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THE STATE OF WORLD FISHERIES AND AQUACULTURE

CONTRIBUTING TO FOOD SECURITY AND NUTRITION FOR ALL

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COVER PHOTOGRAPH ©FAO/Pham Cu

HAI TIEN VILLAGE, VIET NAM. A beneficiary of an FAO TeleFood project that uses fish cages.

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FOREWORD

Fisheries and aquaculture remain important sources of food, nutrition, income and livelihoods for hundreds of millions of people around the world. World per capita fish supply reached a new record high of 20 kg in 2014, thanks to vigorous growth in aquaculture, which now provides half of all fish for human consumption, and to a slight improvement in the state of certain fish stocks due to improved fisheries management. Moreover, fish continues to be one of the most-traded food commodities worldwide with more than half of fish exports by value originating in developing countries. Recent reports by high-level experts, international organizations, industry and civil society representatives all highlight the tremendous potential of the oceans and inland waters now, and even more so in the future, to contribute significantly to food security and adequate nutrition for a global population expected to reach 9.7 billion by 2050.

It is in this context and with this high expectation that the 2016 edition of *The State of World Fisheries and Aquaculture* is being launched. Several recent major international developments will further strengthen its key function as a provider of informed, balanced and comprehensive analysis of global fisheries and aquaculture data and related issues.

First, the Second International Conference on Nutrition (ICN2), held in Rome in November 2014, adopted the Rome Declaration and the Framework for Action, whereby world leaders renewed their commitments to establish and implement policies aimed at eradicating malnutrition and transforming food systems to make nutritious diets available to all. The conference confirmed the importance of fish and seafood as a source of nutrition and health for many coastal communities that depend on their proteins and essential micronutrients, in particular for women of child-bearing age and young children. It stressed the unique window of opportunity that fisheries and aquaculture can provide for ICN2 follow-up towards achieving healthy diets. With this greater awareness of the sector's important role in nutrition comes greater responsibility for how resources are managed in order to ensure nutritious and healthy diets for all the world's citizens.

Second, on 25 September 2015, Member States of the United Nations adopted the 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs), a set of 17 aspirational objectives with 169 targets expected to guide actions of governments, international agencies, civil society and other institutions over the next 15 years (2016–2030). The SDGs are the first global development push in history led by the Member States. They set out specific objectives for countries, developed and developing, to meet within a given time frame, with achievements monitored periodically to measure progress and ensure that no one is left behind. Several SDGs are directly relevant to fisheries and aquaculture and to the sustainable development of the sector, and one goal expressly focuses on the oceans (SDG 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development). To achieve the global transition to sustainable development, countries are now establishing an enabling environment of policies, institutions and governance – grounded in a sound evidence-based approach that takes into account the three dimensions of sustainability (economic, social and environmental) – with closely interwoven targets. FAO and *The State of World Fisheries and Aquaculture* will play a frontline role in monitoring and reporting on specific targets relevant to FAO's mandate under SDGs 2 and 14.

Third, on 8–9 October 2015, 600 delegates representing 70 Members of FAO, the private sector, non-governmental organizations and civil society organizations met in Vigo, Spain, to celebrate the twentieth anniversary of the adoption of the Code of Conduct for Responsible Fisheries (the Code), and to take stock of its achievements and the obstacles encountered in its implementation. The meeting confirmed both the central role of the Code for the sustainable management of living aquatic resources, and the need to accelerate its implementation to meet the relevant SDG targets, in particular those of SDG 14. The move from commitment to action to implement the Code entails an upscaled responsibility for analysis, monitoring and reporting for FAO and *The State of World Fisheries and Aquaculture*.

Fourth, the twenty-first session of the Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change was held in Paris, France, in December 2015. It witnessed an unprecedented international agreement, the Paris Agreement. Its aim is to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by holding the increase in the global average temperature to well below 2° C above pre-industrial levels, increasing the ability to adapt to the adverse impacts of climate change, and fostering climate resilience in a manner that does not threaten food production. COP21 prominently featured the role of oceans, inland waters and aquatic ecosystems for temperature regulation and carbon sequestration, and highlighted the urgency of reversing the current trend of overexploitation and pollution to restore aquatic ecosystem services and the productive capacity of the oceans. Current and future editions of *The State of World Fisheries and Aquaculture* will be a key source of information on progress in implementing the Paris Agreement and its pertinence to oceans and inland waters.

Fifth, FAO's efforts to address illegal, unregulated and unreported (IUU) fishing have yielded real results. The 2009 Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (PSMA) entered into force on 5 June 2016. This is a milestone and will prove a key driver in the international community's fight against the scourge of IUU fishing. Illicit fishing may account for up to 26 million tonnes of fish a year, or more than 15 percent of the world's total annual capture fisheries output. Besides economic damage, such practices can threaten local biodiversity and food security in many countries. The PSMA, which creates binding obligations, sets standards for the inspection of foreign vessels that seek to enter the port of another State. Importantly, the measures allow a country to block ships it suspects of having engaged in illicit fishing and thereby prevent illegal catches from entering local and international markets. This will be a turning point in the long struggle against illegality in the fisheries and aquaculture sector.

Finally, following the adoption in July 2014 of the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication, an umbrella programme has been launched to support governments and non-state actors in their implementation of initiatives to strengthen small-scale fisheries communities, their food security, and their resilience. Small-scale fisheries provide work to 90 percent of the people employed in capture fisheries. Now, their voices will be increasingly heard, their rights respected and their livelihoods safeguarded. More broadly, decent work in fisheries and aquaculture is an important part of FAO's strategic approach to the sector.

FAO has taken into account the above developments within the framework of its own Blue Growth Initiative to accelerate its work in support of sustainable management of living aquatic resources, balancing their use and conservation in an economically, socially and environmentally responsible manner.

Awareness of the vital part that oceans and inland waters must play in providing food, nutrition and employment to current and future generations and in meeting commitments under the 2030 Agenda for Sustainable Development and the Paris Agreement re-focuses the role of this publication as a unique source of global analysis and information on fisheries and aquaculture development. It is my sincere hope that *The State of World Fisheries and Aquaculture 2016* will make a valuable contribution to meeting the challenges ahead and advance understanding of the drivers shaping the fisheries and aquaculture sector, aquatic ecosystems and their contribution to meeting the related SDG targets.

José Graziano da Silva

FAO Director-General

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ACRONYMS AND ABBREVIATIONS

ABNJ
areas beyond national jurisdiction

ALDFG
abandoned, lost or otherwise discarded fishing gear

AR5
Fifth Assessment Report (Intergovernmental Panel on Climate Change)

BGI
Blue Growth Initiative (FAO)

BMP
better management practice

CCAMLR
Commission for the Conservation of Antarctic Marine Living Resources

CODE
Code of Conduct for Responsible Fisheries

COFI
FAO Committee on Fisheries

COP21
twenty-first session of the Conference of the Parties

COREP
Regional Fisheries Committee for the Gulf of Guinea

CSO
civil society organization

DHA
docosahexaenoic acid

EAA
ecosystem approach to aquaculture

EAF
ecosystem approach to fisheries

EBM
ecosystem-based management

EEZ
exclusive economic zone

EPA
eicosapentaenoic acid

EU
European Union (Member Organization)

GAAP
Global Aquaculture Advancement Partnership

GEF
Global Environment Facility

GFCM
General Fisheries Commission for the Mediterranean

GHG
greenhouse gas

GIS
geographic information systems

GLOBAL RECORD
Comprehensive Global Record of Fishing Vessels, Refrigerated Transport Vessels and Supply Vessels

HS
Harmonized System

HUFA
highly unsaturated fatty acid

IAS
invasive alien species

ICN2
Second International Conference on Nutrition

ILO
International Labour Organization

IMO
International Maritime Organization

IOTC
Indian Ocean Tuna Commission

IPOA
international plan of action

IPOA–IUU
International Plan of Action to Prevent, Deter and Eliminate IUU Fishing

IPOA–SHARKS
International Plan of Action for the Conservation and Management of Sharks

IUCN
International Union for Conservation of Nature

IUU
illegal, unreported and unregulated (fishing)

LIFDC
low-income food-deficit country

LOA
length overall

MCS
monitoring, control and surveillance

MDG
Millennium Development Goal

MSY
maximum sustainable yield

NGO
non-governmental organization

OECD
Organisation for Economic Co-operation and Development

PSMA
FAO Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing

RFB
regional fishery body

RFMO/A
regional fisheries management organization/arrangement

SDG
Sustainable Development Goal

SEEA
System of Environmental-Economic Accounting

SENDAI FRAMEWORK
Sendai Framework for Disaster Risk Reduction 2015–2030

SIDS
small island developing States

SSF
small-scale fishery

SSF GUIDELINES
Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication

UNCLOS
United Nations Convention on the Law of the Sea

UNEP
United Nations Environment Programme

VG TENURE
Voluntary Guidelines for the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security

VMS
vessel monitoring system

WCO
World Customs Organization

WHO
World Health Organization

WTO
World Trade Organization

PART 1
WORLD REVIEW

POTTUVIL, SRI LANKA
Fishers gathering the day's catch. FAO provided boats to fishers (and seeds and fertilizers to thousands of farmers) in areas hardest hit by the 2004 tsunami.

PART 1

WORLD REVIEW

OVERVIEW

Faced with one of the world's greatest challenges – how to feed more than 9 billion people by 2050 in a context of climate change, economic and financial uncertainty, and growing competition for natural resources – the international community made unprecedented commitments in September 2015 when UN Member States adopted the 2030 Agenda for Sustainable Development. The 2030 Agenda also sets aims for the contribution and conduct of fisheries and aquaculture towards food security and nutrition in the use of natural resources so as to ensure sustainable development in economic, social and environmental terms.

Many millennia after terrestrial food production shifted from hunter-gatherer activities to agriculture, aquatic food production has transitioned from being primarily based on capture of wild fish to culture of increasing numbers of farmed species. A milestone was reached in 2014 when the aquaculture sector's contribution to the supply of fish for human consumption overtook that of wild-caught fish for the first time. Meeting the ever-growing demand for fish as food in conformity with the 2030 Agenda will be imperative, and also immensely challenging.

With capture fishery production relatively static since the late 1980s, aquaculture has been responsible for the impressive growth in the supply of fish for human consumption (Figure 1). Whereas aquaculture provided only 7 percent of fish for human consumption in 1974, this share had increased to 26 percent in 1994 and 39 percent in 2004. China has played a major role in this growth as it represents more than 60 percent of world aquaculture production.

However, the rest of the world (excluding China) has also benefited with its share of aquaculture in the overall supply of fish for human consumption more than doubling since 1995.

Growth in the global supply of fish for human consumption has outpaced population growth in the past five decades, increasing at an average annual rate of 3.2 percent in the period 1961–2013, double that of population growth, resulting in increasing average per capita availability (Figure 2). World per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 19.7 kg in 2013, with preliminary estimates for 2014 and 2015 pointing towards further growth beyond 20 kg (Table 1, all data presented are subject to rounding). In addition to the increase in production, other factors that have contributed to rising consumption include reductions in wastage, better utilization, improved distribution channels, and growing demand linked to population growth, rising incomes and urbanization. International trade has also played an important role in providing wider choices to consumers.

