THE STATE OF WORLD FISHERIES AND AQUACULTURE

2002

Includes
World Fisheries and Aquaculture Atlas
CD-ROM

Editing, design, graphics and desktop publishing:
Editorial Group
FAO Information Division

ISBN 92-5-104842-8

ISSN 1020-5489

THE STATE OF WORLD FISHERIES AND AQUACULTURE

2002

FAO Fisheries Department

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2002

FOREWORD

During the past two years, the international fisheries community has achieved many important developments: the International Plan of Action on Illegal, Unregulated and Unreported fishing was adopted by FAO members during the first months of 2001; in October of the same year, the Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem called on the world community to promote an effective ecosystems framework for fisheries management; in November 2001, the World Trade Organization's (WTO's) Ministerial Conference in Doha paid special attention to fisheries subsidies and decided that participants in the next round of trade negotiations should aim to clarify and improve WTO disciplines on such subsidies, taking into account the importance of this sector to developing countries; at about the same time, the UN Fish Stocks Agreement came into force; and, in September 2002, the World Summit for Sustainable Development (WSSD) adopted a Plan of Implementation that is clearly focused on improving the sustainability of world fisheries. Aquaculture has received increasing attention during the past two years, as illustrated by the fact that the world's first inter-governmental body to specialize in this field, the Sub-Committee on Aquaculture of the FAO Committee on Fisheries, met in Beijing in the spring of 2002.

In many countries, these international developments have been accompanied by actions aimed at broadening and strengthening fisheries management for the purpose of achieving sustainable fisheries and aquaculture. However, results are slow to arrive, particularly in terms of rebuilding stocks or increasing fishers' incomes. This should be no surprise. Scientists have warned repeatedly that most heavily exploited stocks will take time to recover – if they can do so at all. Patience and perseverance are therefore essential, and fisheries management should foster such attitudes among all those concerned.

One of the important contributions of FAO in this regard is the biennial publication of The State of World Fisheries and Aquaculture (SOFIA), the purpose of which is to provide some of the knowledge required for understanding the fisheries sector.

As in the past, in Part 1 of SOFIA 2002 the situation in China is reported separately whenever doing otherwise might hide significant differences between developments in China and developments in the rest of the world. Part 2 highlights important issues, some of which are not new, such as the difficulty and importance of obtaining reliable fishery statistics and the plight of small-scale and artisanal fishers, while others have emerged more recently, including catch certification, antibiotics and aquaculture and an ecosystems framework for fisheries management. Part 3 contains reports on three studies that have been published recently by FAO. Part 4 reports on the findings of studies on future fish consumption and speculates about the future implications of the rising costs of capture fisheries.

It is the hope of FAO and its Fisheries Department that this new edition of SOFIA will prove to be a useful tool for facilitating a balanced and comprehensive understanding of the fisheries sector, particularly its international aspects.

Ichiro Nomura
Assistant Director-General
FAO Fisheries Department

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ACKNOWLEDGEMENTS

The State of World Fisheries and Aquaculture 2002 was prepared by FAO Fisheries Department staff, led by a team comprising U. Wijkström, A. Gumy and R. Grainger. General direction was provided by the Department's management staff, including: L. Ababouch; J. Csirke; S. Garcia; J. Jia; I. Nomura; B. Satia; J. Turner; and G. Valdimarsson.

The preparation of Part 1, World review of fisheries and aquaculture, was the overall editorial responsibility of R. Grainger assisted by D. Evans (consultant), who coordinated the contributions made by L. Garibaldi (production, capture fisheries); J. Csirke (marine resources); A. Crispoldi (fishers and fishing fleets); R. Metzner (fisheries management); D. Doulman (regional fisheries governance); R. Subasinghe (aquaculture); D.M. Bartley (inland fisheries); S. Vannuccini and G. Laurenti (consumption); S. Vannuccini (utilization and trade); and H. Josupeit (commodity trade).

Contributors to Part 2, Selected issues facing fishers and aquaculturists, included: K. Cochrane (implementing the ecosystem approach to capture fisheries management); D. Evans and R. Grainger (reliable statistics as an essential basis for fisheries management); A. Smith (catch certification and documentation); G. MacFadyean (consultant) (poverty alleviation in small-sale fishing communities); and H. Lupin, R. Subasinghe and D. Alderman (of the Centre for Environment, Fisheries and Aquaculture Science [CEFAS] UK) (antibiotic residues in aquaculture products).

Contributors to Part 3, Highlights of special FAO studies, included: J. Csirke (fisheries and long-term climate variability); the Fisheries Development Planning Service (the search for an operational definition of subsidies provided to the fisheries sector); U. Tietze (techno-economic performance of marine capture fisheries); and N. Hishamunda (aquaculture development in China: the role of public sector policies).

Part 4, Outlook, was written by C. de Young, R. Metzner and U. Wijkström.

Part 5, Fisheries activities of country groupings, was written by A. Gumy.

Several other staff members as well as non-FAO authors have contributed texts on specific issues, and they are cited in the relevant boxes throughout the publication. Information of relevance for all five parts has been provided by FAO staff in the Regional and Subregional Offices. S. Montanaro assisted with preparation of the figures and the tables.

The Editorial Group of the FAO Information Division was responsible for the editing, design and production of The State of World Fisheries and Aquaculture 2002.

Notes: Unless otherwise stated, the source of data for the figures is FAO. Data for China do not include Taiwan Province and Hong Kong and Macao Special Administrative Regions.

GLOSSARY

ACC
Administrative Committee on Coordination (UN)

ACP
African, Caribbean and Pacific Group of States (EC)

ADI
acceptable daily intake

AFFP
Arab Federation of Fish Producers

ASEAN
Association of Southeast Asian Nations

CAC
Codex Alimentarius Commission

CARICOM
Caribbean Community and Common Market

CCAMLR
Commission for the Conservation of Antarctic Living Resources

CCP
critical control point

CCSBT
Commission for the Conservation of Southern Bluefin Tuna

c&f
cost and freight

c.i.f.
cost, insurance, freight

CFRAMP
CARICOM Fisheries Resource Assessment and Management Program

CFP
Common Fisheries Policy (EC)

CIDA
Canadian International Development Agency

CIS
Commonwealth of Independent States

COFI
Committee on Fisheries (FAO)

CRFM
Caribbean Regional Fisheries Mechanism (CARICOM)

CWP
Coordinating Working Party on Fishery Statistics (inter-agency)

DANIDA
Danish International Development Agency

DWFN
Distant Water Fishing Nations

EAF
ecosystem approach to fisheries

EEA
European Economic Area

EC
European Community

ECOWAS
Economic Community of West African States

EEC
European Economic Community (superseded by EC)

EEZ
exclusive economic zone

EU
European Union

FFA
South Pacific Forum Fisheries Agency (ù

FIFG
Financial Instrument for Fisheries Guidance (EC)

FISHSTAT
Computer System for Global Fishery Statistical Time Series

f.o.b.
free on board

GLOBEFISH
Computerized System of Fish Marketing Information

GRT
gross registered ton

HACCP
Hazard Analysis and Critical Control Point (system)

HIPC
heavily-indebted poor countries

IACSD
Inter-agency Committee on Sustainable Development

IATTC
Inter-American Tropical Tuna Commission

IBSFC
International Baltic Sea Fishery Commission

ICCAT
International Commission for the Conservation of Atlantic Tunas

ICES
International Council for the Exploration of the Sea

ICFA
International Coalition of Fisheries Associations

ICLARM
International Centre for Living Aquatic Resources Management

IMF
International Monetary Fund

IMO
International Maritime Organization

IOC
Intergovernmental Oceanographic Commission

IOTC
Indian Ocean Tuna Commission

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

IUU
illegal, unreported and unregulated (fishing)

JECFA
Joint FAO/WHO Expert Committee on Food Additives

LAES
Latin American Economic System

LIFDC
low-income food-deficit country

MCS
monitoring, control and surveillance

MRL
maximum residue limit

MRLVD
maximum limit for residues of veterinary drugs (CAC)

NACA
Network of Aquaculture Centres in Asia-Pacific

NAFTA
North American Free Trade Agreement

NGO
non-governmental organization

NRC
National Research Council (United States)

OECD
Organisation for Economic Co-operation and Development

OIE
International Office of Epizootics

OLDEPESCA
Latin American Organization for Fisheries Development

PRSPs
Poverty Reduction Strategy Papers

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RFB
regional fishery body

RFMO
regional fisheries management organization

SAARC
South Asian Association for Regional Cooperation

SADC
Southern African Development Community

SEAFDEC
Southeast Asian Fisheries Development Centre

SEAFO
Southeast Atlantic Fisheries Organization

SFLP
Sustainable Fisheries Livelihoods Programme

SPF
South Pacific Forum

SPS
Sanitary and Phytosanitary Agreement (WTO)

TAC
total allowable catch

UNCED
United Nations Conference on Environment and Development

UNCLOS
United Nations Conference on the Law of the Sea

UNEP
United Nations Environment Programme

USFDA
United Stated Food and Drug Administration

VMS
Vessel Monitoring System

WECAFC
Western Central Atlantic Fisheries Commission

WHO
World Health Organization

WSSD
World Summit for Sustainable Development

WTO
World Trade Organization

Note: The data on food fish supply (total and per capita) presented for the world in the Overview section of Part 1 (Tables 1 and 2) differ from those presented in the Fish utilization section of Part 1 (Table 8) owing to different time frames. The source of the more detailed figures reported in the latter is the FAO Fisheries Circular No. 821, Rev. 6. [Laurenti, G. (comp.) 1961-1999. Fish and fishery products: world apparent consumption statistics based on food balance sheets], which was compiled using statistics held in the FAO fishery statistical database in August 2001. The world total data presented in the Overview (Tables 1 and 2) are based on more recent production figures of March 2002, which also incorporated historical revisions. The food fish supply data in Tables 1 and 2 are indicative and may be subject to further revision when the food balance sheets are updated.

PART 1
World review of fisheries and aquaculture

World review of fisheries and aquaculture

FISHERIES RESOURCES: TRENDS IN PRODUCTION, UTILIZATION AND TRADE

OVERVIEW

Global production from capture fisheries and aquaculture and the food fish supply is currently the highest on record and remains very significant for global food security, providing more than 15 percent of total animal protein supplies (Tables 1 and 2 and Figure 1). China remains by far the largest producer, with reported fishery production of 41.6 million tonnes in 2000 (17 million tonnes from capture fisheries and 24.6 million tonnes from aquaculture), providing an estimated food supply of 25 kg per capita. However, there are increasing indications that capture fishery and aquaculture production statistics for China may be too high as suggested by several academic studies, and that this problem has become more pronounced since the early 1990s. Because of its importance and the uncertainty about its production statistics, China is usually discussed separately from the rest of the world, as in the previous edition of this document.

Outside China, the world's population has been increasing more quickly than the total food fish supply from production, resulting in a decreased global per capita fish supply from 14.6 kg in 1987 to 13.1 kg in 2000 (Figure 2). This decrease has been unevenly distributed. In some countries and regions fish consumption has decreased, while in others the supply has remained relatively static or has even increased slightly.

In 2000, reported global capture fisheries for the world excluding China returned to the level of the early 1990s, reaching about 77 to 78 million tonnes. This followed the oscillations of the 1994–1998 period, which were caused by the influence of El Niño on the catches of Peruvian anchoveta. There have been some recent relative gains from other regions, particularly Asian inland waters, the Indian Ocean and the West Central Pacific. In some areas, there have been declines from the 1998 figures, particularly in the North Pacific.

This generally stable situation for global catches masks regional disparities. In the Northwest Pacific, reported total catches have doubled from about 12 million tonnes in 1970 to 23 million tonnes in 2000. China began the 1970s with about 20 percent of this catch, but by 2000 its share had risen to more than 60 percent. The rapid rise in China's reported production, particularly the 2.5-fold increase of its catch to nearly 17 million tonnes since 1990, is in marked contrast to the almost halving of other countries' catch from this region, which dropped to less than 9 million tonnes over the same period.

Unlike capture fisheries, aquaculture production has continued to increase markedly. Excluding China, world aquaculture production (other than aquatic plants) exhibited a somewhat lower average annual growth rate (5.3 percent) in the 1990s than it did in the 1980s (7.1 percent). It is believed that aquaculture potential still exists in many areas and for many species.

Employment in the primary capture fisheries and aquaculture production sectors has remained relatively stable since 1995, and was estimated to be about 35 million people in 2000. Of this total, 65 percent were in marine capture fisheries, 15 percent in inland capture fisheries and 20 percent in aquaculture production.

International trade in fish products has again increased to a new record of US$55.2 billion, continuing the last decade's underlying 4 percent annual growth in fisheries trade. Net export trade from developing countries increased from US$10 billion in 1990 to US$18 billion in 2000, corresponding to a real (corrected for inflation) growth of 45 percent.

Global forecasts of upper limits to capture fisheries, which have been made since the early 1970s, are being increasingly substantiated by the evidence of recent years. There are continuing global concerns about the reliability of statistics (see Box 1 and Reliable statistics as an essential basis for effective fisheries management, Part 2, p. 59) and that the pace and direction of fisheries

TABLE 1
World fisheries production and utilization

	1996	1997	1998	1999	2000	2001*
	(million tonnes)					
PRODUCTION						
INLAND						
Capture	7.4	7.5	8.0	8.5	8.8	8.8
Aquaculture	15.9	17.5	18.5	20.1	21.4	22.4
Total inland	**23.3**	**25.0**	**26.5**	**28.6**	**30.2**	**31.2**
MARINE						
Capture	86.1	86.4	79.3	84.7	86.0	82.5
Aquaculture	10.8	11.1	12.0	13.3	14.2	15.1
Total marine	**96.9**	**97.5**	**91.3**	**98.0**	**100.2**	**97.6**
Total capture	93.5	93.9	87.3	93.2	94.8	91.3
Total aquaculture	26.7	28.6	30.5	33.4	35.6	37.5
Total world fisheries	**120.2**	**122.5**	**117.8**	**126.6**	**130.4**	**128.8**
UTILIZATION						
Human consumption	88.0	90.8	92.7	94.4	96.7	99.4
Non-food uses	32.2	31.7	25.1	32.2	33.7	29.4
Population (billions)	5.7	5.8	5.9	6.0	6.1	6.1
Per capita food fish supply (kg)	15.3	15.6	15.7	15.8	16.0	16.2

Excluding aquatic plants.
*** Preliminary estimate.**

TABLE 2
Fisheries production and utilization for the world excluding China

	1996	1997	1998	1999	2000	2001*
	(million tonnes)					
PRODUCTION						
INLAND						
Capture	5.7	5.7	5.8	6.2	6.6	6.6
Aquaculture	4.9	5.1	5.2	5.9	6.3	6.5
Total inland	**10.6**	**10.8**	**11.0**	**12.1**	**12.9**	**13.1**
MARINE						
Capture	73.6	72.5	64.3	69.8	71.3	67.9
Aquaculture	4.1	4.2	4.5	4.7	4.7	5.0
Total marine	**77.7**	**76.7**	**68.8**	**74.5**	**76.0**	**72.9**
Total capture	79.3	78.2	70.1	76.0	77.9	74.5
Total aquaculture	9.0	9.3	9.7	10.6	11.0	11.5
Total Production	**88.3**	**87.5**	**79.8**	**86.6**	**88.9**	**86.0**
UTILIZATION						
Human consumption	60.4	61.5	61.3	61.9	63.0	65.1
Non-food uses	27.9	26.0	18.5	24.7	25.9	20.9
Population (billions)	4.5	4.6	4.7	4.7	4.8	4.9
Per capita food fish supply (kg)	13.3	13.4	13.1	13.1	13.1	13.3

Excluding aquatic plants.
*** Preliminary estimate.**

research and supporting information systems are falling behind the need to understand the relationships between fisheries and the environment and between fisheries management and development. Owing to the understanding that fishing overcapacity and the global reach of fishing operations continue to have deleterious effects on fish stocks, it is becoming more widely recognized that long-term fisheries management and investment need to take into account the environment and natural long-term climatic fluctuations (see Fisheries and long-term climate variability, Part 3, p. 87), including episodic events such as El Niño. Although research is under way on some of these issues, including the nature and extent of human-induced effects on the climate, there remain areas of concern that require new commitments and methodologies. For example, the frequent lack of basic data on subsistence and small-scale fisheries, such as those in many inland waters, contributes to failures in management and policy-making directed at preventing overexploitation, stock decline and exacerbations to rural food insecurity and poverty.

Marine fisheries governance and the prospect of improved fisheries management are gathering pace as fisheries in a growing number of ocean areas come under the purview of regional fisheries management organizations (RFMOs), and as these are being held to greater accountability by the international community. However, progress in some regions and in many national jurisdictions has been weak. In inland waters, important fisheries in large rivers and lakes often suffer from ineffective governance. Inland regional fishery bodies, when they exist, tend to be mostly advisory and have no management powers. In most cases, inland fisheries are subject only to national jurisdictions even though the pressures of population growth will be most felt in tropical inland fisheries, where they will take the form of growing fishing effort. It seems plausible that, in the long term, fish supplies will meet demand only if real prices for fish are raised slightly. This assumes that aquaculture will continue to grow, which presupposes that the environmental concerns relating to it will be addressed.

CAPTURE FISHERIES PRODUCTION

Total capture fisheries production in 2000

FIGURE 1
World capture fisheries and aquaculture production

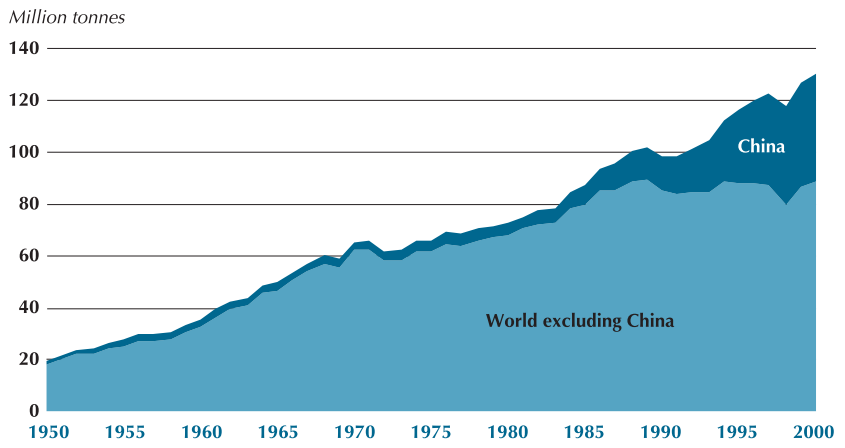
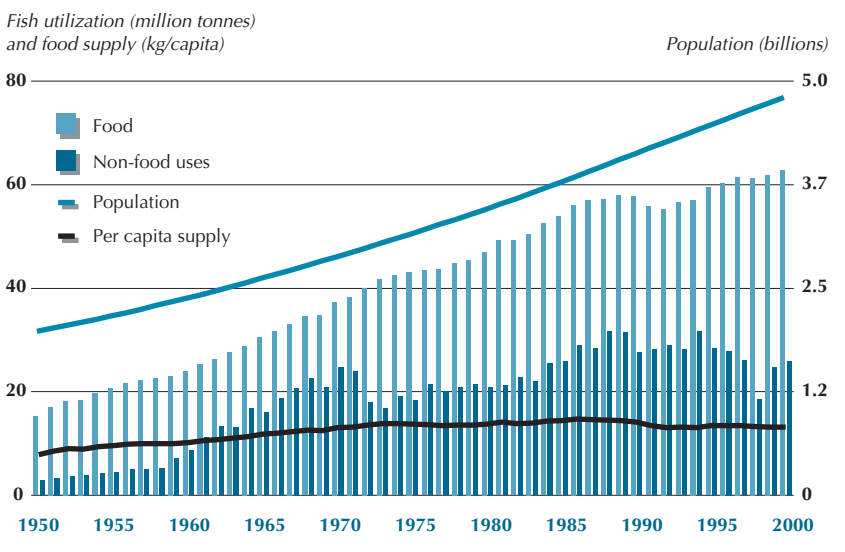


FIGURE 2
World fish utilization and supply, excluding China



BOX 1
FAO's role in fishery statistics

FAO is involved in:

1. promoting the collection and use of statistics;
2. producing statistical manuals and software;
3. training statistical officers;
4. developing/upgrading national statistics systems (recent examples include many African and Mediterranean countries);
5. facilitating global cooperation and establishing norms in fishery statistics (through the inter-agency Coordinating Working Party on Fishery Statistics);
6. collecting statistics from countries, regional fishery bodies, international shipping registers, fishing industry (e.g. marketing and trade data);
7. checking data received for internal consistency, species identification or anomalous trends;
8. consulting the countries concerned about anomalies;
9. publishing statistics on various aspects of fisheries in yearbooks and on the Web and receiving extensive feedback from users.

As a result, the statistics supplied to FAO by national authorities are routinely corrected when mistakes are obvious, better data are available from other sources (such as regional fishery bodies) or countries agree with FAO estimates. FAO interacts with countries to explore problems and try to resolve them, but this process is often slow. When countries do not respond to FAO enquiries, FAO estimates are automatically applied. Occasionally, when countries do not explain or support suspect statistics, those statistics are set aside and FAO estimates published instead. This action is sometimes seen as provocative, but often encourages corrective action by the country concerned. Many countries, including China, are working with FAO to try to address issues concerning the reliability of their fishery statistics.

National reports are the main, but not the only, source of data used by FAO to maintain its fishery statistics database. When data are missing or considered unreliable, FAO includes estimates based on the best information that is available from any source, such as regional fishery organizations, project documents, industry magazines or statistical interpolations. Fleet statistics that are submitted by countries are cross-checked with data from other sources, such as international shipping registers. The international trade statistics obtained from countries are supplemented through a comprehensive network of regional intergovernmental institutions created by FAO (the

Computerized System of Fish Marketing Information [GLOBEFISH]).

In the 1990s, FAO completely revised its fishery production statistics time series by computerizing them back to 1950, including estimates where data were missing, disaggregating data by fishing areas, taking political changes into account (e.g. the emergence of new countries), adjusting species identification as taxonomy evolves, and improving the differentiation between aquaculture and capture fisheries production. The resulting data sets are used in numerous analyses, both outside and within FAO, and are widely available on the Web (as the Computer System for Global Fish Catches [FishStat]).

FAO's global reviews of the state of stocks do not use catch statistics as a primary source of information because more direct indicators often exist. The primary information used is obtained directly from the working groups of FAO and non-FAO RFMOs and other formal arrangements, scientific literature (journals, theses, etc.) and industry magazines, as well as information that is independent of fisheries, such as trade data. Where RFMOs do not exist, such as in the Northwest Pacific, bilateral assessment processes (e.g. that among China, Japan and the Republic of Korea) can be used. Where data do not exist, such as on discards, estimates are made on a one-off basis by expert consultants or through dedicated expert consultations. If FAO has not yet been able to work effectively in an area (e.g. production from illegal fishing), there will be no global-level information for that area, although data will be available for certain fishing areas or certain years. FAO's catch statistics are global in coverage, have complete time series since 1950 and are regularly updated. These advantages mean that they can be used, when other data are lacking, to provide overview trends in fisheries by region, and resource status indicators.

Financial support for the development and maintenance of national fishery statistics systems has decreased sharply in real terms during the last decade. At the same time there have been dramatically increased needs for information on, for example, by-catch and discards, fishing capacity, illegal fishing, vessels authorized to fish in the high seas, economic data (expenditures, revenues, prices, subsidies), employment, management systems, inventories of stocks and fisheries, and aquaculture.

Despite FAO's efforts, the fishery data available are not fully reliable in terms of coverage, timeliness and quality. Data are often submitted to FAO after delays of one or two years. The proportion of catch to be identified at the individual species level has tended to decrease over time, while "unidentified fish" account for an increasing share of reported statistics as fisheries diversify and large stocks are depleted. Stock assessment working groups provide a good means of screening catch data, but stock assessment has become less frequent in many developing regions as a result of human and financial resource restrictions. The general availability of data has not improved significantly over the last two decades. Statistics from artisanal and subsistence fisheries are still a concern, and many key statistics are missing at the global level, such as economic and social data, discards and fishing capacity. As a result, although the available statistics probably do reflect general trends reliably – for example, global development trends or climatic changes (see Fisheries and long-term climate variability, Part 3, p. 87) – the annual figures and the assessments involve some uncertainty, and small changes from one year to another are probably not statistically significant.

The FAO Fisheries Department believes that working with countries is the only way to improve fishery statistics, primarily in order to meet national needs with regard to food security and fisheries management, but also to meet the needs of regional fishery bodies and FAO. Without reliable statistics, effective fisheries management and policy-making are impossible, and there will be serious negative implications at the national and regional levels. Unfortunately, the rehabilitation of major national data collection schemes to provide reliable statistics is necessarily a slow process.

Source: R. Grainger, FAO Fisheries Department.

reached 94.8 million tonnes (Table 1), the highest level ever. The estimated first sale value of this production amounted to some US$81 billion, a marginal increase over the value in 1998. Preliminary catch reports for 2001 from major fishing countries indicate that there may be a marked decrease in global capture production, to about 92 million tonnes. China's catches, which accounted for almost 20 percent of total world capture production in 1998, remained stable in 1999 and decreased marginally in 2000 following the adoption of a zero-growth policy (Figure 3 and Box 2). In 2000, total production from marine and inland capture fisheries for the world, excluding China (Table 2), was about 78 million tonnes, somewhat less than the peak of 83 million tonnes in 1989 but representing an increase from 70 million tonnes in 1998. Such recent changes have been heavily influenced by catches of Peruvian anchoveta, which are affected by environmental factors (i.e. El Niño).

China and Peru were the top producing countries in 2000, followed by Japan, the United States, Chile, Indonesia, the Russian Federation and India (Figure 4). Inland capture production for the world, excluding China, continues a gradually increasing trend; inland fisheries contributed 6.6 million tonnes in 2000, which was 8.3 percent of total world catches.

FIGURE 3
World capture fisheries production

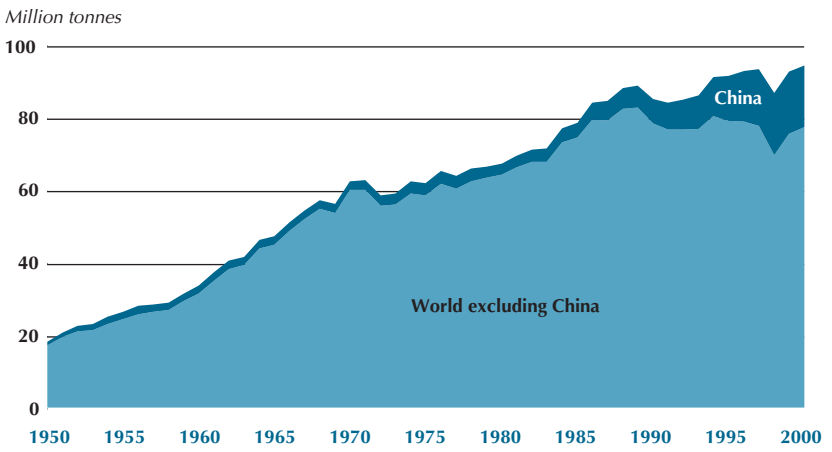
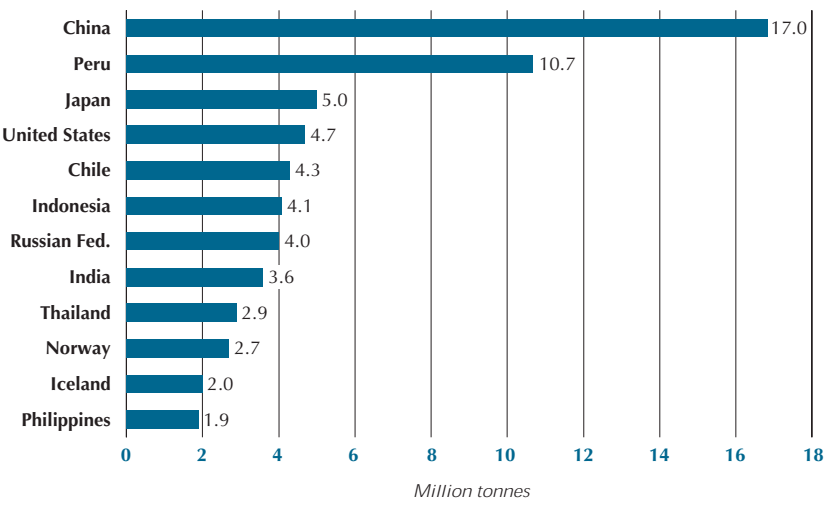


FIGURE 4
Marine and inland capture fisheries: top producer countries in 2000



World marine capture fisheries production increases in 1999 and 2000 came mainly from fisheries in the Southeast Pacific. Landings from these fisheries grew by 77 percent in 1999 and 12 percent in 2000, following a marked decrease of 44 percent between 1997 and 1998. Tropical ocean regions have also exhibited increases since 1998, particularly in the Indian Ocean and the Western Central Pacific, although small declines have been seen in the Eastern Central Atlantic (Figures 5 and 7). The temperate regions of the Southwest, the Northwest and the Northeast Pacific showed decreasing catch trends, but catches from the Northwest and Northeast Atlantic, where stock assessments generally yielded pessimistic results, increased slightly between 1999 and 2000. Most of these increases were due to scallops in the Northwest Atlantic and low-value pelagic species, such as capelin and blue whiting, in the Northeast Atlantic.

Catches of oceanic species have

BOX 2
China

China has made remarkable advances in fisheries production in recent years. Growth in its productive capacity, as indicated by reported estimates of marine and inland capture fisheries and aquaculture, far exceeds growth in fisheries elsewhere in the world. China has become the world's largest producer and consumer of food fish, achieving an apparent food fish consumption of 31.3 million tonnes in 1999 (Figure 9). During the past three decades, estimated per capita consumption based on reported production (which may well have been overestimated for the last decade) has increased from 4.4 kg in 1972 to 25.1 kg in 1999. Notwithstanding this increase, fish continues to contribute about 20 percent of total consumption of animal proteins, largely because of the continuing increase in other meat supplies. Since 1994, China has become the dominant fishing country in the Northwest Pacific, with catches in excess of 20 million tonnes.

As stated in the Overview (p. 3), there are indications that Chinese capture fishery and aquaculture production statistics have been overestimated, particularly in the last decade. Since 1998, a policy of zero growth has been declared for Chinese capture fisheries, and reported catches have reflected this (Figure 3). However, reported aquaculture production has continued to grow very rapidly (Figure 18), particularly for freshwater species. This matter was considered at a national workshop on Chinese fishery statistics, held in conjunction with FAO in April 2001. Estimation of the food fish supply is complicated by uncertainties concerning the production statistics and the quantities of fish utilized for non-food uses, such as direct feed to aquaculture, which are reckoned to be very substantial indeed. A further complicating factor is that trends in apparent fish consumption as derived from FAO's food balance sheets are not directly comparable with those from the Chinese National Statistical Bureau's household food consumption surveys. This is because the latter do not cover fish consumed outside the home (e.g. in restaurants and work canteens), which is considered to be a large and growing proportion of fish consumption. The Chinese authorities are working in collaboration with FAO to reduce many of these uncertainties.

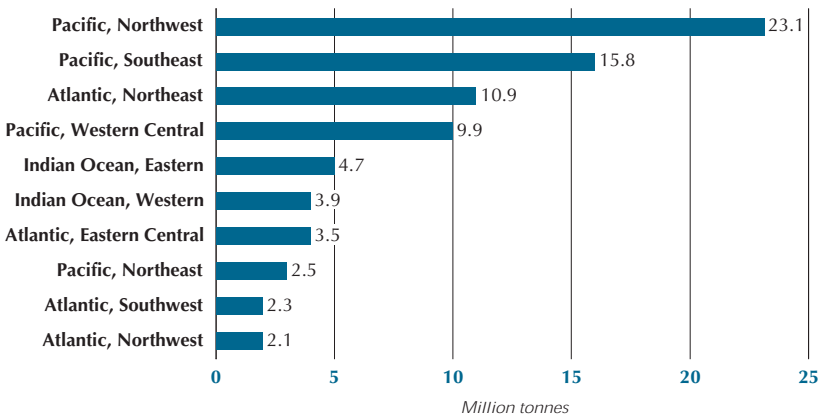
been steadily increasing over recent decades, indicating increasing fishing activity on the high seas (see Box 3). In 2000, the recovery of favourable climatic conditions after the recent El Niño led to anchoveta producing the largest single species catch (Figure 6). Catches of Clupeoids (i.e. herrings, sardines and anchovies) in other areas have shown declines recently, except in the Eastern Central Pacific and the Southeast Atlantic, where they benefited from the return of their upwelling regimes. Chilean jack mackerel, another major small pelagic species caught in the Southeast Pacific, slightly recovered in 2000 after general catch declines since 1995. In the same area, landings of chub mackerel increased in 1999 and then dropped again in 2000, at variance with the general picture of ecosystem recovery in that area.

The negative trend of chub mackerel production in the Northwest Pacific continues, and catch has halved since 1996. In the Gadiformes group (i.e. cods, hakes, haddocks, etc.), world catches of Alaska pollock and cod are still declining, and the only major species to increase are capelin and blue whiting, a deep sea species.

In 2000, catches of the valuable tuna species remained steady compared with 1998, after a peak of about 6 million tonnes in 1999. Catches of the other major fish groups in 2000 were also fairly stable with respect to 1998.

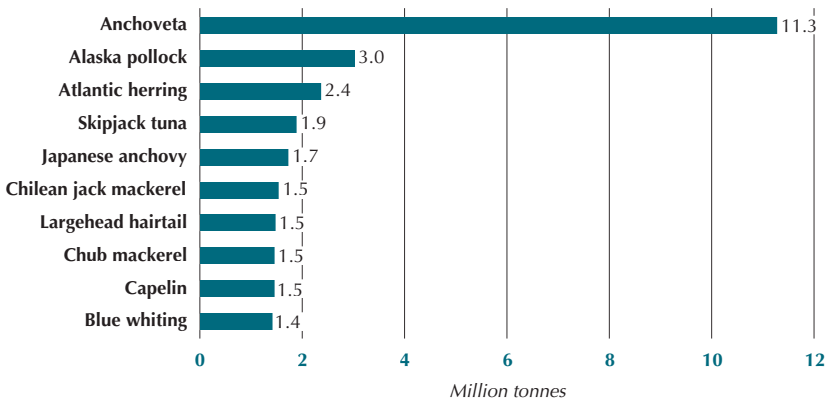
There have been general increases in cephalopod and shrimp catches. Cephalopod catches fell in 1998 but then rose in 1999, reaching a new record of 3.6 million tonnes in 2000. Catches of shrimp have been steadily increasing by an average 3.5 percent per year since 1970, and this growth has shown no signs of slackening in recent years.

FIGURE 5
Capture fisheries production by principal marine fishing areas in 2000



Note: Fishing areas listed are those with a production volume of more than 2 million tonnes in 2000.

FIGURE 6
Capture fisheries production: top species in 2000



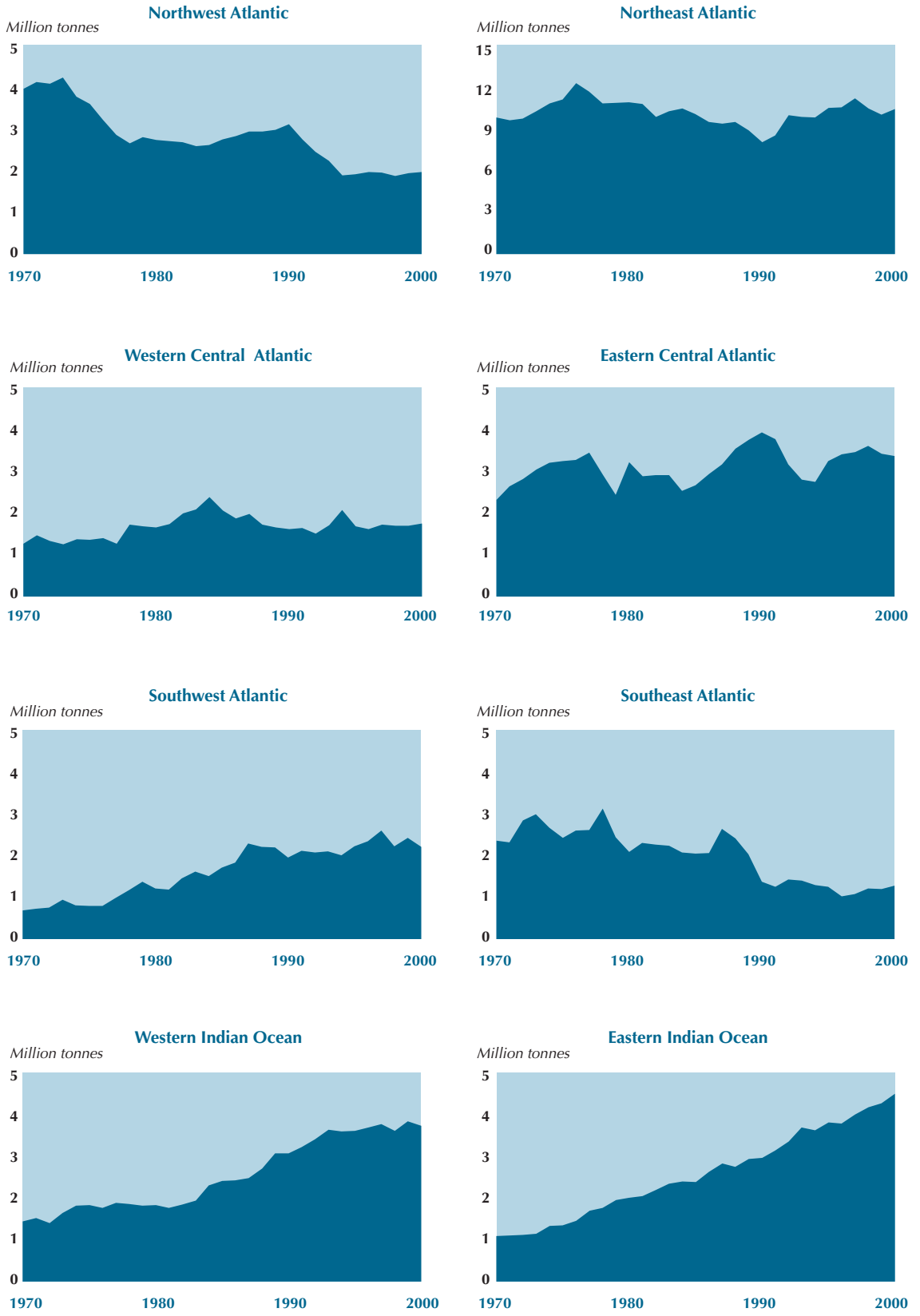
Note: Species listed are those with a production volume of more than 1 million tonnes in 2000.

Several of the species in Figure 6 are widely used as raw material in reduction to meal and oil, and are of low commercial value (species used as input for meal in 2000 were worth an average US$50 to $150 per tonne). In value terms, the most important species caught in 2000 included bigeye tuna (world catches were worth an estimated US$3 billion), yellowfin tuna (US$2 billion), skipjack tuna and Atlantic cod (more than US$1 billion each).

Total fish capture in inland waters in 2000 was about 0.8 million tonnes more than in 1998 (Table 1). Most of the global total came from the catches of Asia and Africa (about 64 and 25 percent, respectively), which have continued to grow in recent years. Those of Europe, North America, South America and Oceania have remained relatively stable. The top ten producing countries account for 64 percent of world inland water production, although China's share decreased from 28 percent in 1998 to 25 percent in 2000 (Figure 8). The bulk of the inland water catches (Table 3) is from developing countries where, in most cases, inland fisheries provide an important source of animal proteins. In most developed countries, fishing in freshwater has become mainly a recreational activity, and commercial inland food fisheries are very limited, except in some large lakes.

Many countries experience significant difficulties in collecting statistics on inland water fisheries. Among the main reasons for this are the scattered characteristics of these fisheries, their unrecorded contribution to subsistence and the lack of related fishery industries. The importance and size of these fisheries may be misrepresented in national and international statistics. In recent years, however, some countries have been revising their inland fishery

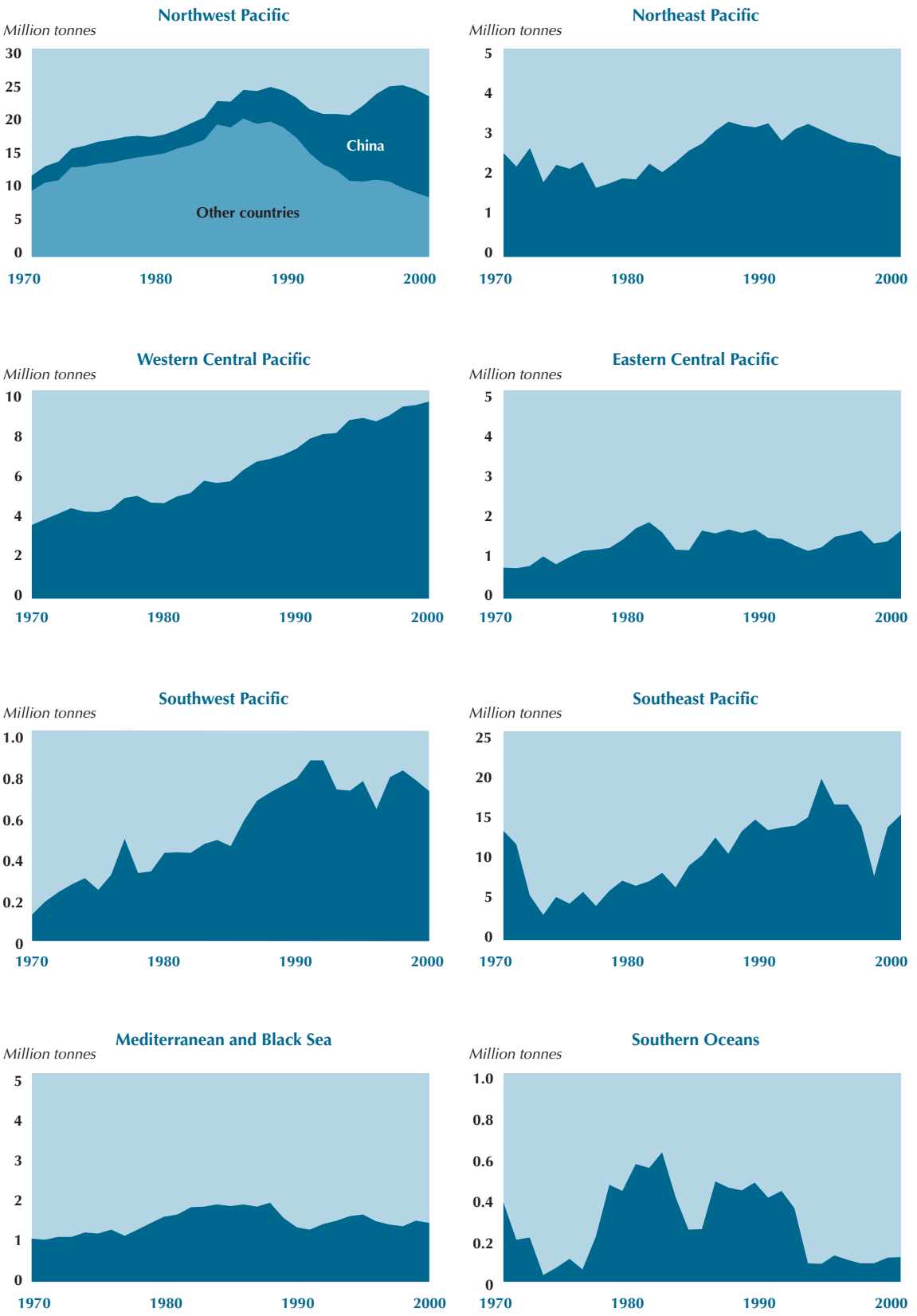
FIGURE 7
Capture fisheries production in marine areas



Note: The scales used vary from area to area.

(Continuing)

FIGURE 7 (continued)
Capture fisheries production in marine areas



Note: The scales used vary from area to area.

statistics through new data collection systems or through the parallel surveys of projects or national institutions whose catch estimates differ greatly from those reported by national statistical offices. This uncertainty over the accuracy of data is one of the factors that make fishery assessment difficult, but FAO and other international agencies are actively working with national institutions to improve the situation.

TABLE 3
Inland capture fishery production by economic class

Economic class	Production in 2000 (million tonnes)	Percentage of world production
China	2.23	25.4
Other developing countries or areas	5.93	67.4
Economies in transition	0.41	4.6
Industrial countries	0.23	2.6
Total	**8.80**	

FISHERS AND FISH FARMERS

In line with the increase in fishery production, over the last three decades employment in fisheries and aquaculture has continued to increase in many countries. In 2000, an estimated 35 million people (Figure 12) were directly engaged in fishing and fish farming as a full-time or – more frequently – part-time occupation, compared with 28 million a decade before.

The highest numbers of fishers and aquaculture workers (Table 4) are in Asia (85 percent of the world total) followed by Africa (7 percent), Europe, South America, North and Central America (about 2 percent each) and Oceania (0.2 percent). These shares closely reflect the different population shares and relative predominance of labour-intensive economies in the continents.

In 2000, fishers and aquaculture workers

BOX 3
Trends in high seas fisheries

In 1976, states began to declare extended fisheries jurisdictions, such as exclusive economic zones (EEZs), in anticipation of international acceptance of this concept. Such acceptance was obtained in 1982 in the United Nations Convention on the Law of the Sea. Since the mid-1970s, a large number of fishing nations have declared EEZs of 200 nautical miles, and high seas fisheries has come to mean fishing that is undertaken outside the EEZs – generally more than 200 nautical miles from the coast.

It is difficult to assess the development of fishing on the high seas because reports to FAO of marine catches make no distinction between those taken within EEZs and those taken on the high seas. Analyses of the FAO catch database of 116 oceanic species items (epipelagic and deep water species that occur principally on the high seas) reveal that catches of oceanic species almost tripled from 3 million tonnes in 1976 to 8.5 million tonnes in 2000 (Figure 10). As some of these species, particularly the oceanic tunas, are also caught within EEZs, this increase may well be more rapid than that of high seas catches per se.

The marked increase in catches of oceanic species is also reflected in the world trade in oceanic species. Import and export quantities in product weight rose from 0.5 million tonnes to almost 2.5 million tonnes over the 1976–2000 period (Figure 11). Faced with increasing evidence of overfishing on the high seas, efforts to manage high seas fisheries also accelerated over that period, and are continuing today with the development of new RFMOs and the revitalization of existing organizations (see International fisheries policy and governance, p. 45).

FIGURE 8
Inland capture fisheries production: top ten producer countries in 2000

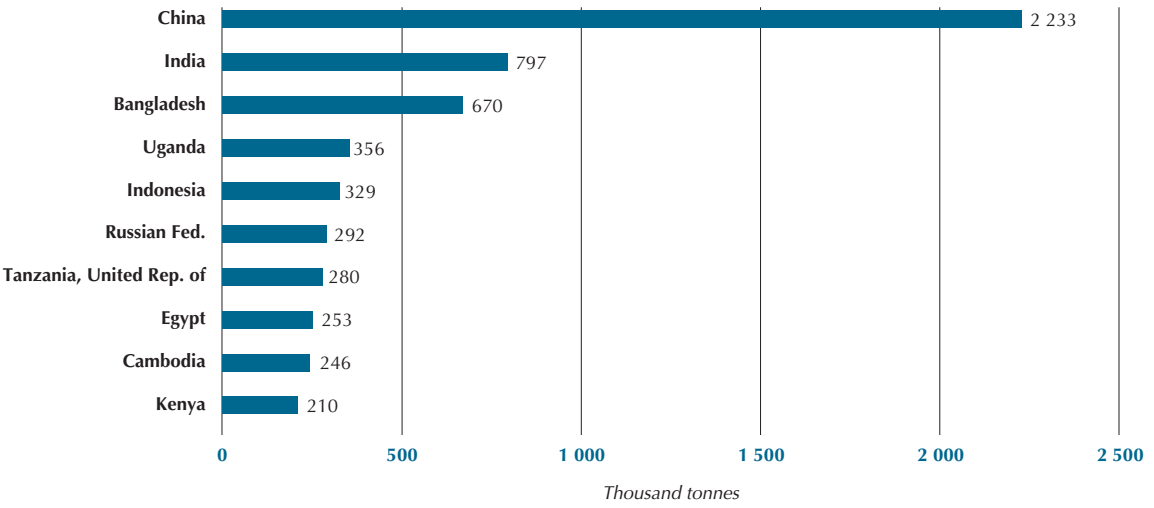


FIGURE 9
China's fish utilization and supply

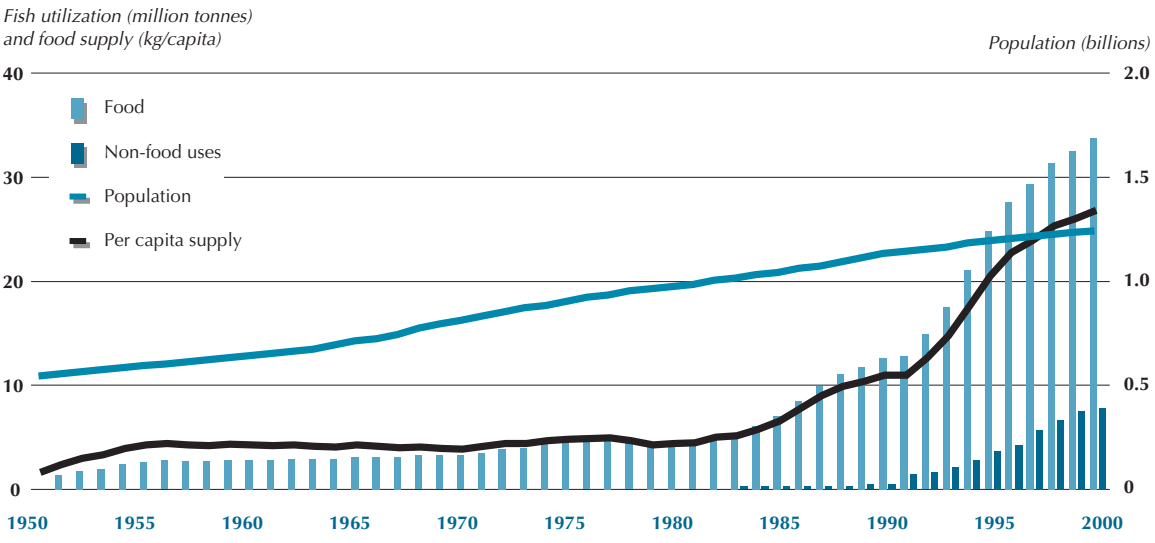


FIGURE 10
World catches of oceanic species (epipelagic and deep water) occurring principally in high seas areas

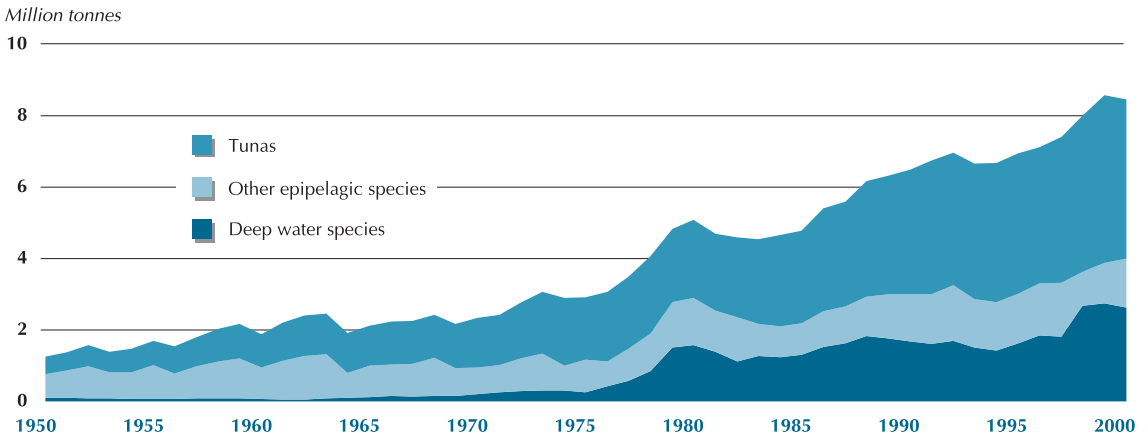


FIGURE 11
World trade in oceanic species

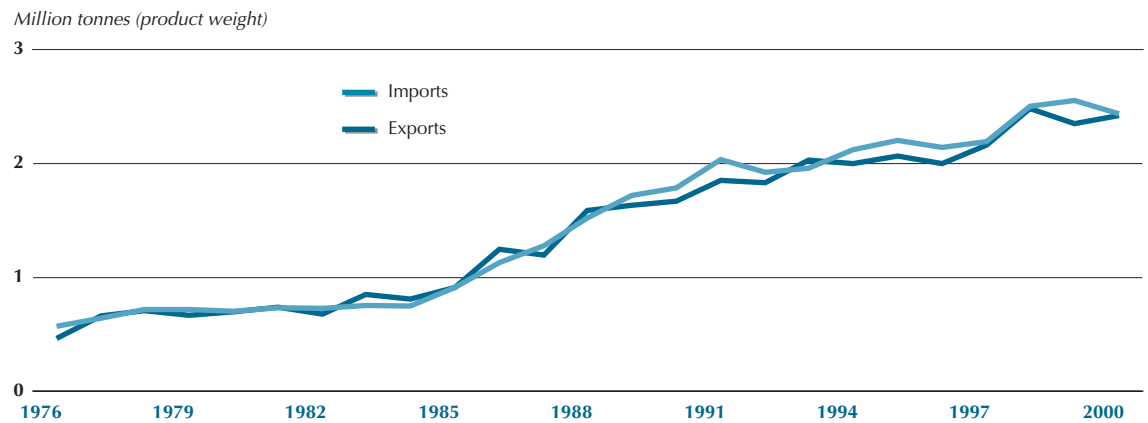
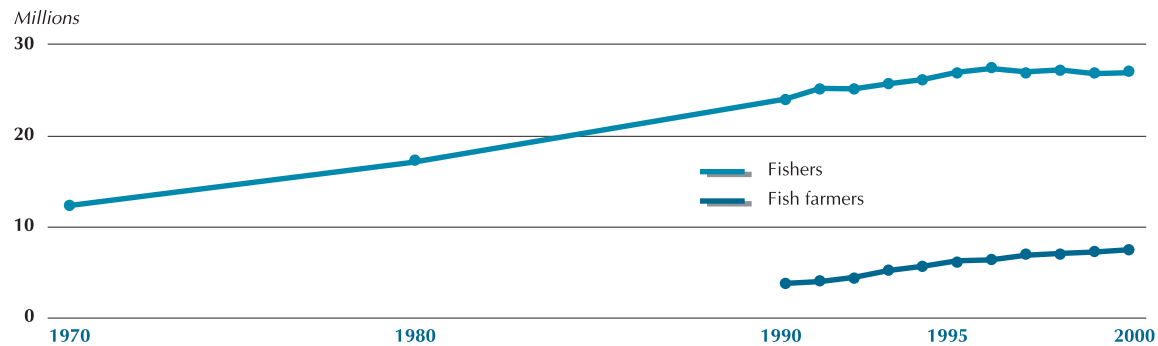


FIGURE 12
World fishers and fish farmers



Note: Prior to 1990 fish farmers are included with fishers. Data include full-time, part-time and occasional workers.

