

**THE STATE OF
WORLD FISHERIES
AND AQUACULTURE
2006**





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THE STATE OF WORLD FISHERIES AND AQUACULTURE

2006

FAO Fisheries and Aquaculture Department

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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FOREWORD

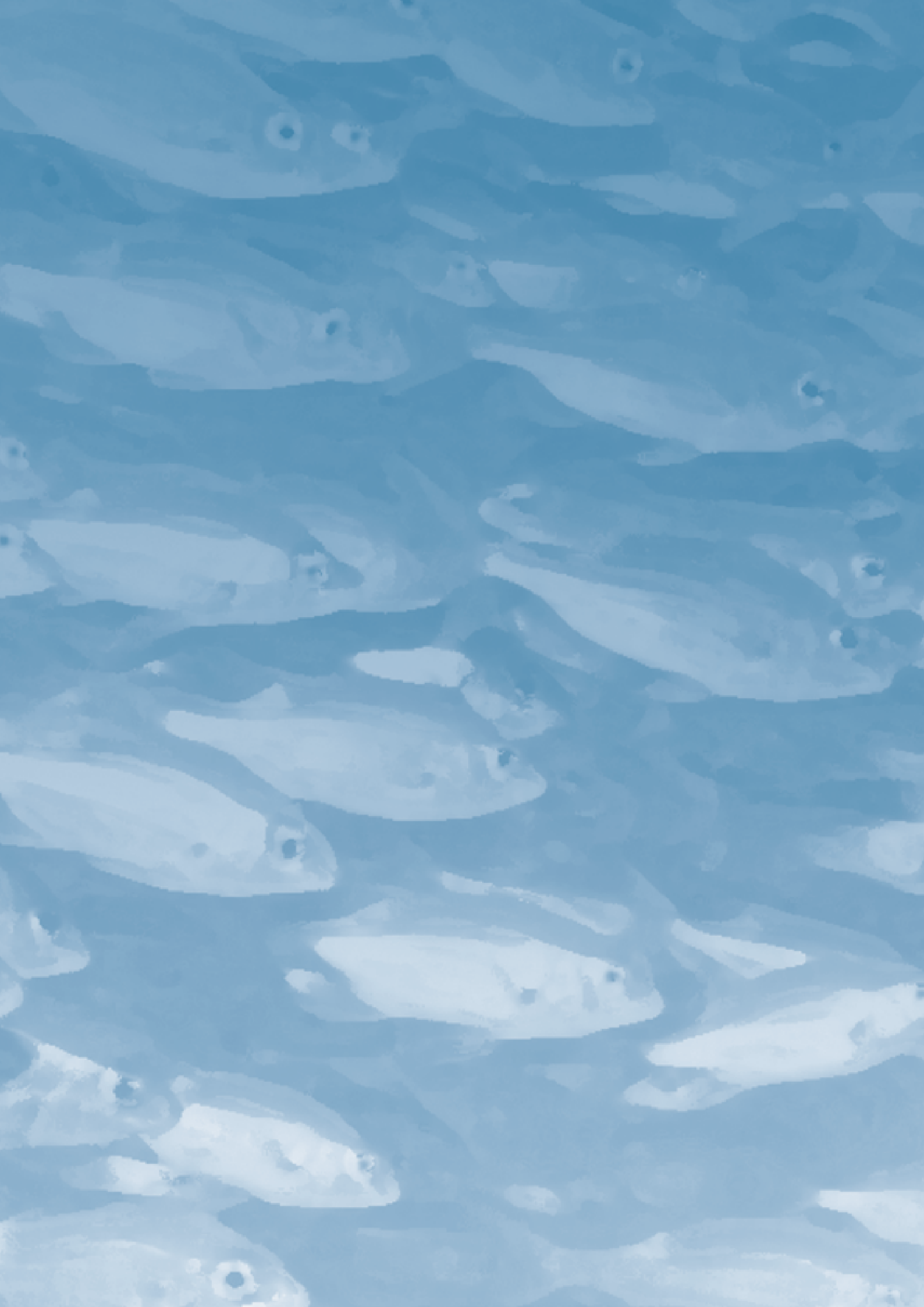
Several decades ago, the efforts of public administrations were concentrated on developing fisheries and aquaculture and ensuring growth in production and consumption. Then, in the 1980s, as many resources became fully exploited or overexploited, the attention of policy-makers began to focus instead on fisheries management, in addition to development of aquaculture. Subsequent recognition of the many failures in management have now led FAO member countries and other relevant stakeholders to broaden the approach and governance; that is, the sum of the legal, social, economic and political arrangements used to manage fisheries and aquaculture in a sustainable manner is currently seen as a necessary context for management and is becoming the main concern.

In keeping with these developments, the issue of governance features in several places of *The State of World Fisheries and Aquaculture 2006*. Part 1 of the document – the World Review of Fisheries and Aquaculture – ends with a new section called “Governance and policy”. Governance issues and related concerns are addressed also in several places in the remainder of the text.

Aquaculture continues to expand, while marine capture fisheries – when summed together worldwide – seem to have reached a ceiling. This development was not unexpected. It has constituted a basic assumption in most discussions and studies concerned with the future of the fisheries sector. Past issues of the report have reported on projections for the sector. Although it may be early to evaluate the accuracy of such projections, it can be interesting to compare them with the developments that actually took place. A brief attempt in this respect is made in the last section, entitled “Outlook”. Reflecting the growing importance of aquaculture, the section ends with a discussion of the challenges that aquaculture is facing as well as of the opportunities that are open to the sector. The discussion is based on a prospective analysis of the aquaculture sector worldwide, which was undertaken by FAO in the past two years.

The format of *The State of World Fisheries and Aquaculture* remains unchanged. Like previous issues, this issue contains a CD-ROM with the *World Fisheries and Aquaculture Atlas*.

Ichiro Nomura
Assistant Director-General
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**ACP**

African, Caribbean and Pacific Group of States

APFIC

Asia-Pacific Fishery Commission

BRC

British Retail Consortium

CBD

Convention on Biological Diversity

CCRF

Code of Conduct for Responsible Fisheries

COFI

Committee on Fisheries

DWFS

distant-water fishing state

EAA

ecosystem approach to aquaculture

EAF

ecosystem approach to fisheries

EEZ

exclusive economic zone

ESD

ecologically sustainable development

EIA

environmental impact assessment

EU

European Union

GAA

Global Aquaculture Alliance

GDP

gross domestic product

GFSI

Global Food Safety Initiative

GT

gross tonnage

HACCP

Hazard Analysis and Critical Control Point (System)

IMO

International Maritime Organization

IPOA-IUU

International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing

ITQ

individual transferable quota

IUU

illegal, unreported and unregulated fishing

LCA

lifecycle assessment

LIFDC

low-income food-deficit country

LVFO

Lake Victoria Fisheries Organization

MCS

monitoring, control and surveillance

NACA

Network of Aquaculture Centres in Asia-Pacific

NEAFC

North East Atlantic Fisheries Commission

NEPAD

New Partnership for Africa's Development

NGO

non-governmental organization

NPOA-IUU

National Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing

OECD

Organisation for Economic Co-operation and Development

RFB

regional fishery body

RFMO

regional fisheries management organization

SWIOFC

South West Indian Ocean Fisheries Commission

TAC

total allowable catch

UNAIDS

Joint United Nations Programme on HIV/AIDS (UNAIDS)

UNCED

United Nations Conference on Environment and Development

UNEP

United Nations Environment Programme

VMS

vessel monitoring systems

WHO

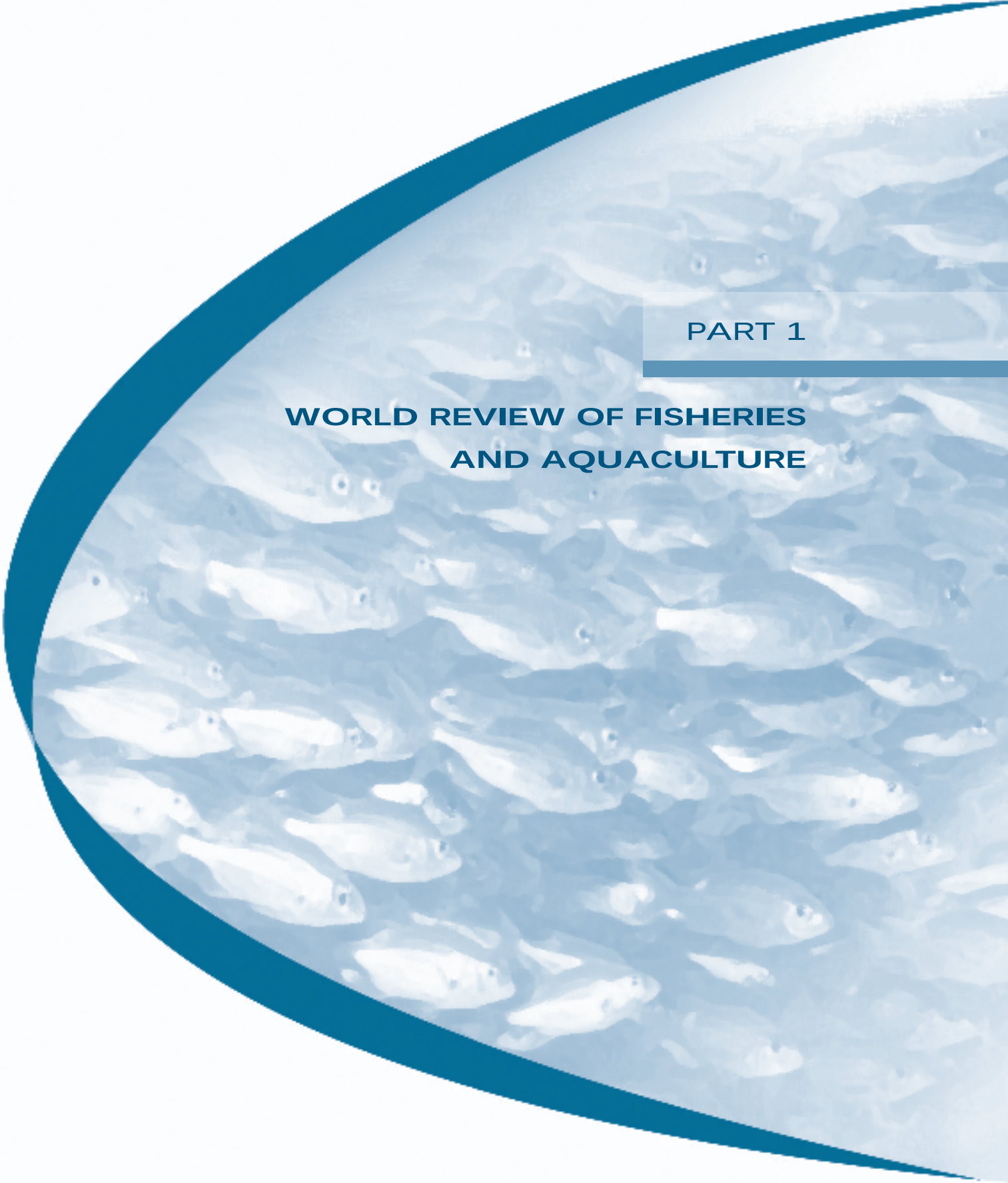
World Health Organization

WSSD

World Summit on Sustainable Development

WTO

World Trade Organization



PART 1

**WORLD REVIEW OF FISHERIES
AND AQUACULTURE**

WORLD REVIEW OF FISHERIES AND AQUACULTURE

Fisheries resources: trends in production, utilization and trade

OVERVIEW

Capture fisheries and aquaculture supplied the world with about 106 million tonnes of food fish in 2004, providing an apparent per capita supply of 16.6 kg (live weight equivalent), which is the highest on record (Table 1 and Figure 1). Of this total, aquaculture accounted for 43 percent. Outside China, per capita supply has shown a modest growth rate of about 0.4 percent per year since 1992 (following a decline from 1987), as growth in supply from aquaculture more than offset the effects of static capture fishery production and a rising population (Table 2 and Figure 2). In 2004, per capita food fish supply was estimated at 13.5 kg if data for China are excluded. Overall, fish provided more than 2.6 billion people with at least 20 percent of their average per capita animal protein intake. The share of fish proteins in total world animal protein supplies grew from 14.9 percent in 1992 to a peak of 16.0 percent in 1996, declining to about 15.5 percent in 2003. Notwithstanding the relatively low fish consumption by weight in low-income food-deficit countries (LIFDCs) of 14.1 kg per capita in 2003, the contribution of fish to total animal protein intake was significant – at about 20 percent – and is probably higher than indicated by official statistics in view of the unrecorded contribution of subsistence fisheries.

Preliminary estimates for 2005 based on reporting by some major fishing countries indicate that total world fishery production reached almost 142 million tonnes,



Table 1
World fisheries and aquaculture production and utilization

	2000	2001	2002	2003	2004	2005 ¹
(Million tonnes)						
PRODUCTION						
INLAND						
Capture	8.8	8.9	8.8	9.0	9.2	9.6
Aquaculture	21.2	22.5	23.9	25.4	27.2	28.9
Total inland	30.0	31.4	32.7	34.4	36.4	38.5
MARINE						
Capture	86.8	84.2	84.5	81.5	85.8	84.2
Aquaculture	14.3	15.4	16.5	17.3	18.3	18.9
Total marine	101.1	99.6	101.0	98.8	104.1	103.1
TOTAL CAPTURE	95.6	93.1	93.3	90.5	95.0	93.8
TOTAL AQUACULTURE	35.5	37.9	40.4	42.7	45.5	47.8
TOTAL WORLD FISHERIES	131.1	131.0	133.7	133.2	140.5	141.6
UTILIZATION						
Human consumption	96.9	99.7	100.2	102.7	105.6	107.2
Non-food uses	34.2	31.3	33.5	30.5	34.8	34.4
Population (billions)	6.1	6.1	6.2	6.3	6.4	6.5
Per capita food fish supply (kg)	16.0	16.2	16.1	16.3	16.6	16.6

Note: Excluding aquatic plants.

¹ Preliminary estimate.

representing an increase of over 1 million tonnes compared with 2004 and a record high production. Although the total amount of fish available for human consumption is estimated to have increased to 107 million tonnes, the global per capita supply remained at about the same level as in 2004 because of population growth. There was a decrease in the contribution of capture fisheries to human consumption, but this was offset by an increase in the aquaculture contribution.

China remains by far the largest producer, with reported fisheries production of 47.5 million tonnes in 2004 (16.9 and 30.6 million tonnes from capture fisheries and aquaculture, respectively), providing an estimated domestic food supply of 28.4 kg per

Figure 1

World capture and aquaculture production

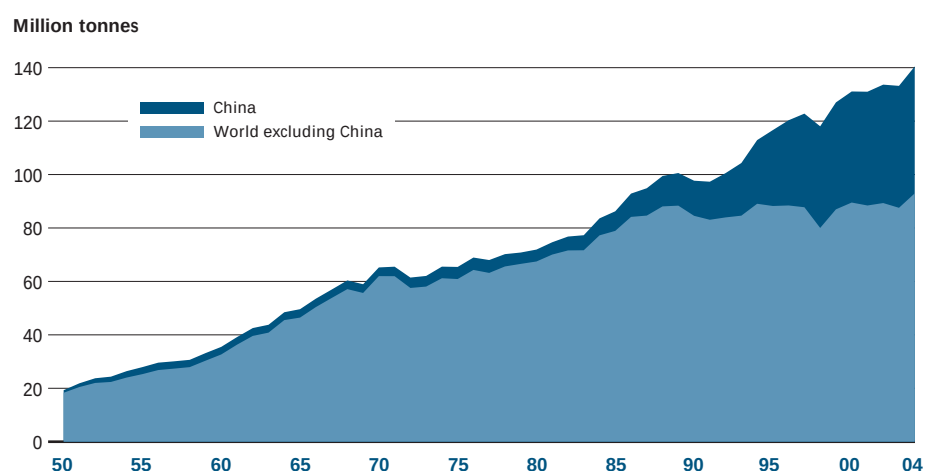


Table 2
World fisheries and aquaculture production and utilization, excluding China

	2000	2001	2002	2003	2004	2005 ¹
(million tonnes)						
PRODUCTION						
INLAND						
Capture	6.6	6.7	6.5	6.6	6.8	7.0
Aquaculture	6.0	6.5	7.0	7.6	8.3	8.8
Total inland	12.6	13.3	13.5	14.2	15.1	15.8
MARINE						
Capture	72.0	69.8	70.2	67.2	71.3	69.7
Aquaculture	4.9	5.3	5.6	6.1	6.6	6.6
Total marine	76.9	75.2	75.8	73.3	77.9	76.3
TOTAL CAPTURE	78.6	76.6	76.7	73.8	78.1	76.7
TOTAL AQUACULTURE	10.9	11.9	12.6	13.8	14.9	15.4
TOTAL FISHERIES	89.5	88.4	89.3	87.5	93.0	92.1
UTILIZATION						
Human consumption	63.9	65.7	65.7	67.5	68.9	69.0
Non-food uses	25.7	22.7	23.7	20.1	24.0	23.1
Population (billions)	4.8	4.9	5.0	5.0	5.1	5.1
Per capita food fish supply (kg)	13.3	13.4	13.3	13.4	13.5	13.4

Note: Excluding aquatic plants.

¹ Preliminary estimate.

capita as well as production for export and non-food purposes. However, there are continued indications that capture fisheries and aquaculture production statistics for China may be too high, as indicated in previous issues of *The State of World Fisheries and Aquaculture*,¹ and that this problem has existed since the early 1990s. Because of the importance of China and the uncertainty about its production statistics, as in previous issues of this report, China is generally discussed separately from the rest of the world.

Global capture fisheries production reached 95 million tonnes in 2004, with an estimated first-sale value of US\$84.9 billion. China, Peru and the United States of America remained the top producing countries. World capture fisheries production has been relatively stable in the past decade with the exception of marked fluctuations driven by catches of Peruvian anchoveta – a species extremely susceptible to oceanographic conditions determined by the El Niño Southern Oscillation – in the Southeast Pacific (Figure 3). Fluctuations in other species and regions tend to compensate for each other to a large extent so that total marine catches, which accounted for 85.8 million tonnes in 2004, do not show such significant variations. Production in the Eastern Indian Ocean and Western Central Pacific continued their long-term increasing trends, and in the highly regulated Northwest Atlantic and Northwest Pacific areas, recent increases were observed following troughs in production. In contrast, catches in two other areas decreased recently: for the first time since 1991, catches from the Northeast Atlantic totalled fewer than 10 million tonnes; in the Southwest Atlantic, a sharp drop in catches of Argentine shortfin squid brought total catches down to their lowest level since 1984. The Mediterranean and Black Sea remained the most stable marine area in terms of capture production. Catches from inland waters, about 90 percent of which occur in Africa and Asia, have shown a slowly but steadily increasing trend since 1950, owing in part to stock enhancement practices, and reached a record 9.2 million tonnes in 2004.

Aquaculture continues to grow more rapidly than all other animal food-producing sectors, with an average annual growth rate for the world of 8.8 percent per year since 1970, compared with only 1.2 percent for capture fisheries and 2.8 percent for terrestrial farmed meat production systems. However, there are signs that the rate of growth for global aquaculture may have peaked, although high growth rates may continue for some regions and species. Aquaculture production in 2004 was reported to be 45.5 million tonnes (Table 1) with a value of US\$63.3 billion or, if aquatic plants are included, 59.4 million tonnes with a value of US\$70.3 billion. Of the world total, China is reported to have accounted for nearly 70 percent of the quantity and over half the global value of aquaculture production. All regions showed increases in production from 2002 to 2004, led by the Near East and North Africa region and Latin America

Figure 2

World fish utilization and supply, excluding China

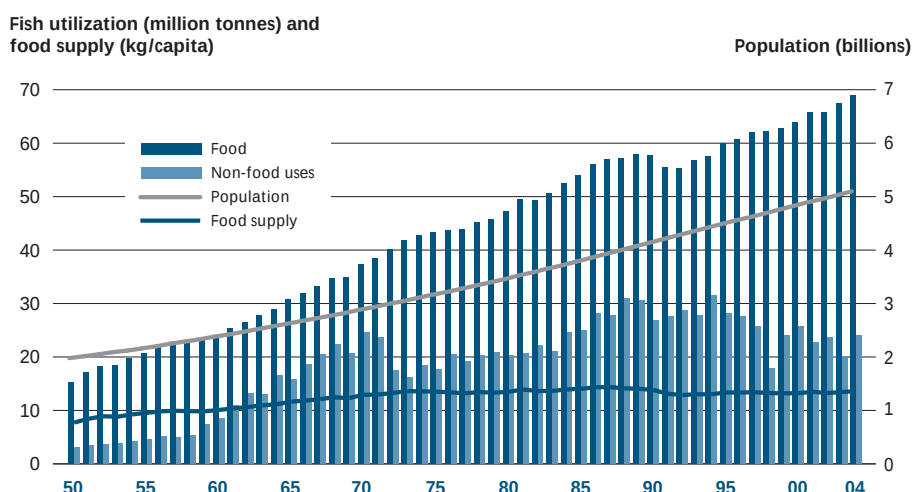
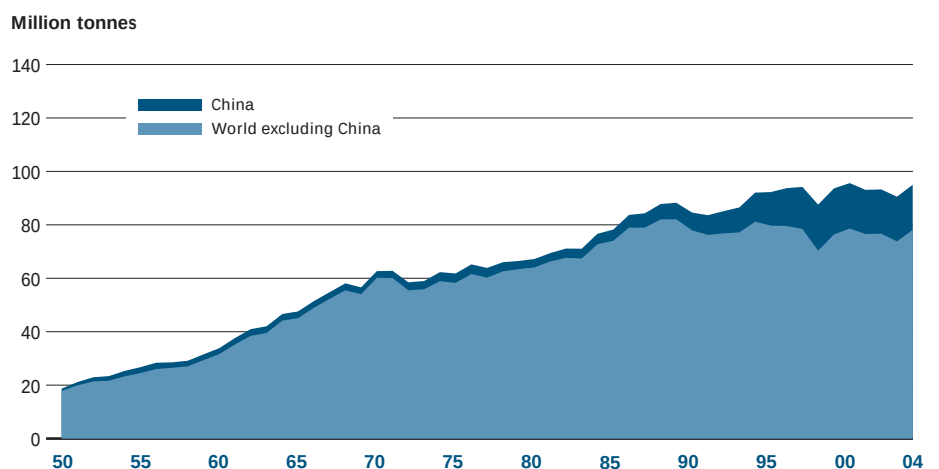


Figure 3

World capture fisheries production



and the Caribbean, with about 14 and 10 percent average annual growth, respectively. Freshwater culture continued to dominate, followed by mariculture and brackish-water culture. Carps accounted for 40 percent of all production of fish, crustaceans and molluscs. The period 2000–04 saw strong growth in production of crustaceans, in particular, and of marine fish. In the same period, production in developing countries other than China increased at an annual rate of 11 percent, compared with 5 percent for China and about 2 percent for the developed countries. With the exception of marine shrimp, the bulk of aquaculture production within developing countries in 2004 comprised omnivorous/herbivorous fish or filter-feeding species. In contrast, carnivorous species accounted for approximately three-quarters of finfish culture production in developed countries.

During the past three decades, the number of fishers and aquaculturists has grown faster than the world's population, and faster than employment in traditional agriculture. In 2004, an estimated 41 million people worked as fishers and fish farmers, the great majority of these in developing countries, principally in Asia. Significant increases in the most recent decades, particularly in Asia, are a result of the strong expansion of aquaculture activities. In 2004, fish farmers accounted for one-quarter of the total number of fish workers in the primary sector. China is by far the country with the highest number of fishers and fish farmers, reported to be 13 million in 2004, representing about 30 percent of the world total. Current fleet-size reduction programmes in China to tackle overcapacity are reducing the number of people engaged in capture fisheries, which declined by 13 percent during the period 2001–04. The numbers engaged in fishing and aquaculture in most industrialized economies have been declining or remain stationary.

The world fishing fleet comprised about 4 million units at the end of 2004, of which 1.3 million were decked vessels of various types, tonnage and power, and 2.7 million undecked (open) boats. While virtually all decked vessels were mechanized, only about one-third of the undecked fishing boats were powered, generally with outboard engines. The remaining two-thirds were traditional craft of various types operated by sail and oars. About 86 percent of the decked vessels were concentrated in Asia; the remainder were accounted for by Europe (7.8 percent), North and Central America (3.8 percent), Africa (1.3 percent), South America (0.6 percent) and Oceania (0.4 percent). Many countries have adopted policies to limit the growth of national fishing capacity or reduce it in order to protect the fishery resources and to make fishing economically viable for the harvesting enterprises. There are indications that the fleets of decked fishing vessels in longstanding developed fishing nations have continued to decrease in size, especially those operating offshore and in distant waters.

However, even in these countries, the rate of reduction of fishing power is generally less significant than the rate of reduction of fishing vessels. On the other hand, some countries report a continuing expansion of their fleets. Overall, the number of fishing vessels worldwide did not change significantly in either 2003 or 2004.

Just as the world fishing fleet appears to have stabilized, the overall state of exploitation of the world's marine fishery resources has tended to remain relatively stable, although for resources this has been the case for a longer period of time. Over the past 10–15 years, the proportion of overexploited and depleted stocks has remained unchanged, after showing a marked increase during the 1970s and 1980s. It is estimated that in 2005, as in recent years, around one-quarter of the stock groups monitored by FAO were underexploited or moderately exploited and could perhaps produce more, whereas about half of the stocks were fully exploited and therefore producing catches that were at, or close to, their maximum sustainable limits, with no room for further expansion. The remaining stocks were either overexploited, depleted or recovering from depletion and thus were yielding less than their maximum potential owing to excess fishing pressure. The situation seems more serious for certain fishery resources that are exploited solely or partially in the high seas and, in particular, for straddling stocks and for highly migratory oceanic sharks. This confirms earlier observations that the maximum wild capture fishery potential from the world's oceans has probably been reached and reinforces the calls for more cautious and effective fisheries management to rebuild depleted stocks and prevent the decline of those being exploited at or close to their maximum potential. In the case of inland fishery resources, there is widespread overfishing, arising from either intensive targeting of individual large-size species in major river systems or overexploitation of highly diverse species assemblages or ecosystems in the tropics.

Total world trade in fish and fishery products reached a record value of US\$71.5 billion (export value) in 2004, representing a 23 percent growth relative to 2000. Preliminary estimates for 2005 indicate a further increase in the value of fishery exports. In real terms (adjusted for inflation), exports of fish and fishery products increased by 17.3 percent during the period 2000–04. In terms of quantity, exports in live-weight-equivalent terms in 2004 accounted for 38 percent of total fisheries and aquaculture production, confirming fish as one of the most highly traded food and feed commodities. The share of fish trade in both total gross domestic product (GDP) and agricultural GDP has roughly doubled over the past 25 years. China has been the world's main exporter since 2002, and in 2004 its fish exports were valued at US\$6.6 billion following remarkable average annual growth of 12 percent in the period 1992–2004. The fishery net exports of developing countries (i.e. the total value of their exports less the total value of their imports) have shown a continuing rising trend over the past two decades, growing from US\$4.6 billion in 1984 to US\$16.0 billion in 1994 to US\$20.4 billion in 2004. These figures are significantly higher than those for other agricultural commodities such as rice, coffee and tea. Shrimp continues to be the most important commodity traded in value terms, accounting for 16.5 percent of the total value of internationally traded fishery products in 2004, followed by groundfish (10.2 percent), tuna (8.7 percent) and salmon (8.5 percent). In 2004, fishmeal represented around 3.3 percent of the value of exports and fish oil less than 1 percent.

In the realm of marine fisheries governance, regional fisheries management organizations (RFMOs) play a unique role in facilitating international cooperation for the conservation and management of fish stocks. These organizations currently represent the only realistic means of governing fish stocks that occur either as straddling or shared stocks between zones of national jurisdiction, between these zones and the high seas, or exclusively on the high seas. Strengthening RFMOs in order to conserve and manage fish stocks more effectively remains the major challenge facing international fisheries governance. Despite efforts over the past decade to improve their management capacity and their images as effective and responsive organizations, some RFMOs have failed to achieve their fundamental goal of the sustainable management of stocks, which has in turn led to increasing international criticism. However, many RFMOs are taking steps to implement the ecosystem approach



to fisheries (EAF) and are striving to adopt the precautionary approach; strengthening international cooperation; promoting transparency; encouraging eligible non-members to become members of organizations or to become cooperating non-parties/entities; and enhancing compliance and enforcement through improved monitoring, control and surveillance.

Similarly for inland fisheries, there is a need for a system of governance for transboundary fisheries and fishery resources. Many of the world's large river basins cross one or several international borders, and many riverine fish species migrate across boundaries with the result that activities in one country may affect fish stocks and communities exploiting the fish stocks in another country. Appropriate fisheries management in such cases requires that suitable policies for sustaining the shared resources (water and biological resources) are developed at the regional level, and that these policies are incorporated into national legislation and implemented. Regional frameworks do exist that deal with the management of inland waters and living aquatic resources, and there have been some recent encouraging developments in this area. But governance remains incomplete as only 44 percent of the international basins are the subject of one or more agreements, and these agreements may not include fisheries. Not only are inland fisheries unlikely to become the primary focus in all water management programmes, but there is also a risk that the needs of fishing communities and small-scale fisheries would not be considered in such programmes unless water governance systems are designed to include inland fisheries.

Unlike capture fisheries, aquaculture activities are generally located within national jurisdictions, and so governance is a national responsibility. There is growing understanding that sustainable development of the aquaculture sector requires an enabling environment, with appropriate institutional, legal and management frameworks guided by an overall policy. Notable progress has been made in a number of institutional, legal and management development areas, including the use of various public- and private-sector partnership arrangements. Integrated land-use and environmental planning are being pursued and regulations implemented, often through self-regulation according to codes of practice. Co-management is an emerging trend, usually applied in the management of common property resources, and as such has been effective in culture-based fisheries, a form of aquaculture practised communally in small water bodies in rural areas.

In recent years, issues relevant to international trade in fishery products have been prominent. They include labelling and traceability requirements; ecolabelling; illegal, unreported and unregulated (IUU) fishing; the sustainable development of aquaculture; subsidies in production and trade agreements. Some of these issues form part of the agenda for the multilateral trade negotiations in the World Trade Organization (WTO), where countries also discuss fisheries and pay particular attention to fisheries subsidies that contribute to overcapacity and overfishing and how these can be disciplined yet reconciled with sustainable development considerations. It seems possible that the outcomes of the fishery subsidy negotiations will depend on how certain technical issues will be defined and agreed and also on how far WTO Members will go in addressing not only trade, but also environmental and development issues.

CAPTURE FISHERIES PRODUCTION

Total capture fisheries production

Global capture production in 2004 reached 95.0 million tonnes, an increase of 5 percent in comparison with 2003, when total catch had declined to 90.5 million tonnes (Table 1). The highest and lowest total catch (Figure 3) in the past ten years (1995–2004) for which complete statistics are available at the end of 2006 coincided with the fluctuating catches of Peruvian anchoveta, a species notoriously influenced by the El Niño effects on the oceanographic conditions of the Southeast Pacific. Catches of this small pelagic species in the decade ranged from a minimum of 1.7 million tonnes in 1998 to a maximum of 11.3 million tonnes in 2000, whereas global total catches excluding anchoveta remained relatively stable between 83.6 and 86.5 million tonnes.

Preliminary estimates for 2005 global capture production indicate that inland water catches have increased by almost 0.4 million tonnes and marine catches have decreased by over 1.5 million tonnes. However, less than one-third of the marine capture production lost in 2005 in comparison with 2004 can be attributed to the high variability of Peruvian anchoveta, as total catches of all other marine species combined were reduced by about 1 million tonnes.

The estimated first-hand value of global capture fisheries production amounted to some US\$84.9 billion, representing a 3.6 percent growth over the value recorded for 2003. Of this total, fish for reduction purposes had a first-hand value of US\$3.4 billion.

The only recent change in the ranking of top ten producer countries (Figure 4) was the gain by Chile. The country moved from sixth place in 2002, to seventh in 2003, to fourth place in 2004 – again a consequence of the fluctuating catches of anchoveta. Official catch statistics reported by China have been highly stable since 1998 (Figure 3) and in the period between 2001 and 2004 varied only from 16.5 to 16.9 million tonnes. However, distant-water catches by Chinese vessels have been growing significantly since 1998 and in 2004 exceeded 0.4 million tonnes, about the same quantity caught by each of Japan, the Republic of Korea and Taiwan Province of China, which traditionally have fished in distant waters but have been progressively reducing their distant-water activities in recent years.

World marine capture fisheries production

Marine capture fisheries production was 85.8 million tonnes in 2004. As for the global total catches (including also inland capture production), its recent trend has been strongly influenced by variations in anchoveta catches off Peru and Chile.

The Northwest and Southeast Pacific still rank as the most productive fishing areas (Figure 5). In the three, mostly tropical, areas (Western and Eastern Indian Ocean, Western Central Pacific) for which, ten years ago, FAO forecast that there was still room for fishery development,² total catches continued to increase in the Eastern Indian Ocean and Western Central Pacific. However, in the Western Indian Ocean capture production decreased in 2004 in comparison with 2003 and the upward long-term trend has probably lost momentum in this fishing area. Coastal fisheries in the Western Indian Ocean seem to be more vulnerable than in the other two areas, with a reduction in total catch, excluding tuna, of 0.2 million tonnes in 2004. Total catches of tuna, which is the most valuable group of species and generally exported out of the area, reached almost 30 percent of the total catch.

Figure 4

Marine and inland capture fisheries: top ten producer countries in 2004

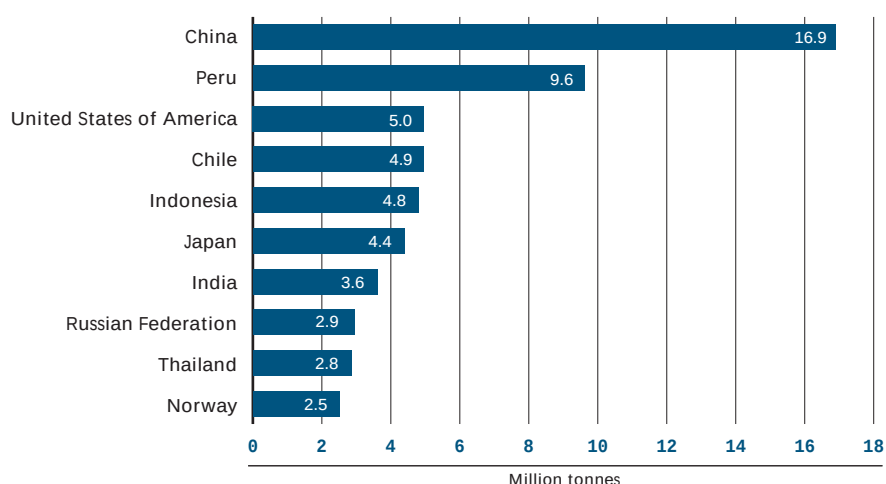
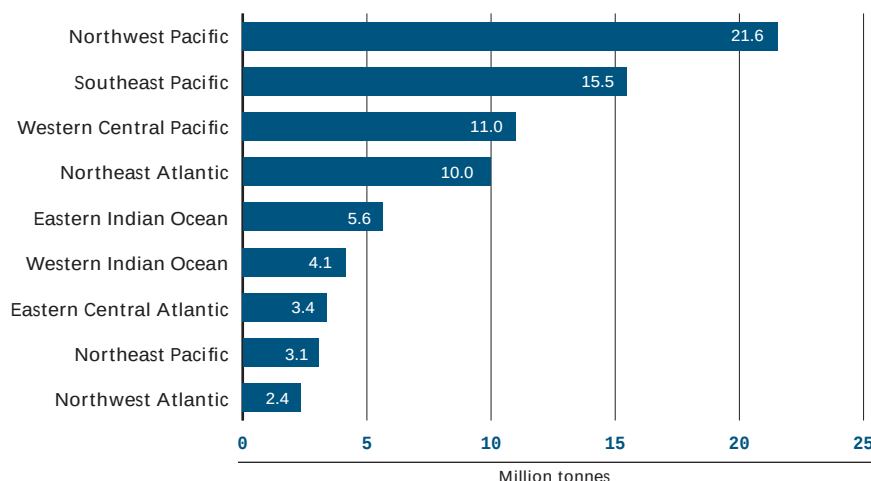


Figure 5

Capture fisheries production: principal marine fishing areas in 2004



Note: Fishing areas listed are those with a production quantity equal to or more than 2 million tonnes in 2004.

A continuous increasing trend in catches can be observed in the Northwest Atlantic and Northeast Pacific since the recent minimums in 1998 and 2000, respectively (see Figure 18 on pp. 30–31). These two temperate fishing areas are among the most regulated and managed in the world, and the catch recovery that has occurred recently may be viewed as an indication of the effectiveness of management measures enforced after the crises experienced in the 1990s. The Mediterranean and Black Sea appears to be the most stable fishing area in terms of total catches (1996 and 2004 quantities were unchanged, with only minor fluctuations), but a more detailed analysis by species group shows an increase in small pelagics and a decrease in demersal fishes, tunas and sharks, suggesting that among the most valuable fishery resources several are declining.

Total catches in 2004 decreased by over 10 percent in comparison with 2002 in three fishing areas: Northeast Atlantic, Southwest Atlantic and Eastern Central Pacific. In the Northeast Atlantic, for the first time since 1991 catches totalled less than 10 million tonnes. A sharp drop in catches of Argentine shortfin squid by local and distant-water fleets (2004 capture production was one-ninth of that in 1999) brought down total catch in the Southwest Atlantic to its lowest level since 1984 (Figure 18). Catches in the Eastern Central Pacific peaked in 2002 at almost 2 million tonnes, but in the following two years declined by about 13 percent.

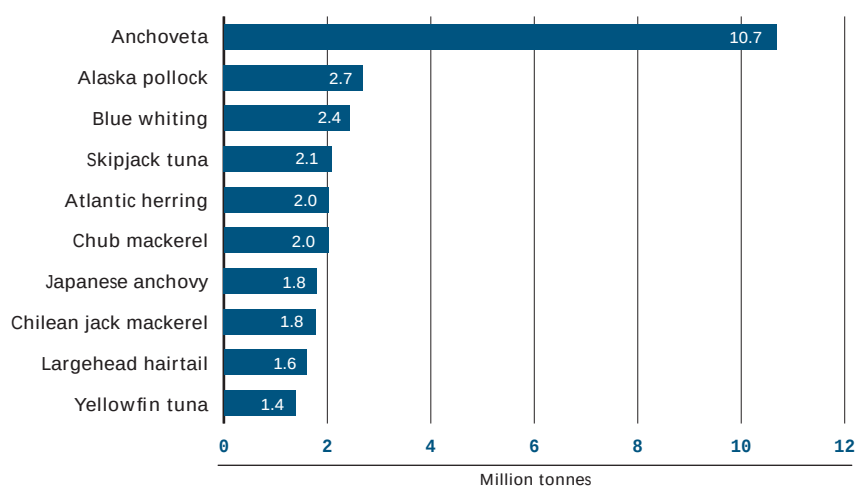
With production totalling about 10.7 million tonnes in 2004, the Peruvian anchoveta leads by far the ranking of the ten most caught marine species (Figure 6). However, there have been no dramatic changes in this ranking since 2002. The capelin (a small pelagic), which ranked fourth in 2002, had dropped from the list by 2004 and was replaced by the yellowfin tuna. Blue whiting and chub mackerel gained some places to the detriment of Japanese anchovy and Chilean jack mackerel.

Catches of oceanic tunas have remained fairly stable since 2002, whereas total catch of deep-water species and of other epipelagic species, mostly oceanic squids, increased by over 20 percent between 2002 and 2004. The share of oceanic catches in the total marine catch exceeded 12 percent in both 2003 and 2004. Box 1 (see pp. 12–13) provides further information on oceanic species.

Regarding trends by species groups, catches of shrimps and cephalopods increased impressively in the decade to 2004 (by 47.2 and 28.4 percent, respectively) and at the end of the decade they both attained the highest ever totals at about 3.6 and 3.8 million tonnes. For the shrimp group, an analysis of species trends is difficult as large quantities of catches are reported as unidentified shrimps. Within the cephalopods, increased catches of jumbo flying squid and of “various squid not

Figure 6

Marine capture fisheries production: top ten species in 2004



identified” from the Pacific compensated for the collapse of Argentine shortfin squid catches in the Atlantic. Total catches of both tuna and shark decreased in 2004 after having reached a peak in 2003.

When analysing catch trends for individual species, it should be kept in mind that a trend may be altered either by underestimation caused by a portion of catches being reported at the unspecified level or, conversely, by improvements in the species breakdown being used to report catch statistics. Although the number of species items included in the FAO capture database has been growing at an average annual rate of 5 percent over the past eight years and the percentage of catches reported at the species level has increased in recent years, about 37 percent of global catches are still not reported at the species level. Some 27 percent are reported at higher taxonomic levels and 10 percent are included under the category “marine fishes not identified”.

World inland capture fisheries production

After a minor decrease in 2002, total global inland catches rose again in 2003 and 2004, reaching a total of 9.2 million tonnes in the latter year. Africa and Asia together continue to contribute about 90 percent of the world total (Figure 7) and their shares are also fairly stable. Inland fisheries, however, seem to be in crisis in Europe, where the total catches have decreased by 30 percent since 1999. The decline in professional fishing in European inland waters can be attributed partly to competition with other human activities in the use of inland water resources and also to the falling economic viability of many commercial inland fisheries. A considerable portion of catches comes from the recreational fishery. Statistics on inland catches in developed countries published by FAO are generally based on information made available by national correspondents, and total catches may vary significantly depending on whether or not the correspondent includes data on recreational catches.

The contrast in the importance and role played by inland fisheries in developed and developing countries (in the latter they are an important source of animal proteins in the poor rural areas) can be further noted by grouping countries by economic class (Table 3). China and other developing countries accounted for 94.5 percent of the global inland catches in 2004, while the combined share of the economies in transition and industrialized countries decreased to 5.5 percent.

The top ten producer countries in 2004 (Figure 8) remained the same as in 2002. Myanmar, the United Republic of Tanzania and Uganda (the last having improved the coverage of its data collection system, leading to an increase in the production registered) gained positions in the ranking whereas Cambodia, Egypt and Indonesia moved down. Unfortunately, many countries still encounter great difficulties in



Box 1

Fishery development phases of oceanic species

Fishing on the high seas continues to attract the attention of international organizations, non-governmental organizations (NGOs) and the general public, all of which have a growing interest in management of high sea resources¹ and a general concern for overfishing. High sea resources are defined as those occurring outside the exclusive economic zones (EEZs), and generally extend 200 nautical miles into the sea.

Unfortunately, it is not possible to extract from the FAO global fisheries statistics database a precise estimate of capture production from the high seas, as catch statistics are reported by broad fishing areas whose boundaries are not directly comparable with those of the EEZs. Thus, the available data do not reveal whether or not the fish were caught within or outside the EEZs. However, as catch statistics for oceanic species are available in the FAO capture database, these can be used to analyse the catch trends and fishery development phases of this group of species, which are fished mostly outside the continental shelves.

Oceanic species can be broken into epipelagic species and deep-water species. The number of species classified as deep-water species continues to increase, reaching 115 in 2004, while the number of epipelagic species remained stable at 60. The improved breakdown of deep-water species reported in national catch statistics parallels the increase that occurred for shark species in recent years. Possible reasons may include a growing global awareness that vulnerable species need to be protected by serious management measures and these cannot be formulated and agreed unless basic information such as catch statistics is systematically collected.

In a recent FAO study,² a method to identify and study phases of fishery development was applied to the 1950–2004 catch data series of oceanic species. The total catch trends (Figure A) show that oceanic epipelagic catches increased fairly steadily during the whole period, whereas fisheries for deep-water resources only started developing significantly in the late 1970s. This was made possible by technological developments applicable to fishing in deeper waters, but was also prompted by the need to exploit new fishing grounds following reduced opportunities owing to extended jurisdictions and declining resources in coastal areas. A comparative analysis of the development phases (Figures B and C) shows in greater detail that by the late 1960s the oceanic epipelagic resources classified as “undeveloped” had fallen to zero. This did not happen until the late 1970s for the oceanic deep-water resources. During the same 20-year period, the percentage of deep-water species classified as “senescent” exceeded that of epipelagic species and has continued to remain higher ever since. This result may be considered as further evidence that deep-water species are generally very vulnerable to overexploitation, mainly on account of their slow growth rates and late age at first maturity.

¹For example, the United Nations Review Conference on the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, held in New York, United States of America, from 22 to 26 May 2006. (See also pp. 120–125.)

²FAO. 2006. *The state of world highly migratory, straddling and other high seas fisheries resources, and associated species*, by J.-J. Maguire, M. Sissenwine, J. Csirke, R. Grainger and S. Garcia. FAO Fisheries Technical Paper No. 495. Rome.

Figure A

World catches of oceanic species (epipelagic and deep-water) occurring principally in high seas areas

Million tonnes (live weight)

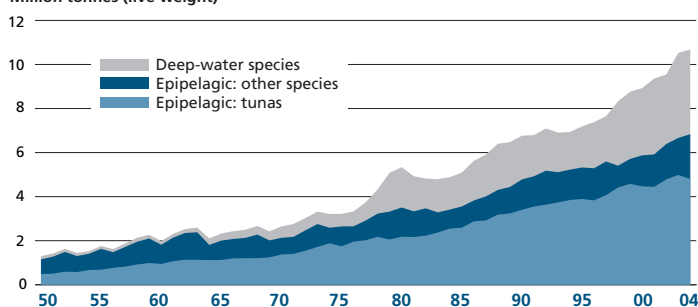


Figure B

Percentage of oceanic epipelagic resources in various phases of fishery development, 1950–2004

Percentage

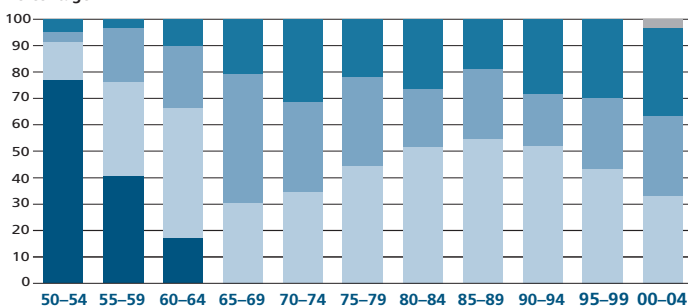


Figure C

Percentage of oceanic deep-water resources in various phases of fishery development, 1950–2004

Percentage

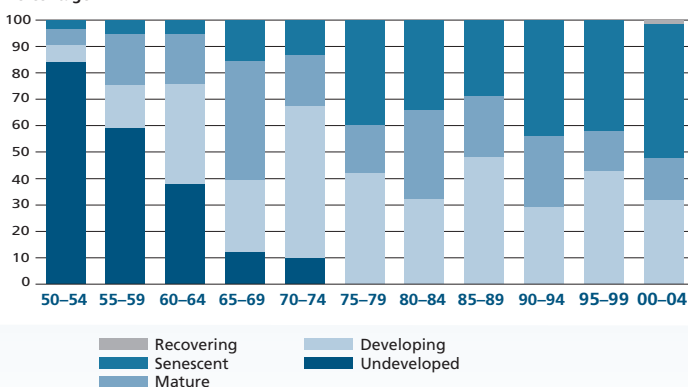
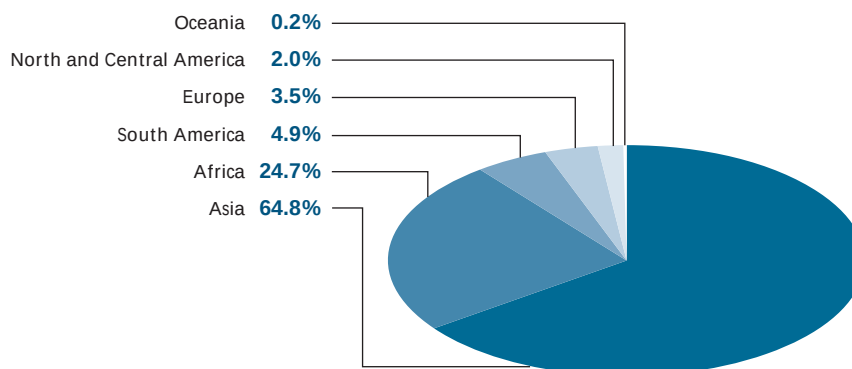


Figure 7

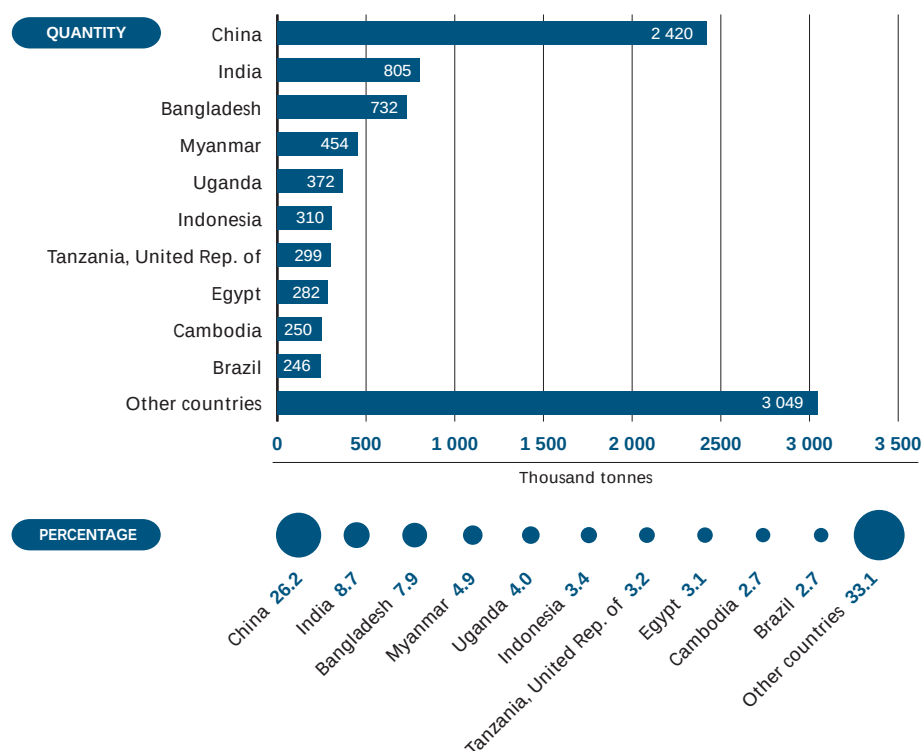
Inland capture fisheries by continent in 2004



Note: World inland capture fisheries production amounted to 9.2 million tonnes in 2004.

Figure 8

Inland capture fisheries: top ten producer countries in 2004



managing and funding the collection of inland capture statistics. For example, despite the fact that African lakes and rivers provide food to a large number of inhabitants and also revenues from fish exported outside Africa, it was necessary for FAO to estimate the 2004 inland total catch for half of the African countries where inland fishing is known to take place.

Table 3
Inland capture fishery production by economic class

	Production in 2004	
	(Million tonnes)	(Percentage share of total)
China	2.42	26.2
Other developing countries	6.29	68.2
Economies in transition	0.29	3.2
Industrial countries	0.22	2.3
Total	9.22	

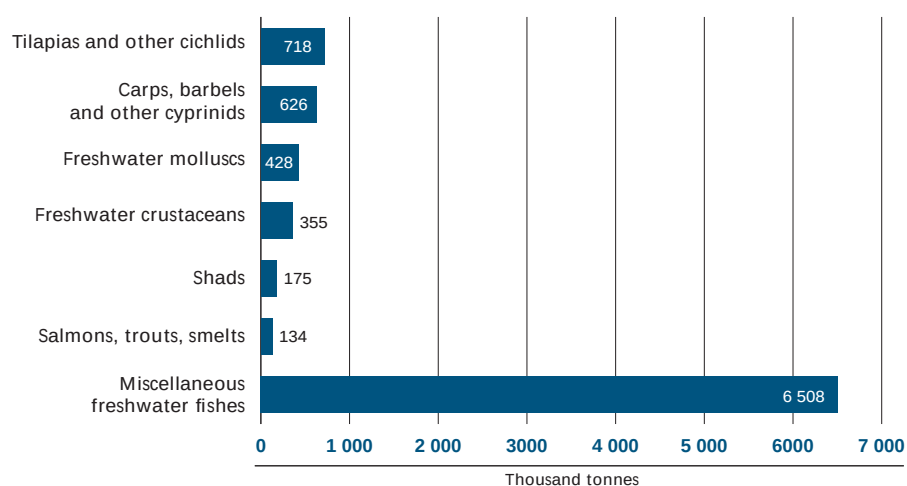
Trend analysis by species or species groups of the inland catch data in the FAO database risks being biased for two main reasons: the very poor species breakdown reported by many countries and the recent large fluctuations within the data for major items in the inland catch statistics reported by China, which represents over one-quarter of the global production.

In 2003 and 2004, global inland catches classified as “freshwater fishes not elsewhere included” again exceeded 50 percent of the total, and only about 19 percent of the total inland catch was reported at the species level. This has negative consequences as catch information by species is required for management purposes. In countries where inland fisheries are significant for food security and economic development, particularly in Africa and Asia, mismanagement of inland fisheries would as a rule lead to economic losses far greater than the expenditures needed to improve quality and detail of inland catch statistics significantly.

Following several years of collaboration with FAO, the species breakdown of the inland and marine catch statistics reported by China has improved. However, capture production trends of the three major inland species groups caught in China (i.e. fishes, crustaceans and molluscs) changed markedly in 2003 and 2004. The halving of “freshwater crustaceans” catches reported by China in 2004, following an extremely high peak in 2002, caused this species group to drop from second to fifth place in the world ranking (Figure 9). Global catches of tilapias and carps have been rising over the past two years, while the capture of shads (a species that tends to suffer from the effects of environmental alterations as the fish migrate between waters with different salinities) in 2004 were 12 percent below the quantities reported for 2002.

Figure 9

Inland capture fisheries: major species groups in 2004



AQUACULTURE

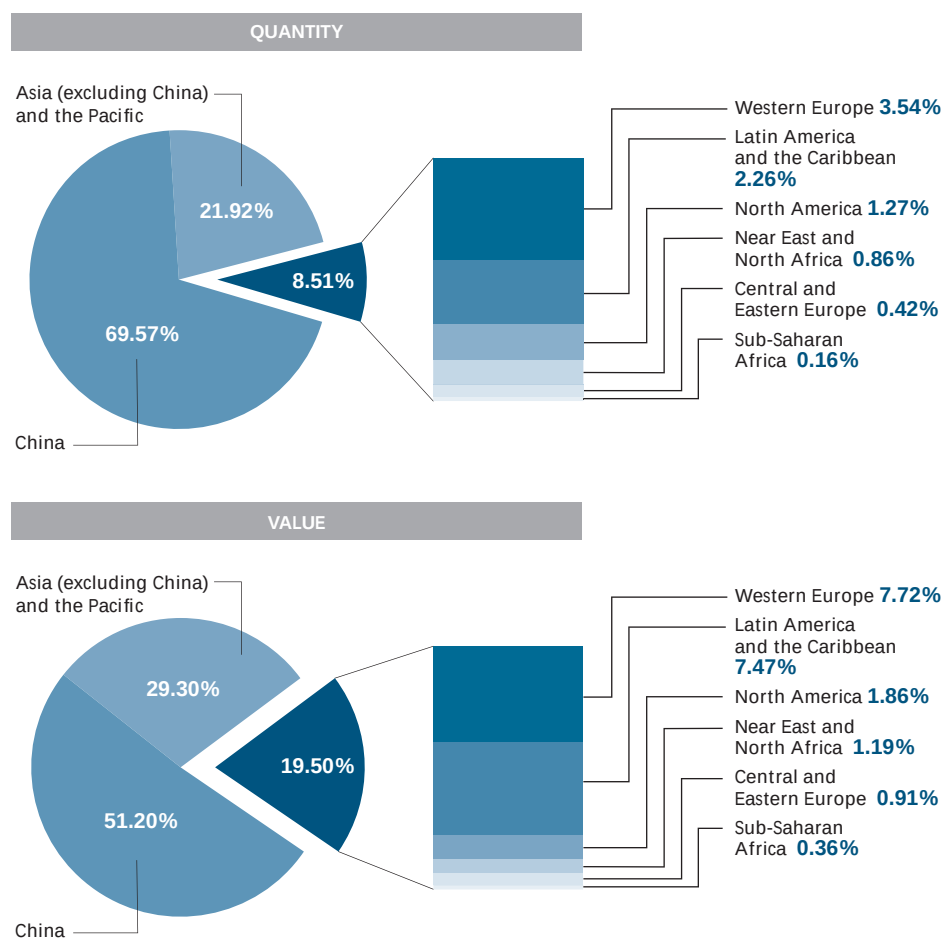
Aquaculture production

The contribution of aquaculture to global supplies of fish, crustaceans, molluscs and other aquatic animals³ continues to grow, increasing from 3.9 percent of total production by weight in 1970 to 27.1 percent in 2000 and 32.4 percent in 2004. Aquaculture continues to grow more rapidly than all other animal food-producing sectors. Worldwide, the sector has grown at an average rate of 8.8 percent per year since 1970, compared with only 1.2 percent for capture fisheries and 2.8 percent⁴ for terrestrial farmed meat production systems over the same period. Production from aquaculture has greatly outpaced population growth, with per capita supply from aquaculture increasing from 0.7 kg in 1970 to 7.1 kg in 2004, representing an average annual growth rate of 7.1 percent.

World aquaculture (food fish and aquatic plants) has grown significantly during the past half-century. From a production of below 1 million tonnes in the early 1950s, production in 2004 was reported to have risen to 59.4 million tonnes, with a value of US\$70.3 billion. This represents an average annual increase of 6.9 percent in quantity and 7.7 percent in value over reported figures for 2002. In 2004, countries in the Asia and the Pacific region accounted for 91.5 percent of the production quantity and 80.5 percent of the value. Of the world total, China is reported to account for 69.6 percent of the total quantity and 51.2 percent of the total value of aquaculture production (Figure 10).⁵

Figure 10

Aquaculture production by regional grouping in 2004



In terms of food fish supply, the aquaculture sector in the world excluding China produced about 15 million tonnes of farmed aquatic products in 2004, compared with about 54 million tonnes from capture fisheries destined for direct human consumption. Corresponding figures reported for China were about 31 million tonnes from aquaculture and 6 million tonnes from capture fisheries – a powerful indication of the dominance of aquaculture in China.

Production within each region is diverse. In the Asia and the Pacific region, aquaculture production from China, South Asia and most of Southeast Asia consists primarily of cyprinids, while production from the rest of East Asia consists of high-value marine fish. In global terms, some 99.8 percent of cultured aquatic plants, 97.5 percent of cyprinids, 87.4 percent of penaeids and 93.4 percent of oysters come from Asia and the Pacific. Meanwhile, 55.6 percent of the world's farmed salmonids come from Western Europe, mainly the northern part of the continent. However, carps dominate in the Central and Eastern European regions, both in quantity and in value.

In North America, channel catfish is the top aquaculture species in the United States of America, while Atlantic and Pacific salmon dominate in Canada. In Latin America and the Caribbean, over the past decade, salmonids have overtaken shrimp as the top aquaculture species group following disease outbreaks in major shrimp-producing areas and rapid growth in salmon production in Chile.

The sub-Saharan Africa region continues to be a minor player in aquaculture despite its natural potential. Even aquaculture of tilapia, which is native to the continent, has not developed significantly. Nigeria leads in the region, with reported production of 44 000 tonnes of catfish, tilapia and other freshwater fishes. There are some encouraging signs in the continent: black tiger shrimp (*Penaeus monodon*) in Madagascar and *Eucheuma* seaweed in the United Republic of Tanzania are thriving, and production of niche species such as abalone (*Haliotis* spp.) in South Africa is increasing. In the Near East and North Africa, Egypt is by far the dominant country in terms of production (providing 92 percent of the regional total) and is now the second biggest tilapia producer after China and the world's top producer of mullets.

The top ten producing countries for food fish supply from aquaculture in 2004 are indicated in Table 4 along with the top ten countries in terms of annual growth in aquaculture production for the two-year period 2002–04. All regions showed increases in production from 2002 to 2004, led by the Near East and North Africa region and Latin America and the Caribbean with 13.5 and 9.6 percent average annual growth, respectively.