Although annual per capita consumption of fish has grown steadily in developing regions (from 5.2 kg in 1961 to 18.8 kg in 2013) and in low-income food-deficit countries (LIFDCs) (from 3.5 to 7.6 kg), it is still considerably lower than that in more developed regions, even though the gap is narrowing. In 2013, per capita apparent fish consumption in industrialized countries was 26.8 kg. A sizeable and growing share of fish consumed in developed countries consists of imports, owing to steady demand and static or declining domestic fishery production. In developing countries, where fish consumption tends to be based on locally available products, consumption is driven more »

FIGURE 1

WORLD CAPTURE FISHERIES AND AQUACULTURE PRODUCTION

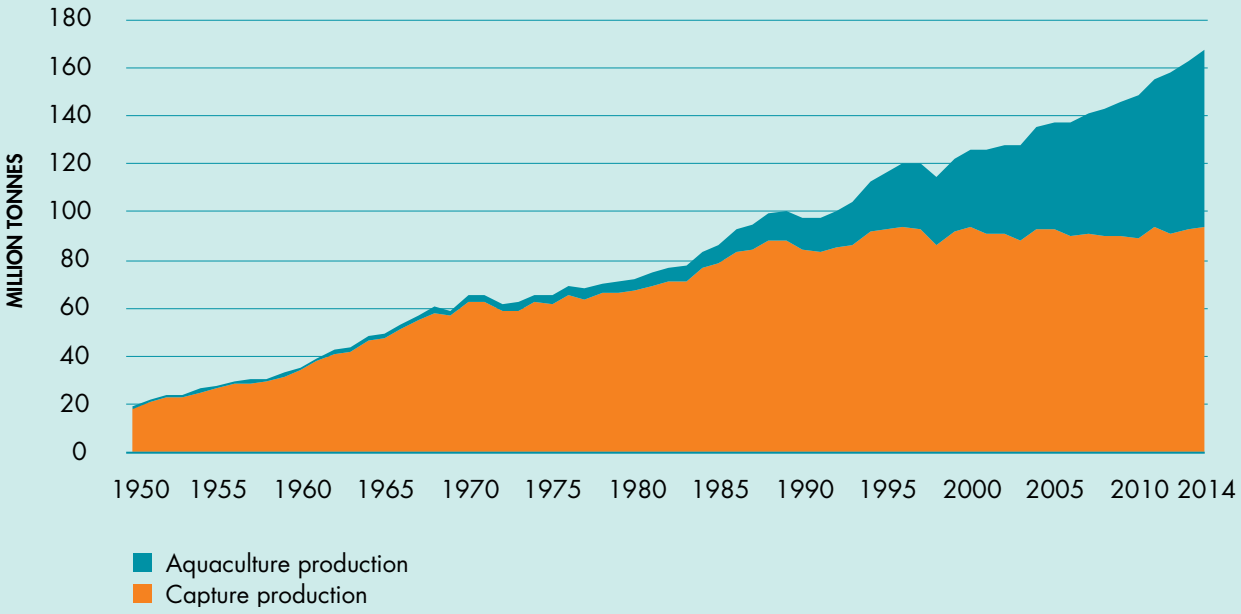

FIGURE 2

WORLD FISH UTILIZATION AND SUPPLY

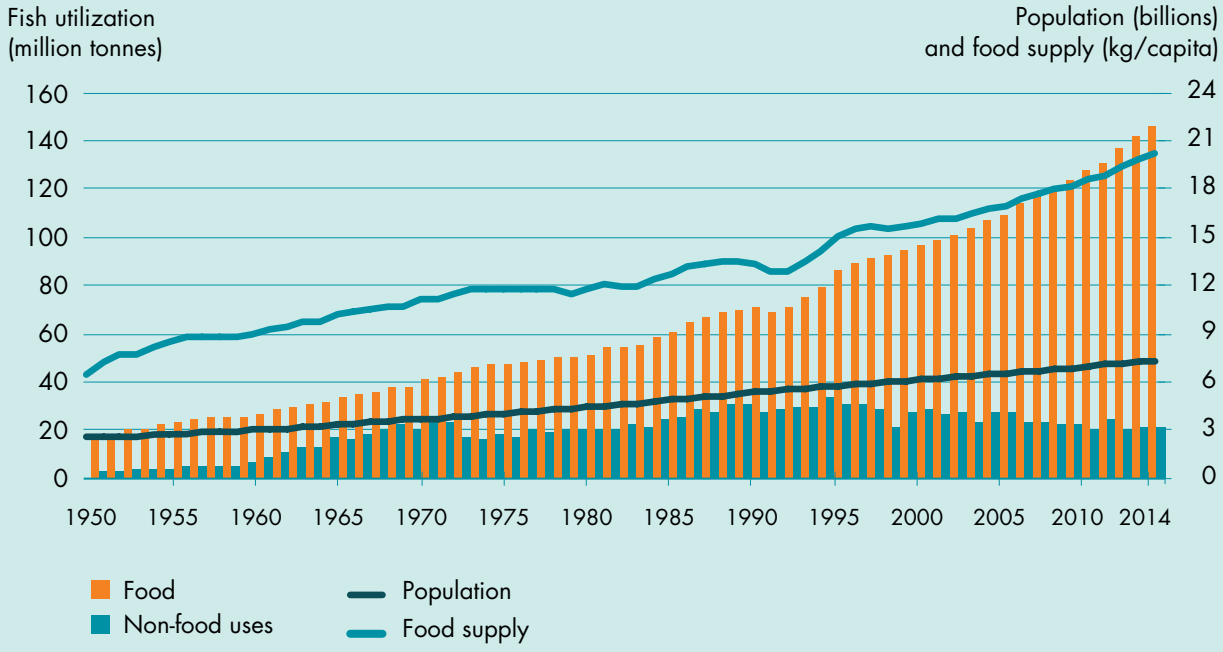

TABLE 1

WORLD FISHERIES AND AQUACULTURE PRODUCTION AND UTILIZATION

	2009	2010	2011	2012	2013	2014
			(Million tonnes)			
PRODUCTION						
Capture						
Inland	10.5	11.3	11.1	11.6	11.7	11.9
Marine	79.7	77.9	82.6	79.7	81.0	81.5
Total capture	**90.2**	**89.1**	**93.7**	**91.3**	**92.7**	**93.4**
Aquaculture						
Inland	34.3	36.9	38.6	42.0	44.8	47.1
Marine	21.4	22.1	23.2	24.4	25.5	26.7
Total aquaculture	**55.7**	**59.0**	**61.8**	**66.5**	**70.3**	**73.8**
TOTAL	145.9	148.1	155.5	157.8	162.9	167.2
UTILIZATION[1]						
Human consumption	123.8	128.1	130.8	136.9	141.5	146.3
Non-food uses	22.0	20.0	24.7	20.9	21.4	20.9
Population (*billions*)	6.8	6.9	7.0	7.1	7.2	7.3
Per capita food fish supply (*kg*)	18.1	18.5	18.6	19.3	19.7	20.1

Note: Excluding aquatic plants. Totals may not match due to rounding.
[1] Data in this section for 2014 are provisional estimates.

» by supply than demand. However, fuelled by rising domestic income, consumers in emerging economies are experiencing a diversification of the types of available fish through an increase in fishery imports.

This significant growth in fish consumption has enhanced people's diets around the world through diversified and nutritious food. In 2013, fish accounted for about 17 percent of the global population's intake of animal protein and 6.7 percent of all protein consumed. Moreover, fish provided more than 3.1 billion people with almost 20 percent of their average per capita intake of animal protein. In addition to being a rich source of easily digested, high-quality proteins containing all essential amino acids, fish provides essential fats (e.g. long-chain omega-3 fatty acids), vitamins (D, A and B) and minerals (including calcium, iodine, zinc, iron and selenium), particularly if eaten whole. Even small quantities of fish can have a significant positive nutritional impact on plant-based diets, and this is the case in many LIFDCs and least-developed countries. Fish is usually high in unsaturated fats and provides health benefits in protection against cardiovascular diseases. It also aids foetal and infant development of the brain and nervous system. With its valuable nutritional properties, it can also play a major role in correcting unbalanced diets and, through substitution, in countering obesity.

Global total capture fishery production in 2014 was 93.4 million tonnes, of which 81.5 million tonnes from marine waters and 11.9 million tonnes from inland waters (Table 1). For marine fisheries production, China remained the major producer followed by Indonesia, the United States of America and the Russian Federation. Catches of anchoveta in Peru fell to 2.3 million tonnes in 2014 – half that of the previous year and the lowest level since the strong El Niño in 1998 – but in 2015 they had already recovered to more than 3.6 million tonnes. For the first time since 1998, anchoveta was not the top-ranked species in terms of catch as it fell below Alaska pollock.

Four highly valuable groups (tunas, lobsters, shrimps and cephalopods) registered new record catches in 2014. Total catches of tuna and tuna-like species were almost 7.7 million tonnes.

The Northwest Pacific remained the most productive area for capture fisheries, followed by the Western Central Pacific, the Northeast Atlantic and the Eastern Indian Ocean. With the exception of the Northeast Atlantic, these areas have shown increases in catches compared with the average for the decade 2003–2012. The situation in the Mediterranean and Black Sea is alarming, as catches have dropped by one-third since 2007, mainly attributable to reduced landings of small pelagics such as anchovy and sardine but with most species groups also affected.

World catches in inland waters were about 11.9 million tonnes in 2014, continuing a positive trend that has resulted in a 37 percent increase in the last decade. Sixteen countries have annual inland water catches exceeding 200 000 tonnes, and together they represent 80 percent of the world total.

Production of aquatic animals from aquaculture in 2014 amounted to 73.8 million tonnes, with an estimated first-sale value of US$160.2 billion. This total comprised 49.8 million tonnes of finfish (US$99.2 billion), 16.1 million tonnes of molluscs (US$19 billion), 6.9 million tonnes of crustaceans (US$36.2 billion) and 7.3 million tonnes of other aquatic animals including amphibians (US$3.7 billion). China accounted for 45.5 million tonnes in 2014, or more than 60 percent of global fish production from aquaculture. Other major producers were India, Viet Nam, Bangladesh and Egypt. In addition, 27.3 million tonnes of aquatic plants (US$5.6 billion) were cultured. Aquatic plant farming, overwhelmingly of seaweeds, has been growing rapidly and is now practised in about 50 countries. Importantly in terms of food security and the environment, about half of the world's aquaculture production of animals and plants came from non-fed species. These species include silver and bighead carps, filter-feeding animal species (e.g. bivalve molluscs) and seaweeds. However, growth in production has been faster for fed species than for non-fed species.

An estimated 56.6 million people were engaged in the primary sector of capture fisheries and aquaculture in 2014, of whom 36 percent were engaged full time, 23 percent part time, and the remainder were either occasional fishers or of unspecified status. Following a long upward trend, numbers have remained relatively stable since 2010, while the proportion of these workers engaged in aquaculture increased from 17 percent in 1990 to 33 percent in 2014. In 2014, 84 percent of the global population engaged in the fisheries and aquaculture sector was in Asia, followed by Africa (10 percent), and Latin America and the Caribbean (4 percent). Of the 18 million people engaged in fish farming, 94 percent were in Asia. Women accounted for 19 percent of all people directly engaged in the primary sector in 2014, but when the secondary sector (e.g. processing, trading) is included women make up about half of the workforce.