TABLE 4
World fishers and fish farmers by continent

	1970	1980	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(..... thousands .....)												
Total													
Africa	1 360	1 553	1 917	2 092	1 757	2 032	2 070	2 238	2 359	2 357	2 453	2 491	2 585
North and Central America	408	547	767	755	757	777	777	770	776	782	786	788	751
South America	492	543	769	738	763	874	810	814	802	805	798	782	784
Asia	9 301	13 690	23 656	24 707	25 423	26 342	27 317	28 552	28 964	29 136	29 458	29 160	29 509
Europe	682	642	654	928	914	901	881	864	870	837	835	858	821
Oceania	42	62	74	77	79	80	74	76	77	78	82	82	86
World	**12 285**	**17 036**	**27 837**	**29 297**	**29 691**	**31 005**	**31 928**	**33 314**	**33 847**	**33 995**	**34 411**	**34 163**	**34 536**
Of which fish farmers													
Africa*	...	...	...	...	...	5	6	14	62	55	56	57	75
North and Central America	...	...	53	73	101	206	206	176	182	185	191	190	190
South America	...	...	16	15	15	20	30	43	44	42	41	42	41
Asia	...	...	3 698	3 882	4 292	4 927	5 389	6 003	6 051	6 569	6 758	6 930	7 132
Europe	...	...	11	12	13	23	26	18	23	25	25	26	27
Oceania	...	...	neg.	neg.	neg.	neg.	1	1	4	5	5	5	5
World	**...**	**...**	**3 778**	**3 983**	**4 423**	**5 182**	**5 657**	**6 254**	**6 366**	**6 880**	**7 075**	**7 249**	**7 470**

***Data for 1993–1995 are not comparable with those for the following years and were reported by only a limited number of countries.**
neg. = negligible.

represented 2.6 percent of the 1.3 billion people economically active in agriculture worldwide, compared with 2.3 percent in 1990. This world average is reflected in most continents, except for Africa, where the percentage of fishing and aquaculture workers is a low 1.3 percent of the total agriculture labour force, and North and Central America, where the share is 1 percent higher than the world average.

Within the total of 35 million people, the number of fishers has been growing at an average rate of 2.2 percent per annum since 1990, while aquaculture workers have increased by an annual average of about 7 percent; these apparent increases are in part a result of better reporting. Most of the growth of employment in fish farming and other culture practices has occurred in Asia, particularly in China, where the reported number of people engaging in cultivation of aquatic life has doubled in the past decade. Greater economic opportunities derive from the commercial aquaculture production sector; for instance, in 1999 the average annual income of Japanese households engaged in aquaculture was nearly twice as much as that of households engaged in coastal fishing. While the households engaged in aquaculture derived an average 64 percent of their income from aquaculture-related activities, fishing-related activities accounted for an average 38 percent of the income of fishing households.

Employment in fishing is decreasing in capital-

intensive economies, notably in most European countries and in Japan. For instance, in Norway employment in the fishery sector has been declining for several years (Table 5). In 1990 about 27 500 people were employed in fishing (excluding fish farming), but this number had declined by 27 percent to 20 100 in 2000. In Japan over the last decade, the numbers of marine fishery workers peaked in 1991 and has been falling ever since to reach a low of 260 000 people in 2000. Of these, about 85 percent were employed in coastal fishery operations, while offshore and pelagic fisheries employed the remaining 15 percent. The vast majority (75 percent) of fishers were self-employed workers, confirming this special feature of the fishery professions. The self-employment rate among men was 70 percent, while among women it was considerably higher at 94 percent.

A characteristic of the fishing workforce in developed economies is the advancing of its age profile, mainly resulting from the profession's decreasing attractiveness to younger generations. For instance, in 2000 in Japan, nearly 32 percent of male marine fishers (who made up 83 percent of the total) were more than 60 years of age. This was an increase of 3 percentage points on the previous year and 18 percentage points on 1980 (14 percent). Comparatively, workers under 25 years of age represented nearly 8 percent of the nearly 398 000 total for male workers in the late 1970s and only 2.7 percent of the 216 100 male workers in 2000.

In countries where fishing and aquaculture are less prominent in the economy, comparative employment and income statistics at this level of detail are often not available. In many developing countries, the largest number of fishers, their spouses and families are occupied in coastal artisanal fisheries and associated activities. The socio-economic importance of these activities is more difficult to measure, but is undeniable, in terms not only of contribution to production and income but also of food security for the coastal communities.

THE STATUS OF THE FISHING FLEET

The most recent FAO estimate indicated that, in 1998, the total world fleet engaged in fishing comprised about 1.3 million decked vessels and

TABLE 5
Number of fishers (including fish farmers) in selected countries

Country	Sex		1970	1980	1990	2000
WORLD	M and F	(number)	**12 284 678**	**17 036 307**	**27 835 441**	**34 535 653**
		(index)	**44**	**61**	**100**	**124**
China	M and F	(number)	2 300 000	2 950 344	9 092 926	12 233 128
		(index)	25	32	100	135
Indonesia	M and F	(number)	841 627	2 231 515	3 617 586	5 118 571
		(index)	23	62	100	141
Japan	M	(number)	437 900	376 900	303 400	216 110
	F	(number)	111 500	80 500	67 200	44 090
		(index)	148	123	100	70
Peru*	M and F	(number)	49 824	49 503	43 750	55 061
		(index)	114	113	100	125
Norway	M	(number)	43 018	34 789	30 017	23 026
	F	(number)	…	…	690	526
		(index)	156	126	100	77
Iceland	M	(number)	4 895	5 946	6 551	5 300
	F	(number)	…	…	400	800
		(index)	70	86	100	88

Index: 1990 = 100.
***Data for Peru exclude inland fishers and fish farmers.**

FIGURE 13
Numbers of decked fishing vessels by continent

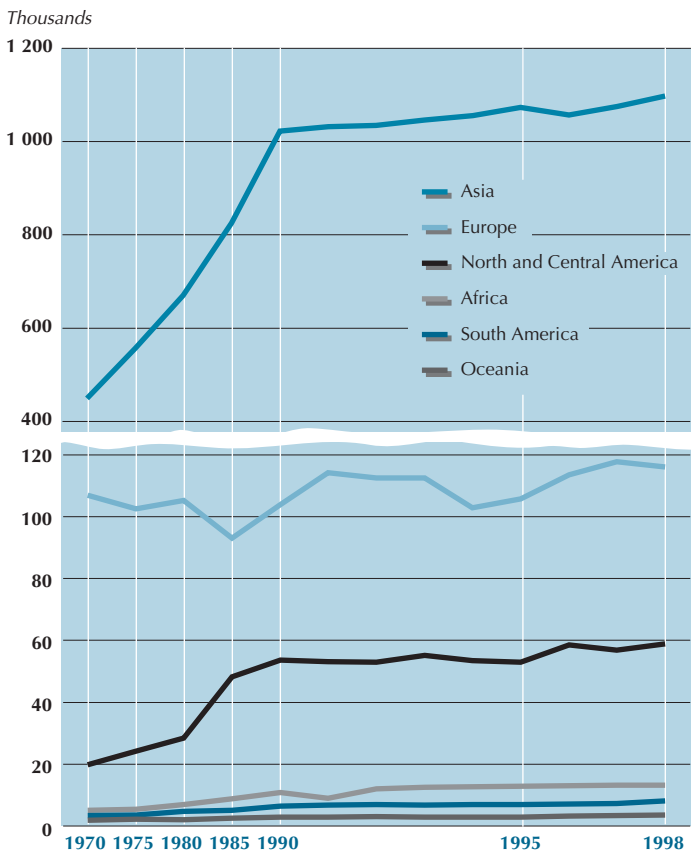
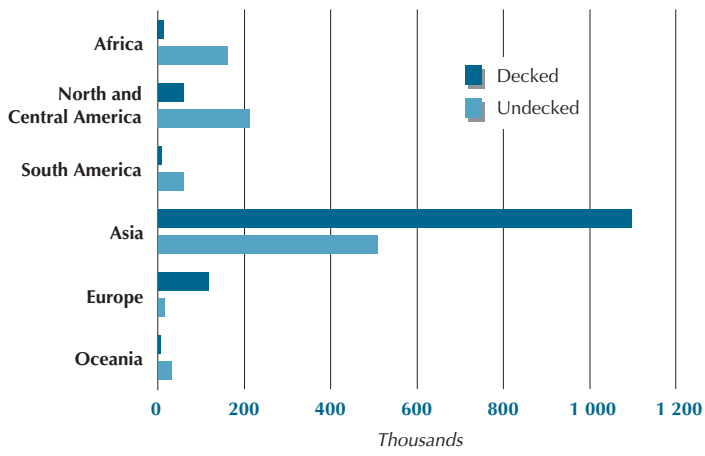


FIGURE 14
Numbers of powered vessels by continent in 1998



about 2.8 million undecked vessels, 65 percent of which were not powered. The vast majority of these vessels were concentrated in Asia (84.6 percent of total decked vessels, 51 percent of powered undecked vessels and 83 percent of total non-powered boats). The remaining 15.4 percent of the world's total decked fishing vessels were accounted for by Europe (8.9 percent), North and Central America (4.5 percent), Africa (1 percent), South America (0.6 percent) and Oceania (a negligible 0.2 percent). Countries in North and Central America had 21 percent of the open fishing vessels with engines, Africa had 16 percent, South America 6 percent, and Oceania 3 percent.

Since the expansion of the world fleet, which continued until the late 1980s, the numbers of decked fishing vessels have been fairly stable. In 1990 they numbered 1.2 million, and yearly fluctuations since then have been about 1 percent; part of this variation is probably owing to statistical reporting methods. The same overall trend applies at the continental level.

Indications of trends after 1998 are not available on a global scale. However, the European Community (EC) fishing fleet decreased from 100 085 vessels in 1995 to nearly 96 000 in 2000. Of the 77 500 vessels for which the length overall is known (it is not known for 18 500 vessels, mainly Italian and Portuguese) about 80 percent measured less than 12 m, the majority of these belonging to Greece and Spain. In 2000, some 14 percent of EC fishing vessels were between 12 and 24 m in length, and fewer than 350 measured more than 45 m (a decrease of 52 units compared with four years before). In December 2000, Norway had a fleet of 8 430 decked fishing vessels and 4 585 open registered vessels. Comparative statistics for 1990 indicated an almost equal number for the decked fleet, while the number of open vessels had nearly doubled. The Icelandic fleet had 1 993 vessels on register in 2001, 55 percent of which were undecked; nearly 40 percent of the decked vessels are more than 20 years old. In Japan, fishing vessels operating in marine and inland waters numbered 361 845 in 1999, down from 371 416 in 1995 and 416 067 in 1990. The vast majority (90 percent) of the total powered vessels

FIGURE 15
Numbers of decked fishing vessels in major national fleets by continent

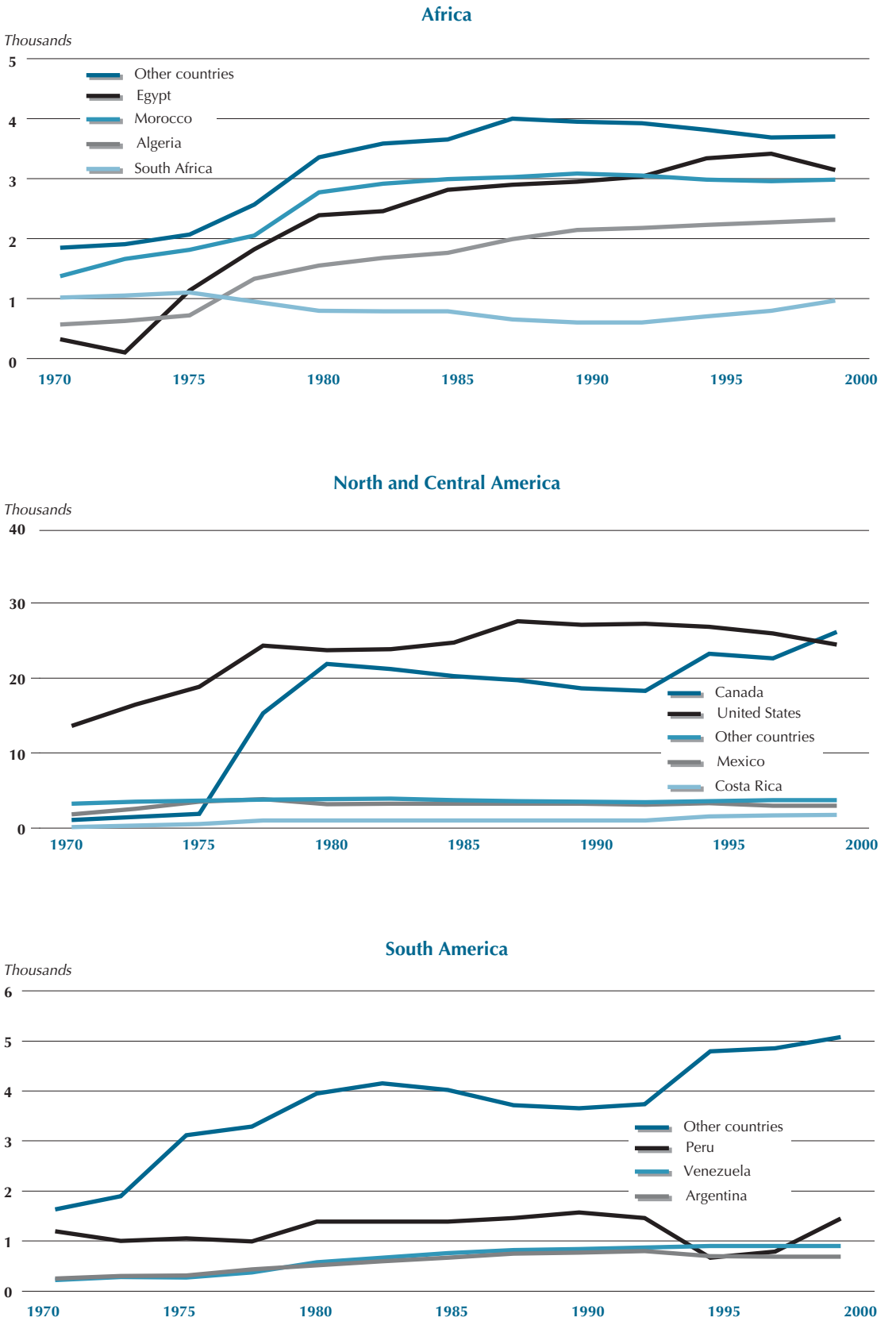


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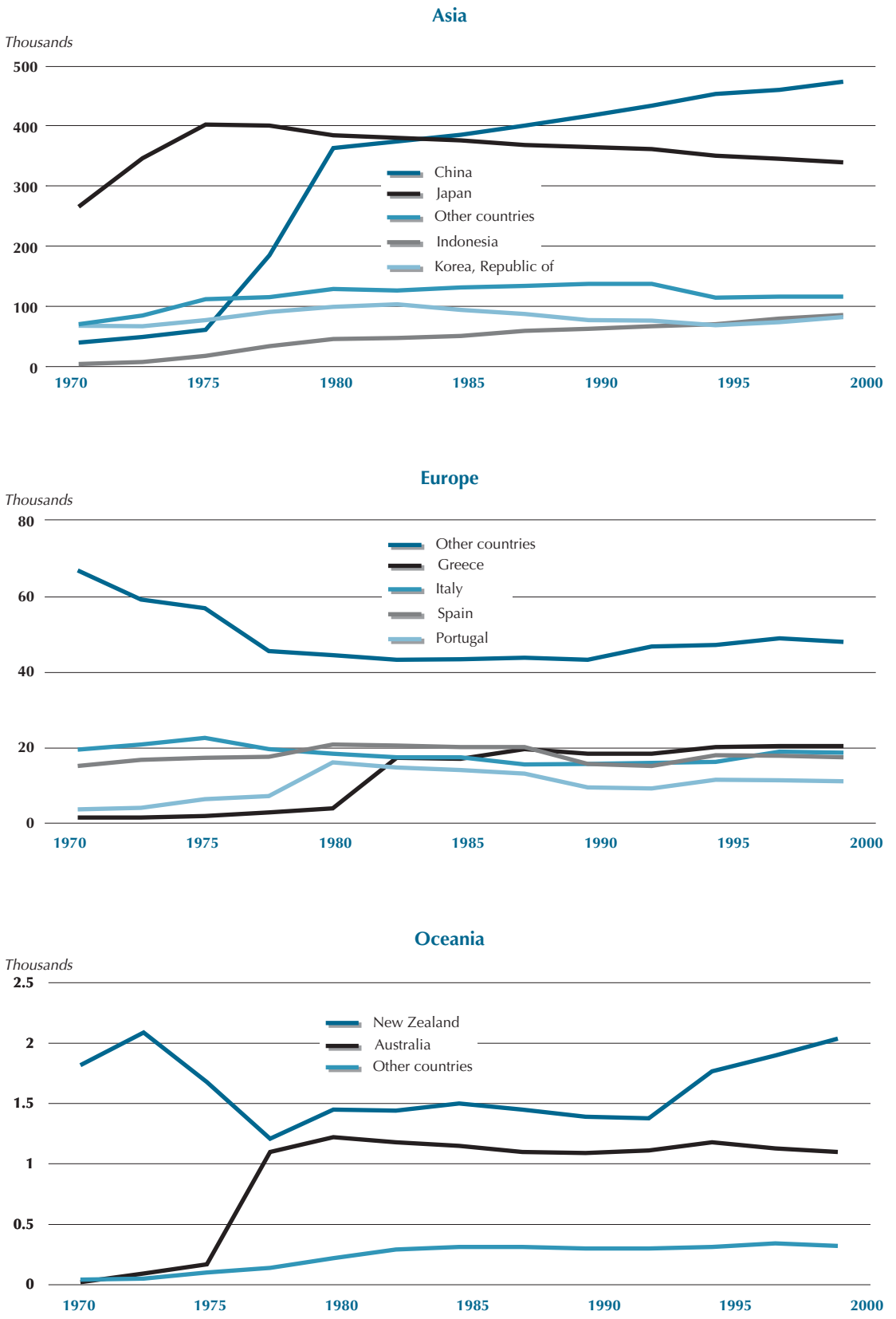
FIGURE 15 (continued)
Numbers of decked fishing vessels in major national fleets by continent



BOX 4
Tracking the fishing fleets through the database of Lloyds Maritime Information Services

Lloyds Maritime Information Services aims to maintain a full picture of all ships, including fishing vessels, of more than 100 gross registered tons (GRT). Vessels are continually added to the database each year; some of these are new vessels that were built that year and others are added as information becomes available. Vessels of more than 100 GRT are the most likely to operate internationally, through access agreements and on the high seas, but these represent only a small proportion of the global fishing fleet. Nevertheless, monitoring the > 100 GRT fleet gives an indication of the changing shape of large-scale industrial fishing (Figure 16). It provides indications of the patterns of change in entries to, and exits from, all shipping registers, particularly open registers. By definition, these registers offer flag state status to almost any ship and are often seen by vessel owners as a means of avoiding controls to which they might otherwise be subject. The number of vessels that are known to exist but for which the flag is unknown is also a cause for concern, although some of these vessels might have been removed from the register before being scrapped. The numbers of vessels in the major open registers with unknown flags are shown in Figure 17. The number of newly built fishing vessels added to the register has remained about 300 per year in recent years, but reductions through scrapping and loss mean that there has been a net reduction in the fleet. The major changes to fleets in the last two years are shown in Table 6. The extent of reflagging in the fishing fleet can be measured by comparing the database in sequential years and by following each vessel through its unique Lloyds or International Maritime Organization (IMO) number (Table 7).

Source: A. Smith, FAO Fisheries Department.

FIGURE 16
Numbers of fishing vessels over 100 GRT recorded in Lloyds Maritime Information Services database

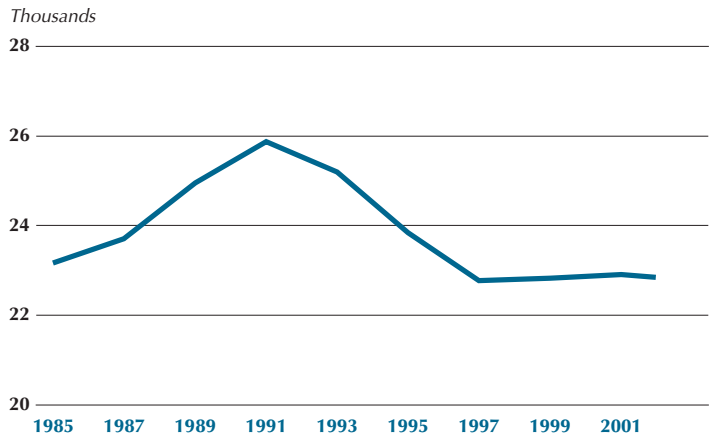
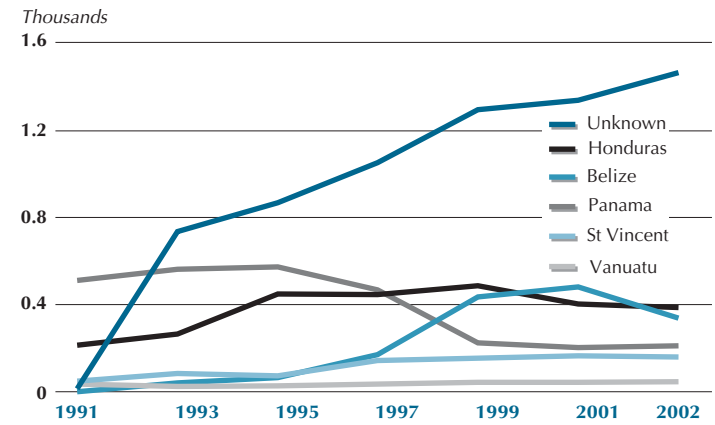


FIGURE 17
Numbers of fishing vessels in the major open registers and of flag unknown



Source: Lloyds Maritime Information Services.

fishing in marine waters were of less than 5 gross tons. Between 1990 and 2000, the number of decked vessels decreased by 45 000 units (a drop of 12 percent).

THE STATUS OF FISHERY RESOURCES

Marine fisheries

Following a decline to 79.2 million tonnes in 1998, total production of marine capture fisheries increased to 84.7 million tonnes in 1999 and 86.0 million tonnes in 2000, thus recovering to levels close to the historical maximum recorded for 1996 and 1997. If China is excluded (see

TABLE 6
Changes to the database of Lloyds Maritime Information Services (for fishing vessels)

Country Register	New building 2000	New building 2001	Scrapping and loss 2000	Scrapping and loss 2001
Argentina	_	_	4	9
Belize	4	8	8	11
Canada	_	_	14	8
Denmark	9	3	_	_
France	5	15	9	9
Germany	_	_	7	18
Iceland	4	17	_	_
Ireland	18	4	_	_
Japan	22	14	237	23
Korea, Republic of	_	_	16	11
Norway	24	18	_	_
Netherlands	10	8	_	_
Russian Federation	_	_	40	51
Spain	40	48	104	48
United Kingdom	10	14	14	20
United States	98	52	23	58
Others	61	92	166	176
Unknown	_	_	44	22
Blank	_	_	43	69
Total	**305**	**293**	**729**	**533**
Net change			**- 424**	**- 240**

TABLE 7
Flagging in and out of shipping registers (by fishing vessels)

Flagging changes	Out 2000	Out 2001	In 2000	In 2001
Argentina	_	_	4	9
Belize	34	29	76	40
Cambodia	_	_	7	5
Cyprus	_	_	9	3
Canary Islands	0	38	_	_
Equatorial Guinea	5	0	_	_
Honduras	89	9	10	11
Ireland	_	_	6	10
Japan	59	12	_	_
Korea, Republic of	_	_	_	_
Namibia	_	_	19	2
Netherlands	8	12	_	_
Norway	6	13	5	9
Panama	29	12	18	14
Russian Federation	21	17	59	56
Spain	15	4	0	39
St Vincent	9	11	17	3
Ukraine	11	11	_	_
United Kingdom	21	7	6	13
United States	12	4	_	_
Vanuatu	12	2	5	5
Others	175	117	155	139
Unknown	56	51	170	0
Total	**562**	**349**	**562**	**349**

Box 2), world production in 2000 was 71.3 million tonnes – about 5 percent less than the historical peak of 75.5 million tonnes in 1995. Most of the recent changes in total global landings from wild marine fishery resources can be explained by the decline and rapid recovery (in biomass and production volumes) that followed the 1997–1998 El Niño. The areas most seriously affected by this recent El Niño were the Southeast Pacific and, to a lesser extent, the Eastern Central Pacific (Figure 7).

The global situation of the main marine fish stocks for which assessment information is available follows the general trend observed in previous years. Overall, as fishing pressure continues to increase, the number of underexploited and moderately exploited

fisheries resources continues to decline slightly, the number of fully exploited stocks remains relatively stable and the number of overexploited, depleted and recovering stocks is increasing slightly.

An estimated 25 percent of the major marine fish stocks or species groups for which information is available are underexploited or moderately exploited. Stocks or species groups in this category represent the main source for the potential expansion of total marine catches. About 47 percent of the main stocks or species groups are fully exploited and are therefore producing catches that have reached, or are very close to, their maximum sustainable limits. Thus, nearly half of world marine stocks offer no reasonable expectations for further expansion. Another 18 percent of stocks or species groups are reported as overexploited. Prospects for expansion or increased production from these stocks are negligible, and there is an increasing likelihood that stocks will decline further and catches will decrease, unless remedial management action is taken to reduce overfishing conditions. The remaining 10 percent of stocks have become significantly depleted, or are recovering from depletion and are far less productive than they used to be, or than they could be if management can return them to the higher abundance levels commensurate with their pre-depletion catch levels. Recovery usually implies drastic and long-lasting reductions in fishing pressure and/or the adoption of other management measures to remove conditions that contributed to the stock's overexploitation and depletion.

Total catches from the Northwest and the Southeast Atlantic have levelled off and remained relatively stable over the last five to ten years, at about half the level of the maximums reached three decades ago. Of particular concern is the failure of the stocks of haddock, redfish and cod to respond to the drastic management measures that have been adopted in the Northwest Atlantic. Most of the changes in the Southeast Atlantic are caused by fluctuations in abundance, and hence catches, of the important small pelagics, in particular Cape horse mackerel, Southern African anchovy and Southern African pilchard. After being severely depleted, the stocks of Southern African anchovy and Southern African pilchard show some signs of recovery, although current management efforts have not been in place sufficiently long to bring catches back to maximum historical levels.

In the Eastern Central Atlantic and the Northwest Pacific, total catches are levelling off at relatively high levels, having recovered from a short decline following their maximum production levels some 10 to 15 years ago. Most of these changes result from recoveries in abundance, hence landings, of small pelagics. In the Northeast Atlantic, the Western Central Atlantic, the Northeast Pacific, the Mediterranean and Black Sea, the Eastern Central Pacific and the Southwest Pacific, annual catches are relatively stable, or show a slight declining trend after reaching their maximum potentials one or two decades ago. In the Southwest Atlantic, total annual catches are declining after reaching an all-time high in 1997. This area is being affected by the depletion, and consequent decline in catches, of one of its most important stocks, the Argentine hake.

In the Southeast Pacific, total annual catches reached an all-time high in 1994, and then declined sharply as a consequence of the severe 1997–1998 El Niño and the depletion of the Peruvian anchoveta and other important stocks in the area. Post-El Niño recovery has been surprisingly fast, particularly in the stocks of Peruvian anchoveta. This has taken the total catches rapidly back to pre-El Niño levels, although some other important and declining stocks such as Chilean jack mackerel and the South American pilchard have given no signs of recovery.

The increasing trend of total catch in the Western Indian Ocean slowed down, having reached a maximum in 1999. Two ocean areas in which total catches are thought to be expanding – and where, at least in theory, there is a higher potential to increase total catches – are the Eastern Indian Ocean and the Western Central Pacific. These areas, together with the Western Indian Ocean, have the lowest incidence of fully exploited, overexploited, depleted or recovering fish stocks and have some underexploited or

BOX 5

Dams, fish and fisheries: a challenge for fishery managers and engineers

Dams for irrigation, flood control, hydropower production and water diversion contribute to development and welfare. The structures and purposes of dams range from high dams for power generation and water supply in steep mountain valleys to irrigation, water diversion or navigation structures in lower areas. Dams are also used for flood control, but this has often not been very successful. Many dams are multifunctional and fulfil several purposes with a single facility.

Dam and weir construction has a long tradition in many parts of the world. Over the last half-century, thousands of large dams have been constructed worldwide. The number of smaller dams, weirs and other in-stream obstacles across rivers is not known on a global scale, but may be in the order of several hundred thousands.

Barriers across rivers often have negative impacts on the natural fish populations and may contribute, along with other factors, to the diminished abundance, disappearance or even extinction of species. An example of this is the extinction of the salmon (Salmo salar) in the River Rhine, a stock that had supported a thriving salmon fishery in the first half of the twentieth century. Dams are threatening many aquatic species in Europe and North America, as well as in other continents where far less is known about the biology, behaviour, fishery and population dynamics of the fish species concerned. In several countries, including India, Nepal and South Africa, research on fish behaviour is being carried out so that fish passes can be adapted to the needs of indigenous species. Depending on the swimming capacities of the fish concerned, even low obstacles (i.e. those of between 20 cm and a few metres in height), such as low weirs or cross-river sills (structures to stabilize the river bottom), can have devastating effects. Examples of affected fish from European rivers include the bullhead (Cottus gobio), the nase (Chondrostoma nasus) and the barbel (Barbus barbus). As well as fish, other aquatic animals – or their aquatic life stages (e.g. among the macrozoobenthos) – can be affected by changes to free longitudinal movements in the river.

Cross-river structures impair animals' movement in two main ways: they constitute barriers to the upstream and downstream migration of species that depend on longitudinal movements in the river at some stage of their life cycle; and they cause physical modifications. The latter include: changes in slope, river bed profile, bottom surface structure and bottom substrate; submersion of gravel zones or riffle sections; destruction of riparian vegetation; and changes in the thermal or trophic regime. The downstream flow regime is often drastically changed. Dams may interrupt longitudinal passage completely, or at least delay migration. Downstream passage through hydraulic turbines or over high spillways can increase mortality, and there may be increased predation on migrating young fish as they pass through a dam's reservoir. The cumulative effect of several obstacles on the same river may have important negative implications for fisheries, especially in tropical regions where river fisheries often contribute substantially to rural livelihoods.

In large rivers, yield models relating river basin area and main channel length to catches suggest that yields increase exponentially as the river length increases. This is owing to the connectivity and cumulative influences of upstream processes within the system (the "river continuum concept"), as well as to lateral processes associated with the riparian, watershed and floodplain dimensions of the stream ecosystem (the "flood pulse concept"). For example, such a yield model may estimate that a 25-km section of river would yield catches of 9 113 kg/year at a distance of 50 km from the river's source. At 250 km from the source, a 25-km section of the same river would yield 37 197 kg/year. If a dam were constructed 400 km from the river's source, and resulted in a loss of 25 km of the river at that point, the reservoir would need to compensate for 57 925 kg/year of catch.

Dams break up a river's longitudinal and lateral continuity and can significantly block nutrient flow throughout the ecosystem, thereby affecting fisheries production in downstream reservoirs and river channels, as well as in estuary and marine environments. The larger the river and the more downstream the location of the dam, the less likely it is that a reservoir fishery will be able to compensate for fish yield losses sustained by the river fishery. Because of the production dynamics, compensation potentials appear higher in shallower reservoirs and in tropical regions than they are in deeper reservoirs and in more northern latitudes.

Estimates show yield potentials of up to 143 kg/ha/year for natural African river and floodplain fisheries, although it can be difficult to compensate for loss in yield from river fisheries. Productive reservoir fisheries have been developed with yields of up to 329 kg/ha/year in small reservoirs in Africa, up

to 125 kg/ha/year in Latin America and the Caribbean and up to 650 kg/ha/year in Asia. Thriving reservoir fisheries can develop in areas where river fisheries contribute little to overall national fishery yields, or in drier regions where dams are constructed for irrigation and fisheries are secondary considerations. The benefits from smaller, shallower reservoirs seem to be more pronounced. Stocking of exotic species, in both reservoirs and the tailwaters of dams, can enhance yields, as long as the exotic fishes are environmentally sound and culturally acceptable to the surrounding human population; some areas have no tradition of fishing and fish consumption.

Obstructed passage can be mitigated to some extent by fish passes (sometimes called "fauna passes") for upstream migration and bypasses for downstream passage, but lost habitat cannot easily be compensated for. For anadromous and potamodromous species, upstream passage past obstacles can use several types of passage, including pool-type fish passes, Denil fish passes, bypass channels that imitate nature and fish lifts or locks. Such species can also be collected and transported, if the facilities for doing so are available. Over the last two decades, especially in Australia, France, Japan and New Zealand, significant progress has been made to develop region-specific technologies to improve fish passage facilities, first for upstream and now also for downstream passage. In 2000, a vertical slot fish pass was constructed at the Iffezheim dam on the River Rhine to allow, inter alia, salmon to migrate upstream. Some countries such as France have amended the relevant laws to make the restoration of free passage at obstacles obligatory, at least on rivers that are classified as important for fish migration. More and more frequently the owner of the dams and weirs has to pay to restore free passage.

Effective and efficient fish passage facilities require knowledge of the biology and behaviour of the species concerned. Thus, if basic biological information is missing, it is difficult to transpose fish passage technology to dam projects in other continents or river systems, or from temperate to tropical conditions. However, limited knowledge of the relevant biology does not justify failure to address the problem. The precautionary approach should always be applied, as recently discussed at a Fish Passage Workshop in South Africa.

The design of fish passes requires a multidisciplinary approach involving engineers, biologists and managers. Designs should be systematically evaluated, if possible through an obligatory and comprehensive long-term monitoring programme. Effective environmental assessment and management, coupled with improvements in the design of civil engineering structures, have made some recent dam projects somewhat more fish-friendly and environmentally acceptable.

Source: G. Marmulla, FAO Inland Water Resources and Aquaculture Service. Based on FAO Fisheries Technical Paper No. 419.

moderately exploited stocks. However, they also have the highest incidence of stocks whose state of exploitation is unknown or uncertain and for which overall production estimates are, consequently, less reliable.

Except for skipjack tuna in some areas, most tuna stocks are fully exploited in all oceans, and some are overfished or even depleted. Overcapacity of the tuna fleets has been pointed out as a major problem in several areas. Of particular concern are the stocks of Northern and Southern bluefin tunas in the Atlantic, Indian and Pacific oceans. These are reported to be overfished and, in most cases, severely depleted.

Another source of concern is the rapid increase in fishing pressure on some of the deep water resources (see Box 3) that are being exploited in seamounts and other deep water areas at high latitudes in the Indian Ocean, the South Atlantic and the South Pacific, particularly orange roughy, alfonsinos and dories. Most of these stocks are slow-growing, long-living animals, and thus are highly vulnerable to depletion when the distribution, abundance and dynamics of their stocks are largely unknown. There is severe risk that, in the absence of effective fishery management regimes, these stocks could easily be depleted long before much is known about their populations. Concern has also been expressed regarding the severe decline of Patagonian toothfish stocks in the southern oceans, which are mostly exploited by illegal, unreported and unregulated (IUU) fishing.

Inland resources

In The State of World Fisheries and Aquaculture 2000, it was reported that inland fishery resources are undervalued and under threat from habitat alteration (see Box 2 of SOFIA 2000), degradation and unsustainable fishing activities. Recent field studies in Southeast Asia[1] have revealed that there are significant problems concerning the accuracy of inland fishery statistics in the region. These problems stem from a lack of adequate resources to collect fishery statistics, the difficulty in obtaining information from the sector, misreporting and a lack of capacity to use information to improve the management of inland fishery resources. Experiences indicate that the situation is probably similar in other parts of the world.

Accurate information is crucial to understanding the importance of inland fishery resources and to managing those resources for the benefit of rural populations. Incomplete or incorrect information is a liability in efforts to provide food security to developing regions. As efforts to improve information on inland fishery resources continue, it is inappropriate at this time to present additional data in The State of World Fisheries and Aquaculture 2002.

AQUACULTURE

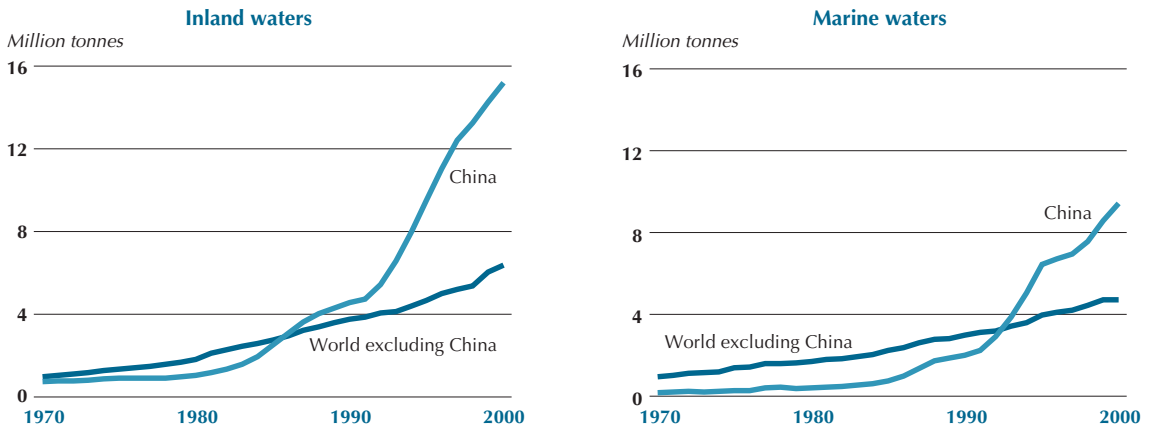
Production

According to FAO statistics, aquaculture's contribution to global supplies of fish, crustaceans and molluscs continues to grow, increasing from 3.9 percent of total production by weight in 1970 to 27.3 percent in 2000. Aquaculture is growing more rapidly than all other animal food producing sectors. Worldwide, the sector has increased at an average compounded rate of 9.2 percent per year since 1970, compared with only 1.4 percent for capture fisheries and 2.8 percent for terrestrial farmed meat production systems. The growth of inland water aquaculture production has been particularly strong in China, where it averaged 11.5 percent per year between 1970 and 2000 compared with 7.0 percent per year in the rest of the world over the same period. Mariculture production in China increased at an average annual rate of 14 percent, compared with 5.4 percent in the rest of the world. However, there is a possibility that China's aquaculture production, particularly its growth since the early 1990s, has been overestimated in the statistics (see Box 2). Figure 18 shows trends in inland and marine aquaculture production for China and the rest of the world.

In 2000, reported total aquaculture production (including aquatic plants) was 45.7 million

[1] FAO. 2002. Inland capture fishery statistics of Southeast Asia: current status and information needs, by D. Coates. RAP Publication 2002/11. Bangkok, FAO Regional Office for Asia and the Pacific. 121 pp.

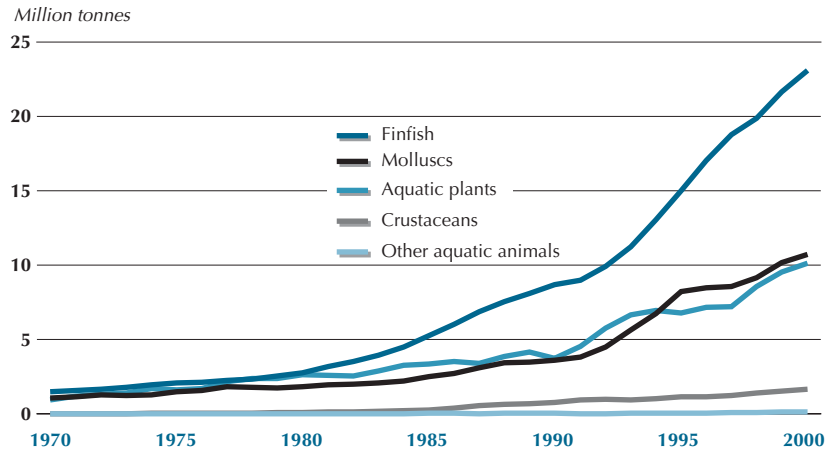
FIGURE 18
Aquaculture production in marine and inland waters



Note: Data exclude aquatic plants.

tonnes by weight and US$56.5 billion by value. China was reported to have produced 71 percent of the total volume and 49.8 percent of the total value of aquaculture production. More than half of the total world aquaculture production in 2000 was finfish, and the growth of the major species groups continues to be rapid with no apparent slowdown in production to date (Figure 19). World aquatic plant production was 10.1 million tonnes (US$5.6 billion), of which 7.9 million tonnes (US$4.0 billion) originated in China.

FIGURE 19
Trend of world aquaculture production by major species groups



In contrast to terrestrial farming systems, where the bulk of global production is based on a limited number of animal and plant species, more than 210 different farmed aquatic animal and plant species were reported in 2000. This great diversity reflects the large number of aquatic species that are readily adaptable to the wide range of production systems and conditions present in the different countries and regions of the world. It should also be noted that the number of species farmed is probably considerably higher than reported, as more than 9.7 million tonnes (21.2 percent) of global aquaculture production was not reported at the species level in 2000. This "unspecified" group is likely to include species that have not yet been recorded individually as being cultured.

In 2000, more than half of global aquaculture production originated from marine or brackish coastal waters. The mean annual growth rate (for the period 1970–2000) was, however, highest for freshwater aquaculture production. Although brackish water production represented only 4.6 percent of total global aquaculture production by weight in 2000, it comprised 15.7 percent of total production by value. The main species groups reared in freshwater were finfish. High-value crustaceans and finfish predominate in brackish

FIGURE 20
World aquaculture production: proportions of species groups by enviroment in 2000

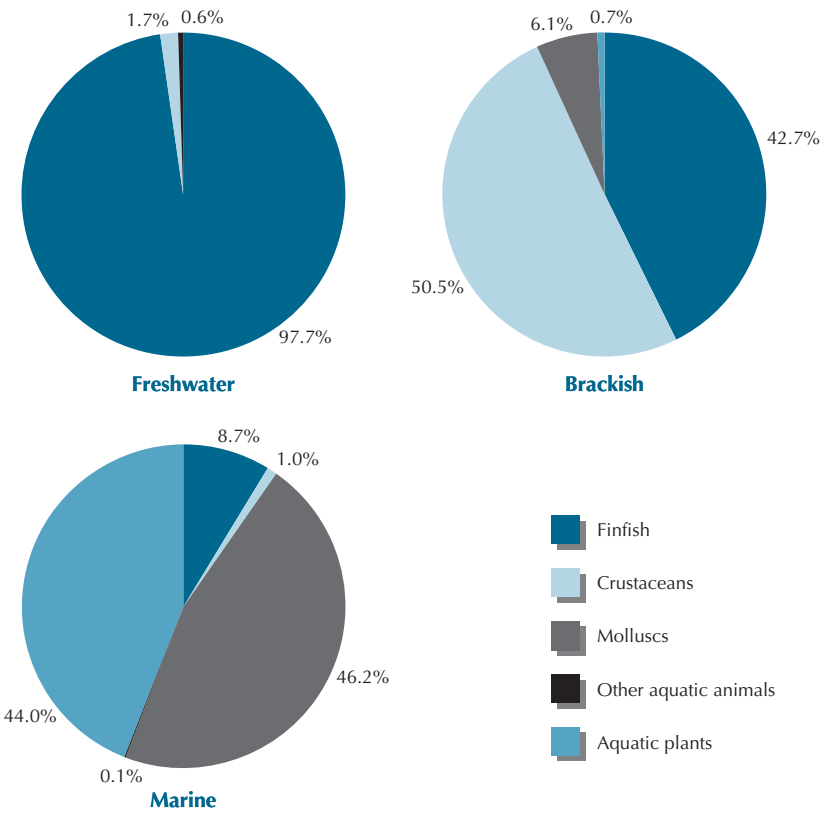
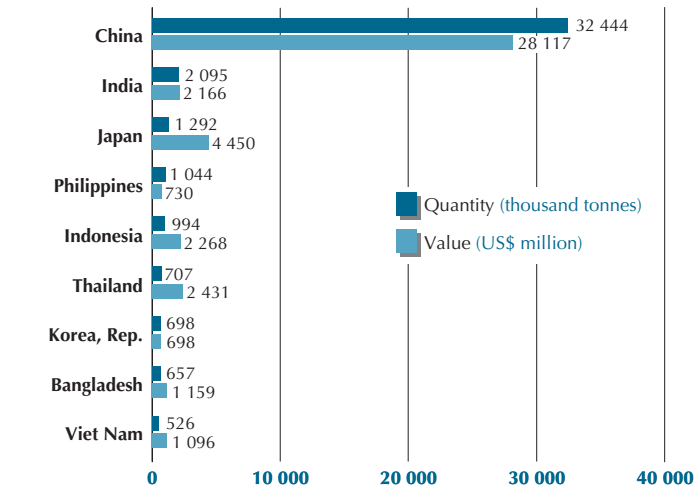


FIGURE 21
Aquaculture production: major producer countries in 2000



Note: Data include aquatic plants. Countries listed are those with a production volume of more than 500 000 tonnes.

water, and molluscs and aquatic plants in marine waters (Figure 20). Production in terms of quantity and value for major producing countries and major species groups is shown in Figures 21 and 22.

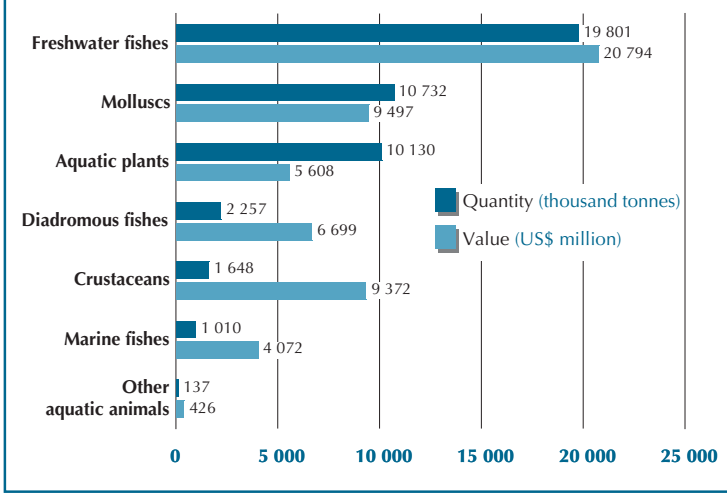
It is particularly significant that aquaculture production in developing countries and low-income food-deficit countries (LIFDCs) has been growing steadily at an average rate of about 10 percent per year since 1970. However, production growth (by both quantity and value) among LIFDCs, excluding China, has been slower than among non-LIFDCs (Figure 23). By contrast, aquaculture production within developed countries has been growing at an average rate of only 3.7 percent per year since 1970, and even showed a decrease of 2.4 percent from 1999 to 2000. With the exception of marine shrimp, in 2000, the bulk of aquaculture production in developing countries comprised omnivorous/herbivorous fish or filter-feeding species. In contrast, 73.7 percent of finfish culture production in developed countries was of carnivorous species.

In terms of food fish supply (i.e. aquatic finfish and shellfish products for human consumption, on a whole, live weight basis – excluding aquatic plants), the world aquaculture sector outside China produced about 11 million tonnes of farmed aquatic products in 2000, compared with about 52 million tonnes from capture fisheries. China's reported figures were about 20 million tonnes from aquaculture and 7 million tonnes from capture fisheries, a stark indication of the dominance of aquaculture in China. Outside China, per capita food fish supply from aquaculture has increased fourfold, from 0.6 kg in 1970 to 2.3 kg in 2000.

Sustainability

During the past three decades, aquaculture has expanded, diversified, intensified and made technological advances. The potential of this development to enhance local food security, alleviate poverty and improve rural livelihoods has been well recognized. The Bangkok Declaration and Strategy (Network of Aquaculture Centres in Asia-Pacific [NACA] and FAO, 2000) emphasizes the need for the aquaculture sector to continue development towards its full potential, making a net contribution to global food availability, domestic food security, economic growth, trade and improved living standards.

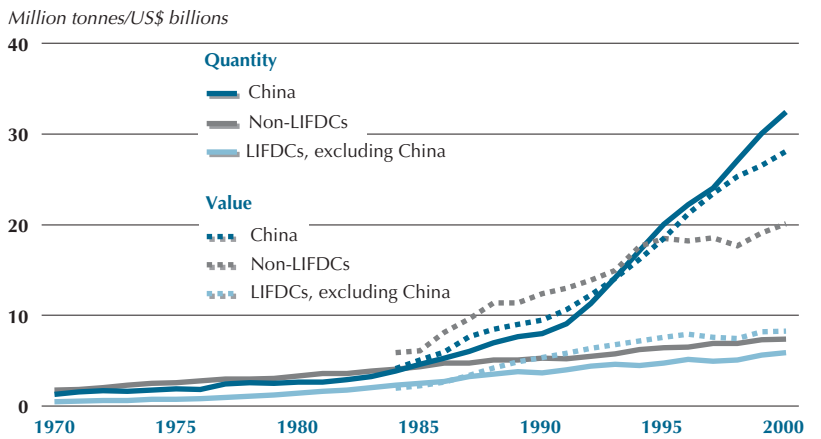
FIGURE 22
Aquaculture production: major species groups in 2000



FISH UTILIZATION

Of the estimated 89 million tonnes of fish produced in 2000 in the world, excluding China, nearly 71 percent (63 million tonnes) was used for direct human consumption. The remainder (about 29 percent) was utilized for various non-food products, mostly for reduction to meal and oil. Corresponding figures for China, which were based on reported capture fishery, aquaculture and fishmeal production and FAO estimates of other non-food uses (see Box 2), were nearly 42 millions tonnes total production and nearly 34 million tonnes (81 percent) for direct human consumption. The remainder was used for the manufacture of fishmeal and other non-food uses, including direct feed to aquaculture.

FIGURE 23
Trends in aquaculture production quantity and value

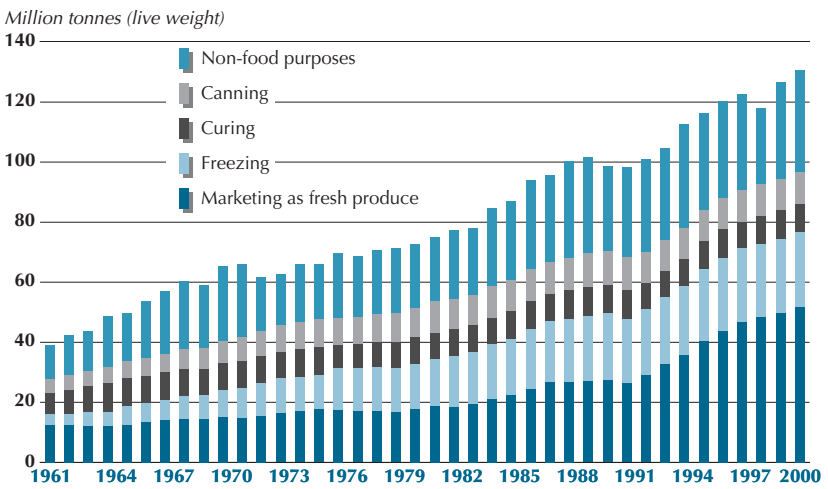


Note: Data include aquatic plants.

As a highly perishable commodity, fish has a significant requirement for processing. In 2000, more than 60 percent of total world fisheries production underwent some form of processing. The most important of the fish products destined for direct human consumption was fresh fish (a share of 53.7 percent), followed by frozen fish (25.7 percent), canned fish (11.0 percent) and cured fish (9.6 percent).

