tropical regions, causing extensive damage. However, deepwater and hard seabed bottom trawling is also highly destructive to benthic habitats and communities. In the Gulf of California/27, the recurrent use of trawling nets has severely altered the composition of benthic communities.

Blast or bomb fishing, which uses small explosives to kill or stun fish, is predominantly used in tropical regions where it destroys the structure of coral reefs and can subsequently cause the collapse of reef fisheries. Poison fishing with toxic chemicals, such as bleach and cyanide, is also highly destructive to coral reefs. The GIWA assessment found blast and poison fishing to be major problems throughout Southeast Asia, as well as in the Brazil Current/39, Caribbean Sea/3 and Somali Coastal Current/46. Cyanide is widely used in the live reef food fishery and the ornamental aquarium fishery in East Africa, East Asia and Southeast Asia.

Destructive fishing practices are the greatest threat to the reefs of the Sulu-Celebes Sea/56 region. While the short-term benefits to fishermen are high, often returning 15-40 USD for a 1-2 USD investment, the social and environmental costs are considerable. Blast fishing is expected to cost Indonesia at least 3 billion USD over the next 20 years, and cyanide use a further 50 million USD. A sustainable hook and line fishery, in contrast, could create net benefits of 320 million USD. In some regions, human consumption of poisoned fish has led to hospitalisation, and even death.