The total number of fishing vessels in the world in 2014 is estimated at about 4.6 million, very close to the figure for 2012. The fleet in Asia was the largest, consisting of 3.5 million vessels and accounting for 75 percent of the global fleet, followed by Africa (15 percent), Latin America and the Caribbean (6 percent), North America (2 percent) and Europe (2 percent). Globally, 64 percent of reported fishing vessels were engine-powered in 2014, of which 80 percent were in Asia, with the remaining regions all under 10 percent each. In 2014, about 85 percent of the world's motorized fishing vessels were less than 12 m in length overall (LOA), and these small vessels dominated in all regions. The estimated number of fishing vessels of 24 m and longer operating in marine waters in 2014 was about 64 000, the same as in 2012.

The state of the world's marine fish stocks has not improved overall, despite notable progress in some areas. Based on FAO's analysis of assessed commercial fish stocks, the share of fish stocks within biologically sustainable levels decreased from 90 percent in 1974 to 68.6 percent in 2013. Thus, 31.4 percent of fish stocks were estimated

as fished at a biologically unsustainable level and therefore overfished. Of the total number of stocks assessed in 2013, fully fished stocks accounted for 58.1 percent and underfished stocks 10.5 percent. The underfished stocks decreased almost continuously from 1974 to 2013, but the fully fished stocks decreased from 1974 to 1989, and then increased to 58.1 percent in 2013. Correspondingly, the percentage of stocks fished at biologically unsustainable levels increased, especially in the late 1970s and 1980s, from 10 percent in 1974 to 26 percent in 1989. After 1990, the number of stocks fished at unsustainable levels continued to increase, albeit more slowly. The ten most-productive species accounted for about 27 percent of the world's marine capture fisheries production in 2013. However, most of their stocks are fully fished with no potential for increases in production; the remainder are overfished with increases in their production only possible after successful stock restoration.

The share of world fish production utilized for direct human consumption has increased significantly in recent decades, up from 67 percent in the 1960s to 87 percent, or more than 146 million tonnes, in 2014. The remaining 21 million tonnes was destined for non-food products, of which 76 percent was reduced to fishmeal and fish oil in 2014, the rest being largely utilized for a variety of purposes including as raw material for direct feeding in aquaculture. Increasingly, the utilization of by-products is becoming an important industry, with a growing focus on their handling in a controlled, safe and hygienic way, thereby also reducing waste.

In 2014, 46 percent (67 million tonnes) of the fish for direct human consumption was in the form of live, fresh or chilled fish, which in some markets are the most preferred and highly priced forms. The rest of the production for edible purposes was in different processed forms, with about 12 percent (17 million tonnes) in dried, salted, smoked or other cured forms, 13 percent (19 million tonnes) in prepared and preserved forms, and 30 percent (about 44 million tonnes) in frozen form. Freezing is the main method of processing fish for human consumption, and it accounted for 55 percent of total processed fish for human consumption and 26 percent of total fish production in 2014.

Fishmeal and fish oil are still considered the most nutritious and digestible ingredients for farmed-fish feeds. To offset their high prices, as feed demand increases, the amount of fishmeal and fish oil used in compound feeds for aquaculture has shown a clear downward trend, with their being more selectively used as strategic ingredients at lower concentrations and for specific stages of production, particularly hatchery, broodstock and finishing diets.

International trade plays a major role in the fisheries and aquaculture sector as an employment creator, food supplier, income generator, and contributor to economic growth and development, as well as to food and nutrition security. Fish and fishery products represent one of the most-traded segments of the world food sector, with about 78 percent of seafood products estimated to be exposed to international trade competition. For many countries and for numerous coastal and riverine regions, exports of fish and fishery products are essential to their economies, accounting for more than 40 percent of the total value of traded commodities in some island countries, and globally representing more than 9 percent of total agricultural exports and 1 percent of world merchandise trade in value terms. Trade in fish and fishery products has expanded considerably in recent decades, fuelled by growing fishery production and driven by high demand, with the fisheries sector operating in an increasingly globalized environment. In addition, there is an important trade in fisheries services.

China is the main fish producer and largest exporter of fish and fishery products. It is also a major importer due to outsourcing of processing from other countries as well as growing domestic consumption of species not produced locally. However, in 2015, after years of sustained increases, its fishery trade experienced a slowdown with a reduction in its processing sector. Norway, the second major exporter, posted

record export values in 2015. In 2014, Viet Nam became the third major exporter, overtaking Thailand, which has experienced a substantial decline in exports since 2013, mainly linked to reduced shrimp production due to disease problems. In 2014 and 2015, the European Union (Member Organization) (EU) was by far the largest single market for fish imports, followed by the United States of America and Japan.

Developing economies, whose exports represented just 37 percent of world trade in 1976, saw their share rise to 54 percent of total fishery export value and 60 percent of the quantity (live weight) by 2014. Fishery trade represents a significant source of foreign currency earnings for many developing countries, in addition to its important role in income generation, employment, food security and nutrition. In 2014, fishery exports from developing countries were valued at US$80 billion, and their fishery net-export revenues (exports minus imports) reached US$42 billion, higher than other major agricultural commodities (such as meat, tobacco, rice and sugar) combined.

Governance of fisheries and aquaculture should be greatly influenced by the 2030 Agenda for Sustainable Development, the Sustainable Development Goals (SDGs), and the Paris Agreement of the Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change. The 17 SDGs and their 169 targets provide a framework to guide development actions of governments, international agencies, civil society and other institutions over the next 15 years with the ambitious aim of eradicating extreme poverty and hunger. Food security and nutrition, and sustainable management and use of natural resources, feature prominently in the SDGs and targets, applying to all countries, and integrating the three dimensions of sustainable development (economic, social and environmental). Moreover, the Paris Agreement recognizes that climate change is a fundamental threat to global food security, sustainable development and poverty eradication. Thus, governance needs to ensure that fisheries and aquaculture adapt to the impacts of climate change and improve the resilience of food production systems.

FAO's Blue Growth Initiative assists countries in developing and implementing the new global agenda in relation to sustainable capture fisheries and aquaculture, livelihoods and food systems, and economic growth from aquatic ecosystem services. It promotes implementation of the Code of Conduct for Responsible Fisheries (the Code) and the ecosystem approach to fisheries and aquaculture (EAF/EAA). Reflecting the objectives of several SDGs, it especially targets the many vulnerable coastal and fisheries-dependent communities where ecosystems are already under stress from pollution, habitat degradation, overfishing and harmful practices.

There is a need to strengthen aquatic ecosystem governance to deal with the increasing use of water space and resources. It is necessary to coordinate various activities taking place in a given region, recognize their cumulative impacts, and harmonize sustainability goals and legal frameworks. This requires adding a layer of governance to deal with coordination across sectors and to ensure that common sustainability goals of environmental protection and ecosystem and biodiversity conservation are met while addressing social and economic development goals.

For the past 20 years, the Code has served as the global reference instrument for the sustainable development of the fisheries and aquaculture sectors. Despite implementation shortfalls and stakeholder constraints, there have been considerable developments in relation to the Code's six core chapters since its adoption. There has been notable progress in monitoring the status of fish stocks, compilation of statistics on catch and fishing effort, and the application of the EAF. The control of fishing operations within exclusive economic zones (EEZs) is now considered much stronger (while less so in areas beyond national jurisdiction [ABNJ]). Steps are being taken to combat illegal, unreported and unregulated (IUU) fishing, control fishing capacity and implement plans for the conservation of sharks and seabirds. Food safety

and quality assurance have been given prime importance, and there is increased attention to addressing post-harvest losses, bycatch problems, and illegal processing and trading. The growth of responsible aquaculture has been remarkable, with several countries now having procedures to conduct environmental assessments of aquaculture operations, to monitor operations and to minimize harmful effects of alien species introductions.

The Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines), which were endorsed in 2014, represent a global consensus on principles and guidance for small-scale fisheries governance and development towards enhanced food security and nutrition. They aim to contribute to and improve the equitable development and socio-economic condition of small-scale fishing communities alongside sustainable and responsible management of fisheries. There is already evidence of important steps in implementation of the SSF Guidelines.

Various seafood stakeholders wish to promote sustainable resource management and reward responsibly sourced seafood products with preferred market access. To this end, they have developed market-based measures commonly known as ecolabels. The number of voluntary certification schemes and their uptake by major import markets have increased dramatically since the first seafood ecolabel appeared in 1999. Such schemes can provide effective incentives for adherence to practices promoting sustainability.

Regional fishery bodies (RFBs) have a key role in the governance of shared fisheries. There are some 50 RFBs worldwide, most providing only advice to their members. However, regional fisheries management organizations (RFMOs), an important subset of RFBs, do have a mandate and the capacity for their members to adopt binding conservation and management measures based on best scientific evidence. The current state of many shared fishery resources has led to criticism of some RFBs, which, in turn, has led to debates on how to strengthen and reform them.

Performance reviews of RFBs and revisions to their constitutive instruments have usually led to improved performance. However, RFBs can only be as effective as their member States allow, and RFBs' performance depends directly on their members' participation, engagement and political will.

The coming into force and implementation of the FAO Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (PSMA) is expected to be a major advance in combating IUU fishing. In addition, global application of the 2014 FAO Voluntary Guidelines for Flag State Performance would be an important complement to the PSMA by improving the implementation of flag State responsibilities. Moreover, market access and trade measures (such as traceability, catch documentation and ecolabelling schemes) would be very beneficial.

Partnerships can be very effective in improving the sustainability of fisheries and aquaculture. Focusing on tuna and deep-sea fisheries, and with an emphasis on creating valuable partnerships and enhancing global and regional coordination on ABNJ issues, the Common Oceans ABNJ Program aims to promote efficient and sustainable management of fisheries resources and biodiversity conservation in ABNJ to achieve internationally agreed global targets. The innovative five-year ABNJ Program, which started in 2014, is funded by the Global Environment Facility (GEF) and coordinated by FAO in close collaboration with three other GEF implementing agencies and a variety of partners.

Another partnership initiative is the Global Aquaculture Advancement Partnership (GAAP) programme established by FAO. Its aim is to bring partners together to channel their technical, institutional and financial resources effectively and efficiently in support of global, regional and national aquaculture initiatives. Specifically, GAAP seeks to promote and enhance strategic partnerships, and to use them to gather resources to develop and implement projects at the various levels. ■

SAINT GEORGE'S, GRENADA
Fish for sale at a local market. An FAO project assists farmers and fishers in the wake of the devastation from Hurricane Ivan.
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CAPTURE FISHERIES PRODUCTION

Total capture fisheries production

Global total capture production in 2014 was 93.4 million tonnes. Catch trends in marine and inland waters are examined separately in the following sections.

There are still several countries that do not regularly report their annual catch statistics to FAO or for which data are not entirely reliable. However, the near doubling of the number of species included in the FAO database in less than 20 years, from 1 035 in 1996 (the first version with separate data for capture and aquaculture production) to 2 033 in 2014, indicates overall quality improvements in data collected.

In compiling the FAO database, data on retained catches officially submitted by countries are cross-checked and complemented with those made available by other sources, e.g. RFMOs with a mandate for tuna and shark species or for non-tuna species in vast ocean areas,[1] and also with data collected by national/territorial authorities (e.g. Guinea-Bissau and Mauritania) on catches by distant-water fishing nations in their EEZ. This complementary work ensures that the FAO capture database includes at least a part of the catches that would go unreported by flags of convenience or countries with loose control of their distant-water fleets.