During the 1990s, there was a significant increase in the proportion of fisheries production used as fresh/chilled fish rather than as other products (Figure 24). The demand for fresh fish increased, but was partially offset by a slight decline in other uses. Fresh fish increased in volume (live weight equivalent) from an estimated 28 million tonnes in 1990 to 52 million tonnes in 2000. Processed fish (frozen, cured and canned) increased in volume (live weight equivalent) from 43 million tonnes in 1990 to about 45 million tonnes in 2000. Freezing represents the main method of processing fish for human consumption, and had a 55 percent share in 2000. In developed countries, the proportion of fish that is frozen has been constantly

FIGURE 24
Utilization of world fisheries production (breakdown by volume)



increasing, and frozen fish has become the most common form of product, with a share of 40 percent of fish production. In developing countries, however, the share of frozen products is very constant at about 12 percent.

Almost all the fishery products used for non-food purposes in 2000 (33.7 million tonnes) came from natural stocks of small pelagics, which represented nearly one-third of the total capture fisheries. Most of these fishery products were used as raw material for the production of animal feed and other products. As catches of small pelagics for reduction regained the levels prevailing before El Niño, the quantity destined for non-food uses was about 9 million tonnes more than in 1998.

TABLE 8
Total and per capita food fish supply by continent and economic grouping in 1999

	Total food supply (million tonnes live weight)	**Per capita food supply** (kg per year)
World	**95.5**	**16.0**
World excluding China	**64.3**	**13.6**
Africa	6.2	8.0
North and Central America	8.1	16.8
South America	2.9	8.5
China	31.2	25.1
Asia (excluding China)	32.5	13.7
Europe	13.9	19.1
Oceania	0.7	22.5
Industrialized countries	25.4	28.3
Economies in transition	3.7	12.7
LIFDCs (excluding China)	20.8	8.3
Developing countries excluding LIFDCs	13.7	14.8

Fish consumption

The total food fish supply for the world, excluding China, has been growing at a rate of about 2.4 percent per annum since 1961, while the population has been expanding at 1.8 percent per annum. Since the late 1980s, however, population growth outside China has occasionally outpaced the growth of total food fish supply, resulting in a decrease in per capita fish supply from 14.6 kg in 1987 to 13.1 kg in 2000 (Figure 2). For China, the corresponding annual increases are 6.4 percent for food fish supply since 1961 and 1.7 percent for the population (Figure 9). Annual growth was steady until the mid-1980s (at 3.8 percent from 1961 to 1985) and then suddenly trebled over the following 15 years (10.8 percent from 1985 to 2000).

The share of the animal protein intake of the whole human population derived from fish, crustaceans and molluscs increased from 13.7 percent in 1961 to 16.1 percent in 1996 and then showed a slight decline to 15.8 percent in 1999.

In industrialized countries (Table 8), where diets generally contain a more diversified range of animal proteins, the supply increased from 13.2 million tonnes in 1961 to 25.4 million tonnes in 1999, implying a rise in per capita

BOX 6

Aquatic biodiversity from rice-based farming systems supports rural livelihoods

Rice fields – much more than rice

In the Upper and Lower Mekong River floodplains in Yunnan Province, China and Kampong Thom Province, Cambodia, an attempt has been made to document the availability of living aquatic resources and the pattern of their use by rice farmers. Farmers used their own tools and techniques to collect aquatic species from the fields. Participatory approaches facilitated learning about the traditional knowledge of the local people, including many ethnic minorities.[1]

Remarkable insights were gained. These rice ecosystems support a rich aquatic biodiversity that is important, not only as a source of daily food and income for rural households, but also as a habitat for rare and endemic species. Fishes are the most important group in terms of species diversity and importance for the local people. A total of 60 and 70 different fish species occur in rice farms in China and Cambodia, respectively. Most of these are consumed fresh or fermented into fish paste. Other species are fermented (either as fillets or in smaller pieces), dried, salted, smoked or used for preparing fish sauce.

Fresh or processed fish is the primary source of protein for local people in these areas, and is usually eaten at every meal. In Kampong Thom, an average family of five people probably consumes about 1 kg of fresh fish every day during the fishing season, i.e. when the rice fields are flooded. The same family needs about 20 kg of fermented fish paste for the dry season. Everything else that is caught is sold in the market. Depending on the fishing tool employed, a farmer can catch 15 to 20 kg of fish on a good day, although the average fish catch during the fishing season is less than 10 kg per day. In China, a variety of fish, crustaceans, molluscs, amphibians, insects, reptiles and aquatic plants from rice-based systems are an essential part of the daily diet, in particular for the rice farming Dai minority in Xishuangbanna. The consumption level of aquatic organisms has remained fairly constant; nowadays about one-fifth to one-third of consumption is derived from capture in rice-based farming, but a decade ago this same capture supplied half of the fish needed in the diet. The use of aquatic organisms as animal feeds and bait, or for medicinal purposes, is an important addition to their human consumption value.

The availability of these aquatic resources is declining. An increasing human population is resulting in overexploitation of seasonally resident fish populations. Pesticide use, the destruction of fish breeding grounds and illegal fishing methods also contribute to the decline. It seems likely that in other rice growing regions of the world where aquatic organisms are harvested from rice fields and contribute to nutritional needs, they too are likely to be subject to similar threats.[2]

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[1] FAO. 2002. Traditional use and availability of aquatic biodiversity in managed ecosystems, edited by M. Halwart and D. Bartley. Rome.
[2] FAO. 2002. Recent FAO initiatives on the availability and use of aquatic organisms in rice-based farming, by M. Halwart. Rome.
Source: M. Halwart, FAO Fisheries Department.

provision from 19.9 to 28.3 kg. The growth rate was steady until the late 1980s and has stabilized again since then. In this group of countries, fish contributed an increasing share of the total protein intake until 1989 (accounting for between 6.5 and 8.5 percent), but its importance has gradually declined since then and its contribution in 1999 (7.7 percent) was back to the level prevailing in the mid-1980s.

In the early 1960s, the average per capita fish supply in LIFDCs was one-fifth of that in the richest countries. The gap has gradually lessened, however, and in 1999 average LIFDC fish consumption was close to half that of the more affluent economies. If China is excluded, per capita supply in LIFDCs increased from 5.0 to 8.3 kg over the period – an annual growth rate of 1.3 percent. In LIFDCs, despite the relatively low consumption by weight, the contribution of fish to total animal protein intake is considerable (nearly 20 percent), and may be higher than official statistics indicate because of the contribution of unrecorded subsistence fisheries to food intake. Over the last four decades,

FIGURE 25
Fish as food: per capita supply

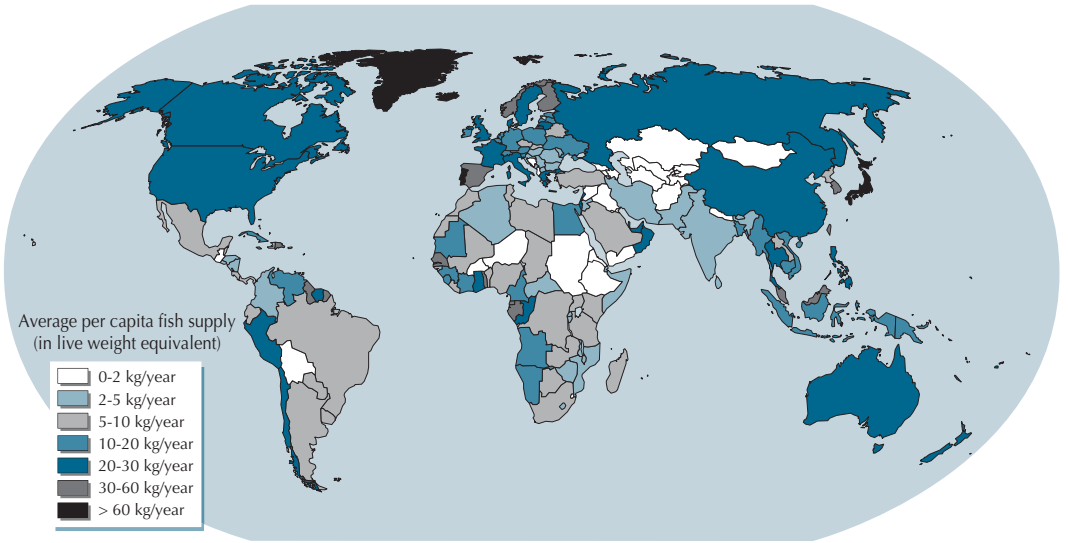
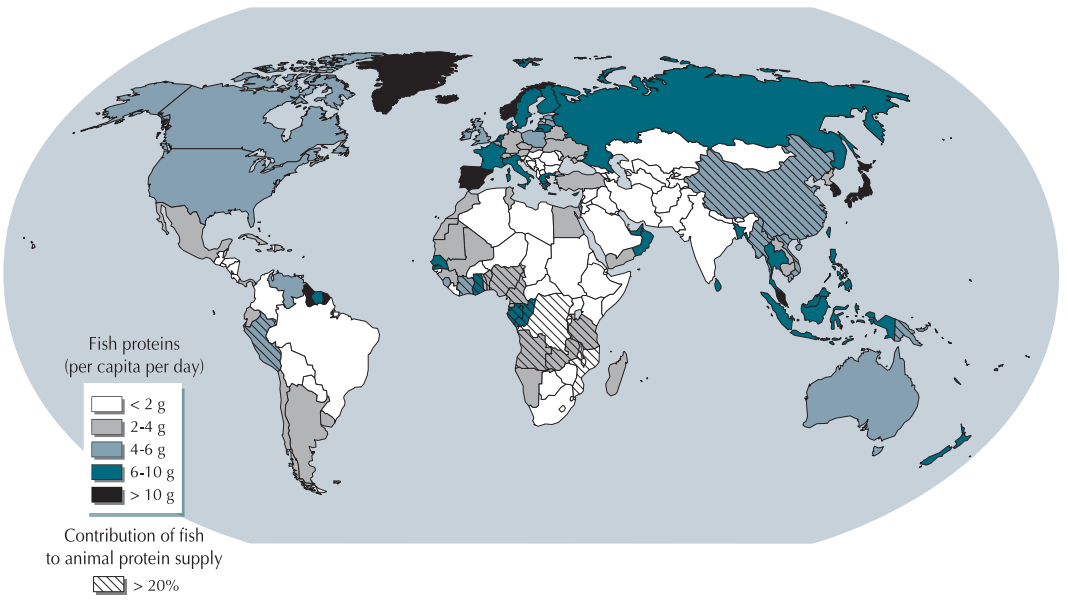


FIGURE 26
Contribution of fish to animal protein supply



however, the share of fish proteins in animal proteins has exhibited a slight negative trend owing to faster growth in the consumption of other animal products.

As well as income-related variations, the role of fish in nutrition shows marked continental, regional and national differences (Figures 25 and 26). For example, of the worldwide 95.5 million tonnes available for consumption in 1999, only 6.2 million tonnes were consumed in Africa (with a per capita supply of 8.0 kg); two-thirds of the total were consumed in Asia – 32.5 million tonnes outside China (13.7 kg per capita) and a similar amount in China alone (giving an apparent supply of 25.1 kg per capita).

Currently, two-thirds of the total food fish supply is obtained from fishing in marine and inland waters; the remaining one-third is derived from aquaculture. The contribution of inland and marine capture fisheries to per capita food supply stabilized at 10 to 11 kg per capita in the period 1970–2000. Recent increases in per capita availability have, therefore, been obtained from aquaculture production from both traditional rural aquaculture and intensive commercial aquaculture of high-value species. On average, for all countries in the world except China, aquaculture's contribution to per capita food availability grew from 0.5 kg in 1970 to 1.8 kg in 2000 – representing an average annual rate of 4.5 percent. In China, where fish farming practices have long traditional roots, the per capita supply from aquaculture is reported to have increased from nearly 1 kg to nearly 19 kg in the same period, implying an annual average growth of 11 percent.

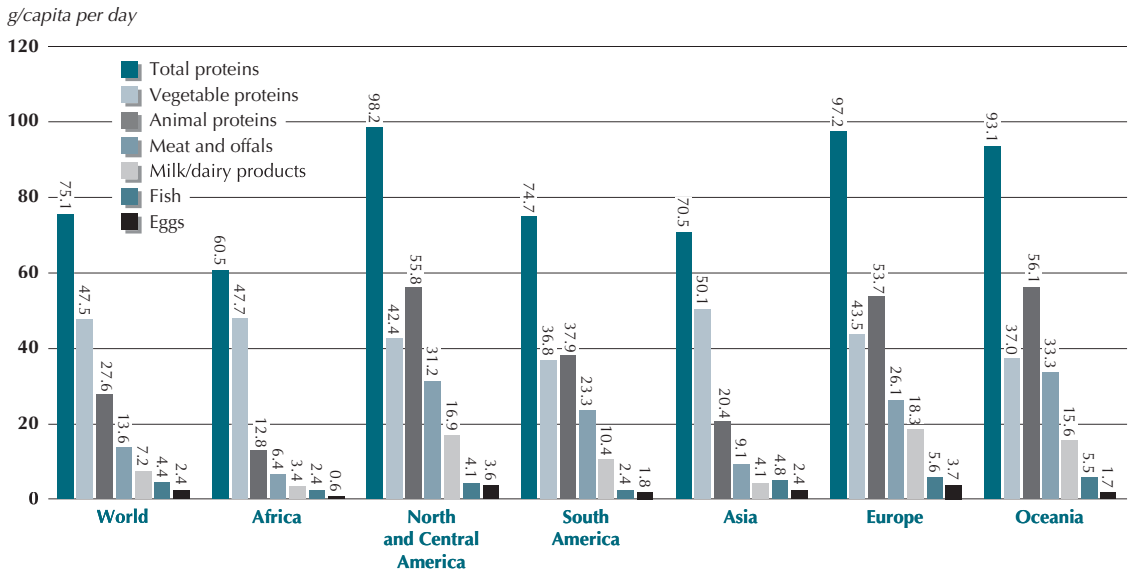
The total amount of fish consumed and the species composition of the food supply vary according to region and country, reflecting the different levels of natural availability of aquatic resources in adjacent waters, as well as diverse food traditions, tastes, demand and income levels. Demersal fish are much preferred in northern Europe and North America, and cephalopods are consumed extensively in several Mediterranean and Asian countries, but to a much lesser extent in other regions. Despite the fast-growing contribution of aquaculture to production, crustaceans are still high-priced commodities and their consumption is mostly concentrated in affluent economies. Of the 16.0 kg of fish per capita available for consumption in 1999, the vast majority (75 percent) was finfish. Shellfish supplied 25 percent – or about 4 kg per capita, subdivided into 1.4 kg of crustaceans, 2.1 kg of molluscs and 0.4 kg of cephalopods.

Freshwater and diadromous species contributed 27 million tonnes of total supply. Marine finfish species provided 44 million tonnes, subdivided into 17 million tonnes of demersal species, 19 million tonnes of pelagics and 8 million tonnes of unidentified marine fish. The remaining 20 percent of the food supply was shellfish, comprising 8.6 million tonnes of crustaceans, 2.7 million tonnes of cephalopods and 12.5 million tonnes of other molluscs. Historically, there have not been dramatic changes in most of the broad groups' shares in average world consumption: demersal fish species have stabilized at about 2.9 kg per capita and pelagic fish at 3.2 kg. Two groups are exceptions in that they showed considerable increases between 1961 and 1999: the availability of crustaceans per capita more than trebled from 0.4 to 1.4 kg, largely because of the production of shrimps and prawns from aquaculture practices; and molluscs similarly increased from 0.6 to 2.1 kg per capita.

Fish contributes up to 180 calories per capita per day, but reaches such high levels only in a few countries where there is a lack of alternative protein foods grown locally and where a preference for fish has been developed and maintained (examples are Japan, Iceland and some small island states); more generally, fish provides about 20 to 30 calories per day. Fish proteins are essential and critical in the diets of some densely populated countries, where the total protein intake level may be low, and it is very important in the diets of many other countries (e.g. fish contributes more than, or close to, 50 percent of total animal proteins in the Gambia, Ghana, Equatorial Guinea, Indonesia, Sierra Leone, Togo, Guinea, Bangladesh, the Republic of the Congo, Cambodia).

Worldwide, more than 1 billion people rely on fish as an important source of animal proteins

FIGURE 27
Total protein supply by continent and major food group (1997–1999 average)



(i.e. fish provides at least 30 percent of their animal protein intakes) (Figure 27). Dependence on fish is usually higher in coastal than in inland areas. About 56 percent of the world's population derives at least 20 percent of its animal protein intake from fish, and some small island states depend on fish almost exclusively.

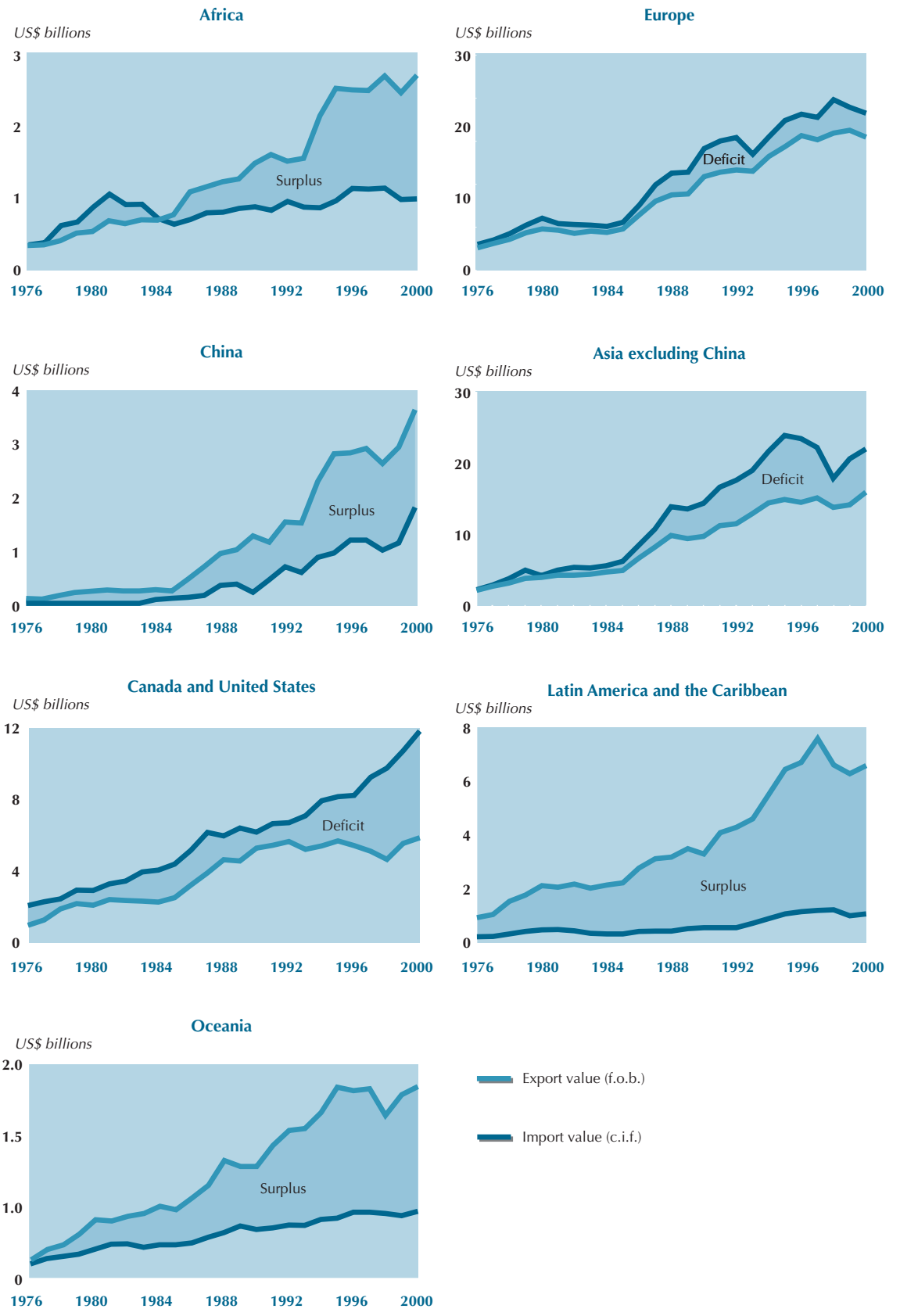
FISH TRADE

In addition to their role as a source of food and livelihoods, fisheries in many countries are also an important source of foreign exchange. In a few cases, fishery exports are essential to the economy. For example, in 2000 they accounted for more than two-thirds of the total value of traded commodities in Greenland, the Seychelles, the Faeroe Islands and Iceland. In many countries there is a substantial two-way trade in fishery products. The trade surplus is significant in South America, Africa, China and Oceania (Figure 28). Products derived from aquaculture production contribute an increasing share of total international trade in fishery commodities (see Box 7).

In 2000, total world trade of fish and fishery products increased to an export value of US$55.2 billion, having grown by 8 percent since 1998. This increase was largely due to a rise in the volume of commodities traded (Figure 29); compared with 1998, the prices of major food products decreased marginally and those of feeds declined sharply. Thailand continued to be the main exporting country, with US$4.4 billion. China experienced a sharp increase in its export performance to reach US$3.7 billion in 2000 – a major growth of 36 percent from 1998 – and is now the second largest exporter. In addition to exports from domestic production, China also reprocesses imported raw material for export, creating a strong value-addition in the process. Norway, which used to be ranked second, reported lower export values. These were partly caused by lower salmon prices, but also by the low value of the euro – the currency of the main trading area for Norwegian fish.

Fish imports reached a new record of US$60 billion in 2000. Developed countries accounted for more than 80 percent of the value of total fishery product imports. Japan was again the largest importer of fishery products, accounting for some 26 percent of the global total; its fishery imports accounted for 4 percent of its total merchandise trade. After the economic recession, which caused a decline in 1998, the value of Japanese imports of fish and fishery products in 2000 returned to the level of 1997. The EC

FIGURE 28
Imports and exports of fishery products for different regions, indicating the net deficit or surplus



BOX 7
Trade in aquaculture products

The main traded products[1] from aquaculture are shrimp and prawns, salmon, and molluscs. Other species showing strong growth in trade are tilapia, seabass and seabream.

Crustaceans

In international trade, the most prominent product from aquaculture is marine shrimp, and aquaculture has been the major force behind increased shrimp trading during the past decade. Shrimp is already the most traded seafood product internationally, and about 26 percent of total production now comes from aquaculture (1.1 million tonnes in 2000). Since the late 1980s, farmed shrimp has tended to act as a stabilizing factor for the shrimp industry. The major crop failures in Asia and Latin America during past years have therefore had an impact on overall supply, demand, prices and consumption trends. Considered a luxury product in most markets, shrimp demand is very dependent on a country's economic climate, and consumption and trade in an individual country may show large variations from year to year. At present, Japanese demand remains weak, as does the United States market after September 2001.

The major markets are Japan, the United States and the EC, and the largest exporters of farmed shrimp are Thailand, Ecuador, Indonesia, India, Mexico, Bangladesh and Viet Nam. Demand for shrimp and prawns is expected to increase in the medium to long term. Asian markets such as China, the Republic of Korea, Thailand and Malaysia will expand as local economies grow and consumers demand more seafood. This trend is already reducing the availability of shrimp to traditional importers, and will eventually put upward pressure on prices if supplies do not expand. Increases in prices will encourage new entries into shrimp farming and, if sustainable methods of production are used, greater stability of prices.

Trade in crab species has increased with growing aquacultural production (140 300 tonnes in 2000). Total exports for fresh, frozen and preserved crab (wild and farmed) reached 240 000 tonnes and US$1.5 billion in 2000.

Finfish

Finfish production ranks first in terms of total aquaculture output, with 23 million tonnes produced in 2000, or about 65 percent of total production from aquaculture. The major share of this total were carps (68 percent of total finfish production in 2000), which are consumed locally in the producing countries (mainly China and India).

International trade in farmed salmon has increased from virtually zero to about 1 million tonnes (2001) in less than two decades. The traded species are mainly Atlantic salmon and, to a far lesser extent, coho salmon, which accounted for 88 and 10 percent of production in 2001, respectively. Growth in trade has followed the growth in salmon production, as the bulk of production is concentrated in a few countries with limited domestic markets – Norway, Chile and the United Kingdom. Norway is the main exporter of Atlantic salmon, and Chile the main exporter of coho salmon and the second largest exporter of Atlantic salmon. The main market for Norway is the EC, which accounts for some 70 percent of Norwegian exports; Chile's main markets are Japan and the United States, accounting for some 55 and 30 percent of Chilean exports, respectively.

Norway has identified Asia as the future growth market (in addition to further penetration of the European markets), and the Norwegian salmon farming industry has spent almost US$150 million on international promotion and advertising over the last few years. Chilean producers foresee strong growth in the United States, Latin American, European and Asian markets, excluding Japan. In contrast to Norway, Chile produces a large quantity of fillets, which are sent fresh by air to the United States market.

The global farmed salmon industry is restructuring rapidly, with a few companies accounting for a large share of production and frequently having strong ties to the feed industry. As production volumes have increased, costs and prices have been driven down and, at current levels (US$2.60

[1] The extent of regional and international trade in aquaculture products is difficult to analyse because trade in many aquaculture products is not yet well documented in the main producing countries. International trade statistics often do not distinguish between wild and farmed origin, and the exact breakdown in international trade is therefore open to interpretation. This situation will change gradually, as producers' associations emerge in producing countries and begin to keep records, and in response to new environmental and labelling requirements that distinguish between farmed and wild products. An important development is the new EU legislation on labelling, which since 1 January 2002 requires most fishery products to carry labels stating whether they originate from capture fisheries or aquaculture.

Source: A. Lem, FAO Fish Utilization and Marketing Service.

to $3.40/kg cost, insurance, freight [c.i.f.]), salmon has become a relatively mid-priced product in international seafood markets.

International trade in trout is much smaller than in salmon, with exports in 2000 reaching some 140 600 tonnes out of a total farmed trout production of 511 000 tonnes. Consumption is concentrated in trout producing countries, but Norway and Chile have been able to farm specific qualities of large-sized, heavy-pigmented trout for the Japanese market (Japan imported 84 000 tonnes of trout in 2001).

Another species to show tremendous growth in output is tilapia (aquaculture production of tilapia and other cyclids amounted to some 1 265 800 tonnes in 2000). International trade is limited but growing, especially between Central American producers (Costa Rica, Ecuador and Colombia) and the United States, and between Asian producers (Taiwan Province of China, Indonesia and Thailand) and the United States and Japan. There is also modest trade between Jamaica and the United Kingdom. The largest exporter, Taiwan Province of China, supplies Japan with high-quality tilapia fillets for the sashimi market, and ships frozen tilapia to the United States market (40 000 tonnes in 2001). Taiwan Province of China exports about 70 percent of its domestic tilapia production. Thailand and Indonesia export less than 5 percent of their production. Viet Nam has also recently entered the world tilapia market, and China exported 12 500 tonnes to the United States in 2001. Zimbabwe now also produces fresh and frozen fillets for the EC market.

In the United States, tilapia is now the third most imported aquaculture product by weight (56 300 tonnes in 2001), after shrimp and salmon. United States imports have been growing strongly and are forecast to grow further in the future. Long-term tilapia prices are expected to decrease, and this should lead to increased exports to the United States, as well as to Europe, which is still an undeveloped market for tilapia.

In Europe, the seabream and seabass industry has grown strongly in the last decade. Production reached 120 000 tonnes in 2001, most of which was exported, mainly to Italy and Spain. The main exporter was Greece, which exported about 70 percent of domestic production. Italy was originally almost the only export market for Greek production but, as a result of market development efforts, Greek exports have now expanded into new markets, such as the United Kingdom, Germany and France, as well as Spain for certain sizes. At the opposite end, trade in fingerlings comes from Italy, Spain and France and goes to farms in Greece, Malta and Croatia.

As seabass/seabream output has grown, costs have been driven down, and market prices declined by more than two-thirds between 1990 and 2002 – from US$16/kg to about US$4 to $5/kg. The rapid saturation of the market and the parallel rapid price decline (60 to 70 percent in ten years, compared with 50 percent for Atlantic salmon) are attributed to the much smaller traditional market for these species (mainly southern Europe) compared with the Atlantic salmon market, lack of diversified products, and limited market development and promotion. The substantial drop in prices of these species is, however, opening new markets and expanding existing ones, although acceptable profit margins at the production end can only be sustained through further improvements in productivity and product diversification. As with farmed salmon, the seabass/seabream industry is becoming consolidated, and several companies are also quoted on the stock exchange in Greece and Norway.

American catfish is now the fifth most consumed fish in the United States (0.5 kg per capita edible weight in 2000), and domestic production reached 280 000 tonnes in 2000. Exports are limited because production is aimed at the domestic market, whereas imports from Viet Nam have rapidly gained market share in the United States (7 700 tonnes) and European markets. The reason for the success of catfish is similar to that of tilapia's success: strong consumer demand for white, easy-to-prepare fillets.

Seaweed

Farmed seaweed production has been growing in the last decade (10 million tonnes in 2000), and is now 88 percent of total seaweed supplies. Most output is utilized domestically for food, but there is growing international trade. China, the main producer, has started to export seaweed as food to the Republic of Korea and Japan. The Republic of Korea, in turn, exports some quantities of Porphyra (red seaweed) and Undaria (brown seaweed) to Japan (23 500 tonnes in 2000).

Significant quantities of Eucheuma (red seaweed) are exported by the Philippines, the United Republic of Tanzania and Indonesia to the United States, Denmark and Japan. Total EC imports of seaweed in 2000 amounted to 61 000 tonnes. Chile is an important extractor, processor and exporter of agar and carrageenen.

Molluscs

International trade in molluscs is relatively limited compared with total output: less than 10 percent of total output is traded. Major importing markets are Japan, the United States

and France, while major exporters are China and Thailand. The contribution of farmed products to trade is uncertain. For all categories, international trade is increasing.

Total fresh and frozen scallop imports have grown from 28 000 tonnes in 1985 to 78 100 tonnes in 2000, reaching a value of US$563 million. Clam imports have grown from 33 000 tonnes to 171 000 tonnes in the same period, valued at US$301 million. Mussel imports showed a downward trend after a peak of 175 000 tonnes in 1992, to reach 137 000 tonnes in 1993 and 151 000 tonnes in 1994. However, mussel imports showed an upward trend again in subsequent years: 200 000 tonnes valued at US$310 million in 2000. Oyster imports have been growing steadily from less than 10 000 tonnes in 1985 to 47 000 tonnes in 2000, reaching a value of US$200 million.

Live organisms

Asia is rapidly increasing its consumption of live seafood as a result of cultural preferences and growing affluence. The live seafood market is largely restricted to the restaurant trade and to consumers with a relatively high disposable income. Major market expansion is anticipated as a result of demand in China, but expansion is also expected in Malaysia, Singapore and Taiwan Province of China, as well as in parts of North America and Europe with large Chinese or Asian communities. Aquaculture's potential to supply the market is promising. The sector is already supplying large quantities of shellfish and limited quantities of grouper, crabs and other species. Technological developments in the culture of preferred live food species will increase aquaculture's contribution to supplies.

Annual international exports of ornamental fish are about US$200 million in value, or less than 1 percent of total world fish trade. However, the total value of the wholesale ornamental trade is estimated at close to US$1 billion, and retail trade at about US$3 billion in the United States alone.

The importance of the ornamental fish trade is not just in terms of its share in international trade. The sector is an important source of income for rural, coastal and insular communities in developing countries and, frequently, a welcome provider of employment opportunities and export revenues.

Asia accounts for more than 50 percent of the world supply of ornamental fish. New players such as the Czech Republic and Malaysia are now competing with the traditionally dominant suppliers. The main importers are the United States (24 percent), Japan (14 percent) and Europe, particularly Germany (9 percent), France (8 percent) and the United Kingdom (8 percent). In international trade, freshwater species represent about 90 percent in value terms, against 10 percent for marine species. Freshwater species are mostly farmed, whereas marine fish come from the wild. However, marine aquaculture is growing strongly as problems related to the environment and the lack of sustainable collection practices make this a more viable long-term alternative.

There appears to be significant regional and international trade in seed of cultured aquatic organisms, mainly from aquaculture sources. In most instances, however, this is poorly documented. As well as the regional trade in Mediterranean seabass and seabream fingerlings, there is also trade in glass eels (e.g. China's recent large purchases of European eel elvers), post-larvae stages of various cultured shrimps, Indian and Chinese carps, and others. There is also limited trade (in terms of quantity) in broodstock. Documentation of the trade in seed will improve gradually in response to concerns about the spread of diseases and the movement of genetic material.

Source: A. Lem, FAO Fisheries Department.

further increased its dependency on imports for its fish supply. Excluding Spain, which is now the third largest importer of fishery products, all other major countries of the euro currency area reported decreased values of imports in 2000. The United States, as well as being the world's fourth largest exporting country, was the second largest importer. Imports were growing in 2000, mainly owing to expanding shrimp imports.

The net receipts of foreign exchange by developing countries (i.e. deducting their imports from the total value of their exports) increased from US$3.7 billion in 1980 to US$18.0 billion in 2000 – a 2.5-fold increase in real (corrected for inflation) terms. In 2000, they increased by nearly 10 percent at current values compared with 1999, after several years of stability at about US$16 billion. This was greater than the net exports of other agricultural commodities such as rice, coffee and tea (Figure 30). For many developing nations, fish trade represents a significant source of foreign currency earnings.

Fish production and trade have grown significantly in the last decades, assisted by improvements in technology, transportation and communications and by sustained demand. A large share of fish production enters international marketing channels, with about 37 percent exported in 2000 (live weight equivalent) in various food and feed product forms. LIFDCs play an active part in this trade, and at present account for almost 20 percent of the value of fishery exports. In 2000, developing countries as a whole supplied slightly more than 50 percent of total exports in value terms. Although there is an important trade of fish and fishery products among the more developed economies, trade

FIGURE 29
World fishery exports by major commodity groups

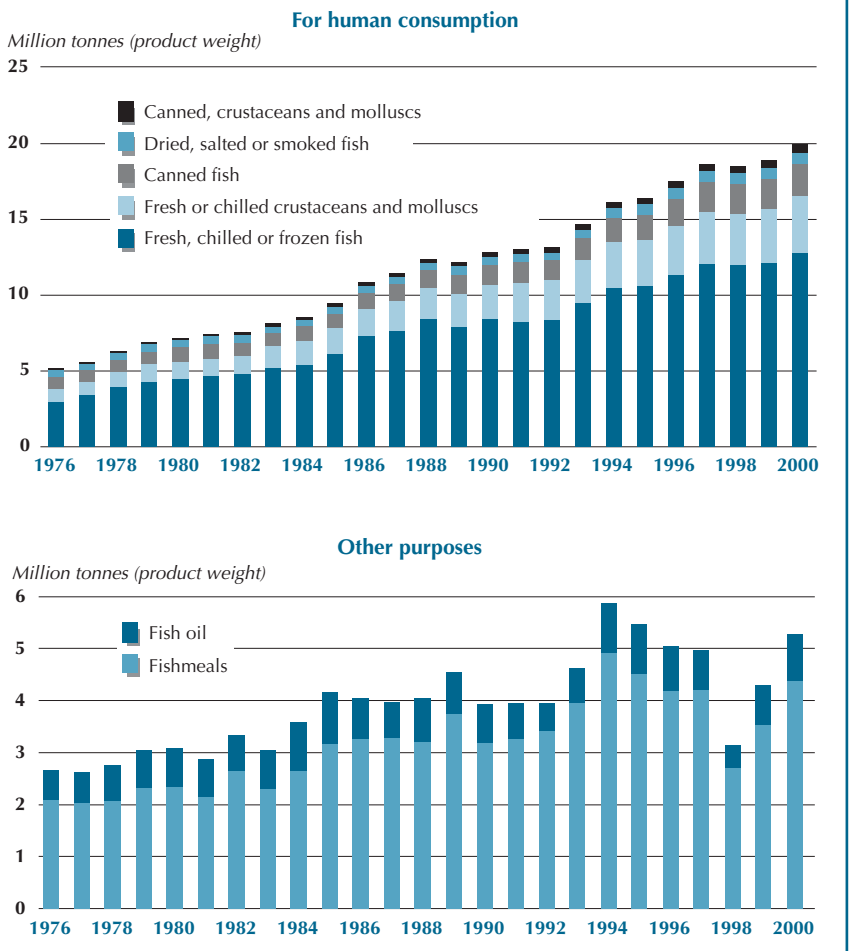
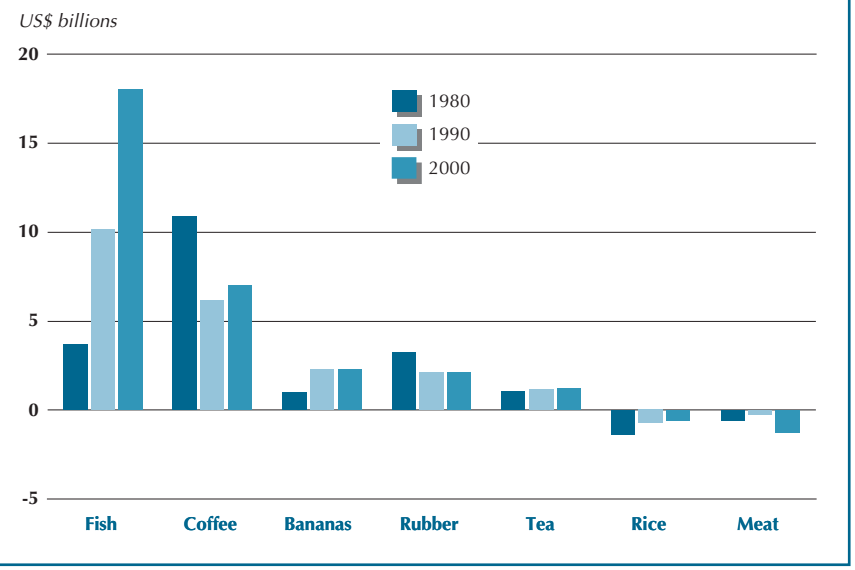


FIGURE 30
Net exports of selected agricultural commodities by developing countries



tends to flow from the less developed to the more developed countries. About 76 percent of the import value is concentrated in three main areas: Japan, the EC and the United States. Although trade among developing countries is increasing, it is still not very substantial and accounted for about 20 percent of those countries' total exports in 1998–2000.

Owing to the high perishability of fish, more than 90 percent of fish and fishery products trade consists of products that have been processed in one form or another. Live, fresh or chilled fish represent only a small, though growing, share of world fish trade; the growth reflects improved logistics and increased demand. Shrimp is the main fish trade commodity in value terms, followed by demersal species (e.g. hake, cod, haddock and Alaska pollock), tuna, salmon, small pelagics, cephalopods and fishmeal.

Fish products traded among industrialized countries are mostly from demersal species, which are traded in fresh, frozen whole and fillet form; lower-value pelagic species such as herring and mackerel, which are traded in fresh and frozen form; and fresh and frozen salmon. Developing countries' exports concern mainly tuna, small pelagics, shrimps, prawns, rock lobsters and cephalopods (octopus, squids and cuttlefishes). In the past, developing countries were involved primarily in exports of raw material for the processing industries of developed countries, but in recent years they have been increasingly involved in adding value to their products prior to export. In addition, a large part of the world's trade in fishmeal originates from developing countries in Latin America. Developing countries' imports concern mainly frozen small pelagics and cured, dried and smoked fish. There are also some imports of raw material (e.g. frozen tuna) for further processing (e.g. canned tuna) and re-export. Emerging markets (Hong Kong Special Administrative Region, Taiwan Province of China, the Republic of Korea, Malaysia and Singapore) are increasingly importing high-value commodities (rock lobster, squid, etc.) for domestic consumption.

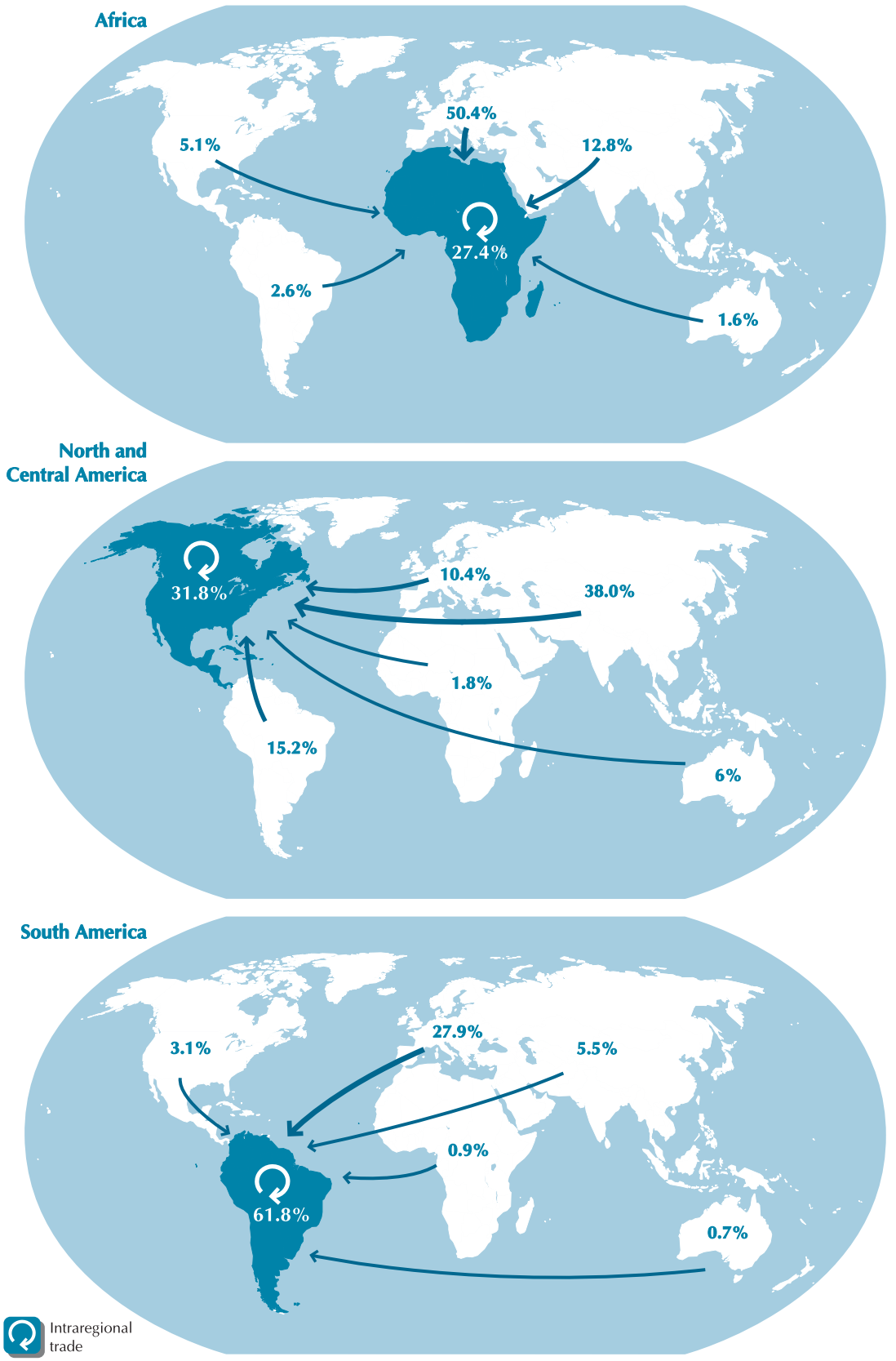
It should be noted that the overall picture presented by the maps in Figure 31 is not exhaustive. Although the countries that reported their imports (some 137 countries for the period 1998–2000) account for 98 percent of the estimated world total, some continental groups have incomplete coverage (e.g. only 40 percent of African countries reported their imports). In such cases, the data indicated should not be taken as the total trade flow of the continental groups to which they refer.

During recent years, international trade in fishery products has faced the following major issues: the change in quality control measures in the main importing countries towards a preventive Hazard Analysis and Critical Control Point (HACCP)-based strategy; the concept of risk assessment; general public concern regarding overexploitation of the resource; environmental concerns regarding aquaculture; and the discussion of traceability and labelling. The EC and the United States made HACCP plans mandatory for all plants producing fish products for their markets. While the United States enforces these measures through importers in the United States, the EC controls the competent authorities in the exporting countries. Risk assessment (i.e. analysis of the risk of consumers falling sick after consuming fish) is still being developed in many countries. The sustainable trade of fish – from either the wild or aquaculture – is of concern to consumers, especially in the developed world. Information about dangerous antibiotics in cultured fish species, or about overfished resources, scares consumers away from fish products. Mangrove depletion through shrimp aquaculture has also received negative press coverage recently. On 1 January 2002, the EC enforced a law on the traceability of fish, which obliges producers to indicate the following on product labels: the commercial name of the species and the Latin name; whether the fish comes from the wild or from aquaculture; the country of origin for freshwater wild and cultured fish; and the ocean of origin for wild marine species. A range of types of labelling, such as ecolabelling or organic product labelling, are being developed and used for fishery products, and this is creating confusion among consumers.

Shrimp

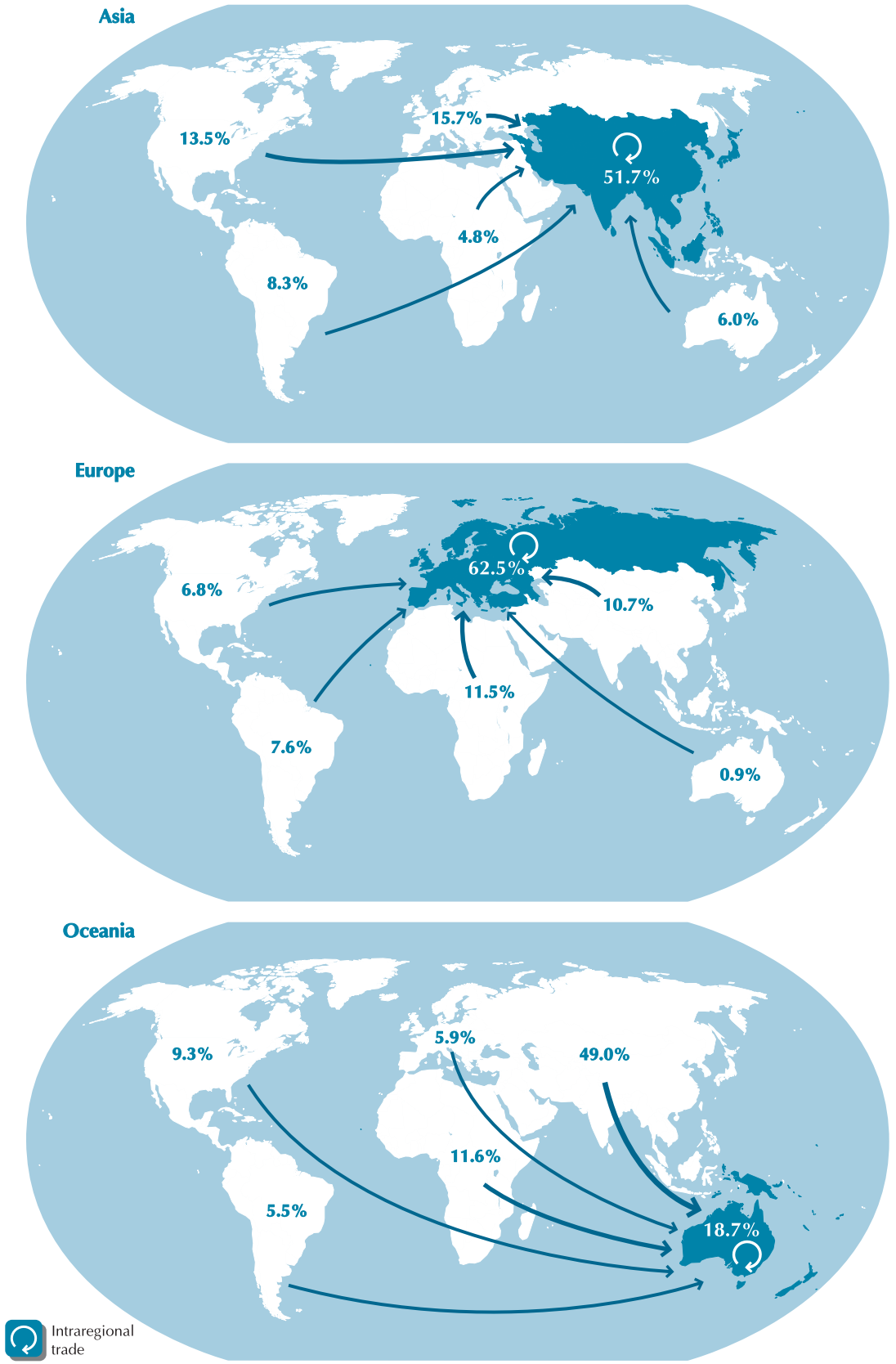
The economic crisis in Japan led to lower

FIGURE 31
Trade flows by continent (percentages of total import c.i.f. values: averages for 1998–2000)



(Continuing)

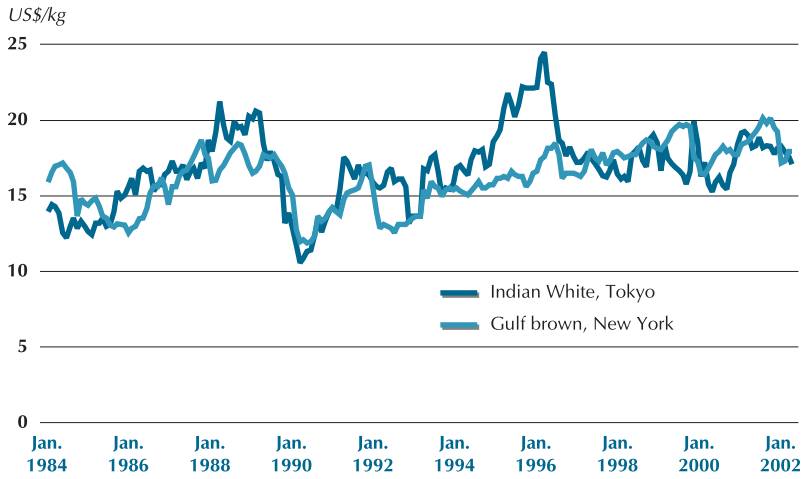
FIGURE 31 (continued)
Trade flows by continent (percentages of total import c.i.f. values: averages for 1998–2000)



demand for shrimp. The main supplying countries had to reduce prices and look for other outlets in order to sell their production. The United States market was strong in 2000, but declined sharply in 2001. The dramatic events of 11 September increased the slowdown of the market. Demand for shrimp in Europe was improving in parallel with the overall economic situation; however, the low level of the euro undercut any substantial growth there. On 29 January 2002, the EC stopped imports of shrimp from China because of the strong presence of antibiotics in cultured shrimp from that country. In other Asian countries, the EC carried out close checks with regard to the presence of antibiotics. These countries prefer to sell to other markets, rather than risk having shipments destroyed at the EC border. This situation upset the international market for shrimp in the opening months of 2002, and prices were extremely low (Figure 32).

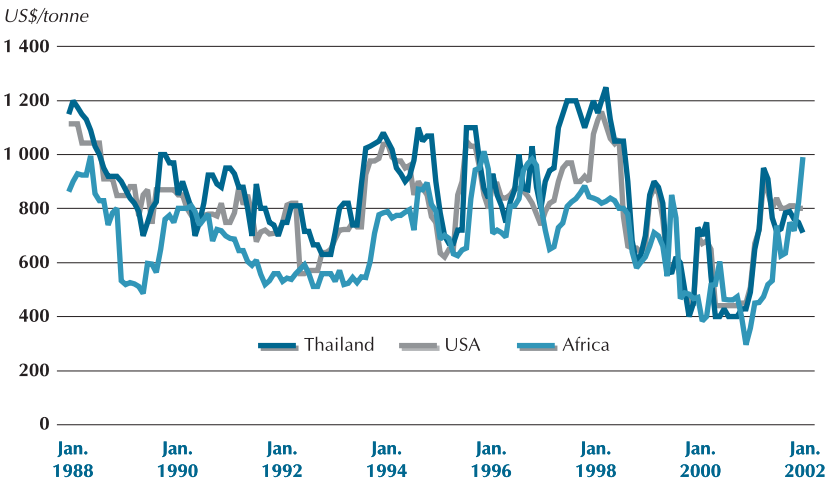
The disease problems that affected Ecuador and Central America in 1999 led to lower production of cultured shrimp in 2000 and also in 2001. Thailand continues to be the main shrimp aquaculture producer, with 250 000 tonnes, and cultured shrimp production is growing after the disease problems experienced there in 1996 and 1997.