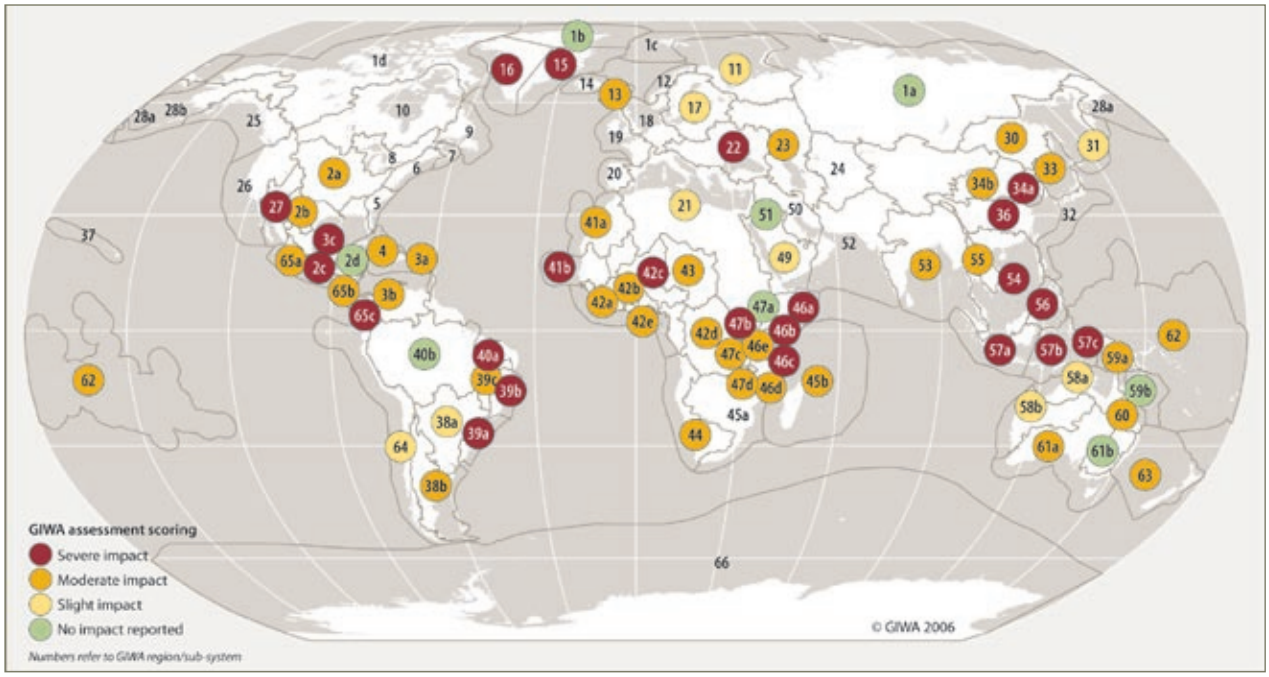


FIGURE 23. IMPACTS OF DESTRUCTIVE FISHING PRACTICES

Decreased viability and biodiversity impacts of aquaculture

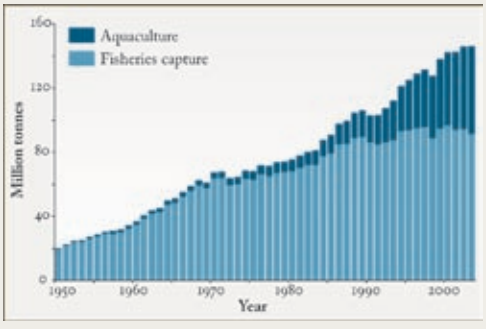
Bacterial or viral diseases can spread from aquaculture stocks and decrease the viability of wild commercial stocks. The introduction of disease through shrimp aquaculture in North Sumatra has resulted in the collapse of wild shrimp stocks. In the Humboldt Current/64, outbreaks of disease in shrimp farms have cost 600 million USD annually, excluding the subsequent economic impact on wild stocks.

Aquaculture or restocking programmes that introduce alien species or genetically modified organisms can affect the biological diversity and structure of ecosystems, as observed in several regions in Central America and South East Asia. In the Philippines and Vietnam, introduced species have extirpated native species. Box 18 discusses the characteristics and impacts of the aquaculture industry.

BOX 18. AQUACULTURE INDUSTRY

Aquaculture, both inland and coastal, is one of the fastest growing food producing sectors in the world, with the annual growth rate exceeding 9% since 1970. Individuals or corporations own aquaculture stocks, whereas wild fisheries are open access. Aquaculture is playing an increasingly important role in meeting the growing demand for fish protein in many tropical and subtropical areas. China accounts for over 70% of the world's aquaculture production, primarily from traditional small-scale systems for local markets. The cultivation of high-value fish and shrimp by industrial aquaculture is growing rapidly.

Exports of aquaculture products provide substantial foreign exchange for many coastal states. Unfortunately, this is often earned at high social and environmental costs. Aquaculture farms often require the clearance of coastal habitats, such as mangroves, and can cause eutrophication and other pollution. Some aquaculture operations have introduced diseases, parasites and alien species into wild fisheries. Aquaculture can cause the overfishing of wild species as cultivated predatory fish and shrimp require protein-rich feed. Social repercussions can include the loss of traditional fisheries, and lower standards of living and reduced food supply for local fishers and farmers. While the continued growth of aquaculture is inevitable, it will only be sustainable and maximise its benefits to society if it is integrated into broader ecosystem-based management. (SOURCE: FAO 2004)



GLOBAL FISHERIES CAPTURE AND AQUACULTURE PRODUCTION 1950–2003.

BOX 19. INTERACTIONS BETWEEN THE FISHERIES AND OTHER GIWA CONCERNS: CASE OF THE BLACK SEA

Over the past 50 years, industrial fishing, pollution, habitat modification and the introduction of species have increased. It is often difficult to determine the degree to which each of these inter-related causes affect fish stocks. The collapse of the pelagic fisheries of the Black Sea provides an illustrative example.

Prior to the 1970s, overfishing depleted the top predators of the Black Sea which led to 'fishing down the food web'. Since the 1970s, urban and industrial expansion, intensive fertilizer use and atmospheric deposition resulted in severe eutrophication, hypoxia and bottom-up impacts on the food web. Additional stressors during the 1970s and 1980s included chemical pollution, the alteration of the inflowing rivers and continued overexploitation of fish populations.

In the late 1980s, ship ballast water introduced the invasive comb jellyfish (*Mnemiopsis leidyi)*. By 1989, they had spread throughout the Black Sea, reaching densities of 1.5-2 kg/m^2. *Mnemiopsis* voraciously consumed anchovy eggs and larvae, while eutrophication and intensive fishing of anchovies and other small pelagic fish continued, resulting in the collapse of the pelagic fisheries of the Black Sea. Total catches of European anchovy (*Engraulis encrasicolus*), estimated at 534 000 tonnes in 1986, had fallen to only 88 000 tonnes by 1991, resulting in the loss of an estimated 150 000 jobs.