Data from capture and aquaculture databases are also used, in addition to those on fish utilization and international trade, to calculate FAO's per capita apparent consumption for fish and fishery products by country, and this information can help spot erroneous data. When it is known that fisheries occurred but no data from official or other sources are available, FAO produces estimates of unreported catches and aquaculture production to make the database as complete as possible and minimize underestimation of national and global fish consumption.

World marine capture production

Total capture production in marine waters was 81.5 million tonnes in 2014, a slight increase on the previous two years (Table 2). However, the global trend in marine fisheries (Figure 3) is usually analysed by removing catches of anchoveta (*Engraulis ringens*). This is because anchoveta abundance is highly variable (being influenced by El Niño episodes), its catches can be very substantial, and the vast majority of the catch does not go for human consumption but is reduced to fishmeal.

Starting from 1950, global catches without anchoveta rose until 1988 when they exceeded 78 million tonnes (Figure 3). Subsequently, catches levelled off, albeit with some fluctuations (also perhaps reflecting a marked reduction in distant-water fishing activities following the dissolution of the Soviet Union). From 2003 to 2009, total catches remained exceptionally stable, with interannual variations never exceeding one percent in absolute amount. Finally, from 2010 there was slight growth every year until a new maximum was reached in 2014, with global catches excluding anchoveta at 78.4 million tonnes.

In 2014, 13 out of the 25 major fishing countries increased their catches by more than 100 000 tonnes compared with 2013 (Table 2). The most significant increments were those of China, Indonesia and Myanmar in Asia, Norway in Europe, and Chile and Peru in South America.

Catches officially reported by China as caught in fishing areas other than "61 Northwest Pacific" grew from 586 000 tonnes in 2013 to 880 000 tonnes in 2014 due to higher catches of cephalopods (South Atlantic and South Pacific) and krill (Antarctic), and catches in area 61 increased by 550 000 tonnes. However, a part of China's 2014 capture production in area »

TABLE 2

MARINE CAPTURE PRODUCTION: MAJOR PRODUCERS

COUNTRY OR TERRITORY	AVERAGE 2003–2012	2013	2014	VARIATION AVERAGE (2003–2012) – 2014	VARIATION 2013–2014	VARIATION 2013–2014
		(Tonnes)		*(Percentage)*		*(Tonnes)*
China	12 759 922	13 967 764	14 811 390	16.1	6.0	843 626
Indonesia	4 745 727	5 624 594	6 016 525	26.8	7.0	391 931
United States of America	4 734 500	5 115 493	4 954 467	4.6	–3.1	–161 026
Russian Federation	3 376 162	4 086 332	4 000 702	18.5	–2.1	–85 630
Japan	4 146 622	3 621 899	3 630 364	–12.5	0.2	8 465
Peru	7 063 261	5 827 046	3 548 689	–49.8	–39.1	–2 278 357
	918 049[1]	*956 416*[1]	*1 226 560*[1]	*33.6*	*28.2*	*270 144*
India	3 085 311	3 418 821	3 418 821[2]	10.8	0.0	0
Viet Nam	1 994 927	2 607 000	2 711 100	35.9	4.0	104 100
Myanmar	1 643 642	2 483 870	2 702 240	64.4	8.8	218 370
Norway	2 417 348	2 079 004	2 301 288	–4.8	10.7	222 284
Chile	3 617 190	1 770 945	2 175 486	–39.9	22.8	404 541
	2 462 885[1]	*967 541*[1]	*1 357 586*[1]	*–44.9*	*40.3*	*390 045*
Philippines	2 224 720	2 130 747	2 137 350	–3.9	0.3	6 603
Republic of Korea	1 736 680	1 586 059	1 718 626	–1.0	8.4	132 567
Thailand	2 048 753	1 614 536	1 559 746	–23.9	–3.4	–54 790
Malaysia	1 354 965	1 482 899	1 458 126	7.6	–1.7	–24 773
Mexico	1 352 353	1 500 182	1 396 205	3.2	–6.9	–103 977
Morocco	998 584	1 238 277	1 350 147	35.2	9.0	111 870
Spain	904 459	981 451	1 103 537	22.0	12.4	122 086
Iceland	1 409 270	1 366 486	1 076 558	–23.6	–21.2	–289 928
Taiwan Province of China	972 400	925 171	1 068 244	9.9	15.5	143 073
Canada	969 195	823 640	835 196	–13.8	1.4	11 556
Argentina	891 916	858 422	815 355	–8.6	–5.0	–43 067
United Kingdom	622 146	630 047	754 992	21.4	19.8	124 945
Denmark	806 787	668 339	745 019	–7.7	11.5	76 680
Ecuador	452 003	514 415	663 439	46.8	29.0	149 026
Total 25 major producers	**66 328 843**	**66 923 439**	**66 953 612**	**0.9**	**0.0**	**30 173**
WORLD TOTAL	80 793 507	80 963 120	81 549 353	0.9	0.7	586 233
SHARE 25 MAJOR PRODUCERS (PERCENTAGE)	82.1	82.7	82.1			

[1] Totals excluding catches of Peruvian anchoveta (*Engraulis ringens*) by Peru and Chile.
[2] FAO estimate.

» 61 could be from other areas because catches classified by China as from "distant water fishery", which include also catches in area 61 outside China's EEZ, increased from 1.35 million tonnes to more than 2 million tonnes in 2014 in the national reports.

In 2014, anchoveta catches in Peru fell to 2.3 million tonnes – half that of 2013 and the lowest since the strong El Niño in 1998 – but in 2015 they recovered to more than 3.6 million tonnes. However, 2014 catches by Peru of all other species were the highest since 2001, with high catches of valuable species such as jumbo flying squid, hake and shrimps. In contrast to Peru, Chile's 2014 anchoveta catches were steady at 0.8 million tonnes, but all other species increased, reversing a declining trend that had started in 2007.

For the first time since 1998, anchoveta was not the top species in the capture ranking as it was surpassed by Alaska pollock. As Table 3 shows, despite the quite stable trend in marine global totals, catches of single major species undergo marked variations over the years.

In the Atlantic and adjacent seas, catches of Atlantic herring (*Clupea harengus*) fell by one-third between 2009 and 2014, whereas those of Atlantic mackerel (*Scomber scombrus*) doubled (see mirrored trends in Figure 4). Herring capture decreased for the three major fishing countries (i.e. Norway, Iceland and the Russian Federation) and all countries operating in the Northeast Atlantic caught greatly increased quantities of mackerel. The latter species is now also landed from the EEZs of Iceland and Greenland, where it was not caught in great quantities before. This is probably an effect of climate change, although this theory needs further local studies.[2] After a significant recovery in the period 2009–2013, Atlantic cod (*Gadus morhua*) has stabilized at about 1.3 million tonnes in the Northeast Atlantic but catches are still extremely low in the Northwest Atlantic, not having exceeded 70 000 tonnes since the collapse in the early 1990s.

In the North Pacific, there have been significant catch increases for Pacific saury (*Cololabis saira*) and gazami crab (*Portunus trituberculatus*). For the former, in addition to increases by other countries, catches by China derived from an additional source have been included for the first time in the FAO database.

Four highly valuable groups – i.e. tunas, lobsters, shrimps and cephalopods – marked new record catches in 2014. Total catches of tuna and tuna-like species were almost 7.7 million tonnes. Skipjack catches surpassed 3 million tonnes and those of yellowfin returned closer to the level of 1.5 million tonnes reached in 2003 and 2004. Catches of albacore and swordfish remained stable, as did those of bigeye, although 80 000 tonnes lower than the 2004 peak at almost 0.5 million tonnes. While the three bluefin tuna species (*Thunnus maccoyii*, *T. orientalis* and *T. thynnus*) are highly targeted for their size and prices on the global market, their contribution in terms of catches is minor (about 40 000 tonnes taken together), with recent reassuring catch trends after years of major declines.

Since the 1980s, American lobster (*Homarus americanus*) and Norway lobster (*Nephrops norvegicus*) have accounted for more than 60 percent of global lobster catches. In 2014, their combined catches exceeded 70 percent of those of the whole group, with American lobster reaching a record high at almost 160 000 tonnes after increasing continuously since 2008. Global catches of shrimp have been stable at 3.5 million tonnes since 2012, as have catches of their major species, with the exception of Argentine red shrimp (*Pleoticus muelleri*), which continued to increase beyond a previous record, a trend that started after a major drop in 2005.[3]

Cephalopods are fast-growing short-lived species that are strongly influenced by environmental variability.[4] Squids represent the great majority of the catches (Figure 5), and after a drop in 2009 their catches have been boosted by jumbo flying squid (*Dosidicus gigas*) in the East Pacific and by Argentine shortfin squid (*Illex argentinus*) in the Southwest Atlantic. Since 2008, catches of cuttlefishes and octopuses have remained relatively

Continues on page 16 »