FIGURE 32
Shrimp prices (wholesale) in the United States and Japan



Note: Frozen, headless, shell-on, 16–20 count.
Source: FAO GLOBEFISH

FIGURE 33
Skipjack tuna prices (c&f) in the United States, Thailand and Africa



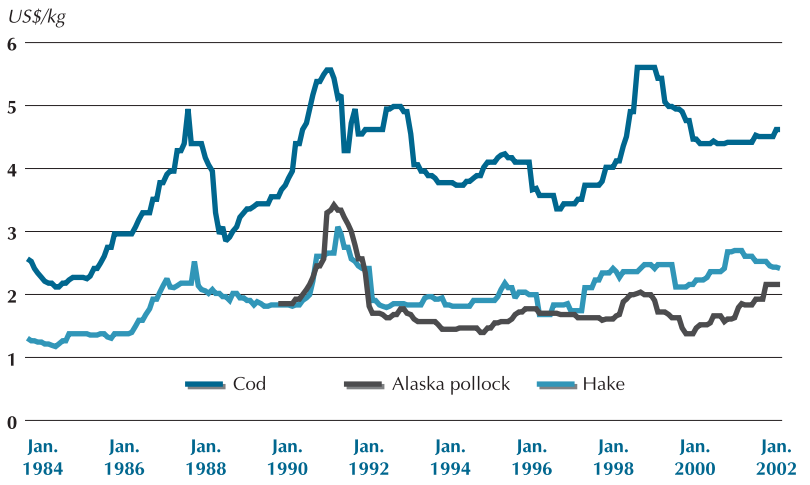
Notes: 4.5–7.0 lb.For Africa: ex-vessel Abidjan, Côte d'Ivoire.
Source: FAO GLOBEFISH

Tuna

Tuna catches were strong in 1999, and skipjack prices declined to an unprecedented low, making fishing uneconomic. In mid-2000, the main tuna vessel owners created an organization with the aim of normalizing the market. This organization introduced stringent catch reduction programmes, which had an immediate effect on prices. During the course of 2001, members of the organization met regularly to ensure that catch reduction continued. Skipjack prices, which hit a low of US$350 per tonne in mid-2000, recovered to reach US$700 to $750 per tonne in May 2002 (Figure 33).

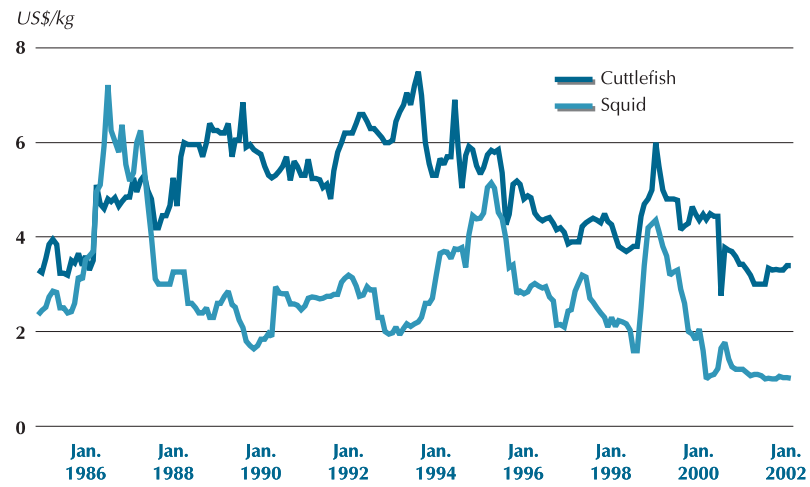
Thailand continues to be the main exporter of canned tuna to the United States market, but lower exports were experienced in 2001. The Philippines remained in second position. The use of tuna loins by Italian canners continues to expand. Loins as raw material now account for

FIGURE 34
Groundfish prices (c&f) in the United States



Note: Blocks.
Source: FAO GLOBEFISH

FIGURE 35
Cephalopod prices (wholesale) in Japan



Note: Cuttlefish – whole, 10 kg/block, 0.4–0.6 kg/pc; squid whole, 7.5 kg/block, 21–25 pc/kg.
Source: FAO GLOBEFISH

about 70 percent of total Italian canned tuna production. Ecuador and Colombia are benefiting from their special duty-free status as Andean community countries and are increasing their shipments to the EC.

Groundfish

Groundfish supply was very limited in the first half of 2001. Alaska pollock supply was reduced in all main markets, and cod and hake also reported lower catches and less availability. Prices did not rise as much as expected (Figure 34), as other species (salmon and tilapia) are replacing groundfish in many markets.

Cephalods

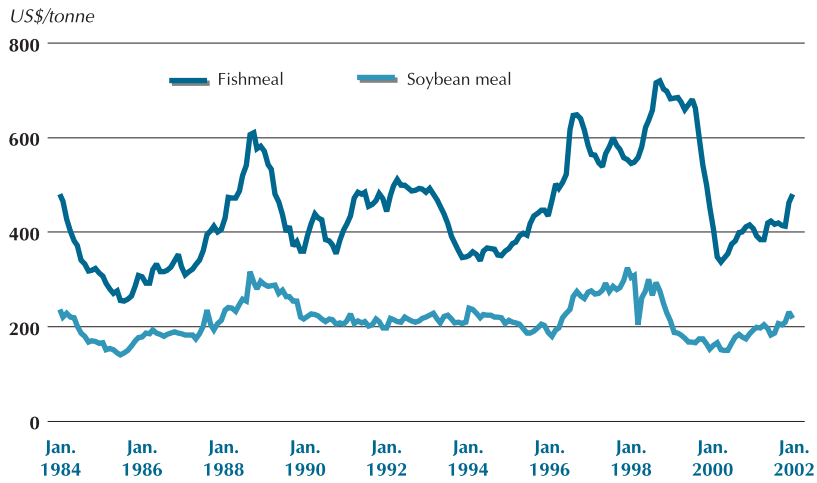
Squid fisheries were low in 2001; especially Illex catches from the Southwest Atlantic. Octopus catches in the Eastern Central Atlantic were good at the beginning of 2001, leading to higher exports to Japan. In a move to protect its octopus industry, the Moroccan Government fixed a minimum price. Japanese traders considered this price too high, however, and sales in this market dropped by 40 percent in 2001 compared with 2000 (Figure 35).

Fishmeal

The bulk of fishmeal production – about 60 percent – is exported each year. In 2001, fishmeal production was an estimated 5.4 million tonnes, a 12 percent decrease from 2000. Various fishing bans and problems with jack mackerel resources in Chilean waters were the main cause of the reduced catch. Peruvian production was also relatively low. In 2001, the bovine spongiform encephalopathy (BSE) scare overshadowed the fishmeal market in Europe because, early that year, the EC prohibited the use of fishmeal in ruminants' diets. In most plants in the

EC, feed for non-ruminants is prepared on the same production lines as feed for ruminants, and the legislation resulted in lower use of fishmeal in pig and poultry feeds as well. Peru and Chile lodged a complaint with the World Trade Organization (WTO) Sanitary and Phytosanitary (SPS) Committee (October 2001) to persuade the EC to lift the current restrictions on fishmeal usage. Fishmeal prices (Figure 36) are expected to increase as a result of good demand, especially from China and other Asian countries.

FIGURE 36
Fishmeal and soybean meal prices (c.i.f.) in Germany and the Netherlands



Note: Fishmeal – all origins 64–65%, Hamburg, Germany; soybean meal – 44%, Rotterdam, the Netherlands.
Source: OIL WORLD; FAO GLOBEFISH

Fish oil

The overall climate of the fish oil market was good in 2001, with strong price improvements. Fish oil production in 2001 was slightly lower than in 2000, and there was little availability of fish oil on the market at the beginning of 2002. Competing vegetable oils seem to be in shorter supply than was initially forecast, and their prices are expected to move up. As a result, a further increase in fish oil prices is likely.

INTERNATIONAL FISHERIES POLICY AND GOVERNANCE

Changing forces in fisheries management

Fisheries policies and management strategies the world over are in a state of flux. Fisheries policy-makers and administrators are increasingly recognizing that fisheries resources must be developed and used in ways that are sustainable. However, continued attempts to use fisheries as the key to solving a complex web of social and economic issues threaten to overwhelm the basic fact that, if these resources are overfished, they will not sustain either social or economic development.

Especially where there is no integrated area management, fisheries management efforts are increasingly complicated by the impacts of a diversity of other activities – such as urbanization, shipping, tourism, deforestation and industrial wastes – on the heavily interdependent elements of the aquatic environment. There is growing recognition that principles, policies and mechanisms for identifying and prioritizing the uses of aquatic areas must be put in place so that the impacts of other sectors' activities on fisheries can be addressed. The need to implement ecosystem-based fisheries management is also being emphasized (see Implementing the ecosystem approach to capture fisheries management, Part 2, p. 55).

In both inland and marine fisheries, the pressures of intensified use, combined with other sectors' intensified use of the areas in which fisheries occur, are slowly but surely refocusing fisheries management on ways of allocating limited fisheries resources among growing numbers of stakeholders. There is growing recognition that overfished resources cannot serve as social security nets or food sources without creating civil strife over who can gain access to, and consume, the remaining fish and that overfished resources cannot be used as a platform from which to promote the ongoing support of profitable industrial fleets. Conflicts and conflict management are becoming key elements of fisheries management activities as the objectives of fisheries legislation and management rapidly expand to accommodate social, economic and environmental

considerations.

In short, the demands of fisheries management have grown beyond the need to address purely biological issues, and must now address and attempt to resolve an array of social concerns and multiple-use issues. As a result, there is an urgent need to reconsider the use of many of the management approaches that have been used to date.

Current management

There is a steadily growing collective will in the international community of politicians and civil society to recognize and support the key role that fisheries play in economic development, food security, poverty alleviation and human health.

Developing countries are continuing their efforts to clarify the linkage between development activities and sustainable resource use. Both population and economic growth are putting enormous additional pressures on inland and marine fishery resources as contributors to food security and providers of a social safety net. At the same time, the use of domestic fisheries to generate foreign exchange is exacerbating allocation issues between artisanal and industrial fleets. The challenges facing developing countries, together with the need for capacity building, are making management (particularly allocation) a difficult task, but there are growing signs that these efforts will have an enduring positive effect on civil and economic development.

In developed countries, legislated principles of sustainability are driving fisheries management efforts to reverse the effects of previous overfishing, and efforts to address overcapacity are receiving considerable attention, although progress is slow. However, as developed countries focus on reducing overcapacity, increasingly intricate technical and social issues are complicating the efforts of fisheries managers. The impacts of displacement and redeployment – of both people and vessels – are becoming the most important, difficult and contentious elements of fisheries management.

Technical measures (e.g. gear, time and area restrictions) continue to dominate fisheries management efforts as methods for achieving the conservation of fish stocks. Such measures are globally recognized as having the potential to be effective, particularly in fisheries where overcapitalization is not a problem. However, there is also an increasing awareness that there are issues of overcapitalization in many fisheries and that, in such cases, these types of fisheries management measures have either failed to result in the conservation or sustainable use of fish stocks, or have only succeeded at considerable cost to society.

Furthermore, as resources become scarcer and are shared by increasing numbers of users, there is a growing awareness that the escalating economic and social costs arising from the use of technical measures need to be compensated for. Thus, as civil society is demanding both stock sustainability and an accounting of the economic and social costs of managing fisheries resources, there is inevitable pressure on managers to consider new or, at the very least, different approaches.

The use of incentives that affect fishers' behaviour and create opportunities for both conservation and economic efficiency is gradually drawing more attention. Despite the inherent benefits of such incentive-based management strategies as community-based quotas, territorial use rights and transferable quota systems, their uptake and application in the fisheries arena are not rapid. One possible alternative to the use of win-win approaches is the consistent and persistent growth of market-based business strategies, such as ecolabelling schemes, which aim to harness market forces and create financial rewards for people working in fisheries and satisfying sustainability and various social criteria.

In many instances, discussions regarding the adoption of incentive-based systems tend to be dominated by concerns relating to initial allocation formulas, consolidation and the exit and entry of participants – all of which can be accommodated in the design process. These concerns are understandable because such management strategies create very strong market incentives and tend to be implemented as a last resort when fisheries stocks are under pressure,

overcapitalization is present and participants are unlikely to be in a position to alter their investment strategies. Unfortunately, however, discussions also tend to ignore the many lessons to be learned from the numerous and varied solutions that have emerged worldwide for coping with just such design concerns.[2]

At present, in part because the incentives generated by many regulatory controls are not being considered, fisheries management efforts regarding overcapacity are primarily concentrating on measuring, coping with and reducing it. Although such efforts are much needed, more emphasis should be placed on management strategies that prevent the initial development of overcapacity, thus avoiding the difficult and socially disruptive consequences of trying to reduce it.

Emerging needs

Several different management approaches are emerging as ways of coping with management pressures. Increasingly, managers are seeking to optimize the use of public fisheries resources by devolving management to local levels, where there is a stronger sense of ownership, and through clearer definition of the community to which a resource may belong.

Efforts to broaden the involvement of stakeholder groups and make fisheries management decision-making more inclusive and representative are being made at all levels, from the international to the very local. Unfortunately, however, in the absence of a concomitant devolution of legislative, managerial, financial and administrative capacity, as well as of much-needed political will, many of these efforts do not fulfil their potential for building on local knowledge and skills. As a result, they tend simply to shift the responsibilities for management without necessarily passing the tools and opportunities that are needed for management success (see, for example, Regional fisheries governance, p. 48).

In other situations (especially where there have been conflicts over the sharing and de facto, if not explicit, allocation of limited or special fisheries resources), stakeholders have begun to turn to alternative fora such as private contractual agreements to resolve managerial and administrative fisheries issues. Such agreements have already been made between particular fishing companies and local communities, between fishers and processors and among members of fisheries organizations. Perhaps the most extreme examples of efforts to bring about more durable, effective and efficient outcomes are non-governmental initiatives from the conservation sector, the private sector and joint industrial–conservation partnerships. By challenging or supplanting existing administrative processes through the intensified use of legal and/or political platforms to achieve their results, such agreements circumvent the existing due processes of fisheries management authorities to bring about faster solutions.

The standard skills base for administering fisheries management needs to undergo rapid changes. Expanded demands on administrators, as well as budgetary constraints, are testing the capacity and capabilities of fisheries administrations the world over. As the principles of sustainable development are adopted, administrators become increasingly accountable for social, economic, financial, legal and governance issues, in addition to conventional conservation matters that draw on information from the natural sciences.

The growing demands of both consumers and harvesters, and the relatively limited capacity of fisheries resources are leading to conflicts over resource sharing. As a result, administrators and stakeholders, alike, need to learn and use a range of conflict management, alternative dispute resolution and mediation techniques.

The growing gaps in developed countries among international norms and regional and national legislative requirements, as well as the inevitable limits on budgets and scientific information, are creating an urgent need for capacity building. The expansion of alternative

[2] See, for example, the discussions on initial allocations of transferable fishing (effort) or fish (catch) quotas for more than 23 fisheries in: FAO. 2001. Case studies on the allocation of transferable quota rights in fisheries. FAO Fisheries Technical Paper No. 411. Rome.

approaches, including precautionary approaches and those based on risk assessment, is beginning to mitigate the absence of detailed stock information with cost-effective and practical measures. At the same time, the practical aspects of expanding fisheries management to include entire ecosystems (see Implementing the ecosystem approach to capture fisheries management, Part 2, p. 55) are stretching the administrative and budgetary limits of fisheries management agencies.

Both developed and developing countries are grappling with the impacts of globalized trade on all aspects of the fishing industry. The fast-moving and far-reaching issues of catch certification, trade documentation and food quality assurances are creating incentives that alter harvesting, production and marketing strategies far more quickly than many fisheries administrations and regulatory processes can keep up with (see Catch certification and catch documentation, Part 2, p. 65). Although these changes are inevitable and not necessarily undesirable, many current management strategies are not equipped to cope with them. Issues of increasingly globalized trade, especially in developing countries, are altering incentives relating to industrialized fisheries and their ability to raise foreign exchange and drive economic development, but the strategic policy or planning groups of fisheries management agencies often do not include trade and development specialists.

Regional fisheries governance

The international community places great importance on subregional and regional fisheries cooperation in the conservation and management of fisheries. This is because many fish stocks are transboundary in character and cannot be managed by a single state.

Since 1945, some 30 subregional and regional RFMOs and arrangements have been established. Chapter 17 of Agenda 21, the United Nations Programme of Action from UNCED, the 1995 United Nations Fish Stocks Agreement and the 1995 FAO Code of Conduct for Responsible Fisheries highlight the role of RFMOs in implementing management measures designed to secure long-term sustainable and responsible outcomes.

The principle task of most RFMOs is to manage fisheries. Some of them do this well, others do not. Why are some of them underperforming? How can regional fisheries governance be strengthened?

International fora, such as the FAO Committee on Fisheries (COFI) and academic journals, discuss the role and activities of RFMOs. Discussion usually focuses on organizational efficiency and the nature and extent of their work, but it is difficult to assess performance in the absence of agreed benchmarks. At an FAO meeting in 2001, RFMO representatives supported, in principle, the need to develop performance indicators for RFMOs and related guidelines, while recognizing that some organizations already used sustainable development indicators to assess their performances.

Inaction is the main manifestation of underperformance. Inaction is an issue for most RFMOs because they work through consensus, which is often very difficult to achieve. Reducing the possible sources of conflict would seem to be a good way of enhancing trust among members. To that end, it has been suggested that each RFMO should establish agreed scientific standards for stock assessment, procedures for revising allocation, information sharing concerning foreign fleets, and standards in respect of port state responsibilities.

Despite the shortcomings in regional fisheries governance, some RFMOs have focused on innovative regional cooperation as a means of enhancing management. Innovations have been adopted to address IUU fishing. Both contracting and non-contracting parties to RFMOs, as well as flag vessels from open registries, have been involved in IUU fishing, which undermines efforts to manage fisheries in a responsible manner. Port and trade measures to deter the laundering of IUU-caught fish are being promoted and implemented by a growing number of RFMOs. Such measures are quite revolutionary, and until recently they would not have been considered appropriate for combating fisheries management problems. This new situation indicates a change in mood on the part

of the international community in its desire to curb IUU fishing and related practices.

A burning issue for RFMOs is their capacity and willingness to accommodate new entrants in a fair and consistent manner. Failure to address membership, capacity, allocation and equity issues could endanger the future work of RFMOs and lead to increased IUU fishing. The lack of agreed criteria caused a split in the International Commission for the Conservation of Atlantic Tunas (ICCAT) in recent years, hampering the organization's ability to deal productively with other problems. In late 2001, however, ICCAT reached an innovative solution for dealing with allocations, including those for new entrants.

RFMOs are needed to facilitate and reinforce regional cooperation. Over the next decade, RFMOs will face the challenge of implementing parts of Agenda 21, the 1995 UN Fish Stocks Agreement and the 1995 FAO Code of Conduct for Responsible Fisheries. However, unless RFMO members cooperate more closely and are prepared to take difficult decisions, which could have adverse short-term social and economic costs on their way to achieving longer-term sustainability gains, even large amounts of scientific research, funding and enforcement will not improve the effectiveness of these organizations.

In order to strengthen the work of RFMOs in a real and effective manner, some basic issues concerning performance must be addressed. States must commit themselves to initiatives that provide the necessary mitigation measures, even though those initiatives might also disadvantage fishers in the short term. Difficult choices must be made to support sustainable solutions. The greater involvement of stakeholders, including industry, in the work of RFMOs could enhance their performance and effectiveness, especially if they are convinced of the need to implement tough and difficult decisions.

Implementation of the 1995 United Nations Fish Stocks Agreement

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 (1995 UN Fish Stocks Agreement) was adopted on 4 August 1995. It entered into force on 11 December 2001, one month after the thirtieth instrument of ratification or accession had been deposited with the Secretary-General of the United Nations.

The purpose of the 1995 UN Fish Stocks Agreement is to facilitate the implementation of certain provisions of the 1982 United Nations Convention on the Law of the Sea (1982 Convention) concerning the conservation and management of straddling fish stocks and highly migratory fish stocks. The agreement complements the 1993 FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (1993 FAO Compliance Agreement) and the 1995 FAO Code of Conduct for Responsible Fisheries.

Implementation of the 1995 UN Fish Stocks Agreement presents major challenges for both states and subregional or regional RFMOs. Underpinning its implementation is the requirement for concerted international cooperation. States that adhere to one or both of these agreements, either directly or through RFMOs, are obligated to cooperate to ensure the effective conservation and management of straddling fish stocks and highly migratory fish stocks.

Even before the agreement entered into force, states – individually and in cooperation with each other – had been engaged in a range of initiatives designed to promote its implementation. Since 1995, some states have adopted new laws and/or regulations to ensure that they are in a position to exercise greater flag state control over the activities of their flag vessels when those vessels are operating on the high seas. Moves to strengthen these controls have gathered momentum as the concerns regarding IUU fishing have increased in international fora, including sessions of the United Nations, FAO and RFMOs (see Box 8). States' political will to address these and related conservation and management problems, which undermine the work and effectiveness of RFMOs, has been highlighted as being essential to meeting the challenges of these

BOX 8
Illegal, unreported and unregulated fishing

IUU fishing and its impact on resource sustainability is a matter of high international concern. It is recognized that if IUU fishing and its related activities are not addressed effectively and holistically, efforts by national administrations and RFMOs to manage fisheries responsibly will be undermined.

With this situation in mind, on 2 March 2001 the Twenty-fourth Session of COFI adopted by consensus the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU). Subsequently, on 23 June 2001 the FAO Council, at its Hundred-and-twentieth Session, endorsed the IPOA-IUU.

The IPOA-IUU is a voluntary instrument concluded within the framework of the 1995 FAO Code of Conduct for Responsible Fisheries. It encourages action by states and RFMOs to address IUU fishing. The IPOA-IUU is innovative in a number of respects, especially regarding the use of internationally agreed market-related measures to combat IUU fishing. Significantly, the IPOA-IUU calls on states to develop and implement national plans of action – aimed at achieving the goals of the IPOA – not later than three years after its adoption (i.e. 23 June 2004).

To support the implementation of the IPOA-IUU, FAO has issued Technical Guidelines for Responsible Fisheries No. 9, Implementation of the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (2002, Rome). This document provides practical guidance on implementation of the IPOA-IUU for states, RFMOs and other interested parties. To disseminate information about the IPOA-IUU, FAO has also issued a non-technical document entitled Stopping illegal, unreported and unregulated fishing. It is intended to provide information to fishers, fishing communities and the public.

Source: D. Doulman, FAO Fisheries Department.

concerns.

The 1995 UN Fish Stocks Agreement places RFMOs in a pivotal and central position in terms of its implementation; they provide the primary mechanism through which participating states should cooperate to achieve enhanced resources conservation and management. Some RFMOs whose mandates extend to the conservation and management of straddling and highly migratory fish stocks have reviewed, or are in the process of reviewing, certain provisions of their respective conventions to ensure that they are consistent with the agreement. In some cases, substantial changes to conventions have been proposed or introduced. Despite these developments, however, RFMOs are grappling with practical aspects of the agreement's implementation, such as how to apply the precautionary approach in fisheries management, how to implement ecosystem management and how to address transparency.

The 1995 UN Fish Stocks Agreement has spawned two new RFMOs: one dealing with the management of straddling fish stocks and the other with highly migratory fish stocks.

The initiatives to establish the Southeast Atlantic Fisheries Organization (SEAFO) and the Western and Central Pacific Tuna Commission were taken essentially for the same reasons, and had the goals of:

- putting the 1995 UN Fish Stocks Agreement into effect in the Southeast Atlantic and the Western and Central Pacific; and
- establishing RFMOs where none previously existed.

Southeast Atlantic Fisheries Organization

The Convention on the Conservation and Management of Fisheries Resources in the South East Atlantic Ocean, which paves the way for the establishment of SEAFO, opened for signature on 20 April 2001. Its purpose is to ensure the long-term conservation and sustainable use of the

fishery resources in the convention area through effective implementation of the convention. Negotiations for the establishment of SEAFO took place over a five-year period. When it opened for signature, the convention was signed by seven states and the EC.

The convention area is based on FAO's Statistical Area 47. It covers high sea areas only, and abuts the EEZs of four coastal states: Angola, Namibia, South Africa and the United Kingdom (the overseas territory of Saint Helena and its dependencies of Tristan da Cunha and Ascension Island).

SEAFO will manage stocks that straddle the EEZs of coastal states and the adjacent high seas. Species subject to management may include alfonsino, orange roughy, armourhead, wreckfish and deepwater hake. SEAFO will also manage discrete high seas stocks, such as that of red crab, even though discrete stocks are not subject to the provisions of the 1995 UN Fish Stocks Agreement. The management of these latter stocks is a logical and practical consequence of the characteristics of the region's geography, stocks and stock distribution, and fisheries management needs. The convention does not address the management of highly migratory stocks, as these are already subject to management by ICCAT.

Key aspects of the SEAFO Convention are the establishment of a commission, a secretariat and compliance and scientific committees; the application of the precautionary approach, contracting party obligations,[3] flag state duties, port state duties and measures taken by a port state; observation, inspection, compliance and enforcement; decision-making; cooperation with other organizations; ensuring the compatibility of conservation and management measures and fishing opportunities; recognition of the special requirements of developing states in the region and of non-parties to the convention; and implementation.

The Government of Namibia has established an interim secretariat to facilitate implementation of the convention. It will fulfil this role pending the convention's entry into force and the full implementation of administrative arrangements. The interim secretariat will implement interim arrangements relating to the authorization and notification of fishing vessels, vessel requirements and scientific observation, and the collection of information to support stock assessment.

[3] Contracting party obligations in Article 6(a) require that a party ensure that its nationals fishing in the convention area and its industries comply with the provisions of the convention.

Commission for the Conservation and Management of Highly Migratory Fish stocks in the Western and Central Pacific Ocean

The Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean opened for signature on 5 September 2000 after four years of complex and intense negotiations. Over the 12-month period that the convention was open for signature, 19 states signed it. In addition, a representative of Taiwan Province of China signed an Arrangement for the Participation of Fishing Entities on 5 September 2000.

The convention provides a balance between coastal state and Distant Water Fishing Nation (DWFN) interests in a number of important areas (e.g. entry into force of the convention and decision-making). It will enter into force 30 days after the deposit of instruments of ratification, acceptance, approval or accession by three states situated north of the 20 °N parallel (i.e. DWFN) and seven states situated south of the 20 °N parallel (i.e. coastal states of the region). If within three years of its adoption (i.e. by September 2003) the convention has not been ratified by three states situated north of the 20 °N parallel, it will nevertheless enter into force six months after the deposit of the thirteenth instrument of ratification, acceptance, approval or accession.

The purpose of the convention is to ensure the long-term conservation and sustainable use of highly migratory fish stocks in the Western and Central Pacific Ocean through effective management, in accordance with the provisions of the 1982 Convention and the 1995 UN Fish Stocks Agreement. The convention applies to the management of all highly migratory fish stocks in the region, but principally to the highly valuable and extensive tuna species in the convention

area – especially skipjack, yellowfin, bigeye and Southern albacore tunas.

The convention area is extensive, covering a tract of the Pacific Ocean that is defined by geographic coordinates in the south and east. In the west and north, because of a number of difficult and sensitive political issues, boundaries are defined by reference to the migratory range of the stocks. In this way the commission, based on its cooperative arrangements with other relevant RFMOs, will define the area of applicability of conservation and management measures for particular species.

The convention seeks to build on established regional arrangements that have been tried and tested (e.g. the regional observer scheme) and to minimize costs and avoid duplication through the use of existing regional organizations (e.g. the scientific expertise of the secretariat of the Pacific Community's Oceanic Fisheries Programme).

The convention provides for, inter alia, the establishment of a commission, a secretariat and scientific and technical and compliance committees; decision-making, transparency and cooperation with other organizations; obligations of members of the commission; duties of the flag state; compliance and enforcement, a regional observer programme and regulation of transhipment; requirements of developing states; peaceful settlement of disputes; and requirements regarding non-parties to the convention.

In preparation for the convention's entry into force, the final session of the Western and Central Pacific Ocean Tuna Conference established a preparatory conference, which started work in April 2002. Its purpose is to establish the organizational and financial framework for the new commission and its subsidiary bodies, in order to ensure that, when established formally, the commission will commence operations effectively and with minimum delay. The conference will also begin the process of collecting and analysing data on the status of the fish stocks and, if necessary, recommend conservation and management measures. It is envisaged that the preparatory conference will complete its work by September 2003. ◆

PART 2

Selected issues facing fishers and aquaculturists

Selected issues facing fishers and aquaculturists

IMPLEMENTING THE ECOSYSTEM APPROACH TO CAPTURE FISHERIES MANAGEMENT

THE ISSUE

In recent years there has been a growing awareness that the traditional approach to managing fisheries, which considers the target species as independent, self-sustaining populations, is insufficient. It is being recognized that sustainable use of the world's living aquatic resources can only be achieved if both the impacts of the ecosystem on the living resources and the impacts of the fishery on the ecosystem are explicitly identified and, as far as possible, understood. It is also being formally acknowledged that fishers are an integral part of the ecosystem and that both ecosystem and human well-being must be achieved.

Awareness of the essential interactions between populations and their biological, physical and chemical environment is not new. As early as 1376, a group of fishers from the Thames estuary in the United Kingdom expressed their concern to King Edward III of England about the ecosystem impacts of the wondrychoun, a form of beam trawl, which they believed would cause "great damage of the common's realm and the destruction of the fisheries". However, such traditional knowledge was frequently overlooked as fisheries grew rapidly in size and efficiency during the nineteenth and twentieth centuries and as science-based, quantitative methods were developed as a means of estimating how to adjust fishing power to resource productivity. Using the most readily available data from fisheries, simple single-species models became the preferred assessment tool. These models focused all attention on the target resources and on the impact that fishing removals had on their dynamics.

The single-species approach is not the only cause of the widespread inadequacy of conventional fisheries management regimes. However, the dangers and limitations of treating fish populations as entirely self-regulating is well illustrated by examples that include the highly variable small pelagic resources of upwelling systems, the suspected species replacements in areas such as the Georges Bank, and the impacts of riverine and coastal developments on, for example, salmon, sturgeon and shrimp stocks in many areas.

POSSIBLE SOLUTIONS

Fisheries managers and scientists have been slow to respond to the growing evidence that the ecosystem should be considered as a whole. Progress has been impaired by the lack of good-quality, relevant data; the poor understanding of population, ecosystem and fishery dynamics and interactions; and the absence of a credible alternative operational management paradigm. The UN Convention on the Law of the Sea of December 1982 does not explicitly provide for an ecosystem approach to fisheries, even though its main focus in relation to fisheries is with the "living resources" of the sea and the environment. Nevertheless, it does include some provisions that recognize the interdependence of target species with other marine organisms and their dependence on their environment.

By the time that the FAO Code of Conduct for Responsible Fisheries (the Code) was adopted by FAO members in November 1995, the principles of an ecosystem approach to fisheries had started to emerge, including in non-fisheries instruments (such as the Convention on Biological Diversity). The Code reflects this, and includes many important ecosystem considerations that are of relevance to fisheries. In the Introduction to the Code, it is stated that: "The Code sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity." Throughout the Code there are references to different ecosystem considerations, and Article 6 requires states to conserve aquatic ecosystems

(Paragraph 6.1). Paragraph 6.6 advocates that: "Selective and environmentally safe fishing gear and practices should be further developed and applied ... in order to maintain biodiversity and to conserve the population structure and aquatic ecosystems" while Paragraph 7.2.2 specifies that management measures should provide for, among many other factors, conservation of biodiversity, consideration of environmental impacts and minimization of deleterious impacts, such as pollution, discards, catch of non-target species and impacts on associated and dependent species. Effective adherence to these and other provisions of the Code would go a long way towards very effective implementation of an ecosystem approach to fisheries (EAF).

The holistic foundations of the Code were further boosted by the Kyoto Declaration made by the 95 country delegations that met in Kyoto, Japan, from 4 to 9 December 1995 for the International Conference on the Sustainable Contribution of Fisheries to Food Security. These countries declared that they would "base policies, strategies and resource management and utilization for sustainable development of the fisheries sector on the following: i) maintenance of ecological systems; ii) use of the best scientific evidence available; iii) improvement in economic and social well-being; and iv) inter- and intragenerational equity", thereby explicitly linking maintenance of ecological systems with fisheries and fisheries management.

The ecosystem approach to management of the oceans and their resources was consolidated in Agenda 21. Review and coordination of the implementation of these aspects among United Nations agencies was facilitated by the now dissolved Sub-Committee on Ocean and Coastal Areas (SOCA) of the Inter-agency Committee on Sustainable Development (IACSD), operating under the umbrella of the UN Administrative Committee on Coordination (ACC).

At its Ninth Session in July 2000, SOCA considered the need to improve coordination and synergies between regional organizations for fisheries and those for the marine and coastal environment. It concluded that both types of bodies could regard the challenge posed by the development of ecosystem approaches to fisheries management and integrated coastal management as a potential platform for practical cooperation.

As a first step in this direction, it was agreed that a paper centred on ecosystem-based management in fisheries would be developed jointly by FAO and the United Nations Environment Programme (UNEP) and would serve as the basis for potential cooperation among competent regional organizations. The paper summarizes the work that regional organizations have undertaken in relation to ecosystem-based management, outlines possible mechanisms for cooperation, and identifies issues for further consideration. It was subsequently discussed at meetings, both of regional seas conventions and of FAO and non-FAO regional fishery bodies (RFBs).

RECENT ACTIONS

The latest step in the slow process towards formal, global acceptance of the need to manage fisheries as integral components of dynamic ecosystems came with the Conference on Responsible Fisheries in the Marine Ecosystem, which was organized by FAO and the Government of Iceland, with support from the Government of Norway, in Reykjavik in October 2001. At the end of this conference, the Reykjavik Declaration was adopted, including the pledge that the signatory nations would "in an effort to reinforce responsible and sustainable fisheries in the marine ecosystem, ... work on incorporating ecosystem considerations into that management to that aim."

The intent is therefore now firmly in place, but there is still considerable uncertainty as to exactly what is entailed by EAF, and how to implement it. To this end, the Reykjavik Conference requested FAO to develop draft guidelines to be presented at the Twenty-fifth Session of the Committee on Fisheries (COFI) in 2003. This work is in progress, and the guidelines have not yet been finalized. Nevertheless, some EAF principles are widely accepted and will almost certainly feature prominently in the guidelines. These principles are already reflected in the Code and are summarized in the following:

- The first step in implementing EAF is to identify and describe the different exploited ecosystems and their boundaries as discrete entities for the purposes of management. Such classification will be guided by the available knowledge of existing fisheries and target stocks, as well as by other information. A degree of pragmatism will be required for this, as all ecosystems have open boundaries across which exchanges occur. However, the definitions should aim to identify units that are largely independent of surrounding areas, and can therefore be effectively managed as individual entities. This problem, albeit on a far smaller scale, will be familiar to fisheries managers who have already experienced a similar lack of clarity when trying to identify reproductively isolated stocks for management purposes. The definitions of ecosystems should include lists of species of importance, identifying particularly vulnerable or endangered ones, and descriptions of the habitats that are critical for the productivity of the ecosystem.
- Once the ecosystem units have been identified, management objectives must be developed for the fisheries of the ecosystem as a whole in order to facilitate obtaining the optimal benefits in a sustainable manner. In accordance with the UN Law of the Sea and the Code, this should involve – as far as possible – the maintenance or rebuilding of the ecosystem, its habitats and its biodiversity to a status that is capable of supporting all species at levels of maximum production. Clearly, within the goal of optimizing benefits from the system as a whole, there will also be the familiar objectives of conventional fisheries management, which cover economic, social and biological desires at a range of species and fisheries scales. However, in EAF, it is also necessary to recognize the ecosystem interactions and constraints, and to take steps to reconcile the wider objectives so that they are all simultaneously achievable, rather than in conflict. In striving for this reconciliation, the equitable allocation of resources remains a central challenge.
- The objectives of EAF must, of course, go beyond those of the individual fishery or even fisheries sector. Broader objectives must also be considered, including: protection and restoration of critical habitats and nursery and spawning areas; maintenance of the quality, diversity and availability of resources; restoration or rehabilitation of populations and stocks, as far as is reasonably possible; and conservation of biodiversity and population structure. Economic and social objectives should also be considered at this wider ecosystem scale by, for example, taking account of rural livelihoods and other socio-economic activities that have an impact or are dependent on the ecosystem.
- As already stated, the potential conflicts and inconsistencies in these objectives need to be reconciled in order to arrive at a set of simultaneously attainable objectives encompassing biological, ecological, economic, social and institutional concerns. This is likely to be the most contentious part of EAF implementation and will require full consultation with all the legitimate interested parties in order to ensure their support and collaboration.
- Once the objectives have been identified and agreed, suitable reference points or sustainability indicators will need to be established through which to inform managers and interested parties on how successful they are being in achieving objectives or remaining within constraints. The reference points must reflect the range of objectives agreed and be based on the best scientific evidence available. The Scientific Committee for Oceanic Research of the Intergovernmental Oceanographic Commission (IOC), with input from FAO, is currently considering suitable reference points for EAF through its Working Group on Quantitative Ecosystem Indicators for Fisheries Management (see: www.ecosystemindicators.org/).
- Clearly, an effective monitoring system will be required to ensure that the state of the ecosystem can be followed through time and can be compared with the reference points, allowing for corrective action when necessary.

- In fisheries management, management measures are the tools that are used to achieve objectives. Many of the measures that are available for EAF will be the same as those used in conventional single-species management: input controls, output controls, technical measures covering gear and vessel controls, and area and time restrictions. The fundamental needs to avoid excess fishing capacity and to ensure economic conditions that promote responsible fisheries are as important for EAF as they are for single-species approaches. However, fisheries control measures will have to be developed and extended to apply to the broader scope of EAF, and controls on non-fishery users need to become a part of an ecosystem approach to fisheries management. Considering ecosystems instead of single populations will highlight the high levels of uncertainty concerning the status and dynamics of ecosystems and their elements, and intelligent application of the precautionary approach is central to EAF.
- The problems associated with open access systems and systems in which access rights exceed the production capacity of the resources are now a well-known cause of management failure in fisheries. This problem is going to be at least as serious in implementing EAF, and the allocation of various forms of explicit, legally enforceable fishing and other use rights is integral to EAF. In allocating these rights, it is necessary to consider all aspects of the ecosystem and the impacts of all its users, whether they use the ecosystem directly or indirectly. Thus, not only will fishing rights need to be considered, but also development rights, pollution rights, tourism rights and others.
- Implementing EAF entails explicit recognition of the full range of users that have an impact on the ecosystem, and it is necessary to establish effective consultation and decision-making processes for regular consultation with all legitimate stakeholders. EAF's involvement of a broader range of interest groups is likely to require greater time and costs for consultation and decision-making, but is essential for ensuring compliance and cooperation.

FUTURE PERSPECTIVE

Through their support of the Code of Conduct (reinforced by the Kyoto and Reykjavik Declarations) and of the various FAO International Plans of Action, most fishing nations of the world have committed themselves to striving to achieve EAF in order to "contribute to long-term food security and to human development and to assure the effective conservation and sustainable use of the ecosystem and its resources" (Reykjavik Declaration). This could be facilitated by improved relationships between regional fisheries and regional environmental organizations. The instruments establishing both types of institution do not generally provide an explicit mandate for ecosystem-based fisheries management, but there are some exceptions. The International Council for the Exploration of the Sea (ICES), the Commission for the Conservation of Antarctic Living Resources (CCAMLR), the International Baltic Sea Fishery Commission (IBSFC) and other fisheries institutions have undertaken work that is relevant, responsive, sound and credible with respect to marine ecosystems and their relation to humanity. In addition, the work of environmental commissions provides good background information that may be taken into account in the ecosystem-based management of fisheries. Extending the number of regional fisheries organizations with a mandate for adopting an ecosystem approach and forging closer links between environmental and fisheries organizations will facilitate the effective implementation of EAF in fisheries around the globe.

Implementation of EAF is likely to be a slow and difficult process, requiring considerable social and economic adjustments within a global environment that is already facing major social and economic problems. Most countries are already struggling to make good progress in implementation of the Code, and will encounter the same difficulties, and some additional ones, as they strive to achieve an effective ecosystem approach in their fisheries management.

Insufficient financial resources, capacity and expertise, as well as competition with other pressing economic, environmental and social needs, are all hindering progress in implementation of the Code. These problems were anticipated for developing countries under Article 5 of the Code, which highlights the special needs of developing countries, but they have not yet been fully addressed.

An ecosystem approach will require the monitoring and assessment of all aspects of the ecosystem, a wider range of management measures, possibly more control and surveillance, and more time dedicated to interacting with a wider range of stakeholders. National management agencies are typically already fully and frequently overstretched, and EAF will require yet more financial and institutional resources and personnel, unless all parties can find means of distributing their skills and labour more effectively and efficiently. Either way, the transition will not be easy and may also prove costly. While an ecosystem approach to fisheries management should deliver increased benefits in the longer term, as ecosystems recover their productivity and structure, there will be transaction costs. Countries will need to make allowance for these costs, and any global-level implementation will require significant assistance to developing countries so that they can meet the transaction costs and raise their capacity to the required minimum level. In all cases, there will also be a need to look for alternative sources of income to help cover the costs of fisheries management; those who benefit most from fisheries are one obvious potential source of such additional funds.

At present there are widespread public and political concerns about the impacts of fisheries on ecosystems. There can be no doubt that these concerns are justified, even if they are sometimes exaggerated. In many countries, fisheries have limited political and economic weight, and in this era of globalization there is a risk that fisheries activities will be seen as expendable and will be curtailed in cases of doubt, unless there is an adequate response from the fisheries sector to the legitimate environmental concerns. This risk adds to the urgency of developing management approaches that provide acceptable results and are adapted to the various characteristics of countries and resources. In the recent political initiatives, from the Code to the Reykjavik Declaration, the global fisheries community appears to be responding to the environmental concerns and to have realized that progress in achieving EAF is essential for the ongoing productivity of aquatic ecosystems and the well-being of society. The incentives for success, therefore, should be high.

RELIABLE STATISTICS AS AN ESSENTIAL BASIS FOR EFFECTIVE FISHERIES MANAGEMENT

THE ISSUE

Fisheries management and statistics

As in all forms of management, the management of capture fisheries involves synthesizing information, analysis and decision-making.[1] Without reliable information, no supportable decisions can be reached, no diagnoses on the state of fisheries can be performed, and no prognoses on the effects of management control can be made. Fisheries management is subject to natural environmental variability and also to long-term changes that may be human-induced, particularly pollution and climate change.

There is thus far more uncertainty and risk in fisheries management than there is in the management of almost any other food sector or industry. Part of the approach to reducing risk lies in improving understanding through better information, more careful analysis and experimentation, and improved decision-making for long-term results.

The importance of fishery statistics and the effects of unreliability

Most methods and approaches to fisheries management require an assessment of fish stocks in terms of their biomass, size or age composition

[1] D. Evans and R. Grainger. 2002. Gathering data for resource monitoring and fisheries management. *In* P.J.B. Hart and J.D. Reynolds, eds. *Handbook of fish biology and fisheries*. Oxford, UK, Blackwell.

and survival, as well as their responses to natural and fishing mortality. Population models, and their dynamics under environmental and human-induced perturbations, are the principal tools. These require data on how much fish has been caught, the size, age or gender of that fish, and the growth and survival rates that it exhibits, as well as additional information on many other factors. In order to make stock assessments relevant to site-specific fisheries management, such additional information might include data on the place and time of capture, the reproductive status and the behaviour of the fish. It is essential to know what is actually being fished from the wild population, as this affects the stock's ability to survive and, most important, to reproduce and repopulate. This is why catch and effort statistics, along with other data regarding the fish caught, are the key and essential basis for effective fisheries management.

Statistics are often also used for direct administrative management control to ensure that fishers are constrained within the set limits. Fisheries management measures often specify how much fish may be taken, by whom, by what means, when and where. Thus, total allowable catch and licence or quota allocation, fishing gear and operational controls, as well as seasonal and area closures, all require monitoring, much of which can only be achieved by the regular and systematic collection of reliable statistics on the catch and the amount of fishing effort.

Fisheries management should protect the food security and livelihoods of dependent communities and try to ensure that benefits from the surplus production of wild stocks are brought into economies in ways that are appropriate to the political, social and development environments in which they occur. Governments and industries need reliable statistics in order to understand the economic relationships within the fisheries sector and its linkages to other sectors, e.g. finance, energy supply or vessel construction. They must plan for training and investment if potential yields are greater than current yields, or for retraining and stable industry reduction if the existing capacity is greater than appropriate. Communities need catch and effort statistics if they are to achieve and ensure a fair and appropriate distribution of benefits. Policy-makers need such statistics so that fishing communities can be properly represented when sectoral policies are being developed. For example, a recent study[2] of inland fisheries in Southeast Asian countries indicates that catches are several times greater than the official statistics and that communities' dependence on fish as a source of protein, as well as their dependence on the fishing livelihoods of subsistence and small-scale fishers, is far greater than officially recognized, resulting in inadequate recognition of fisheries in social, economic, nutritional and environmental policy-making.

In summary, unreliable statistics confound fisheries management on three fronts. They:

- bring greater uncertainty into the stock assessment process, reducing confidence in the accuracy of fisheries management advice and often resulting in conflict among overcautious fisheries managers, overeager fishers and overanxious environmental advocates;
- reduce the public's confidence in the ability of fisheries managers to monitor and manage these national or international natural resources on its behalf, leading to the belief that, in the absence of control, fishers are overexploiting stocks or fishing in inappropriate ways;
- limit economic and social understanding of the position and viability of fisheries sectors, causing uncertainty about human resources, social structure, capital and infrastructure requirements, both in development and for restructuring.

The reliability of fishery statistics

Ever since the modern fisheries era began, the issue of information reliability has pervaded fisheries management, particularly concerning information about the quantity and location of

[2] FAO. 2002. *Inland capture fishery statistics of Southeast Asia: current status and information needs*, by D. Coates. RAP Publication No. 2002/11. Bangkok, FAO Regional Office for Asia and the Pacific. 121 pp.

catches. As early as the sixteenth century, Portuguese fishers jealously guarded their discovery of the great cod fishing grounds of the Grand Banks in the Northwest Atlantic. As capture fisheries approach maximum yields, scientists require more, and more accurate, data on which to base their analyses. Most fishery assessments concerning stocks, fleets and participants will always depend on reliable catch and effort statistics, as will economic and fisheries management advice. Given the increasing demand for food fish and the acceleration of social change, traditional knowledge, which is often rooted in stable communities where it enjoys high levels of credence, is insufficient. Societies, technology and needs change alongside fisheries, and fisheries management must continually adapt to meet new challenges and circumstances. Reliable statistics are the most essential information that is needed.

The range of types of data required to support fisheries management and policy-making is potentially enormous. However, financial or human resource constraints will force management authorities to limit collection to the most important data types. In 1998, FAO published *Guidelines for the routine collection of capture fishery data*,[3] which sets data requirements within a framework of policy/objectives/indicators/strategy. It also offers advice on methods of data collection, data management and the planning and implementation of data collection systems. It is not prescriptive in that it does not offer a list of data types that are always required. Rather, it describes a decision-making framework through which the most appropriate data are collected for the tasks concerned; much of the fisheries information that is collected around the world may be reliable but is of little value. In terms of fisheries management, reliability includes relevance.

There are several other sources of unreliability. Deliberate misreporting or non-reporting by legal and illegal fishers and other participants (processors, traders) is cited by most managers as a key problem, particularly in developed countries and international fisheries. However, in some fisheries, particularly small-scale and developing country fisheries, either there is no law in place that requires fishery data, or there is little infrastructure for the collection of such data. Even when data are collected, they may be based on inadequate sampling or inappropriate sampling design, the origins of which may be lack of finance or trained personnel.

Bias can also be introduced by the statistical authorities, either inadvertently through the application of inappropriate methodologies, or through systematic distortions that are introduced deliberately, for example, to demonstrate that a particular outcome is in line with international obligations (set total allowable catches) or national policy.

Another problem can be lack of timeliness. For statistics to be useful indicators in fisheries management they need to be prepared regularly and within time frames that provide fisheries managers with short-term guidance. Delays in the preparation of statistics can seriously reduce their utility to fisheries managers. Statistics that are five years old but have only just become available may be reliable, but they may have little relevance for today.

The appropriate confidentiality of fishery data is also a factor in understanding the reliability, and hence usefulness, of fishery statistics. A recent report by the United States National Research Council (NRC)[4] concluded that: "Confidentiality of fisheries data is restrictive to the point of hindering both research and management." The report generally accepted that some fishery data have proprietary value and that "some level of confidentiality is necessary to allow fishermen to

[3] FAO. 1998. *Guidelines for the routine collection of capture fishery data*. FAO Fisheries Technical Paper No. 382. Rome. 98 pp. Prepared at an Expert Consultation, held in Bangkok from 18 to 30 May 1998, organized and funded by the FAO/Danish International Development Agency (DANIDA) project "Training in Fish Stock Assessment and Fishery Research Planning" GCP/INT/575/DEN.

[4] NRC. 2000. *Improving the collection, management and use of marine fisheries data*. Washington, DC, National Academy of Sciences. 160 pp.

maintain their businesses and to promote reporting of high quality information … information that might not be as accurate if it were not confidential". The Code of Conduct for Responsible Fisheries makes several references to applicable confidentiality without defining what it means,[5] partly because its meaning depends on individual fishery circumstances and partly because the legal position regarding business information varies from country to country. Nevertheless, the NRC report recommends that existing United States state and federal policies on data confidentiality should be re-evaluated, including creating a mechanism to establish unique proprietary periods for data confidentiality by fishery and "the effects of the loss of confidentiality on precision and bias (hence reliability) … in setting the proprietary period for each type of data".

This means that lowering confidentiality levels may well result in less reliable information, particularly in fisheries, where knowledge (even transient) of the "best" fishing grounds is the major competitive advantage that fishers have. Confidentiality is therefore not a single dimension. It depends on timing and the needs and authorizations of data users. It also depends on the trust that fishers can expect from data users, including confidence in data security and an understanding of the uses to which data will be put.

POSSIBLE SOLUTIONS

Improving the reliability of fishery statistics

Considerable research and analytical effort are regularly put into assessing the precision and accuracy of fishery data and estimating the extent of the fish catch and fishing effort that is entirely unreported. Statistical techniques of ever-greater complexity attempt to reduce the uncertainty of these missing data. The Organisation for Economic Co-operation and Development (OECD) report of the Workshop on the Significance of Reliable Statistics to Conduct Effective Management[6] notes that: "Even using these techniques it has to be acknowledged that the confidence limits attached to the estimates are wide and contribute significantly to a lack of confidence in the resulting advice."

Notwithstanding this general criticism, it is likely that non-reported data will always have to be estimated in several ways in order to improve the reliability of fishery statistics. Indeed, well-designed sampling surveys[7] can offer good insights into a particular data population (including data that have not been sampled). Good statistical design, including validation mechanisms, is thus a primary means of improving reliability. Validation mechanisms include the periodic conducting of frame surveys, the use of observers and inspectors (as parallel samplers to the complete enumeration approach generally used in logbooks), landings and processing throughput data, and vessel monitoring systems.

It is also often claimed that rights-based fisheries or community co-managed fisheries, in which the control of participants is partly the responsibility of fishers themselves, may also generate more reliable data, as it is in fishers' own best interests to maintain good records and participate in the assessment and management decision-making processes. Certainly, incentives to provide accurate data can be crucial to the reliability of the statistics to which they contribute.

Whereas it is often essential to ensure the confidentiality of data in order to ensure their reliability, the methodologies and processes used to collect and collate them should be fully transparent in order to ensure objectivity. Uncertainty associated with statistics should always be expressed, whether as confidence limits, quality indicators or even annotated comments.

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[5] FAO. 1995. Code of Conduct for Responsible Fisheries, Article 7 Fisheries Management (7.4.4 and 7.4.7) and Article 12 Fisheries Research (12.3).

[6] Eurostat. 1995. A review of the quality and reliability of fishery statistics. *In* OECD. *Report of the Workshop on the Significance of Reliable Statistics to Conduct Effective Management*. pp. 185–187. Paris.

[7] FAO. 2002. *Sample-based fishery surveys: a technical handbook*, by C. Stamatopoulos. FAO Fisheries Technical Paper No. 425. Rome. 132 pp.

In addition, improving reliable statistics requires cooperation in the development and adoption of standards. Standardization of nomenclature and coding, adoption of agreed statistical methodologies and implementation of transparent information exchange methods require high levels of transboundary agreement so that the nature and origin of fishery statistics is understood across regions, oceans and the world.

In summary, improving the reliability of fishery statistics involves many factors, including:

- legal and other instruments that obligate fishers to supply reliable data and that establish sanctions, penalties and, where possible, incentives to support these measures;
- realistic and useful approaches to data confidentiality, appropriate access to data and, where possible, incentives to data providers to supply reliable information;
- good statistical design that is cost-effective, sustainable and adaptable to changing circumstances and that includes validation systems;
- high-quality and timely information administration and processing that is objective and transparent and that indicates data uncertainty and quality;
- technological innovations, including vessel monitoring systems (onboard and satellite communications), electronic logbooks and point-of-weighing data capture;
- surveillance systems, including inspectors and observers, to monitor catch and effort, discards and dumping, transhipment and illegal fishing.

Such solutions to the problem of unreliable statistics – which hamper or, in some cases, confound fisheries management – require two conditions in order to be implemented: political will and sufficient capacity.

These possible solutions and requirements were identified by FAO members in 2002 at a Technical Consultation on Improving Information on the Status and Trends of Fisheries, which had the specific task of developing a proposal for improving fishery information in a wide variety of ways and at all levels. The Technical Consultation proposed a draft Strategy for Improving Information on Status and Trends of Capture Fisheries, which will be submitted to COFI in 2003.

As well as objectives and guiding principles, the draft strategy contains direct identification of the actions required and the roles of states, RFBs and FAO to improve factual understanding of fisheries and the exchange of information. It recognizes, *inter alia*, the need for: capacity building in developing countries; data collection systems in small-scale fisheries and multispecies fisheries; development of criteria and methods for ensuring information quality and security; and development of arrangements for the provision and exchange of information. The draft strategy is intended to provide a framework that motivates development partner agencies to fund capacity building in order to improve information and statistics on fisheries.