By the mid-1990s, the invasion of another comb jellyfish (*Beroe* sp.) somewhat controlled the population of *Mnemiopsis*, allowing anchovy stocks to partially recover. However, they decreased again in the late 1990s, due perhaps to the affects of climate warming on the food web.

(SOURCE: BLACK SEA/22)

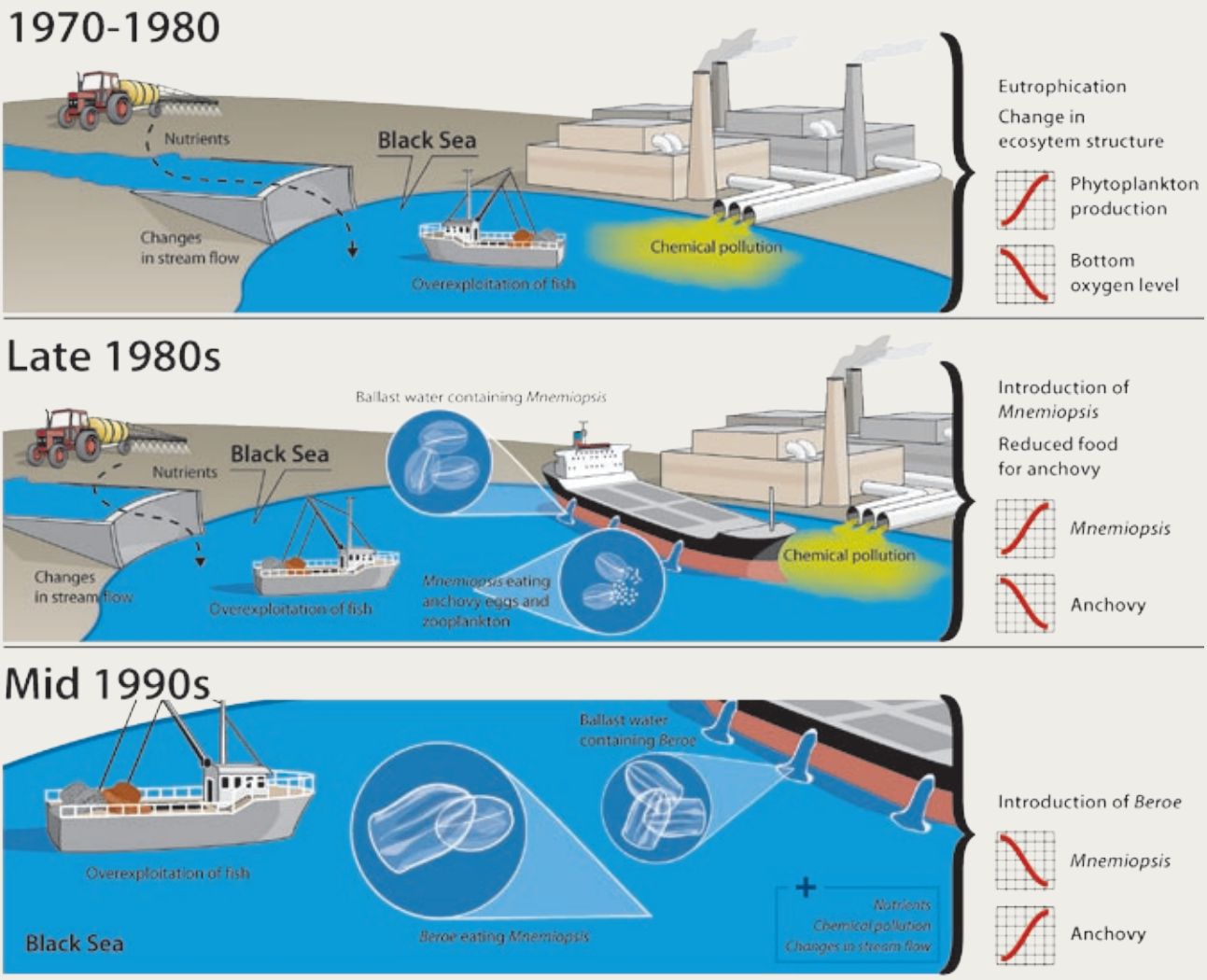


FIGURE 24. FISH FARM, CHINA.
(PHOTO: STILL PICTURES)

ROOT CAUSES

More than 20 GIWA regional teams selected overfishing and other threats to aquatic living resources as the top priority for their region (Table 9 and 10). Overfishing was predominantly attributed to excessive fishing effort, often in combination with destructive fishing practices. The GIWA regional assessments confirm that, despite evidence of severely depleted fish stocks, governments continue to permit large and efficient fishing fleets to overexploit fish resources.