FIGURE 3

TRENDS IN GLOBAL MARINE CATCHES, SEPARATED DATA FOR ANCHOVETA

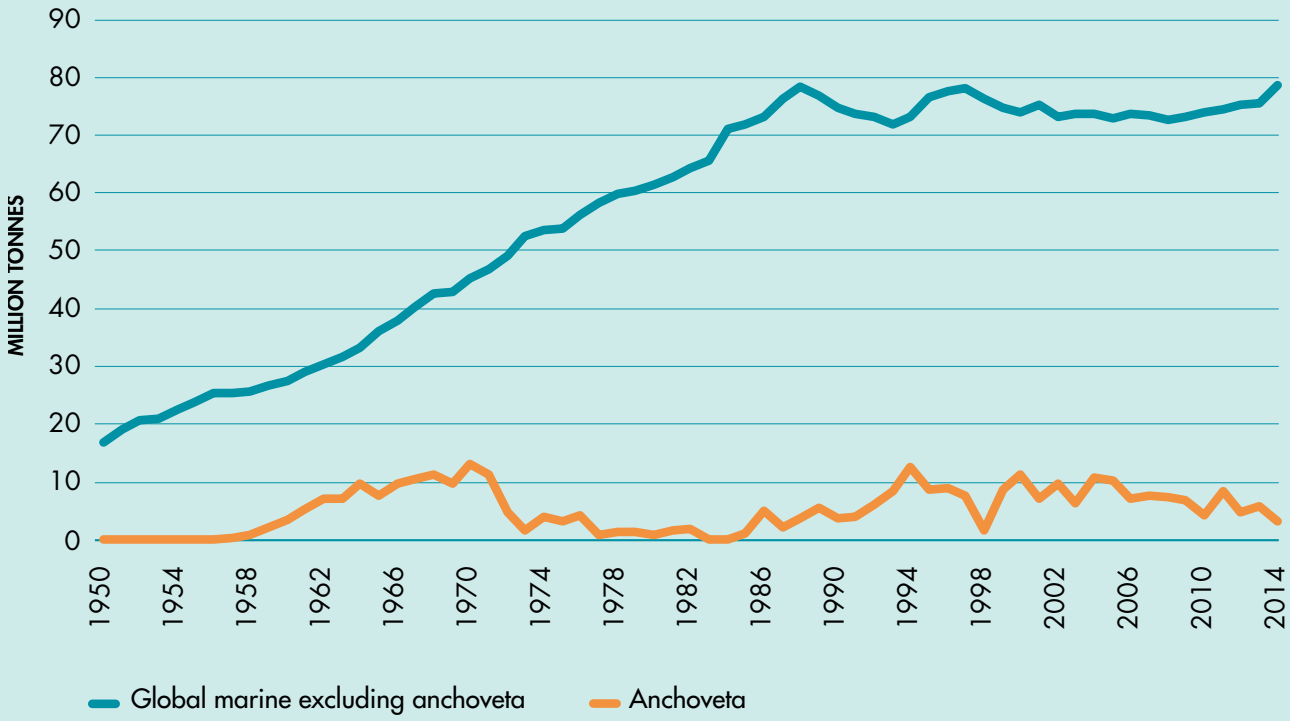


FIGURE 4

CATCH TRENDS OF ATLANTIC HERRING AND ATLANTIC MACKEREL

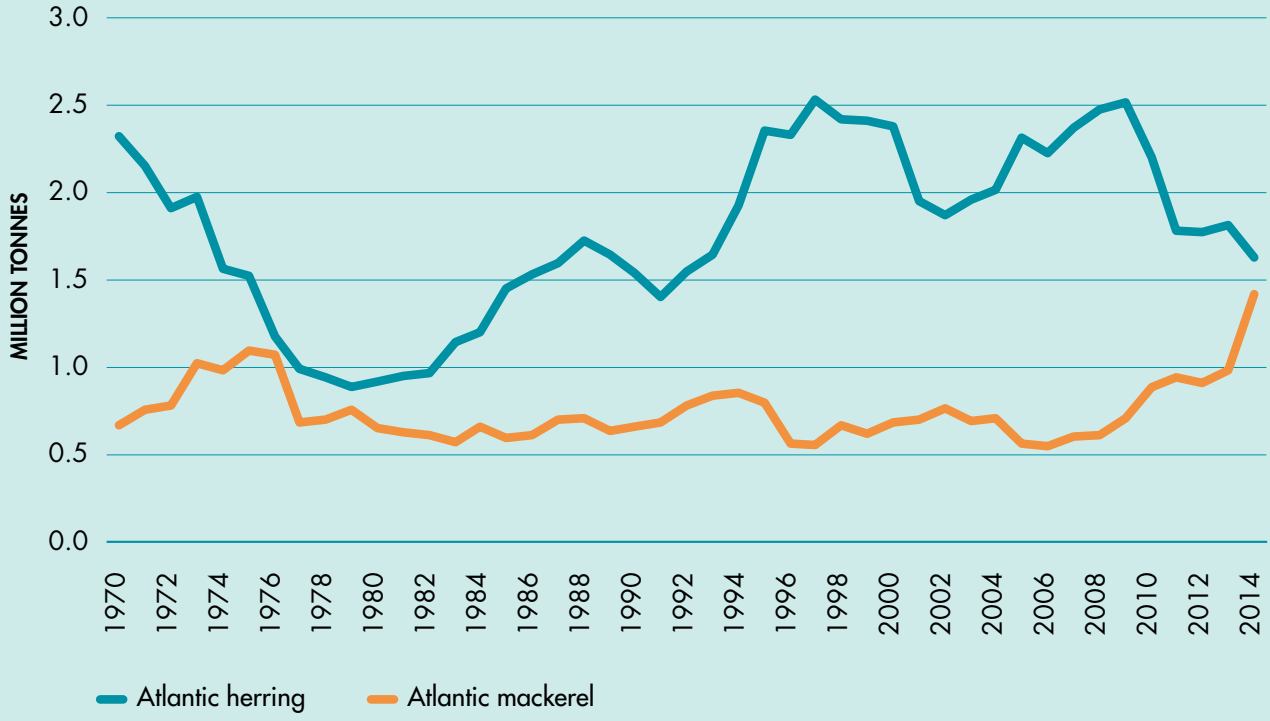


TABLE 3

MARINE CAPTURE PRODUCTION: MAJOR SPECIES AND GENERA

SCIENTIFIC NAME	FAO ENGLISH NAME	AVERAGE 2003–2012	2013	2014	VARIATION		
					AVERAGE (2003–2012) –2014	2013–2014	2013–2014
			(Tonnes)		*(Percentage)*		*(Tonnes)*
Theragra chalcogramma	Alaska pollock (= walleye pollock)	2 860 840	3 239 296	3 214 422	12.4	–0.8	–24 874
Engraulis ringens	Anchoveta (= Peruvian anchovy)	7 329 446	5 674 036	3 140 029	–57.2	–44.7	–2 534 007
Katsuwonus pelamis	Skipjack tuna	2 509 640	2 974 189	3 058 608	21.9	2.8	84 419
Sardinella spp.[1]	Sardinellas nei	2 214 855	2 284 195	2 326 422	5.0	1.8	42 227
Scomber japonicus	Chub mackerel	1 804 820	1 655 132	1 829 833	1.4	10.6	174 701
Clupea harengus	Atlantic herring	2 164 209	1 817 333	1 631 181	–24.6	–10.2	–186 152
Thunnus albacares	Yellowfin tuna	1 284 169	1 313 424	1 466 606	14.2	11.7	153 182
Decapterus spp.[1]	Scads nei	1 389 354	1 414 958	1 456 869	4.9	3.0	41 911
Scomber scombrus	Atlantic mackerel	717 030	981 998	1 420 744	98.1	44.7	438 746
Engraulis japonicus	Japanese anchovy	1 410 105	1 329 311	1 396 312	–1.0	5.0	67 001
Gadus morhua	Atlantic cod	897 266	1 359 399	1 373 460	53.1	1.0	14 061
Trichiurus lepturus	Largehead hairtail	1 311 774	1 258 413	1 260 824	–3.9	0.2	2 411
Sardina pilchardus	European pilchard (= sardine)	1 088 635	1 001 627	1 207 764	10.9	20.6	206 137
Dosidicus gigas	Jumbo flying squid	778 384	847 292	1 161 690	49.2	37.1	314 398
Micromesistius poutassou	Blue whiting (= poutassou)	1 357 086	631 534	1 160 872	–14.5	83.8	529 338
Scomberomorus spp.[1]	Seerfishes nei	834 548	941 741	919 644	10.2	–2.3	–22 097
Illex argentinus	Argentine shortfin squid	446 366	525 402	862 867	93.3	64.2	337 465
Nemipterus spp.[1]	Threadfin breams nei	536 339	581 276	649 700	21.1	11.8	68 424
Cololabis saira	Pacific saury	465 032	428 390	628 569	35.2	46.7	200 179
Portunus trituberculatus	Gazami crab	356 587	503 868	605 632	69.8	20.2	101 764
Acetes japonicus	Akiami paste shrimp	580 147	585 433	556 316	–4.1	–5.0	–29 117
Strangomera bentincki	Araucanian herring	580 805	236 968	543 278	–6.5	129.3	306 310
Sprattus sprattus	European sprat	611 525	394 405	494 619	–19.1	25.4	100 214
Clupea pallasii	Pacific herring	330 017	510 025	478 778	45.1	–6.1	–31 247
Gadus macrocephalus	Pacific cod	373 547	464 367	474 498	27.0	2.2	10 131
Total 25 major species and genera		**34 232 526**	**32 954 012**	**33 319 537**	**–2.7**	**1.1**	**365 525**
WORLD TOTAL		80 793 507	80 963 120	81 549 353	0.9	0.7	586 233
SHARE 25 MAJOR SPECIES AND GENERA (PERCENTAGE)		42.4	40.7	40.9			

Note: nei = not elsewhere included.
[1] Catches for single species have been added to those reported for the genus.

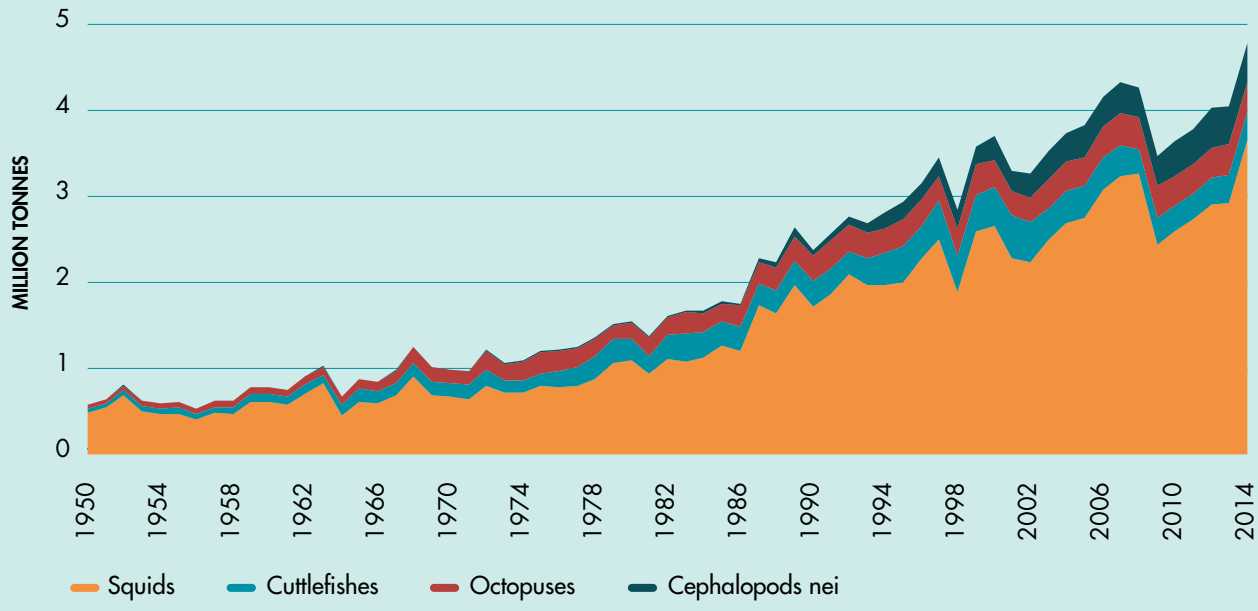
TABLE 4

MARINE CAPTURE PRODUCTION: FAO MAJOR FISHING AREAS

FISHING AREA CODE	FISHING AREA NAME	AVERAGE 2003–2012	2013	2014	VARIATION		
					AVERAGE (2003–2012) –2014	2013–2014	2013–2014
			(Tonnes)		*(Percentage)*		*(Tonnes)*
21	Atlantic, Northwest	2 136 378	1 853 747	1 842 254	–13.8	–0.6	–11 493
27	Atlantic, Northeast	8 969 599	8 454 196	8 654 722	–3.5	2.4	200 526
31	Atlantic, Western Central	1 450 734	1 297 541	1 186 897	–18.2	–8.5	–110 644
34	Atlantic, Eastern Central	3 929 634	4 222 622	4 415 695	12.4	4.6	193 073
37	Mediterranean and Black Sea	1 484 499	1 243 330	1 111 776	–25.1	–10.6	–131 554
41	Atlantic, Southwest	2 021 094	1 974 086	2 419 984	19.7	22.6	445 898
47	Atlantic, Southeast	1 479 746	1 380 608	1 574 838	6.4	14.1	194 230
51	Indian Ocean, Western	4 313 756	4 579 366	4 699 560	8.9	2.6	120 194
57	Indian Ocean, Eastern	6 274 406	7 617 838	8 052 256	28.3	5.7	434 418
61	Pacific, Northwest	20 256 795	21 374 002	21 967 669	8.4	2.8	593 667
67	Pacific, Northeast	2 831 978	3 205 426	3 148 703	11.2	–1.8	–56 723
71	Pacific, Western Central	11 298 748	12 398 778	12 822 230	13.5	3.4	423 452
77	Pacific, Eastern Central	1 825 231	2 024 994	1 907 785	4.5	–5.8	–117 209
81	Pacific, Southwest	642 355	581 852	543 030	–15.5	–6.7	–38 822
87	Pacific, Southeast	11 716 946	8 518 117	6 890 058	–41.2	–19.1	–1 628 059
18, 48, 58, 88	Arctic and Antarctic areas	161 608	236 617	311 896	93.0	31.8	75 279
WORLD TOTAL		80 793 507	80 963 120	81 549 353	0.9	0.7	586 233

FIGURE 5

CATCH TRENDS OF CEPHALOPOD SPECIES GROUPS



» *Continued from page 12*

stable at about 300 000 and 350 000 tonnes, respectively, which represents however a decrease for cuttlefishes and an increase for octopuses compared with previous years.