GLOBAL PERSPECTIVE

International responses to the need for reliable fishery statistics

It is generally recognized that the overall quality of fisheries production statistics has deteriorated, in relative terms, during the rapid expansion in fisheries production of the past 50 years. This has been particularly the case since 1982, when the United Nations Conference on the Law of the Sea (UNCLOS) brought about major changes to the regime of the oceans, and developing countries started to experience additional social and economic difficulties. These difficulties arose despite the calls in UNCLOS for "best scientific evidence"; the previous experience of "crashed" fisheries in developed countries, which developing countries could have learned from as their fisheries rapidly grew; and the well-founded and continuing demand for reliable statistics as the principal basis for fish stock assessment and fisheries management.

Part of the problem is undoubtedly a shortage of money and capacity. However, it is also related to the generally low profile of a natural resource that is hidden from the eyes of politicians by its very medium, and to assumptions that fisheries

can be regarded as common property, open-access systems and that market forces may be sufficient to regulate them. In fisheries management none of these assumptions is true; fisheries have a high profile in terms of global protein supply, particularly in developing countries, and small-scale fisheries in inland and marine waters are probably more important than is currently portrayed; open access has inexorably led to overexploitation in almost all the fisheries where it is practised; and global trade has the potential to skew fisheries away from domestic consumption and self-provisioning, sometimes resulting in the overexploitation of food fish for export. Fortunately, changes in attitude and political will are entering the mainstream of fisheries management, particularly since 1992 when the clear linkages between environmental sustainability and development were globally accepted at the United Nations Conference on Environment and Development (UNCED).

For many years prior to 1992, fishery scientists and managers had been calling for better reliability in fishery statistics. They also accepted and explained the need for caution in the way in which they applied their statistical confidence limits to analyses and advice, long before the precautionary approach became the accepted doctrine of environmental concern. In a direct sense, better and more reliable statistics enable a statistical narrowing of confidence limits, hence lowering the degree of caution that needs to be applied.

The need for reliable fishery statistics is still being voiced in all fisheries fora, from COFI to regional and national meetings. The pace of institutional responses, at least at the international and regional levels, is growing. The oldest of the international institutions is the inter-agency Coordinating Working Party on Fishery Statistics (CWP), which was originally established in 1959 for Atlantic fisheries but has more recently changed its statutes to accommodate regional bodies from around the world. CWP has been instrumental in establishing many standards for fishery statistics, and is currently reviewing its role and approach, particularly in the light of concerns about the quality of fishery statistics and the need for capacity building and minimum harmonized quality standards.

The Code of Conduct for Responsible Fisheries calls for reliable fishery statistics in Article 7 Fisheries Management, as follows:

> *7.4.4 States should ensure that timely, complete and* reliable statistics[8] *on catch and fishing effort are collected and maintained in accordance with applicable international standards and practices and in sufficient detail to allow sound statistical analysis. Such data should be updated regularly and verified through an appropriate system. States should compile and disseminate such data in a manner consistent with any applicable confidentiality requirements.*

In applying the Code to specific objectives, international organizations, in particular the UN, FAO and RFBs, have undertaken a number of initiatives that directly and indirectly call for, initiate or provide for improvements in the provision and dissemination of reliable statistics. The UN Fish Stocks Agreement,[9] which came into force in 2001, contains detailed statistical needs in Annex I Standard requirements for the collection and sharing of data, which must be adhered to by all signatories. The FAO Compliance Agreement,[10] which is yet to come into force, also makes reference in Article 7, Exchange of information, to data needs on fishing vessels and their operational authorizations on the high seas, thus providing for fleet data through the administrative identification of authorized fishing effort.

In addition, four international plans of action[11] on specific issues have been developed since

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[8] Reliable statistics provide the basis for "best scientific evidence", which is prominently referred to throughout the Code, from General Principles (Article 6), Fisheries Management (Article 7), Post-harvest Practices and Trade (Article 11) and Fisheries Research (Article 12).

[9] 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.

[10] Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas.

1998, each of which contains determinations on the collection, processing and dissemination of improved data that are directly related to the issue. New approaches to ecosystem-based fisheries management, with high-level requirements for data from a wide range of sources, are also gradually being brought into the mainstream of fisheries management (see Implementing the ecosystem approach to capture fisheries management, p.55).

RFBs are playing an increasingly important role in fisheries management around the world. The earlier organizations focused largely on science and the development of scientific advice but the more recent organizations – including those still being negotiated[12] – are assuming a role in fisheries administration and management. Most RFBs have scientific committees, the tasks of which include issues related to fishery statistics through specific standing committees or working groups.

Outside the framework of specialized fisheries agencies, the world recognizes that good governance and development, including of natural resources, require improved information. In response to a UN Economic and Social Council resolution on rationalizing and improving statistics and indicators, the Partnership in Statistics for Development in the Twenty-first Century (PARIS 21) was established in 1999, based at OECD in Paris. Through advocacy, information exchange and partnerships, PARIS 21 seeks to contribute to more effective poverty reduction and improved transparency, accountability and effectiveness of governance in developing countries and countries in transition. Improving the reliability of capture fishery statistics (as advocated in the FAO draft Strategy on Status and Trends in Fisheries) in order to enable better fisheries management, sustainable fisheries and more effective fisheries governance would undoubtedly contribute to food security and its role in poverty reduction.

There are some tentative signs that the decline of national authorities' and development partner agencies' interest in statistical development, evidenced by the decline of regional and national field projects dealing with fishery statistical development, is beginning to abate. There are indications that recognition of the importance of statistical development within the mainstream of national and regional development planning is reawakening.

CATCH CERTIFICATION AND CATCH DOCUMENTATION

THE ISSUE

Increasing pressure on high seas resources has caused an intensified search for methods to control the fishing effort, particularly methods to obtain information on unreported catches and to help control the fishing effort on heavily fished species. This has led to the introduction of catch certification and catch documentation schemes.

The Atlantic bluefin tuna is one such heavily fished species. This fishery is carried out mainly on the high sea. While the regional fisheries management organization (RFMO) concerned has the authority to regulate the fishing of Atlantic bluefin tunas by its own members, it had no effective means of dealing with vessels flying the flags of non-members, as in high sea fisheries the flag state has the right to control the fishing activities of only its own vessels. This is seen as a problem by countries that are members of the RFBs that manage such fisheries as that for the Atlantic bluefin tuna.

The majority of the vessels of non-members are registered in countries with open registers. Many of these countries are small and have little or no substantial interest in fisheries. As a result, they do not exert control over the vessels that are registered on their open registers. In addition, frequently they do not report landings, or they report only very low landings, generally because the vessels concerned do not land their catches in

[11] The International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries; the International Plan of Action for the Conservation and Management of Sharks; the International Plan of Action for the Management of Fishing Capacity; and the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing.

[12] Southeast Atlantic Fisheries Organization (SEAFO); Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean; Southwest Indian Ocean Fisheries Commission.

their home countries or ports and are not required to report catches to the flag state. This exacerbates the problem and leads to uncertainty about the quantity being caught in any one period, thereby complicating management for the RFB concerned. In addition, as these vessels are under no ñ or little ñ control, when fishing the high seas they can flout the fisheries management rules approved by an RFMO, often deriving economic advantage from doing so. For this reason the vessels registered in open registers are often referred to as "flags of convenience vessels".

This is the context in which it was decided to try to bring pressure on flags of convenience vessels by limiting their possibilities to market their catches.

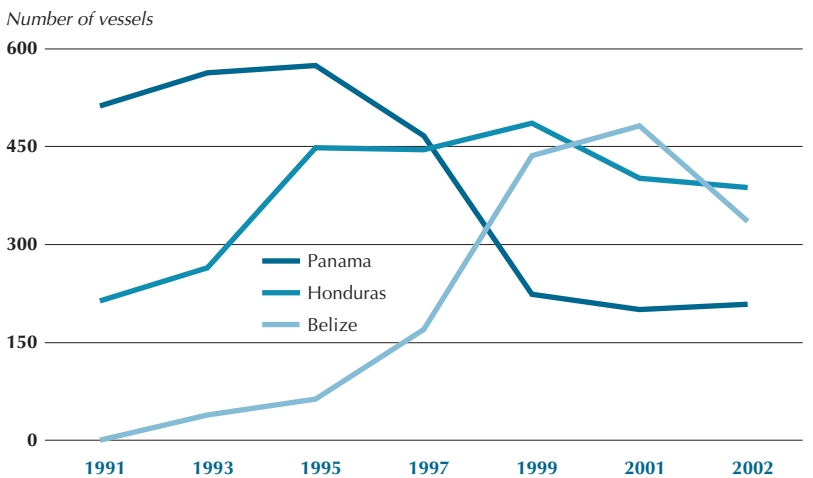
POSSIBLE SOLUTIONS

The International Commission for the Conservation of Atlantic Tunas (ICCAT) was the first RFMO to implement a catch documentation scheme regarding the bluefin tuna caught within its area of jurisdiction. Any bluefin tuna that is imported into any of the ICCAT member countries has to be accompanied by a document that identifies the country of origin. This measure was aimed at recording the catches of vessels that are flagged under countries other than ICCAT members so that the total catches of bluefin tuna can be recorded for management purposes. The document has the rather misleading name of "statistical document". Within a few years, the results of this catch documentation scheme had identified several countries whose flags of convenience vessels were catching up to 30 percent of the total bluefin tuna catch. The introduction of the scheme was facilitated by the fact that Japan and Europe are virtually the sole importers of bluefin tuna.

The ICCAT members agreed among themselves that multilateral trade sanctions should be considered against the open register countries whose vessels were making bluefin tuna catches that did not comply with the ICCAT management measures. The threat of a possible ban on their export of bluefin tuna was enough to encourage these open register countries to join ICCAT and/or to take measures to ensure that they were exercising proper control over the vessels flying their respective flags. Any vessel owners who did not wish to comply with these measures could re-register their vessels in other open registers. This caused significant changes in the registers of Panama, Honduras and Belize, which had many longline vessels of Asian origin.

In November 2001, the European Community (EC) banned the import of some tuna and tuna-like species from specific exporting countries, reflecting the ICCAT management measures, as shown in Table 9. ICCATís success was a useful lesson to other RFMOs that were grappling with the same problem of illegal, unreported and unregulated (IUU) fishing and non-contracting parties. The problems of CCAMLR were very different from those of ICCAT in that CCAMLR was concerned about the overfishing of toothfish in the southern latitudes. In the early 1990s, the catch of toothfish by longline in the very deep waters of southern latitudes had expanded rapidly as a result of its high profitability, and had attracted the attention of many entrepreneurs. The CCAMLR area is very difficult to monitor because of its immense size, the relative lack of coverage by

FIGURE 37
Fluctuations in the main open registers



Note: The decreases shown here were most likely caused by the ICCAT measures.

TABLE 9
EC import bans of tuna and tuna-like species

Exporting country	Bluefin tuna	Swordfish	Bigeye tuna
Belize	Ban	Ban	Ban
Cambodia			Ban
Equatorial Guinea	Ban		Ban
Honduras	Ban	Ban	
St Vincent			Ban

monitoring, control and surveillance (MCS) activity, and the limited presence of exclusive economic zones (EEZs) around the circumpolar region. The French and Australian navies were arresting vessels that had been caught fishing without authorization in the 200-nautical mile EEZs around their respective territories (the Kerguelen and Crozet Islands for France, and the Heard and McDonald Islands for Australia), but significant catches were being made in high seas areas over which no country had jurisdiction; according to some estimates these unreported catches were larger than those reported in the official statistics. In response, CCAMLR introduced a catch documentation scheme. The scheme requires that all the toothfish landed in the ports of its participating parties be accompanied by a catch document, which is authorized by the vessel's flag state and subsequently verified at the port of landing by an authorized flag or port state official. Additional government authorization is required before the toothfish can enter international trade, and the catch document must accompany the toothfish through all stages of the export cycle. Since coming into effect, the scheme has resulted in 18 reports of vessels attempting to land unauthorized catches of toothfish.

Parties to the 1998 Agreement on the International Dolphin Conservation Program (AIDCP) adopted a scheme in June 2001 under which they could issue certificates indicating that canned tuna is "dolphin-safe" (i.e. was harvested without dolphin mortality or serious injury). The dolphin-safe tuna certificate scheme is different from the others in that it is not directed at trade or management measures but at market objectives. Observers are present on all large purse seine vessels. At the time of catch, dolphin-safe tuna is stored separately from tuna that is not dolphin-safe. The tuna tracking number attached to each fish follows it through the system, and copies of the dolphin-safe certificate and the original tuna tracking form are kept by the Secretariat of the Inter-American Tropical Tuna Commission (IATTC). Because it is concerned with environmental issues rather than with fisheries management or trade, this information is not considered to be a trade document (as the tuna and toothfish catch documents are), even though the methodologies of control are similar.

The success of the trade document in providing better catch data and in curbing IUU fishing activities has led ICCAT and other RFMOs to implement similar measures for other species. ICCAT has extended the catch documentation scheme to include swordfish and bigeye tuna. The Indian Ocean Tuna Commission (IOTC) covers bigeye tuna and swordfish with its scheme. This scheme requires certification by officials representing the flag state, and care will have to be taken to ensure that the verification process is carried out in a satisfactory manner. The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) is planning to introduce a catch documentation scheme for Southern bluefin tuna.

RECENT ACTIONS

The proliferation of catch documentation schemes has led the International Coalition of Fisheries Associations (ICFA) to request that all such documentation schemes should be standardized. The Chair of the Meeting of Regional Fisheries Bodies,[13] with FAO assistance, held a meeting in La Jolla, the United States, at which to consider the matter. This meeting produced recommendations on the contents of a standard catch certificate and catch document and on the procedures for processing such a document. FAO is currently designing the

[13] Dr R. Allen, Director, Inter-American Tropical Tuna Commission (IATTC), 8604 La Jolla, CA 92037, USA.

standard documents with input from customs officials who have had experience in handling such documentation. The results will be presented at the Third Meeting of Regional Fisheries Bodies, which is scheduled to take place in March 2003 at FAO, straight after the COFI meeting.

The significance of the terms "catch" and "landings" of fish is often unclear to users and readers. This leads to confusion. CWP has adopted a standard terminology in order to eliminate such confusion and has recommended that FAO and RFMOs using catch documentation schemes should adopt this standard terminology. There have also been problems with implementation, such as choice of the most appropriate conversion factors for estimating live weight equivalent from product weight. Another problem arises from double counting when different parts of the same fish are exported to different countries, each part being accompanied by its own separate set of documents.

The growing practice of fattening bluefin tuna in net cages at tuna farms is making it difficult for the managers of bluefin fisheries to enforce quota allocations. Such farming activity is spreading, particularly in the Mediterranean Basin, where bluefins are caught at sea by purse seines or in traps and subsequently transferred into floating net cages to be fed for a period ranging from a few months to two years.

Recording the volumes of fish caught at sea is a difficult operation, as the fish are generally transferred directly from the purse seines to the net cages without being taken out of the water. At present, such catches are statistically recorded only after the fish have been landed or harvested. The information available, therefore, does not inform managers about which vessels (and which fishing nation) caught the fish, where it was caught and at what size it was caught. This means that the system of allocating bluefin catch quotas to fishing nations becomes increasingly difficult to monitor and enforce.

The Convention establishing the Commission for the Conservation and Management of Highly Migratory Species in the Central and Western Pacific Ocean has not yet entered into force. The Commission does not yet exist as a functioning body, and is not expected to do so for several years. However, the Standing Committee on Tuna and Billfish (an ad hoc meeting of scientists who provide analysis of the fisheries in the region) is considering the introduction of catch certification and trade documentation because there is considerable potential for unreported catches in the Central and Western Pacific area. This is expected to be very difficult to enforce owing to the wide range of fishing fleets involved and the diversity of the ports at which the vessels could land.

IATTC is currently considering a resolution to establish a catch documentation scheme for bigeye tuna taken by longline vessels.

FUTURE PERSPECTIVE

Catch documentation schemes had spectacular success in their early implementation, when they were concerned with one species of large fish from one region that was a target for IUU fishing vessels. Extending the system to smaller fish, in some cases from several vessels or regions, is going to be more problematic and may lead to confusion among species, especially when customs officials have no previous experience of similar initiatives. The problem of customs codes is difficult; however it is thought that the use of catch documentation schemes will, in general, assist in providing better statistics on catches and international trade in fish, as well as identifying IUU fishing vessels and bringing action against them.

While, in principle, the catch certificate and trade document schemes described could be helpful for any fishery managed by an RFMO, it is recommended that priority for the development of new schemes should be given to fisheries that are, or may be, subject to significant levels of IUU fishing. Priority attention should also be given to fisheries harvesting species that are covered by catch certificate or trade document schemes in other fisheries, so as to support the existing schemes of other RFMOs. Consideration should also be given to assisting developing countries in meeting the requirements of catch certification or trade documentation schemes, as many of these countries rely on fisheries products for substantial amounts of foreign exchange.

POVERTY ALLEVIATION IN SMALL-SCALE FISHING COMMUNITIES

THE ISSUE

While economic growth has helped to reduce the proportion of the world's population that is poor, the number of people who remain poor is unacceptably high. The positive impacts of growth on poverty have been less than expected, in part because of inequitable distribution of the benefits, population increases and the effects of the HIV/AIDS epidemic. As a result, many governments and donor agencies have refocused their attention on poverty. The World Bank's World Development Reports for 1990 and 2000, the UN World Food Summit for Social Development in 1995, and the UN Millennium Declaration adopted in 2000[14] all considered poverty alleviation as a principal priority.

In the past, while many development interventions were implicitly aimed at reducing poverty, most did not explicitly focus on improving the living conditions of poor people but aimed at accelerating economic growth through technology and infrastructure development and through market-led economic policies. The lack of an explicit focus on poverty may, in part, explain why the impacts on poverty of many interventions have been neutral, and some may actually have been detrimental. Certainly, the continued levels of poverty in small-scale fishing communities,[15] and in the world as a whole, require that all those concerned take a fresh look at the problem.

It is increasingly acknowledged that poverty is a very complex, multidimensional concept that has many determinants and is concerned with far more than low earnings, i.e. income poverty.[16] An explicit emphasis on poverty is necessary for a better definition and understanding of what it is, so as to be able both to measure progress towards poverty alleviation targets and to gain improved awareness of whom poverty affects and what are the most effective strategies for tackling it.

Poverty in small-scale fishing communities, as in other sectors, is difficult to measure. While there are many studies of poverty in farming communities and among the urban poor, few empirical studies[17] have focused on fisheries. Those that have often concentrate exclusively on income and on the fishers themselves, rather than on a broader concept of poverty in fishing households and communities.

There is now an acceptance that poor fishers and their dependents are not a homogeneous, unchanging group of people. The levels of absolute and relative poverty, within and among small-scale fishing communities, vary considerably by area, country and region.

Although there are poverty traps in fishing communities, over time community members can sometimes become less, rather than more, poor. Fishing communities are often relatively cash-rich compared with farming communities, mainly because fishers sell a larger proportion of their production, more frequently and consistently than do most farmers. They remain vulnerable to sudden variations in earnings, however, making fishing communities often more vulnerable than are communities that rely exclusively on farming. In fact, the issue of vulnerability may be as important as poverty is. It should be recognized, however, that some factors may be important determinants of poverty but not of vulnerability, and vice versa.

Small-scale fishing communities are vulnerable to many events, the outcome of which may be poverty. Examples include: climatic/natural

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[14] The Millennium Declaration contains the commitment to halve, by the year 2015, the proportion of the world's population whose income is less than US$1 a day.

[15] There are many small-scale fisheries in developed countries, but this article examines only small-scale, artisanal and subsistence fishing communities in developing countries that are engaged in marine and inland capture fisheries.

[16] Surveys completed 20 years apart by N. Jodha in two villages in Gujarat, India, found that households with real per capita incomes that had declined by more than 5 percent were, on average, better off according to 37 of their own 38 criteria of well-being (R. Chambers. 1989. Editorial introduction: vulnerability, coping and policy. *IDS Bulletin*, 20[2]).

[17] FAO. 2002. *Literature review of studies on poverty in fishing communities and of lessons learned in using the sustainable livelihoods approaches in poverty alleviation strategies and projects*, by G. Macfadyen and E. Corcoran. FAO Fisheries Circular No. 979. Rome.

events such as yearly and seasonal fluctuations in stock abundance, poor catches, bad weather and such natural disasters as cyclones and hurricanes; economic factors such as market price fluctuations and variable access to markets; and the dangers of working at sea. People in small-scale fishing communities may also be vulnerable to poor health and other wider determinants of poverty. There is an important need to improve the understanding of what makes fishers vulnerable to events and factors that result in poverty, what makes it difficult to improve livelihoods, and what potential solutions exist. Unfortunately, studies suggest that vulnerability appears to be increasing among the poor in small-scale fishing communities.

In developing countries, many millions of people live in small-scale fishing communities. While it is now acknowledged that not all small-scale fishers can be assumed to be poor, a large proportion of them are, and remain so, despite the efforts of donor agencies, national and local governments, non-governmental organizations (NGOs) and the communities themselves. Reasons for continuing poverty include factors from within and outside the fisheries sector: vulnerability, as already discussed; insecure access to resources; tendency to resource depletion; the remoteness of many fishing communities; the agro-ecological characteristics of nearby land; low socio-economic, cultural and political status; a lack of political and financial support (often as a result of an emphasis on semi-industrial and industrial fishing); and competition and conflict with industrial vessels and other economic sectors in coastal areas.

Despite the difficulties of measuring poverty in small-scale fishing communities and of defining who is a fisher (as fishers farm, and farmers fish) and what is a fishing community, some crude estimates of the numbers of income-poor fishers can be proposed as shown in Box 9, which suggests that 5.8 million, or 20 percent of the world's 29 million fishers, may be small-scale fishers earning less than US$1 a day.[18] The income-poor in related upstream and downstream activities, such as boatbuilding, marketing and processing, may be as many as 17.3 million people. These figures suggest an overall estimate of 23 million income-poor people, plus their household dependents, relying on small-scale fisheries.

POSSIBLE SOLUTIONS

Poverty eradication strategies must be well focused, but need to acknowledge that economic factors are not the only determinants of poverty, which also include social, cultural and political variables. Understanding these determinants is crucial to the design and implementation of effective solutions.

It can often be difficult to help poor people to come out of poverty because of their poor health, illiteracy, lack of time and aversion to risk. Poor people's lack of influence and power is an especially important problem, and necessitates trying to identify win-win solutions that are in the interests, not only of the poor, but also of the rich, the élite and the powerful.

The World Bank suggests that "without economic growth there can be no long-term poverty reduction", citing the experience of the last decade. Between 1990 and 1999 those regions of the world with the fastest economic growth made the most gains in terms of reducing the numbers of people living on less than US$1 a day. In regions that experienced economic contraction, the numbers of income-poor increased. However, without concerted efforts to redistribute the wealth from economic growth, the gap between rich and poor is likely to widen.

Solutions outside the fisheries sector can be as important, if not more so, than strategies employed within the sector, so action and coordination across sectors may be required.

Strong economic performance in a country, especially of labour-intensive sectors, is important for small-scale fishing communities because it can create alternative employment opportunities – which are vital given the current levels of resource exploitation and the large numbers of people involved in fishing. Diversity and mobility are key livelihood strategies for the poor.

[18] Note that no information is provided on what can be bought in different regions of the world for US$1.

Increases in general economic performance and diversification not only offer the potential for some fishers to leave fishing, thus benefiting those who remain, but also create a wider range of opportunities and possible strategies for contributing to the household livelihoods of those who remain. This appears to have occurred in Malaysia, for example, which is one of the few developing countries in which the number of fishers showed a decreasing trend in the 1990s. Increases in general economic performance also provide opportunities to improve health services, education, public service delivery (such as the provision of roads and, thus, access to markets), governance, political stability and safety nets, all of which are likely to help with poverty alleviation in small-scale fishing communities. Even where there is little economic growth, there is still scope for progress towards poverty alleviation if policy-makers address these issues. A notable and often cited example is the Indian State of Kerala, which has achieved very high levels of social attainment (education, health, longevity) and a low incidence of poverty, even though economic growth has been limited and per capita income remains low.

Solutions within the fisheries sector: As there is little scope for the further expansion of capture fisheries, given the current levels of exploitation, it is crucial to manage fish resources so as to avoid further resource depletion. Effective and flexible management can improve incomes by limiting entry to the coastal fisheries, avoiding wasteful investments and overcapitalization, and supporting sustainable exploitation practices. It can also improve incomes for the poor by effectively protecting small-scale fishers from the activities of large-scale industrial vessels, thereby enlarging the resource base that the poor can exploit.

There are many different types of fisheries management regime, including unregulated common property (i.e. de facto open access), regulated common property (in which regulation ranges from weak to strong) and regimes that seek to use private property rights as a management tool. A particular management regime and its related regulations can have a significant influence on poverty, as can the governance framework and institutional arrangements that determine the distribution of wealth. Management regimes must therefore be appropriate for each specific context and must be enforced effectively so as to contribute to poverty alleviation in small-scale fishing communities.

Community management and, perhaps even more so, co-management (the sharing of power and responsibility between government and the resource user, e.g. small-scale fishers) offer promising solutions to poverty alleviation, although collective action and co-management can require many years of capacity building before they are effective. Box 10 provides an example of successful co-management in Côte d'Ivoire.

The importance of alternative employment opportunities has already been stressed. Aquaculture is often suggested as an obvious alternative to capture fisheries but, although it does have potential, there may be constraints that prevent poor capture fishers from moving into aquaculture. Such constraints may include high capital costs, a lack of suitable sites and a lack of access to land and water for the poor. Marine-based (eco-)tourism provides another possible alternative that is generating interest in many countries.

Development assistance has often been found to be particularly effective when it supports women in post-harvest and value-added activities, because they often show greater desire and ability to save and contribute to the enhancement of household assets than men do. Given that managerial ability and skill are key determinants of the success of individual fishing operations, interventions that upgrade management and skills and address dynamic entrepreneurship may be especially likely to have an impact on poverty in fishing communities.

The following solutions to poverty alleviation within the fisheries sector are also worth mentioning:

- Reducing/removing subsidies on production inputs may lead to the use of smaller boats and engines, reduced expenditure on fuel and

increased expenditure on labour. In the long term, this should increase profits, create more employment and income for poor fishers and reduce debt. The removal of subsidies to large-scale fishing operations and related infrastructure would also remove market distortions that often disadvantage small-scale fishers. However, short-term social considerations are often more important than long-term ones, so subsidies remain.

- Support must be provided for both *ex-ante* risk management and the *ex-post* coping mechanisms that are used to deal with shocks and stresses, while noting that strategies to reduce vulnerability may need to be different from those aimed at reducing poverty.
- Support for effective organizations in fishing communities (e.g. cooperatives, political lobbying groups and social support groups) can be of benefit to the poor in terms of increasing access to credit, effecting policy change in favour of the poor and reducing vulnerability. Such organizations are most beneficial when: governments are supportive and enabling, rather than constraining or restrictive; fishers identify strongly with the aims and motivations of the organizations concerned; and there is able leadership within fishing communities.

RECENT ACTIONS

Considerable work is now being undertaken to improve the understanding of whom and where the poor are, why they are poor and what mechanisms are most effective for poverty reduction. This explains the increasing importance of poverty mapping, the development of poverty assessment methodologies and the emphasis on well-being and capabilities (rather than on income alone), which focus on sustainable livelihoods. However, few such analyses have been carried out in fishing communities.

Recent activities outside the fisheries sector. Several of the poorest developing nations have developed, or are in the process of developing, Poverty Reduction Strategy Papers (PRSPs) jointly with the World Bank and the International Monetary Fund (IMF). Although few of these currently focus specifically on fisheries, they are likely to be of help where fisheries are identified as a key economic sector or, more generally, where strategies to reduce poverty are in place and small-scale fishers are poor.

Recent debt relief to heavily-indebted poor countries (HIPC), accompanied by efforts to improve health, education and other social services, should also be of benefit to small-scale fishing communities.

Bilateral assistance is focusing increasingly on poverty reduction and food security. Most donors have now put in place strategies and criteria that seek to ensure that their assistance is reaching the poor.

Recent activities within the fisheries sector include those carried out by civil society, donor agencies and national governments.

NGOs and civil society continue to work with local fishing communities to reduce poverty through credit, retraining and alternative employment creation programmes and through support for fishing-related and social organizations.

The plight of fishers and their vulnerability to AIDS were reviewed at a recent meeting organized by the Asian Fisheries Society and the International Centre for Living Aquatic Resources Management (ICLARM).[19]

National governments are becoming increasingly involved in both co-managing the control of industrial vessels' activities in waters where small-scale fishers operate and ensuring fairer international access agreements. There is also a growing realization that many small-scale fisheries need to be restructured. The Philippines offers an example of some degree of success in the government's implementation of a governance model that is based on community management systems. A much broader approach to poverty alleviation in fishing communities is

[19] M. Huang. In press. HIV/AIDS among fishermen: vulnerability of their partners. In *Proceedings of the Global Symposium on Women in Fisheries*, (Sixth Asian Fisheries Forum), Kaohsiung, Taiwan Province of China, November 2001, Asian Fisheries Society and ICLARM, World Fish Centre.

BOX 9

Global estimates of income-poor small-scale fishers and related employment in marine and inland capture fisheries

Assumptions:

1. Overall figures for the numbers of fishers are based on 1990 FAO data.
2. Marine deep sea fishers and those engaged in aquaculture are excluded, along with all those in North America and Europe.
3. The percentage of total fishers and those engaged in related employment who are estimated to be income-poor is based on the *World Development Report 2000/1* figures for the share of the population in each region in 1998 that was living on less than US$1 a day, i.e. it is assumed that the level of poverty in fisheries is the same as it is in other sectors.
4. There are assumed to be three people in related jobs for every one fisher.
5. One hundred percent of all inland fishers are assumed to be small-scale, while 90 percent of all marine coastal, unidentified marine and unspecified fishers are assumed to be small-scale.

Sources: FAO 1990 data on total number of world fishers and World Bank. 2000. *World Development Report 2000/1*. Washington, DC.

Poverty in small-scale fisheries communities

	Africa	South America	Asia	Oceania	Former USSR	Total
% of population on < US$1 a day	46.3%	15.6%	25.6%	11.3%	5.1%	
Inland	279 598	2 583	514 023	0	0	796 203
Marine coastal	112 119	10 148	95 837	458	1 331	219 892
Marine other	112 875	43 867	551 133	13 515	0	721 390
Unspecified	320 733	40 716	3 660 428	0	0	4 021 876
Total	**825 325**	**97 313**	**4 821 421**	**13 972**	**1 331**	**5 759 362**
Number of related income-poor jobs	2 475 974	291 940	14 464 262	41 916	3 993	17 278 087
Total income-poor	**3 301 299**	**389 254**	**19 285 683**	**55 889**	**5 324**	**23 037 449**
World population on < US$1 a day						1 198 900 000
fishers as % of world population on < US$1 a day						1.9%

being tried out in 25 West African countries by the Sustainable Fisheries Livelihoods Programme (SFLP), which is funded by the United Kingdom and implemented by FAO. SFLP also supports policy-oriented normative activities such as the development of guidance materials for poverty reduction policies in fisheries.

OUTLOOK

The international community now shares a vision that makes poverty reduction a priority objective. It is becoming clear, however, that this objective is more difficult to achieve than was previously thought and that it requires special strategies and targeting.

BOX 10
Fisheries co-management in Aby Lagoon, Côte d'Ivoire

Fisheries co-management in Aby Lagoon arose out of a crisis caused by stock depletion, misguided external support, the inability of the fisheries administration to implement satisfactory management measures and the desire of both government and resource users to reduce conflicts between the state and resources users. Co-management has contributed to improving livelihoods and poverty alleviation through increased production and greater value of products and through investments in non-fisheries activities. There is a new sense of empowerment and self-respect in the community, and greater security from better access to resources and supportive social networks.

Source: B. Satia, O. Njifonju and K. Angaman. 2001. Fisheries co-management and poverty alleviation in the context of the sustainable livelihood approach: a case study in the fishing communities of Aby Lagoon in Côte d'Ivoire. Paper presented at the CEMARE-organized international workshop, DFID/FAO Sustainable Livelihoods Programme, at Cotonou in November 2001.

Given the importance of overall economic performance, the expected expansion of the world economy can be viewed positively, as can an improving balance of external debt in HIPC. However, questions remain about whether this overall growth will be sustained, whether it will be reflected in developing countries, whether small-scale fishing communities will benefit, and whether the gap between the rich and the poor can be narrowed.

It is promising that the weaknesses of many conventional centralized fisheries management regimes are being increasingly recognized and tackled, when public resources permit. There is a growing awareness of the need for a process approach to fisheries management (accompanied by capacity building and reform) that is participatory and flexible enough to adapt to changing conditions. Co-management and community management arrangements offer some potential in this regard.

Greater awareness that good governance (by administrators, politicians, local élite groups, fishers and scientists) lies at the heart of many of the solutions to poverty in small-scale fishing communities is vital. However, despite this realization, improving governance and the institutional capacity to effect meaningful change in the poverty status of small-scale fishing communities is still a formidable challenge, even though at least it is a challenge that is now being embraced.

Without outside assistance, poverty status in the small-scale fisheries sector can improve only slowly. Improved governance paradigms and capable management institutions are needed, and they will not become effective unless public resources are provided – at least in an initial stage. Although there is a growing realization of this need in concerned milieus, it is still not clear what action such realization will lead to.

ANTIBIOTIC RESIDUES IN AQUACULTURE PRODUCTS

THE ISSUE

Background. As in other animal production sectors, antibiotics are used in aquaculture during both production and processing, mainly to prevent (prophylactic use) and treat (therapeutic use) bacterial diseases.[20] Antibiotics have also been recommended and used as disinfectants in

fish handling, but this practice has proved to be ineffective and is generally not approved by the fish inspection services. Antibiotics have not always been used in a responsible manner in aquaculture and, in a number of reported situations, control of the use of antibiotics has not provided a proper assurance of the prevention of risks to humans. FAO, the World Health Organization (WHO), the International Office of Epizootics (OIE) and a number of national governments have already raised the issue of irresponsible use of antibiotics in all production sectors, with particular concern for the potential risks to public health. Many governments around the world have introduced, changed or tightened national regulations on the use of antibiotics, in general and within the aquaculture sector.

Public health concerns. When consumed directly by humans as medicine, antibiotics may cause adverse side-effects, but these can generally be avoided through adhering to the recommended dose and duration of therapy. However, when antibiotics are unintentionally ingested as residues in food, the amount ingested cannot be quantified or monitored and may cause direct health concerns, such as aplastic anaemia, which is said to be associated with chloramphenicol. These direct effects pose significant risks to human health. In addition, the unintentional consumption of antibiotics is leading to the development of antibiotic resistance in bacteria that are pathogenic to humans, and this is another important problem that has not yet received adequate attention. The development of antibiotic resistance by pathogenic bacteria is considered to be one of the most serious risks to human health at the global level.[21] The problem arises when bacteria acquire resistance to one or more of the antibiotics to which they were formerly susceptible, and when that resistance eventually makes the antibiotics ineffective in treating specific microbial diseases in humans.[22] Recognition of the risks associated with the direct and indirect effects on human health of both active and passive consumption of antibiotics has led to bans on the use of certain antibiotics in animal food production (particularly those antibiotics for which no safe residue levels can be determined) and to the establishment of maximum residue limits (MRLs) for those with known risks.

Effects on the industry. During the last year, the detection of chloramphenicol in internationally traded shrimp products has caused much concern. The substance has been found in cultured products, resulting in a slowdown in imports, causing economic loss among the concerned producers and reflecting negatively on all shrimps and on aquaculture overall.

POSSIBLE SOLUTIONS

There are two strategies for achieving acceptable levels of antibiotic residues in aquatic products: limiting the use of antibiotics in aquaculture enterprises; and establishing and enforcing MRLs in aquaculture products. Both strategies must be used.

Limiting the use of antibiotics. Antibiotics are necessary for specific and identified uses in aquaculture. Regulation of their commercial availability is one of the ways to ensure that they are used responsibly in aquaculture.

There are several possible strategies for limiting

[20] See, for instance: FAO/SEAFDEC/CIDA. 2000. *Use of chemicals in aquaculture in Asia*, edited by J.R. Arthur, C.R. Lavilla-Pitogo and R.P. Subasinghe. Proceedings of the Meeting on the Use of Chemicals in Aquaculture in Asia, Iloilo, the Philippines, 20–22 May 1996. 235 pp.; and FAO. 1997. *Towards safe and effective use of chemicals in coastal aquaculture*. Reports and Studies, GESAMP No. 65. Rome. 40 pp.

[21] Updated information on the development of microbial resistance can be found at: www.fda.gov/oc/opacom/hottopics/anti_resist.html. See also: K.M. Cahill, J.A. Davies and R. Johnson. 1966. Report on an epidemic due to *Shigella dysenteriae*, type 1, in the Somali interior. *American Journal of Tropical Medicine and Hygiene*, 15: 52–56.

[22] P. Shears. 2001. Antibiotic resistance in the tropics. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 95: 127–130. F. Angulo and P.M. Griffin. 2000. Changes in antimicrobial resistance in *Salmonella enterica* serovar *typhimurium. Emerging Infectious Diseases*, 6(4); and USFDA. 1997. Extralabel animal drug use; fluoroquinolones and glycopeptides; order of prohibition. *Federal Register*, 62(99): 27 944–27 947.

TABLE 10
Possible purchase and user patterns and resulting residual effects of antibiotics in aquaculture

Type of antibiotic	Purchase and use	Residues in fish
Antibiotics specifically approved for aquaculture use ("label use")	"Over the counter" On prescription	Within the levels established by regulatory authorities
Antibiotics to be used under "Extra-label use"[1]	Of approved antibiotics for aquaculture (on professional prescription)	Within the levels established by regulatory authorities
Antibiotics to be used in emergencies and for research	Temporary use and only following specific approval by qualified professionals	No residues in commercialized products, or within the levels established by regulatory authorities
All other antibiotics	Prohibited	Absent

[1] **Extra-label use is defined as "use of a drug in an animal in a manner that is not in accordance with the purpose approved on the label".**

the commercial availability of antibiotics. The two most basic are: identifying the permitted antibiotics (and their MRLs) and prohibiting all others, or identifying the prohibited antibiotics and permitting all others. The first strategy is clearly more in line with the precautionary approach.

A possible scheme for limiting the use of antibiotics by using the first basic strategy is outlined in Table 10.

Establishing and enforcing MRLs. In the twelfth edition of the Procedural Manual of the Codex Alimentarius Commission (CAC),[23] the maximum limit for residues of veterinary drugs (MRLVD) is defined as "the maximum concentration of residue resulting from the use of a veterinary drug (expressed in mg/kg on a fresh weight basis) that is recommended by the Codex Alimentarius Commission to be legally permitted or recognized as acceptable in or on a food."

The MRLVD is based on the type and amount of residue considered to be free from any toxicological hazard for human health, as expressed by the acceptable daily intake (ADI) or by a temporary ADI that utilizes an additional safety factor. The MRLVD also takes into account other relevant public health risks, as well as food technological aspects. When establishing an MRL, consideration is also given to residues of the same drug that occur in food of plant origin and/or in the environment. Furthermore, the MRL may be reduced so as to be consistent with good practice in the use of veterinary drugs, and to the extent that practical analytical methods are available.[24]

RECENT ACTIONS

Limiting the use of antibiotics in aquaculture. Some countries or regions, such as the EC, Canada and Norway, approve a limited number of antibiotics specifically for use in aquaculture. In Canada, the antibiotics approved for aquaculture use are: oxytetracycline, sulfadiazine (trimethoprim), sulfadimethoxine (ormetoprim) and florfenicol.[25] Not only do the regulations approve the types of antibiotic that can be used, they also usually specify the species, diagnosis, dose, duration and withdrawal period to be

[23] CAC is a joint commission formed by FAO and WHO. Since the first steps were taken in 1961 to establish a Codex Alimentarius (food code), CAC, as the body charged with developing that code, has drawn world attention to the field of food quality and safety. CAC is charged with developing food safety standards for worldwide application, and Codex standards have become the benchmarks against which national food measures and regulations are evaluated within the legal parameters of the World Trade Organization's Sanitary and Phytosanitary Agreement (WTO/SPS).

[24] CAC Procedural Manual twelfth edition can be found at: ftp://ftp.fao.org/codex/manual/manual12ce.pdf

[25] Details of antibiotics approved for aquaculture use in Canada can be found at: http://salmonhealth.ca/therapeutant-sapproved.html

observed when an antibiotic is used as a therapeutic agent. Compliance with these conditions and regulations assures that the residues in products are kept below the MRLs and that the risk of pathogenic bacteria developing resistance is negligible or, at least, acceptable.

Chloramphenicol is still an authorized antibiotic in human medicine. Patients who use it as a medicine are taking a risk, but it is a risk that they can (and should) assess and understand fully. In addition, a course of treatment with chloramphenicol should only be followed under the direct supervision of a qualified physician. Chloramphenicol ingestion through the consumption of fish products containing residues, however, could pose health hazards to humans, which could have serious implications. This is why chloramphenicol is authorized for use in human medicine, but not for veterinary applications.

Until 1994, the EC's MRL for chloramphenicol was 10 ppb as a provisional (Annex III) allocation. After 1994, when it became clear that data to demonstrate a safe level of chloramphenicol could not be established, the MRL was changed to zero (Annex IV). The detection limits for chloramphenicol by the accepted testing methodology using high-performance liquid chromatography (HPLC) was then 5 to 10 ppb. Thus, effectively, the MRL for chloramphenicol became 5 ppb. Over the past two years, several tests for chloramphenicol based on enzyme linked immunosorbent assay (ELISA) technology have come on to the market. The stated manufacturer's detection threshold for chloramphenicol using these ELISA-based tests is 0.05 ppb. Since the EC does not recognize an MRL for chloramphenicol (zero tolerance), by using more sensitive tests, analytic chemists have disqualified many of the food items that previously had been accepted as safe for human consumption.

There are nine substances included in Annex IV of Regulation 2377/90/EEC that may not be used in food producing species because no safe level of residue can be determined: chloramphenicol,[26] chloroform, chlorpromazine, colchicine, Dapsone, Dimetridazole, Metronidazole, nitrofurans (including Furazolidone) and Ronidazole. The presence of an Annex IV substance residue (including metabolites) is prima facie evidence of the use of a prohibited substance in a food animal species.

In the United States, several drugs are prohibited for extra-label animal and human drug uses in food producing animals. Those relevant to aquaculture interests include: chloramphenicol, Dimetridazole, Furazolidone (except for approved topical use), Nitrofurazone (except for approved topical use) and fluoroquinolones.

Approved antibiotics can be bought and utilized under two conditions: over the counter, or on prescription by a qualified professional. In Canada, the over-the-counter purchase of oxytetracycline is supported by the existence of a Medicating Ingredient Brochure, which recommends the conditions for its use. It is important that information on the responsible and correct use of antibiotics be provided to aquaculturists. In developed countries (e.g. the United States, EC countries, Canada), most approved antibiotics can only be purchased and utilized on prescription, and under the guidance of a qualified professional.[27]

For extra-label use, a qualified professional may write a prescription for the use of an approved antibiotic under conditions that vary from those approved. In this case, the approving officer will provide specific instructions for the antibiotic's use and is responsible for its application. Under the Canadian regulations, the qualified professional assumes full responsibility for any drug residue violation. Under the United States regulations, there is provision for authorizing licensed veterinarians to prescribe extra-label uses of antibiotics in animal production for drugs that have been approved for

[26] See: www.emea.eu.int/pdfs/vet/mrls/chloramphenicol.pdf

[27] Laws define which qualified professionals are authorized to write drug prescriptions for the treatment of fish in aquaculture and are responsible for controlling them. Such professionals may have different professional backgrounds in different countries; for instance, in the EC and the United States, they are veterinarians (with proper aquaculture training), but in some countries they could be biologists (aquaculture) with proper training in fish medicine and human public health.

human use only. However, the same regulation provides that the United Stated Food and Drug Administration (USFDA) "may prohibit an extra-label drug use in animals if, after affording an opportunity for public comment, the agency finds that such use presents a risk to the public health". This regulation establishes, de facto, a large difference from those countries that allow only the use of approved antibiotics for aquaculture.

This could create situations of lack of control. As expressed by USFDA, "the data and information necessary to determine, in particular situations, whether the resistance level at time of slaughter would be increased above normal as a result of extra-label use is not generally available to practising veterinarians, who must make the extra-label use decisions". In addition to antibiotic residues, therefore, the increased resistance to the specific antibiotic should, in principle, also be monitored. In countries that do not have an effective veterinary service competent in aquaculture or that lack microbiological monitoring, the extra-label use of antibiotics implies irresponsibility and a serious shortcoming in the management of risks to human health.

There are also provisions regarding the use of antibiotics to deal with emergencies (e.g. epidemics) and research. In general, banned antibiotics and banned veterinary drugs pose significant demonstrable risks to human health. Box 11 provides a list of the antibiotics and veterinary drugs that are currently banned in the United States. Banned antibiotics and veterinary drugs may vary from country to country.

Establishing and enforcing MRLs. The procedures by which CAC sets MRLVDs are complex and, owing to the inevitable international involvement, slow. Data are analysed by the Joint FAO/WHO Expert Committee on Food Additives (JECFA), which meets only once a year. When a recommendation is reached (after much JECFA consideration), the conclusions are passed to CAC's own expert committee, the Codex Committee on Residues of Veterinary Drugs in Food (CCRVDF), for further evaluation.[28]

Establishing MRLs for fish presents several problems, including the identification of what are edible tissues and the complex pharmacokinetic properties and metabolism of veterinary drugs in fish. The only full CAC MRLs for aquaculture species listed in the database are for the administration of oxytetracycline at 100 µg/kg to "fish" and "giant prawn", but several additional MRL proposals from JECFA are now within the CAC system. From this it is clear that it will be many years before CAC sets a usable list of MRLs

[28] A database of CAC MRLs so far developed is available at: apps.fao.org/codexsystem/vetdrugs/vetd_ref/q-e.htm.

BOX 11

Drugs currently banned for use in raising animals in the United States (USFDA 2002)

- Chloramphenicol
- Clenbuterol
- Diethylstilbestrol (DES)
- Dimetridazole
- Ipronidazole
- Other nitroimidazoles
- Furazolidone, Nitrofurazone, other nitrofurans
- Sulphonamide drugs in lactating dairy cattle (except approved use of sulfadimethoxine, sulfabromomethazine, and sulfaethoxypyridazine)
- Fluoroquinolones
- Glycopeptides

Source: www.fda.gov/cvm/index/updates/nitroup.htm

TABLE 11
JECFA proposed MRLs relevant to aquaculture

JECFA Meeting number	Year	Drug	Tissue	Species	MRL (µg/kg)	Status
47	1996	Oxytetracycline	Muscle	Giant prawn *(Penaeus monodon)*	100	
48	1997	Flumequine	Muscle and skin in normal proportion	Trout	500	Temporary
52	1999	Thiamphenicol	Muscle	Fish	50	Re-evaluate in 2002
52	1999	Deltamethrin	Muscle	Salmon	30	
54	2002	Flumequine	Muscle and skin in normal proportion	Trout	500	
58	2002	Oxytetracycline	Muscle	Fish	200	

relevant to aquaculture; national or market-area MRLs will therefore predominate in the protection of consumers within their areas. The products that are being assessed by JECFA are given in Table 11.

As well as the MRLs set by JECFA, several countries or country groups have set their own. The MRLs relevant to aquaculture in the EC European Economic Area (EC EEA) and the United States are given in Tables 12 and 13. The information on MRLs for veterinary drug residues in Canada can be found on the Health Canada Web site: www.hc-sc.gc.ca/english/index.html. Specific MRL information is given at: www.inspection.gc.ca/english/anima/fispoi/manman/samnem/bull8e.shtml.

The Bureau of Veterinary Drugs, Health Canada has approved six drug products (eight drug substances) for use in aquaculture (Table 14). Additional information on amended MRLs is also available at: www.hc-sc.gc.ca/english/media/releases/2002/2002_08bk1.htm (see Table 15).

The British Columbia Ministry of Agriculture also has a valuable Web site with information on aquaculture and, in particular, the use of antibiotics in aquaculture: www.agf.gov.bc.ca/fisheries/health/antibiotics.htm.

Japanese MRL information can be found at: www.ffcr.or.jp/zaidan/ffcrhome.nsf/pages/e-info-foodchem. Only two aquaculture MRLs are posted for fish and shellfish in Japan: 0.2 ppm for oxytetracycline and 0.2 ppm for Spiramycin. Listings published elsewhere suggest that a wide range of veterinary medicines has been approved for use in fish in Japan.

MRLs of approved antibiotics are usually conservative. Processing, cooking and frozen storage can reduce the residual levels of antibiotics.[29] However, data regarding the effect of processing, cooking and freezing aquatic animal products on the degradation of antibiotic residues in aquatic animal products are scarce; it is therefore essential to conduct proper exposure assessments, in the form of risk assessments, not only in order to understand the risks but also to reassure consumers.

In the EC, consumer safety is addressed via MRLs established by Council Regulation EEC/2377/90. The EC definition of MRL is virtually the same as that adopted by CACRVD for foods. The Annexes to Regulation 2377/90 are as follows:

- Annex I: full MRL can be set;
- Annex II: safe, no MRL needed to protect the consumer;
- Annex III: sufficient data to set a provisional

[29] Chun-Chieh Lan, Bau-Sung Hwang and Mei-Feng Tu. 2001. Effect of microwave and roast treatment on the degradation of sulfamethazine residue in tilapia meat. *Journal of Food and Drug Analysis*, 9(2): 102–106.

TABLE 12
Current MRLs relevant to aquaculture in the EC EEA

Drug	Annex	MRL (µg/kg)	Species	Council Regulation
All sulphonamides	I	100	All food producing	
Trimethoprim	I	50	Finfish	
Amoxicyllin	I	50	All food producing	
Ampicillin	I	50	All food producing	
Benzylpenicillin	I	50	All food producing	
Cloxacillin	I	300	All food producing	
Dicloxacilin	I	300	All food producing	
Oxacillin	I	300	All food producing	508/1999/EC
Penethamate	I	50	All food producing	
Sarafloxacin	I	30	Salmonidae	
Chlortetracycline	I	100	All food producing	
Oxytetracycline	I	100	All food producing	
Tetracycline	I	100	All food producing	
Bronopol	II		Salmonidae, eggs only	
Somatosalm	II		Salmon	
Azamethiphos	II			1931/1999/EC
Emamectin benzoate	I	100	Salmonidae	1931/1999/EC
Teflubenzuron	I	500	Salmonidae	1931/1999/EC
Tricaine mesylate	II		Finfish	1942/1999/EC
Toschloramide Na	II		Finfish	2393/1999/EC
Diflubenzuron	I	1000	Salmonidae	2593/1999/EC
Thiopental iv	II	n/a	All food producing	749/2001/EC
Flumeqine	I	600	Salmonidae	2728/1999/EC
Oxolinic acid	III expires 1/1/03	300	Finfish	807/2001/EC
Florfenicol	I	1000	Finfish	1322/2001/EC

Note: **Annex I substances have major species or animal group MRLs allocated. Annex II substances are regarded as consumer-safe and do not require MRLs to be set. Only those Annex II substances that are of relevance to aquaculture are included here. Annex III substances have provisional time-limited MRLs to allow final safety data to be generated.**

TABLE 13
Current tolerances relevant to aquaculture in the United States

Drug	Species	Tolerance (MRL)	Status
Trifluralin	Shrimps or prawns	0.001mg/kg	Temporary
Oxytetracycline	Salmonids	0.2mg/kg	Temporary
Oxolinic acid	Salmon, Pacific	0.01 mg/kg	At LOD[1]

[1] LOD = limit of determination.

TABLE 14
Currently approved drugs and their MRLs in Canada

Drug	Species	Tissue	AMRL[1]
Oxytetracycline	Salmonids Lobster	Edible tissue	0.1 µg/g
Sulfadi-methoxine	Salmonids	Edible tissue	0.1 µg/g
Ormetoprim		Edible tissue Muscle/skin	0.5 µg/g 1.0 µg/g
Sulfadiazine	Salmonids	Edible tissue	0.1 µg/g
Trimethoprim		Edible tissue Muscle/skin	0.1 µg/g 1.0 µg/g
Tricaine methanesulfonate	Salmonids	Edible tissue	0.02 µg/g
Formaldehyde	Salmonids		n/a[2]
Florfenicol	Salmonids	Edible tissue	0.1 µg/g[3]

Notes:
[1] AMRL = administrative MRL.
[2] Regulated biological substance, ubiquitous in nature.
[3] MRL is specified for the metabolite, florfenicol amine.

TABLE 15
Additional amended MRLs in Canada

Drug	Marker residue	MRL (µg/g)	Species
Florfenicol	Florfenicol amine	0.8	Muscle of salmonids (salmon, trout, char, whitefish and grayling)
Sulfadiazine	Sulfadiazine	0.1	Muscle of salmonids (salmon, trout, char, whitefish and grayling)
Trimethoprim	Trimethoprim	0.1	Muscle of salmonids (salmon, trout, char, whitefish and grayling)

MRL, but additional data needed to allocate full MRL;
- Annex IV: on safety grounds, no MRL can be set. Substances placed in this Annex are prohibited from use in food animal species, although they may still be used in pet species.

It should be noted that, although no formal MRL regulation has been established in the United States, the equivalent there is the tolerance, which is established by the regulatory authorities.

GLOBAL PERSPECTIVE

HACCP as a risk-based management tool for antibiotic use in aquaculture. In aquaculture, antibiotics are generally administered in feeds, having been either added during feed manufacture or surface-coated on to pellets by the manufacturer or the farmer. During outbreaks of disease, farmers may apply antibiotics using other routes. Clear instructions are therefore required for the feed manufacturers, antibiotic dealers, veterinary authorities and farmers who are responsible for the use of antibiotics. Who provides such information, and who is responsible for regulating and controlling antibiotics nationally?