Common pool resources

The fisheries are common pool resources and are thus difficult to protect from exploitation. As a result, fishing is frequently undertaken when alternative employment opportunities are unavailable. Another common pool attribute is that fishing by one user reduces the size of fish stocks available for others. Many fish stocks are not "owned" by a single country but are instead fished by several nations. The common pool nature of fisheries resources therefore results in overfishing and a lack of interest in maintaining fish habitats.

Three forms of property rights have been used to limit access to common pool resources and define rights and responsibilities of beneficiaries. However, inadequate enforcement, inappropriate incentives and knowledge deficiencies regarding the fishery may result in overexploitation despite a property rights framework.

The GIWA regional experts concluded that overfishing in the Indonesian Seas/57 region is caused by the lack of awareness amongst fishers of the impacts of destructive fishing and having the viewpoint that 'if I don't exploit the fisheries, someone else will'. In Lake Victoria (East African Rift Valley Lakes/47b), weakly enforced fishing regulations permit overfishing and the use of destructive fishing practices, which has resulted in reduced catch per unit effort.

In many parts of the world, particularly inland and nearshore fisheries in developing countries, increasing numbers of artisanal fishers are using destructive fishing methods

TABLE 9. IMMEDIATE CAUSES OF OVERFISHING AND OTHER THREATS TO AQUATIC LIVING RESOURCES

GIWA region	Targeted issues								
	Overexploitation							Destructive fishing practices	
	Immediate causes								
	Excessive effort and fleet capacity	Fishing above recommended quotas	Poor recruitment of fish stocks	Improved fishing technology	Poaching	Biomass shift (related to climatic changes)	Destructive fishing practices	Excessive effort and fleet capacity	Inappropriate fishing gear
11 Barents Sea	✓	✓							
13 Faroe Plateau	✓		✓						
16 West Greenland Shelf	✓			✓				✓	
17 Baltic Sea	✓	✓							
30 Sea of Okhotsk	✓				✓				
31 Oyashio Current	✓				✓				
33 Sea of Japan	✓								
34 Yellow Sea	✓			✓				✓	✓
36 East China Sea	✓		✓				✓		✓
38 Patagonian Shelf	✓							✓	✓
41b Canary Current South	✓						✓		✓
42e Guinea Current LME	✓					✓			
44 Benguela Current	✓			✓					
46 Somali Coastal Current	✓			✓	✓		✓	✓	✓
47b Lake Victoria (East African Rift Valley Lakes)	✓			✓				✓	
54 South China Sea	✓		✓						✓
57 Indonesian Seas	✓								✓
64 Humboldt Current	✓		✓						
65c Pacific Colombia (Eastern Equatorial Pacific)	✓					✓			

NOTE: THE TABLE PRESENTS A SELECTION OF GIWA REGIONS WHERE THE REGIONAL TEAM HAS CONDUCTED A CAUSAL CHAIN ANALYSIS ON THE TWO MOST FREQUENTLY ANALYSED ISSUES OF THE GIWA CONCERN OVERFISHING AND OTHER THREATS TO AQUATIC LIVING RESOURCES.

in an attempt to halt the decline in their catches which, in turn, reduces fish populations and degrades the habitats which support the fisheries. In response, fishers increase fishing effort and adopt further destructive practices. This situation is prominent in the Somali Coastal Current/46 region, where it has resulted in the reduction of household income and nutrition levels, and a growing frustration which often escalates into conflict between artisanal fishers and other stakeholders, especially the tourism industry and conservationists.

Global trends

Several global trends are underlying root causes of the overexploitation of transboundary fisheries, of which population growth, urbanisation and trade are common to the other GIWA concerns, while others are specifically relevant for the fisheries.

Several GIWA regional teams from different parts of the world identified population growth as one of the main factors driving demand for fish products and subsequently the overexploitation of fish.