An increasing number of countries are reporting jellyfish catches, and in most cases in growing quantities. It is not yet clear whether this is due to the development of new fisheries to supply the Asian market or a sign of environmental degradation and a threat to fisheries as jellyfishes compete with fish for food and feed on their larvae.[5]

Table 4 shows catch data by FAO major fishing area. The decline for the Southeast Pacific is due to the drop in anchoveta catches already mentioned above. Other areas with decreasing trends are the Northwest Atlantic, Western Central Atlantic and Southwest Pacific. The situation in the Mediterranean and Black Sea is alarming as catches have dropped by one-third since 2007, a decrease mainly in small pelagics such as anchovy and sardine but one that has also affected most species groups. Fishing areas with increasing trends are the Northwest and Western Central Pacific, as well as both areas in the Indian Ocean. Long-term trends for the Southwest Atlantic are very variable, much influenced by fluctuating catches of Argentine shortfin squid.

Data for 2013 and earlier years for several countries fishing in area 34 (Eastern Central Atlantic) have been revised in the latest version of the FAO global capture database as new information has become available. This has resulted in an increasing trend in both 2013 and 2014, with total catches returning close to the maximum in 2010. A detailed analysis[6] has highlighted a pattern of cycles in historical catches, with time periods ranging from 6 to 13 years, and that the catch share of total capture production by distant-water fishing nations fishing off West Africa fell from 57.5 percent in 1977 to 16.7 percent in 2013.

After a significant decrease from high catches between 1965 and 1989, total capture production in the Southeast Atlantic has been stable at about 1.4 million tonnes per year in the last decade. The bulk of these catches now comes from the EEZs of the three coastal countries (Angola, Namibia and South Africa) as catches of non-tuna species in the high seas have fallen to a few hundred tonnes in recent years.

In the Antarctic fishing areas managed by the Commission for the Conservation of Antarctic Marine Living Resources, catches of krill (*Euphausia superba*) increased substantially up to almost 300 000 tonnes in 2014, a level not reached since the early 1990s, while catches of the highly priced Patagonian toothfish (*Dissostichus eleginoides*) remained stable at about 11 000 tonnes owing to management measures.

Data quality remains a concern for some major producers. Marine catches reported by Indonesia and Myanmar have increased markedly and continuously in the last 20 years. However, the fact that reported capture production did not decline significantly or continued to increase when natural disasters occurred (e.g. the tsunami of December 2004 and Cyclone Nargis in May 2008) made FAO concerned about the reliability of their official statistics. For Indonesia, new estimates, such as those produced by the Indian Ocean Tuna Commission, showed that catches might have been underestimated in the past and, consequently, the increasing trend could also have resulted from a better coverage of the enormous number of scattered landing sites. For Myanmar, recent findings by FAO have shown that official statistics were based on target levels rather than on real data collection. FAO is now in contact with the Myanmar's Department of Fisheries both to run a pilot project to improve data collection in one region (with a view to extending this to the whole country), and to revise together the official capture production figures for the last 10–15 years.

In contrast to the revision of Myanmar data, which is expected to result in lower recorded total catches, improvements to national data collection systems usually produce increased registered catches due to a better system and improved coverage. An FAO Technical Cooperation Programme project is being executed in »

TABLE 5

INLAND WATERS CAPTURE PRODUCTION: MAJOR PRODUCER COUNTRIES

COUNTRY	AVERAGE 2003–2012	2013	2014	VARIATION AVERAGE (2003–2012) –2014	VARIATION 2013–2014	VARIATION 2013–2014
		(Tonnes)		*(Percentage)*		*(Tonnes)*
China	2 215 351	2 307 162	2 295 157	3.6	–0.5	–12 005
Myanmar	772 522	1 302 970	1 381 030	78.8	6.0	78 060
India	968 411	1 226 361	1 300 000 [1]	34.2	6.0	73 639
Bangladesh	967 401	961 458	995 805	2.9	3.6	34 347
Cambodia	375 375	528 000	505 005	34.5	–4.4	–22 995
Uganda	390 331	419 249	461 196	18.2	10.0	41 947
Indonesia	324 509	413 187	420 190	29.5	1.7	7 003
Nigeria	254 264	339 499	354 466	39.4	4.4	14 967
United Republic of Tanzania	307 631	315 007	278 933	–9.3	–11.5	–36 074
Egypt	259 006	250 196	236 992	–8.5	–5.3	–13 204
Brazil	243 170	238 553	235 527	–3.1	–1.3	–3 026
Russian Federation	228 563	262 050	224 854	–1.6	–14.2	–37 196
Democratic Republic of the Congo	225 557	223 596	220 000 [1]	–2.5	–1.6	–3 596
Philippines	168 051	200 974	213 536	27.1	6.3	12 562
Thailand	212 937	210 293	209 800	–1.5	–0.2	–493
Viet Nam	198 677	196 800	208 100	4.7	5.7	11 300
Total 16 major countries	**8 111 756**	**9 395 355**	**9 540 591**	**17.6**	**1.5**	**145 236**
WORLD TOTAL	10 130 510	11 706 049	11 895 881	17.4	1.6	189 832
SHARE 16 MAJOR COUNTRIES (PERCENTAGE)	80.1	80.3	80.2			

[1] FAO estimate.

» collaboration with the Regional Fisheries Committee for the Gulf of Guinea to strengthen fishery data collection systems in five countries in Africa. It has found that Cameroon's existing data collection system did not cover about 13 000 canoes. Estimates of national catches have been introduced to the FAO database to account for the unsampled canoes, including interpolation for an earlier period.

World inland waters capture production

World catches in inland waters were about 11.9 million tonnes in 2014, continuing a positive trend that has resulted in a 37 percent increase in the past decade (Table 5). The bulk of global production is concentrated in only 16 countries, which have annual inland water catches exceeding 200 000 tonnes and together represent 80 percent of the world total.

It is well known that data collection systems for inland water catches in several countries are unreliable or non-existent. This has prompted some experts to propose estimates of global inland catches that are much higher than the figure assembled by FAO, or even greater than marine catches.[7] However, given the limited number of countries with massive inland water catches, the additional millions of tonnes of unreported catches to be added to the current figure of about 12 million tonnes could only come from the top fishing countries.

Nevertheless, all of the top eight countries listed in Table 5 have already significantly increased their reported inland catches in recent years. Moreover, owing to issues of over-reporting in Myanmar (above), a downward revision is expected for its catches.

Some of the major fishing countries in Africa (the United Republic of Tanzania, Egypt and the Democratic Republic of the Congo), Europe/Asia (the Russian Federation) and South America (Brazil) have reported reduced catches in inland waters. Such decreases are not surprising as inland waters are highly affected by pollution, environmental degradation and, due to their limited habitats, resources can be easily overfished. ■

AQUACULTURE PRODUCTION

Total aquaculture production volume and value

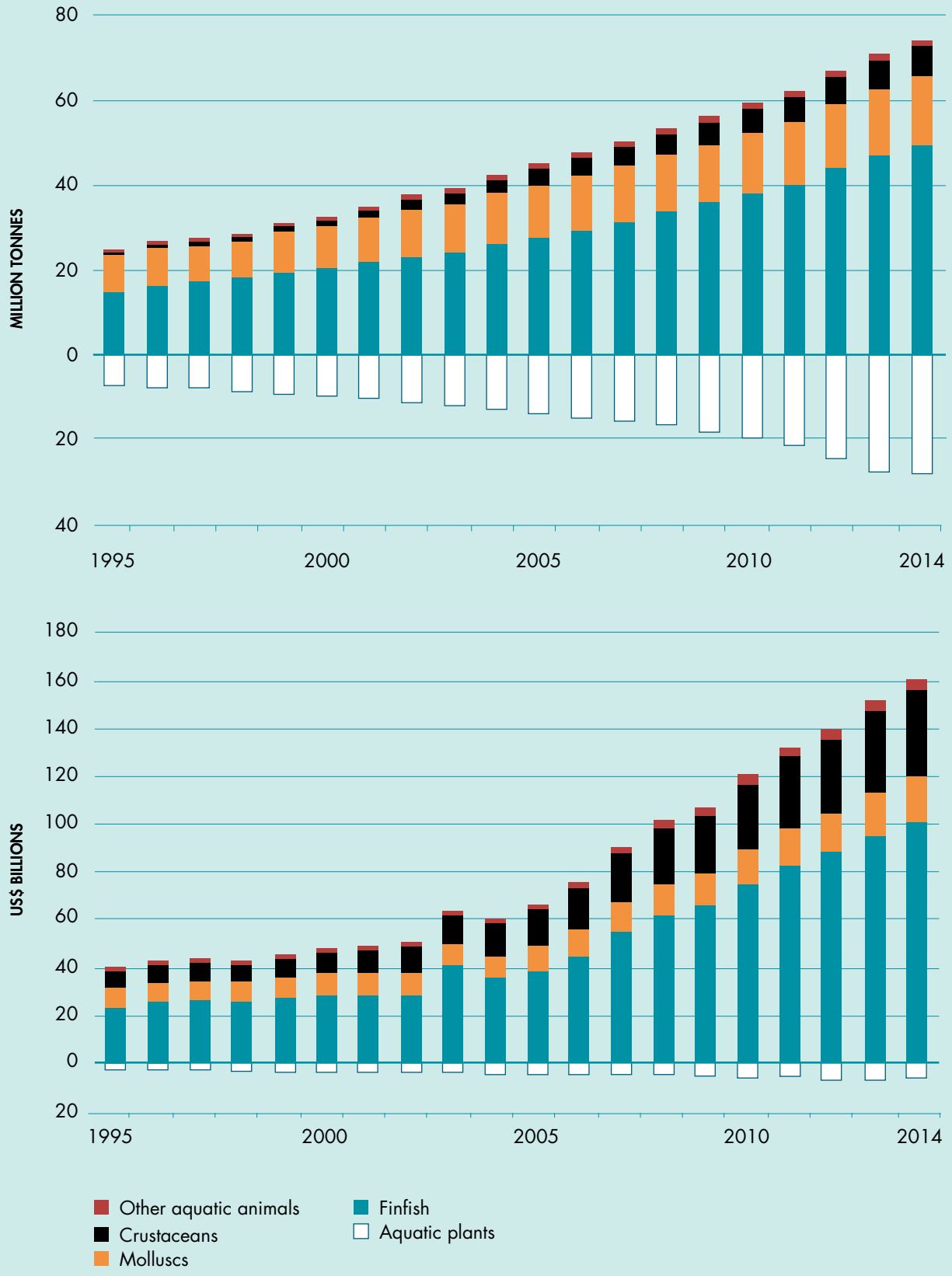
In 2014, fish[8] harvested from aquaculture amounted to 73.8 million tonnes, with an estimated first-sale value of US$160.2 billion, consisting of 49.8 million tonnes of finfish (US$99.2 billion), 16.1 million tonnes of molluscs (US$19 billion), 6.9 million tonnes of crustaceans (US$36.2 billion), and 7.3 million tonnes of other aquatic animals including frogs (US$3.7 billion) (Figure 6). Almost all fish produced from aquaculture are destined for human consumption, although by-products may be used for non-food purposes. Given the practice by some countries of reporting to FAO post-first-sale prices as farmgate prices, the values of aquaculture production are likely to be overstated to some extent. Nonetheless, when used at aggregated levels, the value data illustrate clearly the development trend and the relative importance in value terms for comparison within the aquaculture sector itself.