World aquatic plant production in 2004 reached 13.9 million tonnes (US\$6.8 billion), of which 10.7 million tonnes (US\$5.1 billion) originated from China, 1.2 million tonnes from the Philippines, 0.55 million tonnes from the Republic of Korea and 0.48 million tonnes from Japan. Japanese kelp (*Laminaria japonica* – 4.5 million tonnes) showed the highest production followed by Wakame (*Undaria pinnatifida* – 2.5 million tonnes) and Nori (*Porphyra tenera* – 1.3 million tonnes). An additional 2.6 million tonnes were reported by countries as “aquatic plants” and not further specified. The production of aquatic plants increased rapidly from the 2002 total of 11.6 million tonnes, primarily as a result of large production increases in China.⁶

The growth in production of the different major species groups continues, although the increases seen so far this decade are less dramatic than the extraordinary growth rates achieved in the 1980s and 1990s (Figure 11, Table 5). The period 2000–04 has seen strong growth in production of crustaceans, in particular, and of marine fish. Growth rates for the production of the other species groups have begun to slow and the overall rate of growth, while still substantial, is not comparable with the significant rate increases seen in the previous two decades. Thus, while the trend for the near future appears to be one of continued increases in production, the rate of these increases may be moderating. Figure 12 presents an overview of aquaculture production in terms of quantity and value by major species group for 2004.



Table 4
Top ten aquaculture producers of food fish supply: quantity and emerging growth

Producer	2002	2004	APR
	(Tonnes)	(Tonnes)	(Percentage)
Top ten producers in terms of quantity, 2004			
China	27 767 251	30 614 968	5.0
India	2 187 189	2 472 335	6.3
Viet Nam	703 041	1 198 617	30.6
Thailand	954 567	1 172 866	10.8
Indonesia	914 071	1 045 051	6.9
Bangladesh	786 604	914 752	7.8
Japan	826 715	776 421	-3.1
Chile	545 655	674 979	11.2
Norway	550 209	637 993	7.7
United States of America	497 346	606 549	10.4
TOP TEN SUBTOTAL	35 732 648	40 114 531	6.0
REST OF THE WORLD	4 650 830	5 353 825	7.3
TOTAL	40 383 478	45 468 356	6.1
Top ten producers in terms of growth, 2002-04			
Myanmar	190 120	400 360	45.1
Viet Nam	703 041	1 198 617	30.6
Turkey	61 165	94 010	24.0
Netherlands	54 442	78 925	20.4
Republic of Korea	296 783	405 748	16.9
Iran (Islamic Rep. of)	76 817	104 330	16.5
Egypt	376 296	471 535	11.9
Chile	545 655	674 979	11.2
Thailand	954 567	1 172 866	10.8
United States of America	497 346	606 549	10.4

Note: Data exclude aquatic plants. APR refers to the average annual percentage growth rate for 2002-04.

Table 5
World aquaculture production: average annual rate of growth for different species groups

Time period	Crustaceans	Molluscs	Freshwater fish	Diadromous fish	Marine fish	Overall
	(Percentage)					
1970-2004	18.9	7.7	9.3	7.3	10.5	8.8
1970-1980	23.9	5.6	6.0	6.5	14.1	6.2
1980-1990	24.1	7.0	13.1	9.4	5.3	10.8
1990-2000	9.1	11.6	10.5	6.5	12.5	10.5
2000-2004	19.2	5.3	5.2	5.8	9.6	6.3

The top ten species groups in terms of production quantity and percentage increase in production quantity from 2002 to 2004 are shown in Table 6. Production of carps far exceeded that for all other species groups, accounting for over 40 percent (18.3 million tonnes) of total production of fish, crustaceans and molluscs in 2004. Combined, the top ten species groups account for 90.5 percent of the total aquaculture contribution to fisheries food supply. The largest production for an individual species was the Pacific cupped oyster (*Crassostrea gigas* – 4.4 million tonnes), followed by three species of

Figure 11

Trends in world aquaculture production: major species groups

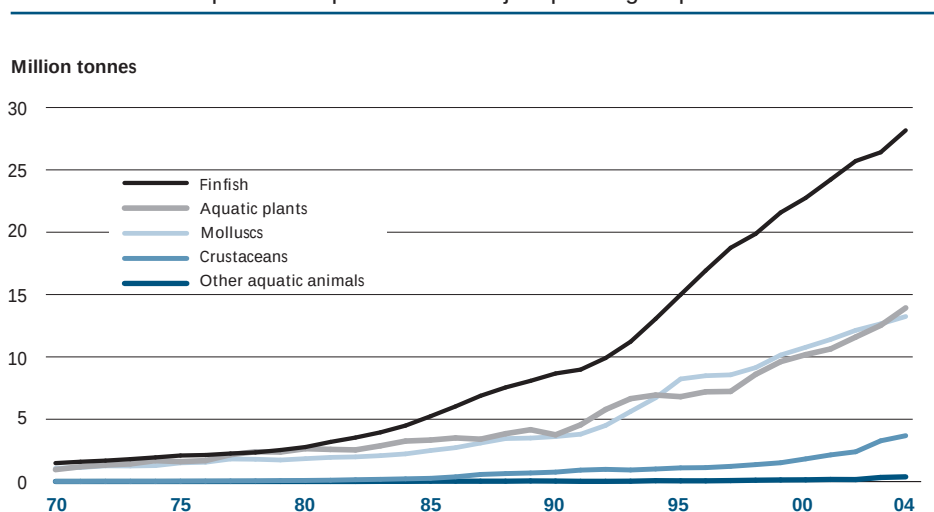


Figure 12

World aquaculture production: major species groups in 2004

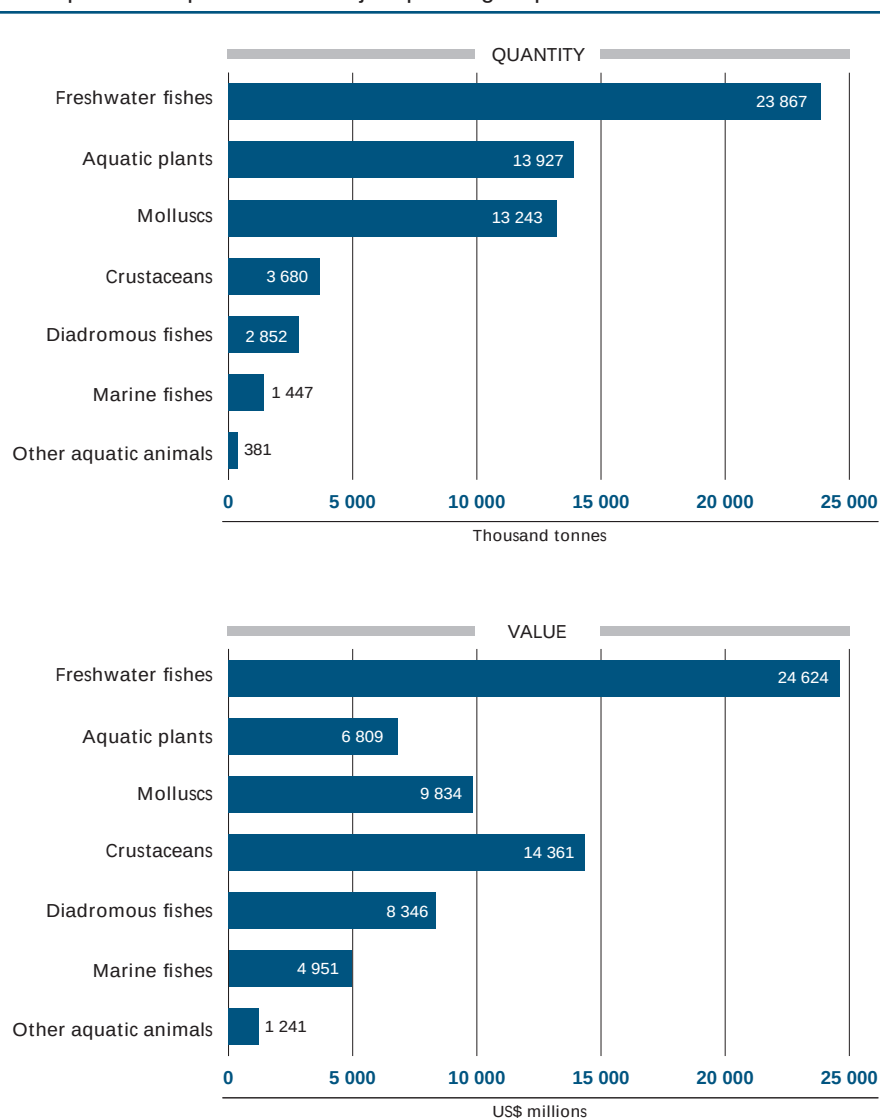


Table 6
Top ten species groups in aquaculture production: quantity and emerging growth

Species group	2002 (Tonnes)	2004 (Tonnes)	APR (Percentage)
Top ten species groups in terms of aquaculture production, 2004			
Carps and other cyprinids	16 673 155	18 303 847	4.8
Oysters	4 332 357	4 603 717	3.1
Clams, cockles, arkshells	3 457 510	4 116 839	9.1
Miscellaneous freshwater fishes	3 763 902	3 739 949	-0.3
Shrimps, prawns	1 495 950	2 476 023	28.7
Salmons, trouts, smelts	1 791 061	1 978 109	5.1
Mussels	1 700 871	1 860 249	4.6
Tilapias and other cichlids	1 483 309	1 822 745	10.9
Scallops, pectens	1 228 692	1 166 756	-2.6
Miscellaneous marine molluscs	1 389 586	1 065 191	-12.4
Top ten species groups in terms of growth in production of fish, crustaceans and molluscs, 2002–04			
Sea urchins and other echinoderms	25	60 852	4 833.6
Abalones, winkles, conchs	2 970	287 720	884.3
Frogs and other amphibians	3 074	76 876	400.1
Freshwater molluscs	13 414	142 346	225.8
Sturgeons, paddlefishes	3 816	15 551	101.9
Miscellaneous aquatic invertebrates	12 593	42 159	83.0
Flounders, halibuts, soles	35 513	109 342	75.5
Miscellaneous coastal fishes	386 160	878 589	50.8
Miscellaneous demersal fishes	16 638	31 531	37.7
Shrimps, prawns	1 495 950	2 476 023	28.7

Note: Data exclude aquatic plants. APR refers to the average annual percentage growth rate for 2002–04.

carp – the silver carp (*Hypophthalmichthys molitrix* – 4.0 million tonnes), the grass carp (*Ctenopharyngodon idellus* – 3.9 million tonnes) and the common carp (*Cyprinus carpio* – 3.4 million tonnes). In terms of value, shrimp culture is second in importance and has increased substantially in the 2002–04 period.

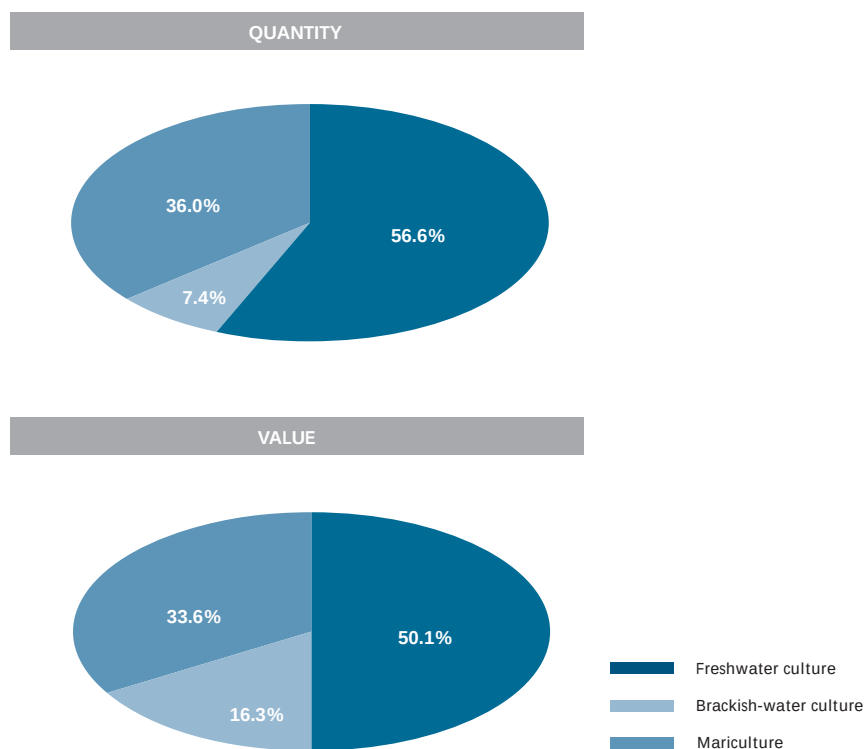
The increasing diversity of aquaculture production can be seen in the list of species groups registering the largest growth from 2002 to 2004. Sea urchins and other echinoderms lead the list with a remarkable increase in reported production from 25 tonnes in 2002 to 60 852 tonnes in 2004. In reality, while this does represent an area of emerging activity in aquaculture, this item also reflects an effort made by China to improve its reporting of aquaculture data. Beginning in 2003, China greatly expanded the number of species reported in its data, including 15 new freshwater species and 13 new marine species. This resulted in corresponding decreases in the reporting of production in aggregated, “unspecified” groupings.

Most aquaculture production of fish, crustaceans and molluscs continues to derive from the freshwater environment (56.6 percent by quantity and 50.1 percent by value) (Figure 13). Mariculture contributes 36.0 percent of production quantity and 33.6 percent of the total value. While much of the marine production consists of high-value finfish, there is also a large amount of relatively low-priced mussels and oysters.⁷ Although brackish-water production represented only 7.4 percent of production quantity in 2004, it contributed 16.3 percent of the total value, reflecting the prominence of high-value crustaceans and finfish.

From 1970 to 2004, Chinese inland water aquaculture production increased at an average annual rate of 10.8 percent, compared with 7.0 percent in the rest of the world.⁸ Similarly, during the same period, Chinese aquaculture production in marine areas, excluding aquatic plants, increased at an average annual rate of 10.7 percent

Figure 13

World aquaculture production of fish, crustaceans and molluscs in 2004:
breakdown by environment



Note: Data exclude aquatic plants.

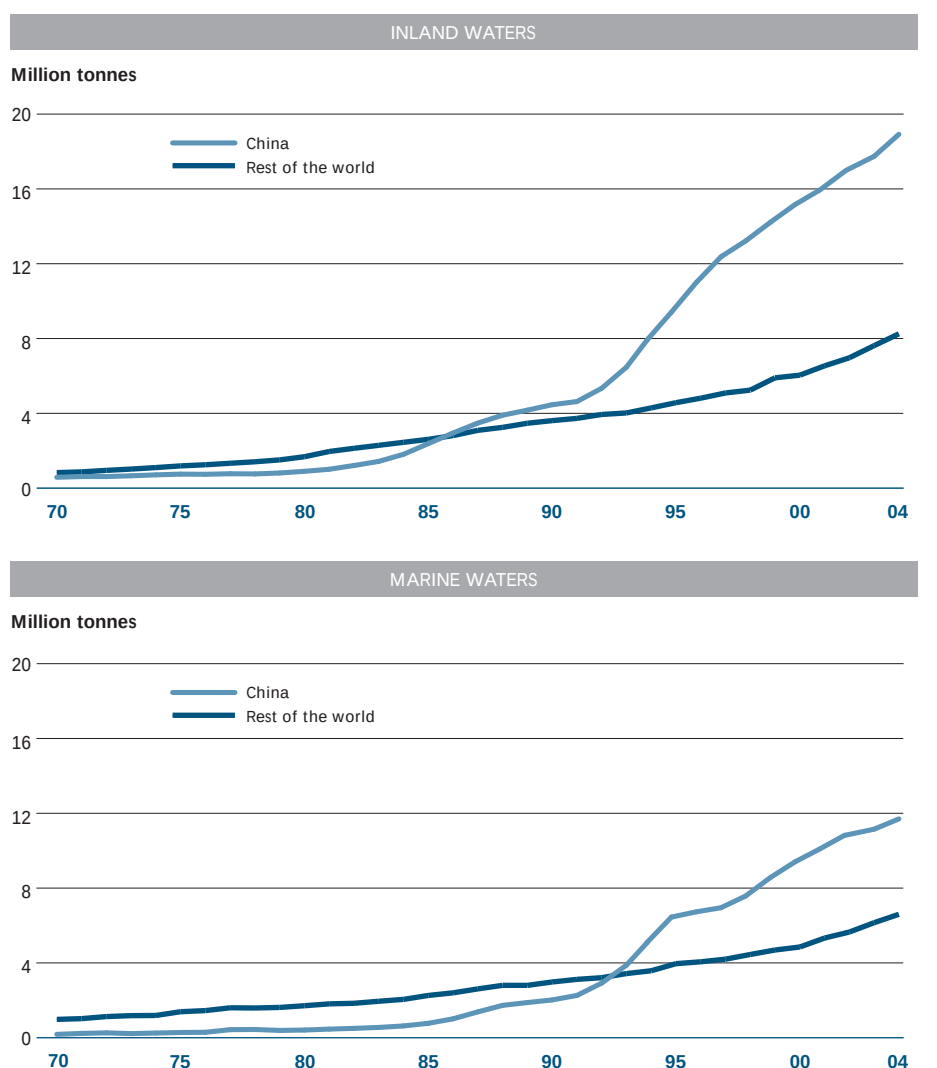
compared with 5.9 percent in the rest of the world. Figure 14 shows trends in inland and marine aquaculture production for China and the rest of the world.

Unlike terrestrial farming systems, where the bulk of global production is based on a limited number of animal and plant species, over 240 different farmed aquatic animal and plant species were reported in 2004, an increase of 20 species compared with the number reported in 2002. These 240 species represent 94 families; moreover, this diversity is probably underestimated, as 8.9 million tonnes (15.1 percent) of global aquaculture production, including an additional 20 families, was not reported to the species level in 2004, and this “unspecified” group is likely to include species not yet recorded as being cultured. Of aquaculture reported to FAO to the species level, the top ten species account for 61.7 percent of total production and the top 25 species for 86.6 percent. These figures are lower than those for 2000 (68.1 percent and 91.0 percent, respectively), providing a further indication that species diversification in aquaculture is increasing.

It is noteworthy that the growth of aquaculture production of fish, crustaceans and molluscs within developing countries has exceeded the corresponding growth in developed countries, proceeding at an average annual rate of 10.2 percent since 1970. In contrast, aquaculture production within developed countries has been increasing at an average rate of 3.9 percent per year. In developing countries other than China, production has grown at an annual rate of 8.2 percent. In 1970, developing countries accounted for 58.8 percent of production, while in 2002 their share was 91.4 percent. In the period from 2002 to 2004, the trend was even more dramatic as production in developing countries other than China increased at an annual rate of 11.0 percent, compared with 5.0 percent for China and 2.3 percent for developed countries.

Figure 14

Aquaculture production in inland and marine waters



Note: Data exclude aquatic plants.

With the exception of marine shrimp, the bulk of aquaculture production within developing countries in 2004 comprised omnivorous/herbivorous fish or filter-feeding species. In contrast, approximately three-quarters of finfish culture production in developed countries was of carnivorous species.

FISHERS AND FISH FARMERS

Millions of people around the world depend on fisheries and aquaculture, directly or indirectly, for their livelihoods. During the past three decades, the number of fishers and aquaculturists has grown faster than the world's population, and employment in the fisheries sector has grown faster than employment in traditional agriculture. In 2004, an estimated 41 million people (Table 7) worked (part time or full time) as fishers and fish farmers, accounting for 3.1 percent of the 1.36 billion people economically active in agriculture worldwide and representing a growth rate of 35 percent from the corresponding figure of 2.3 percent in 1990. The great majority of fishers and fish farmers are in developing countries, principally in Asia. Significant increases over recent decades, in particular in Asia, reflect the strong expansion of aquaculture activities. In 2004, the number of fish farmers accounted for one-quarter of the total number of fish workers. This figure is indicative, as some countries do not collect employment data

Table 7
World fishers and fish farmers by continent

	1990	1995	2000	2003	2004
	(Thousands)				
Total					
Africa	1 832	1 950	2 981	2 870	2 852
North and Central America	760	777	891	841	864
South America	730	704	706	689	700
Asia	23 736	28 096	34 103	36 189	36 281
Europe	626	466	766	653	656
Oceania	55	52	49	50	54
World	27 737	32 045	39 495	41 293	41 408
Of which fish farmers¹					
Africa	3	14	83	117	117
North and Central America	3	6	75	62	64
South America	66	213	194	193	194
Asia	3 738	5 986	8 374	10 155	10 837
Europe	20	27	30	68	73
Oceania	1	1	5	5	4
World	3 832	6 245	8 762	10 599	11 289

¹ Data for 1990 and 1995 were reported by only a limited number of countries and therefore are not comparable with those for the following years.

separately for the two sectors and some other countries' national systems do not yet account for fish farming.

China is by far the country with the highest number of fishers and fish farmers, reported to be 13.0 million in 2004 (31 percent of the world total). Of these, 4.5 million were fish farmers (an increase of 158 percent compared with numbers in 1990), while 8.5 million worked in capture fisheries. Current fleet-size reduction programmes in China, aimed at reducing overfishing, are reducing the number of full-time and part-time fishers. The number of people engaged in capture fisheries declined by 13 percent during the period 2001–04 and there are plans to transfer a proportion of fishers to other jobs by 2007. The policy tools to accomplish this move include, among others, scrapping vessels and training redundant fishers in fish farming. In 2004, other countries with a significant number of fishers and fish farmers were India, Indonesia and Viet Nam.

While the number of people employed in fisheries and aquaculture has been growing steadily in most low- and middle-income countries, the numbers in most industrialized economies have been declining or have remained stationary (Table 8). In Japan and Norway the numbers of fishers have more than halved between 1970 and 2004, with a decrease of 58 percent and 54 percent, respectively. In many industrialized countries, the decline has occurred mainly for fishers working in capture fisheries, while the number of fish farmers has increased.

Estimates indicate that there were about 1 million fishers in industrialized countries in 2004, representing a decline of 18 percent compared with 1990 figures. Productivity increases and falling recruitment count among the various reasons for these shrinking numbers.

In recent decades, growing investment in costly onboard equipment, resulting in higher operational efficiencies and less need for seagoing personnel, has led to a significant decline in the number of people employed at sea.

Moreover, the average age of active fishers is increasing as a result of the rapid decline of recruitment into capture fisheries. For example, according to the 2003 Fishery Census of Japan, 47 percent of male fishers were 60 years of age or older in 2004, 23 percent higher than in 1988. At the same time, the share of the younger



Table 8
Number of fishers and fish farmers in selected countries

Country	Fishery		1990	1995	2000	2003	2004
WORLD	FI + AQ	(number)	27 737 435	32 045 098	39 495 195	41 292 679	41 407 771
		(index)	70	81	100	105	105
	FI	(number)	23 905 853	25 799 922	30 733 366	30 693 835	30 118 720
		(index)	78	84	100	100	98
	AQ	(number)	3 831 582	6 245 176	8 761 829	10 598 844	11 289 051
		(index)	44	71	100	121	129
China	FI + AQ	(number)	9 092 926	11 428 655	12 935 689	13 162 812	13 018 332
		(index)	70	88	100	102	101
	FI	(number)	7 351 927	8 759 162	9 213 340	8 838 638	8 528 361
		(index)	80	95	100	96	93
	AQ	(number)	1 740 999	2 669 493	3 722 349	4 324 174	4 489 971
		(index)	47	72	100	116	121
Indonesia	FI + AQ	(number)	3 617 586	4 568 059	5 247 620	6 052 597	6 240 420
		(index)	69	87	100	115	119
	FI	(number)	1 995 290	2 463 237	3 104 861	3 782 397	3 950 420
		(index)	64	79	100	122	127
	AQ ¹	(number)	1 622 296	2 104 822	2 142 759	2 270 200	2 290 000
		(index)	76	98	100	106	107
Iceland	FI + AQ	(number)	6 951	7 000	6 100	5 100	4 600
		(index)	114	115	100	84	75
Japan	FI + AQ	(number)	370 600	301 440	260 200	295 921	230 990
		(index)	142	116	100	114	89
Norway	FI + AQ	(number)	32 022	28 269	24 399	21 621	19 874
		(index)	131	116	100	89	81
	FI	(number)	27 518	23 653	20 072	17 205	15 586
		(index)	137	118	100	86	78
	AQ	(number)	4 504	4 616	4 327	4 416	4 288
		(index)	104	107	100	102	99
Peru	FI + AQ	(number)	43 750	62 930	93 789	91 757	98 692
		(index)	47	67	100	98	105
	FI	(number)	...	60 030	91 226	88 967	95 512
		(index)	...	66	100	98	105
	AQ	(number)	...	2 900	2 563	2 790	3 180
		(index)	...	113	100	109	124

Note: FI = fishing, AQ = aquaculture; index: 2000 = 100; ... = data not available.

¹ Data for 2003 and 20054 are FAO estimates.

group of fishers (under 40 years old), which represented one-quarter of the total number of marine fishers in Japan in 1982, had declined to 13.3 percent by 2003. The number of Japanese workers employed in offshore and distant-water fishing declined during the period 1998–2003 by 28 percent to 25 000 people in 2003.

In industrialized countries, younger workers seem reluctant to go to sea on fishing vessels. There are probably several reasons. For many young men, neither the salaries nor the quality of life aboard fishing vessels compares favourably with those of land-

based industries. Also, many will be aware of public concerns about the status of stocks and therefore see capture fisheries as having an uncertain future.

As a result, fishing firms in industrialized countries have begun to look elsewhere when recruiting personnel. In Europe, fishers from the economies in transition or from developing countries are starting to replace local fishers. Also in Japan, foreign workers have been allowed to work on Japanese distant-water fishing vessels under the “maru-ship system”.⁹

A characteristic feature of employment in the fishing industry is the prevalence of occasional¹⁰ or part-time employment, peaking in the months of the year when riverine, coastal and offshore resources are more abundant or available, but leaving time in seasonal lows for other occupations. This is especially true in fisheries for migratory species and those subject to seasonal weather variations. During the past three decades, the number of full-time fishers has declined while the number of part-time fishers has grown quite rapidly. This trend has been particularly marked in Asia.

It is not possible to obtain a comprehensive picture of the role of women in the fisheries sector from the available statistics. Millions of women around the world, particularly in developing countries, work in the sector. Women participate as entrepreneurs and by providing labour before, during and after the catch in both artisanal and commercial fisheries. Their labour often consists of making and mending nets, baskets and pots and baiting hooks. In fishing, women are rarely engaged in commercial offshore and deep-sea waters, but more commonly involved in fishing from small boats and canoes in coastal or inland waters – harvesting bivalves, molluscs and pearls, collecting seaweed and setting nets or traps. Women also play an important role in aquaculture, where they attend to fish ponds, feed and harvest fish, and collect prawn larvae and fish fingerlings. However, women's most important role in both artisanal and industrial fisheries is at the processing and marketing stages. In some countries, women have become important entrepreneurs in fish processing; in fact, most fish processing is performed by women, either in their own cottage-level industries or as wage labourers in the large-scale processing industry.

The fisheries sector, including aquaculture, is an important source of employment and income. However, employment in fishing and fish farming cannot be taken as the sole indication of the importance of fisheries to a national economy. The fishing industry also generates considerable employment in shipbuilding and shipyard operations; in the fishing gear industry; in the production of technological equipment; in aquaculture feed production; and in processing, packaging and transport. Unfortunately, statistics are not currently available for the total number of individuals providing inputs to fisheries and aquaculture through these activities.

THE STATUS OF THE FISHING FLEET

Number of vessels

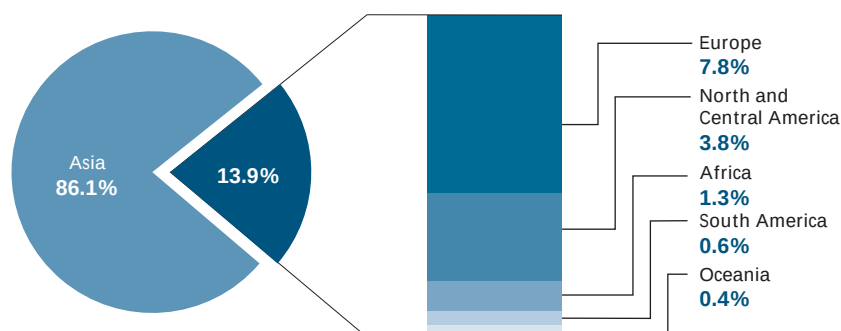
At the end of 2004, the world fishing fleet consisted of about 4 million units, of which 1.3 million were decked vessels of various types, tonnage and power, and 2.7 million were undecked (open) boats. While virtually all decked vessels were mechanized, only about one-third of the undecked fishing boats were powered, generally with outboard engines. The remaining two-thirds were traditional craft of various types, operated by sail and oars. About 86 percent of the decked vessels were concentrated in Asia, followed by Europe (7.8 percent), North and Central America (3.8 percent), Africa (1.3 percent), South America (0.6 percent) and Oceania (0.4 percent) (Figure 15).

Statistics on total tonnage and total power of world fishing fleets are not available on a global basis. Information on the number of fishing vessels and boats is largely derived from national registers and other administrative records, and may therefore include some non-operational units. At the same time, national administrative records often exclude smaller boats whose registration is not compulsory and/or whose fishing licences are granted by provincial or municipal authorities. Data made available to FAO by national respondents concerning these smaller fishing boats are often estimates; in such cases, respondents frequently keep the numbers constant over



Figure 15

Distribution of decked fishing vessels by continent



the years. In addition, reporting practices for fishing fleets operating in freshwaters vary among countries, with only a few countries making a clear distinction between marine and freshwater fleets. In view of all these factors, the currently available information has only limited value for monitoring and detecting global trends in fishing capacity.

Nevertheless, the issue of overcapacity in fishing fleets and their reduction to the levels that should be in balance with long-term sustainable exploitation of resources has received global attention during the past two decades. Many countries have adopted policies for limiting the growth of national fishing capacity in order to protect the aquatic resources and to make fishing economically viable for the harvesting enterprises. The European Economic Community in 1983 decided to tackle the problem by setting maximum levels of fishing capacity and/or effort on the part of Members. However, this policy was found to be unsatisfactory and cumbersome to manage and the European Union (EU) decided to replace this policy with the "Entry-Exit scheme" that has been in force since 2003. The scheme requires that all new fishing vessels be directly compensated by the withdrawal, without public aid, of equivalent capacity. The ten countries that joined the EU in 2004 are also subject to the "Entry-Exit scheme" and to the establishment of vessel registers.

In 2002, China adopted a five-year programme to delicense and scrap by 2007 30 000 fishing boats, or 7 percent of its commercial fleet. The programme, with funds worth the equivalent of US\$33 million per year in compensations, is based on voluntary participation and targets the smaller vessels operating near-shore. A related regulation prevents the construction of new fishing vessels other than to replace an existing vessel that has a fishing licence. In the first year, 5 000 boats were scrapped and their licences withdrawn under this programme. Nevertheless, the numbers of commercial vessels reported to FAO in both 2003 and 2004 are above the number reported as being in operation in 2002.

There are indications that the size of the decked fleets of longstanding developed fishing nations, including Denmark, Iceland, Japan, Norway, the Russian Federation and the United Kingdom, has continued to decrease, especially those operating offshore and in distant waters. However, even in these countries, the rate of reduction of fishing power is generally less significant than the rate of reduction in the number of fishing vessels. This means that while there is a tendency towards smaller fleets in terms of number of vessels, the average size of vessels is increasing. The capacity adjustment process seems to lead to larger vessels that permit owners to improve economic efficiency and operational safety.

On the other hand, data from Indonesia and the Philippines indicate a continuous expansion of their fleets, and in the United States of America the number of vessels over 100 gross tonnage (GT) increased by 3.5 percent between 2003 and 2005. In South

America, while Argentina and Chile reduced the number of industrial vessels, most countries for which data are available have experienced a general growth of coastal fleets. As a result, the number of fishing vessels worldwide has remained fairly constant in recent years (Table 9).

Fish carriers and the high seas fleet

There have been suggestions that the recent rapid rise of fuel prices will change the economics of the fishing industry, especially with regard to distant-water fishing. The use of fish carriers is likely to increase in an attempt to cut overall fuel costs by reducing the time fishing vessels spend steaming to and from the fishing grounds. According to the database of Lloyd's maritime information service, the countries reporting more than 60 fish carriers in 2005 were China, Japan, Panama and the Russian Federation. Forty-three fish carriers (6 percent of the total) were identified as "unknown" flag, among which 50 percent had previously been recorded as flying the flags of Belize or the Russian Federation.

Figure 16 shows the age distribution of fishing vessels and fish carriers above 100 GT operational at the end of 2005. The average age of the global fishing fleet above 100 GT continues to increase, with relatively small numbers of vessels being built in recent years. The pattern of fish carrier construction broadly follows that of the



Table 9
Powered fishing fleets in selected countries

		2000	2001	2002	2003	2004	2005
China	Number	487 297	479 810	478 406	514 739	509 717	513 913
	Tonnage (GT)	6 849 326	6 986 159	6 933 949	7 225 660	7 115 195	7 139 746
	Power (kW)	14 257 891	14 570 750	14 880 685	15 735 824	15 506 720	15 861 838
EU-15	Number	95 501	92 409	90 106	87 881	85 480	83 677
	Tonnage (GT)	2 022 244	2 014 053	1 965 306	1 906 718	1 882 597	1 791 195
	Power (kW)	7 632 221	7 507 699	7 295 386	7 097 720	6 941 077	6 787 611
Iceland	Number	892	955	947	940	939	927
	Tonnage (GT)	175 099	186 573	187 018	179 394	187 079	177 615
	Power (kW)	438 526	468 377	466 288	455 016	462 785	447 260
Japan	Number	337 600	331 571	325 229	320 010	...	...
	Tonnage (GT)	1 447 960	1 406 882	1 377 000	1 342 120	...	...
	Power (kW)	...	...	...	...	...	...
Norway	Number	13 017	11 922	10 641	9 911	8 184	7 723
	Tonnage (GT)	392 316	403 678	394 561	395 327	394 846	373 282
	Power (kW)	1 321 060	1 361 821	1 351 242	1 355 745	1 328 945	1 272 375
Republic of Korea	Number	89 294	89 347	89 327	88 521	87 203	...
	Tonnage (GT)	917 963	880 467	812 629	750 763	721 398	...
	Power (kW)	13 597 179	14 765 745	17 273 940	17 094 036	16 743 102	...
Russian Federation	Number	2 653	2 607	2 625	2 533	2 458	2 256
	Tonnage (GT)	2 424 035	2 285 655	2 619 825	2 092 799	1 939 734	1 176 211
	Power (kW)	2 808 349	2 439 806	2 338 582	2 310 717	2 111 332	1 942 064

Notes:

In 2000–04, the combined marine catches of the above countries represented between 41 and 38 percent of the world total.

Some vessels may not be measured according to the 1969 International Convention on Tonnage Measurement of Ships.

The Icelandic data exclude undecked vessels.

The Japanese data refer to registered fishing boats operating in marine waters.

The Russian Federation data refer to powered decked vessels with a national licence.

Sources:

China: FAO fishery statistical inquiry.

EU-15: Eurostat.

Iceland: Statistics Iceland (<http://www.statice.is>).

Japan: Japan Statistical Yearbook 2006 (<http://www.stat.go.jp/english/data/nenkan/index.htm>).

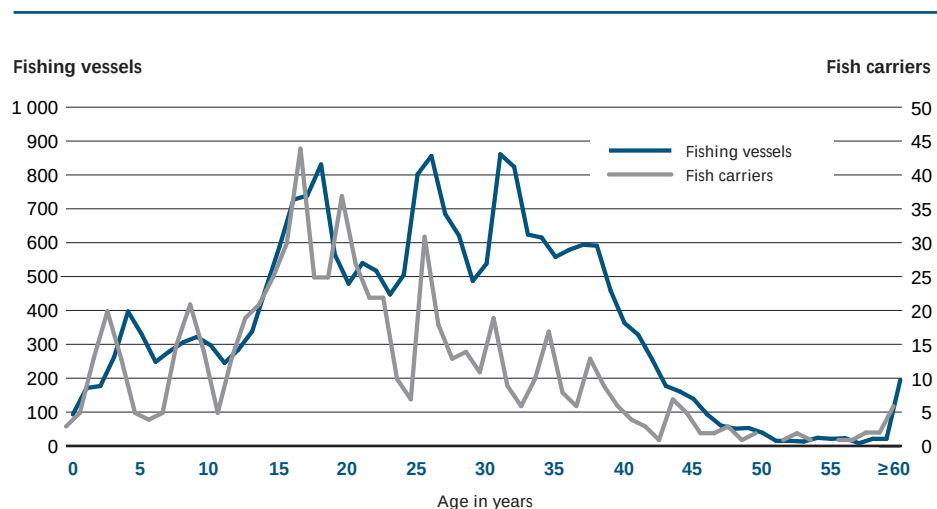
Republic of Korea: Korea Statistical Yearbook 2005, Vol. 52.

Norway: Statistics Norway (<http://www.ssb.no>) and Eurostat.

Russian Federation: FAO fishery statistical inquiry.

Figure 16

Age distribution of fishing vessels and fish carriers above 100 GT operational at the end of 2005



Source: Lloyd's.

fishing fleet, with increasing numbers of fish carriers being built up until the late 1980s followed by a decline. The pattern was broken in the outlier shown for 2002, when 12 fish carriers were built for delivery to Thailand.

Lloyd's data also indicate that in some countries, when a vessel is replaced the old one is exported, with the result that their fishing fleets are generally composed of vessels with a relatively low age. This group of countries includes Japan, Norway and Spain.

Origins of the fleets

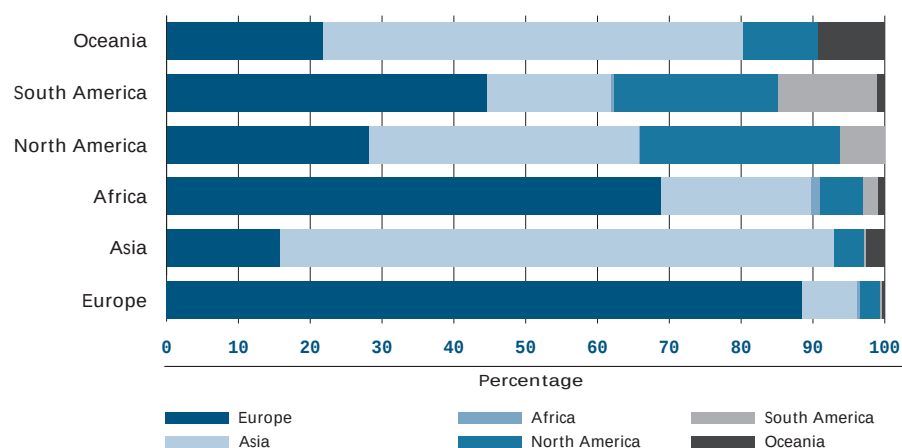
The Lloyd's maritime information service database also contains data about where a fishing vessel was built. Most of the major fishing nations also have major shipbuilding industries that supply their fishing vessels to local and foreign fishing companies. Japan, Peru, the Russian Federation, Spain and the United States of America, all of which are prominent shipbuilders, built more than 60 percent of fishing vessels above 100 GT currently in operation.

Most fishing vessels (78 percent) in operation at the end of 2005 have not changed flag since being launched, and more than two-thirds of them were built in the country where they are registered. In Japan, Peru, Poland, Spain and the United States of America, domestic shipbuilders have supplied over 90 percent of the national fishing fleets. The data for the United States of America obviously reflect the provisions of the Jones Act, which effectively does not allow fishing vessels to be imported into the country. Peru is unique in that it has a substantial fleet (over 650 vessels), of which the great majority of vessels were built, and remain, in the country, with few being exported to other countries. This is believed to be because the fleet consists of specialized Peruvian purse-seiners, which are not in demand in surrounding countries. The Peruvian fleet also has a very high age profile: 70 percent of the vessels are now over 30 years old, which is the average age at which fishing vessels are scrapped.

Nevertheless, some countries depend on foreign boatyards for the supply of vessels above 100 GT. Honduras, Indonesia, Morocco, Panama and the Philippines have more than 200 operational fishing vessels above 100 GT in the Lloyd's database, but most of them were built abroad. Figure 17 shows, by continent in which they are registered, where fishing vessels were built, also by continent. While the European countries, including the Russian Federation and Spain, provide the majority of fishing vessels in Europe and Africa, Asian countries, especially Japan, are the main suppliers of fishing vessels to other Asian and Pacific fishing fleets.

Figure 17

Distribution of shipbuilding areas for vessels registered in regions



Source: Lloyd's.

THE STATUS OF FISHERY RESOURCES

Marine fisheries

The global state of exploitation of the world marine fishery resources has tended to remain relatively stable over the past 10–15 years, even if changes have been reported for some fish stocks and specific areas (Figure 18). The overall examination of the state of stocks and groups of stocks for which information is available confirms that the proportions of overexploited and depleted stocks have remained unchanged in recent years, after the noticeable increasing trends observed in the 1970s and 1980s. It is estimated that in 2005, as in previous years, around one-quarter of the stock groups monitored by FAO were underexploited or moderately exploited (3 percent and 20 percent, respectively) and could perhaps produce more. About half of the stocks (52 percent) were fully exploited and therefore producing catches that were at or close to their maximum sustainable limits, with no room for further expansion. The other one-quarter were either overexploited, depleted or recovering from depletion (17 percent, 7 percent and 1 percent, respectively) and thus were yielding less than their maximum potential owing to excess fishing pressure exerted in the past, with no possibilities in the short or medium term of further expansion and with an increased risk of further declines and need for rebuilding.

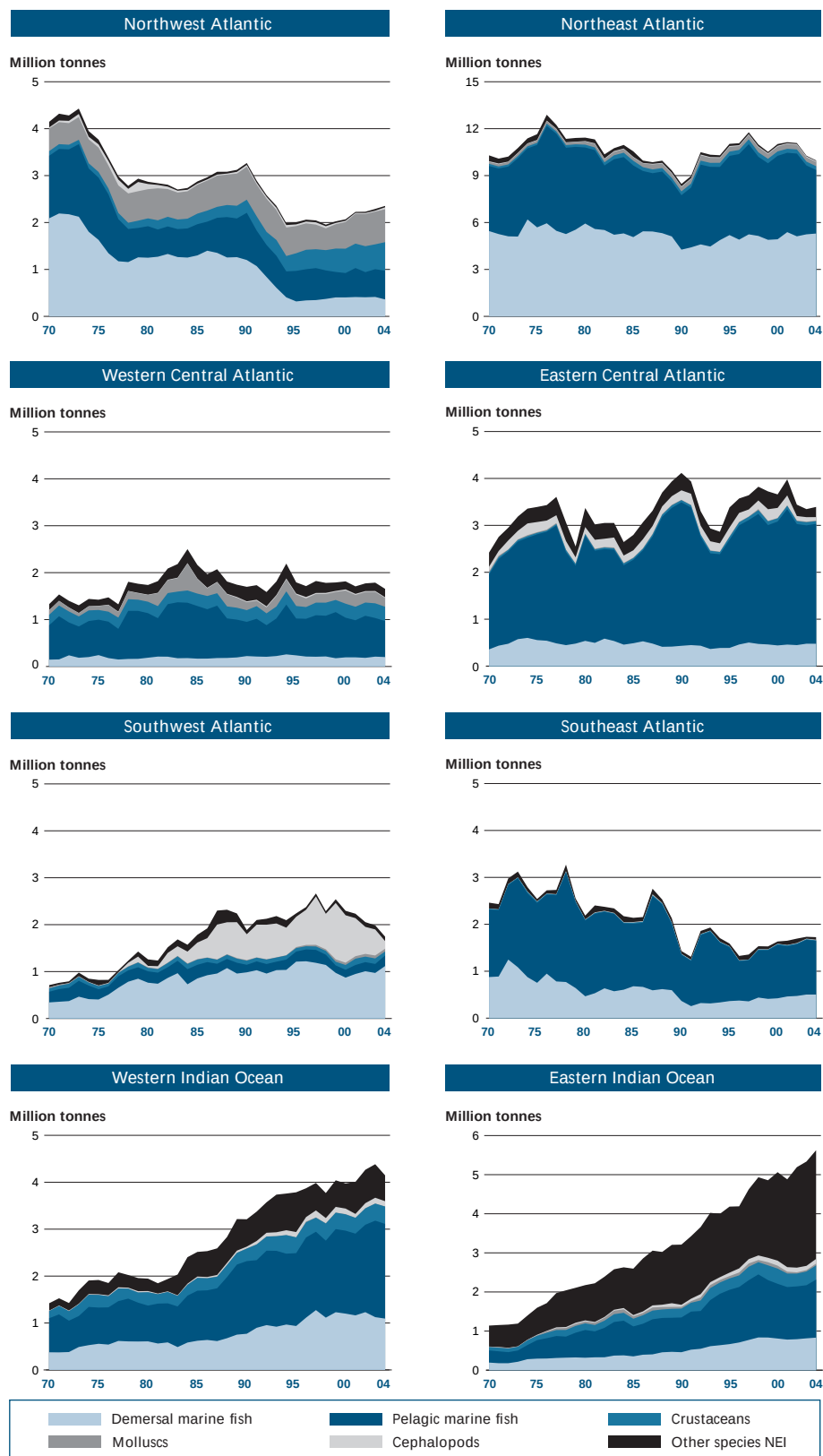
Since FAO started monitoring the global state of stocks in 1974, there has been a consistent downward trend from almost 40 percent in 1974 to 23 percent in 2005 in the proportions of underexploited and moderately exploited stocks, which are those offering some potential for expansion. At the same time, there has been an increasing trend in the proportion of overexploited and depleted stocks, from about 10 percent in the mid-1970s to around 25 percent in the early 1990s, where it has stabilized until the present, while the proportions of fully exploited stocks declined from slightly over 50 percent in 1974 to around 45 percent in the early 1990s, increasing to 52 percent in 2005 (Figure 19).

Most of the stocks of the top ten species, which account in total for about 30 percent of the world capture fisheries production in terms of quantity (Figure 6 on p. 11), are fully exploited or overexploited and therefore cannot be expected to produce major increases in catches. This is the case for the anchoveta (*Engraulis ringens*), with two main stocks in the Southeast Pacific that are fully exploited and overexploited; the Alaska pollock (*Theragra chalcogramma*), which is fully exploited in the North Pacific; the blue whiting (*Micromesistius poutassou*), which is overexploited in the Northeast Atlantic; the Atlantic herring (*Clupea harengus*), with several stocks



Figure 18

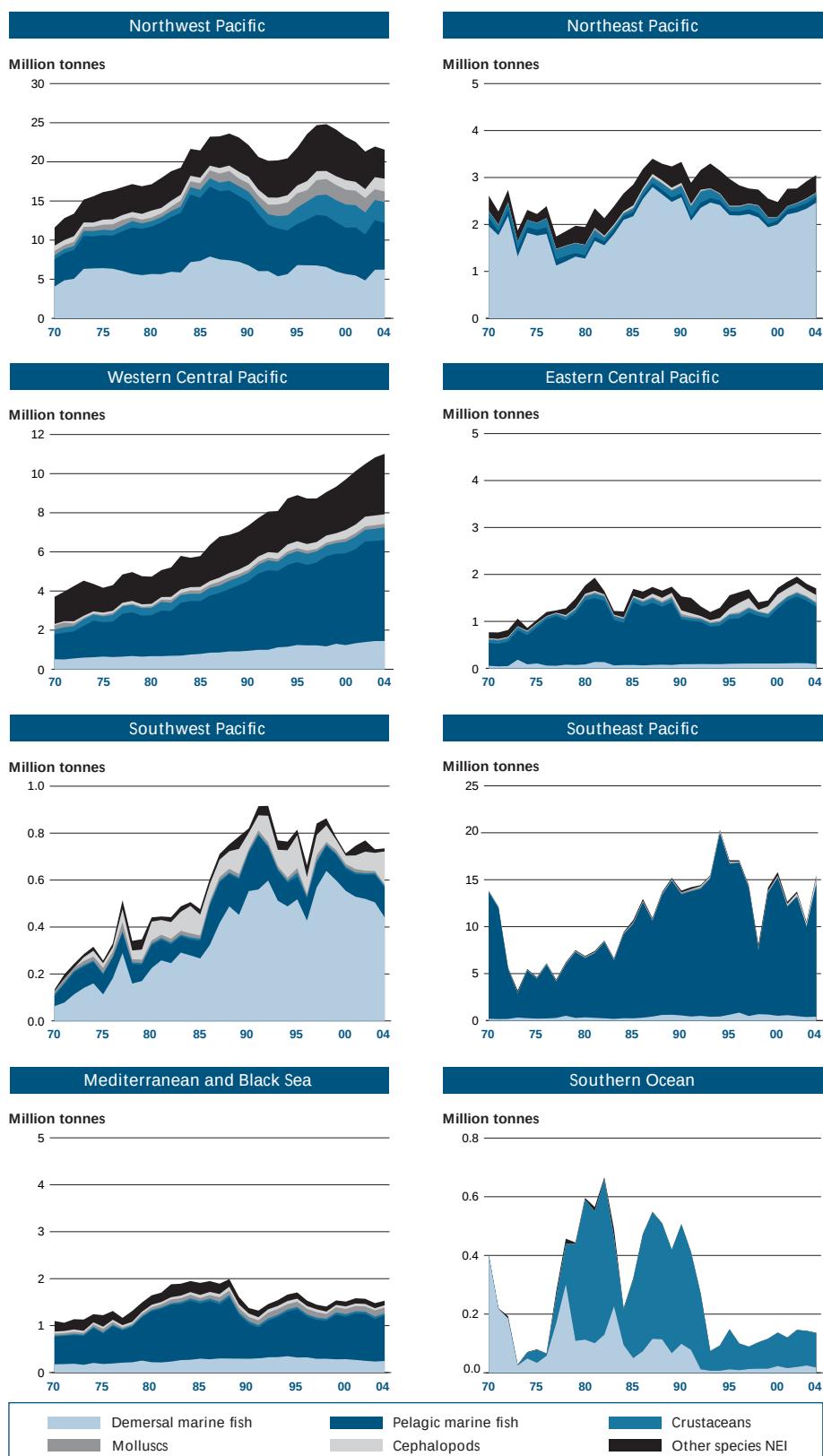
Capture fisheries production in marine areas



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Figure 18 (cont.)

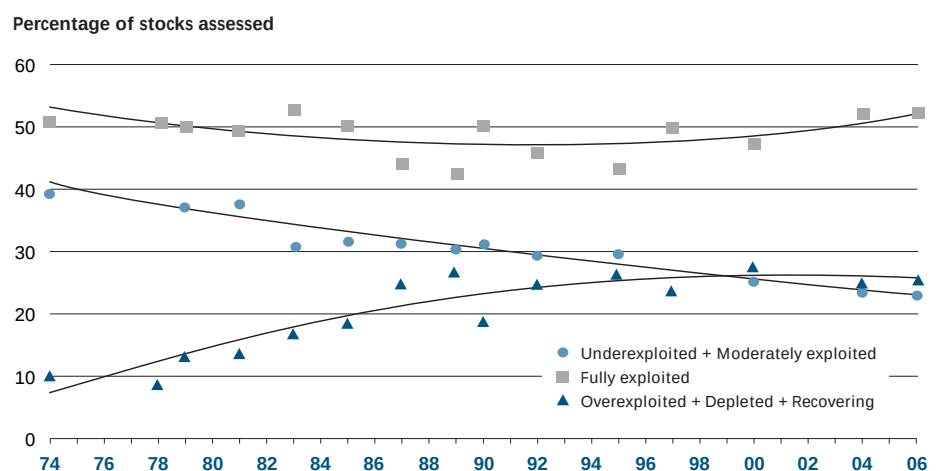
Capture fisheries production in marine areas



Notes: Data exclude aquatic plants and catches of marine mammals, sponges and corals, etc.
NEI = not elsewhere included.

Figure 19

Global trends in the state of world marine stocks since 1974



that are fully exploited and others that are recovering from depletion in the North Atlantic; the Japanese anchovy (*Engraulis japonicus*), which is fully exploited in the Northeast Pacific; the Chilean jack mackerel (*Trachurus murphyi*), which is fully exploited and overexploited in the Southeast Pacific; and the yellowfin tuna (*Thunnus albacares*), which is fully exploited in the Atlantic and Pacific Oceans and probably moderately to fully exploited in the Indian Ocean. Some stocks of skipjack tuna (*Katsuwonus pelamis*) are fully exploited while some are still reported as moderately exploited, particularly in the Pacific and Indian Oceans, where they offer some limited possibilities for further expansion of fisheries production. Some limited possibilities for expansion are also offered by a few stocks of chub mackerel (*Scomber japonicus*), which are moderately exploited in the Eastern Pacific while other stocks are already fully exploited. The largehead hairtail (*Trichiurus lepturus*) is considered fully overexploited in the main fishing area in the Northwest Pacific, but its state of exploitation is unknown elsewhere.

The percentage of stocks exploited at or beyond their maximum sustainable levels varies greatly by area. The major fishing areas with the highest proportions (69–77 percent) of fully exploited stocks are the Western Central Atlantic, the Eastern Central Atlantic, the Northwest Atlantic, the Western Indian Ocean and the Northwest Pacific, while the areas with the highest proportions (46–60 percent) of overexploited, depleted and recovering stocks are the Southeast Atlantic, the Southeast Pacific, the Northeast Atlantic and the high seas, particularly those in the Atlantic and Indian Oceans for tuna and tuna-like species. Few areas of the world report a relatively high number (48–70 percent) of still underexploited or moderately exploited stocks, as is the case for the Eastern Central Pacific, Western Central Pacific and Southwest Pacific, while 20–30 percent of stocks still considered moderately exploited or underexploited are reported for the Mediterranean and Black Sea, Southwest Atlantic and Eastern Indian Ocean.

Four FAO major fishing areas produce almost 68 percent of the world marine catches. The Northwest Pacific is the most productive, with a total catch of 21.6 million tonnes (25 percent of total marine catches) in 2004, followed by the Southeast Pacific, with a total catch of 15.4 million tonnes (18 percent of marine total), and the Western Central Pacific and Northeast Atlantic, with 11.0 and 9.9 million tonnes (13 and 12 percent, respectively), in the same year.

In the Northwest Pacific, large changes in the abundance of Japanese pilchard (or sardine), Japanese anchovy and Alaska pollock have occurred in response to heavy fishing and to natural decadal oscillations. After a period of high abundance in the 1980s, the Japanese pilchard declined followed by a strong recovery of the Japanese

anchovy population, which has been supporting catches of 1.8 to 2.0 million tonnes per year, with 1.8 million tonnes in 2004, while catches of Japanese pilchard remained low with only 230 000 tonnes in 2004 – a fraction of the annual yield of more than 5 million tonnes in the 1980s. This alternation of sardine (or pilchard) and anchovy stocks follows a pattern also observed in other regions that seem to be governed by climatic regimes affecting stock distribution and overall fish abundance. The stocks of Alaska pollock in the Northwest Pacific are fully exploited, as is the case in the Northeast Pacific.

In the Southeast Pacific, the anchoveta has fully recovered after the severe El Niño event of 1997–98 and produced a total catch of 10.7 million tonnes in 2004. Catches of Chilean jack mackerel totalled 1.8 million tonnes in the same year – about one-third of the historical peak production reached in 1995 – while the stock of South American pilchard remains very low, producing a small fraction of the record catches of the 1980s and early 1990s. The Chilean jack mackerel and, particularly, the South American pilchard are in a decadal cycle of natural low abundance and there are no signs of a reversal at present.

The Western Central Pacific is very varied in terms of species caught. The higher catches are produced by the skipjack tuna, which is considered fully exploited in the area. Various species of sardinellas are considered moderately or fully exploited, as are various species of scads and mackerels. Less is known about the miscellaneous coastal fishes being exploited in the area, although some ponyfishes, brems and catfishes are still moderately exploited, while others are reported as fully or overexploited.

In the Northeast Atlantic, catches of blue whiting continue to increase steeply and the species is considered overexploited. Most stocks of Atlantic cod in the area are also overexploited or depleted, while capelin and herring are exploited to their full potential. The Atlantic horse mackerel and the Atlantic mackerel are also fully exploited.

Overall, more than 75 percent of world fish stocks for which assessment information is available are reported as already fully exploited or overexploited (or depleted and recovering from depletion), reinforcing earlier observations that the maximum wild capture fisheries potential from the world's oceans has probably been reached and calls for a more cautious and closely controlled development and management of world fisheries. While this observation applies generally to all fisheries, the situation seems more critical for some highly migratory, straddling and other fishery resources that are exploited solely or partially in the high seas. A recent FAO review of the world's highly migratory, straddling and other high seas fishery resources notes that while the state of exploitation of highly migratory tunas and tuna-like species is similar to that of all fish stocks tracked by FAO, the state of highly migratory oceanic sharks seems to be more problematic, with more than half of the stocks for which information is available being listed as overexploited or depleted.¹¹ Evidence seems to suggest that the state of straddling stocks and of other high seas fishery resources is even more problematic than for highly migratory species, with nearly two-thirds of the stocks for which the state of exploitation can be determined being classified as overexploited or depleted. Although these high seas fishery resources represent only a small fraction of the world fishery resources upon which millions of people are critically dependent for their food and livelihood, these correspond to fish stocks that are key indicators of the state of an overwhelming part of the ocean ecosystem, which appears to be more overexploited than the EEZs. The UN Fish Stock Agreement that entered into force in 2001 is leading to the implementation of measures that are expected to be beneficial in the medium to long term to species fished on the high seas.¹²

Inland fisheries

The nature of many inland fisheries makes assessment of their status extremely difficult. Inland fisheries often use multiple fishing gear to harvest a complex array of species for which catch rates are strongly influenced by seasonality. Catches are frequently not recorded by species or not recorded at all. Additionally, inland fisheries are often practised in remote areas by the poorer sectors of society. These factors make collecting accurate information on inland fisheries extremely costly for public administrations and many do not collect such information or make assessments of the



status of inland fishery resources. To determine the status of marine fishery resources, FAO relies on a network of fishery scientists, the use of expert knowledge and catch and other statistics. No such network exists for inland fisheries and the catch statistics are generally inadequate for use as a measure of stock status. FAO is not therefore in a position to make accurate global statements on the status of inland fishery resources.

Nevertheless, fishery scientists have undertaken some partial assessments. A recent review pointed to the overfished state of many inland fisheries.¹³ It identified two types of overfishing: intensive targeting of individual species and assemblage or ecosystem overfishing.

Targeted fishing for large freshwater fish species in several major river systems in Africa, Asia, Australia, Europe, the Near East, North America and South America has led to a decline in fish abundance. Of the fish targeted in these fisheries, 10 out of 21 species were assessed as being vulnerable or in danger of extinction; for the remaining 11 species the available data were insufficient to assess their status or no assessment was undertaken.

Assemblage overfishing is most common in tropical areas with high species diversity and where local communities depend on a diverse inland fish harvest. This situation prevails in Tonle Sap, a major component of the Mekong River Basin. It was stated in *The State of World Fisheries and Aquaculture 2004* that this basin showed signs of overfishing, yet in 2005 catches from the Tonle Sap were reported as being the largest since records began. However, fishery scientists have pointed out that in that year signs of overfishing were apparent in that the catch consisted mostly of small fish. In addition, catches are reported to have been even higher in past, before official records were kept.

Efforts are under way in many areas to improve the status of selected inland fishery resources through restocking programmes, habitat rehabilitation and improved fishery management. While habitat rehabilitation is a widespread activity in many developed countries, it is not common in developing countries and its efficacy in improving fish stocks has not been evaluated in most cases (see pp. 107–112). Also, the management of rice-based ecosystems for biodiversity, together with the use of alien species and stocking of inland water bodies, continues to improve the fishery resources of many areas, primarily in Asia.¹⁴

Globally, inland fishery resources appear to be continuing to decline as a result of habitat degradation and overfishing. This trend – which is in large part a result of the growing quantities of freshwater being used for hydropower generation and agriculture – is unlikely to be reversed as long as countries do not see inland fisheries as a growth sector. And they are not likely to want to reconsider this viewpoint until they have accurate information on these fisheries and their value to society now and in the future.