Rising incomes per capita increase the demand for higher value, more nutritious and prestigious food, including fish and seafood. This is of particular concern in Asia, where rapid economic growth over the past 30 years and the preference of the population for fish products has resulted in a doubling of fish consumption.

With nearly 40% of fish production traded internationally (FAO 2004) and export of processed fish far greater than domestic consumption, international market trends often determine the nature of fisheries exploitation (Figure 25). An increasing number of fishers throughout Asia are using destructive fishing methods to meet the growing and lucrative export market for live seafood in China and other parts of Asia (Indonesian Seas/57). Prized reef fish, like grouper and Napoleon wrasse (*Cheilinus undulatus*), are driven into corals where divers use cyanide-filled bottles to stun the fish and crowbars to break the coral structure. The fish are sold in the live reef fish markets

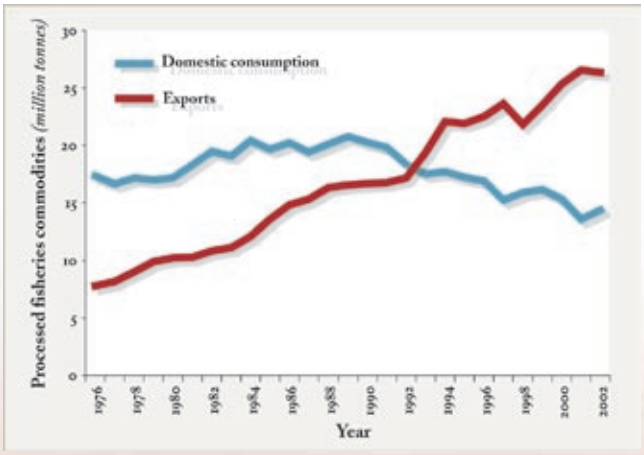


FIGURE 25. GLOBAL FISH EXPORTS AND DOMESTIC CONSUMPTION
(SOURCE: FAO 2003)

FIGURE 26. LIVE FISH FOR SALE IN A RESTAURANT IN HONG KONG
(PHOTO: C. CHEUNG)

of China, Singapore and Taiwan, fetching up to 100 USD per kg (Figure 26). The governments of the countries bordering the South China Sea/54 publicly exhort their fishermen to fish disputed waters, which has resulted in a number of conflicts, notably in the waters around the Spratly Islands. Illegal fishing, overfishing, and poaching of rare species are common in the South China Sea region.

International demand for a specific fish has led to overexploitation in several GIWA regions, such as the Indonesian Seas/57, Lake Victoria (47b), the Patagonian Shelf/38 and Sulu-Celebes Sea/56. In the South China Sea/54 region, as in many other LMEs, trawlers and driftnet operators are often foreign. The value-added component of the industry therefore benefits countries outside of the region, while the region suffers from the effects of declining resources and a deterioration in environmental quality. In order to maintain catch levels, local artisanal and small-scale commercial fishers are reverting to the use of blast fishing.

Insufficient knowledge

Insufficient scientific knowledge and a lack of awareness by fishers and consumers are major obstacles for improving policies and management, and changing the behaviour of consumers and producers.

Inadequate statistics hamper fisheries science and management, particularly in developing countries. This problem was highlighted in all GIWA regions that conducted the causal chain analysis on overfishing and other threats to aquatic living resources. Fishery management models establish allowable catch quotas based on stock biomass, size/age composition, mortalities caused by fishing and natural causes, and catch data. The status of a fishery is difficult to monitor and assess due to natural and fishing-induced fluctuations in fish populations, and the influence of pollution and climate change. Many regions lack adequate exploitation models and information on stock dynamics needed to make informed decisions. Several GEF LME projects are addressing this issue by strengthening national and regional scientific capacity in, for example, the Benguela Current/44, Guinea Current/42 and Yellow Sea/34 regions.

GIWA regional teams recognised that even when accurate data is collected and analysed, the information is often not conveyed to key stakeholders, such as fishers. As a result, fishers lack awareness of the impacts of their actions on fish stocks and their subsequent prosperity. This is a major hindrance to the adoption of sustainable fishing practices. The regional reports note that these knowledge deficiencies were caused by the following failures:

- Information is not communicated to fishers and food processors;
- Information fails to change fishing practices due to understanding difficulties, ignorance and the inability of individuals or firms to act alone;
- Traditional knowledge is often excluded from research, despite its importance to fisheries management. In some GIWA regions, however, traditional knowledge is being incorporated into management strategies.