World aquaculture production of fish accounted for 44.1 percent of total production (including for non-food uses) from capture fisheries and aquaculture in 2014, up from 42.1 percent in 2012 and 31.1 percent in 2004 (Figure 7). All continents have shown a general trend of an increasing share of aquaculture production in total fish production, although in Oceania this share has declined in the last three years.

Continues on page 22 »

FIGURE 6

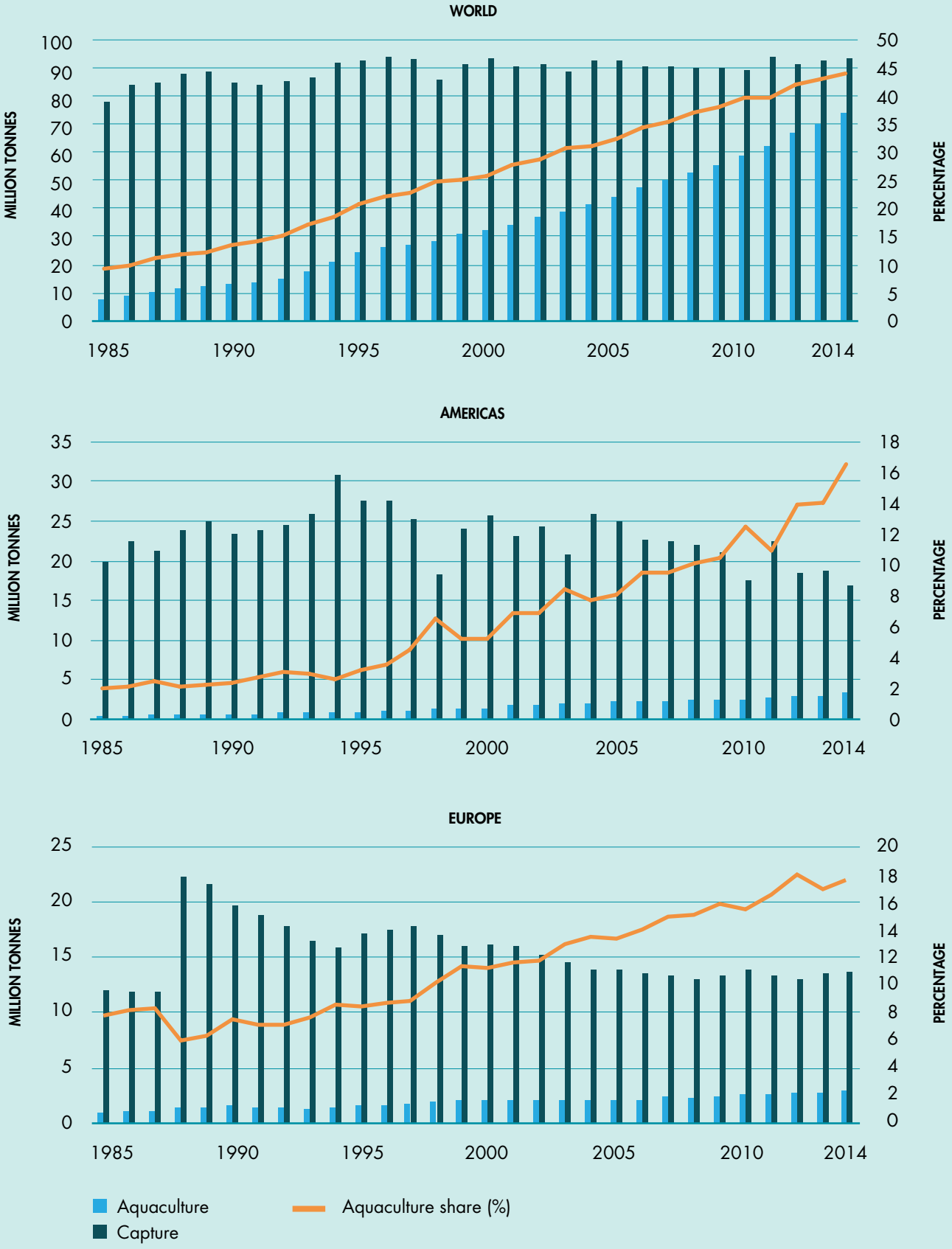
WORLD AQUACULTURE PRODUCTION VOLUME AND VALUE OF AQUATIC ANIMALS AND PLANTS (1995–2014)

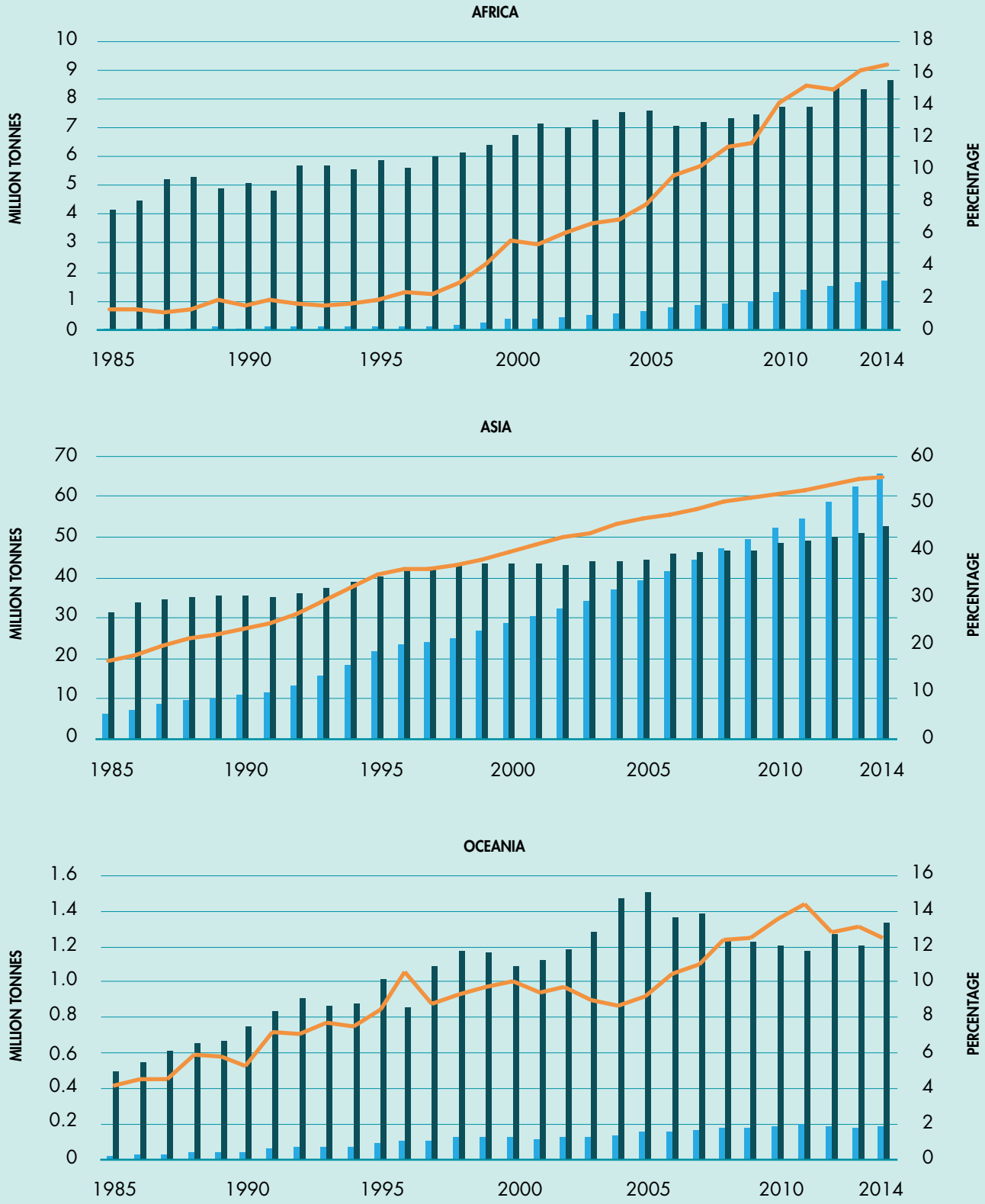


Note: Non-food products, such as seashells and pearls, are excluded.

FIGURE 7

SHARE OF AQUACULTURE IN TOTAL PRODUCTION OF AQUATIC ANIMALS




AFRICA
MILLION TONNES
PERCENTAGE
0
1
2
3
4
5
6
7
8
9
10
0
2
4
6
8
10
12
14
16
18
1985
1990
1995
2000
2005
2010
2014
ASIA
MILLION TONNES
PERCENTAGE
0
10
20
30
40
50
60
70
0
10
20
30
40
50
60
1985
1990
1995
2000
2005
2010
2014
OCEANIA
MILLION TONNES
PERCENTAGE
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
2
4
6
8
10
12
14
16
1985
1990
1995
2000
2005
2010
2014

» *Continued from page 18*

Measured at the national level, 35 countries produced more farmed than wild-caught fish in 2014. This group of countries has a combined population of 3.3 billion, or 45 percent of the world's population. Countries in this group include five major producers, namely, China, India, Viet Nam, Bangladesh, and Egypt. The other 30 countries in this group have relatively well-developed aquaculture sectors, e.g. Greece, the Czech Republic and Hungary in Europe, and the Lao People's Democratic Republic and Nepal in Asia.

In addition to fish production, aquaculture produces considerable quantities of aquatic plants. World aquaculture production of fish and plants combined reached 101.1 million tonnes in live weight in 2014, for an estimated total farmgate value of US$165.8 billion, with farmed aquatic plants contributing 27.3 million tonnes (US$5.6 billion) (Figure 6). Thus, farmed fish constitutes three-quarters of total aquaculture production by volume, and farmed aquatic plants one-quarter, but the latter's share in total aquaculture value is disproportionately low (less than 5 percent).

In terms of global production volume, that of farmed fish and aquatic plants combined surpassed that of capture fisheries in 2013. In terms of food supply, aquaculture provided more fish than capture fisheries for the first time in 2014 (see section Fish consumption, p. 70).

Main groups of species produced

By 2014, a total of 580 species and/or species groups farmed around the world, including those once farmed in the past, had been registered with production data by FAO. These species items include 362 finfishes (including hybrids), 104 molluscs, 62 crustaceans, 6 frogs and reptiles, 9 aquatic invertebrates, and 37 aquatic plants.