FISH UTILIZATION

In 2004, about 75 percent (105.6 million tonnes) of estimated world fish production was used for direct human consumption (see Table 1 on p. 3). The remaining 25 percent (34.8 million tonnes) was destined for non-food products, in particular the manufacture of fishmeal and oil. If China is excluded, the quantities were 68.9 million tonnes and 24.0 million tonnes, respectively (see Table 2 and Figure 2 on pp. 4 and 5). More than 77 percent (37 million tonnes) of China's reported fish production (47.5 million tonnes) was apparently used for direct human consumption, the bulk of which in fresh form. The remaining amount (an estimated 10.8 million tonnes) was reduced to fishmeal and other non-food uses, including direct feed for aquaculture.

In 2004, 61 percent (86 million tonnes) of the world's fish production underwent some form of processing. Fifty-nine percent (51 million tonnes) of this processed fish was used for manufacturing products for direct human consumption in frozen, cured and canned form and the rest for non-food uses. The many options for processing fish allow for a wide range of tastes and presentations, making fish one of the most versatile food commodities. Yet, unlike many other food products, processing does not necessarily increase the price of the final product and fresh fish is often the most highly priced product form. During the 1990s, the proportion of fish marketed in live/

fresh form worldwide increased compared with other products (Figure 20). Live/fresh fish quantities rose from an estimated 35 million tonnes in 1994 to 55 million tonnes in 2004, representing an increase in its share of total production from 31 percent to 39 percent. Freezing is the main method of processing fish for food use, accounting for 53 percent of total processed fish for human consumption in 2004, followed by canning (24 percent) and curing (23 percent). In developed countries (Figure 21), the proportion of fish that is frozen has been constantly increasing, and in 2004 accounted for 40 percent of total production. In comparison, the share of frozen products was 13 percent of total production in developing countries, where fish is largely marketed in live/fresh/chilled form.

Utilization of fish production shows marked continental, regional and national differences. The proportion of cured fish is higher in Africa (17 percent in 2004) and Asia (11 percent) compared with other continents. In 2004, in Europe and North America, more than two-thirds of fish used for human consumption was in frozen and canned forms. In Africa and Asia, the share of fish marketed in live or fresh forms was

Figure 20

Utilization of world fisheries production (breakdown by quantity), 1964–2004

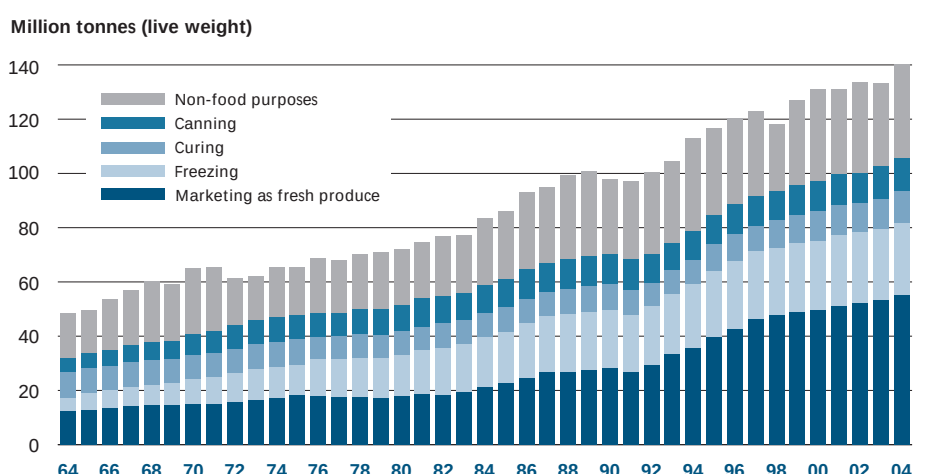
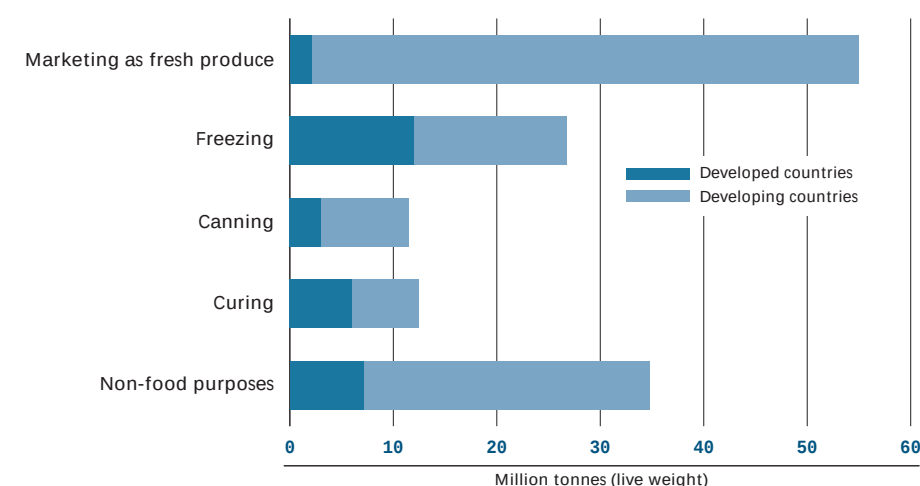


Figure 21

Utilization of world fisheries production (breakdown by quantity), 2004



particularly high. Unfortunately, it is not possible to determine the exact amount of fish marketed in live form from available statistics. The sale of live fish to consumers and restaurants is especially strong in Southeast Asia and the Far East.

In 2004, the bulk of the fishery products used for non-food purposes came from natural stocks of small pelagics. Most of these fishery products were used as raw material for the production of animal feed and other products. Ninety percent of world fish production (excluding China) destined for non-food purposes was reduced to fishmeal/oil; the remaining 10 percent was largely utilized as direct feed in aquaculture and for fur animals. The quantities of fish used as raw material for fishmeal in 2004 reached about 25.5 million tonnes, representing a 17 percent increase compared with 2003, but was still well below peak levels of more than 30 million tonnes recorded in 1994.

CONSUMPTION¹⁵

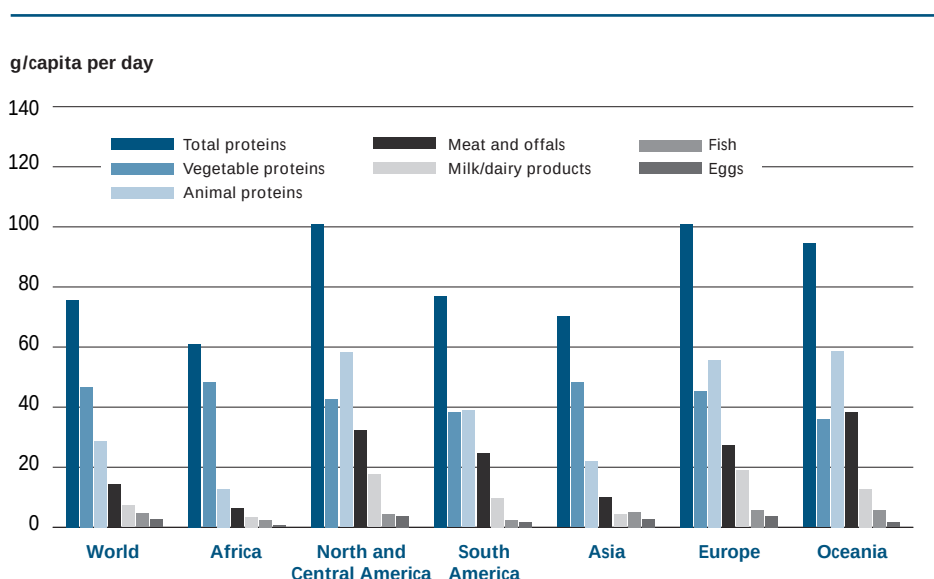
Global per capita fish¹⁶ consumption has increased over the past four decades, rising from 9.0 kg in 1961 to an estimated 16.5 kg in 2003. China has been responsible for most of this increase: its estimated share of world fish production grew from 21 percent in 1994 to 34 percent in 2003, when its per capita fish supply stood at around 25.8 kg. If China is excluded, the per capita fish supply is about 14.2 kg, almost the same as during the mid-1980s. During the 1990s, world per capita fish supply, excluding China, was relatively stable at 13.2–13.8 kg. This can mainly be attributed to a higher population growth than that of food fish supply during the 1990s (1.6 percent per annum compared with 1.1 percent, respectively). Since the early 2000s, there has been an inversion of this trend, with higher food fish supply growth than that of population (2.4 percent per annum compared with 1.1 percent). Preliminary estimates for 2004 indicate a slight increase of global per capita fish supply, to about 16.6 kg.

Global per capita food consumption has also been improving in recent decades. Nutritional standards have shown positive long-term trends with worldwide increases in the average global calorie supply per person (a rise of 16 percent since 1969–71 to reach 2 795 kcal/person/day in 2000–02, with the developing country average expanding by more than 25 percent) and in the quantity of proteins per person (from 65.1 g in 1970 to 76.3 g in 2003). Yet distributional disparities continue to exist. In 2001–03, according to FAO estimates, 856 million people in the world were undernourished, 61 percent of whom were living in Asia and the Pacific and 820 million in the developing countries overall. The highest prevalence of undernourishment is found in sub-Saharan Africa, where 32 percent of the population were undernourished, while an estimated 16 percent of the population were estimated to be undernourished in Asia and the Pacific.

Fish is highly nutritious, rich in micronutrients, minerals, essential fatty acids and proteins, and represents a valuable supplement to diets otherwise lacking essential vitamins and minerals. In many countries, especially developing countries, the average per capita fish consumption may be low, but, even in small quantities, fish can have a significant positive impact on improving the quality of dietary protein by complementing the essential amino acids that are often present only in low quantities in vegetable-based diets. It is estimated that fish contributes up to 180 kilocalories per person per day, but reaches such high levels only in a few countries where there is a lack of alternative foods, and where a preference for fish has been developed and maintained (for example in Iceland, Japan and some small island developing states). Generally, on average, fish provides about 20–30 kilocalories per person per day. The dietary contribution of fish is more significant in terms of fish proteins, which are a crucial component in some densely populated countries where total protein intake levels may be low. For instance, fish contributes to, or exceeds, 50 percent of total animal protein intake in some small island developing states, as well as in Bangladesh, Equatorial Guinea, the Gambia, Guinea, Indonesia, Myanmar, Senegal, Sierra Leone and Sri Lanka. Globally, fish provides more than 2.8 billion people with almost 20 percent of their average per capita intake of animal protein. The contribution of fish proteins to total world animal protein supplies rose from 13.7 percent in 1961 to a peak of 16.0 percent in 1996, before declining somewhat to 15.5 percent

Figure 22

Total protein supply by continent and major food group (2001–03 average)



in 2003. Corresponding figures for the world, excluding China, show an increase from 12.9 percent in 1961 to 15.4 percent in 1989, slightly declining since then to 14.6 percent in 2003. Figure 22 presents the contributions of major food groups to total protein supplies.

In industrialized countries (Table 10), apparent fish consumption grew from 13 million tonnes (live weight equivalent) in 1961 to 27 million tonnes in 2003, with an increase in annual per capita consumption¹⁷ from 20.0 kg to 29.7 kg during the same period. The contribution of fish to total protein intake rose remarkably during the period 1961–89 (between 6.5 percent and 8.5 percent), before gradually declining owing to the increase in consumption of other animal proteins; by 2003, its share (7.8 percent) was back at the levels prevailing in the mid-1980s. Since the early 1990s, the consumption of fish protein has remained relatively stable at around 8.2–8.6 g per capita per day, while the intake of other animal proteins has continued to grow.

Table 10

Total and per capita food fish supply by continent and economic grouping in 2003

	Total food supply (Million tonnes live weight equivalent)	Per capita food supply (kg/year)
World	104.1	16.5
World excluding China	71.1	14.2
Africa	7.0	8.2
North and Central America	9.4	18.6
South America	3.1	8.7
China	33.1	25.8
Asia (excluding China)	36.3	14.3
Europe	14.5	19.9
Oceania	0.8	23.5
Industrialized countries	27.4	29.7
Economies in transition	4.3	10.6
LIFDCs (excluding China)	23.8	8.7
Developing countries excluding LIFDCs	15.8	15.5

Until the mid-1980s, the average per capita apparent fish supply in LIFDCs was one-quarter of the estimated supply in industrialized countries. The gap has been reduced progressively, with stronger growth since the mid-1990s (+2.1 average annual percentage growth during 1995–2003). In 2003, at 14.1 kg it stood at about a half of that of industrialized countries (29.7 kg) and 60 percent of the per capita fish supply of developed countries (23.9 kg). However, if China is excluded, per capita supply in the other LIFDCs is still relatively low, at an estimated 8.7 kg in 2003, with a growth rate of 1.3 percent per year since 1993. Notwithstanding the relatively low fish consumption by weight in LIFDCs (excluding China), the contribution of fish to total animal protein intake in 2003 was significant at about 20 percent, and may be higher than indicated by official statistics in view of the unrecorded contribution of subsistence fisheries. Yet, since 1975, when it peaked at 24.1 percent, this share has slightly declined notwithstanding the continued growth of fish protein consumption (from 2.2 g to 2.7 g during 1975–2003). This is because of the increase in the consumption of other animal proteins.

Fish consumption is distributed unevenly around the globe, with marked continental, regional and national differences as well as income-related variations (Figures 23 and 24). Per capita apparent fish consumption can vary from less than 1 kg per capita to more than 100 kg. Geographical differences are also evident within countries, with consumption usually being higher in coastal areas. For example, 104 million tonnes were available globally for consumption in 2003, but only 7.0 million tonnes were consumed in Africa (8.2 kg per capita); two-thirds of the total were consumed in Asia, of which 36.3 million tonnes were consumed outside China (14.3 kg per capita) and 33.1 million tonnes in China alone (25.8 kg per capita). Per capita consumption in Oceania was 23.5 kg, in North America 23.8 kg, in Europe 19.9 kg, in Central America and the Caribbean 9.4 kg and in South America 8.7 kg.

During the past few years, major increases in the quantity of fish consumed originated from aquaculture, which in 2004 was estimated to have contributed 43 percent of the total amount of fish available for human consumption. Aquaculture production has pushed the demand and consumption for several high-value species such as shrimps, salmon and bivalves. Since the mid-1980s, these species have shifted from being primarily wild-caught to being primarily aquaculture-produced, with a decrease in their prices and a strong increase in their commercialization. Aquaculture has also had a major role in terms of food security in several developing countries, particularly in Asia, for the significant production of some low-value freshwater species, which are mainly destined for domestic consumption. For the world excluding China, the average contribution of aquaculture to per capita supply grew from 13.7 percent in 1994 to an estimated 21.4 percent in 2004, corresponding to an increase from 1.8 kg per capita in 1994 to 2.9 kg per capita in 2004 (an average annual growth of 4.9 percent). Corresponding figures for China indicate an increase from 61.6 percent in 1994 to 83.4 percent in 2004. During the past decade, the per capita supply from aquaculture in China is reported to have increased from 10.9 kg in 1994 to 23.7 kg in 2004, implying an annual average growth of 8.1 percent (Figure 25).

Differences in consumption patterns by species are marked. Demersal fish are preferred in northern Europe and North America, whereas cephalopods are mainly consumed in several Mediterranean and Asian countries. The consumption of crustaceans, being high-priced commodities, is mostly concentrated in affluent economies. Of the 16.5 kg of fish per capita available for consumption in 2003, around 75 percent were finfish. Shellfish supplied 25 percent – or about 4.2 kg per capita, subdivided into 1.5 kg of crustaceans, 0.6 kg of cephalopods and 2.1 kg of other molluscs. Freshwater and diadromous species accounted for 30 million tonnes of the total supply (about 4.8 kg per capita). Marine finfish species provided more than 46 million tonnes, of which 18.4 million tonnes were demersal species, 19.8 million tonnes pelagics and 8.4 million tonnes unidentified marine fish. The remaining share of the total food supply consisted of shellfish, of which 9.4 million tonnes were crustaceans, 3.6 million tonnes cephalopods and 13.4 million tonnes other molluscs. Historically, there have been no dramatic changes in the share of most of the broader

Figure 23

Fish as food: per capita supply (average 2001–2003)

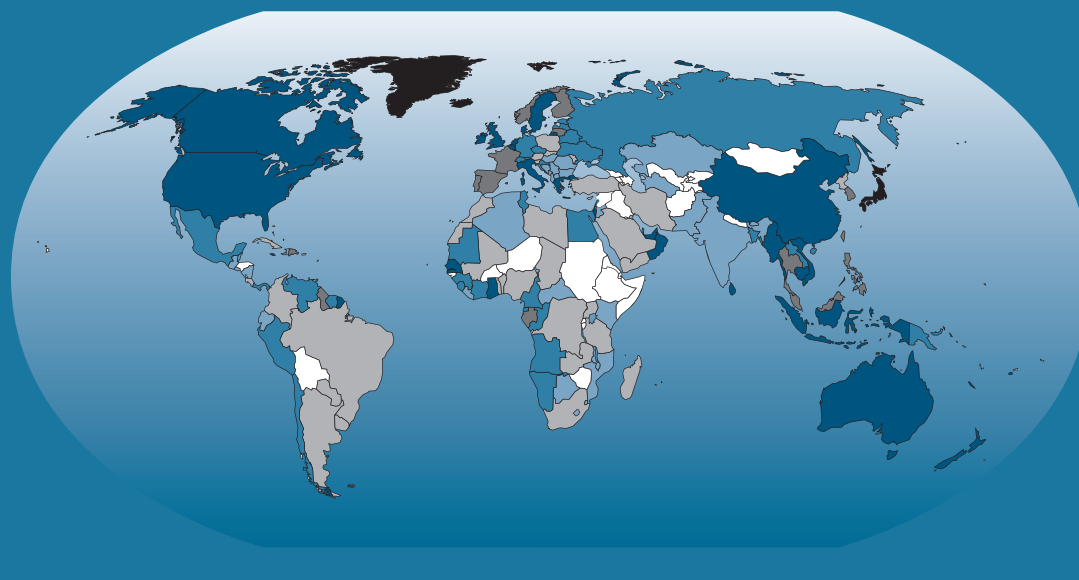
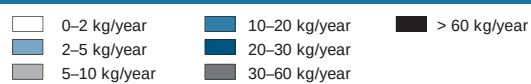
Average per capita fish supply
(in live weight equivalent)

Figure 24

Contribution of fish to animal protein supply (average 2001–2003)

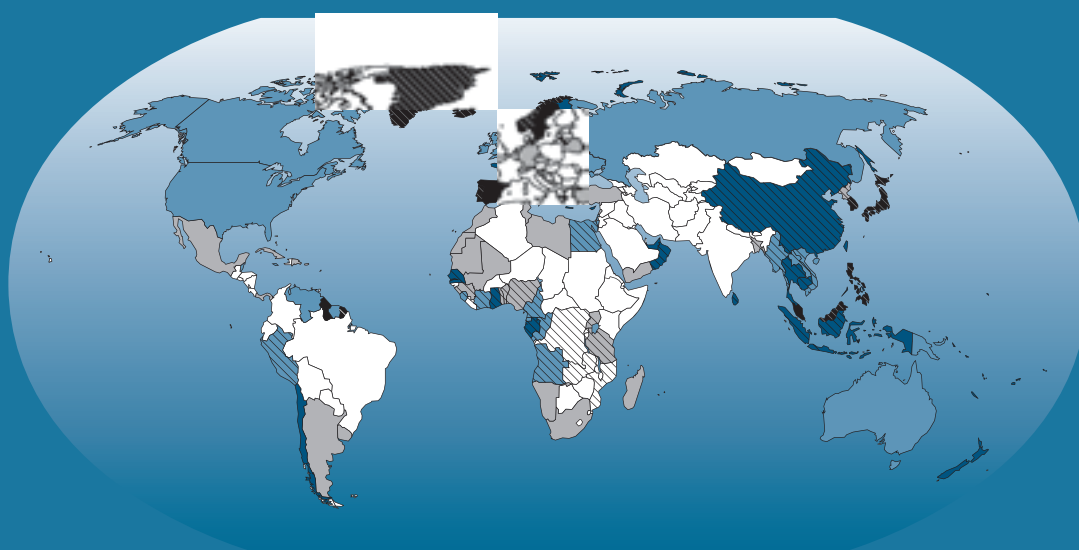
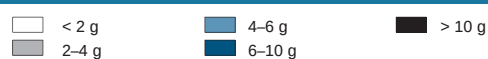
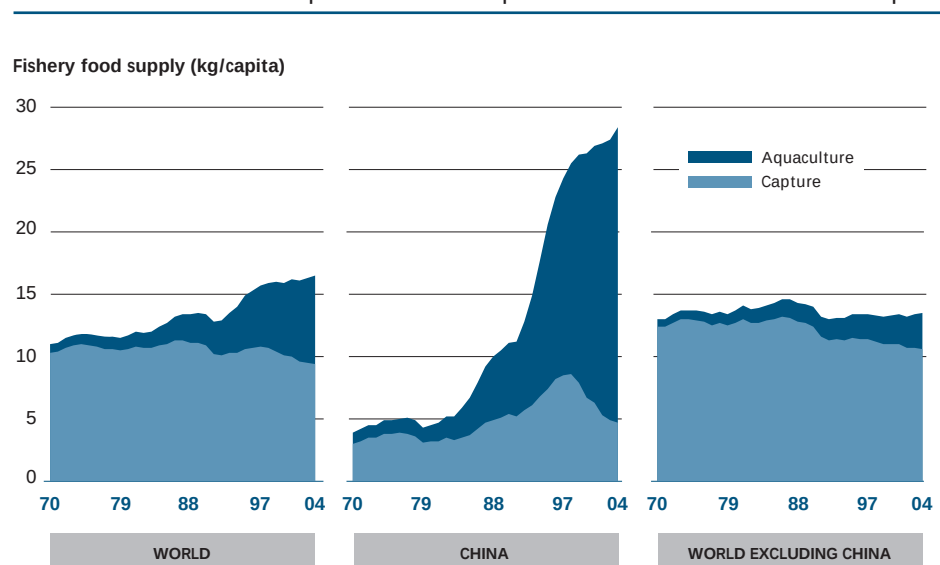
Fish proteins
(per capita per day)Contribution of fish
to animal protein supply

Figure 25

Relative contribution of aquaculture and capture fisheries to food fish consumption



groups in average world consumption; demersal and pelagic fish species have stabilized at around 3.0 kg per capita. Crustaceans and molluscs are exceptions in that they showed a considerable increase between 1961 and 2003. The per capita availability of crustaceans increased more than threefold, from 0.4 kg to 1.5 kg (mainly as a result of the increased production of shrimps and prawns from aquaculture), and the availability of molluscs (excluding cephalopods) increased from 0.6 kg to 2.1 kg per capita.

In recent years, both fish consumption and overall food consumption have been influenced by complex interactions involving several demographic and economic transformations such as population growth; rising incomes and economic growth; rapid urbanization; increased female participation in the workforce; increased international trade; international agreements on trade, rules, tariffs and quality standards; and improvements in transportation, marketing, and food science and technology. All these factors, together with developments in production, processing and prices of commodities, have had a remarkable impact on dietary habits, particularly in developing countries. During recent decades, the increased food consumption of developing countries has been characterized by a shift towards more proteins and vegetables in the diet, with a reduction of the share of basic cereals. For instance, the per capita consumption of meat has increased from 15.1 kg in 1983 to 28.9 kg in 2003, consumption of fish has grown from 7.7 kg to 14.6 kg and that of vegetables from 56.1 kg to 118.7 kg in the same period. These changes in dietary habits have been particularly driven by the impact of rapid urbanization (which increased from a share of 26 percent of total population in 1975 to 43 percent in 2005) combined with the transformations in food distribution. Several developing countries, especially in Asia and Latin America, have experienced a rapid expansion of supermarkets, which are not only targeting higher-income consumers but also lower- and middle-income consumers. Supermarkets are thus emerging as a major force in developing countries, offering consumers a wider choice, reduced seasonality and lower prices of food products – and often safer food.

Dietary habits are also changing in developed countries, where incomes are generally high and basic dietary needs have long been more than satisfied, leading consumers to look for more variety in their diets. Simultaneously, the average consumer is becoming increasingly health- and diet-conscious and usually sees fish as having a positive impact on health. Markets have become more flexible and new products and species have found market niches. The trend, for fish as well as for other food products,

is to provide greater value addition in the catering and retail markets, thus making the products easier for consumers to prepare. Alongside traditional preparations, developments in food science and technology, combined with improved refrigeration and the use of microwave ovens, are making convenience foods, ready-to-cook or ready-to-eat products, coated products and other value-added items a fast-growing industry. The reasons for this rapid expansion include changes in social factors such as the increasing number of women in the workforce and the fragmentation of meals in households as well as the general decrease in average family size and the increase in single-person households. The need for simple meals that are ready to eat and easy to cook has thus become more important. Another trend is the increasing importance of fresh fish. Unlike many other food products, fish is still more favourably received on the market when it is fresh rather than processed. However, historically, fresh fish has been of little importance in international trade owing to its perishable nature and limited shelf-life. Improvements in packaging, reduced air freight prices and more efficient and reliable transport have created additional sales outlets for fresh fish. Food chains and department stores are also taking an increasing share of the fresh seafood sector, and many now provide fresh seafood counters with an extensive variety of fish and freshly prepared fish dishes or salads next to their frozen food counters.

The above-mentioned trends are expected to continue for the foreseeable future. The United Nations Population Division estimates that the world population growth rate will slow, but owing to higher fertility rates, the share of developing countries in the total population will rise to about 83 percent in 2030 (79 percent in 2005). The rapid increase in urbanization is also forecast to continue, from about 3.2 billion people in 2005 to an estimated 4.9 billion in 2030, with most of the growth coming from developing countries (from 1.9 billion to about 3.8 billion). In 2030, 57 percent of the population in developing countries is forecast to be urban, compared with 43 percent in 2005. Population and income growth, together with urbanization and dietary diversification, are expected to create additional demand and to continue to shift the composition of food consumption towards a growing share of animal products in developing countries. In industrialized countries, food demand is expected to grow only moderately and, in determining demand for food products, issues such as safety, quality, environmental concerns and animal welfare will probably be more important than price and income changes. At the global level, animal disease outbreaks could represent an important source of uncertainty. For example, during the past few years, and particularly in 2004 and 2005, the international market for meats was disrupted by outbreaks of animal diseases such as avian influenza and bovine spongiform encephalopathy (BSE). This situation, together with the related import bans, led to an induced shortage in meat supplies in some countries, particularly of poultry, pushing up international meat prices in 2004 and 2005 (+30 percent for poultry in 2004–05) and driving consumers towards alternative protein sources, including fish.

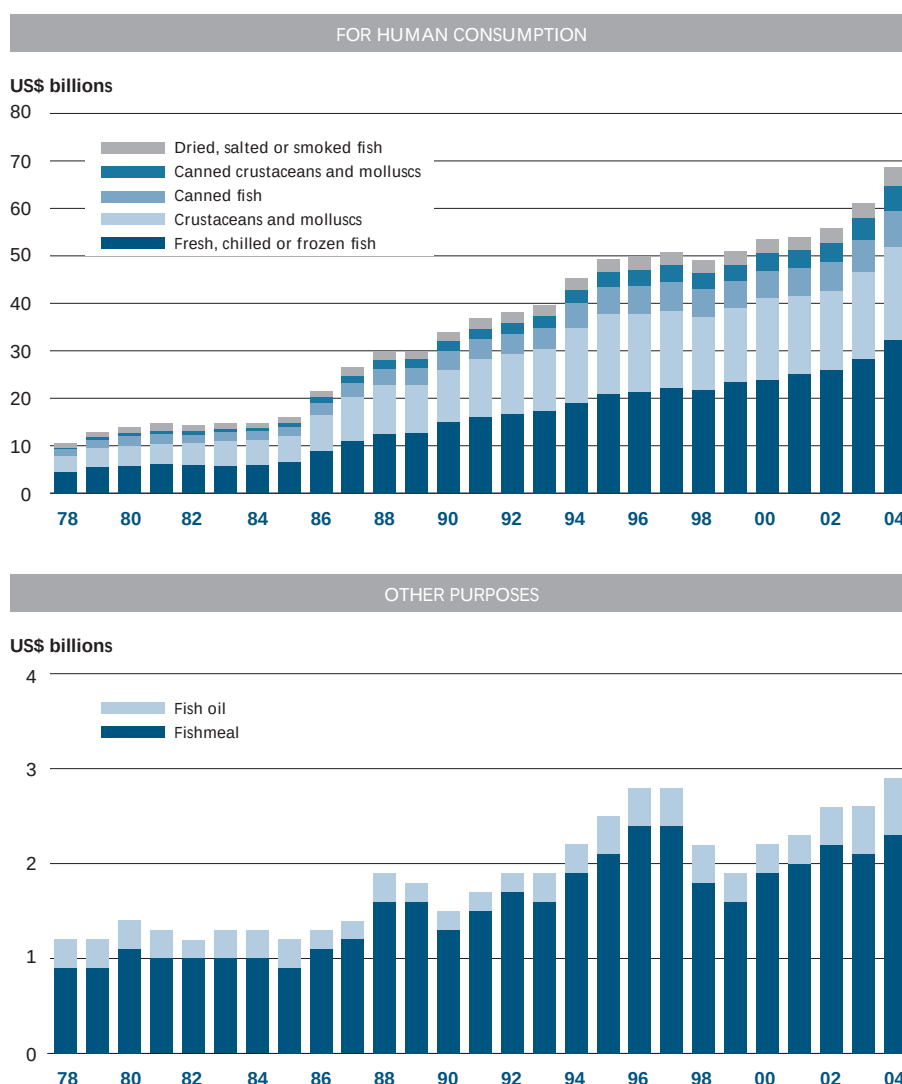
TRADE

In 2004, total world trade of fish and fishery products reached a record value of US\$71.5 billion (export value), representing a 23 percent growth relative to 2000 and a 51 percent increase since 1994 (Figure 26). Preliminary estimates for 2005 indicate a further increase in the value of fishery exports. In real terms (adjusted for inflation), exports of fish and fishery products increased by 17.3 percent during the period 2000–04, 18.2 percent during 1994–2004 and 143.9 percent between 1984 and 2004. In terms of quantity, exports were reported to have peaked at 53 million tonnes (live weight equivalent) in 2004, with a growth of 13 percent since 1994 and of 114 percent since 1984. The quantity of fish traded remained stagnant during the period 2000–03 following several decades of strong increases. The record reached in 2004 by fishery exports coincided with an impressive rise in global trade, despite sharp increases in oil prices and natural disasters. This global growth also continued in 2005. In 2004, prices of several agricultural commodities (particularly of basic foods) also rebounded after a prolonged period of decline. A series of long- and short-term factors contributed



Figure 26

World fishery exports by major commodity groups



to this growth as demand shifted for some commodities in response to market transformations caused by changes in technology, consumer preferences, market structures and policies. One such important factor was the influence exerted by price movements and exchange rates on trade flows, in particular the weaker US dollar, which is also used to denominate many commodity prices, and the marked appreciation of several currencies (especially European currencies) against the dollar.

The share of fishery trade in total merchandise trade is limited; it has been relatively stable at about 1 percent since 1976, with a downward trend through the late 1990s and early 2000s (0.8 percent in 2004). The proportion of fishery exports in total agricultural (including forestry products) exports expanded from 1976 (4.5 percent) onwards and reached a record value of 9.4 percent in 2001. It has since declined, reaching 8.4 percent in 2004. For developed countries, the share of fishery exports in total merchandise exports was about 0.6–0.8 percent during the period 1976–2004. The proportion of fishery exports in total agricultural trade (including forestry products) increased in the late 1970s from 4.1 percent to reach 6.5 percent in the period 1998–2002. In 2004 it declined to 6 percent as a result of the strong increases in exports of agricultural (33 percent) and forestry (37 percent) products compared with 2003. For developing countries, the part of fishery exports in total merchandise exports

expanded in the late 1970s until the late 1980s (2.3 percent in 1988), before slowing down to only 1.2 percent in 2004. The share of fishery exports in total agricultural trade (including forestry products) increased from 5 percent in 1976 to 16 percent in 2002 and then declined slightly to 14 percent in 2004, because of the recent upturn in agricultural and forestry exports (+36 percent and 30 percent, respectively, in the period 2002–04).

Table 11 shows the top ten exporters and importers of fish and fishery products in 1994 and 2004. In 2004, China was the world's major exporter of fish and fishery products, with exports valued at US\$6.6 billion. Despite this, fishery exports represented just 1.1 percent of its total merchandise exports and 29 percent of its agricultural exports (excluding forestry products). China has increased its fishery exports remarkably since the early 1990s. This growth is linked to its growing production, as well as to the expansion of its fish-processing industry, reflecting competitive labour and production costs. In addition to exports from domestic fisheries production, China also exports reprocessed imported raw material, creating a strong value addition in the process. Imports of fish and fishery products to China have also risen over the past decade, from US\$0.2 billion in 1990 to US\$3.1 billion in 2004. This growth has been particularly noticeable in the past few years, since the country's accession to the WTO in late 2001, when it had to lower its import duties, which decreased from an average import tariff as high as 15.3 percent in 2001 to 10.4 percent in 2004.

Table 11
Top ten exporters and importers of fish and fishery products

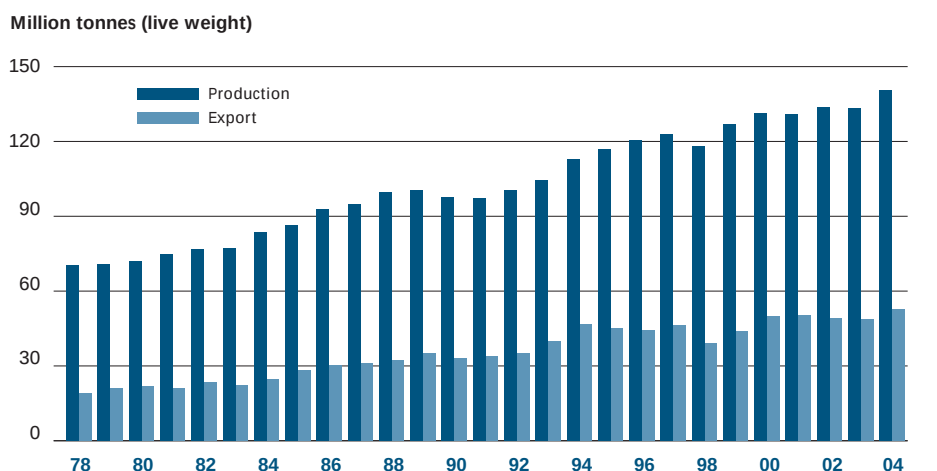
	1994	2004	APR
	(US\$ millions)		(Percentage)
Exporters			
China	2 320	6 637	11.1
Norway	2 718	4 132	4.3
Thailand	4 190	4 034	-0.4
United States of America	3 230	3 851	1.8
Denmark	2 359	3 566	4.2
Canada	2 182	3 487	4.8
Spain	1 021	2 565	9.6
Chile	1 304	2 484	6.7
Netherlands	1 346	2 452	5.5
Viet Nam	484	2 403	17.4
TOP TEN SUBTOTAL	21 243	35 611	5.3
REST OF THE WORLD TOTAL	26 267	35 897	3.2
WORLD TOTAL	47 511	71 508	4.2
Importers			
Japan	16 140	14 560	-1.0
United States of America	7 043	11 967	5.4
Spain	2 639	5 222	7.1
France	2 797	4 176	4.1
Italy	2 257	3 904	5.6
China	856	3 126	13.8
United Kingdom	1 880	2 812	4.1
Germany	2 316	2 805	1.9
Denmark	1 415	2 286	4.9
Republic of Korea	718	2 233	12.0
TOP TEN SUBTOTAL	38 063	53 090	3.4
REST OF THE WORLD TOTAL	13 104	22 202	5.4
WORLD TOTAL	51 167	75 293	3.9

Note: APR refers to the average annual percentage growth rate for 1994–2004.



Figure 27

Share of world fisheries production destined for exports



World fish imports rose by 25.4 percent in the period 2000–04, reaching a new record of more than US\$75 billion in 2004. Preliminary data suggest that in 2005 major importing markets further increased their imports of fish and fishery products.

Fish is traded widely and, in 2004, a large share of fish production entered international marketing channels, with about 38 percent (live weight equivalent) exported as various food and feed products (Figure 27). Developed countries exported some 23 million tonnes of fish (in live weight equivalent) in 2004. Although a part of this trade may be re-exports, this amount corresponds to about 75 percent of their production. Exports from developing countries (30 million tonnes in live weight) totalled around one-quarter of their combined production. The share of developing countries in total fishery exports was 48 percent by value and 57 percent by quantity. A significant share of these exports consisted of fishmeal. In 2004, developing countries contributed about 68 percent, by quantity, of world non-food fishery exports. Developing countries have also significantly increased their share in the quantity of fish exports destined for human consumption, from 43 percent in 1992 to 51 percent in 2004.

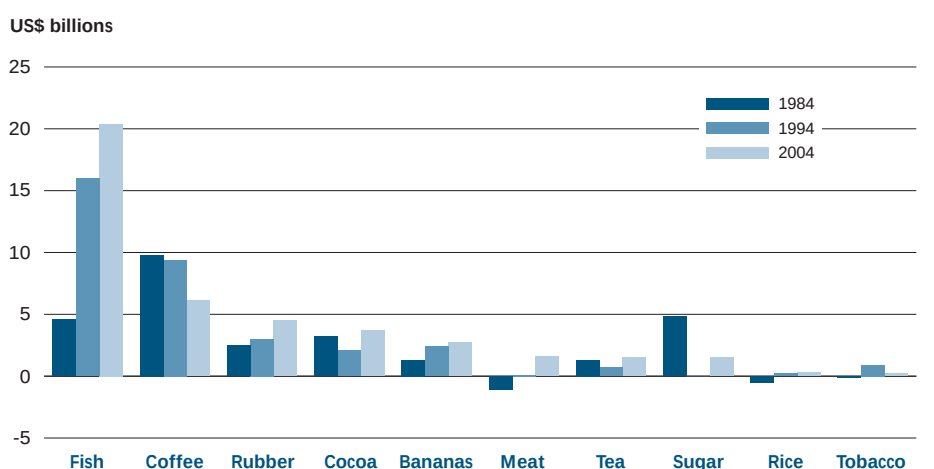
The role of fishery trade varies among countries and is important for many economies, particularly for developing nations. Trade in fish represents a significant source of foreign currency earnings, in addition to the sector's important role in employment, income generation and food security. In a few cases, fishery exports are crucial for the economy. For example, in 2004 they accounted for around one-half of the total value of merchandise exports for Iceland, Kiribati, Maldives, the Federal States of Micronesia, Panama and Saint Pierre and Miquelon.

The past four decades have also seen major changes in geographical patterns of fishery trade. The share of fishery exports of developing countries in global fishery exports increased from close to 37 percent in 1976 to 51 percent in 2000–01, before declining to around 48 percent in 2004. Asian countries accounted for most of this growth; their share in total fishery exports increased from slightly more than 20 percent in 1976 to 32 percent in 2004 and their fishery exports represented 66 percent of the value of the exports from developing countries.

The fishery net exports of developing countries (i.e. the total value of their exports less the total value of their imports) showed a continuing rising trend in recent decades, growing from US\$4.6 billion in 1984 to US\$16.0 billion in 1994 and to US\$20.4 billion in 2004 (Figure 28). These figures are significantly higher than those for other agricultural commodities, such as rice, coffee and tea. The LIFDCs play an active and growing role in the trade of fish and fishery products. In 1976, their exports

Figure 28

Net exports of selected agricultural commodities by developing countries



accounted for 11 percent of the total value of fishery exports – a share that expanded to 13 percent in 1984, 18 percent in 1994 and 20 percent in 2004, when their fishery net export revenues were estimated at US\$9.4 billion.

In many countries there is considerable two-way trade in fishery products (Figure 29). The Latin America and the Caribbean region holds a strong positive net fishery exporter position, as do developing Asia and Oceania. Africa has been a net exporter since 1985, when the factory ships of the former Union of Soviet Socialist Republics and Eastern Europe diminished or ceased landing massive quantities of cheap frozen pelagic fish in West Africa. Europe, Japan and North America are characterized by a fishery trade deficit. In 2004, a total of 97 countries were net exporters of fish and fishery products.

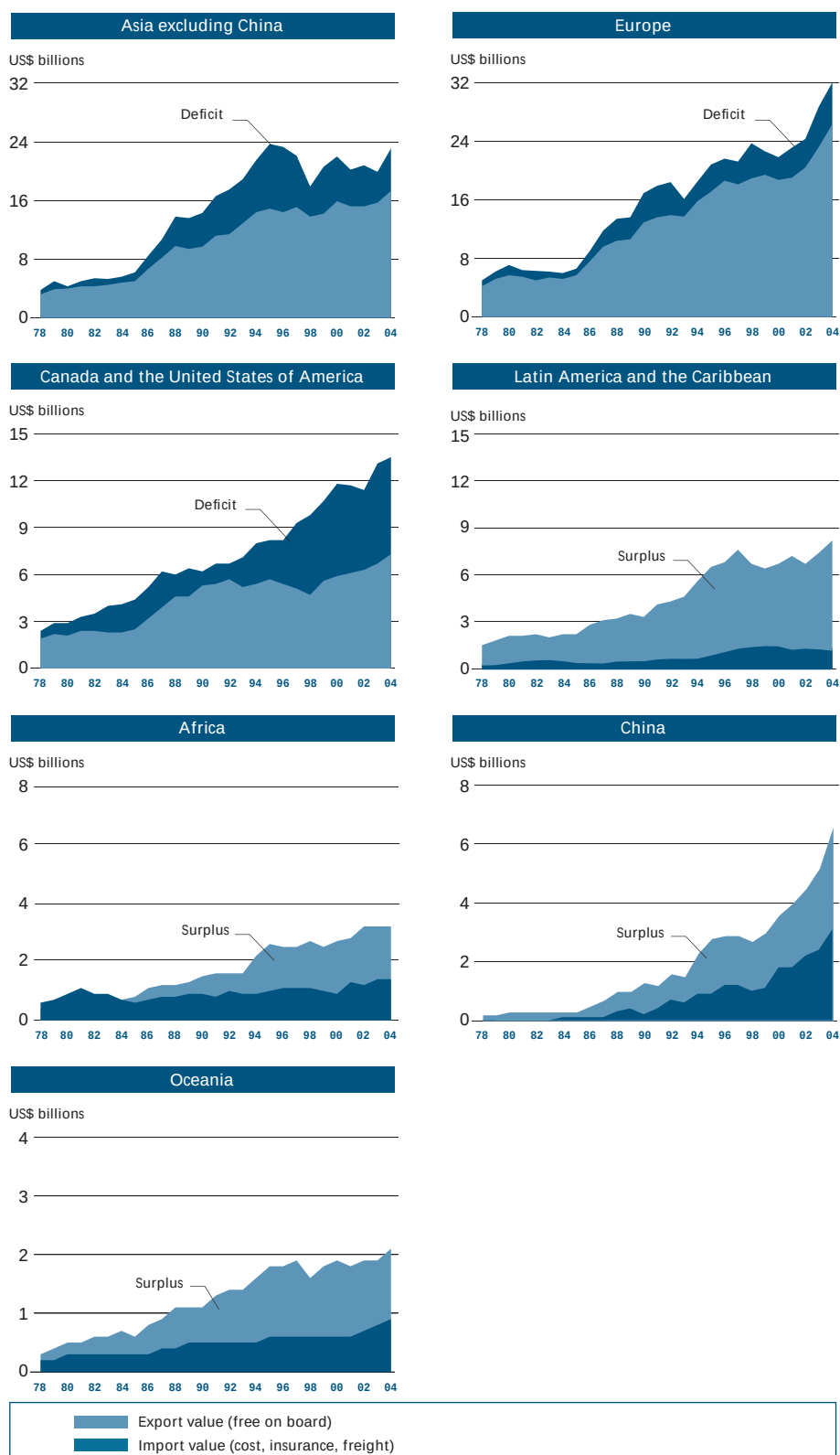
There has been a tendency in recent decades towards increased intensity of fishery trade within regions. Among developed countries, fishery trade remains largely and increasingly self-centred: in the period 2002–04, some 85 percent of the value of developed country fishery exports were destined to other developed countries and more than 50 percent of developed country fishery imports originated in other developed countries. Particularly significant is the role of trade among EU countries, with more than 84 percent of EU exports going to, and about 50 percent of their imports coming from, other EU countries in both 2004 and 2005. Trade between Canada and the United States of America, although much smaller than intra-EU trade, has expanded significantly since 1980, reflecting the growing importance of the North American Free Trade Agreement (NAFTA) – which includes also Mexico – and prior to that the United States–Canada Free Trade Agreement. At present, about 43 percent of their exports and 21 percent of their imports are between the two countries. Trade in fish and fishery products among the more developed economies consists mainly of demersal species, herring, mackerel and salmon.

Conversely, although fishery trade among the developing countries has increased, particularly during the 1990s, it still represents a share of only 15 percent of the value of fishery exports of developing countries. Fishery intra-trade among developing countries should potentially increase in the future, partly as a result of the emergence of regional trade agreements and partly driven by demographic, social and economic trends that are transforming food markets in developing countries. However, developing countries still depend to a large extent on the developed countries, mainly as outlets for their fishery exports, but also as suppliers of their fishery imports for local consumption or their processing industries. In fact, several developing countries are importing an increasing quantity of raw material for further processing and re-export



Figure 29

Imports and exports of fish and fishery products for different regions, indicating net deficit or surplus



to developed countries. Fishery exports of developing countries are gradually evolving from the export of raw material for the processing industry in developed countries to high-value live fish or value-added products. This is happening notwithstanding a variety of barriers (such as high import tariffs on processed products), which often hinder the industry. Many developed countries have invested in processing facilities in developing countries, where costs are lower.

The maps shown in Figure 30 indicate trade flows of fish and fishery products by continent for the period 2002–04. The overall picture presented by these maps, however, is not complete. Although the countries that reported their imports over this period (some 159 countries) account for 99 percent of the estimated world total, some continental groups are not covered completely (e.g. about one-third of African countries did not report their trade in fishery products by country of origin/destination). In this case, the data indicated should not be taken to represent the total trade flow of the continental groups to which they refer. In the period 2002–04, about 77 percent of the value of fishery exports of developing countries was directed to developed areas, mainly to the EU, Japan and the United States of America. These exports consisted mostly of tuna, small pelagics, shrimps and prawns, rock lobsters and cephalopods. The quantity of exports from developed countries to developing countries is relatively insignificant, representing around 15 percent of the total value of developed country exports of fishery products. These exports consist mainly of low-priced small pelagics, which account for about 20–30 percent of developing countries' imports, and raw material for processing.

Owing to the high perishability of fish and fishery products, more than 90 percent of international trade of fish and fishery products is conducted in processed form. In terms of quantity (live weight equivalent), the share of live, fresh or chilled fish was 10 percent in 2004. Live and fresh fish are valuable but difficult to trade and transport and they are often subject to stringent health regulations and quality standards. Yet trade in live fish has increased in recent years as a result of technological developments, improved logistics and increased demand. An elaborate network of handling, transport, distribution, display and holding facilities has been developed to support the live fish trade. New technological systems include specially designed or modified tanks and containers, as well as trucks and other transport vehicles equipped with aeration or oxygenation facilities to keep fish alive during transportation or holding/display. Trade in live fish also includes ornamental fish as opposed to fish for human consumption, and this area has become a lucrative business. Live fish is particularly appreciated in Asia (particularly by the Chinese population) and in niche markets in other countries, mainly among immigrant Asian communities.

Exports of frozen fish have increased during the past decade, from a share of 28 percent of the total quantity of fish exports in 1994 to 36 percent in 2004. Exports of prepared and preserved fish totalled 8.3 million tonnes (live weight equivalent) in 2004, representing a share of 15 percent of total exports (10 percent in 1994). Exports of cured fish accounted for 5 percent of total exports in 2004, but this share had declined slightly over the preceding decade. In 2004, exports of non-food fishery products represented 34 percent of total fish exports in terms of quantity, a large proportion of which originated from Latin American countries.

Shrimp

Shrimp continues to be the most important commodity traded in value terms, accounting for 16.5 percent of the total value of internationally traded fishery products in 2004. The other main groups of exported species were groundfish (10.2 percent – i.e. hake, cod, haddock and Alaska pollock), tuna (8.7 percent) and salmon (8.5 percent). In 2004, fishmeal represented around 3.3 percent of the value of exports and fish oil less than 1 percent.

It is important to note the reduced share of shrimp in total fish trade since its 21 percent peak reached in 1994, notwithstanding the growth of 18 percent by value and of 69 percent by quantity (live weight equivalent) of shrimp exports during



Figure 30

Trade flows by continent (total imports in US\$ millions, c.i.f.; averages for 2002–04)

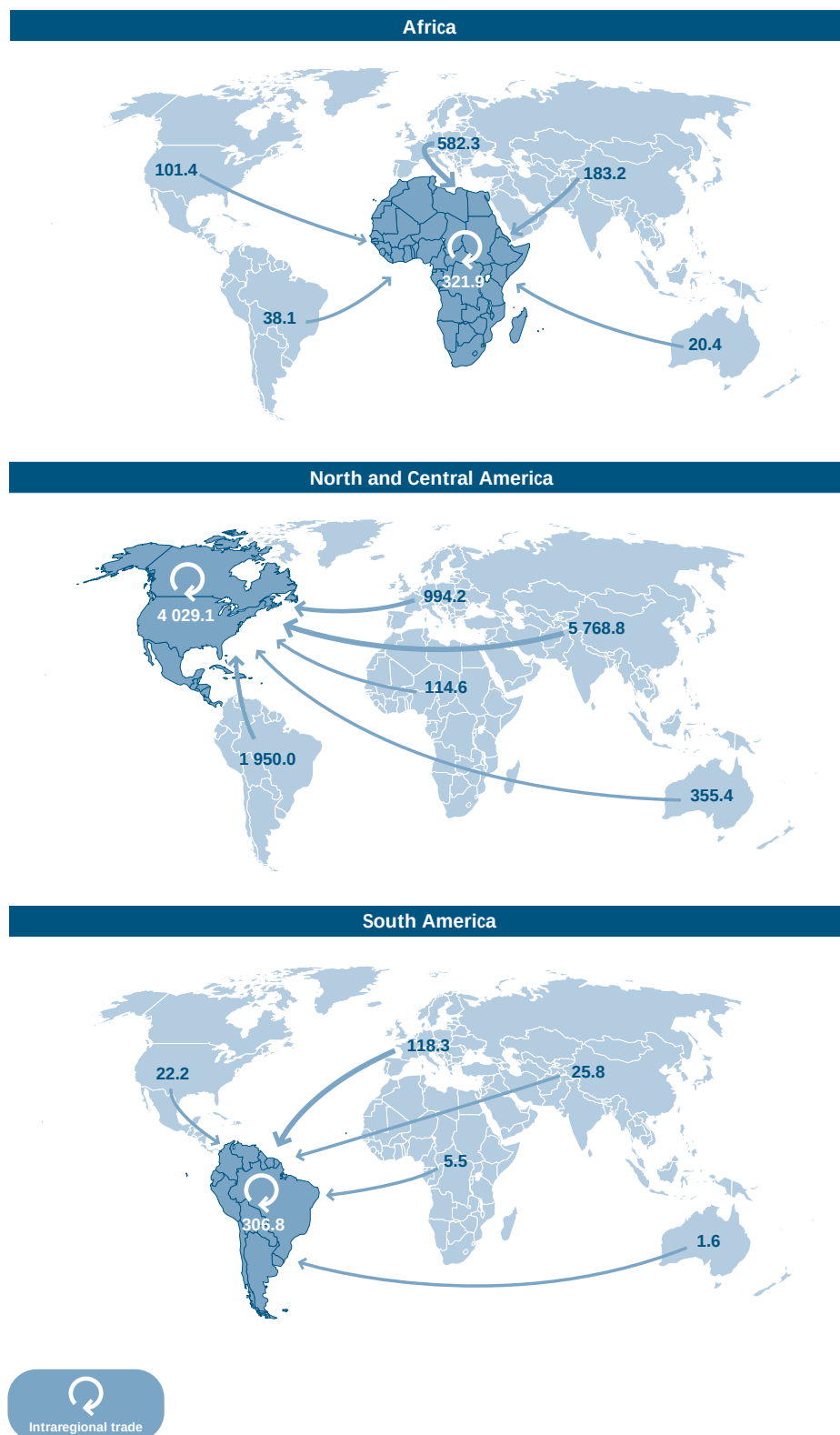


Figure 30 (cont.)

Trade flows by continent (total imports in US\$ millions, c.i.f.; averages for 2002–04)

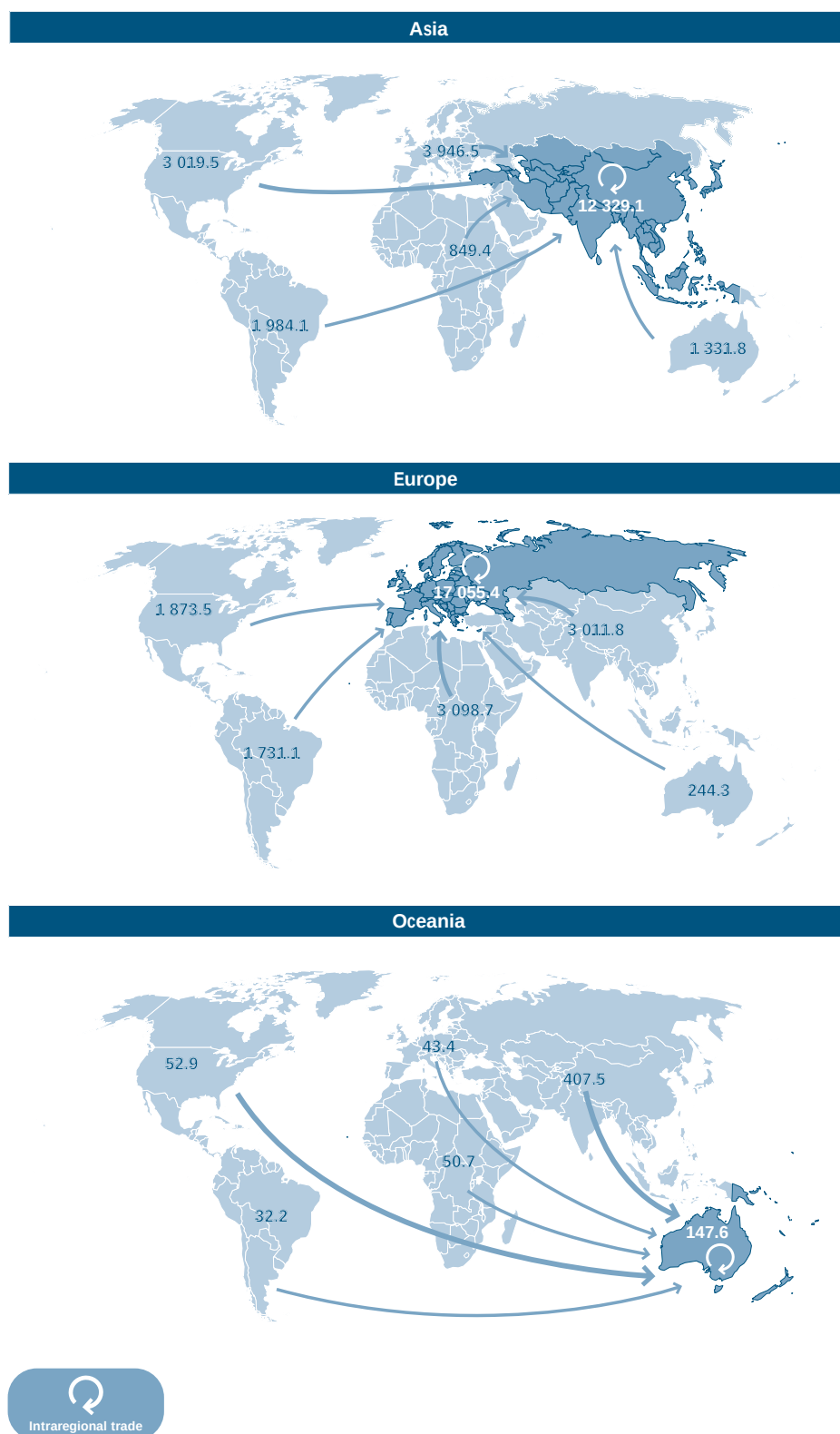
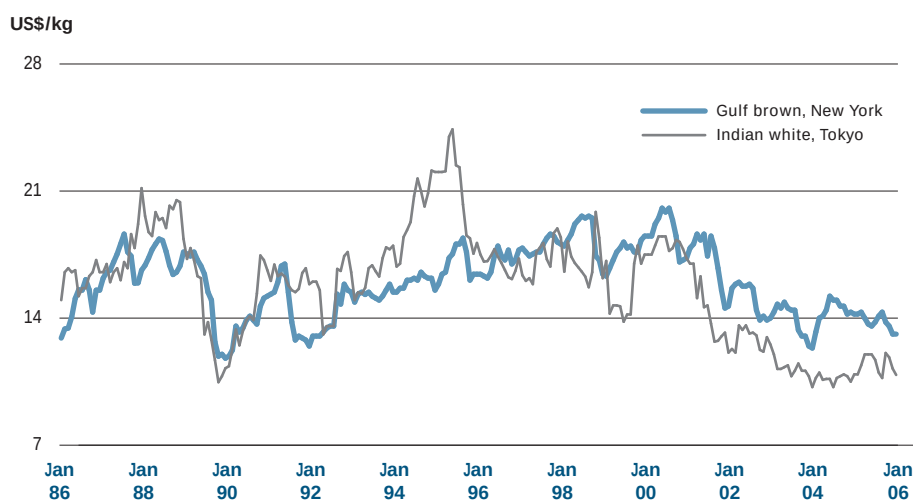


Figure 31

Shrimp prices in Japan and the United States of America



Note: Data refer to wholesale prices for frozen, headless, shell-on shrimps, 16-20 count.

1994–2004. The substantial increase in the quantity of shrimp traded coincided with the strong expansion in aquaculture shrimp production, which has grown rapidly since 1997, with an increase of 165 percent during the period 1997–2004 (annual growth of 15 percent). In 2004, more than 41 percent (or 2.5 million tonnes) of total shrimp production was of farmed origin. The unit value for shrimp exports increased in the 1990s to reach US\$6.9/kg in 1995. Since then, probably as a result of the strong rise in production, it has declined to US\$4.1/kg in 2004.

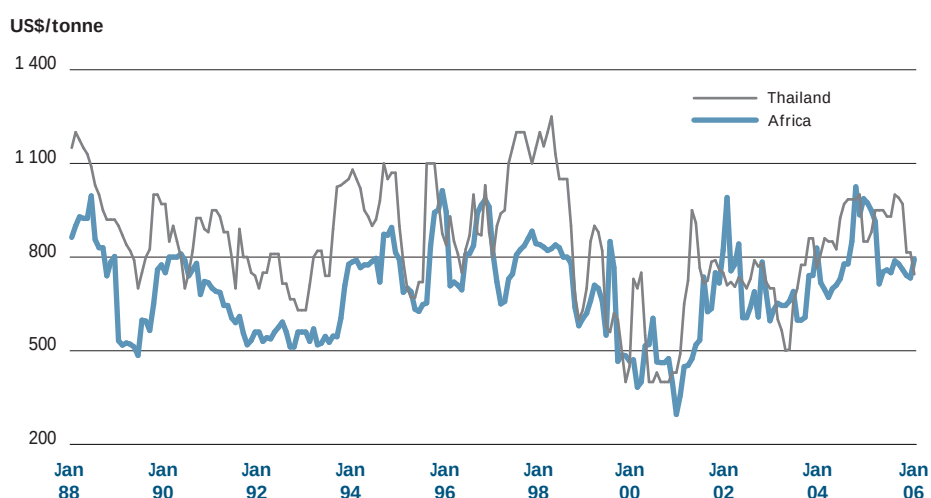
During 2005, shrimp imports in several key markets reached new highs. Key markets were influenced by supply fluctuations, in both the wild and farmed sectors, and regulatory developments in both the EU and the United States of America. Sales to the latter, the world's largest shrimp market, continued to increase and imports reached 530 000 tonnes. Annual shrimp imports into Japan during 2005 declined by 6 percent compared with the previous year. In Europe, shrimp imports increased in 2005, as a result of a strong euro and competitive international prices. The impact of the United States of America's anti-dumping process was evident in a relative switch from the United States market to European markets by suppliers in the six affected countries (Brazil, China, Ecuador, India, Thailand and Viet Nam). The relaxing of EU restrictions on imports of Chinese farmed shrimp was reflected in import share changes in several EU markets, most notably in Spain where China became the leading supplier. Despite signs of a gradual upward trend, initial indications for 2006, including modest demand conditions in key markets, suggest that shrimp prices will remain competitive at least for the medium term. Lower supplies from the main shrimp-producing countries were reported in 2006, which led to some increases in prices. Shrimp prices in Japan and the United States of America are presented in Figure 31.