In the Indonesian Seas/57 region, for example, many local fishermen only have a rudimentary understanding of fish and coral reef ecology. They employ destructive rather than traditional fishing methods as they yield larger catches for minimal effort and cost, despite the long-term impacts on the productivity of the fisheries.

Consumer demand determines the level of pressure on fisheries resources. In developing countries, the exhaustion of fish stocks has forced communities to find alternative sources of protein e.g. in the Benguela Current/44, Indonesian Seas/57, South China Sea/54 and Sulu-Celebes Sea/56. In developed countries, on the other hand, consumption of fish products has not been controlled by market mechanisms as prices do not reflect scarcity due to a combination of (i) fishing subsidies, (ii) access to new fishing grounds in the Indian Ocean and in African waters, and (iii) a food industry with influential power.

Inappropriate subsidies

The governments of the world grant subsidies of up to 20 billion USD annually (Milazzo 1998), thus maintaining and investing in the capacity of fishing fleets. Therefore, rather than establishing policies to control fishing, many governments are actually promoting overfishing. This was highlighted as a problem by GIWA regional teams from the Baltic Sea/17, Barents Sea/11, Oyashio Current/31, Pacific Islands/62 and Sea of Japan/33.

Governments are often reluctant to remove subsidies due to lobbying by the fishing industry and in fear of the negative socio-economic implications for fishing communities. Despite severe overfishing, the EU continues to increase fleet modernisation subsidies, although is now also initiating the decommissioning of some vessels. Russian subsidies were reduced precipitously in the 1990s, which eased fishing pressure but caused economic and social problems along the coast.

Lack of enforcement

Fishing regulations, such as property rights, quotas, protected areas and bans on destructive practices, are difficult to enforce for any government but are especially problematic for many developing countries. Insufficient enforcement was identified as a cause of overexploitation in all causal chain analyses conducted (Table 10). The inability of governments in developing countries to enforce regulations in their territorial waters is a further incentive for large-scale industrial vessels to target these waters for illegal fishing (Box 20).

In the Small Islands (Caribbean Sea/3a), the effects of overexploitation were assessed as severe, with one-third of fish species reported as overexploited. Existing regulations, which are weakly enforced, have failed to maintain populations of reef fishes and large groupers and snappers at sustainable levels, with overfishing occurring even within national parks.

Environmental management is still in its infancy in Southeast Asia, with fisheries management less developed than terrestrial environmental management. The commercial fishing industry has considerable governmental influence, and corruption is a root cause in some countries. In Lake Victoria, the near-collapse of many traditional fisheries and declines in Nile perch led to the implementation of a number of management measures, including the banning of beach seines, undersized mesh nets and trawlers. However, relevant institutions lack the capacity to enforce these fisheries regulations effectively, so they are routinely ignored by fishers.

Poverty

Poverty is a root cause and sometimes a consequence of overfishing. Fishing communities in several developing regions studied by GIWA are particularly vulnerable to the depletion of fish stocks

TABLE 10. ROOT CAUSES AND POTENTIAL POLICY INSTRUMENTS RELATED TO OVERFISHING AND OTHER THREATS TO AQUATIC LIVING RESOURCES