The Hazard Analysis Critical Control Point (HACCP) system is recommended as a way of reducing hazards stemming from the processing of fish and fishery products. Implementation of the HACCP system in fish processing is mandatory, and all exporting countries have to comply with this requirement for international trade. Since the middle of 1990, some developed countries have introduced the system to control hazards from the use of antibiotics at the pond level.[30] The introduction of HACCP to control food hazards in aquaculture, including those stemming from the irresponsible use of antibiotics has been widely recommended[31] and has been discussed by an FAO/Network of Aquaculture Centres in Asia-Pacific (NACA)/WHO Study Group on Food Safety.[32]

HACCP is currently not mandated by most primary animal production regulations that include aquaculture. In many countries, even when the liability may be shared or (depending on regulations) when it remains on the production side, the actual obligation to control the use of antibiotics and their residues rests with the processing industry, as HACCP is mandated within the processing sector. This creates difficulties in implementing control measures on antibiotic use in aquaculture.

All the elements for identifying the critical control points (CCPs) and critical limits of regulatory requirements exist for approved antibiotics and veterinary drugs, specific fish or shellfish species, diagnosis (purpose of use), dose, duration of treatment and withdrawal period. It has been suggested that the CCP would be at the feeding stage, since this is when antibiotics are usually introduced into the production process. The analysis of residues of the antibiotics used, and the checking of compliance with regulations, would form part of the verification procedures. In addition, as USFDA has suggested, the monitoring of residues in flesh may be not enough, and the development of resistance in pond micro-organisms (and/or the target micro-organism) should also be monitored – an additional CCP.

Regarding the fish processing industry, further procedures, activities and monitoring should be performed in addition to the HACCP plan. In particular, prerequisites (e.g. plant location, water supply and effluent control) and good hygiene practices at the pond should be implemented. The storage and handling of antibiotics should be put under a scheme of monitoring, as indicated in the United States HACCP-based regulation for storage of chemicals in the plant, for example.[33]

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[30] G. Valset. 1997. Norwegian hazard controls for aquaculture. *In* R.E. Martin, R.L. Collette and J.W. Slavin. *Fish inspection, quality control, and HACCP*, pp. 392–402. Lancaster, PA, USA, Technomic Publishing.

[31] A. Reilly, P. Howgate and F. Kaferstein. 1997. Safety hazards and the application of the Hazard Analysis Critical Control Point System (HACCP) in aquaculture. *In* R.E. Martin, R.L. Collette and J.W. Slavin. *Fish inspection, quality control, and HACCP*, pp. 353–375. Lancaster, PA, USA, Technomic Publishing. See also: R. Armstrong. International hazard controls in aquaculture, pp. 403–406, in the same work.

[32] WHO. 1999. *Food safety issues associated with products from aquaculture*. Report of a Joint FAO/NACA/WHO Study Group. WHO Technical Report Series No. 883. Geneva. 55 pp.

As with most food hazard-related areas, many people are involved in aquaculture hazard monitoring, including regulators, consumers, producers, processors, journalists and – sometimes – researchers, who may lack a complete picture of a given risk and its possibilities of management. The importance of communicating problems widely has been recognized.[34] Risk communication is a necessary component of antibiotic use for aquaculture purposes. In some countries, there is a considerable lack of information and transparency, which conspires against the proper solution of possible problems, and eventually creates additional ones. Communication with the consumer is particularly important. A crisis, such as the one involving chloramphenicol, alters the national and international fish markets because it fosters consumers' fears about fish as food.

The proper use of approved antibiotics will continue to be necessary in animal production, including aquaculture, and consumers should be reassured that the use of approved antibiotics, in particular under "label use" conditions, does not imply a hazard. In addition to the public health problems that result from people being rendered defenceless to illnesses caused by antibiotic-resistant bacteria and the residues of banned antibiotics, there are also economic constraints to be taken into account.

The future of aquaculture depends, *inter alia*, on the production of safe and wholesome products, and this goal can be achieved. However, the recent crisis with chloramphenicol indicates that the current situation with regard to the use of antibiotics is far from satisfactory. The responsible use of antibiotics can be achieved through implementing adequate risk management measures, including developing and enforcing appropriate regulatory procedures. The information and knowledge base concerning the hazards and risks involved in the use of antibiotics should be improved, and the risks posed by existing hazards, in particular of drug supplies and use, should be communicated. Additional efforts are required in the areas of research, training, capacity building, legal frameworks and communication. Aquaculturists in developing countries should be encouraged always to seek professional guidance in the use of antibiotics, particularly from the regulatory agencies, extension services and qualified professionals. Where there is no adequate professional guidance, countries should embark on developing the necessary capability, and aid agencies and development partners should provide all necessary assistance to this process.

Application of HACCP-based management practices within production systems is central for reducing possible risks. Appropriate guidelines and technical standards should be developed in consultation with all stakeholders. There is also a need to reassure consumers about the safe use of approved antibiotics and measures to constrain the use of banned substances. Relevant information should be made readily available to the general public through various information dissemination mechanisms.[35] Efforts should be made to restrict the use of antibiotics to therapeutic purposes only.[36] Countries should be encouraged to develop and implement more internationally harmonized and transparent procedures for managing and controlling the use of antibiotics in aquaculture.

National or market-area MRLs. National or market-area MRLs will continue to exist until CAC has been able to set MRLs with wide international acceptance. However, the CAC process is slow, so a full range of MRLs will not be available for many years. If there are science-based national or regional MRLs, and the control procedures are based on reasons of consumer safety, claims that trade barriers exist will be unsupportable, provided that the residue control programmes are operated fairly and equivalently between national and imported products.

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33 USFDA. 21 CFR Parts 123 and 124.

34 E. Spencer Garrett, C. Lima dos Santos and M.L. Jahnke. 1997. Public, animal and environmental health implications of aquaculture. *Emerging Infectious Diseases*, 3(4).

35 www.anmv.afssa.fr/oiecc/documents/recommendationsconf.pdf; and www.anmv.afssa.fr/oiecc/documents/recommendations_hanoi.pdf

36 http://europa.eu.int/rapid/start/cgi/guesten.ksh?p_action.gettxt=gt&doc=IP/02/466|0|RAPID&lg=EN&display=

PART 3
Highlights of special FAO studies

Highlights of special FAO studies

FISHERIES AND LONG-TERM CLIMATE VARIABILITY

BACKGROUND

Natural long-term variations in the abundance of wild marine capture fishery resources have been a matter of debate and concern for more than a century. At first, it was the fishery scientific community who paid most attention to these types of long-term fluctuations. However, as world fisheries develop, and as more and longer fishery records become available, long-term changes affecting fisheries have started to attract the attention of fishers, fisheries managers, policy- and decision-makers and the general public.

The first scientific report of long-term fluctuations in herring abundance was published in 1879,[1] based on observations made since the sixteenth century. This report described the so-called "herring periods" in the Bohuslän archipelago, Sweden, which lasted for anything from 30 to 60 years. Since then, many more reports dealing with long-term fluctuations in marine capture fisheries have appeared. As world fisheries expand and more evidence of long-term fluctuations in fish abundance emerges, increased attempts have been made to relate fisheries cycles to available long-term climatic variability signals as a way to identify the possible causal mechanisms of fish fluctuations.

Over the last two decades, relevant research efforts have been devoted to describing and analysing long-term fluctuations in the abundance of commercial species and the possible relationships between ocean climate and fish stock size. FAO has supported this type of study, in which particular attention is paid to improving the knowledge about possible relationships, causes and mechanisms, as well as to the possible uses and applications of improved knowledge for world fisheries conservation and development planning.

FISHERIES AND LONG-TERM CLIMATE FLUCTUATIONS

The abundance of a number of species that show long-term fluctuations, such as the Japanese sardine and the Californian sardine, has been shown to have some correlation with climatic indices. Long-term observations of Japanese sardine outbursts and atmospheric temperature indices (Figure 38) have led to proposals that the long-term regular changes in Japanese sardine catches could be explained by cyclic climate changes.[2] More recently, available FAO and other data sets of world fisheries landings were analysed[3] in an attempt to explore the possible relationships between various climate indices and the catches of selected groups of fish stocks. A time series model, based on well-known climate cycles, was also developed in order to forecast possible trends in main commercial fish catches for 5 to 15 years into the future. While such forecasts must be made with great caution, their results are both provoking and interesting enough to merit further attention and analysis. This article is, to a great extent, devoted to illustrating Klyashtorin's theories and findings, which refer to fish abundance indices as reflected by the possible relationship between annual catches and climate changes. In this context, the term "climate changes" refers to large-scale, long-term effects – or shifts from one climatic state to another – that seem to respond to deterministic cycles, rather than individual climatic events, such as El Niño, or long-term trends, such as global warming.

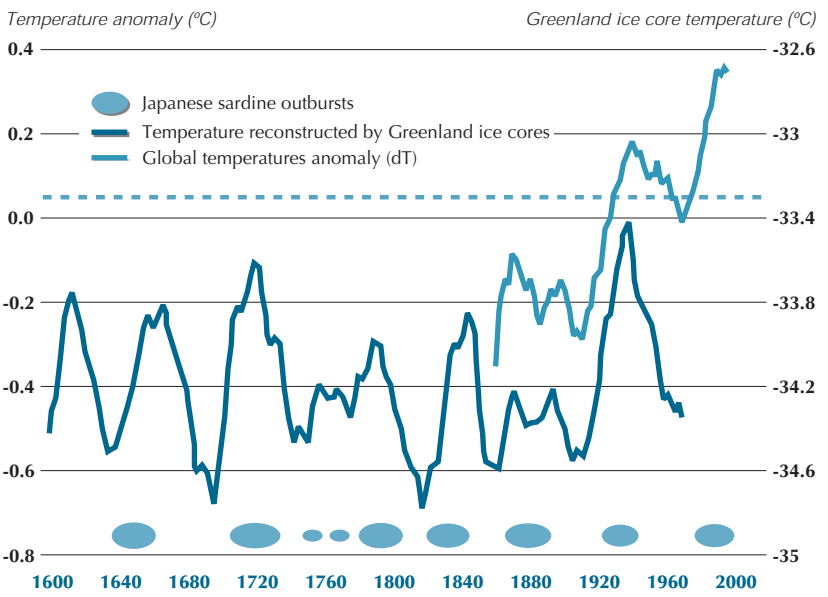
The causal mechanisms that drive most of the

[1] See the citation to A.V. Ljungman (1879) in: FAO. 1983. FAO Fisheries Report, by A. Lindquist. 291(3): 813–821.

[2] T. Kawasaki. 1994. A decade of the regime shift of small pelagics – from the FAO Expert Consultation (1983) to the PICES III (1994). Bull. Japanese Soc. Fish. Ocean., 58: 321–333.

[3] FAO. 2001. Climate change and long-term fluctuations of commercial catches: the possibility of forecasting, by L.B. Klyashtorin. FAO Fisheries Technical Paper No. 410. Rome. 86 pp.

FIGURE 38
Cyclic temperature fluctuations and Japanese sardine outbursts 1600Ð2000



long-term periodic fish abundance fluctuations analysed by Klyashtorin remain unclear, and some of his findings are still working hypotheses. However, the signals and trends in climatic indices and historical fish landings that emerge from his work are of utmost interest, and merit close study so that the mechanisms governing climate change and long-term fish production variability can be understood better and used for management purposes. The argument put forward in most of the cases is that biomass and catches are ultimately driven by climate fluctuations. This runs counter to the conventional wisdom of fisheries management, which considers that biomass and catches are driven mostly by fishing pressure. It has already been suggested[4] that upwelling intensity is linked to large-scale climatic effects, which ultimately affect the rate of nutrient transport into the eutrophic upper ocean layer, thereby changing primary production and, subsequently, fish production. However, while hypotheses relating climate to nutrient availability may be correct, there is no direct evidence of the mechanism, and no conclusive modelling of the causal relationship has so far been possible.

Spectral analysis of the time series of the atmospheric global temperature anomaly (dT), the atmospheric circulation index (ACI) and the length of day (LOD) estimated from available direct observations (110 to 150 years) shows a common periodicity of 55 to 65 years (Figure 39). Spectral analysis of the reconstructed time series of air surface temperatures for the last 1 500 years suggests a similar (55 to 60 years) periodicity. Furthermore, the ACI observations show two alternating climatic epochs, each of approximately 30 years duration, according to the dominance in air mass transport on the hemispheric scale (Figure 40). The ACI has therefore been used as a suitable climatic index for further investigation of long-term regular changes in the landings of major commercial fish stocks.

CORRELATION BETWEEN FISHERIES AND CLIMATE

Evidence for the relationship between climate and fisheries landings comes from two main sources: a few long-term indices of climate and fish stock size for up to 1 700 years, which show similar cyclic patterns as well as correlation between series; and fluctuations in catches from most of the stocks that were examined, which have synchronized since 1900, corresponding to climatic indices over the same period. Both long- and short-term series appear to have a common cycle. The most pronounced periodicity of long-term fluctuations in catches for all time series (excluding anchovy) varies from about 54 to 58 years. The corresponding climate cycles (both measured and reconstructed) vary from 50 to 65 years (with an average of 56 years). Other, less significant, cycles (13 and 20 year fluctuations of summer temperature) may also be of interest, but so far no reliable correlation between these cycles and commercial catch fluctuations has been found.

[4] A. Bakun. 1996. Ocean processes and marine population dynamics. La Paz, Mexico, California Sea Grant and CIB. 323 pp.

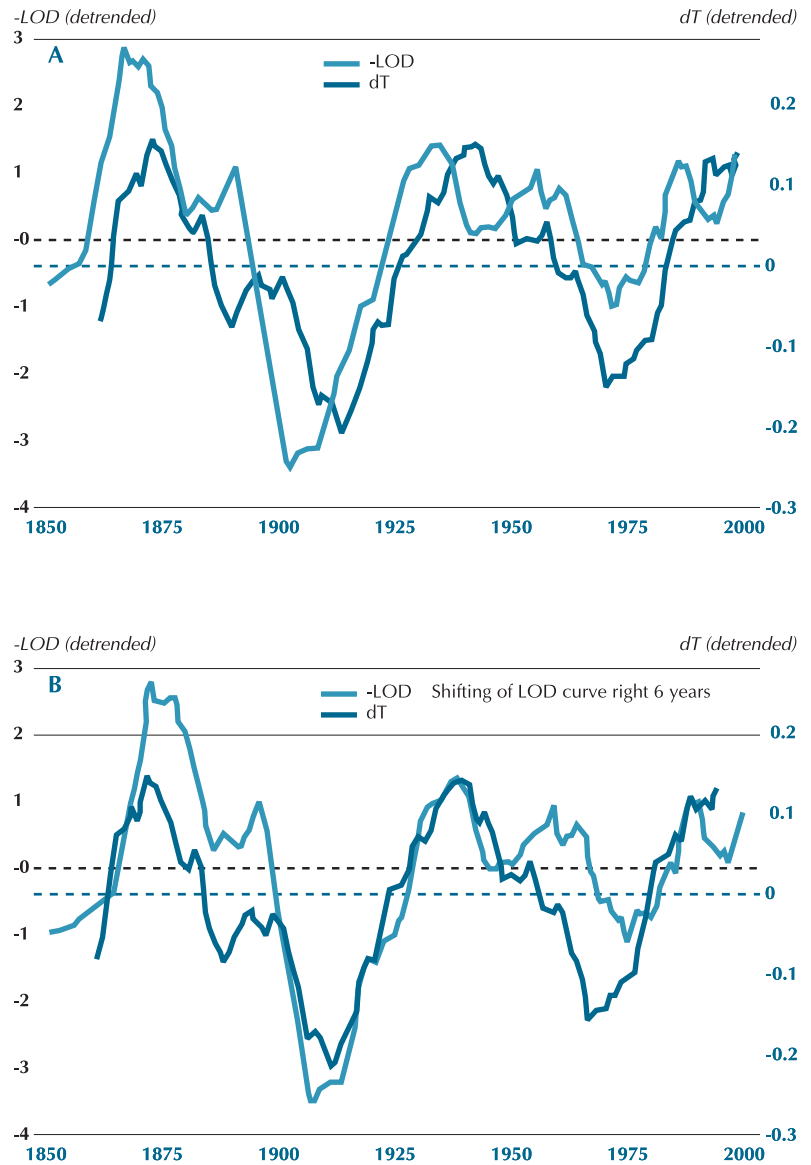
Among the long-term cycles, Japanese chronicles contain historical information on Japanese sardine abundance for the last 400 years (Figure 38). Changes in the availability and abundance of sardine stocks led to the development of several coastal fishing villages, as well as the collapse of others. The average cycle length is about 60 years, and periods of high abundance tend to coincide with warmer atmospheric periods.

Off the coast of California, anaerobic conditions in seasonally layered sediments have preserved fish scales from populations of small pelagic fish. Two time series of the abundance index could be reconstructed for sardine and anchovy stocks for the last 1 700 years from these sediments.[5] Although they demonstrate large fluctuations, it is interesting to note that these time series show no clear differences between the earlier period, when fishing was negligible, and the more recent period, when exploitation has become far greater.

Analysis of the periodicity indicated two principal oscillations in sardine abundance time series: one occurring every 54 to 57 years, and the other every 223 to 273 years. The first of these oscillations is similar to that observed in both air temperature as measured from fossil ice cores and sardine biomass, making it particularly important for fishery forecasting. Dominant fluctuation periods for anchovy are about 100, 70 and 55 years in duration. However, unlike other commercial pelagic species, the regular climate-dependent dynamics of Peruvian anchovy are greatly perturbed every 10 to 15 years by strong El Niño events, so the future catch dynamics of this species are not well approximated by a smooth "average" curve. About 70 to 75 percent of the total anchovy catch in the Pacific is Peruvian anchovy. The increases in sardine and anchovy abundance appear to be linked, respectively, to the two atmospheric regimes (zonal and meridional epochs) that have already been mentioned, suggesting that these two species may be favoured by different climatic conditions.

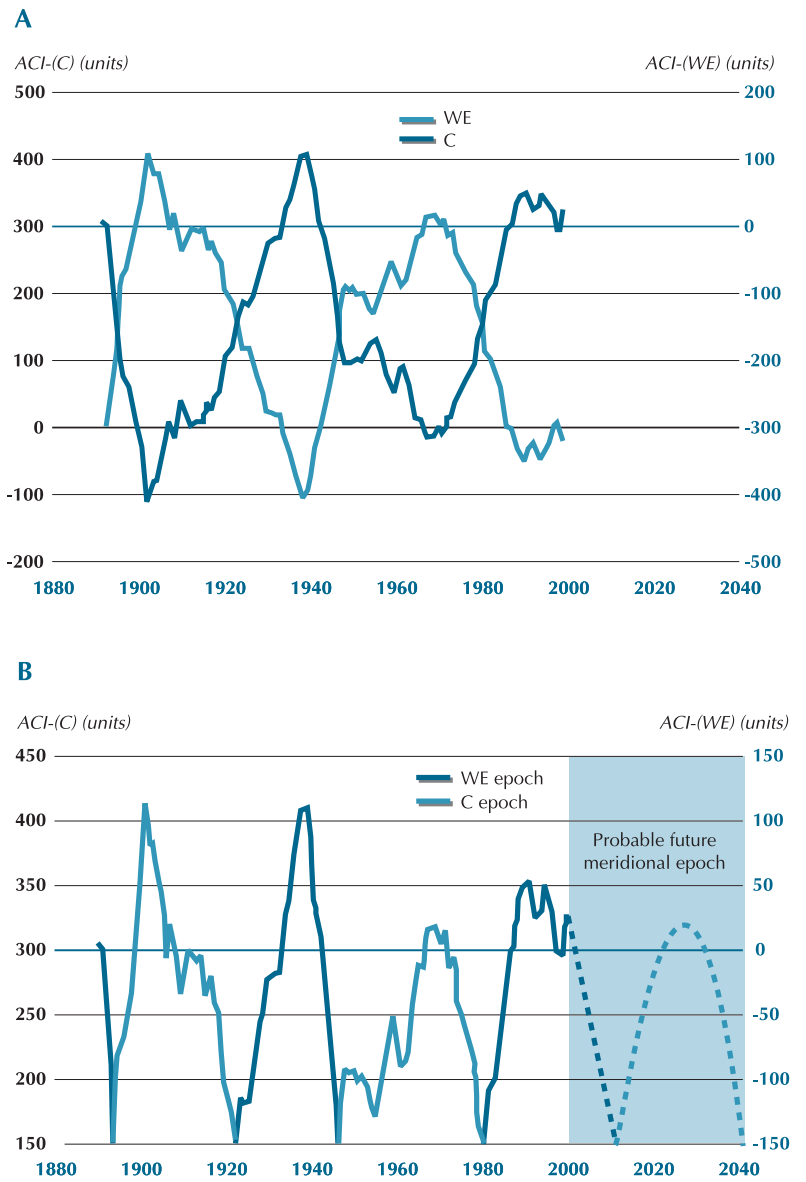
It is reasonable to expect that fish landings

FIGURE 39
Periodicity of detrended values of global temperature anomaly (dT), negative length of day (-LOD) and zonal atmospheric circulation index (ACI) 1850–2000



[5] T.R. Baumgartner, A. Soutar and V. Ferreira–Bartrina. 1992. Recontruction of the history of Pacific sardine and northern anchovy populations over the past two millennia from sediments of the Santa Barbara Basin, California. CalCOFI Report, 33: 24–40.

FIGURE 40
Dynamics of meridional (C) and zonal (WE) forms of the atmospheric circulation index (A) and alternation of meridional and zonal circulation epochs (B) 1880–2040



would have a greater correlation with corresponding regional climatic indices than with more global ones. However, the results obtained so far suggest that the catch dynamics of the main Pacific commercial species (Pacific salmon, Japanese, Californian and Peruvian sardine, Alaska pollock and Chilean jack mackerel) are in closer correlation with the global climatic indices, dT and ACI than they are with their corresponding regional indices. There is not yet a satisfactory explanation for this.

FORECASTING POSSIBILITIES

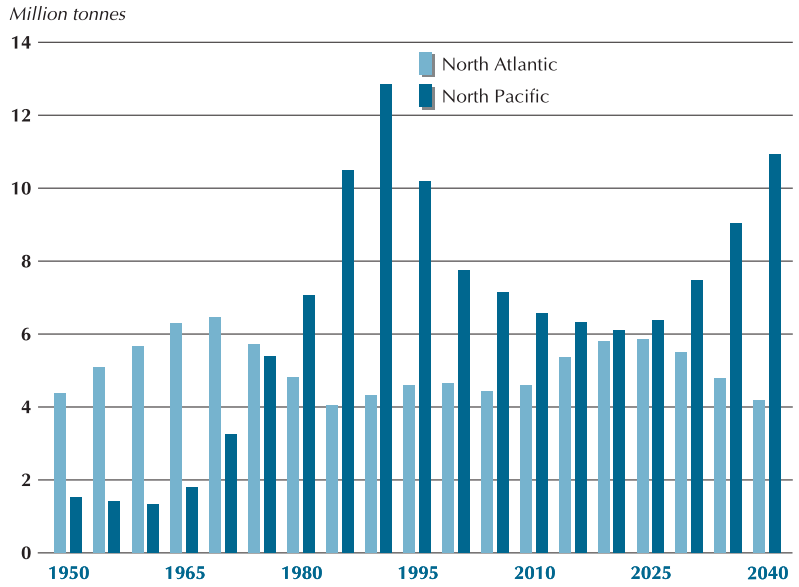
Assuming that the observed past correlation between fish catches and atmospheric regimes will continue in the future, Klyashtorin attempts to forecast total catches of a selected group of major commercial species by fixing the cycle periods at 55, 60 and 65 years (based on the climate cycle) rather than relying on estimates of the cycle length from the relatively short catch time series. His analyses suggest that a shift between the two alternative atmospheric regimes is, indeed, occurring. As a result, provided that the observed synchrony between fish and climatic epochs persists, production of the selected major commercial species over the next decade would be expected to decrease in the North Pacific and increase in the North Atlantic (Figure 41). Forecasting of the major commercial fish landings for the next 30 to 40 years is largely insensitive to the choice of periodicity within the 55 to 65 year range. Species such as Atlantic and Pacific herring, Atlantic cod, South African sardine and Peruvian and Japanese anchovy would be expected to increase during 2000–2015, decreasing thereafter. During the same period, total catch of species such as Japanese, Peruvian, Californian and European sardine, Pacific salmon, Alaska pollock and Chilean jack mackerel would be expected to decrease, increasing thereafter. Overall, the total catch of the main world commercial species considered in the analyses, and representing about one-third of world marine capture landings, would be expected to increase by 5.6 million tonnes by 2015, then to decrease by 2.8 million tonnes by 2030.

POLICY IMPLICATIONS

The possibility of forecasting long-term changes in world capture fish production, based on

observable indices of long-term climatic variability, raises justified scientific, economic and policy expectations and concerns. Fishing pressure is usually claimed to have the major influence on the long-term productivity and size of wild fish stocks. It is commonly accepted that appropriate management could maintain stock size levels that are commensurate with sustainably high catches, and that the usual consequences of management failure are depressed – and even depleted – stock sizes and lower yields. Recognition that, for some key species, deterministic long-term climate-driven impacts on stock abundance are, or could be, as important as suggested calls for a review of research and management strategies and objectives regarding fisheries of the species concerned, as well as of related species. Management responses to short-term fluctuations would have to take into account the possibility that underlying long-term deterministic fluctuations exist. Long-term management aims, which would typically involve capital investment and social and infrastructure development, would also benefit from consideration of the long-term climate effects.

FIGURE 41
Observed (1951–1998) and forecast (2000–2040) catch changes for selected major commercial species in the North Atlantic and North Pacific



Overall, deterministic climate-driven increases and decreases in fish production do not seem to be of great global importance, as increases in a group of stocks in one region tend to be balanced by decreases in another group in another region. However, the fact that long-term climatic changes could determine major epochal increases in fish production from some stocks in some areas, and equivalent declines from other stocks and areas, merits serious consideration because the impacts at the local and regional levels are bound to be far larger. For instance, at present, large international market flows come from developing areas into developed ones (i.e. from the tropics to the North), but the oscillations in production between the North Atlantic and the Pacific Ocean are likely to result in changes to these trade flows. Such changes would have significant impacts on national and regional markets, even though the total supply could remain stable. Changes in investments and fleet movements (and fishing agreements) are also expected to be greater than suggested by the world accumulated total landing figures.

This analysis has not considered anthropogenic climate change and its possible effects on fish production. However, as available data suggest that there is a link between fish production and climate, the need to include the effects of global warming in possible projections is clear. The results reported suggest that shifts in climate could have noticeable positive or negative effects on some, if not most, major commercial fish stocks.

THE SEARCH FOR AN OPERATIONAL DEFINITION OF SUBSIDIES PROVIDED TO THE FISHERIES SECTOR

BACKGROUND

Leading fishing nations are debating the size, the effects and various ways to deal with subsidies in the fisheries sector. The debate is conducted in international fora and started about a decade ago. Progress has been slow, in part because of a lack of clarity in the terms used. Not all participants in

the debate have the same understanding of what is, and what is not, a subsidy in the fisheries sector.[6]

One of the first tasks that FAO undertook in support of this debate was, therefore, to examine the term "subsidy" and to try to obtain consensus – at least among experts – as to what it should mean in the context of fisheries and aquaculture. The examination took the form of an FAO Expert Consultation, held in December 2000.

The experts discussed, inter alia, what would constitute a suitable and operational definition of "subsidy" for the purpose of analysing the effects of subsidies on resource sustainability and on trade. This discussion drew the conclusion that no single definition could be agreed to. Instead, the experts identified four sets of subsidies. They went on to recommend that these sets of subsidies be referred to and used as standards in future studies and discussions.

The experts had two major reasons for choosing this solution: they wanted to make the definition independent of any evaluation of the effects of subsidies and, at the same time, they wanted to ensure that the definition would facilitate such evaluation. They achieved these objectives by, on the one hand, tying the definition to the form of the subsidy – as opposed to its effects – and, on the other hand, classifying subsidies into four groups according to criteria that reflect the relative ease of identifying and quantifying a subsidy and its effects: set 1 being the easiest, and set 4 the most complicated.

In addition, the experts intended that the definition respect the notion that a subsidy is a national policy instrument that reflects an exception to a nationwide policy. The exception is generally reflected both in the form of the policy instrument and in its effects.

The international debate about subsidies continues. It has moved on from the definition of subsidies and is now more concerned with their classification – which is usually based on their perceived effects – and with how to assess their impact.

This article describes the definition of subsidies, as proposed by the FAO Expert Consultation. The text, with a few editorial differences, can be found in the report of the Expert Consultation.[7]

GENERAL CONSIDERATIONS

Many different definitions of a subsidy have been used in economic analyses of trade and natural resource use. Review of these leads to the conclusion that none of the commonly used definitions is adequate for a comprehensive analysis of subsidies' effects on trade and sustainability in fisheries and aquaculture. Unfortunately, the Expert Consultation did not recommend any single definition for the measurement, analysis and political debate of subsidies in fisheries.

Experts tend to place different emphasis on four attributes of subsidies in fisheries and aquaculture:

1. government interventions that involve only financial transfers to producers;[8]
2. government interventions that confer benefits to producers, without involving financial transfers from the government to producers;
3. an absence of government interventions to correct distortions that confer benefits on producers; and
4. the long- and short-term effects of government interventions on firms' benefits and costs.

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[6] Examples of different understandings of the term "subsidy" can be obtained from: FAO. 1993. Marine fisheries and the Law of the Sea: a decade of change. Special chapter (revised) of The State of Food and Agriculture 1992. FAO Fisheries Circular No. 853. Rome; M. Milazzo. 1998. Subsidies in world fisheries – a re-examination. World Bank Technical Paper No. 406. Washington, DC, International Bank for Reconstruction and Development/World Bank, 86 pp.; FAO. 2001. Subsidies for fisheries: a review of concepts, by W.E. Schrank. In Papers presented at the Expert Consultation on Economic Incentives and Responsible Fisheries, Rome, 28 November – 1 December 2000. FAO Fisheries Report No. 638, Suppl., pp. 11–39. Rome.

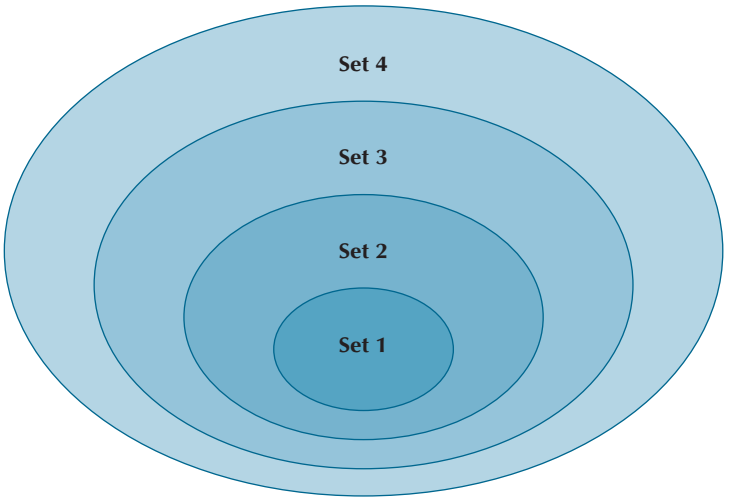
[7] FAO. 2001. Report of the Expert Consultation on Economic Incentives and Responsible Fisheries. Rome, 28 November – 1 December 2000.

[8] The term "producers" includes primary producers (fishing firms), fish processors, distributors, wholesalers and retailers of fish and fish products. In other words, producers include all the firms involved in supplying fish to the final users of fish and fish products.

In order to advance the measurement, analysis and discussion of subsidies in fisheries and aquaculture, the experts at the consultation proposed definitions for four sets of subsidies. The consultation recommended that any analysis and discussion of this issue state explicitly which of the four sets of subsidies is being considered.

The numbering of sets 1, 2, 3 and 4 is not meant to imply any ranking of subsidies. Rather, it indicates that the definition of subsidies in higher numbered sets includes more elements. In other words, set 2 includes the elements that are included in set 1, set 3 includes the elements included in set 2, and so on. This is illustrated in Figure 42.

FIGURE 42
Sets of subsidies



SUBSIDIES

Set 1 subsidies

Subsidies in set 1 are government financial transfers that reduce the costs and/or increase the revenues of producers in the short term.

Set 1 subsidies include direct payments by government to or on behalf of producers, for example, grants to purchase or modernize vessels and income support payments.

All the experts at the consultation believed that definitions of subsidies that include only government financial transfers to producers are too narrow for the present purposes. Such definitions exclude government interventions that affect trade and the use of fishery resources and that involve no financial transfers. Therefore, the definition of set 2 subsidies includes all the government interventions – regardless of whether or not they involve financial transfers – that can potentially reduce the costs and/or increase the revenues of producers in the short term.

Set 2 subsidies

Subsidies in set 2 are government interventions – regardless of whether or not they involve financial transfers – that reduce the costs and/or increase the revenues of producers in the short term.

Set 2 subsidies include tax waivers and deferrals, as well as insurance, loans and loan guarantees provided by government. Set 2 subsidies also include government provision of goods and services at below market prices.[9] Set 2 subsidies correspond closely to many of the definitions used by, for example, the World Trade Organization (WTO).

Most experts at the consultation viewed definitions of subsidies that require active and explicit government intervention, including set 2 subsidies, as too narrow. The lack of government action to correct distortions (imperfections) in the production of, and markets for, fish and fish products confers an implicit benefit to producers, which can affect trade and the use of fishery resources. The experts at the consultation therefore defined set 3 subsidies as including the lack of correcting interventions by government to remove distortions (imperfections) that can potentially affect fishery resources and trade.

Set 3 subsidies

Subsidies in set 3 are set 2 subsidies plus the

[9] Note that this applies only to goods and services for which a market exists. It does not apply to goods and services provided by the government and for which there is no market. See the discussion of management costs in set 3 subsidies.

short-term benefits to producers that result from the absence or lack of interventions by government to correct distortions (imperfections) in production and markets, which can potentially affect fishery resources and trade.

Set 3 subsidies include the implicit benefits to producers that are associated with a lack of government regulations requiring producers to bear the costs that they impose on other parties, including the costs on the environment and natural resources. When the costs imposed on others do not have to be paid for, the cost of production is lower, which in turn influences the amounts of fish produced and traded as well as the health of resource stocks. Such implicit benefits are present where government does not require measures to reduce the catch of, for example, sea turtles, sea birds or marine mammals. In such cases, producers impose costs on others, in the form of damage to the environment, which they do not pay for and do not take into account in their production decisions. Another example is where government does not do enough to prevent the overexploitation of a fishery resource. In this case, producers avoid paying for the costs of harvesting the resource in the short term, while imposing costs on others – and themselves – in the long term. Both the sustainability of the resources and the trade in fish are thereby affected.

All the experts at the consultation agreed that these types of implicit benefits (unpaid costs) can have significant impacts on fishery resource sustainability and trade. However, not all agreed that such implicit benefits should be included as subsidies for the present purposes. In particular, some of the experts believed that this definition encompasses measures that are not open to classification as subsidies, and that their inclusion moves the discussion of fisheries subsidies into areas that are distinct from, and should be addressed in different contexts from, the fisheries subsidies debate.

The experts at the consultation were unable to decide whether the failure to charge for the costs of fisheries management services constitutes a subsidy to producers. There is a lack of research on this issue, and economic reasoning leads to ambiguous conclusions.

Clearly, government provision of a factor input at below the market price constitutes a subsidy under all four definitions. However, there is no market for management services in most fisheries.[10] Some experts argue that producers have no demand for management services and that, instead, management is forced upon them. In addition, in managing fisheries, government is attempting to ensure the sustainability of the resource for the use of future generations and the enjoyment of non-producers who value the existence of healthy fishery resources.

The professional literature on recovering the costs of fisheries management essentially concludes that requiring producers to pay user fees improves the overall efficiency of management; in other words, user fees enhance the value gained from the use of scarce management resources. However, the literature does not address the issue of whether a failure to charge user fees (or to introduce some other form of cost recovery) should be considered a subsidy. Charging user fees reduces revenues (or increases costs), but whether such fees affect supply, trade and sustainability, and how they do so, are not clear at this time. More research is required on this important issue.

Some of the experts at the consultation argued that definitions of subsidies that include only those government interventions (or an absence of correcting interventions) that confer short-term benefits on producers are limited because they do not account for the effects over time of such interventions. An intervention that confers an immediate benefit can ultimately confer harm or losses on producers, especially in fisheries. Some of the experts recommended extending the definition of a subsidy to include interventions (and the absence of correcting interventions) that affect costs and revenues in any direction and over time, i.e. in the short, medium and long terms.

[10] The case of sole ownership is an exception in which the owners of the fishery resource would be willing to pay for a set of services that include research, management administration and enforcement.

Set 4 subsidies

Subsidies in set 4 are government interventions, or the absence of correcting interventions, that affect the costs and/or revenues of producing and marketing fish and fish products in the short, medium or long term.

Set 4 subsidies include all set 3 subsidies plus such interventions as management measures that may decrease (or increase) the short-term benefits to producers but that result in an increase (or decrease) in long-term benefits to producers. An example is where closure of a fishery (or an area of a fishery), which imposes short-term losses on producers, ultimately results in a rebuilt resource stock and higher long-term benefits to producers. Set 4 subsidies explicitly account for the effects over time of government interventions and the absence of correcting interventions. The effects on benefits to producers in the short term may be the opposite of the long-term effects.

TECHNO-ECONOMIC PERFORMANCE OF MARINE CAPTURE FISHERIES

INTRODUCTION

In 1999 and 2000, in close cooperation with several fisheries research institutions and national fisheries administrations in Asia, Africa, Latin America and Europe, FAO reviewed the economic and financial performance of more than 100 fishing fleets in 15 countries. The results are presented in a FAO Fisheries Technical Paper.[11] The studies are part of the monitoring of the economic viability of marine capture fisheries organized by the FAO Fisheries Department.

The studies highlight two aspects of the economic and financial data: the structure of costs and the profitability. In 1999–2000, the influence of financial transfers on profitability was also reviewed.

This article contains some of the highlights of the data collected and the conclusions reached. Special emphasis is given to an international comparison of the structure of costs for small-scale fishing vessels.

[11] FAO. 2001. Techno-economic performance of marine capture fisheries. FAO Fisheries Technical Paper No. 421. Rome.

COST STRUCTURE OF SMALL-SCALE FISHING VESSELS

Europe

Labour costs account for the major share of operating costs (45 to 64 percent) in European small-scale fisheries (Norway, Germany and France). Vessel costs are the second highest cost component, ranging from 20 to 35 percent of total operating costs. At 7 to 20 percent, running costs play a minor role, mainly because of lower fuel expenses. The importance of labour costs compared with vessel costs and running costs is even higher than it is in deep sea trawl fisheries.

When adding the costs of investment, i.e. depreciation and interest on vessel costs, vessel costs gain considerable importance, as shown in Figure 43. Vessel costs and depreciation and interest combined range from 33 to 51 percent of the total costs.

This finding shows that European small-scale fisheries are relatively capital-intensive and that capital is substituting expensive labour. This trend is more pronounced in the case of German and French vessels than it is in the case of Norwegian vessels.

Senegal

The cost structure of Senegalese small-scale fishing vessels differs from that observed in Europe. While labour costs are the most important element of the operating costs in Europe, their share is significantly higher in Senegal than in the developed European countries reported. This supports the general notion that small-scale fisheries in developing countries are more labour-intensive than in developed countries. It is worth noting that vessel costs are the least important element of operating costs in Senegal, reflecting the low costs of vessel maintenance and repair.

Depreciation and interest are less important in Senegal than in most European countries. This reflects the fact that vessels are less expensive, so depreciation and interest are also reduced, and range from 7 percent of the total costs (for handliners) to 21 percent (for two-canoe purse seining), compared with Europe where their share is between 33 and 51 percent.

FIGURE 43
Total costs of small-scale fishing vessels in Europe

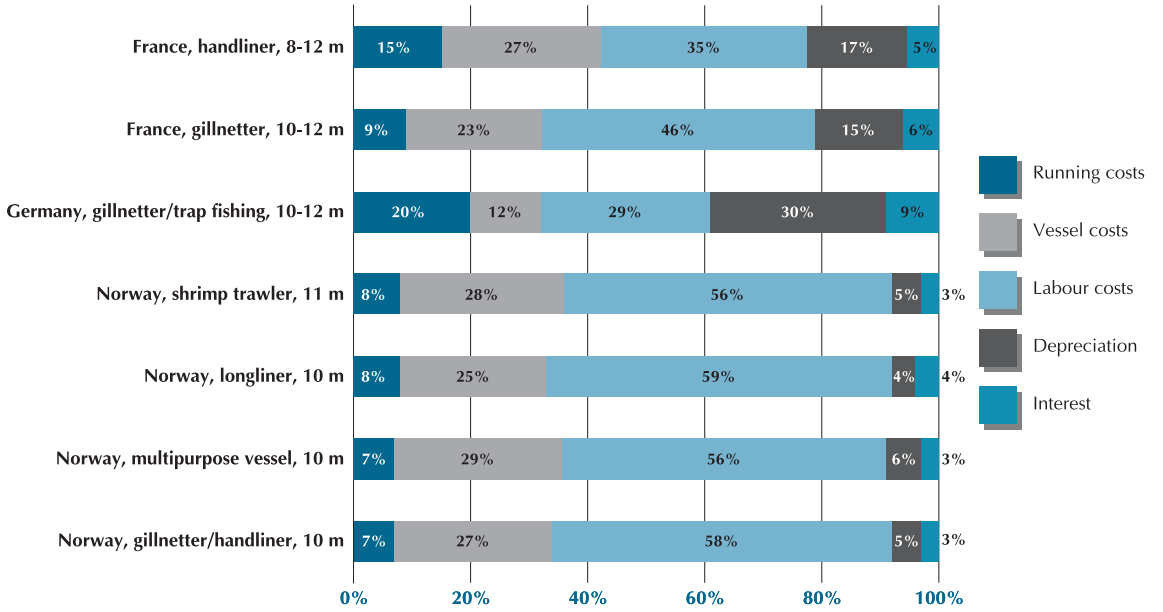
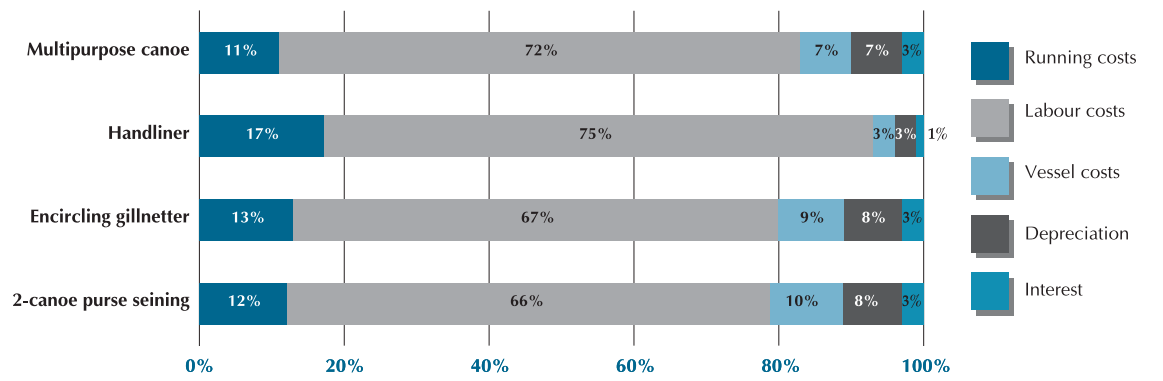


FIGURE 44
Total costs of small-scale fishing vessels in Senegal



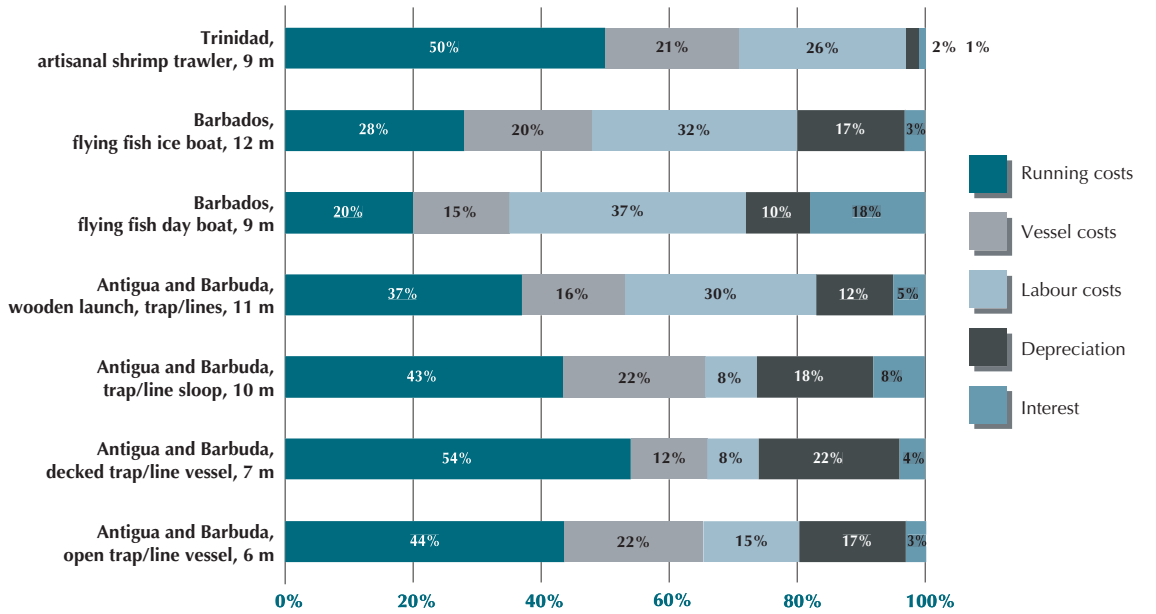
The Caribbean

In the case of small-scale fishing vessels in the Caribbean, a different picture emerges. Only for fishing boats that exploit flying fish from Barbados (using gillnets, dip nets, handlines and fish aggregating devices) do labour costs rank as the highest cost component, followed by running costs and vessel costs. In all the other cases (boats fishing for lobster and high-value bottom species in Antigua and Barbuda, and artisanal shrimp trawlers in Trinidad), running costs are the most important cost component. This reflects the situation observed for deep sea trawlers operating in developing countries.

For traditional lobster boats in Antigua and Barbuda, labour costs are the least important cost component. This contrasts with the situation reported for the country's larger lobster boats and for the artisanal shrimp trawlers in Trinidad, where labour costs are the second highest cost component, followed by vessel costs.

In fact, the total cost structure of small-scale

FIGURE 45
Total costs of small-scale fishing vessels in the Caribbean



fishing vessels in the Caribbean resembles the situation found in Europe more closely than it does the one in Senegal. When depreciation and interest are added, the vessel costs range from 24 to 48 percent, which is close to the situation in Europe and indicates only a slightly lower level of capital investment than that observed there. For boats that catch flying fish in Barbados and sloops that catch lobsters and bottom fish in Antigua and Barbuda the result is even closer to Europe's. For these vessels, the vessel costs plus depreciation and interest account for the highest share of the total operating costs.

Running costs rank second, and labour costs are the least important component of both operating and total expenses for small-scale fishing vessels in the Caribbean (Figure 45). In this they differ from European vessels.

South and Southeast Asia

In South and Southeast Asia, labour costs are the most important component of the operating costs for four of the six types of small-scale fishing vessels studied. The situation is thus similar to that of small-scale fishing vessels in Europe and Senegal. In the cases of the Indian log raft, which operates trammel nets, and the Thai push-netter, running costs exceed labour costs. As is the case for most Caribbean and Senegalese vessels (but not for European small-scale fishing vessels), running costs rank second, and vessel costs third.

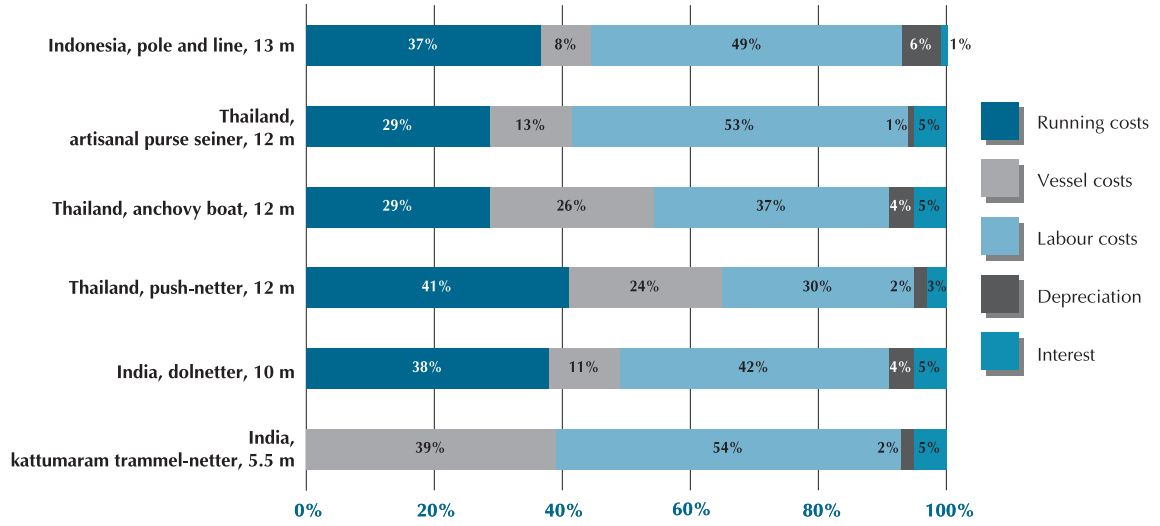
Figure 46 shows that vessel costs, together with the costs of depreciation and interest, range from 15 to 46 percent, which is more similar to the situation found in the Caribbean and Europe than to that of small-scale fishing vessels in Senegal.

However, in no case do vessel costs plus depreciation and interest account for the highest share of total expenses, as was observed for some categories of vessels in Europe and the Caribbean. In three of the six cases (Thai push-netters and anchovy boats and Indian catamaran), vessel costs plus depreciation and interest rank second, while for the other three fleets they are the least important cost component. Again, this indicates a relatively low level of capital investment.

RECENT TRENDS IN FINANCIAL AND ECONOMIC PERFORMANCE

The studies carried out in 1999 and 2000 confirm and validate the findings of the cost and earnings studies carried out between 1995 and 1997. Of the 108 types of fishing vessels studied, 105 (97

FIGURE 46
Total costs of small-scale fishing vessels in Asia



percent) had a positive gross cash flow and fully recovered their cost of operation. Only three types of vessels (stow-netters in China and semi-industrial and industrial shrimp and bottom fish trawlers in Trinidad and Tobago) showed operational losses. Some 92 of the 108 types of vessels (85 percent) showed a net profit after the costs of depreciation and interest had been deducted. This composite result is more positive than that obtained from studies carried out during the 1995–1997 period, when only 61 of the 84 types of vessels studied (73 percent) had a positive net cash flow. The improvement is largely due to the inclusion of fleets operating in Norway, Thailand and the Caribbean, all of which recorded net profits.

Of the ten countries that participated in both the previous and the recent studies, two (France and Spain) showed marked improvements in the profitability of their fishing vessels, while another two (China and Germany) showed declining profitability. In the remaining six countries (Republic of Korea, Indonesia, India, Senegal, Argentina and Peru), the economic results remained substantially unchanged.

The higher prices paid to producers in 1999–2000, compared with the previous study period, contributed to these overall positive results. There were few indications that fishing effort had been reduced and fish stocks had recovered. It was also observed that some fleets had changed their fishing operations to adapt to the new conditions that resulted from depleted and changing abundances of resources and access to new markets.

The impact of cost-reducing and revenue-enhancing government financial transfers differed significantly from country to country. In two countries in the EC and in India, there were strong indications that almost all the vessel types that were covered by the cost and earnings study and received financial transfers would have been profitable even without those transfers. The transfers played a role, however, in increasing earnings and profitability significantly. In the Republic of Korea the situation was mixed, while in Thailand vessels that could avail themselves of tax exemptions on fuel needed to do so in order to have a positive gross cash flow.

Examples of new trends in coastal fisheries include the expanded use of trammel nets by traditional log rafts (kattumarams) on the east coast of India, the introduction of mini outrigger trawlers fishing for shrimp and demersal species in shallow waters off the Indian coast of Orissa and Bengal, the replacement of day boats by so-called ice boats with improved onboard preservation facilities in the flying fish fishery of

Barbados, the modernization and improvement of sloops and launches to cater to the requirements of export markets in Antigua and Barbuda, the diversification of purse seining and pole and line fishing in Indonesia, and the modernization and upgrading of coastal vessels in Thailand, Norway, France and Germany.

In offshore fisheries, the expansion/development of new profitable fisheries with high capitalization and technology was observed. Examples include French and Spanish tuna seiners, German pelagic trawlers, Norwegian combination vessels equipped for pelagic trawling and purse seining, and tuna longliners in India and Indonesia.

Vessels that had previously shown positive results but now incurred losses were generally older vessels, which were continuing to work on overexploited stocks. Examples are Chinese bottom pair trawlers of 25 to 28 m in length, Chinese single bottom trawlers of 26 m in length, Chinese stow-netters of 30.5 m in length and Chinese purse seiners/set-netters of 36 m in length, all of which showed net losses – the stow-netters even showed operational losses – while previously only pair trawlers had shown a net loss and no vessel showed operational losses. Indian purse seiners of 14 m in length fishing mackerel and sardine in the Arabian Sea also showed net losses, while previously they had made a net profit.