Salmon

The relative importance of salmon as a traded item has grown in recent years, to reach 8.5 percent in 2004, up from 7 percent in the mid-1990s, as a result of the booming salmon farming industry in Chile and Norway. The average unit value of salmon exports declined during the past 15 years, from about US\$6.10/kg in 1988 to US\$3.20/kg in 2004. The start of this downward trend coincided with the growth of industrial salmon aquaculture. The huge increase in farmed salmon production had a strong impact on trade. In fact, salmon trade (live weight equivalent) grew significantly during the period 1988–2004, from 375 000 tonnes to over 1.7 million tonnes. However, the decline in unit value seems to have come to an end.

Figure 32

Skipjack tuna prices in Africa and Thailand



Note: Data refer to c&f (cost and freight) prices for 4.5–7.0 pounds of fish. For Africa: ex-vessel Abidjan, Côte d'Ivoire.

The year 2005 was positive for salmon producers and traders worldwide. With farmed salmon prices at their highest level since 2000, salmon farmers in Europe, North America and South America are optimistic. Demand is strong in all markets and supply increased less than had been expected. Profits are abundant thanks to stellar prices and reduced production costs gained through economies of scale and efficiency gains. The outlook for 2006 is positive, although some price reductions can be expected in the future, and in the medium to long term prices should return closer to cost than they are currently. In fact, in a commodity industry, high prices lead to increased production, which in turn depresses prices.

Tuna

Japan is the top world market for *sashimi*-grade tuna. Recent indications of an improved economy in Japan should result in more demand for high-value *sashimi* tuna. The farming of bluefin tuna has had a significant impact on the *sashimi* market in Japan in recent years, although catch limitations do not leave much space for expansion of tuna farming. The reduction of the EU canned tuna import tariff (from 24 percent to 12 percent) for a quantity of 25 000 tonnes from countries such as Indonesia, the Philippines and Thailand was not welcomed by the main European tuna canners. On the other hand, Spanish canners are outsourcing and new canning plants have been installed by Spanish companies in Central America (in El Salvador and Guatemala). The concentration of the world tuna industry in fewer hands is continuing. Prices of skipjack tuna in Africa and Thailand are shown in Figure 32. These prices expanded sharply in the opening months of 2006, after mixed results in 2005, and canned tuna prices also rose as a result. Low catches combined with high fuel prices were the main cause for this price hike. Consumer resistance for canned tuna started to be observed in Europe in 2006, while the United States of America was already reporting lower canned tuna consumption in 2005. Press reports on dangerous levels of mercury in canned tuna are scaring away United States consumers.

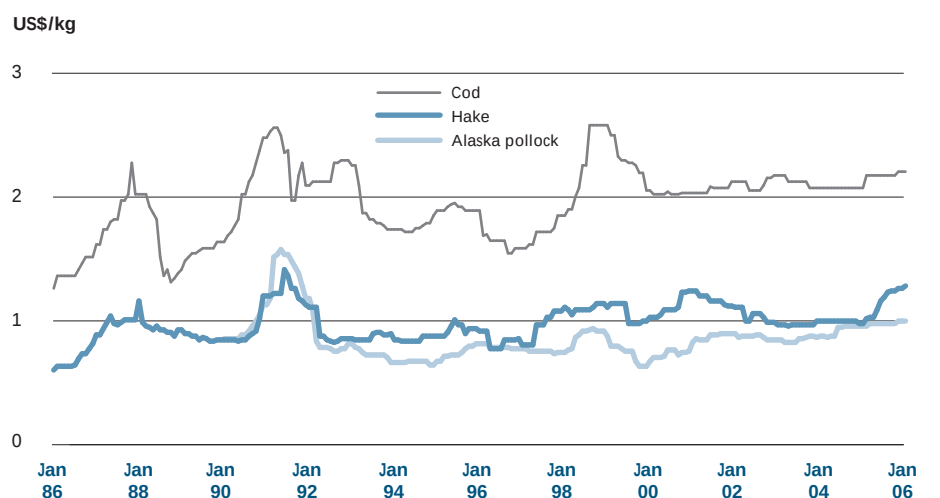
Other finfish

In a tighter supply context, frozen groundfish prices showed a definite upward trend during 2005. Groundfish prices in the United States of America are shown in Figure 33. Increased demand for *surimi* from Asia had an impact on United States Alaska pollock fillet production, and fillet supplies to Europe decreased as a result. Lower hake



Figure 33

Groundfish prices in the United States of America



Note: Data refer to c&f (cost and freight) prices for fillets.

landings in several Latin American countries, notably Argentina, also meant reduced supplies to Europe. China's role in frozen groundfish markets continues to increase. The country expanded its share of Alaska pollock fillet imports in the key French and German markets. It also strengthened its position in European frozen cod fillet markets, notably in Germany and the United Kingdom.

Cephalopods

After several years of reduced production, 2005 was characterized by good supplies, for both squid and octopus. The beginning of 2006 was marked by good squid landings, notably in the Southwest Atlantic. Total production for 2006 should be in line with the good level of 2005. Spain remains the leading European squid market. During 2005, frozen imports (*Illex* and *Loligo*) increased by 7 percent over 2004 levels to almost 160 000 tonnes. In 2005, the Italian squid market followed a similar trend to that of Spain. Japan continued to be the main market for cephalopods worldwide in 2005. The octopus resource in the Central East Atlantic is recovering after years of stringent catch controls by the Moroccan Government. Prices for all cephalopod products stabilized at high levels in 2005 and early 2006. Squid and cuttlefish prices in Japan are shown in Figure 34.

Fishmeal

The bulk of fishmeal production – about 60 percent – is exported each year. In 2005, fishmeal production in the five major exporting countries amounted to 3.5 million tonnes, which compares with 4.7 million tonnes in 2000. Catches of fish for reduction were low in all major fishmeal-producing countries. Fishmeal prices, which increased strongly in 2005 and in the opening months of 2006, are a result of strong demand, especially from China and other Asian countries. Fishmeal and soybean meal prices for Germany and the Netherlands are given in Figure 35.

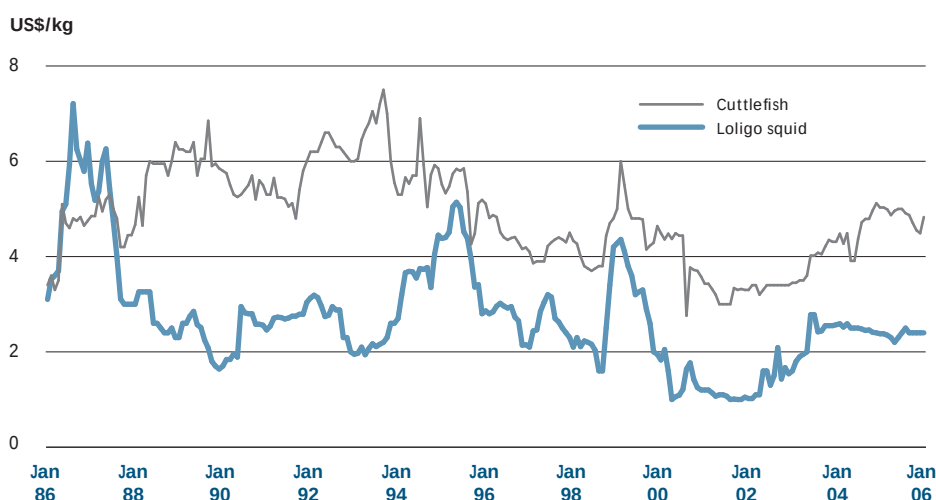
GOVERNANCE AND POLICY

Marine fisheries

RFMOs play a unique role in facilitating international cooperation for the conservation and management of fish stocks. These organizations represent the only realistic means of governing fish stocks that occur either as straddling or shared stocks between zones of national jurisdiction or between these zones and the high seas, or exclusively on

Figure 34

Cephalopod prices in Japan

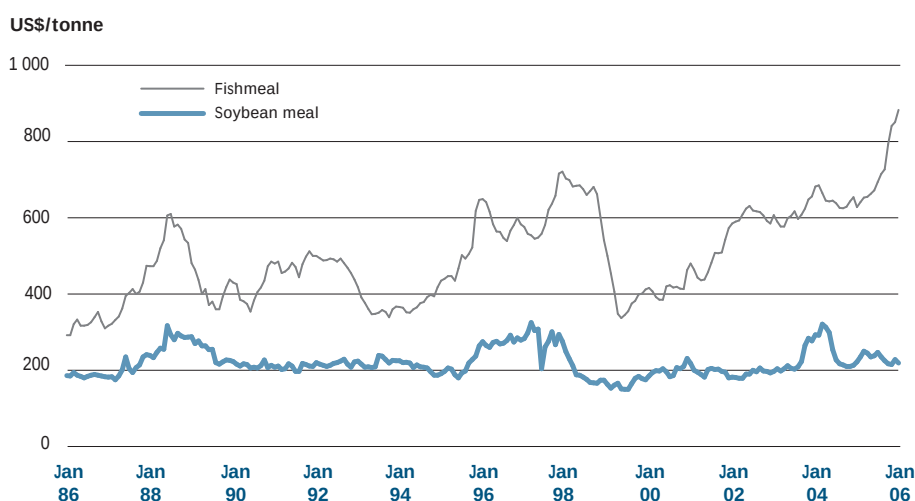


Note: Data refer to wholesale prices.

For cuttlefish: whole, 10 kg/block, 0.4–0.6 kg/pc; for squid: whole 7.5 kg/block, 21–30 kg/pc.

Figure 35

Fishmeal and soybean meal prices in Germany and the Netherlands



Note: Data refer to c.i.f. prices.

Fishmeal: all origins, 64–65 percent, Hamburg, Germany

Soybean meal: 44 percent, Rotterdam, the Netherlands.

Source: OIL WORLD; FAO GLOBEFISH.

the high seas (see Box 2).¹⁸ They seek to promote the long-term sustainable use of the target stocks falling within these mandates, though RFMOs are moving towards a broader ecosystem approach to fisheries management and biodiversity considerations where measures are adopted for species belonging to the same ecosystem or are associated with, or dependent upon, the target stocks.

Strengthening RFMOs in order to conserve and manage fish stocks more effectively remains the major challenge facing international fisheries governance. Despite

Box 2

FAO's role in promoting cooperation for more effective governance

FAO seeks to promote cooperation among regional fishery bodies (RFBs), aware that the need for effective global and regional fisheries governance has been increasing dramatically in importance. FAO's main objective is to foster international fisheries cooperation so as to enhance conservation and management. With this goal in mind, FAO provides technical and administrative support to its 11 RFBs. FAO also encourages all RFBs to work to strengthen their mandates and functions so as to improve their operational efficiency, and the establishment of new bodies where none exists currently. As an ongoing initiative, FAO promotes and hosts the biennial meetings of RFBs as a means of facilitating discussion and information sharing among them. These meetings address the outcomes of the FAO Committee on Fisheries focusing on issues such as the role of RFBs in global fisheries governance, IUU fishing, fleet overcapacity, the EAF, marine protected areas, harmonization of catch/trade documentation and the fishery resources monitoring system.

In response to worldwide public concerns about the state of world fishery resources and related ecosystems, the FAO has been promoting, *inter alia* in the RFBs, the extended application of the Code of Conduct for Responsible Fisheries together with the EAF, as well as the related International Plans of Action (on seabirds, sharks, fishing capacity and IUU).

efforts over the past decade to improve their management capacity and their images as effective and responsive organizations, some RFMOs have failed to achieve their fundamental goal of the sustainable management of stocks. This situation has led to an increasing number of stocks being subject to catch moratoria, together with elevated international criticism concerning the effectiveness of RFMOs. This criticism, from RFMO members as well as civil society, undermines the credibility of, and respect for, RFMOs.

Many RFMOs are focusing their efforts on implementing measures that will operationalize key aspects of the 1995 UN Fish Stocks Agreement and other recently concluded international fisheries instruments (see Box 3). Important steps towards the implementation of these instruments have been taken through the review and updating of mandates: for example, by the General Fisheries Commission for the Mediterranean (GFCM), the Indian Ocean Tuna Commission (IOTC), the Inter-American Tropical Tuna Commission (IATTC), the International Commission for the Conservation of Atlantic Tunas (ICCAT), the North East Atlantic Fisheries Commission (NEAFC) and the Northwest Atlantic Fisheries Organization (NAFO).

Several tuna management bodies are concerned about perceived overcapacity in global tuna fleets. Work they have conducted jointly with FAO indicates the need to move towards a rights-based management system, with interim management procedures suggested in the meantime. These procedures include an immediate moratorium on the entry of additional large vessels and the development of allocation criteria and mechanisms for new participants.

In addition to taking steps to implement the EAF (including measures to minimize bycatch such as sharks, sea turtles and seabirds), RFMOs are striving to adopt the precautionary approach. They are also working to strengthen international cooperation, promote transparency, encourage eligible non-members to become members of organizations or cooperating entities, and enhance compliance and

Box 3

1995 UN Fish Stocks Agreement Review Conference

The 1995 UN Fish Stocks Agreement Review Conference, held in New York, United States of America, from 22 to 26 May 2006, was foreseen in Article 36 of the Agreement when it was negotiated. In reviewing and assessing the adequacy of the provisions of the Agreement, and in proposing means to strengthen its implementation, the Review Conference focused on the relevant provisions relating to the conservation and management of stocks (adoption of measures, overfishing and capacity management, effects of fishing on the marine environment, fisheries not regulated by an RFMO, and data collection and sharing); mechanisms for international cooperation (integrity of RFMO regimes, fishing activity by non-members of RFMOs, functioning of RFMOs and participatory rights); monitoring, control and surveillance, compliance and enforcement (implementation of flag state duties and investigation and penalization for violations); developing states (recognition of the special requirements, provision of assistance and capacity building) and non-parties (increasing adherence to the Agreement).

The Review Conference structured its report around two themes – review and assessment – and proposed means for strengthening the elements in the clusters (in terms of action by states, individually and collectively through RFMOs and, as appropriate, by FAO and the United Nations Division of Ocean Affairs and the Law of the Sea). The strong focus on RFMOs in the recommendations agreed by the Conference reflected their central role in implementing the Agreement. Importantly, it was agreed that high seas discrete stocks would be included within the ambit of the Agreement, thereby eliminating a conservation and management gap for these stocks.

An issue that attracted considerable discussion during the Review Conference was the need for RFMOs to embrace and accommodate new entrants, and in particular developing countries, in an equitable manner within the limits of scientific advice for managed stocks. While noting that this was a delicate issue linked to the concept of “real interest” and effective flag state control over vessels, it was pointed out that a failure to deal adequately with participation and allocation of fishing opportunities within RFMOs could promote, unwittingly, IUU fishing.

On the matter of port state measures – a weak link in the chain in efforts to combat IUU fishing – the Review Conference proposed that FAO, building on the 2005 FAO Model Scheme on Port State Measures and the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, initiate a process to develop, as appropriate, a legally binding instrument on minimum standards for port state measures.

The Review Conference agreed to continue to review the implementation of the Agreement and to the resumption of the Review Conference at a date not later than 2011.



enforcement through improved monitoring, control and surveillance (MCS), including the implementation of mandatory vessel monitoring systems (VMS), the adoption of regional schemes for port state measures and the development of vessel lists.

Two RFMOs established after the conclusion of the 1995 UN Fish Stocks Conference – the South East Atlantic Fisheries Organization (SEAFO) and the Western and Central

Pacific Fisheries Commission (WCPFC) – are implementing the provisions of the 1995 UN Agreement through their Conventions.

In 2004, the FAO Council, in Resolution 1/127, established the South West Indian Ocean Fisheries Commission (SWIOFC) under Article VI of the FAO Constitution. As the newest RFB of its type, it seeks to promote the sustainable development, conservation, rational management and best utilization of fishery resources in the region, with a special emphasis on fisheries targeted at non-tuna species. SWIOFC's membership is open to coastal states whose territories are situated wholly or partly within the area of the Commission (i.e. the Southwest Indian Ocean) and that notify in writing to the FAO Director-General their interest in becoming a member of the Commission. The Commission held its first meeting in April 2005 in Mombasa (Kenya) and its second meeting in Maputo (Mozambique) in August 2006.

Also noteworthy are two other conventions that focus on the conservation and management of deep-sea resources of the high seas (including discrete high seas stocks) and that use the 1995 UN Fish Stocks Agreement as a framework: the South Indian Ocean Fisheries Agreement (SIOFA), which was adopted and opened to signature in July 2006,¹⁹ and the South Pacific Regional Fisheries Management Organisation (SPRFMO), which is still under negotiation. Both of these agreements and organizations are intended to fill high seas management gaps where valuable but vulnerable stocks exist. Some of the stocks covered by the agreements are subject to heavy fishing pressure and in the case of the Indian Ocean they have probably already been overfished.

The perceived lack of action by RFMOs and their inability in some cases to stem stock declines should be viewed in the context of the obstacles faced by many RFMOs, not all of which are of their own making. A lack of political commitment by the members of some RFMOs and unyielding positions that mitigate against sound regional fisheries management (e.g. insistence on the use of consensus-based decision-making, even for RFMOs established in the post-1995 UN Fish Stocks Agreement era, and opt-out/objection provisions for management measures²⁰), has thwarted, if not stalled, efforts by some RFMOs to meet and address conservation and management challenges. Such positions hinder RFMO performance, while criticism is directed at the organizations rather than at their members.

The high incidence and increasing sophistication of IUU fishing continue to undermine the work of RFMOs. The continuing widespread use of flags of non-compliance and ports of convenience exacerbates the scope and extent of IUU fishing. The criminal aspect of IUU fishing is also coming to the fore as organizations take measures against offending fishing vessels and their owners, and RFMO secretariats sometimes receive threats intended to make them withdraw measures that combat IUU fishing.

Coupled with the issue of RFMO credibility are calls for their performance to be reviewed regularly as a means of promoting greater efficiency and accountability. However, this issue is highly sensitive and in some instances RFMO members have been reluctant to support such evaluation believing that it might interfere with their autonomy, disrupt their work and, ultimately, reflect poorly on their membership. Nonetheless, despite objections, the rationale and need for such performance appraisal is taking root and gaining wide international acceptance. It has been argued in international fora that, provided that reviews are undertaken in a transparent and inclusive manner and with the full involvement and cooperation of members and secretariats, RFMOs should embrace the review process as a means of boosting their international reputation. More importantly, the review outcomes should provide concrete results that organizations can adopt and implement to strengthen their conservation and management capacity.

Following consideration of this issue by the Twenty-sixth Session of the FAO Committee on Fisheries (COFI) and the Fourth Meeting of Regional Fishery Bodies, the North East Atlantic Fisheries Commission (NEAFC) in 2005 agreed to undertake an independent performance review of the Commission.²¹ The purpose of the review was

to provide a systematic check on its performance since its inception in 1982 and its consistency with the NEAFC Convention, the 1995 UN Fish Stocks Agreement and other relevant international agreements and instruments. A comprehensive set of criteria was developed, against which NEAFC will be reviewed. The results of the review should point to NEAFC's achievements and areas where there is scope for improvement. The review panel will involve the Chairs of two NEAFC working groups, the Secretary of the Commission, an independent marine scientist and two UN experts, one each from FAO and the United Nations Division for Ocean Affairs and the Law of the Sea (UNDOALOS).

This is the first RFMO performance review to be undertaken, the results of which should be available at NEAFC's annual meeting in 2006. Despite hesitancy on the part of some NEAFC members in proceeding with the review, the Commission has shown leadership in venturing into a new and important area for RFMOs. However, RFMO members are aware that reviews will not, in themselves, lead to enhanced performance: the results of these reviews, which should be accessible to all interested parties, must be translated into time-bound operational measures if RFMO shortcomings are to be addressed and if these organizations are to be strengthened to play an even more effective role in the governance of fish stocks.

In 2005, Ministers attending the Conference on the Governance of High Seas Fisheries and the UN Fish Agreement – Moving from Words to Action²² adopted a declaration that focused, *inter alia*, on the role and work of RFMOs. It noted that these organizations are fundamentally important for high seas fisheries governance. The Ministers undertook to implement, through RFMOs, key measures ranging from strengthened decision-making processes to the implementation of improved MCS to address more vigorously IUU fishing and fleet overcapacity. Moreover, the declaration recognized the need to assist developing countries in implementing international fisheries agreements and for officials to identify practical ways to move forward on the commitments set out in the declaration.

A further initiative that focused attention on IUU fishing and the role played by RFMOs in attempts to combat this problem was the work of the Ministerially-Led Task Force on IUU Fishing on the High Seas.²³ The resultant report addresses improved high seas governance and suggests that a model for be developed for improved governance by RFMOs to deter IUU fishing. It also advocates promoting a more systematic approach to the review of RFMO performance and encourages RFMOs to work together more effectively through improved coordination and the use of port- and trade-related measures. Although the Task Force was led by a small number of fisheries ministers and heads of NGOs, its outcomes are being promoted widely as a means of encouraging greater "buy-in" and participation in the implementation of the report's nine proposals. While many of these proposals are already on the international fisheries agenda and are being implemented to varying degrees, the Task Force's report serves to focus attention more sharply on them and, as a result, attract funding to support more intensive implementation.

Inland fisheries

Many of the world's large river basins cross one or several international borders (Table 12) and therefore activities in one country may affect fish stocks and fisheries in the others. Many riverine fish species are migratory, so even in situations where an impact on a certain species is confined to a particular area, the effects on the species may be felt by communities exploiting the fish stock in other countries. Thus, there is a need for a system of governance for transboundary and international inland waters.

Appropriate fisheries management of transboundary waters requires that suitable policies and strategies for sustaining the shared resources (water and biological resources) are developed at the regional level, and that these are incorporated into national legislation and implemented. The first step would be to identify the species and stocks that are shared and establish whether they are vulnerable and to what threats. The countries would then move on to identify the specific management measures that are required. The FAO Code of Conduct for Responsible Fisheries²⁴



Table 12
International river basins and management frameworks by continent

Continent	International basins ¹	Number of basins with international agreements ¹		Inland water commissions with a mandate in fisheries
		(Number)	(Percentage)	
Africa	59	19	32	8
Asia	57	24	42	2
Europe	69	45	63	12
North America	40	23	58	3
South America	38	6	16	6

¹ Based on United Nations Environment Programme. 2002. *Atlas of International Freshwater Agreements*. Nairobi.

emphasizes, *inter alia*, that “States should ... cooperate at subregional, regional and global levels ... to promote conservation and management, ensure responsible fishing and ensure effective conservation and protection of living aquatic resources throughout their range of distribution, taking into account the need for compatible measures in areas within and beyond national jurisdiction” and, further, “For transboundary fish stocks ... the States concerned ... should cooperate to ensure effective conservation and management of the resources. This should be achieved, where appropriate, through the establishment of a bilateral, subregional or regional fisheries organization or arrangement.”

A range of regional frameworks provide advice on, or deal directly with, the management of inland waters and living aquatic resources. However, the governance system is incomplete as only 44 percent of international basins are subject to one or more agreements, and these agreements deal with a variety of issues that may or may not include fisheries. Many do not focus on fishery resources, but on water as a resource, for example the allocation of water for irrigation, flood protection, navigation or hydropower generation. Nevertheless, the agreements have a mandate in environmental matters, which could be extended to include fisheries although these are often not specifically mentioned. A searchable database of summaries and the full text of most of these agreements can be found at <http://faolex.fao.org/faolex>.

Inland fisheries are especially vulnerable to influences from outside the fisheries sector, for example water diversion, habitat degradation, pollution and loss of habitat. The governance system that applies to inland water bodies rarely considers the maintenance of fisheries as a prime target, and often favours other sectors using the water resource – sectors that are perceived to be more profitable or more important. This system has in some instances resulted in negative impacts for inland fishers and communities dependent on inland fishing.

There are, however, some encouraging developments. Resolution IX.4 of the Ramsar Convention on Wetlands,²⁵ which addresses the conservation, production and sustainable use of fisheries resources, stresses, *inter alia*, that “local, national and international mechanisms should be established, as appropriate, whereby allocation of essential resources for the protection of aquatic resources and specifically fisheries resources are negotiated among all users of the resource”. The European Water Framework Directive²⁶ emphasizes the river basin approach for the integrated and coordinated river basin development and management of all European river systems. The Framework calls for a comprehensive ecological assessment and classification on the basis of the composition and abundance of the aquatic fauna and flora and taking into account the type-specific reference conditions of the water body.

The Mekong River Commission oversees the world's largest inland fishery and, at its 11th Ministerial Council meeting in 2004, pledged to implement “Integrated Water

Resources Management" at basin scale as a means of alleviating poverty and enhancing economic growth. In the lower Mekong Basin, demand for hydropower is expected to increase by 76 percent each year for the next 20 years and the objective of the Commission is to "meet this demand in a way that fully recognizes the requirement to safeguard ecosystems and social interests".²⁷

Within the inland fisheries sector, capture fisheries is competing with aquaculture, *inter alia*, for development assistance. In the past, negative consequences from aquaculture on the aquatic environments have sometimes been predicted. Today, however, in many regions the perceived benefits of aquaculture are increasingly inspiring a change in how water bodies are being used. In Lake Victoria, for example, many interested parties in riparian countries are lobbying the Lake Victoria Fisheries Organization (LVFO) for legislation to permit cage culture in and around the lake and the LVFO has requested FAO's assistance in developing such legislation.

Not only are inland fisheries unlikely to be, or become, the primary focus in all water management programmes, but there is also a risk that the needs of rural and small-scale fisheries will not be considered in these programmes unless water governance systems are expressly designed to include inland fisheries.

Aquaculture

There is growing understanding that sustainable development of the aquaculture sector requires an enabling environment, with appropriate institutional, legal and management frameworks guided by an overall policy. While efforts towards reaching the goal of sustainable development vary among countries, according to the level of commitment by policy-makers and the scale of development of the aquaculture sector, notable progress has been made in a number of institutional, legal and management development areas, including the use of various public- and private-sector partnership arrangements.

Because aquaculture activities are generally located within national borders, most aquaculture is managed, monitored and governed by national instruments and arrangements. This situation contrasts with that of capture fisheries, where important fisheries are transboundary in nature and regional, international and/or global governance instruments are required to harmonize national governance of the shared resources.

The Network of Aquaculture Centres in Asia-Pacific (NACA) is the only true regional intergovernmental organization that promotes aquaculture, and the COFI Sub-Committee on Aquaculture is the only global intergovernmental forum that discusses aquaculture exclusively. There are also several international NGOs and civil society instruments that assist aquaculture regionally. As the importance of aquaculture continues to rise, it is likely that more regional and international instruments will be developed to support governance of the sector.

Among the lessons learned from the establishment and operations of aquaculture networks such as NACA is that technical cooperation among member governments works.²⁸ Building on the NACA experience, the Network of Aquaculture Centres of Central-Eastern Europe (NACEE) was established in 2004. In other regions, especially in Latin America and sub-Saharan Africa, several countries, together with FAO, are exploring the possibilities of establishing such regional networks.

Recent research and reviews clearly indicate that one of the key trends in aquaculture development and management is enhanced regulation and better governance.²⁹ Examples include the implementation of integrated land-use planning, including the establishment of farmer-friendly tenure systems and appropriate environmental planning, and the development and enforcement of regulations for the general management of aquaculture, including aspects such as the use of drugs and chemicals. Self-regulation of the sector has led to several essential developments, such as codes of practice and better management practices, including in collaboration with farmers.

Aquaculture does not exist in isolation, and increased regulation of the sector also requires that its external effects are moderated. Following a trend in some regions



of increasing intensification and rising numbers of farms, environmental impact assessment and routine environmental monitoring are being conducted.

An encouraging trend is that an increasing number of countries have formulated, or are in the process of formulating, fisheries policies, plans, regulations and strategies that accommodate and facilitate growth and efficient management of the aquaculture sector. A recent study by FAO on the integration of fisheries into key national policy documents relating to poverty reduction and rural development showed that the sector has been most effectively mainstreamed in Asia (in the case of poverty reduction strategy papers and national development plans), closely followed by Africa.³⁰

The Abuja Declaration on Sustainable Fisheries and Aquaculture in Africa was adopted by the Heads of State Meeting of the New Partnership for Africa's Development (NEPAD) Fish for All Summit in Nigeria.³¹ On the same occasion, the Global Program on Fisheries (PROFISH)³² was launched. The Program is a new global partnership of developing countries, donors and technical agencies led by the World Bank. These are two significant recent developments that demonstrate national and international commitment towards realizing the potential that fisheries and aquaculture have to contribute to food security, poverty reduction and economic development.

From the federation of aquaculture self-help groups, including women's groups, in one of the poorest villages of India to the Global Aquaculture Alliance, producer associations have been playing a major role in global aquaculture development. While the producer associations have a range of purposes, some of the common ones are: shaping and influencing policy and regulations; providing technical services; facilitating access to markets; developing and promoting codes of conduct, best management practices and self-regulatory practices; and sharing of knowledge.

As part of their overall privatization strategy, many countries engaged in promoting aquaculture development are expanding the scope of their privatization programme to include the aquaculture sector. In sub-Saharan Africa, for example, Kenya's approach is to play a supportive role by fostering participative policy formulation, providing a conducive legal and investment framework, establishing public-private partnerships, providing basic infrastructure support, promoting self-regulation, providing a research platform, undertaking zoning for aquaculture and providing monitoring and evaluation support.

Civil society groups, including NGOs, are also making substantial contributions to policy formulation and implementation and support to poor aquaculture farmers. These groups have been instrumental in making the sector address the issues that arose from unsustainable shrimp farming practices in many countries in Asia and Latin America.

Co-management is an emerging trend and is usually applied in the management of common property resources, such as floodplains and forests. In the context of the aquaculture sector, the application of co-management (see Box 6 on pp. 72–73) has been effective in culture-based fisheries, a form of aquaculture practised communally in small water bodies in rural areas. This form of aquaculture has the potential to increase fish production with minimal input of resources (e.g. in Bangladesh, Sri Lanka, Thailand and Viet Nam). An evaluation of this type of programme in three countries (Bangladesh, the Philippines and Thailand) found that it had contributed to the development of self-help initiatives, local ownership and decision-making in communities.

Trade

The role of fishery subsidies continues to receive great attention from both governments and civil society. Given their cross-cutting nature, subsidies influence the economic, social and environmental dimensions of fisheries. Thus many different interests are involved. Discussions on fisheries subsidies have been taking place at the technical and policy levels, each influencing the other.

On the technical side, much progress has been achieved from a theoretical and analytical point of view from work in several intergovernmental organizations (*inter*

alia, FAO, the Organisation for Economic Co-operation and Development [OECD] and the United Nations Environment Programme [UNEP]) and NGOs (in particular the World Wide Fund for Nature). On the policy side, the main centre for the negotiations on fisheries subsidies is the WTO Negotiating Group on Rules. During the WTO Ministerial Meeting held in China, Hong Kong Special Administrative Region (2005), in reviewing progress achieved in discussions based on the Doha Mandate of 2001, Ministers noted that there is broad agreement that the Negotiating Group on Rules should strengthen disciplines on subsidies in the fisheries sector, including by prohibiting certain forms of fisheries subsidies that contribute to overcapacity and overfishing. Ministers also noted that special and differential treatment for developing and least-developed Members that is both appropriate and effective should be an integral part of the fisheries subsidies negotiations, taking into account the importance of this sector to development priorities, poverty reduction, livelihoods and food-security concerns. Several text-based submissions for fisheries-specific amendments to the Agreement on Subsidies and Countervailing Measures are being discussed. More recently, under the initiative of several Members, the debate on fisheries subsidies seems to be expanding to areas other than fish-capture activities, i.e. to aquaculture, fish processing, etc.

In addition to focusing on the need to discipline fisheries subsidies that contribute to overcapacity and overfishing, countries are debating how to integrate sustainable development considerations into the fisheries subsidies disciplines. Beyond the general issues concerning the implementation of special and differential treatment, difficulties are being faced in defining small-scale fisheries and in incorporating fisheries access agreements fees into the disciplines. It seems possible that the outcomes of the negotiations will depend on how certain technical issues will be defined and agreed and also on how far WTO Members will go in addressing not only trade, but also environmental and development issues.

With the entry of China into the WTO in 2001, all major fishery countries other than the Russian Federation and Viet Nam (which have started membership negotiations) are now Members of the WTO.

The declaration adopted by the WTO Ministerial Conference in 2005 has important implications for fisheries. Import tariffs on non-agricultural goods, which include fish and fishery products, might be reduced using a certain formula. The exact coefficients and reductions for the formula could have been decided in 2006. Developing country exporters would have benefited from "the reduction or elimination of tariff peaks, high tariffs, and tariff escalation, in particular on products of export interest" to them. For fishery products this could have had possible implications for exporters of value-added products, although countries that enjoy preferential treatment today would see their advantage reduced in the future. Since the above scenario did not materialize owing to failure to reach agreement, the future of the negotiations within WTO still remains uncertain.

Other important issues relevant to international trade in fishery products that have been prominent in recent years include the introduction of new labelling and traceability requirements in major markets; the adoption of the FAO guidelines on ecolabelling of fish and fishery products originating from marine capture fisheries; trade disputes between importing and exporting countries related to alleged dumping of aquaculture products and subsidies in production; the expansion of regional trade areas and the number of new bilateral trade agreements with strong relevance to fish trade. The full impact and long-term effects of these agreements in addition to, or as a substitute for, broader multilateral agreements, are not yet clear. One trade agreement of particular relevance for trade in fish and fishery products is the one currently being negotiated at the regional level between the African, Caribbean and Pacific Group of States (ACP) group of countries and the EU. The objective of these negotiations is to conclude economic partnership agreements between the EU and the six different ACP regions and render them operational from January 2008.



NOTES

1. See, in particular, FAO. 2002. *The State of World Fisheries and Aquaculture 2002*, Box 2, p. 9. Rome.
2. FAO. 1996. *Chronicles of marine fishery landings (1950–1994): trend analysis and fisheries potential*, by R.J.R. Grainger and S.M. Garcia. FAO Fisheries Technical Paper No. 359. Rome.
3. Also includes amphibians (frogs and turtles). For brevity, referred to hereafter as “fish, crustaceans and molluscs” or “food fish supply”.
4. FAO. FAOSTAT (www.faostat.fao.org). Accessed 22 May 2006.
5. The regions match those presented in the analysis outlined in FAO. 2006. *State of world aquaculture 2006*. FAO Fisheries Technical Paper No. 500. Rome.
6. The culture of aquatic plants is not considered in the remainder of this section.
7. While mussels and oysters are high-priced per kilogram of meat, they are relatively low-valued in terms of value per kilogram of whole animals, as shell weight can account for a large percentage of the total (live) weight. It should be noted that statistics on aquaculture production are reported as live weight.
8. Here, brackish-water production is assigned to either marine areas or inland areas depending on the area reported by the country. Thus, production in inland areas and marine areas represents the total of aquaculture production.
9. A “maru-ship” is a Japanese ship operated partially by a non-Japanese crew.
10. Occasional fishers are defined as individuals who derive less than 30 percent of total earnings, or who spend less than 30 percent of the total time worked, in fisheries; for part-time fishers these shares increase to between 30 and 89 percent, and for full-time fishers they are at least 90 percent.
11. FAO. 2006. *The state of world highly migratory, straddling and other high seas fishery resources and associated species*, by J.-J. Maguire, M. Sissenwine, J. Csirke, R. Grainger and S. Garcia. FAO Fisheries Technical Paper No. 495. Rome.
12. The United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (available at <http://daccessdds.un.org/doc/UNDOC/GEN/N95/274/67/PDF/N9527467.pdf?OpenElement>).
13. J.D. Allan, R. Abell, Z. Hogan, C. Revenga, B.W. Taylor, R.L. Welcomme and K. Winemiller. 2005. Overfishing of inland waters. *BioScience*, 12: 1041–1051.
14. M. Halwart and M.V. Gupta, eds. 2004. *Culture of fish in rice fields*. Rome, FAO and The WorldFish Center (available at <http://www.worldfishcenter.org/Pubs/CultureOfFish/Culture-of-Fish.pdf>); FAO. 2004. *Tilapias as alien aquatics in Asia and the Pacific: a review*, by S.S. De Silva, R.P. Subasinghe, D.M. Bartley and A. Lowther. FAO Fisheries Technical Paper No. 453. Rome.
15. This section is based on data published in FAO, 2007. *Fish and fishery products. World apparent consumption statistics based on food balance sheets*. Revision 8: 1961–2003. FAO Fisheries Circular No. 821. Rome. Some discrepancy may occur with other sections that quote data made available to FAO more recently.
16. The term “fish” indicates fish, crustaceans and molluscs, excluding aquatic mammals and aquatic plants.
17. Per capita consumption is calculated on an annual basis and using a live-weight equivalent unless otherwise stated.
18. A distinction is made between RFMOs and regional fishery bodies (RFBs). Usually RFBs do not have fisheries conservation and management mandates. Rather, they seek to promote cooperation among members on fisheries matters of common concern, and may have advisory mandates.
19. During the signing ceremony, held at FAO headquarters, Rome, six countries (Comoros, France, Kenya, Mozambique, New Zealand and Seychelles) and the European Community signed the South Indian Ocean Fisheries Agreement.

20. Even if opt-out provisions are not invoked by parties to an RFMO, their existence and potential use by members weakens the effectiveness of management measures adopted. Significantly, the 2006 Review Conference of the 1995 UN Fish Agreement recommended that states individually and collectively through RFMOs “Ensure that post opt-out behaviour is constrained by rules to prevent opting out parties from undermining conservation ...”.
21. RFMO performance reviews were also addressed in paragraph 60 of the United Nations General Assembly Resolution 60/31.
22. Held in St Johns, Newfoundland, Canada, from 1 to 5 May 2005.
23. The work of the Task Force extended over a period of two years. The report was released in March 2006.
24. FAO. 1995. *FAO Code of Conduct for Responsible Fisheries*. Rome.
25. Ramsar. 2005. *Resolution IX.4. The Ramsar Convention and conservation, production and sustainable use of fisheries resources* (available at http://www.ramsar.org/res/key_res_ix_04_e.pdf).
26. Adopted on 23 October 2000 (available at http://ec.europa.eu/environment/water/water-framework/index_en.html).
27. For further information, see http://www.mrcmekong.org/mekong_program_ceo.htm#integrated_water.
28. For further information, see www.enaca.org.
29. FAO. 2006. *State of world aquaculture 2006*, by R. Subasinghe. FAO Fisheries Technical Paper No. 500. Rome.
30. FAO. 2005. *Mainstreaming fisheries into national development and poverty reduction strategies: current situation and opportunities*, by A. Thorpe. FAO Fisheries Circular No. 997. Rome.
31. For further information, see <http://www.fishforall.org/ffa-summit/africasummit.asp>.
32. For further information, see <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTARD/0,,contentMDK:20663251~pagePK:210058~piPK:210062~theSitePK:336682,00.html>.



PART 2

**SELECTED ISSUES
IN FISHERIES AND
AQUACULTURE**

SELECTED ISSUES IN FISHERIES AND AQUACULTURE

The Code of Conduct for Responsible Fisheries: moving into the second decade of implementation

THE ISSUES

Many FAO Members are experiencing difficulties in the comprehensive implementation of the Code of Conduct for Responsible Fisheries, yet most are moving to implement some of the articles.¹ FAO analysis indicates that the scope and intensity of constraints relating to implementation and the nature of the solutions proposed by countries between 2002 and 2004 did not change significantly. The reasons for these difficulties vary across fisheries, regions and country groups. An understanding of the problems that countries are facing and measures to address them will be essential if ongoing efforts to embed the Code more deeply in national fisheries² policies and action are to succeed.

Many of the problems reported are governance-related. Countries recognize that sound governance is required if the full impact of the Code is to be realized. The governance issues identified are numerous and range from primary considerations such as lack of political support for the implementation of the Code through to issues concerning the application of complex management measures such as the precautionary and ecosystem approaches to fisheries. Additional impeding factors cited by countries are that the fisheries sector is not assigned high priority by many governments because of its small economic contribution and is poorly organized in comparison with other sectors of the economy.

An important consideration with respect to the Code is its complementarity with the 2002 World Summit on Sustainable Development's (WSSD) Johannesburg Plan of Implementation. Analysis has shown that there are clear linkages between the two instruments and efforts to implement the Code's principles and goals imply concurrent action to implement the time-bound fisheries components of the Plan.³

Countries have identified the constraints affecting the Code's implementation and have also proposed solutions aimed at addressing them and strengthening the instrument's implementation. The information provided to FAO is summarized below.

Political support for implementation

Flagging political support for the Code undermines the momentum needed to carry forward initiatives that support its full implementation. Governments need to maintain support for implementation even when the necessary measures are politically unpopular. Governments should continue to focus and act on inherent and entrenched problems that lead to unsustainable fisheries practices, some of which have adverse consequences for food security, livelihoods and economic development. These problems, extending beyond fisheries, include poverty, demographic pressure, illiteracy and low levels of education, as well as suspicion of, and a general resistance to, change. In moulding strategies to promote change and to implement the Code, governments should consider and address ethical concerns, including the right to food and environmental stewardship (see Box 4).

Vision, leadership, planning and accountability

Some countries lack a clear vision for the fisheries sector, especially those whose governments fail to provide leadership for stakeholders and a framework for forward planning. To implement the Code effectively, countries have stressed the need for an "enabling environment" characterized by vision, leadership and planning. As part of



Box 4

Ethical issues in fisheries

That there are limits to the extraction of fishery resources has long been recognized by science. Awareness of growing concerns has been raised in global fora such as the United Nations Conference on Environment and Development (UNCED, 1992), the Millennium Assembly of the United Nations (Millennium Summit, 2000) and the World Summit on Sustainable Development (WSSD, 2002). Policy and management issues related to fisheries resources have been explored largely from ecological, technological and socio-economic standpoints, while the ethical components of these issues have been addressed only in an implicit manner.

Ethical concerns related to the well-being of humans and the ecosystem are central to the debate about the future of fisheries and aquaculture. A global view of ethics is emerging. Human health and well-being and basic human rights (such as the right to food) are considered along with environmental stewardship and the intrinsic values and alternative uses of natural resources and the environment. Attention to these concerns has been increasing and will continue to increase, in part as a response to trends in areas such as demographic change, the changing situation of the resources and their associated ecosystems, progress in science and technology, and social and economic evolution worldwide exemplified by globalization, the increasing role of the market and the concentration of economic power.

The most advanced and complete policy framework and reference for global fisheries is the Code of Conduct for Responsible Fisheries. Although elaborated mainly from technological, social, economic and political perspectives, it contains a number of less explicit, but nonetheless fundamental, ethical considerations and addresses both human and ecological concerns directly. In the twenty-first century this will be of growing relevance as fisheries will see a further increase in the impact of the ethical dimensions of fishing and natural resources management on fisheries development and environmental conservation.

FAO has initiated a series of studies on ethical issues in food and agriculture, including fisheries.¹ The fisheries study suggests and elaborates ways to implement the ethical principles drawn from agreed international instruments relating to fisheries and ecosystems. The discussion outlines the main ethical issues in fisheries and the moral imperatives to which they give rise, considers the role and scope of ethics in this context and recalls briefly the institutional foundations of fisheries policies as reflected in the Code of Conduct. The study presents a holistic ethical approach to fisheries, paying special attention to the effects of fisheries management and social policy upon people's living conditions.

¹ FAO. 2005. *Ethical issues in fisheries*. FAO Ethics Series No. 4. Rome.

this process, governments should specify clearly the short- and long-term goals they wish to achieve in the implementation process. It has also been noted that greater accountability on the part of stakeholders enhances the Code's implementation and therefore accountability at all levels should be encouraged.

Policy, legal frameworks and strategies

Inadequate policy, legal frameworks and fisheries development strategies restrict the implementation of the Code by failing to provide the necessary safeguards to prevent unsustainable fisheries practices. To address these shortcomings, countries have pointed to the need to undertake policy and legislative reviews and to elaborate transparent strategies to ensure that the Code's principles and essential elements are adequately reflected in such initiatives.

Human resource development and institutional strengthening

The lack of progress in implementing the Code is linked directly to human resource and institutional capacity constraints. Countries have underscored the need to ensure that capacity-building efforts are maintained and, owing to high attrition rates, that human resource development is sustained. Related to the issue of weak institutional capacity is the need to foster more effective interagency collaboration because a lack of such cooperation has a serious impact on the Code's implementation. Similarly, there is a need to address inadequate coordination and communication among national fisheries administrations and other national agencies and with RFBs.

Availability of, and access to, timely, complete and reliable information

The limited availability of relevant scientific, social and economic information and its poor accessibility to stakeholders inhibits the Code's implementation (see Box 5). This situation contributes to poor levels of scientific and related research – a basic consideration for implementation. To address these shortcomings, countries should promote improvements in the collection and dissemination of information with due regard to information of highest priority. Countries have stressed that there is a lack of social and economic information to support the Code's implementation and have encouraged greater emphasis on its collection and use. In some instances, they have also urged that fishing communities be involved in information collection in small-scale fisheries.

Participation and co-management

A centralized approach to fisheries management and lack of consultation with stakeholders are further obstacles to the Code's implementation. There is a resultant need to involve all stakeholders, including NGOs, more fully. Countries are encouraged to facilitate an "inclusive" approach to fisheries management in which stakeholders, through their participation and co-management, are called upon to play important roles in decision-making (see Box 6). For both small-scale and industrial fisheries, there is increasing evidence that where fisheries decision-making is participatory in character and is seen to be fair and transparent, management measures are implemented more fully, with less recourse to enforcement and at lower cost.

Awareness building

Many stakeholders are unaware of the essential elements of the Code and of its central role in promoting long-term sustainability. The Code's dissemination is adversely affected by a lack of adaptation to local needs, limited availability in local languages and, where it is available, its poor distribution. Many countries have stressed that building awareness about the Code is a primary tool in facilitating its implementation. They have proposed its translation into local languages so as to broaden dissemination and to facilitate the establishment of national awareness-raising campaigns. To support awareness building and the formulation of outreach strategies, countries have proposed that workshops and meetings be continued as a means of dissemination,



Box 5

Information to support implementation of the Code of Conduct for Responsible Fisheries

Underpinning the implementation of the Code, as recognized in Articles 7 to 12, is the need for two broad categories of information: general information about the Code (its goals, coverage, etc.) and specialized and technical information of a research nature.

In order to understand more clearly the scope of these information needs, an FAO study¹ was carried out in 2004 to assess the nature of the information used and produced by selected specialists working in fisheries management. The surveys, case studies, citation analysis and literature review highlighted the breadth of subjects required, the historic depth of relevant information, the scale of information from local to global, and the diversity of information sources.

Given this complexity, it is not surprising that a major effort is required to obtain the best information upon which to base decisions and policy. The lack of global information resources in developing countries presents significant, but not insurmountable, challenges and the study proposes strategies to help meet them. It is also recognized that the results of research and the development lessons learned are often lost because of inadequate opportunities to publish in developing countries. Moreover, capturing information that has been published has never been totally effective and much needs to be done to improve dissemination and the sharing of information, as well as to ensure its preservation for future generations.

The digitization of information and its availability via the Internet offer enormous potential for improved access and dissemination. Stakeholders in many developing countries are, however, still waiting for the reliable, high-speed and cost-effective access that is already available in the industrialized world. Therefore, an effective infrastructure and access to Open Access information resources is essential. Improved integration of the information

that the media be used to their fullest extent and that the use of the Code's technical guidelines (some of which are available in simplified language) continue to be promoted as a basic tool for implementation.

Availability of resources

A lack of resources, including funds, equipment and access to research facilities, constrains the Code's implementation, especially in developing countries, with respect to the ecosystem and precautionary approaches to fisheries and to MCS and VMS programmes. Countries have indicated the need for additional technical support from FAO and financial support from the international donor community. They have also noted that additional resources would enable them to strengthen efforts to elaborate national plans of action, as called for by the four international plans of action.

Fisheries management

Countries are experiencing problems in managing fisheries, developing fisheries management plans and in implementing the international plans of action. They have also pointed out that some fisheries are not subject to management and that such open-access conditions are leading to overfishing. Furthermore, even when fisheries are subject to management, many of the stocks under such regimes continue to be

generated in developing countries into the mainstream of fisheries and aquaculture publications will facilitate the use and validation of research results and avoid costly and wasteful duplication of effort.

The 31st Annual Conference of the International Association of Aquatic and Marine Science Libraries and Information Centers (IAMSLIC), hosted by FAO in October 2005, provided an opportunity to discuss information-resource sharing and networking as the most cost-effective means of meeting information needs.² One issue that emerged from this forum was that few organizations have a mandate that permits them to extend their library and information services beyond their own defined community. There is an obvious need to do so, especially given recent trends towards the decentralization of fisheries management or at least some form of community participation in management. Stakeholders at the local level have limited access to information and their needs should also be understood and met. There is a need to qualify what is meant by the term *lack of information* as a constraint and a concerted effort must be made to find long-term solutions.

¹ FAO. 2005. *Fisheries information in developing countries. Support to the implementation of the 1995 FAO Code of Conduct for Responsible Fisheries*, by J.G. Webster and J. Collins. FAO Fisheries Circular No. 1006. Rome (available at <http://www.fao.org/docrep/007/y5847e/y5847e00.htm>).

² IAMSLIC. 2006. *Information for responsible fisheries: libraries as mediators*. Proceedings of the 31st Annual IAMSLIC Conference, Rome, 10–14 October 2005. Fort Pierce, Florida, USA. In press.



either fully exploited or overexploited and the recovery plans for these stocks, which should be a high priority, are being implemented only slowly. Countries have reported difficulties in applying more advanced forms of fisheries management practices and have indicated the need for assistance in areas such as:

- drafting national codes and national plans of action;
- implementing vessel buy-back and industry restructuring schemes to reduce fishing capacity;
- improving fisheries research capabilities, including possible twinning arrangements between research institutes in developing and developed countries;
- identifying and assessing new and underexploited fisheries resources;
- implementing the ecosystem approach to fisheries.

Noting the strong social and economic pressures on fisheries, including vulnerability to poverty and a lack of alternative employment opportunities for fishing communities, countries have stressed that overcapacity in the fisheries sector should be addressed through employment creation in other economic sectors.

Illegal, unreported and unregulated fishing

IUU fishing, now recognized as an environmental crime, is a major impediment to achieving long-term sustainability. It undermines management efforts and rewards fishers who fail to observe national and regional management arrangements. Countries

Box 6

Introducing and promoting fisheries co-management

Over the past 20 years it has become increasingly evident that fisheries management cannot be effective unless the people who harvest the resources (communities and fishers) are effectively involved in the management process. There is now a shift to systems of co-management, i.e. systems that involve both governments and communities/resource users in shared decision-making and planning.

Experiences with projects piloting co-management in many countries have demonstrated success, but in many cases co-management initiatives were not sustained after project support was removed. Co-management needs to be “mainstreamed” into the daily activities of government and stakeholders.

Based on lessons learned over the past ten years, the Asia-Pacific Fishery Commission (APFIC) contends that four pillars are essential for successful co-management:

- an enabling policy legislative environment;
- empowerment of communities;
- effective linkages and institutions;
- adequate resources.¹

An *enabling policy and legal framework* ensures that, where there is political will, governments can facilitate and support co-management. Typically, the state is entrusted with the management of the fishery resource, but it can assign responsibility to local communities/individuals to manage at the local level, or recognize their competence in this respect. Local ownership improves compliance with locally agreed rules and greatly improves the alignment of these rules with national legislation. It is essential that governments (either locally or nationally) demonstrate a willingness to change policy, involve communities and help define the roles and responsibilities of the different players.

Communities involved in co-management must be *empowered* to ensure effective participation and sustained involvement. The strengthening of organizations and institutions so that they fully recognize their role in the management process is a prerequisite for success.

have reported that their fisheries resources are subject to persistent IUU fishing by both national and foreign vessels. Some of them have started to implement the 2001 FAO International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU) and have elaborated National Plans of Action to Prevent, Deter and Eliminate IUU fishing (NPOAs-IUU), but they lack the capacity to follow through with their implementation. Capacity to thwart IUU fishing as a consequence of poorly developed MCS and VMS remains a major concern. Many countries are focusing more sharply on the implementation of port state measures and product traceability and trade measures as a means of blocking landings and sales of IUU-caught product.

POSSIBLE SOLUTIONS

FAO's Committee on Fisheries, at its twenty-sixth session in 2005, called for a “decade of implementation” for international fisheries instruments. The focus of attention was instruments developed since the United Nations Conference on Environment and

Effective co-management requires *good linkages among participating stakeholders*. The networks of stakeholders must be understood and information sharing between them must be encouraged. Often, other (non-fisheries) users of the resource, such as farmers and the tourism industry, should be involved in certain stages of the process. Ecological well-being (or “state of the resource”) must be balanced with human well-being (i.e. the need for food or income); achieving this balance inevitably requires management trade-offs, which must be recognized and addressed.

Last, it must be recognized that effective co-management requires *resources and time* if it is to work. In the first instance, there obviously has to be a resource that is considered worth managing. The transaction costs for participation in meetings, monitoring, enforcement and management are often underestimated at the start of a co-management initiative. Governments and communities must recognize the need for these resources and commit to their provision.

Our current state of knowledge shows that there is no single template for ensuring success in fisheries co-management initiatives. Experience does show that where there is adequate will, commitment and partnership, fisheries management measures are more effective, conflicts are reduced and there is greater hope for sustainable and rational use of fisheries resources. Governments can play a leading role in committing to co-management and initiating this process.

¹ FAO. 2005. *Report of the APFIC regional workshop on “Mainstreaming Fisheries Management”*, Siem Reap, Cambodia, 9–12 August 2005. RAP 2005/24. Bangkok.



Development (UNCED) in 1992, including the Code (and its associated International Plans of Action and Strategy), to ensure that concerted action would continue to promote long-term sustainability in the fisheries sector. The Code provides an important reference tool for fisheries management and utilization for all countries. Its implementation is contributing significantly to attitudinal and behavioural changes within the sector – changes that are essential for securing a sustainable future for national and regional fisheries resources.

Within the limits of its available resources, FAO continues to focus on assisting countries in implementing responsible fisheries policies and applying the measures necessary to achieve specified sustainable goals. However, FAO's role is limited to a facilitating one as it is the countries themselves that must initiate the measures needed to implement the Code.

An important aspect of FAO efforts to promote the Code's implementation focuses on capacity building, both in terms of human resources and institutional strengthening. Investment in capacity building is necessary for downstream implementation of the

Code. Moreover, returns are generally not reaped in the short term, and capacity loss in developing countries is common as trained personnel move to the private sector, transfer within the government or migrate abroad.

Capacity building is a prerequisite for strengthening fisheries governance. It is also important for implementing more sophisticated approaches to fisheries management, especially the precautionary and ecosystem approaches. Both of these would modify the strong focus that prevails in many countries on production-oriented management regimes that have generally failed to encourage sustainable fishing practices and outcomes.

The Code provides a comprehensive, coherent and transparent framework for fostering cooperation and building bridges with bilateral and multilateral partners in accordance with the spirit of the Code's Article 5, "The special requirements of developing countries". Importantly, the biennial assessments submitted by countries when reporting to FAO on their implementation efforts indicate priority areas for assistance. The international donor community, on the basis of this information, is better placed to target the needs of fisheries and to commit assistance to promoting best practices for long-term sustainability.

Implementation of the Code is demanding in terms of both resources and time – and for most countries must be selective and gradual. A national plan that specifies long-term goals and the means for achieving them is a good first step. Most administrations need access to increased public resources and willingness on the part of governments to accelerate legal change. Incremental implementation will permit hands-on experience through learning by doing.

RECENT ACTIONS

The Code overarches FAO's entire fisheries work programme. All normative and field activities are geared to implementing the Code by building on, and consolidating, past work and achievements and ensuring that current and programmed activities reflect its principles and intent. Much of this work centres on strengthening governance in the fisheries sector. Through partnership and other cooperative arrangements, FAO also provides inputs into non-FAO activities that have a direct impact on the Code's implementation.

In the area of capacity building, FAO has directed considerable efforts to addressing IUU fishing in developing countries – a key aspect of implementing the Code. For example, a global series of dedicated regional workshops has been sponsored to support the elaboration of NPOAs-IUU, which is a basic requirement of the IPOA-IUU (see Box 7) and five regional MCS workshops have been held to disseminate information and provide training on the application of VMS.

A major FAO initiative commenced in 2005 to implement the Model Scheme on Port State Measures that was adopted by the FAO Committee on Fisheries at its twenty-sixth session. Endorsed by other organizations and fora, including the United Nations General Assembly, the Model Scheme is accepted as the basis for developing regional and national port state measures. The FAO initiative focuses on human resource development through regional workshops. The workshops are designed to strengthen national capacity and promote regional coordination so that countries can improve and harmonize port state measures and, as a result, implement the IPOA-IUU tools pertaining to port state measures and meet the requirements of both the FAO Model Scheme and of RFBS. The first workshop will be held in the Pacific Islands region with the cooperation of the South Pacific Forum Fisheries Agency and the West and Central Pacific Fisheries Commission. The region adopted the Model Scheme at its annual session in 2005.

The Code's technical guidelines are fundamental to supporting its implementation. Fourteen technical guidelines have already been prepared, translated into the FAO official languages and disseminated. The most recent concern the contribution of small-scale fisheries to poverty alleviation and food security. Others are in preparation and address the implementation of the IPOA-IUU in inland fisheries, the implementation of the 1999 FAO International Plan of Action for reducing Incidental Catch of Seabirds

Box 7

Strengthening national capacity to combat IUU fishing

Illegal, unreported and unregulated fishing, and its adverse impacts on national and regional efforts to manage fisheries in a long-term sustainable manner, is one of the main problems facing capture fisheries. In March 2005, Ministers declared their intention to renew their efforts to develop and implement national and regional plans of action to combat IUU fishing (NPOAs-IUU).¹ They also urged the provision of additional assistance to developing countries to help them implement their commitments in preventing, deterring and eliminating IUU fishing, including the provision of advice and training to promote the development of fisheries management regimes, at the national and local levels, to combat IUU fishing.

In 2003, FAO embarked upon a series of regional workshops to broaden and deepen the implementation of the 2001 International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU). The workshops were intended to develop and strengthen national capacity so that countries would be better placed to elaborate NPOAs-IUU, the principal vehicles by which the IPOA-IUU is to be implemented.

Between 2003 and 2006, FAO convened nine regional workshops in Eastern and Southern Africa, Southeast Asia, the Caribbean, the Pacific Islands, West Africa, the Near East, South America and Central America. In total, 215 people (18 percent of whom were women) from 90 developing countries (48 percent of FAO's Members) received training.

The workshops sought to raise awareness about the deleterious effects of IUU fishing and the need for countries to act in a concerted and decisive manner to combat such fishing and to provide a comprehensive understanding of the IPOA-IUU, its relationship with other international fisheries instruments (e.g. the 1993 FAO Compliance Agreement and the 1995 UN Fish Stocks Agreement) and its relevance to the fisheries situation in participants' countries. They also aimed to define more clearly the steps that fisheries administrations should take to develop NPOAs-IUU and to share information about the merits of harmonizing measures on a regional basis to prevent, deter and eliminate IUU fishing.

¹ The 2005 Rome Declaration on Illegal, Unreported and Unregulated Fishing was adopted by the FAO Ministerial Meeting on Fisheries in Rome on 12 March 2005.



in Longline Fisheries (IPOA-Seabirds), the implementation of the 1999 International Plan of Action for the Management of Fishing Capacity (IPOA-Capacity), health management, the responsible movement of live aquatic animals, the application of international quality and safety standards for fish exports, the use and control of alien species, stocking, habitat rehabilitation and genetic resource management, information needs, fish trade, and fishing vessel registration. In addition to the Code's technical guidelines, FAO is producing other fisheries and aquaculture guidelines that are designed to promote sustainability in the fisheries sector.