Contributing sector	Underlying root causes	Potential policy instruments	
		Short-term	Long-term
Overexploitation and excessive by-catch and discards			
Fisheries	Common pool resources	▪ Individually transferable quotas ▪ Total allowable catch quotas ▪ Zoning ▪ Limitation of size of vessels ▪ Line and mesh restrictions	▪ Marine protected areas ▪ Community management
	Insufficient scientific knowledge	▪ Stock assessments ▪ Catch surveys ▪ Modelling stocks and ecosystems	▪ Long-term monitoring programmes
	Insufficient knowledge by fishermen	▪ Information on gear and fishing techniques	▪ Training in better management of stocks
	Insufficient consumer knowledge	▪ Eco-labelling of fish products ▪ Eco-labelling of aquarium fishes	▪ Awareness campaigns for consumers and the public ▪ Eliminate price distortions
	Inadequate incentives leading to fleet overcapitalisation	▪ Fleet reduction programmes ▪ Reduce/redesign subsidies	▪ Progressive elimination of subsidies ▪ Promote aquaculture ▪ Job conversion stimulus packages
	Poverty and lack of alternatives	▪ Job conversion stimulus packages	▪ Education and training in alternative activities ▪ Local economic development
	Lack of regulations, compliance and enforcement	▪ Review regulations ▪ Gear verifications ▪ Ban damaging gear ▪ Support enforcement	▪ Capacity building for enforcement ▪ Promote community management
Destructive fishing practices			
Fisheries	Lack of regulations, compliance and enforcement	▪ Review regulations ▪ Gear verifications ▪ Ban damaging gear ▪ Support enforcement	▪ Capacity building/training ▪ Promote community management
	Poverty and lack of alternatives	▪ Subsidise appropriate gear	▪ Alternative livelihood programmes ▪ Local economic development

NOTE: THE TABLE PRESENTS ROOT CAUSES AND POTENTIAL POLICY INSTRUMENTS IDENTIFIED BY GIWA REGIONAL TEAMS.

BOX 20. EXAMPLES OF ILLEGAL FISHING IN THREE GIWA REGIONS

Illegal fishing is a global problem but its impacts are particularly severe in Sub-Saharan Africa, East Asia and Southeast Asia. The three examples below highlight the range and complexity of the issue.

Sulu Celebes Sea/56: The marine fisheries contribute significantly to the economies of Southeast Asia. The legal fisheries sector accounts for 2% of Indonesia's GDP but a significant proportion of the total catch is illegal. Weak enforcement makes the Sulu-Celebes Sea an easy target for illegal commercial fishers. The Indonesian Minister of Environment recently stated that illegal foreign fishing may cost the country 4 billion USD. Unfortunately, accurate data on legal, let alone illegal, fishing is generally unavailable.

Benguela Current/44: Although recreational fishing along South Africa's west coast is regulated, weak enforcement and a lack of prosecutions encourages illegal and unsustainable fishing. Enforcement agencies only have sufficient funds to inspect about 1% of fishing activities. In Namibia and Angola, anglers are not even required to purchase fishing licenses.

Caspian Sea/23: Official catches of sturgeon in the Caspian Sea dropped from a peak of 22 000 tonnes in the 1970s to only 1 800 tonnes by the late 1990s. However, illegal catches are estimated to be many times greater than legal catches. Declining living conditions and increasing unemployment in the 1990s led to small-scale poaching. The impact of which is much smaller than that of illegal commercial fishing, which is often tacitly supported by governments. Enforcement of fishing regulations is expected to remain weak due to widespread corruption and the high profit margins in the illegal fish trade.

as they are highly dependent on the fisheries for their survival and lack alternative livelihood opportunities. The lack of access to credit, alternative employment and social support leaves poverty stricken fishers little option but to unsustainably exploit dwindling stocks and employ destructive fishing practices to increase catches.

POLICY RELEVANT CONCLUSIONS

Global marine fish catches peaked in the late 1980s and have since been declining steadily. According to Pauly (2003), global catches are predicted to continue to gradually decline. If current trends persist, many GIWA regions will witness sequential depletion of fish stocks and continued destruction of habitats.

The uncertain future of the fisheries depicted by the GIWA regional assessments could be avoided if the causes of unsustainable exploitation are addressed. Damaging subsidies that encourage overfishing must be gradually curtailed and appropriate legal, regulatory and incentive frameworks need to be established and enforced. The collection and dissemination of accurate fisheries information is necessary for informed decision-making. Marine protected areas should be adequately enforced and others established. These actions, adopted within an ecosystem-based management approach, can provide substantial long-term benefits for human well-being. Aquaculture will also play a crucial role in boosting fish production to meet consumer demand but precautionary measures should be undertaken in order to avoid associated environmental impacts.