Senegalese purse seiners targeting small pelagics and fishing off the West African coast, which had previously shown net profits, now recorded net losses, although they still recovered their operating costs.

The situation also deteriorated for German cutter trawlers of 22 to 32 m in length fishing demersal fish stocks in the North Sea and Baltic Sea, as well as for German factory trawlers of 60 to 80 m in length fishing demersal fish resources off Greenland and in the waters of the EC. These all showed net losses, but not operational losses, having previously shown a net profit.

Spanish pole and line vessels of 24 m in length also made net losses after making a net profit during the previous study period.

Types of vessels that showed net losses during the first study and a net profit in the second include three types of Spanish tuna seiners of 56, 64 and 70 m in length, deep sea trawlers of about 30 m in length, and three types of deep sea trawlers ranging from 15 to 24 m in length.

AQUACULTURE DEVELOPMENT IN CHINA: THE ROLE OF PUBLIC SECTOR POLICIES

INTRODUCTION

Policy-makers and development agents are increasingly viewing aquaculture as an integral component of the search for global food security and economic development. Mainland China is the world's leader in aquaculture production following a steady development during the last three decades. Identification and analysis of the issues and factors that motivated aquaculture development in China could play a critical role, not only in understanding the future of aquaculture in China, but also in shaping aquaculture development in many parts of the world. It is within this framework that the FAO Fisheries Department and the Government of China jointly conducted this study. The ultimate goal was to evaluate ways in which the Chinese experience of sustainable and lucrative aquaculture development could benefit other countries with aquaculture potential, especially developing countries.[12]

The approach taken to achieving this goal consisted of answering four questions concerning aquaculture in China: Why did aquaculture develop so sustainably? What is its current development level? How was this development achieved? and Where is aquaculture heading?

The information presented in this article came

[12] This article is a summary of FAO. In press. Aquaculture development in China. The role of public sector policies. FAO Fisheries Technical Paper No. 426. The paper and the associated study cover all of China except Taiwan Province of China. It was prepared by a team of Chinese experts and FAO staff and consultants. The data presented on Chinese aquaculture were provided by the Government of China and differ somewhat from some of the data previously published by FAO. Given that the primary purpose of this article is to highlight the policy contributions to the rapid growth of aquaculture in China, it was not considered essential that these statistical differences be reconciled.

mainly from existing documentation on the sector, observations from field visits by experts, and the study team's knowledge of the sector. Major players in the sector also provided useful information. The article discusses the main findings of the study before closing with some concluding comments.

MAIN FINDINGS

The reason for aquaculture development

China has a long history of aquaculture development, which can be divided into three main phases: the pre-1949 period, the 1949–1978 period, and the period from 1978 to the present. The foundations for aquaculture development and growth were laid in the period between 1949 and 1978, after which development has been rapid and steady.

Development seems to have been prompted by food self-sufficiency and economic factors. When the People's Republic of China was born in 1949, the country had just emerged from a period of foreign domination and civil strife. The economy was totally wrecked. Poverty was rampant, food scarce and famines frequent and widespread. As the government strived to rebuild the country's economy, its first priority was to mobilize and organize all the available national resources at its disposal in order to produce enough food and raw materials to feed and clothe the population. Given their production cycles, fisheries and aquaculture were considered to be two sources of animal protein that could be tapped in a short time. In addition, fish was already an accepted food item in people's diet and its production through farming and the harvest of natural waters was well established in China. The goal was also to produce for export in order to earn much-needed foreign exchange with which to purchase capital goods for the construction of the economy.

Current state of the art

Major aquaculture systems, species and production technologies. Major freshwater aquaculture systems include pond, cage, pen and paddy–fish culture in rice fields and indoor running water systems. Pond culture is the most popular and most important fish farming system in China. Major species cultivated in ponds include carps, Chinese bream (Megalobrama amblyocephala), mandarin fish (Siniperca chautsi), Japanese eel (Anguilla japonica), Japanese prawn (Macrobrachium nipponensis), mussel (Hyriopsis cumingii and Cristalia plicata), river crab (Eriocheir sinsensis), soft-shelled turtle (Trionyx sinensis) and introduced exotic species such as channel catfish (Ictalurus punctutatus), tilapia (Oreochromis niloticus), giant prawn (Macrobrachium rosenbergii), large-mouth bass (Micropterus salmoides) and rainbow trout (Onchorhynchus mykiss).

Marine and brackish water culture systems range in type from ponds to floating rafts, pens, cages (inshore, offshore and submerged), tunnels, indoor tanks with water recirculation, sea bottom culture and sea ranching. Before 1980, three species – the seaweeds Japanese kelp (Laminaria japonica) and purple laver (Porphyra tenera) and the mollusc blue mussel (Mytilus edulis) – accounted for about 98 percent of the total marine aquaculture output. Currently, in addition to these species, important marine species include two shrimp species (Penaeous monodon and P. chinensis), the molluscs oysters (Ostrea spp.) and razor clam (Solen constricta), scallops (Argoipecten spp.), abalone (Haliotis discuss hannai and H. diversidor) and finfish.

Farm organization and structure, and relationships among farmers. Ownership of aquaculture ventures in China comprises state, corporate, individual, joint venture and independent foreign venture ownership. In the southern part of China's coastal provinces and autonomous regions, including Zhejiang, Fujian, Guangdong, Guangxi and Hainan, more than 90 percent of the farms belong to individuals and private corporations. In some areas of the region, such as Wenzhou and Taizhou in Zhejiang Province, joint ventures and cooperative farms account for 100 percent of aquaculture businesses. Most partners in joint ventures with foreign investors are from Taiwan Province of China. In the northern part of China's coastal provinces, about 80 percent of aquaculture businesses are corporations. In the country's inland areas, more than 90 percent of freshwater

fish farms are individually or family-owned.

Farm sizes and distribution depend on the species cultured and the geographical location. In northern areas, especially in Shandong and Liaoning provinces, most mariculture farms are large-scale, commercial operations producing mainly kelp, flatfish (Paralichthys olivaceus), scallop and abalone. In southern and inland areas, small-scale farms are preponderant; most of them are freshwater fish farms operated by family units.

Mutually reinforcing relationships between small- and large-scale producers exist. The heads of large-scale companies, referred to as "heads of dragons", can sign contracts with small-scale fish farms involving capital investment, product collection, technical guidance and provision of market information to the small-scale farms. In return for these services, large-scale companies gain community support, which is an essential ingredient for the sustainability of their enterprises, and economic gains.

Seed and feed production. Because of the high demand for seeds, China has hatcheries for a host of different species.

With the exception of eel farming, which still collects seeds from estuarine areas or imports them from other countries, including France, most of the seeds of farmed species are supplied from hatcheries. Hatcheries consist of well-developed bases/stations that are operated by corporations, collectives or individuals. The National Fisheries Technology Extension Centre is responsible for guiding breeding techniques and introducing genetic materials from one region to another. The Fish Identification Committee, under the leadership of the National Bureau of Fisheries, is responsible for the identification of genetic materials and the establishment of multiplication centres.

There are about 12 000 feed mills producing various kinds of animal feeds, including fish feed. Of these, about 1 900 have a production capacity exceeding 5 tonnes per hour. The state still plays an important role in the production of feed for aquatic animals and owns slightly more than 47 percent of the mills, down from 99 percent in 1990. Domestic corporations control 47.6 percent of the mills, up from 0 percent in 1990. The contribution of joint ventures has also been increasing, although slowly; in 1999, they accounted for 3.8 percent of the feed mills for aquatic animals, compared with 0.1 percent in 1990.

Markets and marketing. Aquaculture products are sold in fresh and processed forms. Although most products are sold fresh, basic fish handling and processing technologies are being progressively replaced by the latest modern technologies to add more value to various fish products. Frozen or cold-stored products are replacing salted ones; large packages are giving way to small ones; and soft tin containers are used in lieu of glass containers.

Research, education and extension. The research system consists mainly of national and local fisheries research institutions and universities. In 1999, there were 210 fisheries research institutes in China. National research institutions and universities, most of which are engaged in basic and applied research, are the major power for aquaculture research and technological development. National research institutions are funded by the central government and are under the direct administration of the Chinese Academy of Fishery Sciences within the Ministry of Agriculture. Universities fall under the administration of the Ministry of Education or provincial governments. Local institutions focus on solving the technical problems that affect local aquaculture development. They are more producer-oriented and are sometimes quicker to respond to farmers' needs than are the other two categories. Often, they are also a step ahead of national institutions and universities in terms of practical technological advances. They are funded mainly by provincial and/or municipal governments. Non-fisheries commercial private companies also sponsor aquaculture research, especially in the areas of aquaculture feeds, chemicals (for the control of fish diseases) and breeding and culture technologies of high-value species.

The government has established a system of aquaculture education and training that can

generally meet human resource requirements for the development of the sector.

Education and on-the-job training are fully supported by central and local government. Some 30 universities enrol about 1 000 undergraduate students in aquaculture every year, five universities and research institutions offer doctoral degrees, and nine award master's degrees in aquaculture and closely related areas. There are also about 20 technical secondary schools and a large number of vocational schools with the major task of producing skilled workers for the aquaculture and fisheries sector.

Aquaculture extension has always been strongly supported by the government. The National Fisheries Technology Extension Centre is the national institution responsible for aquaculture extension, and 18 462 fisheries extension stations form a network of services across the country. Extension is jointly funded by central and local government. Research institutions are also starting to extend their findings directly to farmers. As aquaculture develops, a growing number of organizations and commercial companies outside government, especially feed and chemical companies, are showing interest in extension activities. Their motive is profit, as they see extension as an effective means of promoting markets for their products.

Major strengths and constraints. As well as supportive government policies (which are discussed in the following subsection), the main strengths of Chinese aquaculture include well-established seed production technology for freshwater species, a strong and continuing research and development infrastructure, a solid extension service, relatively higher profit and net income per unit of labour, and a strong domestic and international demand for aquatic products. Major constraints include: the continued threat of environmental degradation and disease outbreaks; little improvement in seed supply and genetic conservation; limited suitable land for expansion of land-based aquaculture; and, in many areas, inadequate primary fishery facilities and infrastructure.

DEVELOPMENT POLICIES

General sector-specific policies

A rich general policy mix led to the noticeable development of aquaculture at different periods in China.

Self-reliance in fish through the full employment of resources. When the People's Republic of China was proclaimed in 1949, the government developed a highly centralized system of planning, development and management that continued until the implementation of an open-door policy and economic reforms in the late 1970s. During this period, the government's policy was to push for the population's full participation in the economic life of the country, including in the aquaculture sector. The primary goal was fish self-reliance.

Setting aquaculture as a priority in the development of the fisheries sector. Before 1979, the guiding principles for fisheries and aquaculture emphasized marine fisheries and fishing and tended to underrate freshwater fisheries and aquaculture. This policy led to the severe destruction of fishery resources and the slow development of aquaculture. Thereafter, the government issued a series of regulations to protect fishery resources and to make aquaculture development one of its priorities. Targets were set and means of achieving them defined. Guided by these general principles and policies, which were supplemented by other relevant and more specific policies, Chinese aquaculture development recovered from stagnation. By 1985, output from freshwater and marine water aquaculture had reached 3 090 000 tonnes, accounting for about 43 percent of the combined capture fisheries and aquaculture output.

Establishment of aquaculture production bases. Owing to the construction of government aquaculture production bases, aquaculture developed into an important industry for the rural economy. By 1986, the total area covered by the government's aquaculture bases in China had reached nearly 2 400 km^2 and was yielding 1.5 million tonnes, nearly 50 percent of the country's total aquaculture output for that year.

Promotion of sustainable aquaculture development. Ten years after the Instructions on the Release of Restrictions to Expedite the Development of the Aquatic Products Industry were promulgated in 1986, the industry had developed very rapidly. However, many problems emerged alongside the increase in output. Poor management of aquatic seed resulted in high mortality; diseases broke out; the dissemination and transfer of aquaculture technologies was inadequate; and poorly constructed infrastructures and facilities were widespread. In order to foster and boost the sustainable and rapid development of aquaculture, the State Council issued regulations that demanded further reform and liberalization of aquaculture, radical changes to the structure of the sector, adjustment of the species mix and production structure to market conditions, and the development of new technologies to improve the performance of the whole fisheries sector so as to ensure its sustainable development.

Continuous adjustment of the structure of the aquaculture sector. As the industry developed, it soon became apparent that there were serious inherent structural problems, which needed to be addressed if growth was to continue. In the main aquaculture production areas, the supply of some traditional species exceeded demand, resulting in low prices, reduced sector efficiency and depressed producer incomes. In response, in 1999 the Ministry of Agriculture released the Guiding Instrument on Adjusting the Structure of the Fishery Sector, which had the aim of restructuring the fisheries sector, including aquaculture. The guiding principle concerning aquaculture was to increase efforts to develop new markets and expand existing ones, increase the demand for fish through market promotion, develop new value-added products, improve the quality of aquatic products through technological innovation, provide improved infrastructure and facilities, and reform the legal system.

Establishment of a good administrative framework for aquaculture management and creation of a specialized agency. The National Bureau of Fisheries is the functional department in the Ministry of Agriculture that coordinates the administration of the fisheries sector, including aquaculture. Its main functions are to:

- supervise implementation of the state's general principles, policies and plans for the fisheries sector;
- study and put forward measures for technological advances in fisheries development;
- protect fishery resources and utilize them rationally;
- promote fisheries development;
- organize and supervise the construction of infrastructure in the fisheries sector.

In general, the National Bureau of Fisheries studies and initiates the establishment of general policies and regulations, which are then submitted to the Ministry of Agriculture, the State Council or the People's Congress for approval. Once general policies and regulations have been promulgated, the National Bureau of Fisheries supervises their implementation. The bureau can also set up some specific policies within its area of jurisdiction. Depending on the province concerned, province-level fishery authorities initiate the implementation of the policies/regulations by themselves or after obtaining approval from the provincial government. Other supporting structures for the fisheries sector include: the National Fisheries Technology Extension Centre, which is a semi-governmental institution dealing with implementation of the state's policies on fishery technology and extension services; the Chinese Fishery Academy, which is the national-level academy involved in research on specific subjects, such as the biology of aquatic animals, fishery resources and the socio-economics of fisheries; and the China Society of Fisheries, which is an organization of fishery technicians dealing with technical exchange and promotion. The activities of all of these are coordinated by the National Bureau of Fisheries.

Establishment of a good legal and regulatory framework for aquaculture development. The basic law in fisheries and aquaculture is the

Fisheries Law of the People's Republic of China, which was promulgated by the Standing Committee of the National People's Congress in 1986 and revised in 2000. It first established guiding principles in the development of aquaculture, fishing and processing. Other important parts of the legal system that regulate sustainable development in the fisheries sector, including aquaculture, are the regulations, rules and directive notices that protect fishery resources, provide access to water and areas, protect the environment and control aquaculture production methods and techniques, as well as ensuring the safety of aquatic products. The Fisheries Law is often supplemented by Notices focusing on critical issues facing the industry at the national level.

Emphasis on research, technological development and information dissemination. The rapid development of aquaculture of the past two decades has been strongly supported by research, technology development, education, training and extension, most of which is funded by the government. Scientific research and technological progress, especially the adoption of breeding technologies for different culture species, contributed more than 50 percent to the growth of aquaculture output between 1979 and 1999.

Promotion of high-value species. Prior to the 1970s, the main species cultured in mariculture were seaweeds and molluscs, while herbivorous or omnivorous filter-feeding fish species, such as carps, dominated freshwater aquaculture. There were no feed manufacturers for aquatic animals in China, as there was no supporting demand. When a protein diet was required, trash fish were used as the main ingredient. With the introduction of high-value species such as shrimp in the late 1970s, the home-based feed processing model quickly failed to meet the increasingly high demand for high-quality feed, and this stimulated the development of the fish feed industry. The development of the feed industry further induced the private sector to engage in the farming of more high-value species in both fresh and brackish water, such as the mitten crab, the soft-shelled turtle, eel and the red seabream in the late 1980s and early 1990s. The diversification of high-value species resulted in expanded aquaculture output.

Issue-specific policies

The government also used policies to address specific issues, such as seeds, feed, technology, land and marketing.

Policies on seed issues. The government addressed the limited availability of high-quality seeds, especially of strong, disease-free and disease-resistant seeds, by encouraging private investment in hatcheries, enacting policies aimed at controlling seed quality, and setting up legal provisions on seed production and dissemination.

Policies dealing with feed issues. Feed-related issues were alleviated through the sponsoring of research in feeds and nutrition, the establishment of a regulatory framework for the development of the feed industry, and the provision of economic incentives to investors, especially preferential tariffs on the raw materials used in feed manufacturing.

Policies dealing with appropriate technologies. The government has continued to apply a multitechnology policy to the development of aquaculture. Thus, national research institutions are distributed across the country's climatic and geographic zones. There are five freshwater fisheries research institutions: one in the subtropics; one in the area close to frigid zones; one in the central eastern part of the country; and two in the inner western part. The three marine fisheries research institutes are also evenly distributed, from south to north along China's coast. Different research institutions have developed broad varieties of production technologies for different regions. The government also strongly promotes the diversification of species, especially through the introduction of foreign technologies and exotic species with good commercial aquaculture potential and the expansion of private sector involvement in technological development,

particularly in such areas as the breeding of high-value species and the enclosure of running water systems.

Policies dealing with marketing issues. Recent government policies in marketing have consisted of breaking the state's market monopoly. Under the centralized planning economic structure prior to 1978, the state had the monopoly for buying and distributing aquatic products. This policy greatly reduced farmers' incentives to expand aquaculture production. Since 1979, the government has been reforming the marketing system for aquatic products by gradually, but drastically, liberalizing and privatizing their production, marketing and distribution. Trade barriers among the country's regions were also abolished. In order to develop China's fisheries and aquaculture further, since 1985 the government has created an enabling environment for market development by issuing a series of policies that allow market forces to determine prices of aquatic products; influence open market dynamics and create and set criteria for the construction, design, organization and management of wholesale markets; establish offices responsible for the management of fish product distribution channels; and promote local wholesale market development. The government has also established seafood market information networks and centres which collect information from various markets and disseminate it to the public, especially to companies for use in their production decision-making and planning.

Land issue policies. Land issues were addressed through the structural reform of farm ownership and property rights policies. Since the early 1980s, the government has encouraged and supported the transfer of farm ownership from the public to the private sector. In contrast to the former collective system, in which ownership and the benefits accruing from farming belonged to the state and/or the collective, under the new land law, the socialistic principle of a collective economy and property rights (particularly ownership and individual rights to farm produce) are guaranteed and given to collective members. Each member has equal rights to the farm and gets a share of the value of its produce.

Investment issue policies. Prior to 1979, government enterprises were the norm. Thereafter, a proportion of the productive capital has changed from government allocation to government loans. The government has also provided grants and subsidies to investors, introduced a tax system whereby the tax burden on investments is shared between central and local government, and encouraged joint ventures between central and local government, on the one hand, and between domestic and foreign private investors, on the other.

THE WAY FORWARD

The government intends that aquaculture in China should not only be environmentally friendly, but also rational, healthy and sustainable. It is working towards establishing a plan of action and a sound management system to safeguard the environment. Steps have also been made in developing appropriate management strategies through adoption of the precautionary principle approach, as embodied in FAO's Code of Conduct for Responsible Fisheries. Preventive measures for non-point sources of pollution affecting aquaculture, mainly resulting from land wastes, are planned. These will be achieved through suitable awareness building and the implementation of regulatory control programmes by the responsible authorities.

The future of aquaculture in China looks promising. The government's commitment and support of the sector is strong. Aquaculture continues to be a high priority. The private sector is more interested in aquaculture than it is in other agriculture subsectors of the national economy. Output from capture fisheries is unlikely to increase in the foreseeable future. The demand for fishery products is growing, both within China and internationally. China has good potential for increasing the share of its aquaculture products in international markets, helped by its membership of the World Trade Organization (WTO). The development of freshwater integrated farming, paddy–fish culture and marine aquaculture, and the implementation of participatory community extension services are

the main means for achieving these expectations.

As it continues to develop, aquaculture is expected to continue playing an important role in Chinese society by ensuring food supply and alleviating rural poverty, especially through job creation and income generation for the rural poor. Processing, value adding, marketing and the ornamental fish industry are expected to improve, thereby contributing to the well-being of China's urban, suburban and rural population.

Nevertheless, there are some major impediments to further aquaculture development in China. The supply and availability of quality seed in marine aquaculture are still low. In some well-established aquaculture areas, the supply of traditionally cultured species such as Chinese carps greatly exceeds the market demand, and this seriously depresses prices. The high-value or market-preferred species that are in demand in domestic and international markets are not fully exploited on a large scale. Farming technologies are outdated, often resulting in inefficiency. Water is polluted in some areas, leading to disease outbreaks. Suitable land for land-based aquaculture is also limited.

CONCLUSIONS

China is the world's largest producer of farm-grown aquatic products today. Apart from the country's sheer size and population, this achievement stems mainly from proactive government policies on fisheries, in general, and aquaculture, in particular.

Aquaculture in China has developed through two policy regimes: the egalitarian model under centralized state planning from 1949 to 1978, and the open market economy regime, which started in 1978. The early egalitarian model was primarily responsible for much of the progress achieved in securing food self-sufficiency in fish. Under this model, the government's first priority was to mobilize and organize all the available national resources at its disposal in order to produce more food and raw materials with which to feed and clothe the population. These policies involved the full participation of China's rural communities, which constituted almost 80 percent of the country's total population in the 1950s, and have been highly effective in making Chinese aquaculture what it is today. In addition, the policies led to the creation and accumulation of real assets and wealth at the national, local and individual levels. Rural incomes and livelihoods significantly improved. The policy of rural communities' full participation in aquaculture also produced skilled aquaculture workers for the development and expansion of the industry. In the open market economy model, in which free market forces are allowed to determine the allocation and transformation of productive resources and to allocate aquaculture output among consumers, food self-sufficiency policy has continued to be the pillar of aquaculture development. Other goals are efficiency and acquisition of the much-needed foreign exchange with which to purchase capital goods for rebuilding the economy.

The main engines of aquaculture growth have been the government's recognition of the sector as a development priority; the full utilization of productive resources, including suitable water surfaces, mudflats and waterlogged lands, as well as people; investment in research and technology; the establishment of a nationwide aquaculture extension network reaching the grassroots level; the promotion of aquaculture for poverty alleviation, food security and employment in poorer provinces; and the establishment and constant improvement of the legal framework and regulatory system.

With continued proactive government policies, adequate advanced planning, scientifically designed production technologies and sound management, aquaculture in China can be, and is likely to be, productively stable, sustainable, equitable and profitable. Responsible aquaculture intensification remains physically feasible and will most likely develop, as the best sites have already been used and there is a growing need to protect and preserve the natural environment.

The main challenges to further aquaculture development in China are the limited supply of good-quality seeds for some species; the oversupply of traditionally cultured species, such as carps, which results in low prices; the underexploitation of high-value species; outdated farming technologies; water pollution; the limited

suitable land for expansion; and frequent fish disease outbreaks. In order to overcome these constraints, it can be expected that the Chinese authorities will:

- consider developing industrialized farming systems by improving the design of and upgrading production systems, employing the latest technology and selecting the best combination of species to respond to market conditions in both domestic and international arenas;
- strive to increase the market share of high-value freshwater species suitable for export, and achieve production efficiency, which in turn suggests large-scale industrial farms;
- give greater emphasis to the production of high-quality seed by making use of modern biotechnology;
- establish an integrated scientific system and network of fish breeding and seed production for high-quality indigenous or endemic species, as well as developing fish health management and disease prevention, diagnosis, control and treatment.

The pursuit of policies of this kind implies allocating additional funds to aquaculture development, particularly to support projects in appropriate areas and locations, especially in mid-western regions of the country.

The Chinese models and experiences of aquaculture development provide the following valuable lessons to other developing countries in their efforts to promote and develop aquaculture:

- Aquaculture can be developed in a sustainable manner to generate food and jobs and improve the income and livelihoods of rural and urban populations, thus alleviating hunger and poverty.
- The engine for economically resilient and sustainable aquaculture is the government's will and resolve to establish sound policies to support and develop the sector.
- Full employment of productive factors, including human resources, continuous improvements in the legal and regulatory framework for the development of the sector, and scientific breakthroughs in production technologies will strengthen aquaculture and ensure its sustainability, thereby making it a good contributor to the country's overall economic growth through the supply of food, employment and foreign exchange and the creation of infrastructure, especially in rural areas. ◆

PART 4
Outlook

Outlook

INTRODUCTION

As part of an Organization-wide study of agriculture in the coming decades,[1] the FAO Fisheries Department has commissioned studies of future fish consumption. These are generally developed around economic models of the demand, trade and supply of fish[2] in main markets. One of the main limitations of such studies – including these FAO studies – is that they are usually developed against a background of "business as usual" in respect of public policies and technology change. This means that in the models (real) prices are assumed not to change, which implies that any policy changes or technological developments are assumed to have affected all producers and consumers in a uniform and similar fashion. This is seldom, if ever, the case.

A description of work in progress is given in the first section of this article. It contains preliminary results from studies being undertaken to predict fish consumption by 2015–2030, on the basis of economic modelling.

The second section is an effort to mitigate the weakness of economic modelling. It investigates the "business as usual" scenario in order to see whether it would be realistic, at least in the immediate future, to expect that policy and technology change will not influence developments in the sector and, in particular, the levels of future fish consumption. Thus, the second section is an attempt to foresee the impact of changes in public policies regarding capture fisheries and aquaculture, on the one hand, and the impact of the developments in technology that can be applied by capture fishers and aquaculturists, on the other.

TRENDS IN LONG-TERM PROJECTIONS OF FISH PRODUCTION AND CONSUMPTION

With a view to predicting future fisheries and fish production, FAO commissioned three long-term fish market forecast studies of Japan, 28 European countries[3] and the United States, as well as two global studies.[4] (An analysis of China was also attempted, but proved difficult to realize at this time.) Based on economic models of demand, trade and the supply of fish in main markets, these studies are helpful in providing an analysis of plausible trends in production, consumption and trade. The following five gross trends in production and consumption for the period up to 2030 emerge from the analyses:

- World production, total consumption, food demand and per capita food consumption will increase over the next three decades; however, the rate of these increases will slow over time.
- World capture production is projected to stagnate, while world aquaculture production is projected to increase, albeit at a slower rate than in the past.
- In developed countries, consumption patterns will reflect demand for, and imports of, high-cost/high-value species.
- In developing countries, trade flows will reflect the exportation of high-cost/high-value species and the importation of low-cost/low-value species.

CAPTURE AND AQUACULTURE PRODUCTION

Table 16 gives forecasts for fish consumption, net export and production trends up to 2030. Latin America, Europe and China will supply most of the fish used for non-food uses. Small pelagic

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[1] FAO. In press. Agriculture towards 2015/30. Rome.

[2] In this section the term "fish" also includes crustaceans and molluscs, unless otherwise stated.

[3] Austria, Belgium-Luxembourg, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.

[4] The results of these five reports will be finalized and published as a series of FAO publications by 2003.

TABLE 16
Fish consumption, net export and production trends 1997–2030

Country group	Trend in per capita consumption	Trend in net export	Increase in capture production ('000 tonnes)	Increase in aquaculture production ('000 tonnes)
World	**+**	**n.a.**	**13 700**	**54 000**
			Share in world increase	**Share in world increase**
Africa	-/+	-	4%	1%
China, mainland	+	+	5%	70%
Europe, 28 countries	/	-/+	0%	5%
Former USSR	-/+	No change	0%	0%
Japan	+	-	0%	1%
Latin America and the Caribbean	+	+	57%	7%
Near East in Asia	-/+	+	2%	2%
Oceania, developed	+	-/+	5%	1%
Oceania, developing	-/+	No change	0%	0%
South Asia	/	-	10%	8%
United States	+	-	0%	1%
Rest of Asia, developing	+	-	17%	5%
Rest of Europe, developed	+	No change	0%	0%
Rest of Europe, developing	+	No change	0%	0%
Rest of North America	+	-	0%	0%

Notes: **Percentage data were derived from the Global 1 study, supported by all other studies.**
-/+ indicates that results differed depending on the model used.

species will continue to dominate the fish species used as inputs for aquaculture production (via the fishmeal component of fish feeds).

The largest share in the increase of world capture production over the projection period is predicted to come from Latin America, solidifying its position as the leading producer of capture fisheries production and the leading net exporter. Small pelagic and demersal fish will continue as the major fish groups in total capture fisheries.

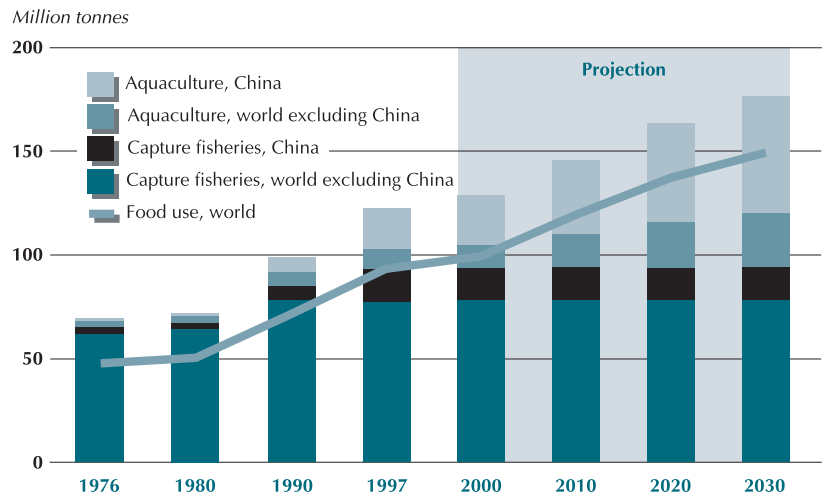
Over the last decade, European production has been characterized by stagnation in capture fisheries production and strong growth in aquaculture production. Ranging from a low of 8.6 million tonnes in 1990 to a high of 10.8 million tonnes in 1995, capture production from 28 countries averaged 10.4 million tonnes between 1994 and 1998. Of this total production, 15 percent was small pelagics and 23 percent demersal fishes. During the same period, the share of aquaculture production increased steadily from 10 percent of total production in 1989 to 15 percent in 1998. The production forecasts for the Europe-28 study reveal a stagnation of capture fisheries production.

Japanese domestic production peaked at 12 millions tonnes in 1974, and has subsequently decreased by almost half to 6.72 million tonnes in 1997; production from capture fisheries is expected to remain at the 1997 level of

approximately 6 million tonnes. Aquaculture production is expected to double to 1.5 million tonnes in three decades. Total production is projected to increase by 11 percent over the 30-year period, with small pelagics, demersals and molluscs remaining the top three nationally produced species groups.

Trends in United States seafood production, consumption and trade are expected to differ widely among species. Trends will also vary as a result of "supply side" changes in capture harvests and differences in the extent to which aquaculture can expand and increase production, as well as of "demand side" differences among species in the effects of changing consumer preferences. As United States per capita income rises, demand is likely to shift from lower-priced species to higher-priced ones.

FIGURE 47
World fish production and food use consumption 1976–2030



Note: Data are from the Global 1 report; in general they are suported by the Global 2 report.

The projections for United States seafood production and consumption were generated by a simple model based on assumptions about changes in fish supply and fish demand in the United States and in the rest of the world, as well as price elasticities of fish supply and fish demand. In the model, prices, consumption and net trade between the United States and the rest of the world are simultaneously determined at levels at which world supply and demand are balanced. Given the simplicity of the model structure and assumptions, the model projections should be considered illustrations of potential future changes rather than reliable projections of what will actually occur. Table 17 summarizes the consumption projections for the year 2030 for four scenarios, or sets of assumptions: medium growth, slower aquaculture growth, high demand, and restricted/partial trade. In all scenarios, changes from the base period (the 1995–1997 average) are driven by growth in aquaculture production and growth in demand, both of which are higher in the rest of the world than in the United States.

In all four of the United States scenarios, with the exception of substantial growth in aquaculture production of freshwater and diadromous fish, relatively little change in United States fish production by 2030 is forecast.

Increases in world aquaculture production will be driven by increases in Chinese production, with South Asia, Latin America and the Caribbean and Europe providing smaller increases. Freshwater species and molluscs will dominate aquaculture production.[5]

In order to meet growing projected consumption needs in Europe, total production increases in volume are estimated to result primarily from increases in aquaculture production. Indeed, the model estimates that farmed production will likely double by 2030, exceeding 2.5 million tonnes in 2015 and reaching 4 million tonnes in 2030.

In the United States, aquaculture production is likely to grow less rapidly than in other countries because of higher costs of labour and land and stricter environmental, health and food safety regulations. As a result, an increasing share of United States fish consumption is expected to come from imports.

[5] However, as indicated in the previous subsection, public policy support for aquaculture is likely to grow worldwide. The implication is that output might, in fact, be expanding at the rates implied here, even if the Chinese production increases do not reach the levels foreseen.

TABLE 17
Summary of projections for 2030 based on the United States model (thousand tonnes, live weight)

		Average for 1995–1997 base period	Projections for 2030 under alternative scenarios			
			Medium	Slower aquaculture growth	High demand	Partial trade
Production	Freshwater	691	852	814	1 012	915
	Pelagic	1 322	1 322	1 322	1 322	1 322
	Demersal	2 251	2 251	2 251	2 251	2 251
	Marine	29	29	29	29	29
	Crustaceans	387	363	363	363	363
	Molluscs	684	627	654	646	659
	Cephalopods	105	105	105	105	105
	Total	**5 469**	**5 549**	**5 538**	**5 728**	**5 643**
Net imports	Freshwater	- 25	167	139	71	62
	Pelagic	169	256	255	107	216
	Demersal	273	488	453	250	378
	Marine	14	20	18	15	18
	Crustaceans	538	872	794	843	796
	Molluscs	202	724	607	792	512
	Cephalopods	- 29	- 25	- 25	- 32	- 28
	Total	**1 142**	**2 501**	**2 242**	**2 046**	**1 955**
Consumption	Freshwater	666	1 019	954	1 084	977
	Pelagic	1 491	1 578	1 577	1 429	1 538
	Demersal	2 525	2 739	2 705	2 501	2 630
	Marine	42	48	47	44	46
	Crustaceans	925	1 235	1 157	1 205	1 159
	Molluscs	886	1 351	1 261	1 438	1 171
	Cephalopods	76	80	80	72	77
	Total	**6 611**	**8 050**	**7 780**	**7 774**	**7 598**

CONSUMPTION

Although global annual per capita consumption of fish is predicted to increase over time, from about 16 kg today to between 19 and 21 kg[6] (live weight equivalent) in 2030, the regional picture will be very diverse. Fish consumption per person is projected to increase in some areas: South Asia (up by almost 60 percent), Latin America and the Caribbean (up by almost 50 percent) and China (up by more than 84 percent) being the top three growth regions. However, it may stagnate or decline in other areas, including: Africa (down by 3 percent), the Near East in Asia (down by 17 percent), Oceania, developing (down by 8 percent), and the countries of the former USSR (down by 4 percent). Non-food use of fish is projected to grow more slowly than total supply, thereby representing a declining share over time.[7]

The projections produced in the five studies (Japan, Europe, United States, Global 1 and Global 2) that are currently under preparation show future consumption reaching levels that are marginally (about 10 percent) below those suggested in an earlier FAO study. The present studies indicate an average per capita consumption of 19 to 21 kg for the world as a whole, against a prior study showing about 22.5 kg.[8]

Globally, changes in consumption patterns reflect increased demand for ready-to-cook or

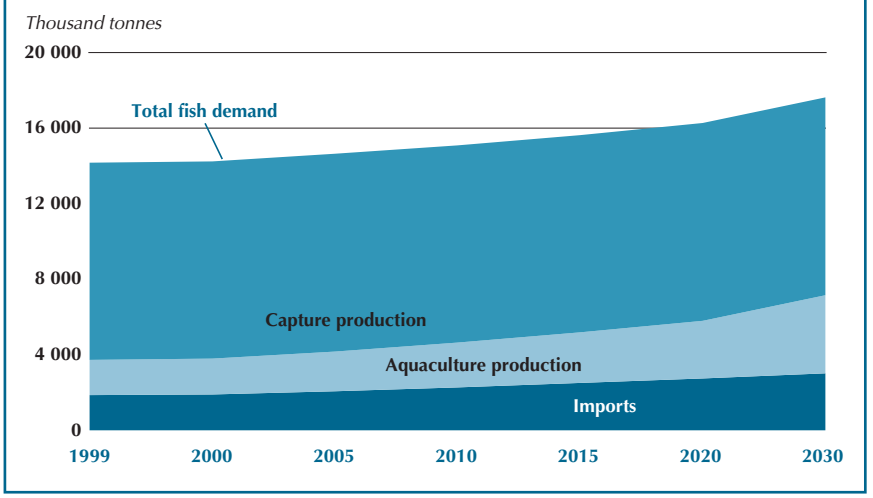
[6] In World agriculture: towards 2015/30 projected annual per capita consumption is between 19 and 20 kg.

[7] There is some uncertainty in estimates of non-food use of fish production because an unknown portion of fresh fish is used directly as inputs into aquaculture, and not for food consumption as was previously believed. For example, in FAO's Food Balance Sheets, when estimates of fish that is input directly into aquaculture are included, the per capita consumption estimates for China are reduced by approximately 3 kg.

[8] FAO. 1999. Historical consumption and future demand for fish and fishery products: exploratory calculations for the years 2015/30, by Y. Ye. FAO Fisheries Circular No. 946. Rome. 31 pp.

ready-to-eat products. The emergence and growth of supermarkets' shares in the distribution of seafood continues to facilitate a greater penetration of seafood products in areas that are remote from the sea. Increased health consciousness has also changed consumption patterns. The processing sector of the fishery industry has demonstrated its capacity to adjust and innovate, and the increase in the importance of supermarkets in fish distribution has had a substantial impact on the source and form of fish products for human consumption.[9] Providers of fish products have generally benefited from all these changes by providing a broader variety of cooked dishes, including fish.

FIGURE 48
Evolution of Europe–28 total fish production over time



Demand for fishery products[10] has been increasing in Asia, partly owing to population and income growth; Japan leads per capita consumption in the region with historical levels of approximately 70 kg per capita, which constitutes approximately 10 percent of the global demand for fish products.

In the Japanese study, only weak substitution and complementarity effects were found between fish and other protein sources.[11] Japanese demand over the 30-year period for various categories of fish is represented in Figure 49. Non-food use is not expected to change over this period, while average per capita consumption is expected to increase by 16 percent. Again, prices in every grouping are expected to increase over time, with demersal fish and aquatic animals prices more than doubling.

In 1998, the main species consumed in Europe were mussels (7 percent of all apparent consumption), followed by cod (7 percent), tuna (6 percent), herring (6 percent), cephalopods (squid, octopus and cuttlefish – 5 percent), sardines (5 percent) and salmon (4 percent). Other significant species included shrimps (4 percent) and trout (3 percent). In terms of total quantity consumed, small pelagic fish such as herrings, sardines, anchovies and pilchards are the main species group and represent 15 percent of the overall consumption, but their market share in terms of value is relatively low owing to their low unit prices.

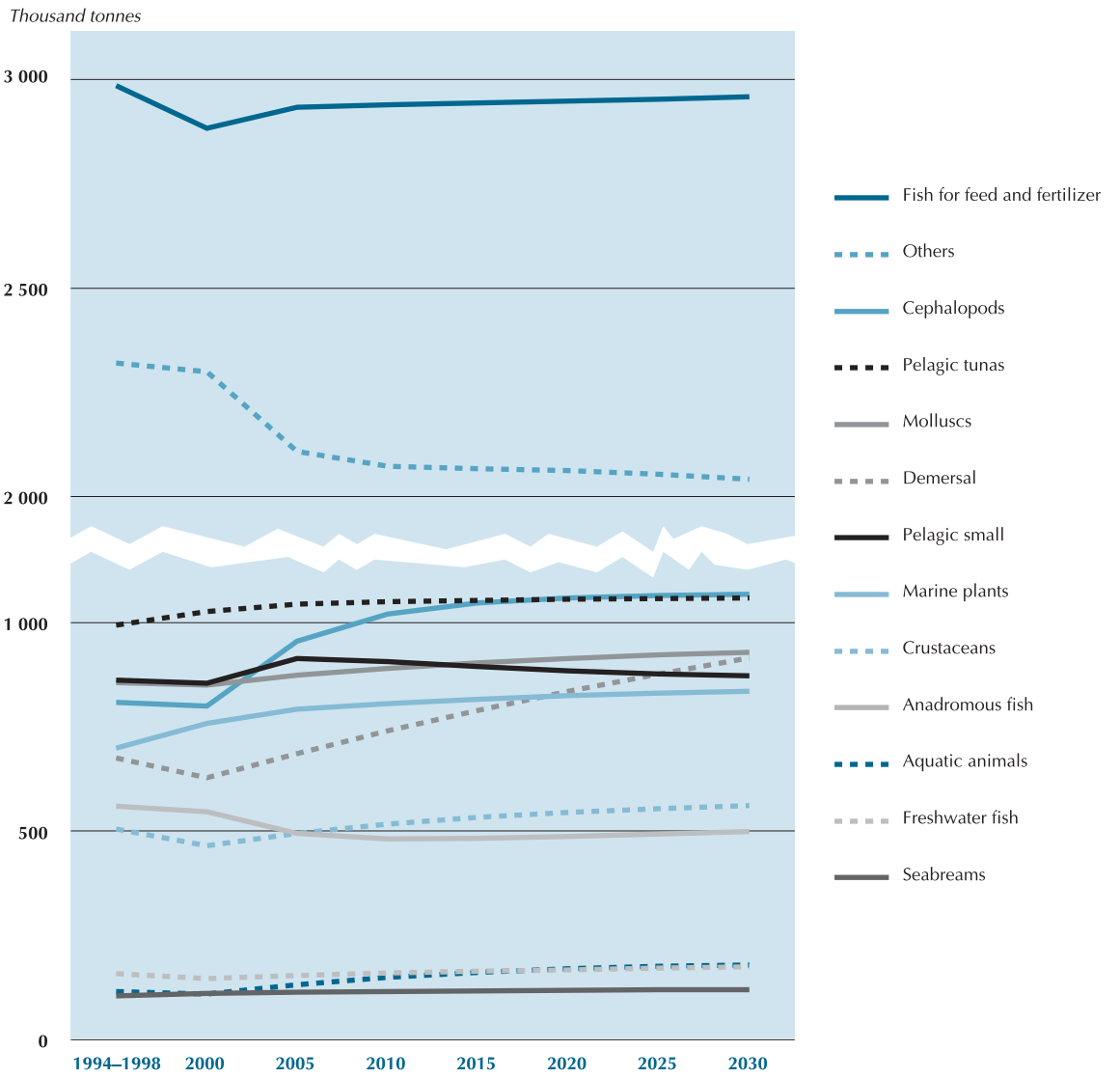
In contrast, demersal species (in particular, the whitefish species group) are the main group of species in terms of value, either for direct consumption or for use in the primary and secondary processing industries of Europe.[12] In 1998, this group accounted for 15 percent of

[9] In 1986, United Kingdom fishmongers had a 51 percent market share of fresh fish, while supermarkets' share was 15 percent. By 1996, the situation was dramatically different: fishmongers' market share had fallen to 30 percent, while that of supermarkets had increased to approximately 50 percent. In France, supermarkets are now the source of approximately 60 percent of retail fish sales. In Spain, it has been estimated that traditional fish markets generated less than 40 percent of retail sales in 1998 and that they will continue to lose market share in the future.

[10] Fish and fish products groupings comprise: freshwater fish, anadromous fish, marine fish-pelagic-tunas, marine fish-pelagic-small, marine fish-demersal, marine fish-others, crustaceans, molluscs, cephalopods, aquatic animals and aquatic plants.

[11] Own-price elasticities ranged from -0.12 to -0.80 (seaweeds to seabreams), while income elasticities ranged from 0.07 to 0.80 (pelagic smalls to aquatic animals). As a result, the Japanese regional study includes a detailed econometric analysis of demand for fish products with the goal of estimating precise own-price and income elasticities for a large number of fish species categories. Substitutions among protein sources (i.e. fish, beef, pork, chicken and egg) are analysed using an "almost ideal demand" system. A separate time trend analysis is used to forecast income to 2030, which is then fed back into the previously estimated demand function in order to estimate fish demand until 2030.

FIGURE 49
Japanese demand for fish to 2030



Notes: Predictions assume a 1 percent annual increase in GDP. Unless otherwise stated, demand is for food use.

consumption in volume, but had an appreciably higher market share in terms of value.

Future trends in fish production and consumption in 28 European countries are projected on the basis of estimated production capabilities, demand functions and the political framework of the European Union, and the detailed results of the model can be shown in terms of percentage changes from the base period (the average for 1994–1998). Although the absolute estimates of fish for food consumption are expected to decrease in only three countries (Estonia, Latvia and Spain), per capita fish consumption is expected to decrease in the same three countries, plus Norway, Portugal and Sweden, as a result of demographic changes. Marine fish (tunas, small pelagic, demersal and others) will provide the majority of total

[12] The principal species in this group include cod, hake, haddock and whiting.

consumption; however, the growth in consumption will be greatest for cephalopods, crustaceans, freshwater fish and anadromous fish. Frozen and prepared and/or preserved fish are expected to dominate the category of fish for food consumption.

In all four of the United States model scenarios, net imports and consumption are projected to increase, but growth in total fish consumption is relatively modest, at less than 25 percent in the highest scenario. Slower aquaculture growth results in less growth in consumption. Higher demand in the rest of the world also results in less growth in United States consumption and imports because relatively higher growth in demand in the rest of the world causes a greater share of world production to be consumed in other countries. Less trade in fish results in less growth in imports and, correspondingly, less growth in consumption.

As elsewhere in the world, future United States consumption of fish from capture harvests is highly uncertain and unlikely to increase. Indeed, both the volumes of fish that are potentially available to the United States for consumption and the prices of fish relative to other animal proteins will be significantly influenced, if not determined, by global capture harvests and aquaculture production. Thus, the rapid growth in United States per capita consumption of imported farmed shrimp and salmon provides an example of the kind of changes in United States fish consumption and trade that will be most important in the future.

By themselves, the historical trends of the past several decades do not provide a clear indication of how United States fish consumption may change in the future. Total United States per capita seafood consumption was relatively stable for the six decades prior to 1970, increased rapidly during the 1970s and 1980s, and showed little change during the 1990s. Different fish species and products exhibit widely varying trends, many of them driven by changes in capture fishery conditions. The clearest long-term trend is for growing per capita consumption of aquaculture products such as shrimp, salmon and catfish.

WORLD TRADE FLOWS

In very general terms, the distribution of net exports at the country/regional level shows:

- increasing net exports for some of the countries/regions, such as China and Latin America and the Caribbean;
- declining net exports for the rest of Asia and the rest of North America;
- rising net imports for Africa, the United States, Europe and Japan;
- a switch from net imports to net exports in the case of the Near East in Asia;
- a change from net exports to net imports for South Asia.

Because Japan relies increasingly on its imports as a source of supply, and because these imports represent 30 percent of world trade in fish products, it is plausible to anticipate that shifts in Japanese consumption trends will have significant impacts on world markets.[13]

Europe, including the EC, is one of three important markets for fish products. Of Europe's more than 480 million consumers, 370 million live in EC member countries, making the EC as important an importer of fish as Japan and the United States are. In addition, because of differing consumer preferences, there is also strong intraregional trade of fish products.

The most important developments affecting future United States fish consumption and trade will occur outside the United States. In short, the share of world production that is consumed by the United States will be affected by the global demand for fish. Domestically, future capture harvests are expected to continue to vary over time as a result of natural factors, such as changes in ocean conditions, even though United States fisheries have to be managed to prevent overfishing (as defined in United States legislation) and the stocks of most important commercial species in the United States are not considered overfished.

In general, those species imported into and consumed in developed nations are considered

[13] See footnote 11, p. 115.

TABLE 18
Estimated percentage changes in European fish production and consumption, 1994–1998 to 2030

	Fish for food use		Fish for non-food use		Fish production by source		
	Production	Consumption	Production	Use	Aquaculture	Capture	Total production
Austria	- 60	21	-	- 7	- 65	0	- 57
Belgium and Luxembourg	- 5	12	- 24	74	- 1	0	0
Bulgaria	- 18	142	-	- 2	78	0	28
Cyprus	11	40	-	- 2	261	0	58
Czech Republic	- 5	29	-	- 30	80	0	66
Denmark	8	35	- 10	- 8	95	0	2
Estonia	0	- 19	- 6	- 38	- 13	0	0
Finland	6	13	- 69	- 23	- 41	0	- 4
France	- 6	16	- 1	- 6	109	0	33
Germany	18	33	14	6	217	0	43
Greece	- 1	12	- 58	12	160	0	33
Hungary	5	50	-	- 11	- 54	0	- 30
Ireland	8	9	12	- 3	1 073	0	91
Italy	3	21	13	- 18	136	0	52
Latvia	- 3	- 19	- 23	- 17	- 7	0	0
Lithuania	- 28	47	- 5	- 11	- 7	0	0
Malta	27	49	-	- 28	159	0	98
Netherlands	11	10	-	- 75	45	0	8
Norway	5	9	25	15	142	0	14
Poland	- 28	29	- 13	9	463	0	32
Portugal	- 6	2	- 42	- 24	35	0	1
Romania	- 49	81	- 57	11	- 33	0	- 14
Slovakia	- 29	16	-	- 11	- 5	0	- 2
Slovenia	0	26	- 100	- 35	100	0	27
Spain	4	- 2	26	12	222	0	39
Sweden	7	5	5	- 58	- 20	0	0
United Kingdom	21	24	- 24	- 24	189	0	21

Note: **- = the average 1994–1998 base was zero.**

high-value species (in monetary terms). In contrast, those imported and consumed in developing nations tend to be classified as low-value species, and serve both as important sources of protein for a large portion of the world's poor and as inputs into fish and livestock production.

Exports of high-value products from developing countries may serve as important sources of income and may compensate for the decline in local market access to high-value species. However, additional research is necessary before the implications of these trade patterns on food security can be evaluated.

THE LONG-TERM OUTLOOK

Projecting long-term changes in seafood production, consumption and trade is a complicated and challenging task. The factors that affect the respective models' results include:

- the increasingly global scale of markets for fishery products;
- the interdependence of the demand for fish and the supply of competing food products;
- the number and diversity of fish species;
- uncertainty about factors affecting supply and demand;
- a lack of data.

These factors present significant challenges and mean that any long-term projections up to 2030 must be carefully interpreted. The practical modelling assumptions and limitations make it useful to interpret the models' results in the context of possible technological and policy changes.

Despite these difficulties and detractions, the models do provide the opportunity to make general inferences about probable long-term trends, given the current state of knowledge. The similarity of different models' results in the face of varied approaches, data sources and assumptions provides fortuitous reassurance that the trends depicted by the models are not unreasonable.[14]

FOOD AND EMPLOYMENT: THE PROSPECTS

This second section reviews the interaction between production possibilities (as limited by the ecosystem and available technology) and public sector policies in the short and medium terms. The review is carried out from of the point of view of capture fishers, aquaculturists and policy-makers. Because there are different points of view and interests within these groups, the analysis is broad and not applicable to all members of the groups; there will be exceptions.

Public sector policy-makers are primarily concerned about the contribution that aquaculture and capture fisheries make, and can make, to jobs and food supplies. They formulate public sector policies for fisheries and aquaculture, taking into account the extent to which food and employment are created by these two sectors of the economy.

Capture fishers and fish farmers are largely preoccupied about the same aspects as policy-makers – food and employment – but on a microscale. They strive to improve their incomes by perfecting equipment and methods. Generally, each individual has a natural tendency to try to circumvent the limits imposed by nature (the ecosystem) and by public sector policies.

CAPTURE FISHERS

As reported in The status of fishery resources (Part 1, p. 21), most capture fishers harvest fully exploited or overexploited stocks, often under access conditions that are similar to those of open access. This means that, in the long term, as a group, they cannot expect to increase the volume of fish captured – or the profits – simply by trying harder or fishing more, and from society's point of view there is a waste of resources. For fishers this is a problem; and in growing economies it is a growing problem because, as time passes,

[14] Although reflecting different levels of detail (e.g. different levels of aggregations of species groups and geographic regions), there are similarities in the ways in which the models were developed. The respective authors first analysed historical trends to determine income and price elasticities, consumption, production and trade patterns related to fish and fish products. Next, using trend analysis techniques and a multitude of probable assumptions about the future, the authors projected future demand and supply for fish and fish products. Imbalances were then reconciled, either through price clearing mechanisms or through fluctuations in trade.

BOX 12
Limitations inherent in long-term fish projections

For reasons of tractability, the FAO studies used the following assumptions:

- Fish within a species group are homogeneous.
- Fish within a species group are traded freely at a single world price.
- There is no interspecies interaction (i.e. zero cross-price elasticities among species groups), and no cross-price effects of other substitute commodities.
- No major changes in environmental conditions (i.e. normal weather and climate patterns) have occurred.
- No major breakthroughs in science and technology, as well as in resource management practices, have been made.
- No major changes in national, regional and international regulations governing the fisheries sector have been made.

In modelling fish production and consumption, the number and diversity of fish species and products pose a major challenge. Even within seemingly similar species groups, the outlook for future capture or aquaculture production varies (e.g. salmonids or crustaceans). Similarly, future demand may differ from species to species, and different species are likely to vary in the extent to which they are substitutes for each other. The more these differences are accounted for, the more complex the modelling task becomes in terms of statistical analyses and general control; conversely, the more different species or species groups are aggregated, the less reliable or "useful" the results.