Many partner organizations are active in the fisheries sector in developing countries, providing assistance predicated, if not formulated, on implementing the Code, its associated instruments and the other international fisheries instruments concluded since UNCED (e.g. the 1995 UN Fish Stocks Agreement). The nature and

scope of this assistance varies by country and region but its underlying thrust is to encourage fishers and fishing communities to act more responsibly and to encourage sustainable fishing and utilization practices.

OUTLOOK

The outlook for the Code's implementation remains mixed in many countries even though there are strong indications that it is taking root in many of them and guiding efforts in the management and use of fisheries. Developing countries face a suite of constraints that impede governance and inhibit their capacity to implement the Code. All countries, irrespective of their level of development, are grappling with the implementation of new approaches to the management of fisheries. Conceptually, these approaches are readily elaborated and understood but constraints are encountered when action is required to put them into practice.

The need for ongoing capacity building and institutional strengthening, taking into account the difficulties and needs identified by developing countries, is critical if further progress is to be achieved. Efforts to build on past outcomes by broadening and deepening implementation are required. Countries will continue to be strained as they seek to implement the considerable number of international fisheries instruments concluded since UNCED, especially in fulfilling the obligations they have assumed through the acceptance of some of these instruments.

The logistical aspects of promoting "inclusive" approaches to fisheries, as envisaged in the Code, are proving to be a challenge for many countries and greater efforts should be devoted to achieving higher levels of participation in decision-making. In many countries, participatory approaches to fisheries are new, requiring fundamental adjustments in both thinking and organization. Coupled with broader stakeholder participation is the need to promote greater accountability among stakeholders.

Maintaining momentum to support the Code's implementation is an ongoing issue for many countries. In the face of limited capacity and stressed by the workload, many fisheries administrations are buckling under the strain. This stress is also highlighting and exacerbating other administrative shortcomings that impede implementation. This situation points to the need for countries to continue monitoring their progress with regard to implementation and to take remedial action to the extent that their resources and capacities permit.

Sustainable growth and expansion of aquaculture: an ecosystem approach

THE ISSUE

Aquaculture has a long tradition in some parts of the world, and many examples of well-integrated aquaculture systems can be found throughout mainland Asia and in the Pacific Islands. In the past, these activities were generally limited in impact owing to their small scale and their low-input nature. The systems were reliant on locally produced inputs, often within the larger farming system. With the progressive development of aquaculture as a commercial enterprise capable of generating significant income at household or business levels, these linkages have tended to be broken. Even in less-developed economies (such as certain countries in Africa) where aquaculture was introduced some decades ago as a low-investment subsistence alternative, today's production is increasingly aimed at satisfying market demands rather than supplying fish for household needs.

Commercial aquaculture development invariably involves the expansion of cultivated areas, higher density of aquaculture installations and the use of feed resources produced outside the immediate area. With more intensive production methods there are also tendencies to introduce alien species, use more intensive formulated feed regimes and, in some systems, administer chemicals for the control or management of diseases. All these practices can have an aggregated effect at the ecosystem level and compromise its overall integrity.

Common effects of many aquaculture practices on the ecosystem may include any of the following:

- increasing demands on fisheries for fishmeal/oil, which are major constituents of carnivorous/omnivorous species feeds;
- nutrient and organic enrichment of recipient waters resulting in a build-up of anoxic sediments;
- changes in benthic communities;
- eutrophication of lakes or coastal zones;
- disruption, and sometimes permanent restructuring, of biological and/or social environments;
- competition for, and in some cases, depletion of resources (e.g. water);
- negative effects from escaped farmed organisms.

The large-scale (extensive and/or intensive) development of shrimp culture in some areas has resulted in the degradation of wetlands and mangroves, and has also caused water pollution and salinization of land and freshwater aquifers. The misapplication of chemicals, the collection of seed from the wild and the introduction of alien species have also caused concern in some locations. Even intensive aquaculture practices that do not require external feeds, such as mollusc culture, can under certain conditions produce local anoxia of bottom sediments and increased sedimentation. Expansion of commercial aquaculture has also led to instances of negative interaction with coastal small-scale fisheries, when there is competition for space with fishers and/or when escaped fish or environmental deterioration negatively affects fisheries. Some of these effects can indeed “jeopardize the options for future generations to benefit from the full range of goods and services provided by ecosystems”.⁴

As is the case in most food production systems, aquaculture has, or can have, negative impacts. These must be kept within socially acceptable limits.⁵ The inadequate environmental management of (intensive or extensive) aquaculture is an issue that needs to be taken seriously. Letting aquaculture development proceed irresponsibly or taking only partial approaches to its management incurs a risk that the negative impacts may counteract any benefits from aquaculture or that it will not produce the expected benefits. In the long term, aquaculture may fail to provide the additional fish supplies needed to meet the demands of a growing world population.

Nevertheless, aquaculture itself is also subject to the negative impacts of anthropogenic factors such as contamination of feed and of aquatic environments by urban waste and agricultural pollution, and landscape mismanagement. These factors limit the scope and nature of aquaculture development in some regions of the world.

POSSIBLE SOLUTIONS

The conventional approaches

It is not surprising, perhaps, that attempts to deal with the negative impacts of aquaculture have taken many forms. On the one hand, those responsible for governing the sector have developed broad principles (e.g. the Earth Summit) and codes of conduct (e.g. the Code of Conduct for Responsible Fisheries). On the other hand, those who are asked to harmonize the expectations of aquaculture entrepreneurs with the exigencies of the ecosystem often have recourse to control and command strategies (e.g. licences, standards for feed, use of pharmaceuticals).

Regulations

In an attempt to control inadequate developments, countries worldwide have implemented a large number of aquaculture regulations. These have varied from the general – for example, banning of mangrove utilization for aquaculture practices – to the very specific – for example, determining maximum production per area, rules for disease control, and use of drugs.

However, these regulations – neither on their own nor taken together – do not provide a comprehensive framework for ensuring the sustainable use of aquatic environments. That will happen only when aquafarming is treated as an integral process within the ecosystem.



Advances in technology have made production more efficient and have facilitated intensification. Yet the regulations in place cannot guarantee sustainability, especially as most of them focus on the individual farmer and do not consider the additive (cumulative) or synergistic effects of multiple farms on a particular area. At the same time, farmers' economic appraisals tend to have a narrow (short-term) view, focused on the more immediate production results. Such appraisals do not include the medium- and long-term revenues and costs that may be imposed on the farming activity itself and on the rest of the society in the form of a reduced supply of ecosystem goods and services.

Moreover, and equally important, the regulatory structure for aquaculture often does not allow, or facilitate, a production mode or approach that is conducive to a balanced ecosystem. Nutrient cycling and reutilization of wastes by other forms of aquaculture (polyculture) or local fisheries are frequently prohibited or discouraged.⁶

Decision-making tools

Environmental impact assessment⁷ (EIA), in its various forms, is possibly the most common tool in use. EIA has been used worldwide by those in charge of controlling the impact of all kinds of human activities that are potentially damaging for the environment, including commercial aquaculture. A typical EIA considers the positive as well as negative aspects of the activity, whether direct or indirect, and of an environmental, social and economic nature. However, as employed, the EIA usually does not take into account other kinds of impact that are relevant for aquaculture. Frequently it is activity-oriented, even farmer-oriented, but does not consider strategic or integrated planning.

A wide range of EIA and monitoring procedures are currently employed worldwide and some of them are well adapted for use with aquaculture proposals and activities. Yet in many other cases such procedures are simply not used, not sufficiently developed, or are well known but not implemented. Also, they may be inadequately designed inasmuch as they are not capable of providing key information on changes in the ecological features of the specific environments that sustain – or are proposed to sustain – given aquaculture practices.⁸ A major drawback of EIAs is that they usually cannot be applied to existing aquaculture enterprises because they do not provide the detailed information necessary to apply remedial measures for any harm already done to the environment.

A further problem is that EIAs alone do not ensure a sufficiently coherent view of the ecosystem. Frequently, where aquaculture is practised there are also, *inter alia*, agriculture, industrial or urban development and tourism. These all use common resources (e.g. coastal areas, water), yet in many cases each is evaluated independently without considering the future likely development of other users and of the combined effect on the ecosystem. Likewise, EIAs often fail to take into account the human and social aspects of the target activity, in particular with regard to the poorest segments of society.

The ecosystem approach to aquaculture

The mandate

The concern about the impact of human development on the ecosystem goes back several centuries. Recently, the 1992 Earth Summit in Rio de Janeiro, Brazil, concluded that environmental management policies, often developed for one sector without much regard to other sectors, were not adequately covering the full impacts of human development and exploitation on the environment.⁹ Following the summit there was a concerted move to develop and apply a more holistic approach to policy decision-making with regard to sustainable development. This included a more ecosystemic approach to development and management.

The first principle for an ecosystem approach, as described by the Convention on Biological Diversity (CBD), is that the objectives of management of land, water and living resources are matters of societal choice.¹⁰ But, this novel approach to

management of natural resources also implies focusing on changing human behaviour and attitudes towards the use of natural resources.

In 1995, the Code of Conduct for Responsible Fisheries was adopted by the FAO Conference. The Code also deals with aquaculture more specifically through Article 9, addressing many aspects relevant for its sustainable development.

All of the above amount to an implicit recognition by those concerned that a number of potential impediments to continued growth and intensification of aquaculture must be overcome, if this activity is to conform to the growing expectations of society for ecologically sustainable development (ESD).¹¹ The ecosystem approach to aquaculture will indeed be the way to overcome these impediments and can serve as the ESD implementation framework that is essential to satisfy the conceptual objectives of UNCED, WSSD, CBD and other international instruments.

The implications

An agreed definition of the ecosystem approach to fisheries (EAF) already exists.¹² The ecosystem approach to aquaculture can be modelled on this definition, as follows:

An ecosystem approach to aquaculture (EAA) strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties of biotic, abiotic and human components of ecosystems including their interactions, flows and processes and applying an integrated approach to aquaculture within ecologically and operationally meaningful boundaries. The purpose of EAA should be to plan, develop and manage the sector in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by aquatic ecosystems.

This definition implies the need to use proper instruments, processes and structures to deal effectively with issues of an environmental, social, technical, economic and political nature. Following the principles of the EAF¹³ and ESD, the EAA should have three main objectives within a hierarchical tree framework: i) human well-being, ii) ecological well-being and iii) the ability to achieve both, i.e. effective governance.

The EAA framework can be developed and applied/used at least at the scales or levels described below,¹⁴ but with the requirement to provide adequate norms and regulations for each level.

At the farm level with the implementation of sound EIA or similar decision-making tools (i.e. those that ensure proper consideration of, and accounting for, ecosystem effects of the proposed activity) for new aquaculture activities and the development of retrospective impact assessment and mitigation tools for activities that already exist. At this level, some of the relevant decisions to be made with an ecosystem perspective are site selection, production level, species to be used (exotic versus native), farming systems and technologies and, very important, the socio-economic effects at the local level. Likewise, improved management practices are usually implemented and followed up at the farm level.

At the proper geographical scale. This can vary and consist of, for example, the watershed, the coastal zone, the offshore marine area or the biogeographical region where aquaculture activities take place. The application of strategic planning and management guidelines and tools should promote the development of human societies around integrated and sustainable aquaculture. Issues such as escapees, disease transmission, contamination from and to aquaculture, competition for land and water use will be relevant at this level. Likewise, the implications for human well-being are highly relevant at this geographical scale, for example regarding job availability, rural development, consideration of indigenous communities and gender issues. The latter aspects need to be considered within existing scenarios and alternative projects for human development in the area.

While the EAA should be the responsibility of aquaculture agencies, its full implementation will require collaboration with, and cooperation from, agencies



responsible for managing other activities that have an impact on the aquatic ecosystem (e.g. capture fisheries administration, coastal zone development bodies, watershed management organizations, agriculture, forestry, industrial development). The design of aquaculture management zones could be a relevant tool, particularly when including the benefits of integrated multitrophic aquaculture¹⁵/polyculture or integrated aquaculture–fisheries initiatives. Such approaches can also be relevant at the farm level. Further important aspects, at both farm and regional levels, are anthropogenic impacts on aquaculture and the need for increased protection from such impacts.

At the industry level. At this broader level the EAA should apply where issues such as availability of raw material (in particular fish) for feed manufacture and broader ecosystem impacts on fisheries and agriculture resources need to be considered. Tools such as lifecycle assessment (LCA)¹⁶ of aquaculture commodities could be useful at this level. Other relevant issues include those relating to markets and marketing, employment and salaries, and social opportunities for the region and the country.

RECENT DEVELOPMENTS

A good model for practical implementation of EAA can be found in Australia, where an ESD approach to aquaculture has been developed and is being implemented.¹⁷ The approach combines analytical and participatory methods and aims to achieve ecosystem and human well-being through effective governance.

A relevant step towards EAA was provided by GESAMP in 2001 when it published its guidelines and tools for the planning and management of coastal aquaculture development.¹⁸ The planning process proposed uses EIA but within a broader framework that considers the integration of aquaculture with other coastal activities and assesses costs and benefits in a more comprehensive manner.

Several research initiatives focusing on a more ecosystemic approach to aquaculture are currently in progress, such as the ECASA project in the Mediterranean Sea,¹⁹ which is facilitating the adoption of the EAA in this region.

Even though the EAA is still at a very early stage of development, relevant lessons can be drawn from its application within the ESD framework as well as from experiences and knowledge obtained from freshwater integrated fish farming and coastal polyculture systems (e.g. fish and mussels, fish and seaweeds). These experiences derive from the sustainable use of ecosystems through enhancing or combining aquaculture activities with other activities, such as fisheries (e.g. aquaculture-based fisheries) and agriculture (e.g. rice–fish farming). These culture systems contribute positively to environmental improvement by recycling nutrients and organic matter through integrated farming systems. Integrated aquaculture–agriculture practices have shown how rice–fish culture can help farmers reduce the use of environmentally damaging pesticides, while fish culture naturally improves the fertilization of rice fields, protein production and economic viability. Wastewater-fed freshwater aquaculture and coastal mollusc and seaweed farming can be used to recover excess nutrients, thereby reducing risks of eutrophication and other negative effects.²⁰ These technologies and management approaches can also be considered as important mitigation strategies to be applied in existing farms for which no appropriate planning was done or for which EIA types of tools were not used, or were used improperly.

Considering consumers' increasing awareness of environmental and food safety issues, some farmers and (more often) farmers' associations/consortia have adopted a variety of standards and labels, most of which are specifically intended to allay consumers' concerns about negative environmental consequences. Examples of such labels are the "better management practices", clean production agreements, "principles of responsible aquaculture",²¹ and certification and ecolabelling schemes.²² Certain portions of the industry, at least, in different countries and regions, are becoming more aware and better prepared to adopt a full EAA.

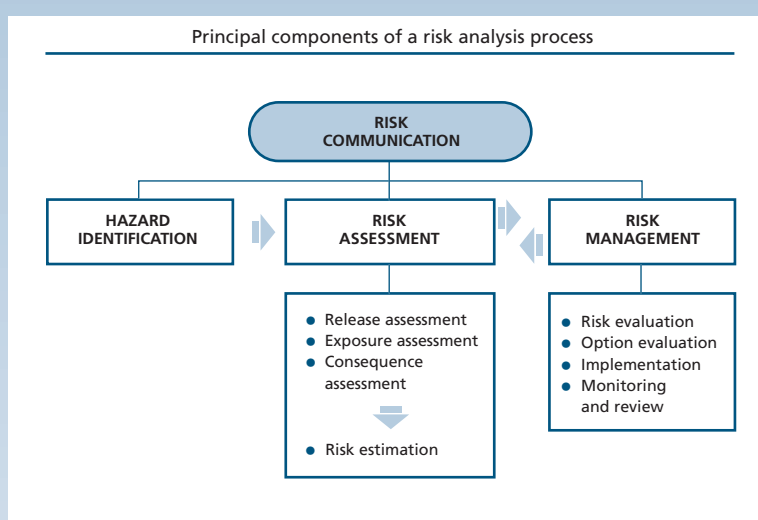
Other key aspects to be considered when implementing an EAA include the following.

Box 8

Risk analysis

"Risk" has been defined as "a combination of the severity of consequences and likelihood of occurrence of undesired outcomes", and "hazard" as "the presence of a material or condition that has the potential for causing loss or harm".¹ No matter how well managed a system is, there will always be associated hazards and risks.

The process of risk analysis is driven by multiple objectives for resource protection as embodied in a number of international agreements and responsibilities.² The principal components of a risk analysis process are illustrated below.³



When applying any risk analysis, all people at risk should be included. Civil society dialogue and public-private partnerships should be promoted. The use and dissemination of reliable scientific information should be an integral part of risk management. At the national level, enabling legal and policy environments that support the application of risk assessments and management measures should be promoted. In order to understand more clearly the risks, hazards and vulnerabilities; to develop methods to assess them as well as study the connections between the different risk events and patterns; and to identify integrated approaches to risk management, awareness raising and capacity building will be necessary and should be treated as matters of priority, especially for developing countries.

Key challenges in applying risk analysis to aquaculture are the inadequacy of scientific information, both in terms of quality and quantity, and the lack of appropriate methodology.

¹ R.W. Johnson. 1998. Risk management by risk magnitudes. *Chemical Health & Safety*, 5(5): 1-2.

² Examples include the Agreement on the Application of Sanitary and Phytosanitary Measures, the Convention on Biological Diversity, the Cartagena Protocol on Biosafety and Codex Alimentarius.

³ FAO. 2004. *Surveillance and zoning for aquatic animal diseases*, edited by R.P. Subasinghe, S.E. McGladdery and B.J. Hill. FAO Fisheries Technical Paper No. 451. Rome.

Box 9

Alien species in fisheries and aquaculture

The ecosystem approach, as defined by the Convention on Biological Diversity, recognizes that the decision to develop, use or conserve resources will be a matter of societal choice and the sovereign rights of governments. One aspect of these choices concerns the use or not of alien species. Wise choices will depend on accurate information.

Article 9.2.4 of the Code of Conduct for Responsible Fisheries recommends that "States should establish ... databases ... to collect, share, and disseminate data ...". The FAO Database on Introductions of Aquatic Species (DIAS) contains over 4 000 records of introductions of fish, molluscs, crustaceans, aquatic plants and other aquatic organisms.

The information in DIAS is incomplete, however. This mostly reflects the fact that concerned authorities have not monitored and evaluated past introductions. Monitoring and evaluation of the use of alien species in fisheries and aquaculture need to be improved and preferably should include analysis of both environmental and socio-economic impacts.

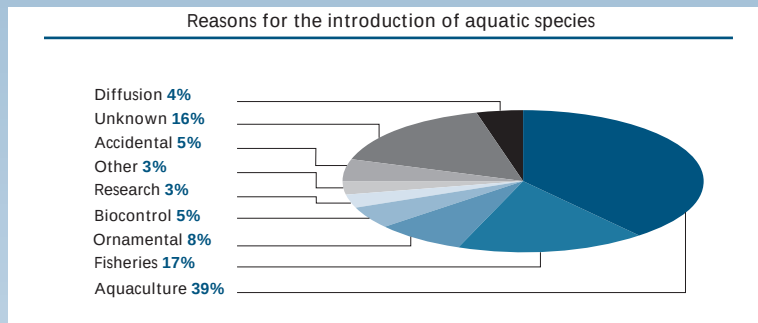
Analysis of the information contained in DIAS revealed that the ten species most often introduced include omnivores, herbivores and carnivores, as listed below ranked from most to least common:

1. Common carp (*Cyprinus carpio*)
2. Rainbow trout (*Oncorhynchus mykiss*)
3. Mozambique tilapia (*Oreochromis mossambica*)
4. Silver carp (*Hypophthalmichthys molitrix*)
5. Grass carp (*Ctenopharygodon idella*)
6. Nile tilapia (*Tilapia nilotica*)
7. Large-mouth bass (*Micropterus salmoides*)
8. Mosquito fish (*Gambusia affinis*)
9. Big head carp (*Aristichthys nobilis*)
10. Goldfish (*Carassius auratus*)

Aquaculture was the main reason for the deliberate movement of aquatic species across national borders (see Figure).

Although DIAS does contain reports on the impacts of alien species, the information is incomplete and indicates that improved monitoring and assessment are needed. Impacts of introduced species fall into two broad categories: ecological, which includes biological and genetic effects, and socio-economic effects. However, these two categories are not independent and socio-economic changes brought about by alien species can, in turn, cause further ecological changes. Although records in DIAS indicate that there are more positive social and economic benefits than negative impacts from the use of alien species, adverse impacts can be serious.

- There is a need to define relevant policies and regulations at the farm, regional, subsectoral and sectoral levels that focus more clearly on aquaculture as an integral means for human development. This implies involving the farmers and the private sector in decision-making (implementing the ecosystem approach with all stakeholders), which may require clarifying the costs and benefits of an EAA as well as defining rights and duties at all levels. The EAA may not be implemented successfully if it is not fully understood and adopted by the industry and the individual farmers. It may also be necessary to create economic and other incentives for an EAA. In general, an EAA can be a powerful pathway to meeting



Negative environmental impacts, which are not always immediately obvious, have included loss in native biodiversity from:

- direct ecological interactions such as predation and competition;
- genetic contamination when alien species breed with local strains or species;
- disease transmission when alien species bring in new pathogens;
- habitat alteration.

Negative economic impacts may arise when the biodiversity that is affected supports agriculture or fisheries. An example of this is the introduction of the golden apple snail into 15 countries, mostly in Asia, in the hope of developing an export industry. However, none of these 15 countries has reported snail exports and, instead, rice farmers in these countries have suffered as the snail consumes large quantities of paddy (rice). Other examples include the European crayfish and European oyster industries that were destroyed by pathogens that accompanied crayfish and oysters imported from North America.

There are benefits to the use of alien species, however. Agriculture provides a clear example – most of the world's agriculture is based on animal and plant species grown outside their natural range. Such benefits can also be obtained in aquaculture. Chile introduced Pacific and Atlantic salmon in the 1970s and is now the world's leader in farmed salmon production. The oyster industry in Europe is now based on the Pacific oyster. Tilapia, a group of species originating in Africa, is cultured worldwide and provides income and high-quality protein to many rural areas. Tilapia production in Asia is increasing both in farms and in culture-based fisheries, and many of these farmers and fishers are in the lower income classes.



ecocertification requirements as well as the broader objectives of food security and safety. It can favour the joint certification of fish production clusters (e.g. aquaculture clusters or fisheries/aquaculture clusters).

- The future of the EAA will be highly dependent on government actions. As is usual when implementing sustainable development-related approaches, the capacity-building process in research, administration and industry will be a crucial element.
- Within the EAA, the economic evaluation of projects (including externalities) will become essential for decision-making. Tools and comparative approaches are becoming available that will facilitate such evaluations.

- Relevant tools will include proper research to understand the implications for the ecosystem of different aquaculture practices and to define the risks both from and to aquaculture, and the application of risk analysis in aquaculture (see Box 8).
- There will be a need to facilitate an operational definition of ecosystem boundaries for management, for example to assess carrying capacity or water-management needs and to clarify administrative and legal jurisdictions. This will require the use of different tools and methodologies (e.g. geographic information system tools). However, defining the ecosystem boundaries and evaluating their implications could be very challenging, for example when addressing the ecosystem boundary effects of the use of fishmeal or other feeds such as soybean.

OUTLOOK

Scientific support to decision-making needs to be improved. Such support includes work to adapt and promote the adoption of a precautionary approach and of integrated assessments covering environmental, social, economic, institutional and political issues. The need for scientific support is spreading across all sectors and should lead to an upgrading of aquaculture research, particularly in strategic analysis and in developing and evaluating different scenarios such as shortages of fishmeal and the spread of pandemic diseases. While efforts towards more ecosystem-friendly aquaculture will be made, the global drift of populations towards coastal areas will grow. This will increase the risk of conflicts between aquaculturists and other users of the coastal zone as well as create opportunities for synergies. It is not easy to foresee what might be the societal response in terms of allocations of (water and land) resources and in terms of what is an acceptable environmental impact and what is not.

Ongoing and foreseen technological developments, in particular for feeding, water recirculation systems and offshore aquaculture, will contribute to the implementation of the EAA. However, these costly technologies are also demanding in terms of energy and will pose unique challenges and opportunities for the EAA, particularly offshore. In general, as for the EAF, the EAA is likely to be adopted first in developed countries. Developing countries will require technical and other forms of collaboration to enhance their capacity to contribute to a global improvement in the sustainability of aquaculture production.

Promoting aquaculture as a real economic and social opportunity and a truly sustainable activity will require profound changes to, and better integration of, national administrative and governance structures. The required changes in governance of the sector, although not trivial, are not unique to aquaculture. They apply also elsewhere and are likely to happen in the fisheries subsector more generally. This deep contextual change, affecting legal frameworks, administrations, development banks, etc., should facilitate aquaculture development. Administrations should come to see aquaculture as best managed jointly with fisheries and/or with other coastal activities such as agriculture. The need for such structural changes in the public administration can be seen as an obstacle but can also be seen as an opportunity to release the social benefits that are likely to develop through synergies among food production sectors.

Stimulated by ecolabelling schemes, supported by governments' efforts to improve infrastructures and capacity building, and by action research, aquaculture should be able to evolve in the direction of the EAA, particularly if participative processes are put in place.

The allocation of fishing rights: an evolving issue

THE ISSUE

The topic of allocation – how to share, portion, allot, distribute – is at the heart of any and all efforts around the world to manage fisheries. There is worldwide recognition

that the question of how to share limited fisheries resources must be addressed and that this means finding ways of determining who can catch what. These are sensitive decisions, but there is growing recognition in both the private and public sectors that the longer fishing communities and fisheries managers avoid allocating fishing rights, the greater the risk of making decisions that, ultimately, do not lead to fisheries that are as healthy or as sustainably utilized as they could be.

There is also a growing recognition that classical fisheries management approaches to limiting catches of fish do not create economically viable fisheries, and that rights-based approaches can create the conditions that allow commercial goals to support, and not to undermine, biological objectives. However, negative perceptions about rights-based approaches persist, in part because they require resolving the fundamental fisheries management dilemma of who gets which fish.

POSSIBLE SOLUTIONS

The challenges of allocating fishing rights

Allocating fishing rights is contentious because it means making some explicit social, political, legal and economic decisions. These decisions can have significant impacts on people – ranging from a few individuals and their communities to entire states and regions of the world. Indeed, in essentially open access situations where there is extreme overcapacity, the process of moving from an open access to a rights-based management system that involves the allocation of fishing rights is likely to require major structural reforms that are well beyond the resources of a local fishing industry and its communities.

The allocation of rights need not create permanent losers, as fishers who are not granted rights can be compensated with public or private funds as part of temporary support for structural reform in fisheries. This support is temporary because once stock recovery has occurred, fishing effort has shrunk and overcapacity has been reduced, the sector itself can start to generate public revenues. Such revenues are essential in developing countries, in particular for building various forms of infrastructure (e.g. for transportation, health and education). For some of those countries, the main challenge associated with allocating fishing rights lies in finding the resources needed to finance the introduction of fishing rights, where they do not exist, or to resuscitate traditional systems of property rights.

Legally, allocating fishing rights implies that the state must have the possibility of allocating such rights in the first place. Currently, some legal systems do not support the allocation of fishing rights.

In addition, once rights have been established, there is a need for legal systems that can support and uphold the implementation of such rights. In particular, there need to be adequate legal foundations to uphold the elements of security, durability and enforceability of the exclusiveness of these rights – and such conditions may not always exist.

To add to the social, political and legal challenges of allocating fishing rights, the design, implementation and operation of rights-based programmes need to reflect the particular circumstances and goals of the people who are participating in them. Although the fundamental principles are the same, there is no single perfect design that can be applied indiscriminately across different types of fisheries.

Many of the highly publicized rights-based programmes developed over the past 20 years have started out by allocating fishing rights to the individual people actively fishing in a fishery, but this approach is only one of many. Fishing rights have also been allocated to communities and other groups whose members may have fished in a particular fishery or area.

Once allocated, the enforcement of fishing rights – and ensuring the exclusivity of these rights from infringements by people outside rights systems – can have two types of impact. In some fisheries, especially those where current enforcement activities are minimal, enforcement costs can rise – but these costs may be more than offset by the increased profits accruing to the participants in the fishery. In other fisheries, where



enforcement costs have already skyrocketed to ensure compliance with complex controls and regulations, enforcement costs can fall as participants in the fishery begin to realize the value of their asset and engage in self-enforcing behaviour, reducing the need for intensive and costly enforcement. In both situations, technological advances in communications, monitoring, control and surveillance are making it easier and cheaper to undertake enforcement activities in areas previously thought unmonitorable because they are remote or the fishers are spread over enormous areas.

Finally, one of the major challenges associated with allocating fishing rights is that the very success of rights-based programmes creates a threat to their existence – simply because they create the conditions for profitable fisheries that are not confronted by the serious issue of overfishing caused by overcapacity. Where such rights have been allocated, the original decisions concerning allocations are frequently challenged by those outside the system who want to participate in the now profitable and sustainable fisheries.

Fortunately, the many lessons learned about allocating fishing rights mean that these challenges are not insurmountable.

Overcoming the challenges of allocating fishing rights

The basic characteristics of fishing rights are well known and agreed. Fishing rights need to be durable (long-lasting), divisible, transferable, exclusive and secure,²³ and many of the centuries-old community-based management systems around the world were premised on these characteristics – at least until the imposition of modern top-down concepts of management altered them.

Furthermore, with the contemporary evolution of rights-based fishery management programmes, the process of allocating fishing rights and the phrase “rights-based approach” no longer equate with one very particular type of rights-based management that has received a great deal of attention – the use of individual transferable quotas (ITQs). Recent developments in the allocation of fishing rights mean that the world has far more options than simple ITQs as the sole means of rights-based management. Efforts are increasing to codify informal rules and to amend legal frameworks to incorporate customary fishing rights into contemporary legal parlance and/or establish the conditions necessary to support them.

The current variety of schemes for formally allocating fishing rights has vastly expanded the range of fisheries and fishing situations to which rights-based schemes can be applied. Indeed, fishing rights have been allocated under longstanding programmes such as the community development quota (CDQ) systems that have been operating in fishing communities in the Bering Sea; the various types of territorial use-right systems such as those found in Fiji, Japan, the Philippines and Samoa; the Management and Exploitation Areas for Benthic Resources in Chile; and the Beach Management Units found in Kenya, Uganda and the United Republic of Tanzania.

Very importantly, the process by which these systems are designed and implemented has changed considerably over the past ten years. Participatory processes with extensive stakeholder- and community-based dialogues are now recognized as critical when designing and allocating fishing rights in order to meet the needs and engage the support of the people who are affected by them. Managing people's expectations and deliberately considering how people respond to positive and negative incentives are becoming standard procedures, because doing so helps to diffuse tensions regarding issues of equity and social justice and has been shown to help legitimize the final product.

In addition to transparent processes and guidelines to reduce the potential for community conflict and uncertainty, solid policies – a combination of planning and market-based mechanisms supported by governance and legislative frameworks – are now considered absolutely necessary as part of the allocation of fishing rights.

Where the rights-based management programmes are already supported by a legal framework, fishers and managers are increasingly aware of the benefits of such programmes and are working to achieve their implementation. Communities

– of fishers, conservationists and non-consumptive users – are realizing the value that their fisheries assets can have if managed to achieve both sustainability and profitability, in the case of commercial fishing, and this is important because it means that communities are realizing that they can benefit from becoming the stewards of their fisheries assets. The designation of fishing rights as a shared community asset has the potential not only to inspire resource stewardship, but also to provide for the possibility of future access to food, income and biodiversity – and this may be especially critical for communities afflicted by high incidences of HIV and AIDS.

RECENT DEVELOPMENTS

Seven years ago, deliberations from the FishRights99 conference held in Fremantle, Western Australia, highlighted many of the essential aspects of using property rights in fisheries management. More recently, the Sharing the Fish '06 conference held in Perth, Western Australia, served as a focal point for communicating many of the recent developments pertaining to the related activity of allocating fishing rights.

In terms of the practical aspects of allocation, there is a growing body of documentation and analysis regarding the lessons learned from allocating individual and community-based fishing rights in fisheries around the world, ranging from conference proceedings²⁴ and workshop reports²⁵ to specific case studies.²⁶

More locally, some countries and, within them, fisheries departments are developing and using economic and bioeconomic models to assist fishers, communities and managers in looking at the effects of allocating fishing rights on the many different groups²⁷ that can be considered within the fishing sector.²⁸ Moreover, these models are also starting to be used to address the allocation of water to various uses (fishing versus the generation of hydroelectricity, agricultural purposes or marine parks)²⁹ and the (re)allocation of rights to the space in which fisheries may occur to ports and other coastal activities.

Despite these efforts, there is still a need to explore systematically alternative governance models³⁰ and legislative alternatives for allocating fishing rights so as to reveal the full potential of using mixed spatial and output control regimes. There are lessons to be learned from community-based regimes, the integration of governance and biological objectives, and models of individual behaviour in alternative regimes.

OUTLOOK AND FUTURE PERSPECTIVE

Those who harvest, sell and buy fish are gradually becoming aware of the power and importance of rights-based approaches and they are exerting a growing influence on their future use.

Communities are looking to realize the full value of their fisheries assets – not only for their members who are alive today, but also for their future generations. Fishers in developed countries are aware that the days when fishing under *de facto* open access regimes was a good gamble are over and are moving to operate within management programmes that offer increased fiscal stability and reliability. Commercially, products that are harvested and processed in an environmentally friendly and sustainable way are being mainstreamed into world markets by corporations and being demanded by consumers.

At the same time, with the evolution of rights-based management systems and the processes by which these are developed, designed and implemented, political concerns over the allocation of fishing rights are being addressed from the ground up, thereby eliminating some of the political hazards that have previously hindered their uptake. This, in turn, is providing signals to politicians that controversies surrounding fishing rights are surmountable and worthy of their attention.

Combined, these various ground-level interests are driving the adoption of rights-based approaches to fisheries management and, with these, the allocation of fishing rights. The message that is emerging from the world community is that there is a need for a new governance paradigm that allows for and supports allocating fishing rights.



In the absence of a coordinated worldwide effort to develop a coherent framework for allocating fishing rights, progress will continue at more localized levels (in communities, RFMOs and species-specific organizations) where there is opportunity for collective action, far-sighted leadership and improved institutional frameworks – so that capture fisheries, while limited, can be economically viable.

Impact of market-based standards and labels on international fish trade

THE ISSUE

Fish and fishery products are the most traded food in the world. Thirty-eight percent (live weight equivalent) of the total yearly production, estimated at around 140 million tonnes in 2004, enters international trade. Over half of this trade in value originates in developing countries, where it represents an important source of foreign exchange earnings, in addition to providing employment for many millions in the fish industry (see pp. 41–52).

Developed countries accounted for about 81 percent of the total value of fish imports, estimated at more than US\$75 billion in 2004. About 74 percent (in value) of these products were imported by the European Union, Japan and the United States of America, which dominate the world market both in terms of prices and market access requirements.

While fish supply from wild capture fisheries has stagnated over the years, the demand for fish and fishery products has continued to rise. Consumption has more than doubled since 1973; the increasing demand has been steadily met by a robust increase in aquaculture production, estimated at around 45 million tonnes in 2004 or 32 percent of total world fish production, up from a mere 3.9 percent in 1970.

As a result of the globalization and expansion of international food trade, the food industry has experienced significant consolidation and concentration in the industrialized countries. This has led to the emergence of fewer but more powerful food firms, with substantial bargaining power *vis-à-vis* other players up and down the supply chain. Although wholesale and restaurant chains strongly influence fish distribution in many countries, power has been shifting to the retailers as a result of increased consolidation of retailers, *inter alia*, into supermarket chains and the growth of goods produced under a retailer's or private label. This supermarket system is expanding rapidly to developing countries in Africa, Asia and Latin America.³¹

As the last link in the supply chain between producers and consumers, retailers have seen their responsibility towards consumers increase, resulting in a greater need for controlling safety, quality and other food attributes to prevent any risk of damage to their reputation.

Reasons for development of market standards

Several concurrent developments account for the development of market standards and the possible expansion of their use in fish trade:

- The growing importance of global trade in fish has developed in a setting of the increasing influence of civil society and consumer advocacy groups over the agendas of governments, companies and international organizations on different aspects of the food systems. Food demand has been changing with the evolution of lifestyles, demographics and increase in household incomes. Increasingly demanding consumers expect not only safe and high-quality foods but also a transparent and informative trail that can be used to trace the origin of food, its quality, and the environmental and/or social conditions current during its production, processing and distribution. Retailers have been translating and transmitting these consumer

demands back through the supply chain to producers and processors by developing standards. These increasingly include additional characteristics of manufacturing and production processes, such as prevailing environmental, labour and health conditions. In fact, most retailers claim that their standards are higher than those set by governments in a number of areas. In addition to regulations and consumer demands, private standards often cover commercial specifications such as quantities, quality consistency and delivery punctuality.

- With reduced government financing of regulatory activities, public authorities have been increasingly engaging the responsibility of the industry for ensuring food safety and quality. Fish producers and processors are responsible for implementing good practices and sanitary and Hazard Analysis and Critical Control Point (HACCP) plans.³² Many food companies and retailers have adopted other voluntary standards such as ISO 9000 or ISO 22000 for safety and quality assurance, ISO 14000 for the environment or SA 8000 for social conditions. This, in turn, has led to an increased use of global business to business (B2B) standards in procurement from suppliers, including for developing country exporters supplying international markets. As a result, B2B standards are increasingly used as a governance tool in the food industry.
- Global coalitions for setting food safety standards, such as the Global Food Safety Initiative (GFSI) and the British Retail Consortium (BRC) have emerged. The economic losses and negative publicity impact of food scares are so high that firms in such coalitions have agreed that food safety is a pro-competitive issue of high importance for the coalition members. Pro-competitive issues relate to concerns that are so complex, but at the same time so essential to the survival of any firm or industry of the coalition, that they are dealt with in a collaborative fashion, and therefore are agreed by members not to be subject to competitive action. However, members continue to compete over quality, price, service and variety.
- There is increased concern that expanding international fish trade may further strain the sustainability of fish stocks and the marine environment and, where resources are not effectively managed, impede efforts to reduce pressures that drive overfishing. As a response, several retail companies have committed to purchasing only fish harvested from certified sustainable fisheries.
- Small but potentially lucrative market niches (organic aquaculture, fair trade, etc.) have also emerged, which private companies try to enter and occupy.

Examples of market standards used in fish trade

The market standards currently used in international fish trade primarily address consumer protection and resource sustainability. Small market niches are governed by specific standards such as “label rouge” in France, “Quality Mussels” in Ireland or Canada or “organic farmed fish” labels. Furthermore, some countries and producers’ associations have established labels to certify implementation of best practices or codes of conduct.³³

Below follows a brief review of various market standards in use in international fish trade.

Food safety and quality

The Global Food Safety Initiative (GFSI) was founded in May 2000 as a retail-led network of food safety experts and their trade associations to enhance food safety, strengthen consumer confidence by setting requirements for food safety schemes and improve cost efficiency through the food supply chain.

According to the GFSI, its standards are based on Codex Alimentarius and other legislative requirements to address consumer health and safety concerns. The Initiative



also addresses the requirements of certification bodies. The benchmarked food safety standards can then be applied by food suppliers throughout the supply chain, upon agreement with retailers, when defining contracts for sourcing products. Retailers and suppliers have the discretion to apply the benchmarked standards to specific products, and this may vary across countries according to regulatory requirements, product liability and due diligence regulations as well as company policies. Due diligence is observed when a retailer, or supplier, takes all reasonable precautions to prevent customer illness or injury by preventing the sale of an unsafe or illegal product.

In 1998, BRC, responding to industry needs, introduced the BRC Food Technical Standard to evaluate its own-brand foods marketed by retailers. These standards would also serve to provide United Kingdom retailers and brand owners with evidence of due diligence to use in case of prosecution by enforcement authorities.

The BRC standard covers the HACCP system, quality management, factory environmental standards, and product and process control. Suppliers undergo an evaluation by BRC-certified auditors who are recognized by an accreditation body. The standard has recently been revised to reflect new EU legislation and is claimed to be used in many countries worldwide.

Ecolabels

In the past decade, significant resources have been used worldwide in the seafood industry to promote the purchase of seafood only from sustainable sources, and several major corporations have built comprehensive food-sourcing campaigns around sustainable seafood initiatives. These initiatives aim to tap into growing consumer demand for environmentally preferable products, channelling purchasing power towards seafood products from sustainably managed fisheries and/or aquaculture activities.

Consequently, a number of ecolabelling initiatives have been introduced in the fisheries sector as market-based incentives to improve fisheries management systems.³⁴ Ecolabels are certifications given to products that are deemed to have a lower negative impact on the environment than other similar products. By appealing to consumer preferences, the ecolabelled products may generate higher returns than those that either do not qualify for ecolabelling or those whose producers do not seek to obtain such labelling. Several national, international, industry-sponsored, NGO-led and consumer–supplier partnership certification and standards schemes in the fisheries sector already exist – each with distinct criteria and assessment methods that have variable levels of transparency. The claims made by ecolabels also vary widely – some indicate that a product is not overfished, others focus on the absence of marine mammal bycatch and still others promise that their product is “ecosystem friendly”.

Some schemes focus on ensuring that a management system or process is “sustainable”, while others focus on the performance or outcome of the management system. Schemes that set standards for processes or systems without prescribing sustainable outcomes are not necessarily comparable with schemes that seek to grade performance or ensure sustainable production. A related issue is how to maintain sustainable results. On the implementation side, for example, monitoring and data collection pose significant problems in many countries and there are particular challenges related to traceability.

Aquaculture

Given the increased use of market standards in the fruits and vegetables sector and the globalization of food trade, several retailers are extending their use to aquaculture products. At the same time, market standards represent a means for reducing public concern over veterinary drug residues in aquaculture products. Several initiatives have been developed recently, although the extent of their use in fish trade and their impact are not yet fully known.

The Global Aquaculture Alliance (GAA) developed the Responsible Aquaculture Program to promote best management practices for aquaculture. This programme

encourages the culture of safe, wholesome seafood in an environmentally and socially responsible manner, with a view to improving the efficiency and long-term sustainability of the aquaculture industry.³⁵

In response to the industry's growing call for more formal recognition of sustainable practices, the GAA aligned with the Aquaculture Certification Council,³⁶ an international non-profit organization that offers "process" certification for shrimp production facilities with a primary orientation towards seafood buyers. This body exclusively applies GAA's Best Aquaculture Practices standards in a certification system that combines on-site inspection and effluent sampling with mandatory requirements for product safety and traceability.

In 1997, a European retail working group, EurepGAP,³⁷ established its own standard for good agricultural practices to reassure consumers that food that exhibited the EurepGAP label had been produced in a safe and sustainable manner. Originally developed with reference to fruits and vegetables, the standard was expanded in 2005 to include integrated quality assurance schemes for aquaculture. The EurepGAP partnership collaborates with both retailers and producers and consults regularly with consumer groups, NGOs and governments in the development of its protocols.

EurepGAP is a quality and safety management system aimed at providing tools for verifying best practices in a systematic and consistent way through the use of product protocols and compliance criteria. It is designed to permit benchmarking of local schemes to EurepGap, thus extending participation under the scheme. This is seen as important in fulfilling a basic aim of facilitating trade in safe and sustainable farm production.

Organic fish-farming labels

A number of companies are working to win a market niche with "organic seafood". Organic labelling usually signifies that food has been farmed without artificial inputs – especially synthetic fertilizers and pesticides – and has been grown using environmentally sound farm management techniques. Organic labelling of seafood focuses on aquaculture products. Efforts to explore organic labelling of fish are more recent, and less than 1 percent of aquaculture fish is organic.³⁸ This share is expected to increase rapidly, however, especially with technical support from development agencies.

Implications

The unprecedented development in market standards raises a number of major issues:

1. If trade liberalization is to bring benefits to all, including to developing countries, then rising market standards should not constitute a barrier or additional impediments for entry to major markets by producers and processors from developing countries.
2. In the absence of regulatory frameworks, the setting of market standards by a company, or by a coalition of companies or retailers, which can exercise significant market power, may increase the risk of anti-competitive behaviour as this power may be used to impose lower prices throughout the supply chain.
3. How are the boundaries defined between public regulations on the one hand and private market standards on the other? And who is responsible for what? While governments that use standards as trade barriers can be challenged through the rules of the WTO, what mechanism should be set to deal with companies whose standards are challenged as technical barriers to trade?
4. The uncertainties described for market standards also hold for ecolabelling schemes. While it is recognized that ecolabelling will encourage suppliers to implement responsible fishing practices, ecolabelling can also be seen as a private-sector attempt to replace governmental conservation policy. How can ecolabelling schemes be reconciled with the public sector's responsibility to protect and regulate the use of natural resources?



Nevertheless, and in spite of these major issues, some argue that meeting and adhering to market standards can have a positive effect, including for developing countries, in particular by spurring new competitive advantages and investments in technological capacity.

Some governments and industry groups fear that these standards may disguise underlying intentions to protect domestic industries and restrict market access, or that they may be used to add a new layer of constraints for exporters by adding to existing food safety and quality requirements in major markets. Also, the burden of complying with these standards may fall disproportionately on small suppliers, for whom the cost of acquiring information about, and achieving, certifiable status and standards is relatively higher.

Furthermore, as certification programmes proliferate, consumers and producers face choices regarding which programmes carry the most value. Competing certifying claims may confuse consumers, causing them to lose confidence in standards, thereby depriving the approach of its value. Questions also arise concerning which certification programmes best serve consumer protection, the environment, the public and the industry. Such a scenario is serious, as the credibility of standards, and of the associated certification and accreditation bodies, is of paramount importance.

POSSIBLE SOLUTIONS

Possible actions to mitigate existing concerns are briefly described below.

Increased transparency

For some exporters, business will become riskier and more uncertain as importers impose new and more stringent market standards. Increased transparency in the development and application of these standards would reduce the risks that exporters confront and enhance market access. Furthermore, a thorough study is needed on the impacts of market standards for both importing and exporting countries, including an assessment of the costs and benefits of complying with these standards. In respect of costs, such a study would evaluate the direct costs imposed on the exporters by the need for new physical infrastructures, larger implementation capacity and better technical know-how.

Harmonization and equivalence

Regional and international cooperation is necessary for the development of harmonized and transparent standards and compliance procedures. These standards and procedures may build on the work of the FAO/World Health Organization (WHO) Codex Alimentarius (safety and quality), FAO (ecolabelling, organic fish farming) and the International Organization for Standardization (ISO) (certification, accreditation). More attention should be given to opportunities for mutual recognition of standards and simplification of compliance procedures. This, in turn, should lead to cost reductions, especially for developing countries and small enterprises.

Technical assistance and phase-in for developing countries

International efforts to manage the negative impacts of standards could be coupled with similar efforts in regional and bilateral economic arrangements. In developing countries, external funds are needed to support implementation and compliance, and, when possible, industry standards could be accompanied by phase-in periods.

Ecolabelling

A key challenge is how to elaborate criteria that are general yet applicable to specific regions, countries and fisheries. The acceptance and credibility of standards are closely related to how the standards were developed, the standards themselves, and the accrediting or certifying process by which suppliers are evaluated.

The FAO guidelines on ecolabelling from marine capture fisheries provide an internationally agreed reference for harmonizing ecolabelling schemes and also for certification and accreditation. However, there is a need to clarify the relationship between ecolabels and international trade rules and to create synergies between the two as well as to provide a neutral forum for translating the FAO guiding principles into transparent and credible criteria and guidelines for developing the ecolabels and their certification and accreditation.

RECENT ACTIONS

The development of market standards and labels and their potential impact on international trade have been the subject of recent debates in many international fora. Sanitary and quality issues are the subject of regular debates within the Sanitary and Phytosanitary (SPS) and Technical Barriers to Trade (TBT) Committees of the WTO. However, these discussions have been dealing mainly with the regulatory requirements and with the implementation of the special and differential treatment of developing and least-developed countries and have not touched upon market standards. WTO Members, in the Doha Declaration, committed themselves to examining labelling requirements for environmental purposes within the framework of the Committee on Trade and Environment, where discussions have been taking place since 2001. These discussions have focused on voluntary schemes based on the lifecycle approach.

Market standards have also been debated by the Nordic Council of Ministers,³⁹ the Commission of the European Communities,⁴⁰ the International Centre for Trade and Sustainable Development,⁴¹ the FAO Committee on Fisheries⁴² (which developed international guidelines for ecolabelling), its Sub-Committee on Fish Trade,⁴³ and the World Aquaculture Society.⁴⁴

The debates in these fora highlight that while market-driven standards and labels can offer opportunities to spur competitive advantages and investment in technological developments to expand market shares and extract more value, many developing countries and small-scale enterprises fear that these standards can disguise underlying intentions to protect domestic industry or create additional burdens to already existing and highly demanding regulatory requirements.

FUTURE PERSPECTIVE

Consumer pressure on the fishing industry and on governments to improve fisheries management is increasing. Campaigns seeking to reduce or eliminate consumption of particular overfished stocks or endangered species (e.g. the recent swordfish boycott by restaurants on the east coast of the United States of America) are becoming more common. In addition to concerns relating to the safety and quality of fish products, other issues of global concern, such as environmental protection, social requirements and IUU fishing, are likely to be increasingly governed through market-driven standards and schemes.

The growing influence of large wholesale, retail and restaurant chains over fish markets seems to indicate a trend for the increasing use of market standards and certification schemes. However, the extent of this trend and its implications for the governance of fish trade are not well known and need to be studied further, taking into consideration regional specificities. Should market standards become important tools in the governance of fish trade, it will become imperative to develop an international plan of action to ensure coherence with WTO trade measures. Such an action plan ought to address, *inter alia*, transparency, the use of science-based criteria, harmonization and equivalence, and technical assistance to developing countries. The Technical Guidelines for Responsible Fish Trade currently in development for the implementation of the relevant articles of the Code of Conduct for Responsible Fisheries is likely to address market-based standards.



HIV and AIDS in fishing communities: a public health issue but also a fisheries development and management concern

THE ISSUE

In the past decade, it has become evident that AIDS-related illness and mortality are devastatingly high in some fishing communities.⁴⁵

A synthesis of surveys conducted since 1992 in ten low- or middle-income countries in Africa, Asia and Latin America for which data were available (Brazil, Cambodia, the Democratic Republic of the Congo, Honduras, Indonesia, Kenya, Malaysia, Myanmar, Thailand and Uganda) shows that, in all except one (Brazil), HIV prevalence rates among fishermen or in fishing communities are between 4 and 14 times higher than the national average prevalence rate for adults aged 15 to 49. These considerable rates of HIV infection place fisherfolk among groups more usually identified as being at high risk; they are greater than those for other mobile populations such as truck drivers and the military in all countries (again except for Brazil) for which relative data are available.⁴⁶ Because fisherfolk are numerous compared with people in other subpopulations with high HIV prevalence, such as injecting drug users, military personnel and prisoners, the number of fisherfolk likely to be HIV positive may be very high, making them a priority for support for prevention, treatment and care programmes for HIV and AIDS.

Available estimates of HIV prevalence and reports of illness and death from AIDS-related conditions are based either on surveys of fishermen or of fishing communities in general. Prevalence rates for the many women working in fishing communities have not been assessed but are likely to be similar or even higher, given that men and women living and working in the same communities share a similar risk environment and are also often linked through sexual networks. In some African fishing communities, for example, women fish traders and fishermen are linked both occupationally and sexually through so-called “sex for fish” transactions, where informal contracts between fishermen selling to female fish traders include the exchange of sexual services instead of, or supplementary to, the exchange of money. Furthermore, the subordinate economic and social position of women in many countries increases their vulnerability.

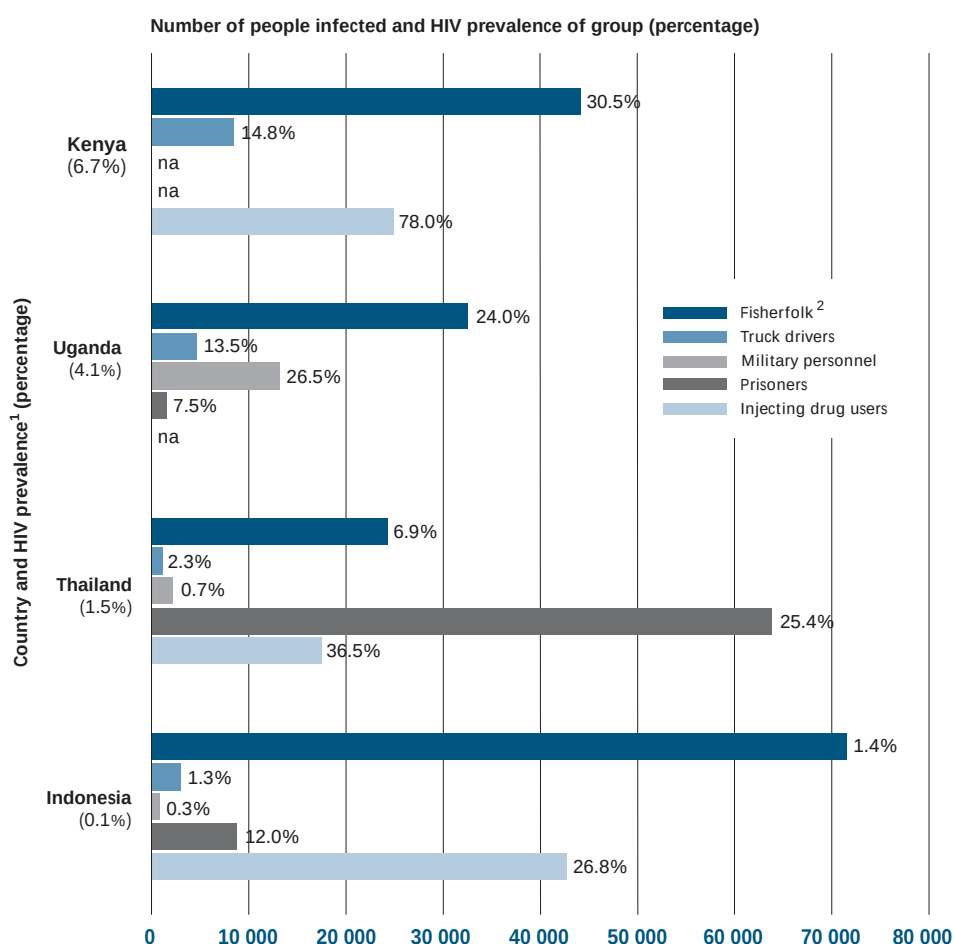
Vulnerability to HIV and AIDS stems from complex, interdependent causes that may include the mobility of many fisherfolk, the time fishers and fish traders spend away from home, their access to daily cash income in an overall context of poverty and vulnerability, their demographic profile (they are often young and sexually active) and the ready availability of commercial sex in many fishing ports. Also significant are cultural factors related to fishing as a high-risk, low-status and uncomfortable occupation, which lead to high-risk sexual behaviour practices.⁴⁷ Many of these causes make fisherfolk not only vulnerable to HIV and AIDS but also more likely to miss out on access to prevention, treatment and care.⁴⁸ Exposure to water-borne diseases and to malaria, along with poor sanitation and limited access to medical care, also combine to increase susceptibility to infection. These proximate risk factors are all related to underlying poverty, insecurity and marginalization affecting both women and men in many fishing communities. The proportion of people infected with HIV in a fishing community, and the impacts of AIDS-related morbidity and mortality in that community, will depend on the extent to which the above factors occur and on how they combine to increase vulnerability.⁴⁹

As fisheries become more integrated into the global economy and labour market, the probability increases that mobile fisherfolk become a “bridge” population, linking areas of high and low prevalence.⁵⁰ In Walvis Bay, Namibia, for example, visiting Asian and European fishermen, most of whom have received little advice on sexual health risks, frequently establish relationships with Namibian sex workers, or become involved in other forms of “transactional sex”.⁵¹

It is important to stress that AIDS in fishing communities is not a phenomenon exclusive to one region. Indeed, in terms of the overall dimension of the epidemic, and

Figure 36

Estimated HIV prevalence and number of people infected among subpopulations considered at higher than average risk for HIV in two African and two Asian countries



Notes:

1. Average national prevalence rates for sexually active adults.

2. For fisherfolk, the estimated number of people infected is calculated using HIV prevalence data from epidemiological surveys of either fishing villages or individual fishers, multiplied by the estimated number of fisherfolk (fishery sector workers) according to national or FAO statistics. Details of methods used and data for six other countries are available in E. Kissling, E.H. Allison, J.A. Seeley, S. Russell, M. Bachmann, S.D. Musgrave and S. Heck. 2005. Fisherfolk are among groups most at risk of HIV: cross-country analysis of prevalence and numbers infected. *AIDS*, 19(17): 1939–1946.

taking into account differences in the size of fishing populations between continents, it is likely that more fisherfolk in South and Southeast Asia are infected with HIV than in Africa.⁵²

Impacts of HIV and AIDS and implications for fisheries management and development

Although reports of high prevalence of HIV and incidence of AIDS-related illness have been reported sporadically in the literature from around the world since the early days of the AIDS epidemic, this issue has only recently become a prominent concern in fisheries management and development, so there is limited formal survey information and economic analysis of its impact on the sector. However, a considerable body of evidence on the impacts of HIV and AIDS, both from other rural production sectors and from work on poverty analysis in fishing communities, does exist and can be summarized as follows:⁵³

Box 10

What makes women in fishing communities vulnerable to HIV/AIDS?

Women in fishing communities play important roles in fish processing and marketing activities. They also undertake many of the non-fishing, income-generating activities that compensate for the seasonality and day-to-day variability of fishing and related activities. As well as funding and performing most childcare and household tasks, women also often assume responsibility for family food security, health, social and education expenses.

Inequities that contribute to women's vulnerability to HIV/AIDS may include a combination of the following:¹

- Traditional gender roles and low levels of education constrain women's participation in community-level management structures and processes.
- Women in fishing communities sometimes occupy low-margin competitive activities such as small-scale fish trading and alcohol manufacture and sale, in which sex is used as part of the exchange (transactional sex and "sex for fish").
- Women are often sexually active at an earlier age than men and may be biologically more susceptible to infection.
- Women may lack negotiating power on safer sex practices.
- Legislation related to women's rights, when it exists, is poorly enforced.
- Men often control decision-making, both within the family economy and concerning access to natural resources, savings and credit, education, and to social and political networks.

¹ FAO. 2005. *Impact of HIV/AIDS on fishing communities: policies to support livelihoods, rural development and public health*. New Directions in Fisheries: A Series of Policy Briefs on Development Issues No. 2. Rome.

- *Individual fishers and fish workers* with AIDS-related illnesses have a declining ability to engage in physically demanding labour, such as fishing or mobile trading and transport. Those who are ill experience job loss, stigmatization and isolation.
- *Fishing households* affected by AIDS have reduced income, spend any savings on medical care, sell productive assets (such as fishing equipment) and withdraw their children from school. Their poverty deepens, their food security decreases and their vulnerability increases.
- *Fishing fleets, firms, agencies and communities* experience loss of labour and expertise, making them less efficient. AIDS can have divisive impacts on communities, corroding trust and social cohesion and therefore the capacity for collective action. High levels of illness reduce individual time horizons, undermining commitment to shared long-term goals such as community fishery management and development projects. For fisheries departments, firms and agencies, long periods of illness of their staff and the purchase of anti-retroviral therapies can be very costly.
- *Fisheries management and development* are stifled in countries where many fishers and fishery managers (including community leaders) become ill. This, in turn, reduces management capacity, decreases productivity and efficiency, leads

to increased pressure on more physically accessible inshore resources and diverts fishery development resources into HIV prevention and AIDS mitigation efforts. The overall impacts point to an increased incidence of poverty and levels of vulnerability in small-scale fisheries and reduced likelihood of sustainable exploitation of resources whereby responsible fishing targets may be compromised.