The severity and extent of overfishing has fostered the creation of a new ecosystem-based paradigm for fisheries management which aims to conserve the structure and functions of ecosystems. According to Sherman and Duda (1999), it attempts to minimise the impacts of fishing on non-target species, physical habitats, inter-species interactions and spatial processes. Ecosystem management also coordinates well with integrated water resource management, which is discussed in the chapter on freshwater shortage. The ecosystem approach is increasingly being endorsed by the UN and regional and national fishery institutions as a framework for fisheries management and as a means of achieving the fisheries goals of the World Summit on Sustainable Development (WSSD 2002). The GEF LME projects incorporate an ecosystem management approach to improve fisheries management, combat pollution and habitat degradation, and strengthen governance. Several regions assessed by GIWA have adopted ecosystem-based management as a goal. The policy instruments discussed in this section are practical ways to introduce elements of ecosystem-based management into fisheries management (Table 10).

Providing information to stakeholders

Accurate data on fish stocks and recruitment is essential for fisheries management. This information must be dissemi-

nated to stakeholders, such as fishers, the food industry, government agencies and consumers. The GIWA regional experts who prepared the South China Sea/54 assessment identified three key information and communication needs: (i) the collection and analysis of accurate fisheries data; (ii) conduct feasibility assessments prior to exploiting new fish stocks; and (iii) enhance regional communication regarding fisheries statistics, planning and management. These requirements are universal for policy-makers and producers but they are rarely met. Certification of fish is a relatively new and, as yet, uncommon approach to enable consumers to purchase fish caught by sustainable techniques.

Community management is normally based on restricting fishing methods, as well as managing the location and timing of catches. Community-based management was recommended by many GIWA teams, particularly in Sub-Saharan Africa and Southeast Asia.

Reform of subsidies and fleet reduction programmes

Until recently, governments have made relatively little effort to reform subsidies which currently encourage overfishing. The reduction of subsidies remains a contentious and complicated issue. It often involves joint involvement of national governments, regional regulatory bodies and the World Trade Organization (WTO). There needs to be controlled and gradual reductions in subsidies backed up with community support in order to minimise associated social problems. Alternative subsidies may give fishers an incentive to adopt sustainable fishing practices.

The most straightforward measure for relieving fishing pressure is to reduce the fishing fleet. However, the feasibility of such a measure is dependent on the level of influence the industry has on regulators and other governmental institutions. Decommissioning has therefore been more effective in the small-scale fisheries of developing nations rather than in reducing industrial fishing fleets of developed countries. Some EU fleet reduction programmes have effectively exported their overcapacity to developing regions. China, in response to overfishing and agreements with Japan and South Korea, announced it will reduce its fishing fleet by 12% to 220 000 vessels and the number of fishermen by 10% to 2.7 million (Sea of Japan/33). Although these reductions are encouraging, they are too insignificant to turn the tide of overfishing.

PART OF THE FISHING FLEET IN MAR DEL PLATA, ARGENTINA. (PHOTO: IBL)

Quotas and other catch restrictions

Total Allowable Catch (TAC) quotas, based on the concept of maximum sustainable yield, can be used to reduce fishing effort. By making the quotas individually transferable (ITQs), the efficiency of TAC quotas is improved. The implementation of TAC quotas can be challenging, in terms of the initial allocation of quotas, the level of by-catch, and monitoring and enforcement issues. Precautionary quotas and the closure of fisheries for a sufficient period have allowed full recovery of severely depleted stocks in European and North American waters (e.g. herring, yellow flounder and gadoids). Fishing and processing quotas were also proposed by GIWA regional

experts for freshwater systems, such as Lake Victoria. The precautionary approach is a major step towards achieving sustainable fishing but requires comprehensive monitoring, realistic stock assessments, social and economic support programmes and proper mechanisms to control implementation.

Technological advancements have made fishing more efficient and sometimes more destructive. However, gear restrictions and the promotion of selective technology are measures commonly employed in many GIWA regions and, in some cases, are effective in protecting stocks, but they increase fishing costs.

Zoning and marine parks

The establishment of protected areas or fishing areas regulated by seasonal and zonal restrictions can allow the rejuvenation of fish stocks and the protection of target species. Although zoning is generally effective for small-scale community fisheries, it can be difficult to enforce such restrictions on the industrial fishing industry. The enforcement of marine parks is expensive, but the benefits can be significant; fish catches near the Bamburi Marine Park in Kenya increased more than two-fold since its designation as a marine park (Somali Coastal Current/46b).