A lack of, or inconsistency in, data presents another of the major challenges in modelling fish production and consumption. Often, consumption and trade data are presented as product weight, and production – or landings – as live fish weight; exact conversion rates are therefore necessary in order to match these two sets of data. Sometimes, price data do not exist, and inexact proxies such as trade weighted values have to be used. For simplicity, a single world price may be assumed, even though much information is lost when price variation is ignored in this way (e.g. barriers to trade and transportation costs). As with the diversity of species, the type and quality of data may constrain a model's structure and the general methodology that can be used.

Improving the quality of data and solving these issues constitutes a major, ongoing research effort for FAO.

Source: C. de Young, FAO Fisheries Department.

fishers will lag further and further behind their compatriots who are employed in other sectors. To improve their standard of living at the same rate as the rest of the community, fishers need to increase their net (real) income every year. To do so they must earn more, and this generally means catching more, as prices of fish are difficult to raise unilaterally. Increasing volume caught per person and year is not feasible unless some fishers leave the industry voluntarily. In that case, the use of superior technology or fishing methods would result in higher catches, without other fishers necessarily being worse off.

The reduction in the number of fishers that was observed during the last decades in several Organisation for Economic Co-operation and Development (OECD) countries explains why, in rich economies recording steady economic growth, many capture fisheries experience productivity growth through the adoption of new materials, equipment and fishing methods.[15] The labour force usually shrinks because elderly fishers stop fishing and few young people join the fishing fleet.

[15] See: FAO. 2000. The State of World Fisheries and Aquaculture 2000, pp. 13–16. Rome.

In some fisheries, however, the nature of the fishing (the combination of the species' biological characteristics and the environment) is such that fishers have not managed to become significantly more effective, even when those employed in commercial fishing have declined in number. In addition, there are instances in which, after some time, commercial fishing has ceased altogether, in spite of fish stocks remaining healthy. This has been the case in inland fisheries in temperate climates, particularly in smaller lakes and rivers. It is likely to become gradually the case in small-scale marine fisheries, initially in temperate climates.

In poor countries and in countries with stagnant economies most fishers harvest stocks that are fully exploited or overexploited. Growth of population, and limited employment opportunities outside the fisheries sector, lead to a situation in which young people have little choice but to try to join the sector, thus the number of fishers increases, or at the very least remains constant. Only economic growth in the economy as a whole will make it possible to introduce technology that will increase productivity – in parallel with a reduction in the number of effectively employed.

In summary, it seems clear that technology will not help capture fisheries to overcome the present limits to global landings. In fact, it is doubtful that technology developments will be such that the fishing of smaller fish stocks, particularly in smaller water bodies, will continue to be economically attractive.

In the course of the 1990s, it became clear that the combined capacity of fishing fleets should not continue to grow and that, in many cases, fleets were already too large. Several countries have introduced measures to control and reduce fishing capacity. As those concerned analysed how this situation had come about, a consensus developed that fisheries management must be based on more secure rights for those who engage in commercial fishing. Simultaneously, in several countries, particularly in rich market economies, the economic consequences of some public sector activities are being seen as contrary to the interests of the sector and of society as a whole. As a result, three public sector-specific policies are being promoted: the reduction, or even the complete elimination, of subsidies; the adoption of an ecosystems-based approach to fisheries management; and in countries with open market economies, a call for the state to be compensated for the costs of managing the fisheries sector.

Where adopted and promoted, these policies will increase the average costs per kilogram of the fish produced by capture fishers. In OECD countries, yearly financial transfers have been recorded as corresponding to between 3 and 90 percent of the value of landings.[16] The costs of fisheries management have been estimated as being between 3 and 20 percent of landed values.[17]

It is clear that such cost increases could be substantial if they were all passed on to the industry at the same time; such costs could not be passed on abruptly to the consumer. However, even when shifted gradually to the fishing industry, and by the industry gradually to the consumer, the effect will be that the market for wild-caught fish will shrink in size as real prices of fish products rise. Production will contract.

These policies may also contribute to an increase in volumes landed. However, after some time, the fisheries will encounter a new upper limit – imposed by the natural conditions of the aquatic ecosystem. Global production increases from improved management have been estimated to be a few million tonnes, but it is important to note that better management would, above all, lead to smaller but economically far healthier capture fisheries.

In poor economies, if the same policies (no subsidies, an ecosystems approach to management, and cost recovery) were implemented, costs would increase, although less so than in developed economies. There are several reasons for this, including: the existing weak, or even absent, fisheries management,

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[16] OECD. 2000. Transition to responsible fisheries: economic and policy implications, p.131. Paris.

[17] E. William, R. Arnason and R. Hanesson, eds. In press. The cost of fisheries management. Aldershot, UK, Ashgate Publishing.

implies that there are correspondingly fewer costs to recover; a lack of resources for ecosystems-based management; and limited money for financial transfers.

It seems likely that these policies will be promoted first in rich, open market economies. Even if they were also promoted in developing countries, cost increases would be more pronounced in rich economies. The net result will be that demand for "cheap" imports will intensify in North America, Europe and, possibly, Japan. Exports from developing countries are likely to increase, reflecting the growing gap in prices between local and export markets.

AQUACULTURISTS

The ecosystem and the technologies used favour aquaculturists in comparison with capture fishers. Aquaculturists benefit from the fact that, in their search for lower costs of production and higher net revenues, they can work to improve both the fish and the production methods used, while fishers can do little or nothing about the fish[18] and have to concentrate on fishing gear and methods. However, aquaculturists' freedom to improve fish is limited by the need to consider the effects of new or modified fish on the aquatic ecosystem and human health.

Many aquaculturists have already benefited from not only the selective breeding of fish[19] but also the better performance of, for example, feeds, vaccines and the automatic handling of feed, as well as of the fish produced. This is likely to continue to be the case. The effects have been significant in terms of increased production of concerned species. Development has been of the win–win type, as both producers and consumers have gained when prices for cultured species have fallen as a result of increased production.[20] As is natural in market economies, savings have been passed on to consumers, leading to the opening up of non-traditional markets (Atlantic salmon in Asia, tropical marine shrimps in Europe). This trend will certainly continue.

The vast bulk of aquaculture production is composed of a small number of species; in 2000, 29 species accounted for 78 percent of production. There is no evident reason why other species from among the several thousand that are exploited by capture fisheries could not eventually be raised economically in a controlled environment.

The appropriate legal framework for most modern aquaculture technologies is known. It is generally in place in rich economies where aquaculture is an established economic activity and is being put in place in developing economies. In developed economies, management and enforcement costs as a share of the value of the produce are lower for aquaculture than for capture fisheries.

At present, more than 90 percent of production comes from Asia, although there is no inherent reason for aquaculture not to be a common, viable and sustainable activity outside Asia. Increasingly, it is being realized that aquaculture can be effectively promoted through appropriate policies, and in Asia – particularly China (see Aquaculture development in China: the role of public sector policies, Part 3, p. 99) – it has grown in response to consciously developed policies aimed at its promotion. Public management of aquaculture is not dissimilar to public management of agriculture; it is thus generally cheaper than the management of capture fisheries.

So, in developed economies, application of the three policies will lead to some increase in aquaculture production costs but, as a rule, this increase will be significantly smaller than it will be for capture fishery products. In developing economies the costs will probably be somewhat higher.

The real costs of transport and communication

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[18] See: FAO. 2001. The economics of ocean ranching. Experiences, outlook and theory, by R. Arnason. FAO Fisheries Technical Paper No. 413. Rome.

[19] Selective breeding has contributed to improving yields and results for fish (carp, salmon, tilapia) more than for shrimps or bivalves.

[20] Over a period of 15 years since the mid-1980s, the average operating costs per kilogram of salmon in Norwegian fish farms declined by two-thirds in real terms. See: J.L. Anderson. 2002. Aquaculture and the future, why fisheries economists should care. Marine Resource Economics, 17(2): 133–151.

will most likely continue to fall – albeit slowly. As a result, aquaculturists in rich, temperate zone economies will be exposed to competition with producers from increasingly distant areas. Temperature zone aquaculturists may still be able to compete, depending on the rate of technological development and application. It is not unlikely, however, that they will find it increasingly difficult to compete with aquaculture products from poor countries (tropical and temperate). To some extent, the outcome will depend largely on whether or not the "anti-subsidy" lobby wins the present international argument and, if it does, on whether the subsidy ban would then be extended to aquaculture processes and products. In that case, the possibilities for stimulating and promoting aquaculture growth in rich, open market economies will be curtailed and future growth in non-OECD countries will be stimulated.

POLICY-MAKERS

Policy-makers for fisheries and aquaculture have traditionally been concerned with food production and employment. While policy objectives in these areas continue to be valid, policy-makers increasingly need to – and do – give attention to demands for non-consumptive and recreational uses of aquatic resources and to the imperative demand from global civil society that the aquatic ecosystem as a whole be conserved and maintained.

During the last decades the contribution of aquaculture and capture fisheries to food and employment has been mixed. Aquaculture has generally done better than capture fisheries. In percentage terms, world production and employment have, since 1990, grown faster in aquaculture than in capture fisheries (see Figure 1, p. 5, and Figure 12, p. 15).

Although most aquaculture systems are not labour-intensive, aquaculture has become an important source of employment in many countries. In Norway, employment in the sector rose from virtually zero to about 3 500 people in 1999. In China, expanding aquaculture production is reflected in a rapidly increasing number of people employed.

During the recent past, the demand for non-consumptive and recreational uses of aquatic resources has, in some instances, conflicted with the interests of commercial fishers. Although these conflicts are important where they occur, they are not frequent and, seen in a global perspective, they are not a significant impediment to commercial fisheries. This is likely to remain the case, at least for recreational fisheries, because the majority of these fisheries will gravitate towards smaller water bodies and are content with small catches; that is, they will take over fisheries as they become economically uninteresting for commercial fishers. The conflicting interests of non-consumptive users and commercial fishers, on the other hand, may remain or even expand.

Policies that aim to preserve the aquatic ecosystem will have an impact on both capture fishers and aquaculturists, and policy-makers will be increasingly obliged to ensure that such policies work. Large-scale, commercial aquaculturists will probably be able to coexist with the policies through the adequate selection of culture sites and technologies. Costs for cultured products will be higher than when the policies are not present, but activities will develop.

Some capture fishers are in a less fortunate situation. What for them is normal fishing may be judged by others to have negative consequences for the aquatic environment. If the fisheries are small, or not developed, it may become economically convenient for the government to close them down or prevent their development. The cost of compensating (including retraining) existing fishers may be smaller than the costs incurred in managing and/or developing the fisheries.

This is not to say that aquaculture will not encounter difficulties. It has encountered obstacles (environmental destruction, disease) in the past and will do so in the future. So far, however, major obstacles have been overcome and, although several species have run into difficulties, overall growth has been steady.

In summary its seems likely that many policy-makers will find that, on balance, aquaculture conforms better than capture fisheries to public

policy objectives for food production, employment, environment and non-food use of aquatic resources. In concrete terms, fish produced by capture fishers are likely to become increasingly costly, and in some instances more rare, while fish produced through aquaculture will become more common and price trends for cultured species may start high but are then likely to fall.

Some policy-makers will not have to choose between supporting capture fisheries and supporting aquaculture. However, representatives of either group – capture fishers or aquaculturists – will no doubt draw the attention of policy-makers and the general public to any advantage that their own sector has over the other.

CONCLUSIONS

It seems plausible that, in the medium term, in both developed and developing countries, public policies will favour aquaculture, but not necessarily at the expense of capture fisheries. It is plausible that policy-makers will find it easier to defend public support for aquaculture than for capture fisheries, although among those who put the environment before employment and income generation there will be some who argue that the emergency that must be remedied is that of unmanaged, or badly managed, capture fisheries, and not aquaculture.

Part of the analysis in the preceding section calls into question a commonly held assumption about the future of capture fisheries: that catches of food fish have stabilized and will remain at their present levels during the coming decades. If the analysis is correct, current landings of harvested species might fall, not because of excessive effort but because of a reduction in effort. Of course, this will be a gradual development that may not even be noticeable in this decade. ◆

PART 5

Fisheries activities of country groupings

ASSOCIATION OF SOUTHEAST ASIAN NATIONS

The Association of Southeast Asian Nations (ASEAN) was established on 8 August 1967, in Bangkok, with the signing of the Bangkok Declaration. At present, its members are Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam.

The ASEAN Declaration states that the aims and purposes of the Association are: i) to accelerate economic growth, social progress and cultural development in the region, through joint endeavours and in the spirit of equality and partnership, in order to strengthen the foundations for a prosperous and peaceful community of Southeast Asian nations; and ii) to promote regional peace and stability, through maintaining respect for justice and the rule of law in the relationship among countries in the region and through adherence to the principles of the United Nations Charter.

FISHERIES: PURPOSE AND ACTIVITIES

In consideration of the conceptual framework of the Hanoi Plan of Action to implement the ASEAN Vision 2020, the Senior Officers of the ASEAN Ministers of Agriculture and Forestry (SOM-AMAF) held a Special Meeting from 27 to 29 April 1998 in Phuket, Thailand. At that meeting, it was decided that the Strategic Plan on ASEAN Cooperation in Food, Agriculture (including Fisheries) and Forestry (1999–2004) should cover overall cooperation in the three major sectors, with particular emphasis on strengthening food

TABLE 19
ASEAN: fisheries and aquaculture production, food balance and trade

	1988	1992	1996	2000
Aquaculture production				
Inland production (000 tonnes)	856	1 007	1 520	1 830
Percentage of world total	12.0	10.9	9.6	8.5
Marine Production (000 tonnes)	341	596	742	876
Percentage of world total	7.5	9.7	6.9	6.2
Fisheries production				
Inland production (000 tonnes)	971	1 036	1 128	1 319
Percentage of world total	15.7	16.7	15.2	15.0
Marine production (000 tonnes)	7 882	9 372	10 309	11 760
Percentage of world total	9.6	11.8	12.0	13.7
Fisheries and aquaculture production				
Combined total (000 tonnes)	10 051	12 012	13 700	15 785
Percentage of world total	10.0	11.9	11.4	12.1
Food balance				
Total food supply (000 tonnes)	8 033	9 624	11 015	…
Per capita supply (kg)	19.0	21.1	22.5	…
Fish as share of animal protein (%)	46.4	44.9	43.9	…
Trade in fishery commodities				
Total imports (US$ millions)	1 142	1 904	2 078	1 878
Percentage of world total	3.6	4.7	3.9	3.4
Total exports (US$ millions)	3 437	5 753	7 619	8 666
Percentage of world total	10.8	14.3	14.5	15.7

Note: **… = data not available.**

security arrangements in the region, enhancing the international competitiveness of food, agricultural and forest products and strengthening ASEAN's position in international fora.

The Plan's implementation is coordinated by the ASEAN Secretariat. In the field of fisheries and aquaculture, the implementation is carried out by the Sectoral Working Group on Fisheries. Cooperation in fisheries focuses on: the standardization of quality control measures and processing techniques for fish and fishery products; the standardization, and subsequent adoption, of aquaculture practices, particularly for shrimps; the harmonization of fisheries sanitary measures; and the harmonization of regulations for agricultural products (including those from fisheries) derived from biotechnology. In 1994, ASEAN started to collaborate with the Southeast Asian Fisheries Development Centre (SEAFDEC) in promoting the sustainable management and utilization of marine fisheries resources in the Southeast Asia region. ASEAN-SEAFDEC cooperation has strengthened further in recent years, especially since the ASEAN-SEAFDEC Fisheries Consultative Group was established in 1999.

The Special Meeting of SOM-AMAF, held in April 2000 in Brunei, decided on the implementation of seven ASEAN-SEAFDEC collaborative programmes (all of which have already been started). The programmes cover: the upgrading of the traditional fish processing industry; promotion of mangrove-friendly aquaculture; conservation and management of the sea turtle; regionalization of the Code of Conduct for Responsible Fisheries; development of a fish disease diagnostical inspection mechanism; improvement of fisheries statistics; and fish trade and environment. The Special Meeting also decided to organize an ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium (Fish for the People), which took place in November 2001. This Conference approved the Resolution on Sustainable Fisheries for Food Security for the ASEAN Region and a related Plan of Action.

COOPERATION WITH FAO

Member countries of ASEAN and its Fisheries Working Group do cooperate closely with FAO through the FAO Regional Office in Bangkok. The ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium (Fish for the People) was prepared in collaboration with FAO.

CARIBBEAN COMMUNITY AND COMMON MARKET

The Caribbean Community and Common Market (CARICOM) was established by the Treaty of Chaguaramas on 4 July 1973 for the principal purpose of enhancing, through cooperation, the economic, social and cultural development of the populations of member countries. CARICOM'S members are Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Lucia, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Suriname and Trinidad and Tobago.

FISHERIES: PURPOSE AND ACTIVITIES

In fisheries, CARICOM aims to "promote the development of the fisheries subsector in member states with a view to optimal exploitation of their resources on a sustainable basis". It intends to do this by strengthening the legal and institutional framework, in part through the formulation and implementation of a common CARICOM Fisheries Policy.

The CARICOM Fisheries Unit, located in Belize, was established in 1991 to execute the CARICOM Fisheries Resource Assessment and Management Program (CFRAMP), which ended in 2001. It was funded jointly by the Canadian Government, through the Canadian International Development Agency (CIDA), and participating CARICOM countries. One of the outcomes of CFRAMP is the formation of the Caribbean Regional Fisheries Mechanism (CRFM). In February 2002, the heads of government of CARICOM member countries signed the Inter-Governmental Agreement that established the CRFM.

TABLE 20
CARICOM: fisheries and aquaculture production, food balance and trade

	1988	1992	1996	2000
Aquaculture production				
Inland production (000 tonnes)	3	3	4	5
Percentage of world total	0.0	0.0	0.0	0.0
Marine production (000 tonnes)	0	0	1	3
Percentage of world total	0.0	0.0	0.0	0.0
Fisheries production				
Inland production (000 tonnes)	2	2	2	2
Percentage of world total	0.0	0.0	0.0	0.0
Marine production (000 tonnes)	87	101	107	172
Percentage of world total	0.1	0.1	0.1	0.2
Fisheries and aquaculture production				
Combined total (000 tonnes)	92	107	114	182
Percentage of world total	0.1	0.1	0.1	0.1
Food balance				
Total food supply (000 tonnes)	146	143	162	...
Per capita supply (kg)	11.7	10.8	11.7	...
Fish as share of animal protein (%)	19.2	18.9	18.8	...
Trade in fishery commodities				
Total imports (US$ millions)	67	55	98	102
Percentage of world total	0.2	0.1	0.2	0.2
Total exports (US$ millions)	82	106	141	211
Percentage of world total	0.3	0.3	0.3	0.4

Note: **... = data not available.**

The mission of the CARICOM Fisheries Unit includes: improving the quality and availability of fisheries resource information, including improving fisheries management information systems; strengthening the capacity of national fisheries administrations to manage fisheries; promoting fishers' involvement in development; implementing and monitoring fishery management plans; improving scientific capability in the region's fishery sector; supporting Caribbean researchers and managers in the sustainable management of aquatic resources; supporting the development of a multi-stakeholders approach to coastal zone management; and promoting the rational use and management of fisheries resources in the Caribbean.

The CARICOM Fisheries Unit is currently executing the following projects:

- the EC-funded fisheries component of the Lomé IV Integrated Caribbean Regional Agricultural and Fisheries Development Program (CARIFORUM Fisheries Project), which is intended to benefit several African Caribbean and Pacific Group of States (ACP) countries in the Caribbean region, including CARICOM countries. This six-year project started in August 1999;
- the Project on Multi-stakeholder Approaches to Coastal Zone Management in the Caribbean, supported by the International Development Research Centre.

COOPERATION WITH FAO

CARICOM and FAO have cooperated closely over the past decades on various aspects of fisheries, including policy and legal matters. FAO has provided technical assistance to CFRAMP in specific areas since its inception in 1991 and, over the past four years, FAO and CFRAMP have collaborated in implementing joint technical activities through the Western Central Atlantic Fisheries Commission (WECAFC). Such activities have included training in stock assessment and the assessment of major fish stocks (e.g. spiny lobster, penaeid shrimp, flying fish) in the WECAFC region. Over the past two years, FAO has provided technical support to member countries of the Organization of Caribbean States and Barbados (a subset of CARICOM member countries) through an FAO Technical Cooperation Programme on the development of standards for the construction and inspection of small fishing vessels. At present, FAO is providing assistance through the Technical Cooperation Programme project, Preparation for an Expansion of the Domestic Fisheries for Large Pelagic Species.

COMMONWEALTH OF INDEPENDENT STATES

The Commonwealth of Independent States (CIS) was established in December 1991. It is a voluntary association consisting of the following States: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, the Republic of Moldova, the Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan. The main purpose of the Commonwealth is to develop and strengthen cooperation and to serve the cause of peace and security.

FISHERIES: PURPOSE AND ACTIVITIES

To date, no common fisheries policy among countries of the CIS has been elaborated. Coordination is achieved through bilateral and multilateral agreements among the member countries, which can be divided into two groups:

i) states that have inland water fisheries and aquaculture activities only (Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, the Republic of Moldova, Tajikistan, Turkmenistan, Uzbekistan); and
ii) states that have a well-developed distant-water fisheries sector (the Russian Federation, Ukraine and – to a certain extent – Georgia).

Most CIS countries have concentrated on the restructuring of their fleets and on the processing and marketing sectors.

TABLE 21
CIS: fisheries and aquaculture production, food balance and trade

	1988	1992	1996	2000
Aquaculture production				
Inland production (000 tonnes)	307	213	99	120
Percentage of world total	4.3	2.3	0.6	0.6
Marine production (000 tonnes)	0	1	2	1
Percentage of world total	0.0	0.0	0.0	0.0
Fisheries production				
Inland production (000 tonnes)	679	441	306	359
Percentage of world total	11.0	7.1	4.1	4.1
Marine production (000 tonnes)	8 952	5 707	4 853	4 072
Percentage of world total	10.9	7.2	5.6	4.7
Fisheries and aquaculture production				
Combined total (000 tonnes)	9 939	6 362	5 261	4 552
Percentage of world total	9.9	6.3	4.4	3.5
Food balance				
Total food supply (000 tonnes)	...	3 519	3 759	...
Per capita supply (kg)	...	12.4	13.2	...
Fish as share of animal protein (%)	...	10.1	10.5	...
Trade in fishery commodities				
Total imports (US$ millions)	-	35	574	443
Percentage of world total	-	0.1	1.1	0.8
Total exports (US$ millions)	...	826	1 780	1 466
Percentage of world total	...	2.1	3.4	2.7

Note: **... = data not available.**

COOPERATION WITH FAO

To date there is no agreed policy within the CIS countries concerning their cooperation with FAO. Each State acts independently in fishery matters.

ECONOMIC COMMUNITY OF WEST AFRICAN STATES

The Treaty of Lagos, which established the Economic Community of West African States (ECOWAS), was signed by representatives of 15 West African States in Lagos on 28 May 1975. At present, the following countries adhere to the treaty: Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, the Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, the Niger, Nigeria, Senegal, Sierra Leone and Togo.

The ECOWAS Treaty specifies the Community's objective, to be achieved in stages, as being the creation of an economic and monetary union. Cooperation in the development of agriculture, forestry, animal husbandry and fisheries is one of its primary aims. The first stage in this cooperation entails the harmonization of internal and external policies; the second stage envisages the adoption of a common agricultural policy.

FISHERIES: PURPOSE AND ACTIVITIES

Based on the recommendations of the Industry, Agriculture and Natural Resources Commission at its meeting in Cotonou, Benin, in April 1980, ECOWAS organized a conference of experts in Dakar, Senegal, to develop national policies to ensure better management and surveillance of waters under the jurisdiction of its Member States and also to ensure the conservation of fisheries resources in the region. Several recommendations were made concerning research, surveillance, the harmonization of fishing agreements and legislation, trade in fish and fishery products, data collection, etc. Members have made progress in implementing such recommendations.

TABLE 22
ECOWAS: fisheries and aquaculture production, food balance and trade

	1988	1992	1996	2000
Aquaculture production				
Inland production (000 tonnes)	11	17	21	28
Percentage of world total	0.2	0.2	0.1	0.1
Marine production (000 tonnes)	0	1	…	…
Percentage of world total	0.0	0.0	…	…
Fisheries production				
Inland production (000 tonnes)	333	330	390	435
Percentage of world total	5.4	5.3	5.2	4.9
Marine production (000 tonnes)	975	1 201	1 322	1 390
Percentage of world total	1.2	1.5	1.5	1.6
Fisheries and aquaculture production				
Combined total (000 tonnes)	1 320	1 549	1 734	1 854
Percentage of world total	1.3	1.5	1.4	1.4
Food balance				
Total food supply (000 tonnes)	1 816	1 857	2 173	…
Per capita supply (kg)	11.2	10.3	10.8	…
Fish as share of animal protein (%)	32.6	31.7	32.8	…
Trade in fishery commodities				
Total imports (US$ millions)	343	479	578	509
Percentage of world total	1.1	1.2	1.1	0.9
Total exports (US$ millions)	425	425	791	603
Percentage of world total	1.3	1.1	1.5	1.1

Note: **… = data not available.**

COOPERATION WITH FAO

ECOWAS's formal relationship with FAO is based on an exchange of letters between the Director-General of FAO and the Executive Secretary of ECOWAS. A Cooperation Agreement was established with FAO in December 1984, since which time FAO has been cooperating with the Community in various fields. However, as an organization, ECOWAS is not a member of any of FAO's statutory bodies.

In the mid-1990s, at the request of ECOWAS, FAO carried out a study entitled Economic development of fisheries, which made special reference to aspects of fisheries by foreign vessels off West Africa. In its conclusions, the study emphasized the necessity and the opportunities for regional cooperation in support of fisheries management and regional food security. Furthermore, FAO regional fishery projects have been cooperating with ECOWAS Member States, especially in promoting fisheries management in the artisanal subsector.

EUROPEAN COMMUNITY

The Treaty of Rome established the European Economic Community (EEC) in 1957. In 1993, the Treaty of Maastricht established the European Union (EU) as a broader framework which retained the EEC, now the European Community (EC), as a legal entity. The aims of the EC include the abolition of restrictive trading practices and the free movement of capital and labour within the union. A single market with free movement of goods and capital was established in January 1993. The following countries are members of the EC: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

FISHERIES: PURPOSE AND ACTIVITIES

The Common Fisheries Policy (CFP) is the EC's instrument for the conservation and management of fisheries and aquaculture. It was created with the aims of managing a common resource and meeting the obligation set in the original Community Treaties. Wild fish are a natural and mobile resource that is considered common property. The treaties creating the Community stated that there should be a common policy in this area; that is, common rules adopted at the Community level and implemented in all Member States. DG Fisheries is the Directorate-General responsible for the CFP, which is scheduled to be reviewed in 2002.

TABLE 23
EC: fisheries and aquaculture production, food balance and trade

	1988	1992	1996	2000
Aquaculture production				
Inland production (000 tonnes)	195	226	250	240
Percentage of world total	2.7	2.4	1.6	1.1
Marine production (000 tonnes)	714	686	889	1 049
Percentage of world total	15.7	11.2	8.2	7.4
Fisheries production				
Inland production (000 tonnes)	97	96	104	86
Percentage of world total	1.6	1.5	1.4	1.0
Marine production (000 tonnes)	7 037	6 570	6 507	5 861
Percentage of world total	8.5	8.3	7.6	6.8
Fisheries and aquaculture production				
Combined total (000 tonnes)	8 043	7 578	7 750	7 236
Percentage of world total	8.0	7.5	6.4	5.5
Food balance				
Total food supply (000 tonnes)	7 795	8 358	8 805	…
Per capita supply (kg)	21.5	22.7	23.5	…
Fish as share of animal protein (%)	9.3	9.9	10.3	…
Trade in fishery commodities				
Total imports (US$ millions)	12 261	17 270	19 352	19 609
Percentage of world total	38.7	43.0	36.7	35.5
Total exports (US$ millions)	6 400	8 580	11 000	11 398
Percentage of world total	20.2	21.4	20.9	20.6

Note: **… = data not available.**

The CFP came into existence in 1983, although the first elements of this policy had already been introduced in 1970. Since then, it has been developed and adjusted continuously in accordance with international developments and changes within the EC itself. The CFP takes into account the biological, economic, social and environmental dimensions of fishing. Its implementation entails the following main issues and related measures.

Conservation and responsible fishing. The EC policy for the conservation of fishery resources focuses on:

- limiting fishing effort through a strict licensing system;
- restricting catch volumes by setting total allowable catches (TACs) and establishing technical measures to minimize the occurrence of discards;
- promoting more selective fisheries by establishing technical measures related to mesh sizes, selectivity devices, closed areas and seasons, minimum fish and shellfish landing sizes and limits of by-catch;
- reducing fishing capacity to a level compatible with fishery resources availability;
- adapting management to fishing areas shared between the Community and third parties through active membership in nine regional fisheries bodies.

Fishing beyond Community waters. The EC has exclusive competence in international relations in the domain of fisheries. It is empowered to undertake international commitments towards third countries or international organizations in matters relating to fisheries. The European Commission, on behalf of the Community, negotiates fisheries agreements with third countries and participates in various regional fisheries organizations. The EC has concluded 21 fishing agreements with third countries and is currently a member of nine regional fisheries organizations. The EC is also member of FAO.

Restructuring the fishing sector. Restructuring of the EC fisheries sector relies heavily on the implementation of the structural policy, the purpose of which is to adapt and manage the development of structures (the equipment required to produce goods and the organization of production processes) in the fishing and aquaculture industry. EC assistance in the fisheries sector is provided under the Financial Instrument for Fisheries Guidance (FIFG). The FIFG aims to:

- contribute to the achievement of a lasting balance between fisheries resources and their exploitation;
- strengthen competitiveness and the development of economically viable businesses in the fishing industry;
- improve market supply and increase the value that can be added to fish and aquaculture products through processing;
- help revitalize areas that are dependent on fisheries and aquaculture.

Common organization of the market. The EC set up a system for the common organization of the market for fisheries and aquaculture products almost 30 years ago. Since July 1996, the common market organization in fisheries and aquaculture products has been being adapted to increased globalization of markets, greater dependence on imports, continued scarcity of resources, change in consumption patterns and concentration and vertical integration within the distribution chain. The common organization of the EC market has four components:

- common marketing standards for quality, grades, packaging and labelling of both EC and imported fishery products;
- producers' organizations, which are voluntary associations of fishers that are established to help stabilize markets (their role is to protect fishers from sudden changes in market demand);
- a price support system that sets minimum prices below which fish products cannot be sold. Financial support is available to producers' organizations if they have to take fish and shellfish off the market, store them for later use or process them;
- rules for trade with non-EC countries.

Enforcement of the law in the fishing sector. The 1992 review of the CFP stressed the need to make the policy more effective. A new control regulation, created in 1993, reinforced the role of surveillance and extended the CFP's domain of action from that of direct conservation measures to one that also included implementation of structural policy, marketing, transport and sale of fish and shellfish. The new regulation also encouraged harmonization of the proceedings and penalties against wrongdoers across the EC. Information technology was to be used to complement traditional monitoring methods. Fishing surveillance has also been substantially strengthened by the setting up of a Vessel Monitoring System (VMS).

Fishing and the wider environment. In 1997, a ministerial meeting on the integration of fisheries and environmental issues, held in Bergen, Norway, and attended by ministers from all North Sea States and by EC representatives, agreed on a so-called "ecosystem approach" to marine environments, which included elements of the precautionary approach. More recently, a group of nations and the EC adopted the Reykjavik Declaration in October 2001. The Declaration pledged that they would "in an effort to reinforce responsible and sustainable fisheries in the marine ecosystem, ... work on incorporating ecosystem considerations into that management to that aim." Given the commitment demonstrated by various states and international organizations, including the EC, to integrating an environmental dimension into their policies, greater effort is now being made to implement a strategy for enhancing the integration of environmental protection requirements into the CFP.

The international dimension of fisheries in relation to environmental issues has acquired greater importance for the EC in recent years. Bilateral and multilateral negotiations with third countries have increased, as have negotiations within regional fisheries organizations and international bodies. International trade of fish and fishery products has also become more important for the Community, especially in relation to import trade as well as to environmental issues and health and safety standards of fish and fishery products.

Review of the CFP. EC legislation foresees a review of the CFP during 2002. It also provides that, before 31 December 2002, the Council shall decide on any necessary adjustments to be made. In March 2001, the Commission published a report on the fisheries situation in the EC and a Green Paper on the future of the CFP, which discusses the weaknesses and challenges facing the CFP and presents a number of options for its reform. On the basis of that Green Paper, the Commission launched wide consultation with all interested parties and, on 28 May 2002, issued the *Communication from the Commission on the reform of the Common Fisheries Policy*. This document presents a

brief review of the crucial issues to be addressed by CFP reform, taking into account the outcome of the recent debate. It also states that the reform must lead to a new CFP that is capable of providing sustainable development in environmental, economic and social terms. This will be achieved through measures aimed at meeting several CFP objectives: responsible and sustainable fisheries and aquaculture activities that contribute to healthy marine ecosystems; an economically viable and competitive fisheries and aquaculture industry that benefits the consumer; and a fair standard of living for those who depend on fishing activities. In order for the CFP to function effectively it is essential that it include good governance principles. The reforms that have been proposed regard the nine areas: resources conservation and fisheries management; repercussions of the conservation policy on the fishing fleet; access to waters and resources; control and enforcement; international fisheries; aquaculture; the social dimension of the CFP; economic management of fisheries in the EC; and effective and participatory decision-making. Measures to pursue, objectives to be achieved and a package of reforms are proposed.

COOPERATION WITH FAO

The EC is a full member of FAO. The EC is also a member of most FAO regional fishery bodies and participates actively in the work of several of these.

In the recent past, the EC has provided funds to support FAO work in the implementation of its international agreements and plans of action for improved global management of fishing capacity, shark fisheries, incidental catch of seabirds in longline fisheries and illegal, unreported and urregulated (IUU) fishing.

LATIN AMERICAN ECONOMIC SYSTEM

The Latin American Economic System (LAES) is a regional intergovernmental organization that groups 28 Latin American and Caribbean countries: Argentina, the Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, the Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago, Uruguay and Venezuela. LAES was established on 17 October 1975 by the Panama Convention.

The objectives of LAES are to promote a system for consultation and coordination, aiming to achieve consensus in the form of joint positions and common strategies on economic issues for the Latin American and Caribbean region. The common strategies may be for individual countries or groups of countries. LAES also serves to promote cooperation and integration among the countries of the region.

FISHERIES: PURPOSE AND ACTIVITIES

The Action Committees of LAES are flexible cooperation mechanisms set up when more than two Member States voice interest in promoting joint programmes and projects in specific areas. These committees are dissolved once their objectives are fulfilled, otherwise they may become Permanent Bodies of the System.

At present, LAES has no Action Committees, but it does have two functioning

TABLE 24
LAES: fisheries and aquaculture production, food balance and trade

	1988	1992	1996	2000
Aquaculture production				
Inland production (000 tonnes)	46	84	165	282
Percentage of world total	0.6	0.9	1.0	1.3
Marine production (000 tonnes)	99	219	387	556
Percentage of world total	2.2	3.6	3.6	3.9
Fisheries production				
Inland production (000 tonnes)	500	439	486	472
Percentage of world total	8.1	7.1	6.5	5.4
Marine production (000 tonnes)	15 777	17 385	21 066	19 247
Percentage of world total	19.1	21.9	24.5	22.4
Fisheries and aquaculture production				
Combined total (000 tonnes)	16 421	18 127	22 104	20 557
Percentage of world total	16.4	18.0	18.4	15.8
Food balance				
Total food supply (000 tonnes)	3 569	3 769	4 706	...
Per capita supply (kg)	8.5	8.4	9.8	...
Fish as share of animal protein (%)	7.8	7.4	7.8	...
Trade in fishery commodities				
Total imports (US$ millions)	358	472	1 049	1 022
Percentage of world total	1.1	1.2	2.0	1.9
Total exports (US$ millions)	3 139	4 243	6 633	6 544
Percentage of world total	9.9	10.6	12.6	11.9

Note: **... = data not available.**

cooperation mechanisms. One of these – the Latin American Organization for Fisheries Development (OLDEPESCA) – has the objectives of promoting the rational exploitation of fisheries in the region and coordinating joint actions with its Member States: Argentina, Brazil, Colombia, Costa Rica, Cuba, Chile, the Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela.

COOPERATION WITH FAO

There is a long record of cooperation in technical activities between FAO and LAES. Initially the forum for this cooperation was the Action Committee of Sea and Fresh-water Products. When this action committee was dissolved, OLDEPESCA was established, and this independent body has become the centre of cooperation. FAO usually attends the annual OLDEPESCA conferences of Fisheries Ministers.

LEAGUE OF ARAB STATES

The League of Arab States, more generally known as the Arab League, was established on 22 March 1945. It comprises Algeria, Bahrain, the Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, the Libyan Arab Jamahiriya, Mauritania, Mayotte, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, the Sudan, the Syrian Arab Republic, Tunisia, the United Arab Emirates and Yemen.

The broad objectives of the Arab League are to develop cooperation and strengthen complementarity among the Member States in economic, cultural, scientific, social and military fields. To do so, the League has set up several specialized agencies. Those of interest to FAO are: the Arab Bank for Economic Development in Africa (Khartoum, the Sudan); the Arab Centre for the Study of Arid Zones and Dry Lands (Damascus, the Syrian Arab Republic); the Arab Fund for Economic and Social Development (Kuwait); the Arab League Educational, Cultural and Scientific Organization (Tunis, Tunisia); the Arab Organization for Agricultural Development (Khartoum, the Sudan); the Arab Academy for Science, and Maritime Transport (Alexandria, Egypt); and the Inter-Arab Investment Guarantee Corporation (Kuwait).

FISHERIES: PURPOSE AND ACTIVITIES

The League of Arab States has no subsidiary body or institution that deals exclusively with fisheries matters.

TABLE 25
League of Arab States: fisheries and aquaculture production, food balance and trade

	1988	1992	1996	2000
Aquaculture production				
Inland production (000 tonnes)	61	74	84	315
Percentage of world total	0.9	0.8	0.5	1.5
Marine production (000 tonnes)	1	9	15	51
Percentage of world total	0.0	0.1	0.1	0.4
Fisheries production				
Inland production (000 tonnes)	222	241	301	319
Percentage of world total	3.6	3.9	4.1	3.6
Marine production (000 tonnes)	1 348	1 296	1 433	1 767
Percentage of world total	1.6	1.6	1.7	2.1
Fisheries and aquaculture production				
Combined total (000 tonnes)	1 632	1 620	1 833	2 451
Percentage of world total	1.6	1.6	1.5	1.9
Food balance				
Total food supply (000 tonnes)	1 181	1 370	1 590	...
Per capita supply (kg)	5.5	5.8	6.2	...
Fish as share of animal protein (%)	8.3	9.8	9.8	...
Trade in fishery commodities				
Total imports (US$ millions)	248	259	395	473
Percentage of world total	0.8	0.6	0.7	0.9
Total exports (US$ millions)	754	841	1 102	1 323
Percentage of world total	2.4	2.1	2.1	2.4

Note: **... = data not available.**

COOPERATION WITH FAO

FAO has participated in several meetings organized by subsidiary bodies of the Arab League. The Organization has attended and partly sponsored meetings of the Arab Federation of Fish Producers (AFFP), which is a subsidiary of the Council for Arab Economic Union. In 1998, FAO was represented at the Conference on the Development of Marine Fisheries in the Arab World, organized by the Council.

NORTH AMERICAN FREE TRADE AGREEMENT

Canada, Mexico and the United States of America are members of the North American Free Trade Agreement (NAFTA), which came into effect on 1 January 1994. NAFTA's main aims are to contribute to the expansion of world trade; create, expand and secure markets for the goods produced in their territories; reduce distortions to trade; create new employment opportunities and improve working conditions and living standards in their respective territories; and address related environmental and conservation issues.

NAFTA is a trading block of global reach. It is innovative, as it establishes linkages between economies with different levels of economic development. Current discussions envisage the linking of existing subregional integration schemes, of which NAFTA is one, into a Free Trade Area of the Americas.

FISHERIES: PURPOSES AND ACTIVITIES

NAFTA does not have any particular activities concerned with fisheries.

COOPERATION WITH FAO

To date, there is no cooperation between NAFTA and FAO on fisheries matters. NAFTA member countries deal individually with FAO in this field.

TABLE 26
NAFTA: fisheries and aquaculture production, food balance and trade

	1988	1992	1996	2000
Aquaculture production				
Inland production (000 tonnes)	252	297	303	357
Percentage of world total	3.5	3.2	1.9	1.7
Marine production (000 tonnes)	147	188	194	248
Percentage of world total	3.2	3.1	1.8	1.8
Fisheries production				
Inland production (000 tonnes)	262	200	194	173
Percentage of world total	4.2	3.2	2.6	2.0
Marine production (000 tonnes)	8 343	7 440	7 176	6 880
Percentage of world total	10.1	9.4	8.3	8.0
Fisheries and aquaculture production				
Combined total (000 tonnes)	9 003	8 126	7 867	7 659
Percentage of world total	9.0	8.1	6.5	5.9
Food balance				
Total food supply (000 tonnes)	6 541	7 298	7 263	...
Per capita supply (kg)	18.3	19.5	18.4	...
Fish as share of animal protein (%)	6.8	7.4	7.3	...
Trade in fishery commodities				
Total imports (US$ millions)	6 021	6 785	8 321	11 983
Percentage of world total	19.0	16.9	15.8	21.7
Total exports (US$ millions)	5 087	5 985	6 178	6 580
Percentage of world total	16.0	14.9	11.7	11.9

Note: **... = data not available.**

SOUTH ASIAN ASSOCIATION FOR REGIONAL COOPERATION

The South Asian Association for Regional Cooperation (SAARC) was established in 1985 by the Heads of State and Government of Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. SAARC's main goal is to accelerate economic and social development in Member States through joint action in certain agreed areas of cooperation. To achieve this objective SAARC seeks to:

- promote the welfare of the peoples of South Asia and improve their quality of life;
- accelerate economic growth, social progress and cultural development in the region, and provide all individuals the opportunity to live in dignity and realize their full potential;
- promote and strengthen collective self-reliance among the countries of South Asia;
- promote active collaboration and mutual assistance in the economic, social, cultural, technical and scientific fields;
- strengthen cooperation with other developing countries;
- strengthen cooperation among Member States in international fora on matters of common interest, and cooperate with international and regional organizations with similar aims and purposes.

TABLE 27
SAARC: fisheries and aquaculture production, food balance and trade

	1988	1992	1996	2000
Aquaculture production				
Inland production (000 tonnes)	1 050	1 581	2 045	2 673
Percentage of world total	14.7	17.0	12.9	12.5
Marine production (000 tonnes)	37	63	148	119
Percentage of world total	0.8	1.0	1.4	0.8
Fisheries production				
Inland production (000 tonnes)	986	935	1 345	1 697
Percentage of world total	15.9	15.1	18.1	19.3
Marine production (000 tonnes)	2 615	3 458	3 816	3 966
Percentage of world total	3.2	4.4	4.4	4.6
Fisheries and aquaculture production				
Combined total (000 tonnes)	4 687	6 038	7 354	8 455
Percentage of world total	4.7	6.0	6.1	6.5
Food balance				
Total food supply (000 tonnes)	4 093	5 076	6 265	…
Per capita supply (kg)	3.9	4.4	5.1	…
Fish as share of animal protein (%)	12.4	13.3	14.1	…
Trade in fishery commodities				
Total imports (US$ millions)	38	61	79	89
Percentage of world total	0.1	0.2	0.2	0.2
Total exports (US$ millions)	765	1 012	1 680	2 102
Percentage of world total	2.4	2.5	3.2	3.8

Note: **… = data not available.**

FISHERIES: PURPOSES AND OBJECTIVES

The Integrated Programme of Action is the key component of SAARC's activities. It now includes 11 areas of cooperation, each covered by a Technical Committee: Agriculture; Communications; Education; Culture and Sports; Environment and Meteorology; Health and Population Activities; Prevention of Drug Trafficking and Drug Abuse; Rural Development, Science and Technology; Tourism; Transport; and Women in Development. Regular meetings of counterpart scientists are a very important feature of the Technical Committee on Agriculture, and a list of fisheries counterpart scientists has also been prepared and made available.

COOPERATION WITH FAO

SAARC does not cooperate formally with FAO in fisheries or aquaculture.

SOUTHERN AFRICAN DEVELOPMENT COMMUNITY

The Declaration and Treaty establishing the Southern African Development Community (SADC) was signed at the Summit of Heads of Government in Windhoek, Namibia, in August 1992. Its member countries are Angola, Botswana, the Democratic Republic of the Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, the United Republic of Tanzania, Zambia and Zimbabwe. The objectives of the SADC are to:

- achieve development and economic growth, alleviate poverty, enhance the standard and quality of life of the peoples of southern Africa and support the socially disadvantaged through regional integration;
- evolve common political values, systems and institutions;
- promote and defend peace and security;
- promote self-sustaining development on the basis of collective self-reliance and the interdependence of Member States;
- achieve complementarity among national and regional strategies and programmes;
- promote and maximize productive employment and utilization of the resources of the region;
- achieve sustainable utilization of natural resources and effective protection of the environment;

TABLE 28
SADC: fisheries and aquaculture production, food balance and trade

	1988	1992	1996	2000
Aquaculture production				
Inland production (000 tonnes)	3	7	7	8
Percentage of world total	0.0	0.1	0.0	0.0
Marine production (000 tonnes)	1	3	2	3
Percentage of world total	0.0	0.0	0.0	0.0
Fisheries production				
Inland production (000 tonnes)	679	632	583	631
Percentage of world total	11.0	10.2	7.8	7.2
Marine production (000 tonnes)	1 556	1 205	947	1 289
Percentage of world total	1.9	1.5	1.1	1.5
Fisheries and aquaculture production				
Combined total (000 tonnes)	2 239	1 846	1 540	1 930
Percentage of world total	2.2	1.8	1.3	1.5
Food balance				
Total food supply (000 tonnes)	1 525	1 327	1 244	…
Per capita supply (kg)	10.3	8.0	6.7	…
Fish as share of animal protein (%)	22.6	18.3	17.3	…
Trade in fishery commodities				
Total imports (US$ millions)	224	231	286	195
Percentage of world total	0.6	0.5	0.5	0.3
Total exports (US$ millions)	200	299	602	892
Percentage of world total	0.6	0.7	1.1	1.6

Note: **… = data not available.**

- strengthen and consolidate the long-standing historical, social and cultural affinities and links among the peoples of the region.

FISHERIES: PURPOSES AND ACTIVITIES

SADC's work related to specific sectors has been handled by Sector Coordinating Units (SCUs). These were allocated to individual Member States, who provided coordination, leadership and guidance on the formulation, implementation and management of sector-specific policies, programmes and projects. A Sectoral Committee of Ministers, chaired by the coordinating country's minister for the sector, supervised the sectoral activities. There are currently 21 such SCUs. At present, however, SADC is undergoing an institutional restructuring process, which involves strengthening the SADC Secretariat based in Gaborone and phasing out the SCUs within the next two years. As part of this restructuring, in December 2001, SADC launched a new Food, Agriculture and Natural Resources Directorate (FANR) which deals with eight subsectors, including Marine Fisheries and Resources. FANR is gradually assuming responsibility for marine fisheries and resources, and the previous Council of Ministers decision to allocate such responsibility to Namibia's Ministry of Fisheries and Marine Resources (taken in 1991) has been cancelled.

One of SADC's most important recent achievements in the field of marine and inland fisheries and aquaculture is the Protocol on Fisheries, which was adopted during the Summit of Heads of State and Government in August 2001. The Protocol is inspired by the FAO Code of Conduct for Responsible Fisheries and aims to promote the responsible use of living aquatic resources in the SADC region. Specialist committees and technical working groups have been established to this end.

SADC has also identified and analysed priorities for marine policy issues within the region with a view to developing a strategy to support the harmonization of fisheries policy and the legal framework, based on the principles established by the Code of Conduct for Responsible Fisheries and the Protocol on Fisheries. This process received technical and financial assistance from an FAO Technical Cooperation Programme project.

The SCU of marine and fisheries resources is coordinating the implementation of seven projects that focus on the priority areas for the sector: the Regional Fisheries Information System; SADC monitoring, control and surveillance (MCS) of fishing activities; support to the SADC Marine Fisheries Sector SCU; and Benguela Current Large Marine Ecosystem programmes.

Funding of more than US$60 million, for current SADC marine fisheries projects over the next five years, has been committed.

COOPERATION WITH FAO

SADC and FAO cooperate closely in relation to fishery matters. FAO is providing technical and financial assistance to two of the projects being implemented by the SCU for marine and fisheries resources.

SOUTH PACIFIC FORUM

The South Pacific Forum (SPF), consisting of Heads of Government, was established in 1971. It provides an opportunity to discuss a wide variety of South Pacific and international concerns and issues common to members, including the promotion of a free trade area in the South Pacific region. In 1998, the members of the SPF and its affiliated agencies were: Australia, Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. The SPF has a Secretariat (Forum Secretariat) which promotes regional cooperation among members on important economic issues.

FISHERIES: PURPOSE AND ACTIVITIES

The South Pacific Forum Fisheries Agency (FFA) was established as a specialized agency by the SPF in 1979. The FFA Convention reflects the common concerns of member countries regarding conservation, optimum utilization and coastal states' sovereign rights over the region's living marine resources. The functions of FFA include accumulating detailed and up-to-date information on aspects of living marine resources in the region; evaluating and analysing data to provide clear, timely, concise, complete and accurate advice to member countries; developing and maintaining a communication network for the dissemination of information to member countries, and implementing policies and

TABLE 29
SPF: fisheries and aquaculture production, food balance and trade

	1988	1992	1996	2000
Aquaculture production				
Inland production (000 tonnes)	2	2	3	4
Percentage of world total	0.0	0.0	0.0	0.0
Marine production (000 tonnes)	39	66	98	124
Percentage of world total	0.9	1.1	0.9	0.9
Fisheries production				
Inland production (000 tonnes)	22	23	19	22
Percentage of world total	0.3	0.4	0.3	0.3
Marine production (000 tonnes)	588	856	824	1 031
Percentage of world total	0.7	1.1	1.0	1.2
Fisheries and aquaculture production				
Combined total (000 tonnes)	650	947	943	1 181
Percentage of world total	0.6	0.9	0.8	0.9
Food balance				
Total food supply (000 tonnes)	522	537	584	…
Per capita supply (kg)	20.9	20.2	20.7	…
Fish as share of animal protein (%)	8.8	8.6	9.2	…
Trade in fishery commodities				
Total imports (US$ millions)	415	483	599	610
Percentage of world total	1.3	1.2	1.1	1.1
Total exports (US$ millions)	1 095	1 372	1 743	1 767
Percentage of world total	3.5	3.4	3.3	3.2

Note: **… = data not available.**

programmes that been approved by the Forum Fisheries Committee. The following are the main functions and objectives of FFA.

Economics and marketing. Assistance is given to member countries in the formulation of policies and identification of projects for the sustained use of their tuna resources (the main areas covered are tuna management, industry, marketing, fisheries access, training and linkages).

Legal services. Support is provided to strengthen member countries in the understanding of their legal responsibilities and rights and ability to fulfil responsibilities and take advantage of rights. This support includes the provision of advice in the fields of international law, national legislation, illegal fishing, access negotiations and of training for responsible lawyers and officers within member countries. FFA is simultaneously assisting members in achieving full and independent legislative control of their fisheries resources and ensuring the necessary regional compatibility and cohesion.

Monitoring, control and surveillance. MCS activities aim at reinforcing the capacity of fishing operators in member countries to comply with national regulations and regional licence conditions. This function includes such actions as: assistance to member countries in developing and coordinating national MCS plans; coordination of regional observer programmes and assistance to the development of national observer programmes; coordination of regional surveillance operations; collection and dissemination of data in support of national MCS operations; assistance to FFA members in determining their maritime boundaries; and provision of training, advice and regional exchanges on enforcement and technological developments. FFA's achievements in this field include:

- participation in the coordination and planning of aerial surveillance flights covering members' EEZs;
- the successful development and implementation of a regional observer programme for the South Pacific;
- the research, design and implementation of a satellite-based VMS;
- the establishment of a Maritime Surveillance Communications Network, which will integrate other information systems, including the VMS.

The FFA also undertakes *corporate and treaty services*, including the establishment and maintenance of administrative systems that meet the requirements of treaties and agreements for which FFA is responsible. In the field of *information technology and communication*, FFA has developed an innovative and sophisticated computer system that provides support in the reception, processing and transfer of information to facilitate the monitoring and control of foreign fishing fleets as well as to increase the speed, efficiency and cost-effectiveness with which FFA conducts its work.

FFA has brought important economic and social benefits to its members. Small island developing states have benefited, in particular through regional cooperation and the adoption of regional minimum standards. Regionally agreed measures to limit fishing effort (e.g. in the purse seine tuna fishery) have also been of tangible benefit to FFA member countries.

COOPERATION WITH FAO

FFA has formal relations with FAO, which cooperates with the agency on a range of technical issues, including such matters as joint training exercises and exchanges of technical information. FAO participates in the annual Forum Fisheries Committee meeting as an observer.

FAO also participates as an observer in the Preparatory Conference for the Establishment of the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. This conference is preparing for the establishment of the Commission after the entry into force of the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific. ◆