- *The rural economy*, directly and indirectly linked to the fishery sector, is also affected:
 - Revenue generated by individuals from their fishery-related activities that would have been invested back into the fishery or other economic activities (land, livestock, business enterprises), or spent on services that keep cash in circulation in rural markets, is instead diverted to meeting the expenses of illness in the household.
 - Health services are burdened by the costs of dealing with AIDS-related illness, deflecting resources from other health needs, such as maternal and child care and malaria treatment.
 - Local governments faced with the costs of AIDS may therefore reduce resources for other service needs. Moreover, working time is redirected towards assisting affected colleagues and attending funerals.
- *Population-level impacts* can arise because many fishing populations are highly mobile. Men shift between landing sites and local markets on a daily and seasonal basis. Fish processors, traders and transporters – both men and women – move among landing sites, regional and national markets and fish processing factories. Other service providers – including sex workers – move with them. These movements and networks are likely to play a part in the transmission of infection between high-prevalence subpopulations and those currently at lower risk. Lack of access to services and traditional social support networks in fishing villages means that people living with AIDS who are too ill to work have to return to their “home” communities to be cared for. This has implications for the spread of HIV and increases the number of people experiencing the impact of AIDS.
- *Food security* is also jeopardized, as AIDS may reduce the ability of fishing communities to supply fish and fish products to those low-income groups who are dependent on fish as the only affordable source of animal protein and micronutrients. These are crucial nutritional elements for child development and also for increasing the efficiency of HIV/AIDS treatments.

POSSIBLE SOLUTIONS

The fisheries sector is an important contributor to development and to national economies. Fisheries have links with services and other industries and make a substantial contribution to GDP, employment, nutrition and revenue generation.⁵⁴ Supporting and promoting sectoral development will help reduce the spread and impacts of the epidemic both within the sector and within the population in general. Preventing infection with HIV and the onset of AIDS will help to maintain and enhance the sector's contribution to poverty reduction and food security and to reduce the risks of HIV transmission in fisheries-dependent regions.

One important task is to invest in preventing infection with HIV in fishing communities. This can be achieved by addressing (largely male) risk behaviour, which is thought to be related to occupational risk factors, social factors related to mobility and, more generally, to the social, political and economic marginalization of many fisherfolk.⁵⁵

A second important – and related – task is to address women's higher vulnerability to HIV arising from gendered socio-economic disadvantages in many societies. Inequalities in men's and women's access to and ownership of assets, income-earning opportunities, power relations and negotiation of sexual relationships need to be addressed as a priority in fishing communities. Such efforts require novel partnerships



between donors, fishery agencies and health agencies, and within and between communities themselves.⁵⁶

All over the world, the impoverishment and marginalization of small-scale fisherfolk increases their vulnerability to the diseases of poverty, including AIDS. Reducing poverty in fishing communities will also address many of the conditions that put fisherfolk at risk of being infected with HIV. Recent guidelines for improving the contribution of the small-scale fishery sector to poverty reduction⁵⁷ provide an appropriate framework for national governments to respond to poverty in fishing communities.

RECENT ACTIONS

Until recently, initiatives responding to AIDS in the fisheries sector were fragmented and working in isolation, largely at the community and project levels and lacking in national policy support and access to global funds to combat AIDS. Moreover, these initiatives relied on approaches developed for farming or urban communities that often proved inappropriate and/or ineffective for fishing communities. This situation is changing and higher-level policy responses involving national governments, international organizations, donors and NGOs working in both the fishery and health sectors are beginning to respond to the information that is reaching them from fishing communities and the external organizations who work closely with them.

For example, an International Workshop on Responding to HIV and AIDS in the Fishery Sector in Africa was held in Lusaka, Zambia, in February 2006. The workshop was organized by the WorldFish Center and sponsored by the International Organization for Migration, FAO and the Swedish International Development Agency. It was co-hosted by the Government of Zambia through the Ministry of Agriculture and Cooperatives and the National AIDS Council. Ninety participants attended from 13 countries in Africa and from international organizations. They represented government agencies in the fisheries and health sectors, research institutions and civil society organizations active in working with fishing communities. The purpose of the workshop was to enable professionals and organizations working in response to HIV and AIDS in African fisheries to share experiences, appraise the efficacy of their approaches and identify actions in research and development that will further improve their impact. The workshop reviewed and compared research findings and approaches applied in response to HIV and AIDS in fishing communities and the wider fishery sector, identified good practice examples for wider application, identified next steps in development and research to scale up these examples and initiated a network of practitioners in Africa for capacity building, scaling-up and further development of approaches.⁵⁸

At the national level, the Department of Fisheries Resources in Uganda, responding to reports of the devastating impact of HIV and AIDS on the country's fishing communities, has recently published a strategy to ensure that the sector receives an appropriate allocation of government and donor resources.⁵⁹

The importance of recognition at the national and international policy levels is also illustrated by a project in the Congo where AIDS-affected fishing communities at Pointe Noire work in partnership with the National AIDS Control Programme, which is supported by the Global Fund for AIDS, TB and Malaria. This has allowed funding of community-led initiatives for HIV/AIDS prevention, treatment, care and mitigation.⁶⁰

Elsewhere, the South Pacific Commission was among the first to recognize and respond to the problem of high incidence of HIV in fishing communities.⁶¹

OUTLOOK

The differential in HIV prevalence between fisherfolk and the general population is likely to persist for several years, unless there is a major response to include fisherfolk in populations identified as being at risk. So far, although individual governments and some UN agencies have responded, there has been no acknowledgement of fisherfolk

Box 11

The FAO strategy on chronic diseases

The HIV/AIDS pandemic and major debilitating diseases, notably malaria and tuberculosis, have a major impact on nutrition, food security and rural livelihoods. FAO's mandate relates directly to the Millennium Development Goals of significantly reducing the number of people who live in extreme poverty and extreme hunger. These goals can only be achieved if considerable attention is focused on combating the diseases associated with poverty. AIDS is one such "disease of poverty", and addressing its impacts has become an important part of FAO's core mission to help meet the Millennium Development Goals related to poverty and hunger.

FAO has recently been making efforts to bring agriculture and food security to the centre of the fight against killer diseases. In 2005, 23 out of 27 FAO divisions implemented one or more activities on HIV/AIDS. In early 2004, the Organization approved the Priority Area for Interdisciplinary Action (PAIA) on AIDS to strengthen intra- and interagency collaboration in responding to AIDS and other diseases.

Through its normative and operational work and through strengthened partnerships, FAO aims to contribute to:

- preventing further transmission of HIV/AIDS and other poverty-related diseases through addressing structural problems of rural livelihoods that are drivers of poverty and vulnerability to the diseases of poverty;
- improving the quality of life of people living with HIV/AIDS and associated infections through advice on good nutrition, nutritional support, protection of property rights, access to investment opportunities and elimination of stigma;
- mitigating the impact of poverty-related diseases through support in formulating enabling agricultural/rural development sector policies, plans and programmes and strengthening institutional capacity as part of the wider social and economic development strategy.

Source: FAO. 2005. *Addressing the impact of HIV/AIDS and other diseases of poverty on nutrition, food security and rural livelihoods, 2005–2015: the FAO strategy*. Rome.



as a "neglected group at higher risk" by the Joint United Nations Programme on HIV/AIDS (UNAIDS).⁶² Unless UNAIDS acknowledges the epidemic among fisherfolk in this way, it is unlikely that global, coordinated action resulting in significant lowering of prevalence of HIV in fishing communities will take place. Although prevention efforts targeted at sex workers will help reduce the transmission of HIV in client populations (including fishermen), this is not likely to be enough to reduce the high risks of HIV transmission within fishing communities because transactional sex, not sex work, is one potential major route of transmission (e.g. in Zambian inland fisheries).⁶³

NOTES

1. Based on questionnaire responses by FAO Members in 2002 and 2004 relating to implementation of the Code.
2. Fisheries implies aquaculture, as appropriate.
3. S.M. Garcia, and D.J. Doullman. 2005. FAO's Fisheries Programme and the Plan of Implementation of the World Summit on Sustainable Development. In S.A. Ebbin, A. Hakon Hoel and A.K. Sydnos. *A sea change: the exclusive economic zone and governance institutions for living marine resources*, pp. 169–193. Dordrecht, Germany, Springer.
4. FAO. 2003. *The ecosystem approach to fisheries*. FAO Technical Guidelines for Responsible Fisheries No. 4, Suppl. 2. Rome.
5. FAO. 1997. *Review of the state of world aquaculture*. FAO Fisheries Circular No. 886, Rev. 1. Rome.
6. J. Taylor. 2004. Defining the appropriate regulatory and policy framework for the development of integrated multitrophic aquaculture practices: the Department of Fisheries and Oceans perspective. *Bull. Aquacul. Assoc. Canada*, 104(2): 68–70.
7. Environmental impact assessment (EIA) is a process for anticipating the effects on the environment caused by a development. Where effects are identified that are unacceptable (externality costs exceeding the social and economic benefits), these can then be avoided or reduced during the design process or the project could be plainly rejected.
8. Information obtained from countries reporting to the Code of Conduct for Responsible Fisheries.
9. United Nations. 1992. *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3–14 June 1992*. A/CONF.151/26 (Vol. I). New York, USA.
10. United Nations Environment Programme. 2000. *Report of the Fifth Meeting of the Conference of the Parties to the Convention on Biological Diversity*. UNEP/CBD/COP/5/23. Decision V/6, pp. 103–106 (available at <http://www.biodiv.org/doc/meetings/cop/cop-05/official/cop-05-23-en.pdf>). Most countries are party to the CBD (188 parties, 168 signatures).
11. The United Nations World Summit on Sustainable Development (WSSD), held in Johannesburg in 2002, addressed all aspects of sustainable development, with the major focus on poverty and development. There was agreement that environmental degradation is a concomitant of poverty and cannot be satisfactorily addressed until poverty itself is addressed.
12. Op. cit., see note 4.
13. FAO. 2005. *Putting into practice the ecosystem approach to fisheries*. Rome.
14. Modified and adapted from W.J. Fletcher, J. Chesson, M. Fisher, K.J. Sainsbury and T.J. Hundloe. 2004. *National ESD Reporting Framework: the "how to" guide for aquaculture*. Version 1.1. Canberra, Fisheries Research and Development Corporation (FRDC).
15. Finfish aquaculture and seaweed and shellfish aquaculture for bioremediation of coastal waters (seaweeds and shellfish are used as biological nutrient removal systems) and for economic diversification.
16. FAO. 2006. *FAO-World Fisheries Trust Workshop on Comparative Environmental Costs of Aquaculture and Other Food Production Sectors*. Meeting Report (in preparation). LCA is a method for environmental assessment that identifies the impact of a product from raw material to waste, identifying the impact categories, e.g. resource use, water, energy, land, contribution to climate change, to eutrophication and to decreasing biodiversity. This approach provides a good accounting mechanism for different food production systems and also helps identify the most relevant stage in the production chain where technological developments are needed to reduce impacts.
17. Op. cit., see note 14.

18. GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). 2001. *Planning and management for sustainable coastal aquaculture development*. GESAMP Reports and Studies No. 68. Rome.
19. ECASA (Ecosystem Approach to Sustainable Aquaculture) is an EU-funded Framework 6 Research and Technical Development project with 16 research partners from 13 member states. It is the successor to several 4th and 5th Framework Programme projects that have helped to push forward research on an ecosystem approach to aquaculture, especially in the Mediterranean (for further information, see <http://www.ecasa.org.uk/index.htm>).
20. Op. cit., see note 5.
21. FAO's work, in cooperation with partners in the Shrimp Consortium, has resulted in the publication FAO/NACA/UNEP/WB/WWF. 2006. *International principles for responsible shrimp farming*. Bangkok, NACA.
22. For example, the Global Aquaculture Alliance and the Aquaculture Certification Council (<http://www.aquaculturecertification.org/accmiss.html>).
23. FAO. 2000. *The State of World Fisheries and Aquaculture 2000*, pp. 52–57. Rome.
24. See, for example, FAO. 2000. *Use of property rights in fisheries management*, edited by R. Shotton. Proceedings of the FishRights99 Conference, Fremantle, Western Australia, 11–19 November 1999. Workshop presentations. FAO Fisheries Technical Paper No. 404/2. Rome.
25. See, for example, FAO. 2004. *The conservation and management of shared fish stocks: legal and economic aspects*, by G. Munro, A. Van Houtte and R. Willmann. FAO Fisheries Technical Paper No. 465. Rome.
26. See, for example, FAO. 2001. *Case studies on the allocation of transferable quota rights in fisheries*, edited by R. Shotton. FAO Fisheries Technical Paper No. 411. Rome.
27. These groups may include consumptive as well as non-consumptive users and include indigenous/aboriginal groups, recreational groups, commercial fishers within a fishery and different commercial fisheries.
28. See, for example, R. McLeod and J. Nicholls. 2004. *A socio-economic valuation of resource allocation options between recreational and commercial fishing uses*. Australian Government FRDC Project 2001-065 and Department of Fisheries. 2005. *Integrated fisheries management report: abalone resource*. Fisheries Management Paper No. 204. Perth, Government of Western Australia.
29. J. Conrad, H. Franklin, L. Nøstbakken, S. Stone and C. Viteri. 2006. *Fisheries management in the Galapagos Marine Reserve: a bioeconomic perspective*. Economic and Sector Study Series, RE3-06-002. Washington, DC, Inter-American Development Bank.
30. FAO. 2002. *Report of the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks*. Bergen, Norway, 7–10 October 2002. FAO Fisheries Report No. 695. Rome.
31. OECD. 2004. *Private standards and the shaping of the agro-food system*. AGR/CA/ APM (2004) 24.
32. FAO. 2005. *Code of Practice for Fish and Fishery Products*. CAC/RCP 52 – 2003. Rev 2. Rome.
33. Examples include the Industry Standards for the Live Reef Food Fish Trade, the Federation of European Aquaculture Producers' Code of Conduct for Aquaculture, the Thai Marine Shrimp Culture Code of Conduct or Fundación Chile's "Code of Good Environmental Practices for Well Managed Salmonoid Farms". The last two resulted from the requirements of importers and retailers.
34. Examples of ecolabelling schemes include the Marine Stewardship Council (MSC), Dolphin-safe/Dolphin friendly labels, the Marine Aquarium Council (MAC), Carrefour's "Pêche responsable" logo and Unilever's Fish Sustainability Initiative.
35. Through adherence to its published codes: Guiding principles for responsible aquaculture, Codes of practice for responsible shrimp farming and Best Aquaculture Practices standards.



36. Aquaculture Certification Council Inc. (<http://www.aquaculturecertification.org/>).
37. The Global Partnership for Safe and Sustainable Agriculture – EurepGAP (www.eurep.org).
38. Examples of organic labelling schemes include the International Federation of Organic Agriculture Movements, Naturland Organic Standards, the National Association for Sustainable Agriculture Australia, Bio Gro New Zealand Production Standards, KRAVKontroll AB Organic Standards and Debio Standards for Organic Aquaculture.
39. Nordic Council of Ministers. 2000. *An arrangement for the voluntary certification of products of sustainable fishing*. Nordic Technical Working Group on Fisheries Ecolabelling Criteria. Final Report. Copenhagen.
40. Commission of the European Communities. 2005. *Communication from the Commission to the Council, the European Parliament and the European Economic and Social Committee. Launching a debate on a Community approach towards eco-labelling schemes for fisheries products*. COM(2005)275 final. Brussels.
41. International Centre for Trade and Sustainable Development. 2006. *A Review Meeting on Fisheries, International Trade and Sustainable Development: A policy paper*. Geneva.
42. FAO. 2005. *Guidelines for the ecolabelling of fish and fishery products from marine capture fisheries*. Rome.
43. FAO. 2006. Tenth Session of the COFI Sub-Committee on Fish Trade, 30 May–2 June 2006, Santiago de Compostela, Spain.
44. World Aquaculture Society. The 2006 Annual Meeting and Conference, 9–13 May 2006, Florence, Italy.
45. E.H. Allison and J.A. Seeley. 2004. HIV and AIDS among fisherfolk: a threat to “responsible fisheries”? *Fish and Fisheries*, 5(3): 215–239.
46. E. Kissling, E.H. Allison, J.A. Seeley, S. Russell, M. Bachmann, S.D. Musgrave and S. Heck. 2005. Fisherfolk are among groups most at risk of HIV: cross-country analysis of prevalence and numbers infected. *AIDS*, 19(17): 1939–1946.
47. Op. cit., see note 45, and C. Bishop-Sambrook and N. Tanzarn. 2004. *The susceptibility and vulnerability of small-scale fishing communities to HIV/AIDS in Uganda*. Report of a sector project funded by Policy Advice for Sustainable Fisheries, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH and FAO HIV/AIDS Programme, Rome (available at http://www.fao.org/sd/dim_pe3/docs/pe3_040101d1_en.doc).
48. J.A. Seeley and E.H. Allison. 2005. HIV and AIDS in fishing communities: challenges in delivering antiretroviral therapies to vulnerable groups. *AIDS Care*, 17(6): 688–697.
49. C. Bishop-Sambrook and N. Tanzarn. 2004, op. cit., see note 47.
50. E.H. Allison and J.A. Seeley. 2004. Another group at high risk for HIV. *Science*, 305: 1104.
51. C. Keulder. 2006. Ships, trucks and clubs: the dynamics of HIV risk behaviour in Walvis Bay. In WorldFish Center. *Responding to HIV and AIDS in the Fishery Sector in Africa: Proceedings of the International Workshop*, 21–22 February 2006, Lusaka, Zambia, pp. 41–49. Cairo.
52. Op. cit., see note 46.
53. Op. cit., see note 50, and FAO. 2005. *Impact of HIV/AIDS on fishing communities: policies to support livelihoods, rural development and public health*. New Directions in Fisheries: A Series of Policy Briefs on Development Issues No. 2. Rome.
54. FAO. 2006. *Contribution of fisheries to national economies in West and Central West Africa. Policies to support wealth creation, sustainable livelihoods and responsible fisheries*. New Directions in Fisheries: A Series of Policy Briefs on Development Issues No. 3. Rome.

55. Op. cit., see notes 45, 48 and WorldFish Center. 2006. *Responding to HIV and AIDS in the Fishery Sector in Africa: Proceedings of the International Workshop*, 21–22 February 2006, Lusaka, Zambia, pp. 41–49. Cairo.
56. The Sustainable Fisheries Livelihood Programme (SFLP) has recently produced a policy brief (op. cit., see note 53) outlining appropriate response strategies.
57. FAO. 2005. *Increasing the contribution of small-scale fisheries to poverty alleviation and food security*. Technical Guidelines for Responsible Fisheries No. 10. Rome.
58. WorldFish Center, 2006, op. cit., see note 55.
59. Government of Uganda. 2005. *Strategy for reducing the impact of HIV/AIDS on fishing communities*. Department of Fisheries Resources, Ministry of Agriculture, Animal Industries and Fisheries, Kampala, Government Printer.
60. Sustainable Fisheries Livelihoods Programme in West Africa. 2004. Fisheries and AIDS. *SFLP Liaison Bulletin No. 17 & 18*, pp. 4–35.
61. Secretariat of the Pacific Community (SPC). 1999. *Safe sex and safe seafaring – something to think about*. 1st SPC Heads of Fisheries Meeting, Noumea, New Caledonia, 9–13 August 1999. Background Paper 10. Noumea, New Caledonia.
62. UNAIDS. 2006. *AIDS Update*. Geneva.
63. S. Merten and T. Haller 2006. “Fish for sex” exchange in the Kafue Flats, Zambia. In WorldFish Center. *Responding to HIV and AIDS in the Fishery Sector in Africa: Proceedings of the International Workshop*, 21–22 February 2006, Lusaka, Zambia, pp. 59–64. Cairo.



PART 3

**HIGHLIGHTS
OF SPECIAL STUDIES**

HIGHLIGHTS OF SPECIAL STUDIES

Rehabilitation of riverine habitat for fisheries¹

INTRODUCTION

Human activities have left their mark on streams and rivers for thousands of years. As a consequence of industrialization and human population growth, pressure on natural watercourses and their aquatic habitats has intensified through history and the degradation of aquatic habitats has accelerated – with negative consequences for aquatic species and therefore also for fisheries. Currently, nearly all watercourses in developed countries have been adversely affected by development to various degrees and inland water habitats in many developing countries are following the same route.

However, the situation is gradually changing and many developed countries are trying to reverse these longstanding negative impacts through rehabilitation of riverine habitats. The international community, including FAO, through the Code of Conduct for Responsible Fisheries,² has acknowledged the value of understanding ecosystem processes – the biological, physical and chemical qualities of aquatic habitats; habitat protection and rehabilitation; nutrient cycling; and the interactions of non-target species – in maintaining the productivity of fisheries. The Code thus recognizes the need to conserve and rehabilitate habitats cost-effectively through an ecosystem approach. According to the Code's technical guidelines for inland fisheries: "States should clearly formulate national plans for the use of water including allocation for fisheries and for the protection of the aquatic environment".³

Unfortunately, there have been only a limited number of good studies of habitat rehabilitation and monitoring on which to base advice, especially for developing countries. Although the studies reviewed provide technical information on rehabilitation projects from various parts of the world, most were undertaken in temperate countries, and modifications of the methods and strategies used there may be necessary before they can be adapted to other riverine habitats. Another concern is that many studies on the effectiveness of habitat rehabilitation have analysed the physical-chemical parameters of the water, i.e. the water quality, rather than the increase in fish production.

GENERAL PRINCIPLES

Restoration of riverine habitats to pristine conditions is generally not practical; it is usually only realistic to aim at rehabilitating key functions in the ecosystem through the rehabilitation or re-creation of functional habitats and the establishment of connectivity between them. Where habitats have been degraded and fish production has decreased as a result, rehabilitation efforts should be preceded by assessments of what has happened to the aquatic ecosystem, i.e. what functions have been lost or degraded. The goal of such assessments is both to identify the impacts on specific areas of the ecosystem or on key ecosystem processes that affect stream habitats, and to specify management actions required to restore or rehabilitate those processes that sustain aquatic habitats and support fish production (Table 13).

Restoring specific fish populations is subordinate to the goal of restoring the ecosystem that supports multiple species. As long as all rehabilitation actions are consistent with the overriding goal of restoring ecosystem processes and functions, habitats will be restored for multiple species.

Many conflicting uses, and thus social and economic interests, are at stake in inland waters. Indeed, the requirements for the maintenance of healthy stocks of fish and other living aquatic resources and the fisheries that depend on them are frequently of secondary importance to other considerations. Therefore, the costs and benefits of



Table 13
Specific conditions of aquatic habitats important for the rehabilitation of fisheries

General category	Examples
Water flow	Minimum acceptable flow Timing of flow Speed of change in discharge or water level
Habitat connectivity	Maintenance of access to critical habitats (longitudinal; lateral) Removal of obstructions to fish movement or mitigation (e.g. fish passage facilities) Maintenance of access to inflowing tributaries in lakes Connectivity to lateral marshes, floodplains, etc.
Habitat diversity	Maintenance of and access to critical habitats Provision for adequate diversity in main waterbody Maintenance of riparian vegetation structure
Water quality	Avoidance of chronic or acute, diffuse or point source pollution by toxic substances Regulation of nutrients with critical limits
Physical disturbance	Limitation of boat wash road and other development Limitation of forest and plant removal and on weed cutting Limitation of grazing or other disturbance
Basin characteristics	Land-use practice to avoid erosion and uncontrolled runoff Avoidance of inappropriate types of vegetation cover Connectivity buffer zones

Source: Adapted from R.L. Welcomme. 2001. *Inland fisheries: ecology and management*. Oxford, UK, Fishing News Books.

maintaining or restoring inland fisheries need to be balanced against the costs and benefits of other uses of the water. Moreover, it should be recognized that the costs of all alternative uses of inland waters comprise not only actual expenses incurred, but may also include losses of future opportunities. It should also be recognized, when estimating the costs of maintaining healthy fish stocks, that there are alternative approaches to protection, mitigation and rehabilitation.

Benefits from rehabilitation include not only the income that can be generated from fishing, but also ecosystem services such as nutrient cycling, sediment transport and carbon sequestering, as well as less tangible benefits such as those relating to the aesthetic and conservation aspects of an intact ecosystem. Because cost–benefit calculations may favour non-fisheries use in the short term, it is important to consider the time horizon taken into account in the analysis. The time horizon should be long enough to allow the short-term result to be balanced with the long-term interests and values inherent in the ecosystem. This applies not only to new projects for the use of freshwater but also to existing ones. Neglecting an already degraded environment will only delay – and possibly increase – the bill for rehabilitation.

A multidisciplinary basin-wide approach that includes land and water management is needed if rehabilitation is to be achieved sustainably. Fisheries managers, and those responsible for conserving the environment, must negotiate the best possible conditions for the maintenance of fish stocks and fisheries. However, the economic interests of other sectors, for example power generation, navigation, agriculture and industry, are difficult to counterbalance because it is not easy to provide well-documented and accurate figures that demonstrate the economic value of the intact aquatic habitat and its associated fish populations and biodiversity. In this process, it is the task of fisheries managers and those responsible for conserving the environment to negotiate the best possible conditions for maintaining the fish stocks and fisheries. Where politicians have defined an enabling framework, tensions among the various stakeholders can be reduced and larger benefits derived from the many goods and services the aquatic ecosystems supply, including products for human consumption.

Decision-makers may choose from management schemes ranging from “do nothing”, when the costs involved with rehabilitation are unacceptable, to “provide

mitigation and rehabilitation", or to "provide total protection" with the establishment of sanctuaries in which no activities are allowed in the watershed.

METHODS FOR REHABILITATION

Rehabilitation of rivers should focus on creating structural diversity (depth, flow, substrate and riparian structures) and re-establishing longitudinal and lateral connectivity (Table 14). At the same time, it should aim to create conditions that favour communities of species. Many rehabilitation measures are currently guided by the principle of the "potentially natural species composition", where not only existing species are considered as targets of rehabilitation, but also species that had lived there in the past and might one day return/be brought back. The habitat characteristics requiring improvement must be identified accordingly, including all functional units used by fish and especially during sensitive stages of the fishes' lifecycles. However, the final rehabilitation strategy must be sufficiently flexible to allow new knowledge and tools to be incorporated.

The level of knowledge concerning species and ecosystems associated with inland waters is variable and patchy on a global scale. Relatively simple and species-poor systems, such as temperate salmonid streams, are relatively well understood, while the much more complex large tropical rivers are less well studied and only



Table 14
Common categories of habitat rehabilitation and examples of common actions

General category	Examples	Typical goals
Road improvements	Removal or abandonment Resurfacing Stabilization Addition or removal of culverts	Reduce sediment supply Restore hydrology Improve water quality
Riparian restoration	Fencing to exclude livestock Removal of grazing Planting of trees and vegetation Thinning or removal of underbrush and bushes	Restore riparian vegetation and processes Provide shade and shelter Improve bank stability and instream conditions
Floodplain connectivity	Levee removal Reconnection of sloughs, lakes Excavation of new floodplain habitats	Reconnect lateral habitats Allow the river channel freedom to meander and shift its course
Dam removal and flow modification	Removal or breaching of dam Increase in instream flows Restoration of natural flood regime	Reconnect migration corridors Allow natural transport of sediment and nutrients
Instream structures	Placement of log or boulder structures Engineered log jams Placement of spawning gravel Placement of brush or other cover Re-meandering a straightened stream	Improve instream habitat conditions for fish
Nutrient enrichment	Addition of organic and inorganic nutrients	Boost productivity of system to improve biotic production Compensate for reduced nutrient levels from lack of anadromous fishes
Miscellaneous rehabilitation techniques	Reintroduction or removal of beavers Brush removal Bank protection Habitat protection through land acquisition, conservation, easements or legal protection (laws) Instream flows	Reduce or increase habitat complexity Prevent erosion or channel migration Protect habitat from further degradation Provide adequate flows for aquatic biota and habitat

poorly understood. It is therefore frequently necessary to work with models that require only limited knowledge of the biology of individual species, but focus more on the restoration of ecosystem functions and processes. Detailed planning for the conservation of specific species requires more complete knowledge of the biology and the behaviour of the species involved.

Structural diversity

Fish abundance may be increased locally in the short to medium term. It has been demonstrated that the improvement of habitats through enhancing structural diversity – by adding instream structures such as logs or boulders or by creating pools and riffles that serve to oxygenate the water, trap sediments and provide shelter – increases fish abundance locally in the short to medium term. However, because this often does not address the underlying causes of habitat degradation, a more permanent solution requires large changes that restore or mimic natural processes.

Many rivers and streams have been canalized, for navigation purposes or in order to carry away water more efficiently. In this situation habitat complexity may be increased through decanalization and by restoring meanders and reconstructing floodplain habitats. This will increase the length of the streams and lead to physical and biotic changes that will benefit fish and invertebrates. However, such large-scale projects are relatively recent and there has not yet been enough time to evaluate the results properly.

Restoration of processes

Important elements in restoring the ecosystem processes are the linkages between aquatic and terrestrial ecosystems. A few studies indicate that in areas with degraded riparian habitat where there is no tree cover on the banks, water temperatures, for example, tend to be higher and fish abundance lower than in areas where the vegetation is intact. Riparian vegetation is also important in providing shade, shelter, nutrients, woody debris and food for fishes. Replanting and protection to exclude cattle and other grazers of riparian vegetation have proved effective as a means for restoring fish populations in some areas.

Restoration of floods

Floods are necessary for a variety of ecological processes and associated species of plants, trees, animals, fishes and birds. Where the natural flood pattern cannot be fully restored it may still be possible to restore partially key features of the flood cycle. Important elements in the flood cycle include timing, amplitude, duration, rapidity, smoothness and upstream drawdown level. Managers of dams and hydroelectric plants should be encouraged to time the release of their water in accordance with natural flood cycles to enable rehabilitation of fisheries that are dependent on floods.

Longitudinal connectivity

Rehabilitation of river fisheries depends on the longitudinal exchange of fish, nutrients, sediments, organic matter and water in sufficient quantity and quality. Rehabilitation strategies often include small-scale interventions that are easy to implement but may have limited long-term impact. For example, because of the decrease of anadromous fish species, some streams currently have only 6–7 percent of their historic nitrogen and phosphorus levels. In such situations, nutrient flows along the river have been augmented with salmon carcasses or inorganic nutrients, resulting in some increases in juvenile salmon and macro invertebrate abundance.

However, more serious rehabilitation projects should involve longer-term strategies that address fish movements, water flow, land-use planning and water-resource management for the entire catchment level or river basin.

Migratory fishes are often the most valuable commercially, but are among the first to disappear when water becomes polluted or when migration routes are interrupted by physical structures. Migratory species are therefore often used as indicators of

ecological health. However, it is not only the long-distance migratory species that suffer from habitat fragmentation but all species that during their lifecycle depend on longitudinal movements.

When improving migration conditions for fish, it is important to look at all life stages as their requirements might be quite different (e.g. upstream migration of small young eels; downstream migration of large adult eels). Passage mitigation structures should thus be designed according to the needs and abilities of the different species and the different life stages of those species. For example, the design of sluices that regulate the flow of water in and out of poldered areas will determine whether pelagic fish eggs, bottom-living juveniles or adult fishes are able to enter the area.

When migration routes have been blocked by dams, the best solution for fisheries is to remove the dam in order to ensure both upstream and downstream passage. Dams have a limited operating life (around 50 years) and are costly to maintain. In the United States of America, approximately 500, mostly small, dams have been removed during the past 20 years. Apart from allowing fish movement both upstream and downstream, removal is also highly effective at restoring processes that have been disrupted as a result of damming, such as nutrient cycling and transport of nutrients and sediments.

Fish passes, which facilitate the movement of fish past blocking structures, have commonly been used to restore fish migration. When fish passes are incorporated into the early design of a dam construction project, their costs are equivalent to only a small percentage of the total costs. But if fish passes have to be fitted retroactively, costs increase drastically. If dam construction cannot be avoided, it is thus the responsibility of fisheries managers at least to ensure that the appropriate types of fish passes are planned at the earliest stages of the project. It is also important to choose the fish pass design that matches most closely the behaviour and requirements of the species present (or likely to be present at a later stage). Fish passes designed for salmonids, for example, should not be used blindly if non-salmonid species are the target group, because these passes might be ineffective or less effective for species with swimming abilities different from those of salmon. If little is known about the requirements of the species present, the most versatile fish pass design should be chosen, which in many cases would be the vertical slot pass (Figure 37).

Figure 37

Vertical slot fish pass, Iffezheim, River Rhine, France/Germany



Lateral connectivity

Lateral connectivity of habitats to the main river channel is also essential for many fisheries. Lowland rivers with floodplains are often contained by massive levee systems erected to protect cropland, settlements and other infrastructure against floods. The result of such development is that the floodplains become isolated from the rivers, and the seasonal dynamics of the system are eliminated, with negative consequences for the fisheries.

Heavy anthropogenic modifications (e.g. densely populated areas along rivers), and the resulting social and economic costs involved in removing levees, mean that this rehabilitation method is not always feasible. However, dikes can be set back to allow a partial flooding of the former floodplain. In certain areas the river may also be allowed to inundate the entire floodplain. By re-allowing the fish to enter flooded areas to spawn and feed, the large surplus production of juvenile fishes, which is characteristic of healthy floodplains, ensures adequate recruitment of fish to restore fish populations.

Isolated waterbodies such as side channels, oxbow lakes and floodplain pools may be linked through the installation or improvement of culverts or through the creation of natural channels. These are good options because they rely on already existing habitats that only need reconnection. When such natural habitats are absent they can be replaced by human-made waterbodies such as gravel extraction sites or borrow pits, which can be engineered to favour species diversity.

CONCLUSION

The studies reviewed in this section clearly indicate that riverine habitat rehabilitation should be based on an ecosystem approach in which key processes are re-established and maintained. In this way rehabilitation will benefit a number of aquatic species and therefore help improve inland fisheries. To ensure the maximum efficiency of remedial measures, the ecological requirements of all riverine species during all their life stages (particularly those of migrants) must be taken into consideration from the earliest planning stages. The watershed, or basin, provides a geographic setting: the entire basin should be considered, as no rehabilitation project can be considered in isolation from its basin and the people who live there. Activities upstream can counteract any effort made at the local level.

Inland fisheries are most seriously affected by factors external to the fishery sector. Social, economic and institutional issues, and competing uses of inland waters, often impede the application of technologies to rehabilitate rivers for fisheries. Major interventions (re-meandering, floodplain restoration or removal of dams) are costly and require the active cooperation of riparian landowners and other stakeholders, or the acquisition of the land by the state. Although the cost-effectiveness of rehabilitation projects has seldom been studied, it is clear that habitat protection is the most cost-effective means for maintaining riverine fisheries.

Knowledge of inland waters, including their aquatic biodiversity and fisheries, remains partial in many parts of the world and few habitat rehabilitation projects have been adequately evaluated. Although further research and information are clearly desirable, the rehabilitation methods reviewed above do show promise, and our existing knowledge of ecosystem functions, ecosystem processes and the requirements of aquatic species should allow us to act now to rehabilitate many important fisheries if the political will is strong enough.

Responsible fish trade and food security

BACKGROUND

Since ancient times, fish from the oceans and other aquatic bodies have been an important source of food. However, those who specialize in harvesting fish cannot consume all the fish caught. Even at low levels of productivity, there is a need to barter or exchange the surplus. Trading, even locally and domestically, is more innate to a fishery than it is to livestock or agriculture.

A major component of global trade has long been food products such as spices, grains, salt, fruits, sugar, meat and fish. The global food trade has bridged vast distances and cultures. Today, fish is being transported to the market from all over the world. The biggest fish market in the world, Tsukiji Fish Market in Tokyo, is a good example – fresh fish from all the world's oceans are on display there.

Trade in fish products connects producers with consumers and contributes to food security and higher living standards. For some time, observers of fish trade have been debating whether or not this is true for all those involved in and/or linked with trade in fish and fish products. In these debates, concerns relating to fish and food security have tended to focus directly on fish for consumption. Consequently, when fish exports have been examined, the focus has been primarily on how they reduce the availability of fish for domestic consumption; fish imports, on the other hand, have been seen mostly as a means of increasing local food-fish availability. In fact, the relationship between trade (exports and imports) and food security is more complex. Production for export can enhance the incomes of poor fishers substantially and thus raise their trade-based entitlements, enabling them to achieve greater food security.

In order to understand how, when and where trade in fishery products contributes to, and/or detracts from, food security, FAO and the Norwegian Agency for International Development (NORAD) commissioned a global study consisting of assessment studies in 11 countries: Brazil, Chile, Fiji, Ghana, Kenya, Namibia, Nicaragua, the Philippines, Senegal, Sri Lanka and Thailand.⁴ The countries were selected as examples of countries actively involved in international fish trade and to ensure a wide geographical spread. Moreover, these countries have seen a rapid increase in their fish exports over the past 10 to 20 years.

The study addressed the trade issue from a broader perspective than has been the practice in much of the recent debate. It focused primarily on the direct and indirect influence of fish trade on food security and reviewed in detail the positive and negative impacts of international fish trade on food security in LIFDCs. Figure 38 illustrates schematically how the direct and indirect influences of fish trade were evaluated.

MAIN FINDINGS OF THE STUDY

The study's main conclusion was that international trade in fishery products has had a positive effect on food security in the developing countries participating in such trade.

International fish trade has increased dramatically over the past 20 years, from US\$15.4 billion in 1980 to US\$71.5 billion in 2004. Developing countries have particularly benefited from this increase, with their net receipts increasing from US\$3.7 billion to US\$20.4 billion over the same period. This was greater than their net exports of other food commodities such as coffee, bananas, rice and tea taken together.

There is, however, room for improvement. Trade statistics indicate no significant change in the composition of exports from developing countries over the past decades. Most exported fish products are frozen. While in some instances this is because of the nature of the product being exported, there is also some evidence that tariff escalation in developed countries has prevented the growth of an export trade in value-added fish products from developing countries.

Production and trade statistics also indicate that international trade has not had a detrimental effect on the availability of fish as food. Increases in production, coupled with import and export of fishery products, have ensured continued availability of fish for the domestic markets in LIFDCs. Moreover, proceeds from fish exports are also used to import other foods, including fish products.

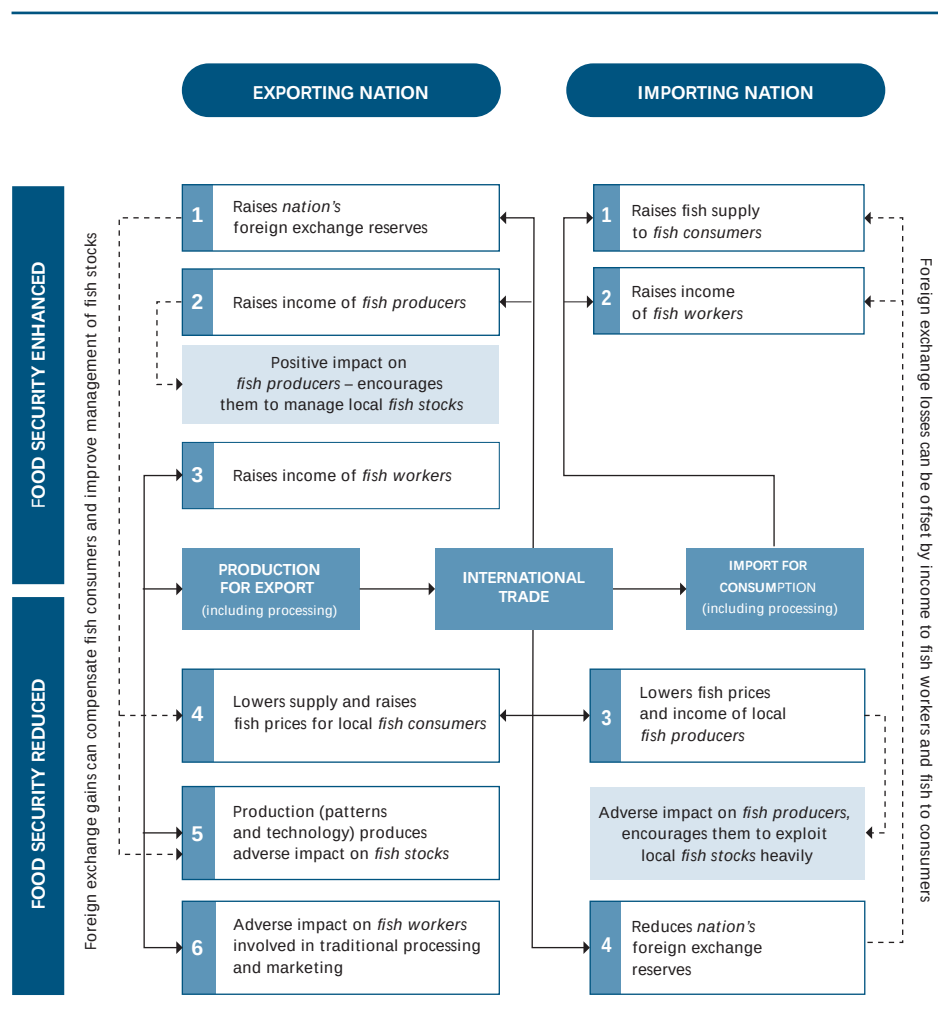
In all the countries studied, the number of people employed in export-oriented fisheries had increased over time. Significant new employment had been created in fish-processing activities as a result of international trade. At the time of the study, the total number of employees in fish-processing activities varied according to the size of the trade operations – from 900 in Kenya to 212 000 in Thailand.

In eight of the 11 countries studied, international trade had had a positive impact on food security.⁵ This conclusion was based on outcomes related to the national economy and on impacts on fishers, fish workers and fish consumers.



Figure 38

International trade in fishery products: impact on food security in low-income food-deficit countries



Additionally, fish exports were among the top ten foreign-exchange earners in eight of the countries – Chile, Fiji, Ghana, Kenya, Namibia, Nicaragua, Senegal and Thailand. Without doubt, in LIFDCs the earnings from international trade in fishery products contribute to ensuring food security at the aggregate level.

Thailand, one of the world's largest fish-exporting countries, has seen a considerable increase in rural incomes as a result of the overall export orientation of the economy. Fishers are likely to have benefited to the extent that their harvesting and production were linked to export-oriented species. Poverty levels in the rural areas have also dropped significantly.

Modern international trade also has consequences for the lives of the traditional fish processors, the vast majority of whom are women – generally middle-aged and with little education. Any change in the trade policy of a country has an impact on women fish workers. This has important bearings on the question of food security and poverty. On the one hand, as numerous studies have shown, an increase in the income of women, as opposed to men, has a greater positive impact on household food security. Expanding fish-processing activities in developing countries, including those generating additional value to fish destined for export markets, has created new jobs among women, mainly young women. On the other hand, increased exports of fishery products, particularly to developed countries, has led to a significant decline

in the quantity, and also an increase in the price, of fish available to women involved in traditional fish processing. This has resulted in some loss of employment, income or both.

The study found that international trade in food products generally has a negative impact on fish resources. Clearly, there is an urgent need for more effective and sustainable resource-management practices, without which there can be no sustainable international trade. Preserving the resource base and the integrity of the aquatic ecosystem is a *sine qua non* for food security – with or without international trade. The fundamental requirement is to sustain the growth of fish production and maintain a harmonious balance between the three realms – marine capture, inland capture and aquaculture – in accordance with the social and physical context. In aquaculture, achieving a new balance between intensive and extensive production techniques, including more efficient feed-conversion ratios and the search for non-animal protein feeds, should be a priority.

The study also highlights the need for free and transparent trade and market policies. These will help ensure that the benefits accruing from international fish trade are shared by all segments of society. In this respect, the study underscores the recommendation of FAO's Code of Conduct for Responsible Fisheries that states consult with all stakeholders, industry as well as consumer and environmental groups, in the development of laws and regulations related to trade in fish and fishery products.

Finally the study recommended the following targets for countries, particularly developing countries, aiming to increase food security through international fish trade:

1. better fishery resource management;
2. better information on the chain of custody and trade structure;
3. recognition of subsistence fishing as a major source of direct food security;
4. more social security for fish workers;
5. improved livelihood-related infrastructure, such as housing, sanitation and water supply;
6. better coordination in data and statistics collection;
7. assistance for developing countries in adapting to new market conditions;
8. better regional cooperation among developing countries;
9. more inclusive and responsible fish trade;
10. responsible fish consumption in developed countries.



Trash or treasure? Low-value/trash fish from marine fisheries in the Asia-Pacific region⁶

INTRODUCTION

Marine fishery products from both capture and culture continue to play a significant role in the food security, poverty alleviation and economies of many countries in the Asia-Pacific region. Over the past 20 years, major changes have occurred in these fisheries – overexploitation of marine coastal fishery resources has led to the encouragement of coastal aquaculture to meet the growing demand for seafood, income, employment and export earnings in many countries.

The shift to aquaculture to make up for reduced capture supply and quality may not have factored in the close link between capture fisheries and aquaculture. This is particularly the case where aquaculture depends on the capture fishery to provide its feed, either directly as fresh fish or through fishmeal and fish oil. Fishing and aquaculture have become locked into a loop (see Figure 39), where the demand for low-value/trash fish for fish and animal feeds supports increased fishing pressure on already degraded resources. This raises some important questions regarding the social, economic and ecological costs and benefits of this system, its sustainability and future trends.

Box 12

Low-value/trash fish: a definition

For the purpose of this article we define *low-value/trash fish* as: Fish that have a low commercial value by virtue of their low quality, small size or low consumer preference. They are either used for human consumption (often processed or preserved) or fed to livestock/fish, either directly, or through reduction to fishmeal/oil.

Note that in China and Thailand the term only applies to fish used as livestock/fish feed.

PRODUCTION OF LOW-VALUE/TRASH FISH

In many coastal demersal fisheries in Asia, “fishing down the food chain”⁷ has resulted in an increase in the percentage of low-value/trash fish, especially in heavily fished areas in China, Thailand and Viet Nam. The Asia-Pacific Fishery Commission (APFIC) has provided initial estimates for six major fish-producing countries in the region (Table 15). A weighted average⁸ of low-value/trash fish across the six countries amounts to 25 percent of the total marine catch, with estimates greater than 50 percent in specific fisheries.

Figure 39

The “low-value/trash-fish loop”, where increasing demand sustained by increasing prices drives increased fishing and resource degradation

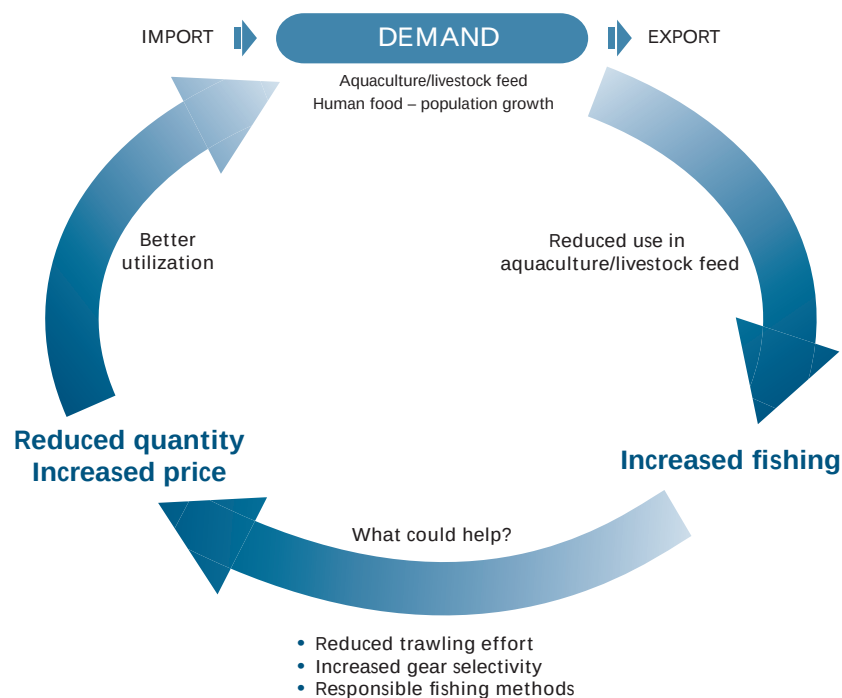


Table 15
Estimations of annual low-value/trash-fish production in the Asia-Pacific region

Country	Low-value/ trash fish (Tonnes)	Share of total catch (Percentage)	Dominant gear ¹	Year of estimation
Bangladesh	71 000	17	Gill nets (48) Non-mechanized set bags (42)	2001–02
China	5 316 000	38	Trawl	2001
India	271 000	10–20	Trawl	2003
Philippines	78 000	4	Trawl (41) Danish seine (22) Purse seine (12)	2003
Thailand	765 000	31	Trawl (95)	1999
Viet Nam	933 183	36	Trawl	2001

¹ Figures in parentheses are percentages.

Source: APFIC country studies cited in FAO. 2005. *Asian fisheries today: the production and use of low-value/trash fish from marine fisheries in the Asia-Pacific region*, by S. Funge-Smith, E. Lindebo and D. Staples. RAP Publication 2005/16. Bangkok.

USES OF LOW-VALUE/TRASH FISH

Low-value/trash fish (using the broader definition) are an important food source for poor people in many developing countries. Small-scale fishers generally keep low-value/trash fish for home consumption, after selling other fish with higher market demand. Some of the low-value/trash fish are consumed fresh while some are preserved or processed (e.g. into fish sauce or pastes). The proportion of low-value/trash fish used for human consumption can be quite high; for example, in Bangladesh about 60 000 tonnes of the total 71 000 tonnes of low-value/trash fish landed are consumed either directly or in a dried form.

Varying amounts of the low-value/trash fish are used for livestock/fish feed in the different countries (100 percent in China and Thailand – by definition, and little in Bangladesh and India). A conservative estimate for the amount of fish used for livestock/fish food in Asia would be in the order of 25 percent of the capture fisheries production.

Box 13

Low-value/trash fish prices

At the local level, prices of low-value/trash fish vary according to the species, season and abundance of other fish and fishery products. At the low end, fresh low-value/trash fish have been known to fetch as little as US\$0.04 per kg (e.g. in Thailand), while their price can be as high as US\$1.50 per kg (e.g. in India). Fishmeal-producing industries in the Asia-Pacific region, however, buy low-value/trash fish at prices ranging from US\$0.25 to US\$0.35 per kg, depending on the protein concentrations of the fish.



There also has been considerable innovation and diversification into new fish products in recent years in an attempt to utilize previously unwanted bycatch, especially from shrimp and finfish trawlers.

Using FAO statistics for capture and aquaculture production in the region, a very approximate “back of the envelope” calculation can be developed to trace the flow of fish products through direct and indirect human use (Figure 40). For 2003, the recorded marine capture fishery landings in the Asia-Pacific region amounted to 39.3 million tonnes (for all carnivorous and omnivorous fish, excluding molluscs and seaweeds), with about 1.8 percent discarded,⁹ giving a total capture figure of approximately 40.0 million tonnes. Of this, 29.5 million tonnes were used directly for human consumption and 9.8 million tonnes (25 percent) used for livestock/fish. The total aquaculture production in the region for all fish (again excluding molluscs and seaweeds) is estimated at 28.0 million tonnes. This indicates that approximately 50 percent of fish for human consumption produced in the Asia-Pacific region comes directly from capture fisheries, while 50 percent comes through an aquaculture pathway (this fish is consumed both within the region and exported).

ISSUES ASSOCIATED WITH LOW-VALUE/TRASH FISH

Several issues concerning low-value/trash fish need to be resolved in order to ensure that fisheries of the Asia-Pacific region contribute more to the region's sustainable development.

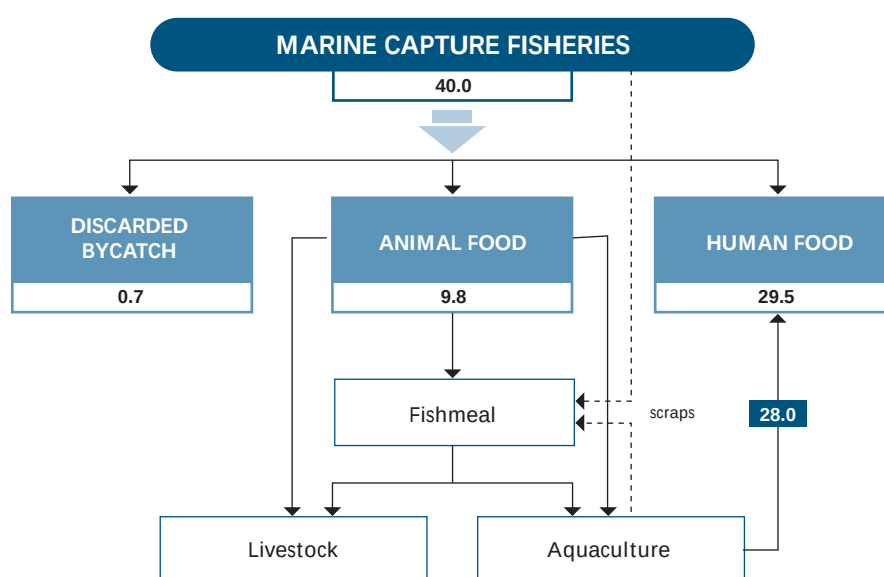
Increasing demand for low-value/trash fish for aquaculture and other animal feeds

FAO estimates that an annual global production increase of 3.3 percent until 2030 is feasible in the aquaculture sector.¹⁰ The International Food Policy Research Institute (IFPRI) gives an estimate of some 2.8 percent until 2020.¹¹ The production of higher-value species will increase the most, given the rising demand for these fish products. The largest rise in production is expected to be in China.

In many areas, these culture practices have been transformed from extensive systems to semi-intensive and intensive culture systems, for which increasing amounts

Figure 40

Production flows in the Asia-Pacific region, by major categories of fish (million tonnes, live weight equivalent)



of feed are required. Fishmeal remains the preferred protein source for most aquaculture feeds. The fishmeal component of feeds can be replaced by vegetable protein (e.g. soya) or monocellular proteins, but the economics of this practice currently remain unattractive. It is worth noting that chicken, cattle and pigs do not naturally feed on fish and therefore the inclusion of fishmeal in feeds for these animals is a nutritional or economic convenience rather than an absolute necessity; the same cannot be said for carnivorous fish.

Competition between use for fishmeal versus use for human food

There is a growing conflict between those who favour using low-value/trash fish for animals and fish versus those who argue it should be used for human consumption. Some argue that it would be more efficient and ethical to divert more of the limited supply to human food (e.g. in the form of value-added products). However, without external interventions (such as incentives and subsidies), it will be the economics of the different uses of low-value/trash fish in different localities that will channel the fish one way or the other. For example, in Viet Nam, as the national demand for fish sauce is expected to double over the next ten years, the competition for mixed low-value/trash fish will increase between those who culture catfish (*Pangasius*) and those who use these fish as raw material for low-cost fish sauce. In contrast, culture operations for high-value marine finfish and lobsters can afford to pay more for anchovy than can fish sauce manufacturers in central Viet Nam. The purchasing power of those who culture higher-value species will tend to draw on lower-priced capture fishery resources. Where this happens, it is important to appreciate the employment and income generation afforded by high-value aquaculture and factor in the ability of those who are employed in this activity to purchase food, rather than produce it or catch it directly.

Sustainability of harvesting

Low-value/trash fish have ready local markets and can be sold easily in many landing sites, but may have relatively limited markets beyond these areas in view of their poor quality, appearance, size or bony nature. Hence, there seems to be little incentive to discourage the harvesting of low-value/trash fish given their important contribution to aquaculture, overall employment and consequent export earnings. Also, the low-value/trash fish catch is based on a large number of short-lived, highly productive species for which, apart from targeted low-value/trash fisheries in China, there is little evidence of current overexploitation leading to reduction in overall fish production.

The concern, for both capture fisheries and aquaculture, is that there is no way of knowing how sustainable this system might be. The WorldFish Center has analysed low-value/trash fish trends in several countries based on past scientific trawl surveys. The results show that many families of fish that include both low-value/trash fish species and commercial species have suffered severe declines in abundance, whereas families containing only low-value/trash fish species have been less affected.¹²

A further aspect of the sustainability issue is that the low value of these fish does not reflect their high ecological value. Removing large quantities of them from the environment creates a void in the food chain, which could also lead eventually to the reduction or loss of larger fish species. Moreover, fishing with demersal gears that destroy habitats adds to the overall ecological impact.

Growth overfishing – harvesting juveniles of commercial species

An issue related to that of low-value/trash fisheries is the capture of juvenile fish of important commercial species (so-called “growth overfishing”). Between 18 and 32 percent of low-value/trash fish in the Gulf of Thailand are juveniles of commercially important fish species. Given a chance to grow to a larger size, these high-value species could, when harvested, yield much more in terms of total quantity landed and, more importantly, in terms of value.

Juvenile/trash fish excluder devices have been tested in trawl nets in several Southeast Asian countries. However, given the many conflicting uses for low-value/trash



fish, it is difficult to envisage a management system that optimizes the supply of these fish for both human and livestock/fish uses and at the same time excludes juvenile fish.

Lack of incentives for improved post-harvest

Because of the high demand for low-value/trash fish and the good economic gains they offer, many fishers have decided that careful handling and chilling are not essential. According to some reports in Viet Nam, 20–30 percent, or even 50–60 percent of high-value fish on some offshore trawlers, become low-value/trash fish as a result of poor storage.

Discarding of unwanted fish

Discarding practices are seen by many as a waste of fish and fish protein. For the Asia–Pacific region, discards in most fisheries in China and Southeast Asia are now considered to be negligible owing to the greater utilization of low-value/trash fish as food and feeds. There has also been a change in perception of what constitutes a target species. Given the expansion of markets for low-value fish, almost all catches can now be regarded as “targeted” (i.e. they produce neither bycatch nor discards). Exceptions will, of course, occur: for instance, in Brunei Darussalam, fishing for low-value/trash fish is not permitted (for aquaculture or local consumption), and hence a discard estimate of some 70 percent is still being quoted. Fisheries with high discard rates still exist; these include the Bangladesh industrial finfish and shrimp trawling fishery, which has an estimated discard rate of some 80 percent.

PRIORITY AREAS FOR FURTHER WORK

A draft action plan to address the above issues was developed during the APFIC Regional Workshop on Low Value and “Trash Fish” in the Asia–Pacific region.¹³ This plan recommends the action outlined below.

- **Fishery interventions**

1. Reduce trawling and push net effort (and clearly monitor the effect of capacity reduction).
2. Introduce improved selectivity of fishing gears/fishing practices.
3. Facilitate a reduction in the “race for fish” through rights-based fisheries and co-management.
4. Protect juvenile nursery areas (refugia/closed areas, seasonal closures).
5. Provide alternative social support measures (including employment).

- **Improved utilization**

6. Improve post-harvest fish handling.
7. Develop new fish products through processing.

- **Improve feeds for aquaculture**

8. Change from direct feeding to pellet feeding.
9. Reduce fishmeal content by substitution of suitable ingredients in pellets.
10. Invest in feed research for inland/marine species.
11. Promote adoption of, and changeover to, pellet feeds.

The challenge is now on how to implement these actions. Several activities have been planned by the APFIC, including a Regional Consultative Forum Meeting and the development of recommendations through the Commission.

Conservation and management of shared fish stocks: legal and economic aspects

SOME KEY ISSUES

A shared fish stock is one that is harvested by two or more states (or entities). The stock may be shared by virtue of the fact that it crosses the boundary of a coastal state's EEZ into one or more neighbouring EEZs (transboundary stock),¹⁴ or because it crosses the

EEZ boundary into the adjacent high seas, where it may be subject to exploitation by distant-water fishing states (highly migratory or straddling stock),¹⁵ or finally because it is to be found exclusively in the high seas (discrete high seas stocks). FAO estimates that as much as one-third of global marine capture fishery harvests may be based on such shared stocks, and argues that the effective management of these stocks stands as one of the great challenges faced in achieving long-term sustainable fisheries.¹⁶

In response to this challenge, FAO, in cooperation with the Government of Norway, convened the Norway–FAO Expert Consultation on the Management of Shared Fish Stocks in October 2002.¹⁷ FAO also provided technical support to the Sharing the Fish Conference 06, held in Australia,¹⁸ one of the major themes of which was the management of (internationally) shared fish stocks.

Shared fish stocks are more difficult to manage than those confined to the waters of a single coastal state's EEZ because, with a few exceptions, a strategic interaction develops between and among the states sharing the resource or resources. If, for example, two coastal states are sharing a transboundary stock, the harvesting activities of the first state are bound to have an impact upon the harvesting opportunities of the second state and vice versa. Thus, a strategic interaction inevitably develops between the two coastal states, with each state attempting to predict and respond to the harvesting plans of the other.

TRANSBOUNDARY FISH STOCKS

At the close of the Third United Nations Conference on the Law of the Sea in 1982, transboundary stocks were seen as *the* shared fish stock management problem. It was believed that only a small percentage of world capture fishery harvests would come from fish stocks lying outside the emerging EEZs. Consequently, stocks crossing the EEZ into the adjacent high seas were seen as a minor resource-management problem.¹⁹ No one questioned the importance of transboundary fish stocks, which were, and continue to be, ubiquitous. In a thorough study of such stocks, the number of transboundary stocks was estimated conservatively to be in the order of 1 000–1 500 worldwide.²⁰

The legal framework for the management of these stocks is provided by the 1982 United Nations Convention on the Law of the Sea, Article 63(1). The article imposes an obligation upon coastal states sharing a transboundary stock, or stocks, to negotiate in good faith over arrangements for management of the stocks. What the article does not do, however, is to impose an obligation on the states to reach an agreement. If the states are unable to do so, then each state is to manage that segment of the stock within its EEZ, in accordance with its rights and obligations laid down by other parts of the 1982 Convention.²¹ Thus, the Convention does allow for non-cooperative management of the resource or resources. This could be referred to as the default option.

In light of this default option, two questions must be addressed:

- (a) What are the consequences, if any, of coastal states adopting the default option and not cooperating in the management of transboundary stocks, at least not beyond the exchange of scientific information? and
- (b) What conditions must prevail if a fully fledged cooperative resource management arrangement between and among the coastal states is to be stable over the long run?

If the answer to question (a) is that the negative consequences of non-cooperative management are trifling, then question (b), of course, becomes irrelevant.

In addressing these questions, it should be recognized that the strategic interaction between and among coastal states sharing transboundary stocks referred to earlier plays a critical role in the resource management problem. Economists, in attempting to find answers to questions (a) and (b), find themselves compelled to do so through the lens of the theory of strategic interaction (or interactive decision theory) – popularly known as game theory. Once deemed to be an esoteric specialty, game theory is now so widely used in the field of economics that the Nobel Prize in Economic Sciences has



been awarded twice to specialists in game theory, the latter time being in 2005.²² The theory is, moreover, applied widely in other fields, such as international relations, legal studies, political science and evolutionary biology.

The theory of strategic interaction – game theory – is divided into two broad categories: the theory of non-cooperative games and the theory of cooperative games. The insights provided by the theory of non-cooperative games offer guidance in addressing question (a). What these insights warn is that one cannot safely assume that the “players” (coastal states) will find some way to manage their respective shares of the resource effectively. There is a serious risk that the players will be driven to adopt courses of action (“strategies”) that each player knows will be harmful, if not destructive. This goes under the title of the “Prisoner’s Dilemma”, from a famous non-cooperative game designed to illustrate the point.²³ These predictions of non-cooperative game theory have been validated many times over in the real world of shared stock fisheries.²⁴ Explicit cooperation in transboundary fish stock management does, other than in exceptional cases, truly matter. Question (b) cannot be avoided.

In turning to the cooperative management of transboundary stocks, two preliminary questions must be dealt with. First, what is the desired level of cooperation? Over 25 years ago, John Gulland distinguished between two levels of cooperation: the primary and secondary levels.²⁵ The primary level of cooperation involves the exchange of scientific information and data alone; the secondary level involves cooperation in the “active management” of the resource(s), which in turn involves determining (i) the allocation of benefits from the fishery, (ii) the optimal resource-management programme through time, and (iii) effective implementation and enforcement. The Norway–FAO Expert Consultation concluded that, while the primary level is useful as a precursor, it is seldom adequate in, of and by itself. Coastal states must be prepared to cooperate in the “active management” of the resource(s).

The second question is: what in fact is to be allocated among the coastal states sharing the resource? Is it shares of the agreed-upon total allowable catch (TAC) between, or among, the coastal state fleets, or is it the net economic returns from the fishery over time? The two are not necessarily the same. Historically, one of the most effective fishery cooperative management regimes, both in terms of the profitability of the fishery and the conservation of the resource, was that focused on the fur seals of the North Pacific from 1911 to 1984. Four states were involved (Canada, Japan, Russia/ Union of Soviet Socialist Republics and the United States of America). The fleets of two of the states received annual allocations of zero. Nonetheless, all four states benefited economically from the cooperative management of the resource.²⁶

The theory of strategic interaction, in the form of the theory of cooperative games, highlights the conditions that must be met if the cooperative regime is to remain stable through time. Of course, the allocation of the economic benefits from the shared fishery must be seen to be fair. There is, however, a requirement, or rather a condition, that goes beyond this, which could be referred to as the bedrock condition. The condition is that each participant (coastal state) in a cooperative resource-management arrangement must at all times expect to receive long-term benefits from the cooperative arrangement that are at least equal to the long-term benefits it would receive if it refused to cooperate. In game theory parlance, this is referred to as the “individual rationality condition”.

This bedrock condition, once stated, seems obvious. The report of the Norway–FAO Expert Consultation observes, however, that, although obvious, the condition is often ignored in practice.²⁷

In the first instance, the condition requires that the implementation and enforcement provisions of the cooperative management arrangement be fully effective. If a participating coastal state believes that it has received a “fair” allocation, but also believes that enforcement provisions are so weak that cheating will be encouraged, the state may well calculate that its economic returns from cooperation will fall short of what it could expect to gain from non-cooperation, and will act accordingly.

In the second instance, the individual rationality condition requires that the scope for bargaining should be kept as broad as possible. If, for example, the cooperative resource-management arrangement is such that each coastal state's economic returns from the fishery are to be determined solely by the harvest of its fleet within its EEZ, the scope for bargaining may be too narrow to ensure a stable cooperative resource-management regime. The report of the Norway–FAO Expert Consultation, in addressing the issue, talks in terms of “negotiation facilitators” (also known as side payments). The report states that the “... development of cooperation can be facilitated by supplementing the allocation of TAC shares by such devices as access arrangements and quota trading (both trading in kind and cash)”.²⁸ If, in fact, what is being shared among the participating states is the flow of net economic benefits from the fishery, then it makes no sense to restrict the allocation of these benefits to TAC shares among the coastal state fleets.

The second fundamental requirement, or condition, that must be met if the cooperative resource-management arrangement is to prove stable over time is that the arrangement be “resilient”. Every cooperative arrangement can be expected to be subject to unpredictable shocks, arising from environmental, economic, political or other factors. If the arrangement lacks flexibility or resiliency, a hitherto stable cooperative arrangement can be easily thrown into disarray, such that the “individual rationality” condition for one or more participants is no longer satisfied.²⁹

STRADDLING AND HIGHLY MIGRATORY FISH STOCKS

The comfortable belief, at the close of the Third United Nations Conference on the Law of the Sea in 1982, that fish stocks to be found both within the EEZ and in the adjacent high seas were of minor importance, proved, during the remainder of the 1980s and the early 1990s, to be quite simply wrong. Case after case of overexploitation of such stocks emerged, for example groundfish resources on the Grand Bank of Newfoundland, pollock resources in the Bering Sea “Doughnut Hole”, jack mackerel resources off the coasts of Chile and Peru, orange roughy resources off the South Island of New Zealand and bluefin tuna in the Atlantic and Southern Oceans.³⁰ The problem became so serious that the United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks was convened from 1993 to 1995 in order to address it. The Conference resulted in the 1995 UN Fish Stocks Agreement,³¹ which was designed to buttress the 1982 Convention.

Straddling and highly migratory fish stocks are covered in the 1982 Convention, in Articles 63(2) and 64 of Part V on the EEZ and in Part VII on the high seas. The Convention, Part VII in particular, leaves somewhat uncertain the rights, duties and obligations of coastal states and distant-water fishing states (DWFs) with regard to the high seas segments of straddling and highly migratory fish stocks. This lack of clarity, in turn, made it difficult to establish effective cooperative management arrangements for these stocks.³² The 1995 UN Fish Stocks Agreement was meant to address this weakness.

Under the Agreement, straddling and highly migratory fish stocks are to be managed on a region-by-region basis through RFMOs,³³ which are to be open to states (including DWFs) having a genuine interest in the resources. Only those states belonging to an RFMO, or agreeing to abide by the management and conservation measures established by the RFMO, are to have access to the fishery resources encompassed by the RFMO.³⁴ Each RFMO is, *inter alia*, called upon to ensure that the management measures for the high seas segments of the resources and those measures for the intra-EEZ segments of the resources are compatible with each other.

The two questions posed above with respect to transboundary stocks – (a) the consequences of attempts to establish cooperative management arrangements being unsuccessful and (b) the conditions that must be met if a cooperative management arrangement is to be stable through time – are equally relevant to the management of straddling and highly migratory stocks. Once again, economists, in attempting to answer these questions, find themselves compelled to do so through the lens of the theory of strategic interaction (game theory).



The answer to the first question is the same as the answer provided in the context of transboundary stocks: non-cooperative management carries with it the threat of a “Prisoner’s Dilemma” type of outcome with overexploitation of the resources. Indeed, it was the manifest consequences of non-cooperative management of straddling and highly migratory stocks that provided the motivation and rationale for convening the UN Fish Stocks Conference.³⁵ Once again, cooperative management is of critical importance to the sustainability of these stocks.

Moving to the second question, the conditions that must be met to ensure the long-term stability of cooperative resource-management arrangements, discussed in the context of transboundary stocks, apply with equal force to RFMOs. The cooperative management of straddling and highly migratory stocks through RFMOs is, however, a much more demanding undertaking than the cooperative management of transboundary stocks. First, the number of participants in an RFMO is likely to be substantially greater than the typical transboundary stock cooperative management.³⁶ The larger the number of participants, the more difficult it is to achieve stability, if for no other reason than the fact that the enforcement problem becomes steadily greater as the number increases.³⁷

Second, while the participants in a transboundary stock cooperative arrangement can generally be expected to be constant in number and nature over time, this is not the case with RFMOs. A typical RFMO will include DWFSs among its participants, whose fleets are nothing if not mobile. In particular, a DWFS that was not a founding member of the RFMO may request membership subsequently. The 1995 UN Fish Stocks Agreement explicitly calls upon RFMO founding members to accommodate prospective new members or entrants.³⁸ How prospective new members can be accommodated, and persuaded to be members of good standing within the RFMO, without undermining the willingness of founding members to cooperate, is an issue that has not yet been resolved.³⁹ This issue is closely linked to the most marked difference between transboundary stock cooperative arrangements and RFMOs – the threat of “free riding”.

Free riding involves the enjoyment of the fruits of cooperation by non-participants in the cooperative arrangement. If free riding is extensive, participants in the arrangement may calculate that their benefits from cooperation will be less than what they would obtain through non-cooperation – the “individual rationality condition” once again. Free riding is conceivable in a transboundary stock cooperative management arrangement, but real-world cases are very difficult to find.⁴⁰ In contrast, free riding has been a chronic problem with regard to fishery resources in the high seas.

Fishing activities by non-RFMO participants in the high seas area governed by the RFMO, contrary to the management provisions of the RFMO, are deemed to constitute *unregulated* fishing, as opposed to illegal fishing. Uncontrolled and unregulated fishing provides strong encouragement for free riding, in spite of Article 8 of the 1995 UN Fish Stocks Agreement.

Free riders can, of course, be encouraged by RFMO members to change their ways and become new members of the RFMO. Is this really a viable solution, however? Recent “cutting edge” analysis by economists applying the theory of strategic interaction to straddling and highly migratory stock management suggests that, if unregulated fishing is not curbed, there will be cases in which the circle cannot be squared, in which it is not possible to satisfy all RFMO members, old and new. The attraction of free riding will be too strong. In such cases, the RFMO will prove to be inherently unstable.⁴¹ The inevitable conclusion is that, in order for the emerging RFMO regime to prosper, it is of utmost importance that unregulated fishing be effectively curbed. In this context the importance of the IPOA-IUU and its effective implementation cannot be overstated.

DISCRETE HIGH SEAS STOCKS

Until recently, there was little that could be said about discrete high seas stocks, which had been described as the “orphans of the sea”.⁴² The legal framework for their

conservation and management is provided by Part VII of the 1982 Convention, which obliges states to cooperate with each other, negotiate the adoption of measures and, as appropriate, establish subregional or regional organizations. The attention of the international community has focused increasingly on these stocks, particularly as a consequence of a growing concern regarding deep sea fisheries and species. The recent opening to signature of the South Indian Ocean Fisheries Agreement (SIOFA) and the ongoing negotiations towards the establishment of the South Pacific Regional Fisheries Management Organisation (SPRFMO) (see p. 56) are illustrative of that trend. An important step forward was also made when the UN Fish Stocks Agreement Review Conference addressed high seas discrete stocks within the ambit of the Agreement (see p. 55). Thus, the questions raised above also apply to the high seas “discrete” fish stocks.

Marine capture fisheries management in the Indian Ocean: status and trends

INTRODUCTION

During the first half of the 1990s, in response to the increasing concern about many of the world's fisheries and following UNCED, a number of international fisheries instruments provided an impetus for countries to strengthen their fisheries management. A key step in supporting such efforts is the development of more detailed, systematic and comparable information on fisheries management trends. The *State of World Marine Capture Fisheries Management Questionnaire* was developed by FAO in 2004 in response to this need. FAO used this questionnaire to carry out a study on the trends of marine capture fisheries management in 32 Indian Ocean countries.⁴³

METHODOLOGY

Fisheries management experts were requested to complete the detailed questionnaire for 30 countries,⁴⁴ focusing on direct and indirect legislation affecting fisheries, costs and funding of fisheries management, stakeholder involvement in management, transparency and conflict management, and compliance and enforcement. The information was organized into two major components: national fisheries management in general and the tools and trends in the top three fisheries (by quantity) in each of the three marine capture fishing sectors in the Indian Ocean (large-scale/industrial, small-scale/artisanal/subsistence and recreational). Fisheries analysed within the questionnaire were limited to national fisheries within continental and jurisdictional waters; they excluded high seas fishing and foreign fishing in EEZs under access agreements.

Within the countries surveyed, 55 large-scale, 61 small-scale and 18 recreational fisheries were identified as the top three largest fisheries by quantity in each subsector. As the definitions for each subsector, as well as whether a fishery was defined by gear or by species, were left open to allow for relative definitions within each country, the resulting data are to be used with caution.

On completion of the questionnaire, subregional reviews were drafted based on the individual country reviews. An analysis of the combined questionnaire responses provided a snapshot of fisheries management in the Indian Ocean during the 2003–05 period and partial results are provided below.

OCEAN-WIDE TRENDS

Political and legislative frameworks

All countries within the region had specific legislation for the management of marine capture fisheries and almost all such legislation provided a legal framework for fisheries management, with slightly less providing an administrative framework. However, the term “fisheries management” was defined in only one-quarter of those



countries responding, and only 57 percent of the countries had laws and regulations designed to serve as a legal framework for fisheries management and fisheries management plans. In addition, in only a minority of cases did national legislation require that fisheries management decisions be based on at least one of the following analyses: biological analyses/stock assessments, social impact analyses, economic analyses, or monitoring and enforcement analyses. There was therefore relatively little legal guidance on the processes for taking management measures and, hence, fisheries managers often lacked the interdisciplinary information required to develop proper management measures.

The legislation in most countries identified a single agency or other authority⁴⁵ as being responsible for marine capture fisheries management at the national level; however, these agencies/authorities legally shared management responsibilities with other agencies and/or were further assisted by government or quasi-government agencies (which, in turn, were supported by universities) in their fisheries research. In many cases, the fisheries agencies/authorities were also supported by at least one other agency (e.g. navy or coast guard) for the monitoring and control of fisheries laws.

The policy framework in place within the region was more often than not development-oriented, despite many fish stocks being considered at least fully exploited.⁴⁶ When specific fisheries management objectives were provided for in the legislation, the objectives tended to be split into either development-oriented or sustainability-oriented lines. Countries in the Red Sea and the Gulf Sea tended to have development-oriented objectives; those countries along the eastern rim of the Indian Ocean tended to specify sustainability criteria within the legislation; while those along the western rim tended not to have specific management objectives within their legislations (South Africa and Madagascar excluded). However, most countries' fisheries management was affected by at least one other national legislation based on sustainability concepts.

In only approximately half of the countries were a large majority of the marine capture fisheries considered as being "managed in some way"⁴⁷ and, of those fisheries considered managed, most lacked any formal documented management plans. Nevertheless, the perception within the countries is that the number of fisheries managed in some way has increased over the past ten years.

Status of the fisheries

When matched up with global comparisons of large-scale versus small-scale fisheries,⁴⁸ the relative sizes between these subsectors in the Indian Ocean remained consistent (Table 16). The small-scale fisheries involved over 2.5 times more participants (employed part-time or full-time, or as subsistence fishers) than the large-scale fisheries and total landings from the two subsectors were approximately equal in size.

The number of participants had increased over the previous ten-year period in most fisheries across the three subsectors, yet had decreased in some of the fisheries.

Directional changes over the previous five years in landings from large-scale fisheries varied across the countries: seven countries reported decreased trends in terms of quantity, while 11 countries reported decreased trends in terms of value. It is interesting to note that in some of these countries trends in quantities and values moved in opposite directions over the five-year period. Most countries reported positive trends in both landings quantities and values within the small-scale sector and, when quantities and values went in opposite directions, quantities decreased while values increased. Changes in quality or price variations may explain this phenomenon.

Concerning stock status, an FAO report published in 2005 signalled little room for further expansion in these fisheries,⁴⁹ in addition to the possibility that some, if not most, stocks might already be overexploited. It should also be noted that, within the subregional reviews included in the 2005 report,⁵⁰ the review authors had indicated more serious conditions for certain species than were portrayed at the larger statistical area used in the 2005 report. These views stress further the need for precaution within the Indian Ocean, especially when the effects of IUU fishing and discarded bycatch quantities on the stocks are difficult to ascertain and control.

Table 16
Basic data on the largest Indian Ocean fisheries by subsector

	Fishery subsector		
	Large-scale	Small-scale	Recreational
Number of participants	1 600 000	4 300 000	90 000
Total landings (tonnes)	4 000 000	4 200 000	n.a.
Number of vessels	73 000	313 000	n.a.

Notes:

Data are for the top three (by quantity) fisheries for each subsector within 30 Indian Ocean countries.

Indonesia and Malaysia include data from both Pacific and Indian Ocean fisheries.

Data for recreational fisheries include only 11 out of 18 fisheries identified owing to lack of available information.

n.a. = not available.

Management tools in use within the largest fisheries

The toolkit of technical measures for fisheries management used in the region included spatial restrictions, temporal restrictions, catch and size restrictions, rights/incentive-adjusting restrictions and gear restrictions (Figure 41). The results of the questionnaire brought to light certain tendencies within the Indian Ocean countries.

- Countries preferred the use of spatial (especially marine protected areas and marine reserves) and gear (especially type and size) restrictions over other technical measures for managing marine capture fisheries.
- Other than the issuance of fishing licences, very few incentive-adjusting or rights-providing mechanisms were used.
- Tools currently in use within the small-scale sector had been, for the most part, established or increased within the last ten years, while those tools in use within the large-scale and recreational fisheries had not experienced many changes in use patterns, with the exception of increased use in spatial restrictions.
- Although recreational fisheries were active in at least ten countries in the region, few management measures were applied to these fisheries other than the establishment of marine protected areas and reserves and, less frequently, the granting of licences and the adoption of gear type restrictions.

Participatory mechanisms and conflict management within the largest fisheries

Although legal or formal definitions of those having an interest in the use and management of fisheries resources were not common in the region, stakeholders had been identified in most fisheries across the three subsectors. In many cases, it was felt that arrangements had been made to consult these stakeholders and to work with them on the management of these fisheries; however, these sentiments were less strong within the small-scale subsector.

If stakeholders were part of the fisheries management decision-making process, the management process had often been accelerated within the large-scale subsector but not necessarily within the small-scale subsector and rarely within the recreational subsector. However, the participatory approach had led to a reduction in conflict within the fisheries and had created incentives and reasons for stakeholders to practise “responsible” fisheries stewardship voluntarily.

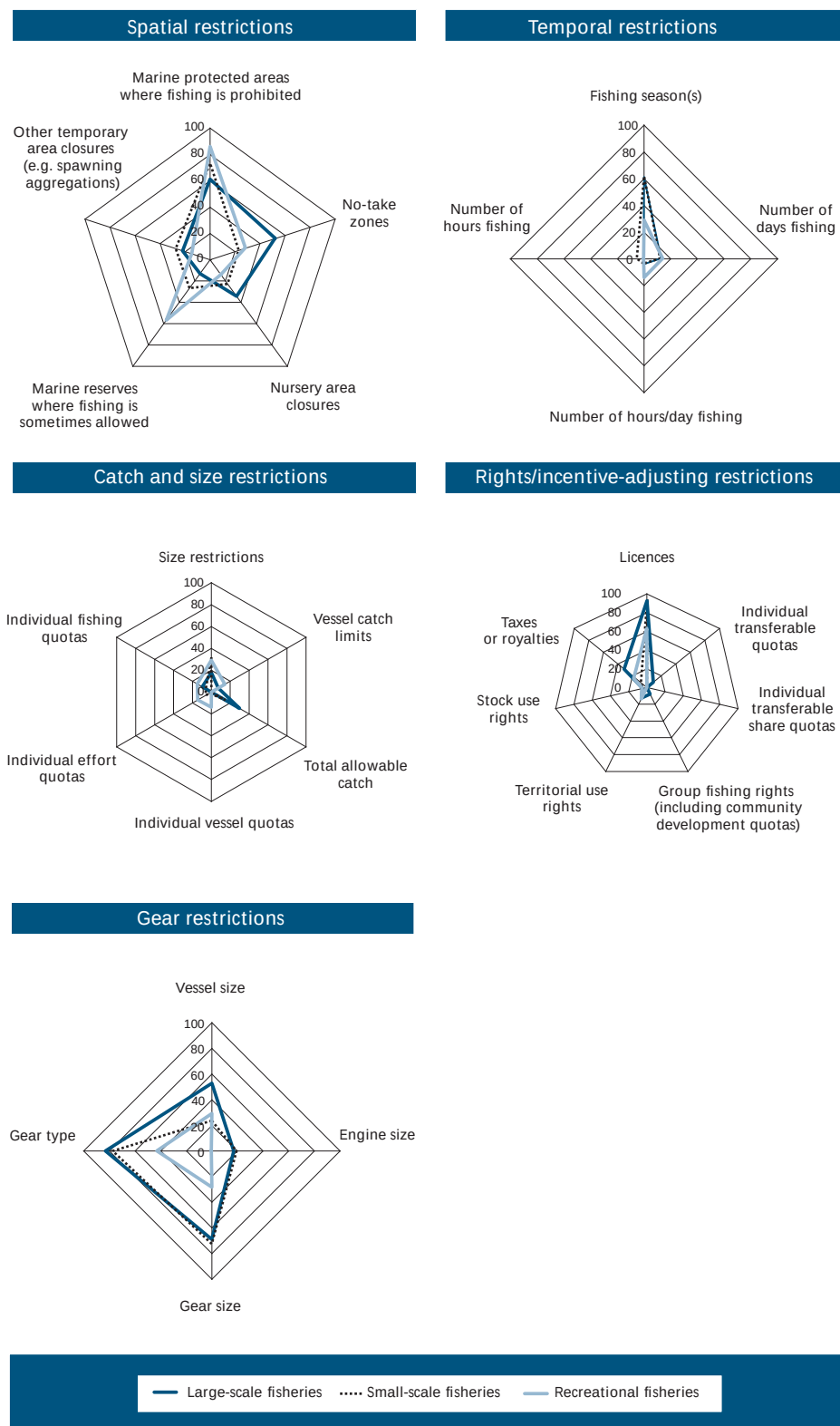
Although participatory approaches to management assisted in reducing conflict within and among the fisheries, there remained significant levels of conflict throughout the subsectors. Within the large-scale and small-scale sectors this was often caused by competition among different vessel categories or with other fisheries, while conflict within the recreational subsector tended to arise from competition with all other uses for the same area of water.

Conflict-resolution processes were used within about a third of the fisheries reviewed; such processes included zoning for specific users, stock enhancement, resource allocation between and among the fisheries, and educational methods to



Figure 41

Technical measures for fisheries management in use in the Indian Ocean countries (percentage of countries)



Note: Data refer to the percentage of countries in which the measure is used in at least one of the top three fisheries.

sensitize users regarding the multiple-use nature of certain resources. There was little variation among the subsectors except that sensitization methods were more common in the recreational subsector than elsewhere.

Fleet capacity management within the largest fisheries

Within the Indian Ocean, fleet capacity was measured in the majority of large-scale and recreational fisheries; however, capacity measurement within the small-scale subsector was rarely undertaken. In addition, although there was often a sense that overcapacity existed within almost half of the fisheries, very few capacity-reduction programmes were put into place to adjust for the levels of effort.

When measures were used, the preferred method for reducing capacity levels was the purchase of fishing licences from the fishery, followed by a less-used approach of buying-out fishing vessels licensed to operate in the fisheries. Licence removal was found to be an efficient means for immediately reducing any excess fishing capacity, while vessel buyouts were considered much less effective. In addition, these initial licence removals, when supported by ongoing licence purchases, were deemed effective for ensuring that any excess fishing capacity did not return.

Such capacity-reduction programmes were generally supported through government funds, but several instances occurred in which programmes were paid for by participants within the fishery itself or, occasionally, by participants within other fisheries.

Costs and funding of fisheries management

Budget outlays for fisheries management included, *inter alia*, funding for research and development, monitoring and enforcement, and daily administrative management. Only in approximately 10 percent of the countries were these activities not covered in some way by national government funding. However, national funding sources tended to decrease as management moved towards regional and local levels – contrasting with the increased trends in management costs at these levels, owing in part to decentralization policies throughout the region.

Fisheries management cost-recovery mechanisms, other than licence fees, were uncommon within the large-scale and small-scale fisheries. In cases where revenues were collected from fisheries activities, more often than not these revenues went directly to the central government budget. Therefore, the link between benefits and costs of management services could not be made and fisheries authorities continued to base their management activities on governmental appropriations. Interestingly, the use of licence fees and other resource rent-recovery schemes were common within the small number of recreational fisheries, perhaps reflecting differing views as to whether access to a resource is assumed to be a right or a privilege.

Compliance and enforcement

In most cases, the above-mentioned increases in management costs were associated with increased monitoring and enforcement activities, but were also a result of increased conflict management and stakeholder consultations. Linked to increased monitoring and enforcement is the perception that, over the past ten years, the numbers of infractions had increased in many countries.

Compliance and enforcement tools within the region focused on inspections, whether on-land or at-sea. The use of additional tools, such as onboard observers or VMS, was less widespread within the region.

When faced with infractions, most countries relied on small fines or the revocation of fishing licences as deterrents; however, the perception within the vast majority of countries within the region was that the funding provided was not sufficient to enforce all fisheries regulations, the penalties for non-compliance were not severe or high enough to act as deterrents, and the risk of detection was too low to promote adherence to fisheries regulations.



SUMMARY AND CONCLUSIONS

The challenges regarding fisheries exploitation and management in the Indian Ocean countries are not dissimilar to those in other regions.

- Legislative reforms had improved the regulatory framework but application of such reforms had remained limited and lack of effective MCS had undermined fisheries management.
- Fisheries policies often remained development-driven and without consideration of economic, social, biological and environmental sustainability criteria; however, examples of holistic management approaches existed within the region and experiences from these could prove useful for the region.
- Conflicts between and among fisheries remained pervasive.
- The high number of small-scale vessels and fishers, combined with the potential role of small-scale fisheries in poverty alleviation and prevention, remained a constraint to the development and implementation of management of these fisheries.
- Reliance on classical and costly stock assessment had limited the ability of countries to gather consistent stock data. Combined with the need for “hard” data, fisheries planning capacities were often stalled at the status quo even while the qualitative data suggested that many stocks were fully exploited or overexploited.
- Socio-economic data were collected infrequently or not at all; therefore, the contribution of small-scale fisheries to human well-being, food security, and poverty alleviation and prevention was poorly understood and the impacts of potential management measures were not being evaluated throughout the three subsectors.
- Information on shared and transboundary stocks was often missing or inadequate and relevant institutions' arrangements were often non-existent.
- Integration of stakeholders in the fisheries management process had increased but remained limited, leading to continued difficulties in managing fishing capacity within all subsectors, but specifically within the small-scale subsector.
- The multispecies nature of most fisheries had not been taken into consideration.
- Clearly defined priorities regarding the objectives for each fishery were lacking, leading to inappropriate planning and increased conflicts within and among the fisheries.

Actions to address these issues may include:

- the introduction of adaptive and cost-effective management strategies, based on strengthened management structures with well-defined, prioritized objectives;
- the strengthening of the ecosystem approach to fisheries management;
- the investigation of cost-effective data gathering methods for biological, economic, social and environmental aspects of fisheries;
- an effective enforcement of fishery laws and regulations;
- a better control over growth in fishing fleet capacity;
- a greater harmonization of the definition and application of laws and regulations, where appropriate;
- the development of fisheries management plans with relevant stakeholders;
- the development of national plans of action to address IUU and fishing capacity issues;
- an active participation in regional initiatives such as RFBs to assist in the control of IUU fishing, the harmonization of fisheries laws and regulations, and the development of consistent management measures with respect to shared and transboundary stocks;
- greater involvement of stakeholders in management with consideration given to co-management schemes, especially at the local level, requiring the creation or strengthening of organizations to represent fishers and other interests.

The countries of the Indian Ocean will need to continue in their development of sustainable fisheries-management frameworks, addressing both international norms and agreements as well as adapting to each country's specific situation and needs. Although there is no panacea for managing all fisheries, countries could benefit from the experiences of other countries in the same region as well as elsewhere, and from

existing literature in the search for creative and cost-effective methods for managing fisheries.

In addition, regardless of the management framework chosen, if there is a lack of political will to implement the relevant laws, regulations and management measures, even perfectly designed frameworks will remain on the bookshelves.

Finally, a better understanding of the effects of implemented management measures on the fisheries (e.g. economic efficiency, social justice and stock health) would greatly assist in the adaptive improvement of fisheries management.

Refuelling the fishing fleet

THE ISSUE

The price of diesel rose by 100 percent in the two-year period January 2004 to December 2005 (Figure 42). This severely affected the profitability of the catching sector of the fishing industry, mainly by cutting the profit margins of fishing vessels, and almost certainly resulted in many fishing vessels making a financial loss in 2005.

The fish-catching sector is entirely dependent on fossil fuel for its operations and currently has no alternative form of energy. Fishers and other entrepreneurs in the sector are locked into a situation in which they are the unfortunate victims of international circumstances. Although the present situation forces them to focus on the short-term problems, they must address those linked to the availability of petroleum in the medium-to-long term. As petroleum is a non-renewable resource, eventually supplies will decline and become more expensive in real terms. This sombre prospect is combined with a growing pressure to use less petroleum because of the greenhouse effect caused by carbon emissions from the use of fossil fuels. Thus, there is a pressing need to identify alternative sources of energy for the specific needs of the fishing industry.

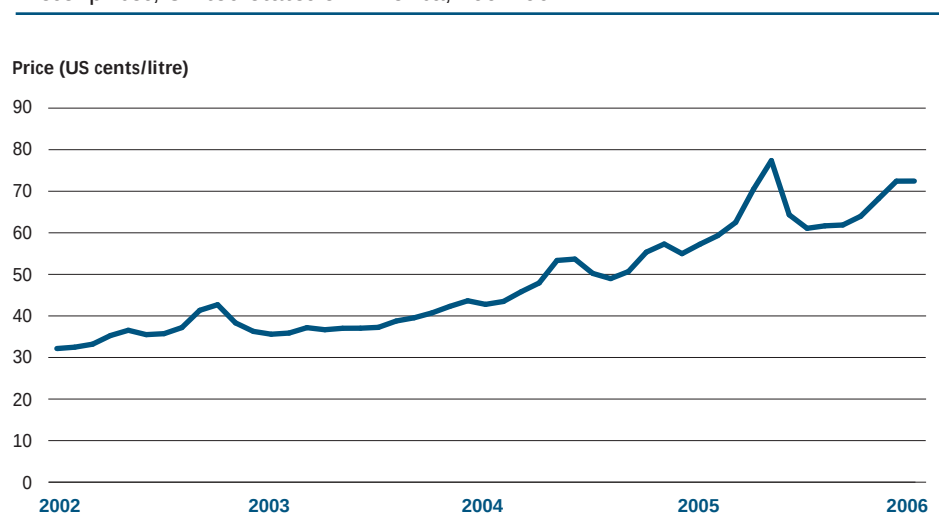
It should be noted that fuel prices in the fishing industry worldwide are far more homogenous than for road transport because fuel for industrial use, including farming and fishing, is taxed at a lower rate. On the other hand, fuel for road transport varies widely in price because of the wide range of taxation rates levied. Some Southeast Asian countries have policies that subsidize fuel for fishing.

FAO estimates that in 2005 the fish-catching sector consumed 14 million tonnes of fuel at a cost equivalent to US\$22 billion, or about 25 percent of the total revenue



Figure 42

Diesel prices, United States of America, 2002–06



Source: International Energy Agency.

of the sector projected to the equivalent of US\$85 billion.⁵¹ More efficiency is being sought within the fishing industry, *inter alia*, by using specialized fish transport and supply vessels, permitting fishing vessels to spend more time fishing and less time steaming to and from the fishing grounds. However, these and other operational fuel-mitigation measures taken by fishers (e.g. trawlers converted to pair trawling, which is a far more effective use of energy) are estimated to reduce consumption by no more than 20 percent and are unlikely to counteract the increase in fuel costs completely. Fish prices will probably take some time to adjust upwards, so, as long as the price of diesel fuel remains at 60 cents/litre, the sector will continue to experience financial difficulties.

Over the past decade, FAO has carried out a series of international studies of profitability in the fish-catching sector.⁵² In all, 88 fisheries were sampled between 1995 and 1997, 108 fisheries in 1999–2000 and 75 fisheries in 2002–03. These studies revealed that vessels from developing countries were spending relatively far more on fuel than were vessels from developed countries. Fuel costs expressed as a percentage of the revenue from landed catch were almost twice as high in the former group of countries, as can be seen in Table 17. The table also shows a general rise during the period 1995–2003, from 14.85 percent to 18.53 percent, for the average cost of fuel worldwide measured as a share of revenue from fish landed. Estimated annual fuel costs at the 2005 average price level (all other costs and revenues assumed to remain unchanged) are also indicated.

The FAO studies also analysed the fuel consumption for different categories of fishing gear. The differences between active and passive fishing gears were not as pronounced as might have been expected (Table 18).

Several conclusions can be drawn from Table 18.

Table 17
Fuel costs as a percentage of the revenue from fish landed, developing and developed countries

	Fuel costs as a percentage of revenue			
	1995–1997	1999–2000	2002–2003	2005 ¹
Developing countries	18.52	20.65	21.63	43.26
Developed countries	11.08	9.78	10.20	20.40
Global average	14.85	16.70	18.53	37.06

¹ Estimated.

Table 18
Fuel costs as a percentage of the revenue landed by type of fishing gear, developing and developed countries

	Fuel costs as a percentage of revenue			
	1995–1997	1999–2000	2002–2003	2005 ¹
Developing countries				
Active demersal	17.19	30.28	26.15	52.30
Active pelagic	17.33	17.60	16.99	33.98
Passive gear	18.78	17.06	19.33	38.66
Developed countries				
Active demersal	10.57	8.64	14.37	28.74
Active pelagic	n.a.	7.65	5.48	10.96
Passive gear	5.57	4.95	4.61	9.22

Note: n.a. = not available.

¹ Estimated.

- There are significant differences in the fuel costs between fishing fleets in developed and developing countries. Vessel owners in developing countries pay a far higher component of their revenues for fuel than do their counterparts in developed countries and the proportion has been rising. It is likely to have been almost twice as large in 2005 as in 2002–03. This difference does not only prevail in fisheries but throughout the industrial sector. Developed countries are far more energy-efficient than are developing countries.⁵³ It seems that fishers in developing countries are more susceptible to increased fuel prices than are their counterparts in developed countries.
- The difference in the relative importance of fuel costs is most discernable for passive gears. In all the three studies, developing country fishers using passive gears were found to spend, as a proportion of revenue, at least three times more than fishers using passive gears in developed countries.
- The average ratio of fuel cost to revenue rose from 14.85 percent to 18.53 percent between 1995 and 2002 – an increase of almost 25 percent.

SIMULATION OF ECONOMIC PERFORMANCE

As stated above, FAO has analysed the economic performance of fishing fleets worldwide. Of the 88 fisheries sampled in 1995–97, no fishery had a negative gross cash flow and only 15 had a negative net cash flow when depreciation and interest payments were taken into account.⁵⁴ The detailed data on expenditures and revenues available from the 1995–97 study can be used to simulate the effect of doubling the 1995–97 fuel prices. Such a simulation results in 55 fisheries suffering a negative net cash flow.

Given the large and rapid increases in the price of fuel and the potential for a fishing industry to collapse in the short term because of these changes, some governments might wish to protect the fishing industry from such violent changes. One possibility would be to adjust the price of fuel so that in any given year it would increase by no more than a specified percentage – say 10 percent above the consumer price index. This would allow the industry to adapt to the new circumstances and eventually readjust to the real price of fuel.

IMPACT ON THE PUBLIC SECTOR

Increases in fuel prices will affect fisheries not only through their impact on fishers and other entrepreneurs in the sector, but also through their impact on the public sector. As most of the public sector is allocated a set budget for running costs, higher fuel costs can result in reduced availability of fuel, *inter alia*, for patrol duties or for scientific research. More cost-effective methods will have to be sought for monitoring fishing fleets. VMS are likely to become more common and manned sea or air-borne patrols may be replaced by the use of unmanned aircraft.

LONG-TERM FUEL PROSPECTS (BEYOND PETROLEUM)

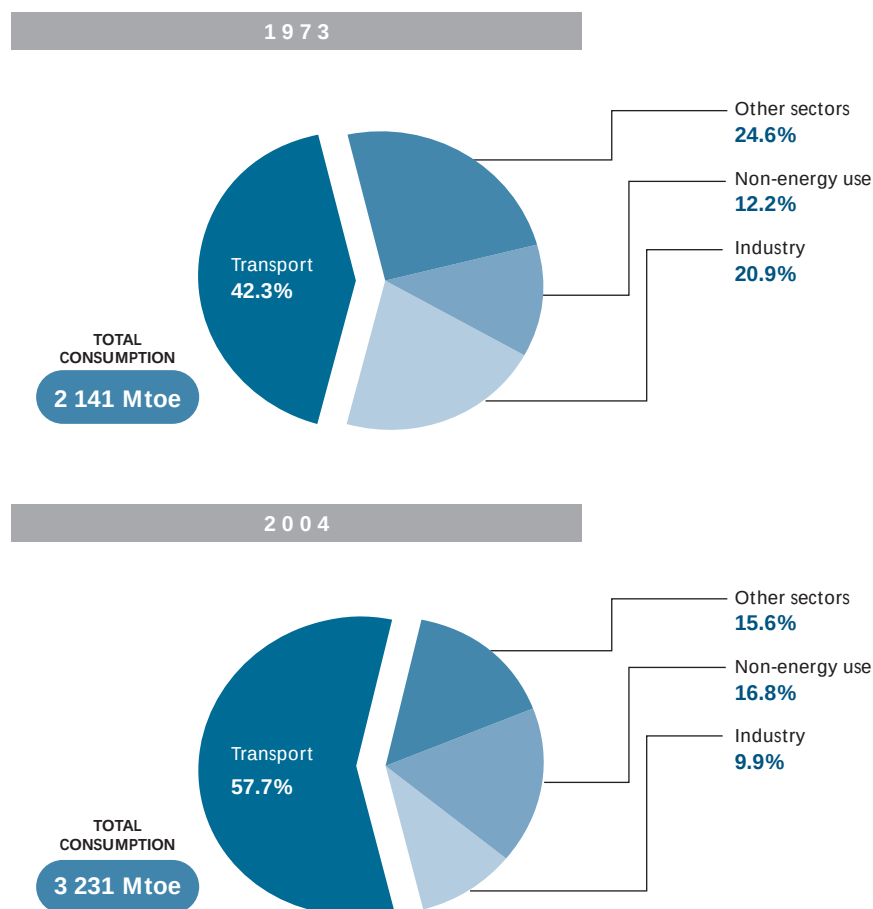
The large increase in the price of fuel and doubts about future supplies require that these issues are taken into account in any discussion on fuel in the fishing industry. Figure 43 shows the increase in demand/supply of oil from 1973 to 2004 and the sectors to which the oil was supplied. It is clear that transport is the largest user of oil and that its share of the total oil supplied is increasing and is expected to increase further. On the other hand, the 14 million tonnes of fuel used by the global fishing industry accounts for less than 0.5 percent of global oil consumption. It follows that both the price and demand for oil are going to be determined by other consumers of oil, especially the transport sector.

The current fuel crisis is one of many that have occurred since that triggered by the Suez crisis in 1956. The main causes have not been the global lack of petroleum, but the uncertainty of the supply from the oil-producing countries to the oil-consuming countries. The hurricanes that affected the oil refineries in the Gulf of Mexico in 2005 are only one of the elements that have pushed the price of petroleum to the very high levels currently prevailing. For many, the reason that the current price levels are so high is that petroleum supply is so tightly bound to demand that any disruption causes a



Figure 43

Global consumption of oil by sector, 1973 and 2004



Notes: Other sectors comprise agriculture, commercial and public services, residential and non-specified.

Mtoe = million tonnes of oil equivalent.

Source: Key World Energy Statistics 2006 © OECD/IEA, 2006, p. 33.

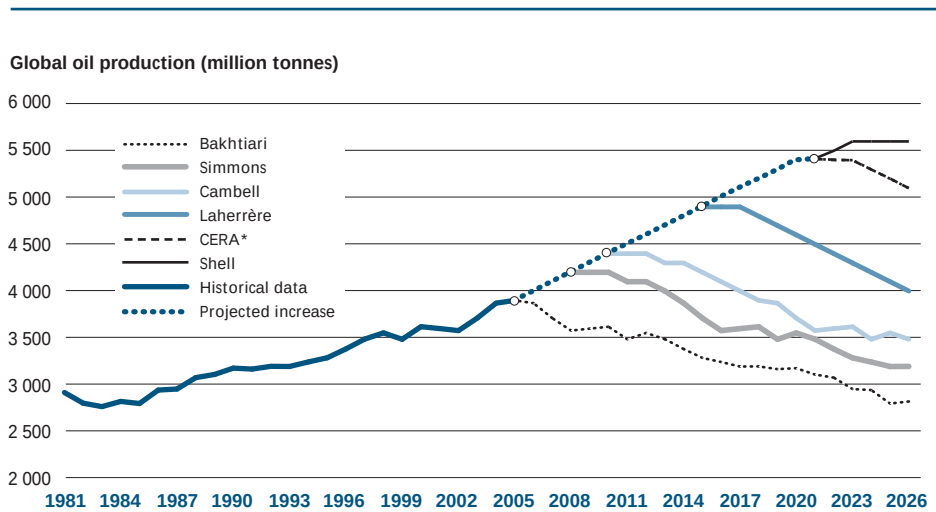
price hike. However, it is paradoxical that the entities that have been responsible for the supply of petroleum (i.e. the major oil companies and governments) are currently benefiting from the increased prices while the consumers, including fishers, have to pay a higher price for petrol and diesel. Petroleum has the most volatile price of all the commodities.

Another issue that might eventually have more serious implications for the fishing industry than the current price increases is the long-term sustainability of petroleum production. The issue is controversial and experts can be divided into the “petro-pessimists”, who predict the occurrence of oil “peaking” in the near future, and the “petro-optimists”, who maintain that this scenario is still some time in the future. But all are agreed that fossil fuels will be depleted by the end of the twenty-first century (see Figure 44).

Some, perhaps the most enlightened, analysts point out that it is not the time at which oil peaks that is the important factor, but the actions that are taken by governments and energy companies prior to that event. It should be noted that many such actions are already being undertaken by governments and that alternative fuels are currently being sought for transport uses. These actions include the increased recovery of oil from existing wells, the conversion of gas and coal to liquid fuels

Figure 44

Simplified representation of some oil-peaking scenarios by a number of experts in 2006



Notes: Historical data series from BP. 2006. *Statistical Review of World Energy 2006*, workbook of historical data (see www.bp.com).

*CERA: Cambridge Energy Research Associates.

and the exploitation of heavy oils and tar sands. More efficient vehicles are being developed and ethanol is being produced as an alternative renewable fuel in agriculture (Figure 45). These developments are also being actively promoted in the interests of combating the effects of global warming. Already, motor vehicles are being powered by hydrogen in Iceland and California, the United States of America, and plans are in hand in Iceland to extend the use of this energy source to power fishing vessels. The disadvantage of this solution is that hydrogen, ethanol and methanol require far more storage space than the equivalent energy content of petroleum (i.e. energy density). However, extensive research is being carried out to develop more efficient hydrogen cells. The replacement of petroleum by such hydrogen cells will also depend on the relative costs of the two energy sources.

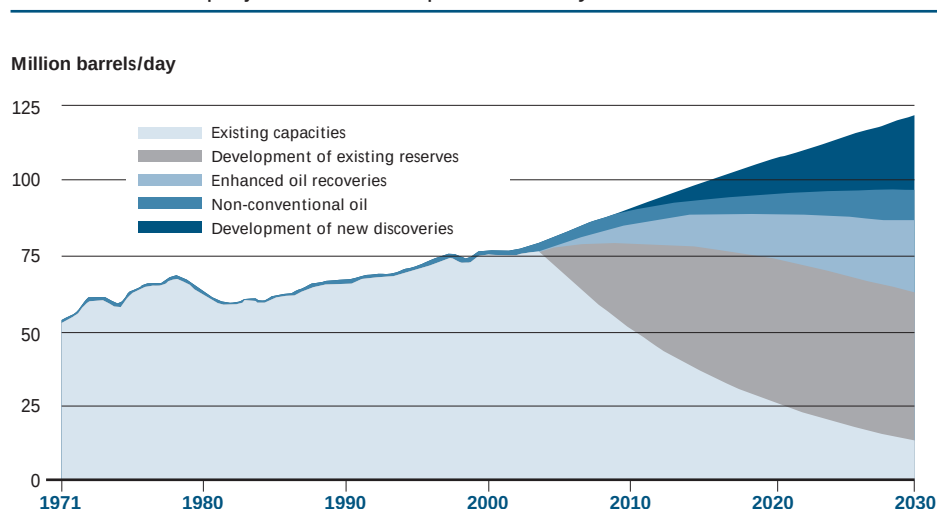
The solution for alternative energies for road transport might not necessarily be the most appropriate solution for the fishing industry. The International Maritime Organization (IMO) has regulations in force governing pollution caused by burning fossil fuels (International Convention for the Prevention of Pollution from Ships [MARPOL]) and safety (International Convention for the Safety of Life at Sea [SOLAS]) that relate to the flash point⁵⁵ of fuel on board ships. These safety requirements are repeated in the IMO Torremolinos Convention on Fishing Vessel Safety, which has not yet entered into force. Specifically, the use of fuel with a flash point below 60 °C is prohibited. Although these regulations might not be strictly applied to fishing vessels it would be foolhardy not to take such considerations into account in an industry that has an extremely high fatality rate. This would mean that pure methanol or ethanol would not meet the requirements for fuel as they have flash point of 10 °C and 12 °C, respectively. However, this does not rule out the use of methanol and ethanol to form biodiesel.⁵⁶ This would also have the advantage that the energy density would be similar to that of conventional diesel, requiring little or no modification to the engines. Any substantial change in energy density would have a critical impact on fishing vessel design in a manner reminiscent of the change from steam power to internal combustion engines in the 1940s.

The rate at which alternative fuels are introduced will be totally dependent on the current and future price of petroleum. Sustained higher prices will accelerate the development of research on alternative fuels and their production. Increased



Figure 45

Past, current and projected world oil production, by source



Source: World Energy Outlook 2004 © OECD/IEA, 2004, p. 103.

uncertainty with regard to international politics or increased terrorism will increase the need for fuel security and will have a similar effect.

CONCLUSIONS

The predictions of Sheik Yamani, the ex-chairman of the Organization of the Petroleum Exporting Countries (OPEC), when he stated "The Stone Age did not end for lack of stone, and the Oil Age will end long before the world runs out of oil",⁵⁷ might well be true.

Causes of detentions and rejections in international fish trade⁵⁸

INTRODUCTION

Fish and fishery products are one of the major traded food commodities and this trade is likely to increase in the future to meet the ever-increasing demand for fish and seafood. However, thousands of tonnes of imported fish and seafood products are detained, rejected or destroyed each year at the national borders of many importing regions in the world. This is a post-harvest loss that can be prevented, at least in part, providing more value for fishing efforts, making more fish and seafood available for human consumption and contributing to reduce pressure on fish stocks.

One of the most serious difficulties for exporters is that they face standards and regimes of safety and quality requirements that vary from one important target market to another. These differences concern regulations, standards and control procedures, including controls at the border where seafood products can be rejected, destroyed or put in detention awaiting permission to enter or destruction. In order to promote harmonization and equivalence among seafood-trading nations, these differences need to be reduced and ultimately removed and replaced by agreed international control systems and standards based on objective criteria and scientific techniques such as risk assessment.

It is important, however, to realize that, beyond sheer numbers, the type of border case (safety, quality or economic fraud) and its direct macro- and microeconomic impacts are different and this needs to be taken into account when comparing the different cases and strategies to reduce them.

RELATIVE FREQUENCY OF BORDER CASES BY IMPORTING REGION

The term “border case” is used to cover any situation where a fish product is detained, rejected, destroyed, returned to sender or otherwise removed, even if only temporarily, from the trade flow.

Figure 46 shows a quite dramatic difference in the absolute numbers of border cases in the various importing countries/regions when shown relative to import quantities.

At first glance, the United States of America has around ten times as many border cases per 100 000 tonnes as the EU or Japan, and three to four times as many as Canada. This should not be taken to indicate necessarily that the United States of America has a higher performance in border controls or that products exported to that country have more non-conformity problems. In fact, the data need to be adjusted and substantiated to enable comparisons of performance to be made among the regions studied. Three main reasons contribute to the number of border cases in the United States of America being overstated.

First, a high percentage of United States cases end up with the product actually entering the country after re-examination, sorting, re-packing, provision of new documentation and information or new labelling. During 1999–2001, 78 percent of detained shipments were eventually released for import into the United States of America.⁵⁹ Therefore, in this regional comparison only around 22 percent of the United States cases can be considered as “bona fide” border cases. Taking this into account, the United States of America had only around twice as many border cases than did the EU and Japan and only 60–80 percent of those reported by Canada (see Figure 46, United States adjusted data).

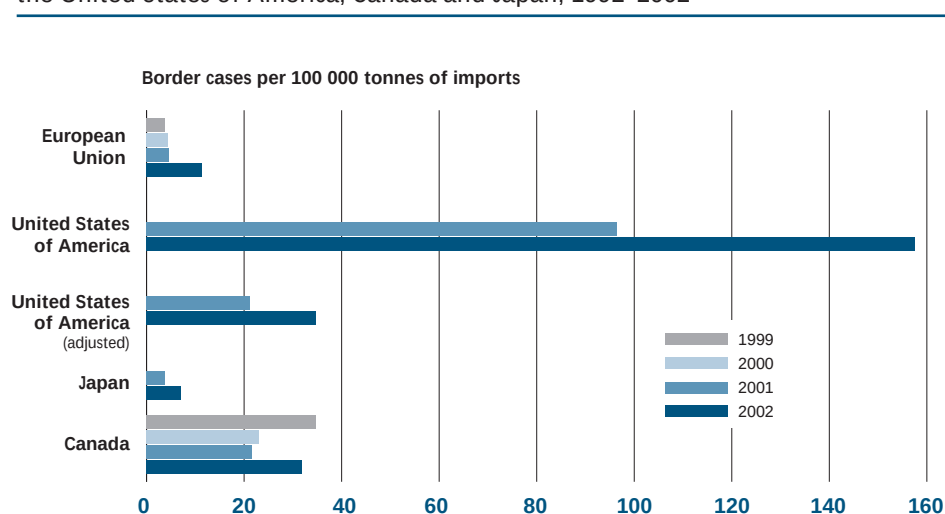
Second, the other countries/regions, especially the EU, use some sort of “prevention at source” approach. Indeed, the EU relies on national competent authorities in exporting countries to examine establishments and products to assess their conformity to EU requirements prior to shipment. By so doing, the authorities detect and stop several non-conformity cases in the exporting countries. This approach has proved to be more preventative and cost-effective than relying solely on controls at the border. However, it can also penalize well-managed seafood companies in countries that may not have the resources or the capacity to put together a competent authority that meets the EU requirements and cannot export to the EU as a result.

Canada, and to some extent Japan, have adopted a less formalized “prevention at source” approach but appear to be less active in promoting it than the EU. Canada has



Figure 46

Total border cases relative to import quantities for the European Union, the United States of America, Canada and Japan, 1992–2002



also concluded “Agreements” with a limited number of countries – Australia, Ecuador, Iceland, Indonesia, Japan, New Zealand, the Philippines and Thailand – whereas Japanese importing companies have a long tradition of fielding quality controllers to work at the exporting sites. In both cases, some non-conformity cases are eliminated before consignments are shipped.

In an increasing number of countries, including the United States of America,⁶⁰ experts advise administrations to adopt a “prevention at source” approach because of its higher performance and cost-effectiveness. This approach can only lead to a win-win situation for both the exporter and the importer: fewer safety and quality problems are experienced by the importer and the inherent costs and damages of border cases are reduced for the exporters. At the same time, administrations can make important savings as resources needed for control at borders are reduced significantly and can be used more effectively to target problem cases, increasing administrative efficiency. Moreover, a reduction in losses arising from rejections and detentions should eventually result in greater supply of safe fish and fewer illnesses attributable to unsafe foods. However, when introducing the “prevention at source” approach it is important to ensure that exporting developing countries are assisted in their efforts to build the national capacity needed to ensure safety and quality of exported fish products.

A third difference is the types and methods of control and standards applied at the border by the importer. In the importing countries studied, not only are border checks different, but the analytical techniques used, and the criteria or standards applied to judge conformity or non-conformity, vary from one country to another. Most importantly, these criteria and standards are not always based on fully fledged scientific risk assessments. This can not only create arbitrary barriers to trade, but it is also costly as it may cause safe products to be refused in some regions while unsafe products may be distributed in others. Consequently, there is a need to harmonize the procedures and the standards, at least as a first step, among these major markets, using risk-assessment methodologies where applicable.

CATEGORIES OF BORDER CASES: PATTERNS AND TRENDS

The breakdown of border cases into three main categories – microbial, chemical and other causes – for the 43 countries and the EU/regions covered in this publication is summarized in Figure 47. The differences in the profile of each of these major importers are quite obvious, with both the EU and Japanese border cases being predominately microbial or chemical in origin, while these causes only account for a quarter to a third of border cases in the United States of America and Canada. Given the well publicized increase in 2001–02 of chemical (veterinary drug residues) contamination of fish products originating in Asia (especially for shrimps), it is interesting to note that this becomes evident in the EU data, where chemical contamination becomes a dominant category while, for other major importers, a similar trend is not noticeable. As these other regions also were importing large quantities of shrimp from Asia during this period, they were clearly handling the imported products differently, or recording the related data differently.

However, the obvious differences highlighted again point to the significant variations in approaches to controls at the borders of the countries being studied. For an exporter, it would be helpful if these procedures were harmonized, so that if they export a product, it should be treated the same way at the borders of all importing countries. The multitude of approaches to border control impose extra costs on traders. These differences in approach may be significant, but the economic effects are difficult to quantify owing to the lack of relevant data, most importantly about the quantities and value of rejected products and the costs of controls.

PERFORMANCE OF EXPORTERS, GROUPED BY CONTINENTS, IN MAJOR MARKETS

Again, the available data permit only a crude analysis here, but the results do provide a useful reference for discussion. The only two importing regions with full data over the

Figure 47

Relative frequency of causes of border cases for the European Union, the United States of America, Canada and Japan (percentage)

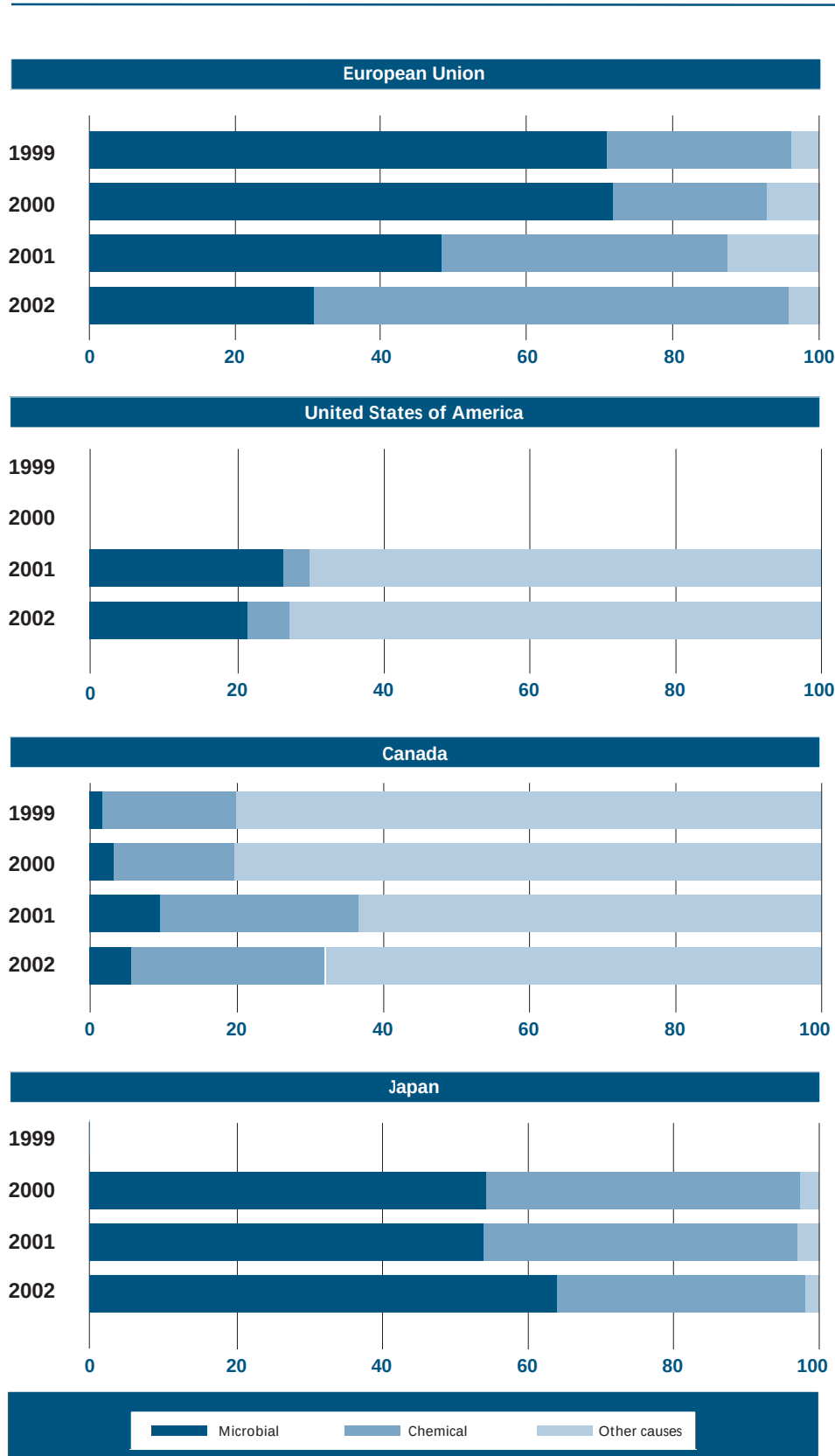


Table 19
Performance of continents in exporting to the European Union, Canada and Japan

	1999		2000		2001		2002	
	Border cases/ 100 000 tonnes	Rank	Border cases/ 100 000 tonnes	Rank	Border cases/ 100 000 tonnes	Rank	Border cases/ 100 000 tonnes	Rank
To EU								
Oceania	–	1	–	1	5.9	5	–	1
North America	–	1	1.0	3	1.1	2	0.7	2
Europe (not EU)	0.1	3	0.3	2	0.3	1	1.0	3
Central and South America	1.8	4	4.8	4	2.8	3	5.9	4
Africa	7.0	5	5.7	5	4.4	4	6.2	5
Asia	12.9	6	13.9	6	16.4	6	51.5	6
To Canada								
United States of America	1.0	1	0.5	1	2.6	1	1.3	1
Central and South America	31.6	2	19.1	3	25.6	3	25.2	2
Europe (not EU)	32.0	3	18.3	2	9.1	2	29.1	3
Asia	67.5	4	44.6	4	32.6	4	56.8	4
Oceania	113.8	5	177.7	5	136.0	5	144.2	5
EU	199.4	6	178.9	6	198.3	6	245.4	6
Africa	277.4	7	1 029.9	7	1 436.8	7	1 069.9	7
To Japan								
Europe					0.3	2	0.3	1
North America					0.5	3	0.5	2
Africa					0.0	1	1.1	3
Central and South America					0.8	4	1.5	4
Oceania					3.9	5	5.7	5
Asia ¹					6.6	6	12.5	6

¹ 2001 detention figures used are derived from an average 12-month period from April 2000 to October 2001; 2002 figures are from November 2001 to October 2002.

four-year period 1999–2002, allowing for comparison of the performance of exporting continents, are the EU and Canada. The Japanese data allow this comparison for the two periods 2000-01 and 2001-02 (Table 19).

Looking at the data from the perspective of the importing market, significant variations can be seen in the relative performance of the exporters in the six continents, dependent on whether fish is being sent to the EU, Canada or Japan. This fact alone is worthy of comment. There are two main reasons why this might occur. First, the importing regions – the EU, Canada and Japan – apply different criteria for border actions (whether sampling frequencies, limits for contamination levels or other procedures); and, second, the six exporting continents send different volumes and products (either different risk categories or of varying quality) to the export markets.

If the latter is the case, and given that the products exported to the EU and Canada are fairly similar (frozen fish dominates, with significant numbers of crustacea, cephalopods, molluscs, etc.), it would seem that individual exporters recognize the differences and target their products to suit the market criteria. This certainly does happen, but it is probably more likely that importing regions treat the imports (as a whole) in different ways resulting in different border actions. In the case of the

Japanese market, the high number of border cases reported for products imported from Asia may reflect the fact that neighbouring countries also have access to high-risk products that are similar, if not identical, to those produced by Japanese fisheries. And it is these products that account for the high number of border cases. However, this is only conjecture given the nature of the data available.

A comparison of the incidence of border cases by each exporting continent is interesting. Specifically, Oceania ranks highest when exporting to the EU, but ranks very poorly when exporting to Canada and Japan. Africa is the poorest performer in terms of exports to Canada and second poorest in exports to the EU. However, the continent performs quite well in exports to Japan. The poorest performer by some margin in exporting to the EU is Asia; this performance level has been exacerbated in recent years by the veterinary drug residue issue mentioned above. Asia is also the poorest performer in terms of exports to Japan. However, it outperforms both Oceania and the EU in exporting to Canada, although it still performs only moderately. Central and South America performs very well in terms of exports to Canada but less well when exporting to the EU and Japan. North America is consistently a top-performing exporter.

It is not easy to determine the significance of this variation or what has caused it. It was noted above that there seemed to be a tendency for those exporting the smallest absolute quantities to have more border cases per unit volume – and this certainly applies in the case of exports to Canada. However, this does not apply to the EU, as Oceania is the smallest exporter but is one of the top performers with the lowest frequency of border cases. Neither does this pattern apply to Japan, as Asia is the largest exporter, but is a poor performer.

Additional research aiming to establish in more detail why these differences occur may give misleading results, mainly because of the overriding influence of two factors: the importing nations use different procedures (sampling plans, analytical techniques, type of defect) and/or the criteria regarding imports and the products exported differ among importing regions. Again, for the benefits of international trade, and ultimately the consumer, it is desirable that the importing rules are harmonized both in terms of the governing legislation and its implementation to enable proper evaluation of performance.

ECONOMIC IMPLICATIONS OF BORDER CASES

While international efforts are focusing on harmonization, several development agencies and donors have been exploring ways and means, both financial and technical, to assist developing exporting countries in building national and regional capacity to meet international safety and quality standards. Proper assessment of the extent of assistance needed is key in decision-making about such assistance. Therefore, costing the impact of substandard quality and safety products would be of interest not only to producers, processors, quality control authorities and consumers, but also to governments, donors, public health authorities and development agencies. In addition to the large economic losses incurred because of fish spoilage, product rejections, detention and recalls – and the resulting adverse publicity to an industry and even to a country – there are costs related to human health. Fish-borne illnesses cost billions of dollars in medical care and the loss of productivity of those infected causes large indirect costs to the community.

Furthermore, risk managers, who will be weighing different mitigation options, need economic data to assess the cost-effectiveness of the different options presented to them. Unfortunately, the detention/rejections data, as they are generally collected, cannot be exploited to assess the cost of border cases. It is important to have access to such information in future for the reasons mentioned above.

Table 20 represents an attempt to estimate the cost of border cases in Japan using data available from the Japanese Ministry of Health, Labour and Welfare (MHLW).⁶¹ Unfortunately, similar data were not available for the other importing countries. The table estimates the total volume of Japan border cases at 255.2 tonnes and 490.6 tonnes, respectively, for 2001 and 2002. These represent a small fraction



Table 20
Estimated quantity and value of border cases for Japan

Product type	Import			Border cases		
	Quantity (Tonnes)	Value (US\$ million)	Unit cost (US\$/tonne)	Number	Quantity (Tonnes)	Value (US\$)
2001						
Fresh fish	375 000	1 849	4 931	16	35.2	173 571
Frozen	2 344 000	8 647	3 689	84	184.8	681 727
Canned	281 000	1 786	6 356	4	8.8	55 933
Cured	34 000	320	9 412	11	24.2	227 770
Live	37 000	351	9 486	1	2.2	20 869
Total 2001	3 071 000	12953		116	255.2	1 159 870
2002						
Fresh fish	329 000	1 603	4 872	15	33	160 776
Frozen	2 362 000	8 730	3 696	174	382.8	1 414 829
Canned	353 000	2 033	5 759	4	8.8	50 679
Cured	36 000	329	9 139	28	61.6	562 962
Live	38 000	356	9 368	2	4.4	41 219
Total 2002	3 118 000	13 051		223	490.6	2 230 465

(0.0083 percent and 0.016 percent, respectively) of total imports to Japan in those years. They were valued at US\$1 159 870 and US\$2 230 465 (or 0.009 percent and 0.017 percent of total import values), respectively, for 2001 and 2002. For the period 2001–02, the average revenue lost was estimated at US\$4 546 per tonne detained and US\$10 000 per border case.

The revenues lost to exporting companies when consignments are rejected are, as a rule, much greater than the costs of prevention needed to enable the companies concerned to avoid these border cases. This affirmation has been confirmed by several studies, compiled and reported by FAO,⁶² which estimated the costs of implementing good management practice and HACCP. In the United States of America, 1995 cost estimates for HACCP implementation for seafood-processing plants averaged US\$23 000 in the first year and US\$13 000 per year in subsequent years. In parallel, prices for seafood were also estimated to increase by less than 1 percent in the first year and less than 0.5 percent in subsequent years, with the larger cost increase expected to reduce consumption by less than 0.5 percent.

Other studies carried out in the United States of America estimated the costs of implementing the HACCP-based Model Seafood Surveillance Program (MSSP) in the United States crab industry at US\$3 100 per plant or US\$0.04 per kg, representing 0.33 percent of the processor price. Compliance costs were estimated at US\$6 100 per plant. Investment costs averaged US\$3 200 for large plants and US\$1 700 for small plants. In all, the added cost per kg of product for compliance was US\$0.02 for small plants and insignificant for large plants. For molluscan shellfish (oysters, mussels, clams), these costs were estimated at US\$5 500 per plant. Annualized compliance costs per kg were estimated at US\$0.11 for small plants and US\$0.01 for larger plants.

In Bangladesh upgrading the plant and implementing HACCP for the shrimp industry were estimated to cost between US\$0.26 and US\$0.71 per kg and between US\$0.03 and US\$0.09 for the plant's maintenance. Those were higher than the corresponding estimates for the United States of America, mainly because the Bangladesh shrimp industry had to start from scratch and also had more small- and medium-sized enterprises. It is well established that in the fish-processing industry economy of scale lowers the costs of safety and quality systems in large enterprises. Nevertheless, even though these costs were high, they represent only 0.31 percent (implementation) and 0.85 percent (maintenance) of the 1997 prices.⁶³

More importantly, the cost of installing and operating HACCP systems remains very low in comparison with the revenue lost by exporters in border cases, currently estimated to be US\$4.55 per kg on average. Indeed, the per kg costs of implementing and maintaining HACCP or HACCP-based systems would represent between 1.46 percent and 3.4 percent (United States of America) or 6.45 percent to 17.6 percent (Bangladesh) of the revenue lost in border cases. Furthermore, these revenue losses should be considered only as the visible part of the iceberg. The cost of transportation, the resulting adverse publicity, the requirements for systematic physical checks of subsequent shipments, the loss of client confidence and ensuing market shares, market diversions, loss of momentum, decreased prices, reduced capacity owing to temporary or permanent closures, are certainly additional costs with far-reaching impacts, but unfortunately difficult to quantify.

CONCLUSIONS AND RECOMMENDATIONS

The study details the regulations governing imports into the EU, Canada, Japan and the United States of America and presents and discusses the data available about the border cases (detentions, rejections, re-exports, etc.) in the same countries/region.

Key issues arising from the study include a need to harmonize the procedures and methods used to govern imports, to base the actions taken on risk assessment where consumer safety is in question and, importantly, to communicate the actions taken to all interested parties in a manner that is unambiguous, transparent and easily obtained and analysed. The study makes recommendations about the actions governments and industry can and should take to facilitate trade in fish and fish products by improving border control systems, border control data collection and dissemination, improving export performance and development assistance. It suggests further work that needs to be undertaken in this important, but little-studied, aspect of international trade.



NOTES

1. This section draws on the following sources: FAO. 2005. *Habitat rehabilitation for inland fisheries: global review of effectiveness and guidance for rehabilitation of freshwater ecosystems*, by P. Roni, K. Hanson, T. Beechie, G. Pess, M. Pollock and D.M. Bartley. FAO Fisheries Technical Paper. No. 484. Rome; I.G. Cowx and R.L. Welcomme. 1998. *Rehabilitation of rivers for fish*. Oxford, UK, Fishing News Books; FAO/Deutscher Verband für Wasserwirtschaft und Kulturbau. 2002. *Fish passes – design, dimensions and monitoring*. Rome, FAO; M. Larinier and G. Marmulla. 2004. Fish passes: Types, principles and geographical distribution – an overview. In R.L. Welcomme and T. Petr, eds, *Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries Volume II*, RAP Publication 2004/17, pp. 183–205. Bangkok, FAO Regional Office for Asia and the Pacific; M. Larinier, F. Travade and J.P. Porcher. 2002. Fishways: biological basis, design criteria and monitoring. *Bull. Fr. Pêche Piscic.*, 364(Suppl.); FAO. 2001. *Dams, fish and fisheries. Opportunities, challenges and conflict resolution*, edited by G. Marmulla. FAO Fisheries Technical Paper No. 419. Rome; and G. Marmulla. 2003. Dams and fisheries. In FAO. 2003. *Review of the state of world fishery resources: inland fisheries*. FAO Fisheries Circular No. 942, Rev. 1, pp. 29–35. Rome.
2. FAO. 1995. *FAO Code of Conduct for Responsible Fisheries*. Rome.
3. FAO. 1997. *Inland fisheries*. FAO Technical Guidelines for Responsible Fisheries No. 6. Rome.
4. The study report was published as FAO. 2005. *Responsible fish trade and food security*, by J. Kurien. FAO Fisheries Technical Paper No. 456. Rome.
5. Brazil, Chile, Fiji, Ghana, Namibia, Kenya, Nicaragua, the Philippines, Senegal, Sri Lanka and Thailand.
6. The article draws on a range of FAO documents and data sources to provide an insight into the current issues surrounding low-value/trash fish production in the region. These include: FAO. 2005. *Asian fisheries today: the production and use of low-value/trash fish from marine fisheries in the Asia-Pacific region*, by S. Funge-Smith, E. Lindebo and D. Staples. RAP Publication 2005/16. Bangkok; and FAO. 2005. *Discards in the world's marine fisheries: an update*, by K. Kelleher. FAO Fisheries Technical Paper No. 470. Rome.

A number of comprehensive country studies were also initiated by the APFIC and have provided the basis for much of the information discussed. A recent review carried out under the auspices of the Australian Centre for International Agricultural Research (ACIAR) was also used: P. Edwards, L.A. Tuan and G.L. Allan. 2004. *A survey of marine low trash fish and fishmeal as aquaculture feed ingredients in Vietnam*. ACIAR Working Paper No. 57. Canberra.

7. "Fishing down the food chain" refers to the practice in some tropical demersal coastal fisheries whereby larger and more valuable fish species (often of a higher trophic level, e.g. carnivores such as bream, sharks and rays) become overfished, and fishing practices change to catching large quantities of mainly low-value species (often of a lower trophic level, e.g. squid and jellyfish).
8. An average weighted by the amount of low-value/trash fish caught in the different countries.
9. FAO. 2005. *Discards in the world's marine fisheries: an update*, by K. Kelleher. FAO Fisheries Technical Paper No. 470. Rome.
10. FAO. 2002. *The State of World Fisheries and Aquaculture 2002*. Rome.
11. IFPRI. 2003. *Fish to 2020 – supply and demand in changing global markets*. Washington, DC.
12. WorldFish Center. 2006 (forthcoming). *Regional synthesis on the analysis of "TrawlBase" data for low value/trash fish species and their utilization*. Penang, Malaysia.
13. FAO. 2005. *APFIC Regional Workshop on Low Value and "Trash Fish" in the Asia-Pacific Region*. Hanoi, Viet Nam, 7–9 June 2005. Asia-Pacific Fishery Commission (APFIC). RAP Publication 2005/21. Bangkok.

14. With regard to terminology, there is a second school of thought that uses the term “transboundary” as a generic one to denote all fish stocks exploited by two or more states (entities). This school of thought uses the term “shared” to denote stocks to be found within two or more neighbouring EEZs.
15. Highly migratory stocks are those set forth in Annex I of the 1982 Convention on the Law of the Sea, and consist primarily of the tuna species. Straddling stocks are all other stocks (excluding anadromous and catadromous stocks) to be found, both within the EEZ and the adjacent high seas. Transboundary stocks and highly migratory/straddling stocks are not mutually exclusive.
16. Shared fish stocks are also found in inland water bodies, including lakes and rivers, where they pose the same cooperative management challenges.
17. FAO. 2002. *Report of the Norway–FAO Expert Consultation on the Management of Shared Fish Stocks*. Bergen, Norway, 7–10 October 2002. FAO Fisheries Report No. 695. Rome; FAO. 2004. *The conservation and management of shared fish stocks: legal and economic aspects*, by G. Munro, A. Van Houtte and R. Willmann. FAO Fisheries Technical Paper No. 465. Rome.
18. Sharing the Fish Conference 06, Fremantle, Australia, 26 February–2 March 2006 (available at <http://www.fishallocation.com>).
19. FAO, 2004, op. cit., see note 17.
20. J.F. Caddy. 1997. Establishing a consultative mechanism or arrangement for managing shared stocks within the jurisdiction of contiguous states. In D. Hancock, ed. *Taking stock: defining and managing shared resources*, pp. 81–123. Australian Society for Fish Biology and Aquatic Resource Management Association of Australasia Joint Workshop Proceedings, Darwin, Northern Territory, 15–16 June 1997. Sydney, Australia, Australian Society for Fish Biology.
21. FAO, 2004, op. cit., see note 17.
22. The Nobel Prize in Economic Sciences in 2005 was awarded jointly to Thomas Schelling (United States of America) and Robert Aumann (Israel). The press release, announcing the award, read as follows: “Why do some groups of individuals, organizations and countries succeed in promoting cooperation while others suffer from conflict? The work of Robert Aumann and Thomas Schelling has established game theory – or interactive decision theory – as the dominant approach to this age-old question” (http://nobelprize.org/nobel_prizes/economics/laureates/2005/press.html). This is, of course, precisely the question that has to be confronted in the context of shared fish stocks.
23. The “Prisoner’s Dilemma” and its relevance to the management of shared fish stocks is discussed in detail in FAO, 2004, op. cit., see note 17.
24. Ibid.
25. FAO. 1980. *Some problems in the management of shared stocks*, by J.A. Gulland. FAO Fisheries Technical Paper No. 206. Rome.
26. FAO. 1994. *Marine fisheries and the law of the sea: a decade of change*. FAO Fisheries Circular No. 853. Rome; S. Barrett. 2003. *Environment and statecraft: the strategy of environmental treaty-making*. Oxford, UK, Oxford University Press.
27. FAO, 2002, op. cit., see note 17.
28. Ibid., p. 8.
29. An example of a cooperative fisheries management arrangement being upset by an environmental shock is provided by the Canada–US Pacific Salmon Treaty. See: K.A. Miller. 2003. North American Pacific salmon: a case of fragile cooperation. In *Papers presented at the Norway–FAO Expert Consultation on the Management of Shared Fish Stocks*. Bergen, Norway, 7–10 October 2002, pp. 105–122. FAO Fisheries Report No. 695, Suppl. Rome.
30. United Nations. 1992. *The law of the sea: the regime for high seas fisheries: status and prospects*. New York, USA; FAO. 2006. *The state of the world’s highly migratory, straddling and other high seas fish stocks, and associated species*. FAO Fisheries Technical Paper No. 495. Rome. Of the world tuna stocks for which the state of exploitation has been assessed, 29 percent are estimated to be depleted or overexploited. Bluefin tuna stocks figure prominently in this estimate (FAO, 2006, pp. 15–16).



31. The full title is Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks.
32. See G. Munro. 2000. The UN Fish Stocks Agreement of 1995: history and problems of implementation. *Marine Resource Economics*, 15: 265–280.
33. FAO, 2004, op. cit., see note 17.
34. Ibid.
35. Munro, Van Houtte and Willmann remark that “... the overexploitation of straddling/highly migratory fish stocks worldwide ... bears powerful testimony to the predictive power of the economic analysis of the non-cooperative management of such resources”. See FAO, 2004, op. cit., note 17, p. 45.
36. Transboundary stock cooperative arrangements with large numbers of participants do exist, but these are the exception, not the rule. In the case of RFMOs, large numbers of participants are the rule, not the exception.
37. With a large number of participants (players), it is standard in game theory analysis to talk of coalitions. All the players together constitute the “Grand Coalition”. There can, in addition, be subcoalitions. In such a game, it is not sufficient to worry about individual players deciding they would be better off by not cooperating; stability of the Grand Coalition also requires that each subcoalition can expect to receive returns from cooperation that are at least as great as it would expect to obtain by going off and competing against the rest.
38. Articles 8, 10 and 11.
39. FAO, 2004, op. cit., see note 17.
40. Ibid.
41. M. Lindroos. 2002. *Coalitions in fisheries*. Helsinki School of Economics Working Paper W-321; P. Pintassilgo. 2003. A coalition approach to the management of high seas fisheries in the presence of externalities. *Natural Resource Modeling*, 16: 175–197.
42. FAO, 2004, op. cit., see note 17. The issue was also discussed in FAO. 2004. *The State of World Fisheries and Aquaculture 2004*. Rome, pp. 91–99.
43. This article is a summary of FAO. 2006. *Review of the state of world marine capture fisheries management: Indian Ocean*. FAO Fisheries Technical Paper No. 488. Rome. Similar reviews covering the Atlantic and Pacific Oceans are planned.
44. Questionnaires were received from Australia (west coast), Bahrain, Bangladesh, Comoros, Djibouti, Egypt (Red Sea coast), Eritrea, India (east coast), India (west coast), Indonesia (Pacific and Indian coasts), Islamic Republic of Iran, Iraq, Jordan, Kenya, Kuwait, Madagascar, Malaysia (Pacific and Indian coasts), Maldives, Mauritius, Mozambique, Myanmar, Oman, Pakistan, Qatar, Saudi Arabia, South Africa (east coast), Sri Lanka, the Sudan, Thailand (Indian Ocean coast), United Arab Emirates and Yemen. Questionnaires were not received for the Seychelles, Somalia and the United Republic of Tanzania.
45. Occasionally as a stand-alone authority or fisheries ministry but more often in the form of a fisheries department within an agriculture/livestock or environment ministry or a combined agriculture/fisheries ministry.
46. FAO. 2005. *Review of the state of world marine fishery resources*. FAO Fisheries Technical Paper No. 457. Rome.
47. Based on the questionnaire results, the concept of “managed” was mostly inferred to mean (i) published regulations or rules for specific fisheries: (ii) legislation concerning individual fisheries, and (iii) interventions/actions to support specific management objectives.
48. See, for example, D. Thompson. 1980. Conflict within the fishing industry. *ICLARM Newsletter*, 3(3): 3–4; F. Berkes, R. Mahon, P. McConney, R.C. PolInac and R.S. Pomeroy. 2001. *Managing small-scale fisheries: alternative directions and methods*. Ottawa, International Development Research Centre.

49. FAO, 2005, op. cit., see note 46.
50. Subregional reviews covering the eastern, western and southwestern Indian Ocean. Australia was left as a stand-alone review.
51. FAO. 2007 (forthcoming). *A study into the effect of energy costs in fisheries*, by A. Smith. FAO Fisheries Circular No. 1022. Rome.
52. FAO. 1999. *Economic viability of marine fisheries. Findings of a global study and an interregional workshop*, by J.-M. Le Rey, J. Prado and U. Tietze. FAO Fisheries Technical Paper No. 377. Rome; FAO. 2001. *Techno-economic performance of marine capture fisheries*, edited by U. Tietze, J. Prado, J.-M. Le Rey and R. Lasch. FAO Fisheries Technical Paper No. 421. Rome; FAO. 2005. *Economic performance and fishing efficiency of marine capture fisheries*, by U. Tietze, W. Thiele, R. Lasch, B. Thomsen and D. Rihan. FAO Fisheries Technical Paper No. 482. Rome.
53. Energy intensity, measured in terms of the amount of energy required to produce a unit of GDP, increases during the first stage of industrialization in developing countries before decreasing as observed in maturing economies. OECD countries have a GDP of US\$5 277 per tonne of oil equivalent (Toe), whereas non-OECD countries have an average of US\$1 272 per Toe. Source: International Energy Agency Web site (<http://www.iea.org/>).
54. Op. cit., see note 51.
55. Flash point is the lowest temperature at which a liquid can form an ignitable mixture in air near the surface of the liquid. The lower the flash point, the easier it is to ignite the material.
56. The flash point of biodiesel is 150°C; however, it does become highly viscous and could freeze at low temperatures. This can be avoided by mixing biodiesel with conventional diesel.
57. Anon. 2003. The end of the oil age. *The Economist*, 23 October, p. 12.
58. This article summarizes FAO. 2005. *Causes of detentions and rejections in international fish trade*, by L. Ababouch, G. Gandini and J. Ryder. FAO Fisheries Technical Paper No. 473. Rome.
59. J. Allshouse, J.C. Buzby, D. Harvey and D. Zorn. 2003. International trade and seafood safety. In J.C. Buzby, ed. *International trade and food safety: economic theory and case studies*. Agricultural Economic Report No. 828, pp. 109–124 (available at <http://www.ers.usda.gov/publications/aer828/aer828.pdf>).
60. National Academy of Sciences. 2003. *Scientific criteria to ensure safe food*. Washington, DC, The National Academies Press (available at <http://www.nap.edu/openbook/030908928X/html/R3.html>).
61. MHLW Web site (available at <http://www.mhlw.go.jp/english>).
62. FAO. 1998. *Seafood safety. Economics of Hazard Analysis and Critical Control Point (HACCP) programmes*, by J.C. Cato. FAO Fisheries Technical Paper No. 381. Rome.
63. J.C. Cato and C.A. Lima dos Santos. 1998. European Union 1997 seafood-safety ban: the economic impact on Bangladesh shrimp processing. *Marine Resource Economics*, 13(3): 215–227.



PART 4

OUTLOOK

OUTLOOK

INTRODUCTION

A few years have passed since major quantitative studies were undertaken on the future of the fisheries sector and the results published in *The State of World Fisheries and Aquaculture*. How do the projections compare with recorded developments? It is, of course, too early to come to any definite conclusions even for the projections aimed at 2010. Nevertheless, a start can be made. The results are provided in the first part of this section.

During the past two years FAO has conducted a comprehensive study of the aquaculture sector. The study focused on establishing recent trends and on identifying challenges and opportunities for the sector. These were further discussed in a prospective study. The second part of this "Outlook" summarizes the most important findings of the prospective study. Naturally, a large part of these findings confirm observations and suggestions already made – some of which have been published in earlier versions of this report – but some are new.

REVISITING GLOBAL PROJECTIONS

Table 21 is taken from *The State of World Fisheries and Aquaculture 2004* – where it appeared as Table 16. An additional column (in blue) containing FAO statistical data for 2004 has been inserted in this updated table.

The table contains projections for 2010, 2015, 2020 and 2030, all based on information for the sector available around the year 2000. At the time of writing, information is available about what actually happened during the first part of the decade, including 2004. The four-year period is short and there is little reason to discuss in detail the validity of projections other than those for 2010.

There does not seem to be any reason not to expect that world fisheries and aquaculture production, four years into the decade, have moved some way towards the figures predicted for 2010. A rapid glance at the table indicates that this is so. Marine fisheries have reached a ceiling, in terms of output, while a growing aquaculture



Table 21
Fish production in 2004 and projections for 2010 and later

Information source	Simulation target year						
	2000	2004	2010	2015	2020	2020	2030
	FAO statistics ¹	FAO statistics ²	SOFIA 2002 ³	FAO study ⁴	SOFIA 2002 ³	IFPRI study ⁵	SOFIA 2002 ³
Marine capture	86.8	85.8	86		87	–	87
Inland capture	8.8	9.2	6		6	–	6
Total capture	95.6	95.0	93	105	93	116	93
Aquaculture	35.5	45.5	53	74	70	54	83
Total production	131.1	140.5	146	179	163	170	176
Food fish production	96.9	105.6	120		138	130	150
Percentage used for food fish	74%	75%	82%		85%	77%	85%
Non-food use	34.2	34.8	26		26	40	26

Note: All figures – other than percentages – are in million tonnes.

¹ Based on the statistics available to the FAO Fishery Information, Data and Statistics Unit in 2000.

² Based on latest statistics of the FAO Fishery Information, Data and Statistics Unit.

³ FAO. 2002. *The State of World Fisheries and Aquaculture 2002*. Rome.

⁴ FAO. 2004. *Future prospects for fish and fishery products: medium-term projections to the years 2010 and 2015*. FAO Fisheries Circular FIDI/972-1. Rome.

⁵ International Food Policy Research Institute. 2003. *Fish to 2020: supply and demand in changing global markets*, by C. Delgado, N. Wada, M. Rosegrant, S. Meijer and M. Ahmed. Washington, DC.

sector is providing sufficient fish to permit per capita supplies of fish to remain almost constant. Only two features of the sector appear to have diverged from expectations: inland capture fisheries and the quantities of fish being used for non-food purposes. In both cases the quantities have exceeded the projections.

Marine capture fisheries

The image of stagnation provided by marine capture fisheries is false. The stagnation in terms of output in no way reflects a stagnating sector. Not only are landings increasing in some fisheries – exemplified by the fisheries in the Northwest Atlantic – and decreasing in others (see p. 10), but the sector is continuously adjusting to changing political, economic and social environments. In fact, considerable efforts are required by the sector to adjust to a situation of no – or very limited – growth in landings and more stringent management of fishing effort.

Some projections for marine fisheries production foresee an initial decline as stock recovery takes place, followed by an expansion of quantities captured, in some cases arriving at stable catches above those recorded prior to overfishing. While some stocks are recovering, there is no indication to date that landings for these stocks will expand to exceed the historical maximum sustainable yield levels.

Thus, it currently seems reasonable to expect that marine capture fisheries production will remain between 80 and 90 million tonnes per year, with an average somewhere in the middle of this range.

Freshwater capture fisheries

Contrary to projections, landings from inland fisheries have remained high and even increased somewhat. The projection for 2010 is that landings will have fallen to only two-thirds of the 2000 level. However, the projections were based on incomplete information; as information improves, the basis for past projections comes into question.

The freshwater fisheries sector is comprised of two subsectors: a large non-commercial, or subsistence, subsector, and a more formal commercial subsector. As mentioned on page 33, the landings of the subsistence fisheries are not usually included in official records of freshwater fisheries, generally because their magnitude is not known by the responsible fisheries administration. Similarly, catches destined for sale from many small-scale fisheries are not always fully documented. The catches from larger commercial freshwater fisheries are more often and more accurately included in the records.

The freshwater fisheries sector also suffers from a degraded aquatic environment and increased uses of freshwater for agriculture, hydropower and other purposes. Often, these activities take precedence over managing and reporting on freshwater fisheries, and this trend can be expected to continue as long as the real value of freshwater fisheries is unknown.

Efforts by FAO and others are under way to improve the official records of both commercial and non-commercial inland fisheries. In some cases, improved statistics now give a more accurate picture of freshwater fisheries, but because good baseline information on catch and numbers of commercial and subsistence fishers was not available previously, little can be said about trends. Information on freshwater fisheries and the numbers of fishers is improving.

Aquaculture

Aquaculture (excluding aquatic plants) production continues to grow both in China and in the rest of the world. Most noteworthy, perhaps, is that aquaculture production over the past four years has grown faster outside China (a combined increase of 37 percent) than in China (where expansion has been 24 percent). This means that as long as the annual rate of increase in production outside China remains at around 8 percent, the prediction of 53 million tonnes of aquaculture production for 2010 (see Table 21) will be met even if Chinese production remains at the level reported for 2004 (of 30.6 million tonnes).

However, production in China is not likely to stagnate so suddenly; more importantly, conditions for the continued growth of aquaculture are favourable, particularly in South America and Africa. Thus, a first impression is that, at least during the rest of the current decade, aquaculture will contribute to future world fish supplies as was expected in 2000.

Fish utilization

The projections for the decade ending in 2010 were constructed on the expectation that quantities of fish used for non-food purposes would decline from about 35 million tonnes per year to 26 million tonnes per year. This does not seem to be happening. In 2004, the quantities used for non-food uses were as high as four years earlier. Why?

For the average consumer, some fish are more appetizing than others. Among those that are not valued as human food (e.g. menhaden and sand eel), some are available in large quantities and have no uses other than as animal feed or, in the past, fertilizer. These species are the backbone of the fishmeal industry. Unfortunately for this industry, the availability of these species can change dramatically from year to year.

Among the fish used by the fishmeal industry is the Peruvian anchoveta (*Engraulis ringens*). This species can contribute as much as one-third of the raw material used for fishmeal worldwide in a given year, but the standing biomass of the species usually fluctuates dramatically from one year to the next. Therefore, the fluctuation in anchoveta landings in Chile and Peru largely explains the fluctuations also in the amount of fish allocated to non-food uses worldwide. Any attempt to identify a trend in the use of fish for non-food purposes must somehow eliminate the random nature of the changes in quantities available in the sea and landed. One simple approach is to construct moving averages over a number of years.

The six-year moving average increased from about 29 million tonnes per year during the period 1994–99 to more than 32.5 million tonnes for the period 1999–2004. The increase is explained by a rapid expansion in China of the quantities used for non-food purposes – both for reduction to fishmeal and for other purposes. In China, the six-year moving average increased from 5 million tonnes per year of fish for non-food use during the period 1994–99 to 9.3 million tonnes for the period 1999–2004. For the rest of the world, the six-year average fell by 1.5 million tonnes, arriving at 23.4 million tonnes per year for 1999–2004.

Nevertheless, the increase in non-food uses has not prevented the expected increase in food use. In 2004, the amount of fish used as food had reached 105.6 million tonnes, 8.7 million tonnes more than four years earlier. It is aquaculture, and to some extent inland capture fisheries, that has made this possible. The growth in aquaculture output destined for human consumption (intermediary products excluded) has compensated for the proportion of capture fisheries landings that have been dedicated to fishmeal and other non-food uses. Of course, this has been possible because a large part of aquaculture production is not dependent on feeds fortified with fishmeal.

Fishmeal and availability of fish as food

It now seems unlikely, in the middle of the decade, that only 26 million tonnes of fish will be used for purposes other than food by 2010, but the extent to which this is unlikely this is difficult to establish. There are opposing forces at work.

On the one hand, aquaculturists – and other fishmeal users – will demand increasing quantities in the immediate future. These must come from capture fisheries, however, as aquaculture produce is generally too costly for uses other than human food.

On the other hand, the future demand for fishmeal in the aquaculture industry will be influenced by the results of research aiming to substitute fishmeal used in feed for fish and crustaceans. When the results of this research become technologically and economically feasible, the impact on fishmeal manufacturing could be rapid, and the quantities of fish demanded by fishmeal factories might well fall as projected in the past.

Halfway through the decade, however, such results do not seem to be forthcoming, so the demand for fishmeal will continue to grow. This will result in a rise in the real price of fishmeal (and fish oil), which in turn will contribute to increasing incentives



for using more fish as raw material in fishmeal plants. Such a development would lead to an increase in the real cost of some aquaculture produce, *ceteris paribus*, and production would expand more slowly than would otherwise have been the case.

As only part of the aquaculture sector is dependent on fishmeal in feeds, it seems unlikely that this scarcity of fishmeal will significantly hinder the overall growth of the sector, but there will be some reduction. Thus, in the absence of a “technological fix” that would make it possible to substitute significantly, if not fully, fishmeal in shrimp and fish feeds, the amount of fish available for human consumption in 2010 will probably be below 120 million tonnes, more likely in the range of 110–115 million tonnes. If freshwater fisheries production continues at present levels or expands, which may be the case during the rest of the decade, the availability of fish for human consumption will increase in a similar measure.

MEDIUM-TERM CHALLENGES AND CONSTRAINTS FOR AQUACULTURE

FAO recently concluded a prospective analysis intended to provide an insight into the future of aquaculture globally. The process was complex and included an assessment of demand and supply of fish and fish products. The analysis encompassed the preparation of national aquaculture sector overviews for more than 100 countries, five regional workshops in which participants discussed the aquaculture development status and trends in their region, the preparation of seven reports on regional aquaculture development status and trends¹ and a global expert survey on aquaculture development using the Delphi Technique. The material developed in this process, and other relevant documentation, was then synthesized to form a draft global review of the status and trends in aquaculture development.² Subsequently, this document was submitted to a group of experts, who were requested to reach consensus on the document and to craft the prospective analysis of future aquaculture development.³

The remainder of this section draws on the prospective analysis for a discussion of the possible behaviour of factors that are likely to influence significantly the development of aquaculture in the next decade or two. It starts with a few observations on the situation confronting aquaculture in sub-Saharan Africa.

The special situation of sub-Saharan Africa

In sub-Saharan Africa, per capita consumption of fish has lagged behind that of the rest of the world, decreasing from a high of 9.9 kg per capita in 1982 to the most recent estimate of 7.6 kg in 2003. The region can ill afford to see this trend continue or worsen. However, aquaculture can help also here as has been noted by the New Partnership for Africa's Development (NEPAD). In 2005, the NEPAD “Fish for All Summit” raised international awareness about the potential of aquaculture in the continent.⁴ Thus, for the coming years and decades, aquaculture is likely to become a priority for development. Indications are that assistance to Africa's aquaculture sector will be renewed in ways that are long-term in nature and favour private investment.

However, severe obstacles must be overcome. Most countries in sub-Saharan Africa have limited resources to deliver quality public goods and services for the aquaculture sector, and the private sector has not reached a level of development at which it could compensate for these deficiencies. So, the international community is likely to work increasingly in partnership with African development agents and institutions to ensure that aquaculture and fish production in the continent become part of its overall development process and that the public goods and services are provided.

Overarching conditions required for this to occur, identified during a recent FAO review,⁵ are political stability and good governance. More emphasis should also be placed on private-sector investment in aquaculture. Private-sector efficiency will be facilitated by the establishment of an enabling public-sector environment combined with a strategy to pursue development within the limits of available resources. The positive impacts of enhanced aquaculture development will be further complemented by the aggressive implementation of Poverty Reduction Strategy Papers, the

development of national aquaculture strategies and good legislation. The analysis also concluded that incentives and risk-reduction measures for foreign direct investment are necessary and that large-scale foreign-funded commercial aquaculture ventures could have trickle-down effects and boost the development of small- and medium-scale commercial aquaculture.

Conditions of particular relevance for the future of aquaculture in sub-Saharan Africa include the availability of quality inputs such as seed and feed and access to good quality information, affordable long-term investment capital, and land and water resources. Where these conditions prevail, sustainability will be enhanced and risks reduced. Given the importance not only of international assistance, but also of international markets, it is imperative that the image of African aquaculture is a positive one. This will permit benefits to accrue that include direct and indirect advantages to the most needy. The adoption of appropriate management practices for environmental protection and the sustainable use of aquatic resources will be vital in this regard, as will high standards for food safety. Finally, efficient communication and knowledge transfer using modern information technology will both improve overall global knowledge and skills and also link African aquaculturists with their counterparts in other continents.

Trends, opportunities and constraints

Of the many factors that determine the supply of aquaculture products and will, to a large extent, also determine the availability and consumption of fish, those outlined below are expected to play a lead role in the coming decades.

Access to land and water resources, and intensification

With a few possible exceptions, there is little new land available for fish farming in most countries around the world, especially in Asia, the leading aquaculture producer. Land shortage is, and is likely to remain, one of the major constraints to aquaculture expansion globally.

Governments have taken various measures to address the issue. These include the conversion of agriculture to aquaculture land where crops such as rice have failed to produce competitive returns. A further example is the integration of aquaculture into existing farming systems. Later aquaculture development in Southeast Asia, in the mid-1980s, took place in agricultural land, mainly sugar plantations. However, the possibility of using non-agricultural land for aquaculture is increasingly restricted. In the case of shrimp farming, most remaining mangroves are protected against encroachment. Because there is no possibility of increasing land area, one solution is to intensify land-based production, and intensification is becoming a growing trend in aquaculture worldwide. However, because production costs generally rise with the level of intensification, not all farmers are expected to intensify. Instead, many may choose to reduce intensity and produce less output, but lower the costs and/or their vulnerability to fish health and/or environmental problems.

The unavailability of freshwater could also limit future aquaculture development. In addition to its use for human consumption, agriculture and the farming of freshwater aquaculture species, freshwater is used in brackish-water culture of species such as shrimp as a means of reaching optimal salinity levels. Its use in aquaculture is frequently regarded as a loss for agriculture and, in many cases, agriculture has been given priority in the allocation of water. Yet the two sectors need not be mutually incompatible as policies can be put in place to encourage multiple uses of water. Nevertheless, in many countries, as aquaculture expands, access to clean water is increasingly likely to become a limiting factor.

Access to adequate feed: fishmeal, fish oil and "low-value/trash fish"

The use of aquafeeds will continue to play an important role in aquaculture development and production. The availability and cost of feed can be critical constraints to aquaculture. Irregularity or shortages of feed supplies add to risks and



may jeopardize operations; such problems have occurred in many countries, especially in Africa and some parts of Asia.

There are mixed feelings about the reliance on fishmeal and fish oils in many countries. On the one hand, with the predicted global increase in aquaculture production, the demand for aquafeed will continue to grow, as will the demand for fishmeal and fish oil. According to the International Fishmeal and Fish Oil Organisation, the use of fishmeal in aquafeed is expected to rise by more than 5 percent (from 2.87 to 3.02 million tonnes from 2002 to 2012), while the demand for fish oil will increase by more than 17 percent (from 0.83 to 0.97 million tonnes) from 2002 to 2012.⁶ Considerable progress has been made in finding suitable alternatives to the fishmeal and fish oil from vegetable and terrestrial sources. However, the most promising results obtained so far are with omnivore/herbivore finfish and crustaceans, where total replacement of fishmeal has been possible.

On the other hand, as the production of fishmeal and fish oil is expected to remain stable over the next decade, the proportion of fishmeal use by the animal production sector is expected to fall and the use of vegetable-based protein and oil to increase. In addition, with technological advances, greater efficiencies in feeding are expected. It is therefore unlikely that the supply of fishmeal and fish oil will be a limiting factor in aquaculture feeding. However, this optimism should be considered with certain caution; the demand for fishmeal and fish oil from developing economies such as China may have a profound impact on overall supply and demand. In 2004, China imported 1 128 000 tonnes of fishmeal, or 29.6 percent of total global fishmeal imports, and accounted for more than one-third of world soybean imports.⁷

The use of low-value/trash fish in aquaculture is also an important factor for future development. Approximately 5–6 million tonnes of low-value/trash fish are used as direct feed in aquaculture (see pp. 118–119). Low-value/trash fish are primarily used for marine cage farming in China and in some Southeast Asian countries, including Cambodia, Indonesia, Thailand and Viet Nam, and to a lesser extent in tuna cage farming in the Mediterranean countries and in Mexico. It is projected that, by 2013, China alone would require 4 million tonnes of low-value/trash fish to sustain its marine cage culture. The requirement for Viet Nam has been estimated at around 1 million tonnes.⁸ It seems the use of low-value/trash fish in aquaculture feed is unlikely to be sustainable. There are concerns that its continued use may result in adverse environmental effects and biosecurity risks, and claims that the so-called low-value/trash fish should be used as human food are mounting.

Greater capitalization and diversification of production systems and species

In spite of limited land and water resources, aquaculture entrepreneurs, attracted by high prices, are likely to find new ways (in addition to intensification) of producing sufficient fish to meet demand. One plausible way might be offshore cage culture and enclosure systems, probably with large corporations taking the lead because the economies of scale needed for farms to be profitable will require the production of enormous quantities of fish.

Greater production requires greater capitalization, that is, money invested in machinery, in sophisticated and expensive technologies and in training. Expansion in production will probably depress fish prices when, at the same time, companies will be competing for labour. This scenario implies that, in growing economies, real farm wages are likely to increase. Thus, in the long run, aquaculture employers will have to use less labour and more capital to maintain the profit margins needed to stay in business. Aquaculture, therefore, is likely to change from being labour-intensive to being capital-intensive. In other words, (labour) productivity is expected to be the key factor in the future of aquaculture.

Diversification is also expected to expand to new species or strains, especially of fish with a high commercial value. Generally speaking, an allocation of productive resources towards the production of high-commercial-value species, away from low-value species, can be expected. This development is already taking place in several parts of the world. Expansion of marine fish production in Southeast Asia is a good example; another is

found in the Philippines, where sea-cage culture of milkfish is replacing brackish-water ponds. In the United States of America, the government has already established a legal and regulatory basis for offshore aquaculture in the country's EEZ. The potential for offshore aquaculture is high worldwide, especially in Asia and the Pacific, North and Latin America, Europe and West and Southern Africa.

Aquaculture of non-food species such as ornamental fish farming is an industry full of promise for the future. In 2000, the global wholesale value of live freshwater and marine ornamental fish (live animals for aquaria) was estimated at US\$900 million, with an estimated retail value equivalent to US\$3 billion. Because of its growing potential for increasing rural employment and income and generating foreign exchange earnings, governments are increasingly promoting the culture and trade of ornamental fish. However, the outbreak of diseases is a threat to the development of this industry. It has been reported that a single strain of koi herpes virus has spread globally as a result of unregulated trade in ornamental fish. The continued spread of this virus could become a considerable problem for ornamental koi carp and for the common carp, both cultured and wild. It is hoped that the effective implementation of the measures adopted by countries to arrest the spread of fish diseases will prevent the future occurrence of such epidemics.

Ecotourism is an emerging industry and has the potential to spread throughout the world. A number of countries are promoting aquaculture-related ecotourism. Recreational fisheries in lakes and reservoirs play a significant role in Central and Eastern Europe, notably in Belarus, the Baltic States, Moldova, the Russian Federation and Ukraine. In Malaysia, there is a growing interest in integrating aquaculture operations with tourism, such as marine cage culture and "put and take" fishing ponds. Offshore sites are a potential area where aquaculture-related ecotourism could be further developed; for example, visits to cage culture sites could be promoted as part of coral reef expeditions.

The need to exploit further the potential of adding value to aquaculture products through the development of non-food uses, particularly in the context of increasing production costs, is widely accepted. The use of waste byproducts of processing, such as viscera (salmon), skins (tilapia), chitins (shrimp) and anti-arthritis compounds (green mussels) offers possibilities in this area. With the adoption of expensive machinery and technologies and more intensive production techniques combined with ever-rising energy costs, the costs of production are likely to increase further. Producers will need to explore every means possible for increasing revenues – including the expansion of marketing aquaculture byproducts for non-food uses.

In addition, in regions and countries where aquaculture is already well established, evidence shows that an increase in the number of farms for mariculture of high-value species has generally been accompanied by a reduction in the number of farms producing low-value (but high-volume) species such as cyprinids. China is one of the many examples. In the future, the reduction in freshwater aquaculture production may partly be offset by an expansion in marine production, particularly through the culture of relatively high-value commercial species. Whether it is low-value freshwater species or high-value marine species, the supply of high-quality seed will remain important.

Access to capital

With progressive intensification and diversification of aquaculture to systems and species requiring sophisticated technologies, access to capital will be a key factor for development. Capital will be needed not only for investment and operating costs, but also for aquaculture insurance as these high-tech investments will probably attract more risks than generally experienced in conventional aquaculture.

While access to capital might not be an issue in developed countries, it is certainly a stumbling block to aquaculture development in the developing world. With a few exceptions, the capital market is poorly developed and poorly accessible in Asia and the Pacific, Eastern Europe, Latin America and the Caribbean, and sub-Saharan Africa. As a consequence, in these regions the possibilities for developing and introducing



new technologies are severely limited. Recourse to foreign investment is essential but, again, is severely limited. This problem is expected to persist, although there is room for some optimism. Provided that good governance and policies conducive to investment exist, the growing ease with which capital can be channelled from one country to another may enable capital-intensive farming systems to expand also in developing countries. Already, sizeable flows of foreign investments are reported in sub-Saharan African countries including the Gambia, Namibia, Nigeria, Senegal and Uganda for the culture of species such as shrimp, catfish and tilapia. There are also reports of significant capital inflows into Latin America, particularly Brazil and Chile, for the culture of salmon and other species. This trend is likely to continue for quite some time.

The farming of seaweed has expanded rapidly and offers new investment opportunities as demand has outstripped the supply from natural resources. The seaweed industry provides a range of products generating an annual production value of US\$5.5–6 billion. Of this, food products for human consumption contribute about US\$5 billion, substances extracted from seaweeds (carrageenan, agar and alginate) account for most of the remaining billion dollars, while smaller, miscellaneous uses, such as organic fertilizers and animal feed additives, make up the rest. This section of the industry is highly international and is an example of an activity where access to capital does not appear to be a limiting factor. There are indications that the seaweed industry is likely to expand in the coming decades.

Environmental management

Intensification may sustain the profitability of farming operations, but it does so at a cost. At times, it leads to farm management complications (especially with regard to water quality and health of culture animals). Also, concerns are often expressed about the environmental carrying capacity, which can be strained by increased numbers of farms and/or intensity of production systems. The production performance of the sector will depend on how well these issues are addressed.

Recent studies⁹ indicate that the output of nitrates and phosphates from aquaculture can be considered insignificant in terms of their contributions to nutrient loading in most regions of the world, although they may have local impacts on eutrophication and algal blooms. Great strides have been made over the past decade in mitigating nutrient and organic inputs from aquaculture. Notable advances and innovation in automated feeding technology have significantly reduced feed input while maintaining productivity and improving economic efficiency. These developments have been strengthened by the increased use of fallowing by fish farmers. Farmer and consumer associations, civil society and institutional buyers such as supermarket chains and other key stakeholder groups are actively promoting the development of standards and codes aimed at ensuring an environmentally and socially responsible aquaculture. Such improvements have been noticeable worldwide for a number of commodities, particularly salmon. They are likely to continue contributing to improving aquaculture's public image, thereby giving production an upward push.

Rising energy costs

Even before the current global energy crisis, energy costs represented an important share of the production costs in many commercial aquaculture operations. With further intensification and the use of more sophisticated technologies, it is likely that more energy will be needed, thereby exacerbating the energy cost problem. As for land and water, aquaculture must compete with other activities for energy. To alleviate this problem, researchers around the world are seeking low-cost energy sources. More efficient pumps have been suggested as one of the options. Another is the use of recirculating systems. While recirculation requires energy, it does not need water pumped from lower levels and so is energy-efficient. Wind-powered pumps are being used on a limited scale in freshwater aquaculture in many countries, but their capital cost is high. The inability to design a low-cost high-volume pump for saltwater shrimp farming has also restricted their use. Solar-powered pumps present the same difficulties.

In addition to seeking alternative sources, farmers are developing strategies and practices to reduce energy requirements. In certain culture practices, energy costs for pumping could be minimized with the combined use of bioremediation and low-discharge, or even zero-discharge, techniques. However, more research on these techniques is required.

Human resources development

Human resources development is pivotal to the future of aquaculture. The success of the sector will depend on whether progress in building the human capacity of the public and private sectors can keep pace with new developments in technology, international trade and legislation. Although this has been the subject of repeated debate in the past few decades, the need for human capacity to face the challenge of producing aquatic food to meet future demand is likely to remain an important issue in the next decade. Related issues, many of which are beyond the control of the aquaculture sector, include the so-called “brain drain”, or migration of trained personnel from developing to developed countries, and the loss of human and social capital because of the effects of HIV and AIDS in many parts of the world, particularly in Africa. Natural disasters, such as the 2004 Asian Tsunami, also often result in heavy destruction of human capacity. These factors could still affect aquaculture for the foreseeable future.

Research and development

As aquaculture continues to feel the pressure to expand, research and development will be key. Research faces the challenge of providing policy-makers and practitioners with cutting-edge knowledge and innovations, ranging from genetic improvement of farmed fish to sophisticated cage designs for fish culture in offshore sites and improved feed, health and environmental management. Aquaculture development has been hampered, however, by three factors relating to the fundamental requirements of research and development, namely insufficient funds, lack of core research staff and weak research infrastructure. This situation again explains the need for more investment in the development of human resources; human capacity stands out as imperative for sustainable aquaculture development. An increase in the quantity and quality of human resources is needed in the search for aquaculture opportunities. Successful human resources development should trigger the development of more efficient aquaculture-related technology, legislation and management.

Information and communication technologies and networking

Continuous dramatic advances in information and communications technologies are creating new opportunities for communication, imparting learning and sharing knowledge in a timely and cost-effective manner. The challenge for governments and other stakeholders in aquaculture development is to seize and apply these opportunities for the benefit of the sector.

Information exchange through networking is likely to play an important role in the development of the sector. Although FAO has so far not been successful in creating self-sustaining aquaculture networks, with the exception of NACA, possibilities for networking are being explored in several regions. A Network of Aquaculture Centres in Central–Eastern Europe (NACEE) has been established and is eventually expected to become independent. Such networks, particularly in Latin America and sub-Saharan Africa, could contribute to more rapid development of the sector. In line with the 1995 Kyoto Declaration,¹⁰ and the recommendations of the COFI Sub-Committee on Aquaculture, there is a need for governments and international aid agencies to consider supporting the establishment of these networks.

Access to markets

Growing national and international markets and the ability to trade in these markets will continue to have a strong influence on the growth of aquaculture. International trade of farmed fish has been progressively increasing over recent decades. This



expansion in trade has induced some countries to apply high import tariffs on fish and fishery products as a way of protecting domestic aquaculture industries against foreign competition.¹¹

With the progressive liberalization of trade, tariffs have been lowered in many instances. However, non-tariff barriers (including technical and non-technical) have emerged as the main obstacle to trade and market access for exports to developed countries.¹²

In particular, domestic producers in importing countries have increasingly accused those selling products in their national markets (i.e. the exporters in other countries) of dumping and/or of benefiting from subsidies. These complaints have occasionally led importing countries to implement concrete measures against such imports, including the introduction of minimum import prices and countervailing duties to compensate for the alleged dumping or subsidy. Such disputes are increasingly being brought to the WTO for resolution by the WTO Dispute Settlement Mechanism; examples have included farmed species such as shrimp and salmon. As the industry grows and more aquaculture products move into international trade, the competition for market shares will become stiffer and an increasing number of such accusations and disputes can be expected.

Access to export markets has also become complicated by the need to comply with regulations concerning product quality and safety requirements on the part of importing countries (see pp. 136–143). It seems likely that market access could be improved through the development of certification systems for food safety and quality. Lack of compliance with these standards and regulations could have a serious impact on international trading of aquaculture products from developing countries. As a consequence, farmers, particularly the small-scale operators, are forming small associations or clusters and making efforts to implement better management practices and improve self-regulation. They view this as a means of both responding to demands for compliance with international trading standards and of increasing profits and minimizing production losses.

Given the significant contribution of developing countries to global aquaculture production, growing protectionism in developed countries would, of course, reduce aquaculture production in the developing world and thereby reduce the likelihood that aquaculture would be able to maintain the per capita supply of fish at its current levels. The impact of increased protectionism would be felt most keenly by small producers, who may not be able to bear the high costs of compliance – at least for internationally produced commodities – and who could eventually be pushed out of business.

In light of this situation, it seems that market diversification is likely to play an important role. The development of niche markets, such as for organic aquaculture products or aquaculture ecolabels, will go hand in hand with aquaculture of both established and novel species and products. Further liberalization of fish trade under new multilateral and/or bilateral agreements could provide new opportunities for the expansion of the aquaculture sector.

Additionally, in many developing countries, particularly in Asia, domestic aquaculture industries compete with imports for the domestic market shares of final products. In an attempt to overcome this problem, aquaculture producers and processors are slowly moving towards the development of processed products for both national and export markets. This value-addition strategy is an avenue for improving the profitability of aquaculture enterprises. There is also a trend towards targeting local urban markets with standardized, value-added “easy-to-cook” or “supermarket-type” products. As competition for markets increases, these trends are likely to grow and intensify.

Sound policies and governance

Good governance, including political stability, has a major influence on aquaculture development at all scales. It reduces the costs of doing business, attracts investment into the sector and enhances the industry’s competitiveness both at home and globally.

Macroeconomic policies – such as fiscal policies, access to human resources and skills, and technology – play a similar, and equally important, role. Increased participation of stakeholders in the governance of the sector will become more important. Greater aquaculture sustainability will be achieved through the strengthening of farmer associations and by self-regulation in the aquaculture industry.

In many countries, there is no legislation specifically for aquaculture. Instead the sector is governed by a multiplicity of ad hoc laws, often subject to different interpretations. Where this is the case, sound governance means providing the sector with an “aquaculture legal act”. Such acts do exist and it seems likely that during the coming decade public administrations will customize them to meet the needs of their particular countries, reflecting their varying levels of aquaculture development.

In countries with incipient aquaculture industries, governments are going to need to invest substantial sums in building institutions and establishing governance arrangements for aquaculture, in particular for industrial, export-oriented aquaculture ventures. As law enforcement is a constraint in many countries, strong emphasis will be placed on increasing self-regulation through farmer associations and by the sector as a whole. Self-regulation is likely to grow and become a norm.

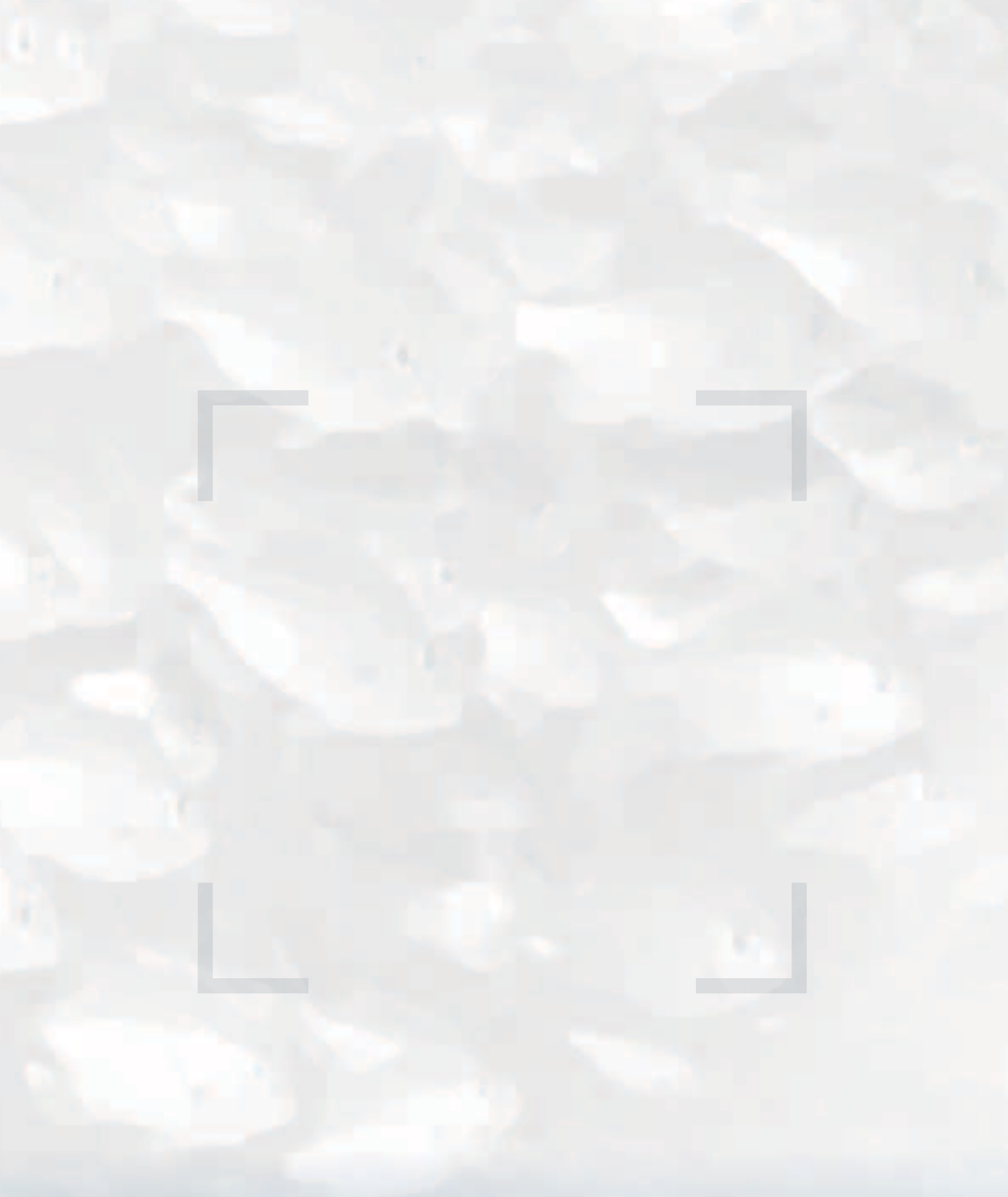
Government support

Generally, a government's commitment to provide increased support to the aquaculture sector is a prerequisite for the sector's sustainable development. The commitment takes the form of clear articulation of policies, plans and strategies and the availability of adequate funding support. The challenge, and a potentially constraining factor, is the level of commitment of governments, particularly those of developing countries. Will it falter and shift as new global economic opportunities arise and the competition for scarce financial and natural resources increases? While the level of commitment will vary within and among regions, depending on the importance of aquaculture in national economies and well-being, it is nonetheless expected that in countries where aquaculture contributes substantially, or is seen as a potential contributor, to growth, poverty alleviation and food security, the commitment will hold and the level of support increase.



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THE STATE OF WORLD FISHERIES AND AQUACULTURE

2006

Several decades ago, the efforts of public administrations were concentrated on developing fisheries and aquaculture and ensuring growth in production and consumption. Then, in the 1980s, as many resources became fully or overexploited, the attention of policy-makers began to focus instead on fisheries management, in addition to development of aquaculture. Subsequent recognition of the many failures in management have now led FAO member countries and other relevant stakeholders to broaden the approach and governance, that is, the sum of the legal, social, economic and political arrangements used to manage fisheries and aquaculture in a sustainable manner is currently seen as a necessary context for management and is becoming the main concern.

Aquaculture continues to expand, while marine capture fisheries – when summed together worldwide – seem to have reached a ceiling. Reflecting the growing importance of aquaculture, *The State of World Fisheries and Aquaculture 2006* ends with a discussion of the challenges that aquaculture is facing as well as of the opportunities that are open to the sector. The discussion is based on a prospective analysis of the aquaculture sector worldwide, which was undertaken by FAO in the past two years.

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