In the decade 2005–2014, fish culture production grew at 5.8 percent annually, down from the 7.2 percent achieved in the previous decade (1995–2004). Inland finfish aquaculture, the most common type of aquaculture operation in the world, accounted for 65 percent of the increase in fish production in the period 2005–2014. Inland finfish culture in earthen ponds is by far the largest contributor from aquaculture to food security and nutrition in the developing world, although cage culture of finfish is increasingly being introduced to places where conditions allow. As Table 6 shows, the main groups of species produced from inland aquaculture and marine and coastal aquaculture differ among continents. Overwhelmingly dominated by seaweeds in terms of volume, aquatic plant farming is practised in about 50 countries. It expanded at 8 percent per year in the past decade, up from 6.2 percent in the previous decade, with output more than doubling in this period (Table 7).

Farming of tropical seaweed species (*Kappaphycus alvarezii* and *Eucheuma* spp.) in Indonesia is the major contributor to growth in aquatic plant production in the world. Indonesia increased its annual farmed seaweeds output by more than 10 times, from less than a million tonnes in 2005 to 10 million tonnes in 2014, and its national policy aims to continue this rate of growth. Indonesia's share of world farmed seaweed production increased dramatically from 6.7 percent in 2005 to 36.9 percent in 2014.

The production of microalgae cultivation is poorly reflected in available aquaculture statistics worldwide and significantly understated in FAO's global statistics. For example, *Spirulina* spp. production is reported by only a few countries, and this represents only a small fraction of the real production in the world (Table 7). Large-scale production of *Spirulina* spp. and other microalgae has existed for many years in countries such as Australia, India, Israel, Japan, Malaysia and Myanmar, without production data being reported to FAO.

TABLE 6

PRODUCTION OF MAIN SPECIES GROUPS OF FISH FOR HUMAN CONSUMPTION FROM INLAND AQUACULTURE AND MARINE AND COASTAL AQUACULTURE IN 2014

		INLAND AQUACULTURE	MARINE AND COASTAL AQUACULTURE	TOTAL
			(Tonnes)	
Africa	Finfish	1 682 039	12 814	1 694 853
	Molluscs	–	3 708	3 708
	Crustaceans	7 240	5 108	12 348
	Other animals	–	1	1
	Total Africa	**1 689 279**	**21 631**	**1 710 910**
Americas	Finfish	1 076 073	1 018 460	2 094 533
	Molluscs	–	539 989	539 989
	Crustaceans	63 915	652 610	716 525
	Other animals	567	–	567
	Total Americas	**1 140 555**	**2 211 059**	**3 351 614**
Asia	Finfish	40 319 666	3 388 124	43 707 790
	Molluscs	277 744	14 545 398	14 823 142
	Crustaceans	2 673 159	3 507 019	6 180 178
	Other animals	520 244	370 538	890 782
	Total Asia	**43 790 813**	**21 811 079**	**65 601 892**
Europe	Finfish	477 051	1 820 109	2 297 160
	Molluscs	–	631 789	631 789
	Crustaceans	74	241	315
	Other animals	39	824	863
	Total Europe	**477 164**	**2 452 963**	**2 930 127**
Oceania	Finfish	4 432	63 124	67 556
	Molluscs	149	114 566	114 715
	Crustaceans	–	5 558	5 558
	Other animals	–	1 354	1 354
	Total Oceania	**4 581**	**184 602**	**189 183**
World	Finfish	43 559 260	6 302 631	49 861 891
	Molluscs	277 744	15 835 450	16 113 194
	Crustaceans	2 744 537	4 170 536	6 915 073
	Other animals	520 850	372 718	893 568
	TOTAL WORLD	47 102 391	26 681 334	73 783 725

TABLE 7

PRODUCTION OF FARMED AQUATIC PLANTS IN THE WORLD

	2005	2010	2013	2014
		(Thousand tonnes)		
Kappaphycus alvarezii and *Eucheuma* spp.	2 444	5 629	10 394	10 992
Laminaria japonica	4 371	5 147	5 942	7 655
Gracilaria spp.	936	1 696	3 463	3 752
Undaria pinnatifida	2 440	1 537	2 079	2 359
Porphyra spp.	1 287	1 637	1 861	1 806
Sargassum fusiforme	86	78	152	175
Spirulina spp.	48	97	82	86
Other aquatic plants	1 892	3 172	2 895	482
TOTAL	13 504	18 993	26 868	27 307

FIGURE 8

WORLD AQUACULTURE PRODUCTION OF FED AND NON-FED SPECIES (1995–2014)

Fed and non-fed aquaculture production

Feed is widely regarded as becoming a major constraint to the growth of aquaculture production in many developing countries (Box 1). However, by volume, half of world aquaculture production in 2014, including seaweeds and microalgae (27 percent) and filter-feeding animal species (22.5 percent), was realized without feeding (Figure 8).

The culture of non-fed animal species in 2014 produced 22.7 million tonnes, representing 30.8 percent of world production of all farmed fish species. The most important non-fed animal species include: (i) two finfish species, silver carp and bighead carp, typically in inland aquaculture; (ii) bivalve molluscs (clams, oysters, mussels, etc.); and (iii) other filter-feeding animals (such as sea squirts) in marine and coastal areas.

Europe produced 632 000 tonnes of bivalves in 2014, and its major producers were Spain (223 000 tonnes), France (155 000 tonnes) and Italy (111 000 tonnes). Bivalve culture in China in 2014 was about 12 million tonnes, 5 times that produced by the rest of the world. Other major Asian bivalve producers include Japan (377 000 tonnes), the Republic of Korea (347 000 tonnes) and Thailand (210 000 tonnes).

Growth in production has been faster for fed species than for non-fed species, although production of non-fed species can be more beneficial in terms of food security and the environment. The usually less-costly production of non-fed aquaculture is largely undeveloped in Africa and Latin America, and may offer potential through species diversification to improve national food security and nutrition in those regions. Of the 8.2 million tonnes of world production of filter-feeding finfish produced from inland aquaculture in 2014, China harvested 7.4 million tonnes, and the rest was produced in more than 40 other countries.

Production distribution, per capita production, and major producers

Global coverage of aquaculture production statistics has continued to improve, with a record 200 countries and territories now included in the FAO database. The overall pattern of uneven production distribution among regions and among countries within the same region remains unchanged (Table 8). Asia has accounted for about 89 percent of world aquaculture production of fish for human consumption in the past two decades. Africa and the Americas have improved their respective shares in world total production, while those of Europe and Oceania have dropped slightly.

Aquaculture development has outpaced population growth, resulting in increased per capita aquaculture production in the past three decades in most regions (Figure 9). Asia as a whole has pushed far ahead of other continents in raising per capita farmed fish production for human consumption, but huge differences exist among different geographic regions within Asia.

In 2014, 25 countries recorded aquaculture production in excess of 200 000 tonnes. Collectively, they produced 96.3 percent of farmed fish and 99.3 percent of farmed aquatic plants in the world (Table 9). The species produced, and their relative importance in national total production, vary significantly among the top producers. China remains by far the major producer although its share in world fish production from aquaculture has declined slightly from 65 percent to below 62 percent in the past two decades. ■

BOX 1

FEED PRODUCTION AND MANAGEMENT PRACTICES IN AQUACULTURE

A recent study highlights the need to optimize feed production and on-farm feed management practices in aquaculture.[1] Its analysis is based on country- and species-specific case studies and regional and specialist-subject reviews. Providing fish farmers with well-balanced feed at cost-effective prices is a prerequisite for profitable production. Formulation issues, and in particular the provision of species-specific feeds that meet the nutritional requirements of different life stages of the farmed species, remain important topics for both commercial and farm-made feed production sectors. Many aquafeeds in Asia and Africa are produced either on-farm or by small-scale feed manufacturers. Improvements to the quality and preparation of such feeds should boost productivity and cut costs.

The small-scale production sector is constrained by various factors, including inadequate access to finance, a lack of technical innovation, an absence of feed formulation and processing knowledge, and insufficient training. The development of public–private partnerships with farmers groups or associations to share resources and provide access to improved manufacturing capacity offers great potential. Farmers across many countries and sectors are unaware of the importance of appropriate feed handling and storage techniques. The role of feed management practices in optimizing production parameters needs to be conveyed to farmers. It is necessary to establish the use and efficacy of appropriate feeding systems, and to promote the use of feed tables and feed and production records. Farmers need simple tools to monitor farm production indices (e.g. feed conversion efficiency and growth rate) and training on how to take corrective actions.

In extensive and semi-intensive production systems, there is a need to establish the qualitative and quantitative relationships between natural pond productivity and the impact of supplemental and farm-made feeds on nutrient cycling and retention in the farmed species. Developing a better understanding of these dynamics is central to optimizing feed formulations and reducing feed costs. The implications of feed type, formulation and feed management practices on the environmental footprint and economics of the farming operation are important issues that farmers need to consider when planning their activities. If farmers understand and can quantify the economic inter-relationships between feed type and costs, performance and feed management, they can significantly improve their profitability. Economic tools for this purpose to assist farmers need to be developed.

Poor regulatory control and a lack of standards throughout the aquafeed value chain are constraints to feed supply, quality and use. Appropriate aquafeed policy, regulatory frameworks, and feed standards need to be developed in those countries where they are lacking, and institutional capacity needs strengthening in agencies responsible for aquaculture management, monitoring and compliance. Other issues that need to be addressed are training and the dissemination of information to farmers, particularly small-scale farmers with limited access to the latest technological and management developments. Weak extension and information dissemination networks result in low adoption rates of new feed production technologies and management practices. Consideration should be given to promoting programmes that use local media to provide farmers with extension messages, including, among others: up-to-date feed ingredient availability; quality, price and supplier information; and feed formulation and ingredient inclusion rates.

1 Hasan, M.R. & New, M.B., eds. 2013. *On-farm feeding and feed management in aquaculture*. FAO Fisheries and Aquaculture Technical Paper No. 583. Rome, FAO. 67 pp. Includes a CD–ROM containing the full document (585 pp.). (also available at www.fao.org/docrep/019/i3481e/i3481e00.htm).

TABLE 8

AQUACULTURE PRODUCTION BY REGION AND SELECTED REGIONAL MAJOR PRODUCERS: QUANTITY AND PERCENTAGE OF WORLD TOTAL PRODUCTION

REGIONS AND SELECTED COUNTRIES		1995	2000	2005	2010	2012	2014
Africa	**(thousand tonnes)**	**110.2**	**399.6**	**646.2**	**1 285.6**	**1 484.3**	**1 710.9**
	(percentage)	***0.45***	***1.23***	***1.46***	***2.18***	***2.23***	***2.32***
Egypt	(thousand tonnes)	71.8	340.1	539.7	919.6	1 017.7	1 137.1
	(percentage)	*0.29*	*1.05*	*1.22*	*1.56*	*1.53*	*1.54*
Northern Africa, excluding Egypt	(thousand tonnes)	4.4	4.8	7.1	9.9	13.9	16.9
	(percentage)	*0.02*	*0.01*	*0.02*	*0.02*	*0.02*	*0.02*
Nigeria	(thousand tonnes)	16.6	25.7	56.4	200.5	253.9	313.2
	(percentage)	*0.07*	*0.08*	*0.13*	*0.34*	*0.38*	*0.42*
Sub-Saharan Africa, excluding Nigeria	(thousand tonnes)	17.4	29.0	43.1	155.6	198.8	243.7
	(percentage)	*0.07*	*0.09*	*0.10*	*0.26*	*0.30*	*0.33*
Americas	**(thousand tonnes)**	**919.6**	**1 423.4**	**2 176.9**	**2 514.2**	**2 988.4**	**3 351.6**
	(percentage)	***3.77***	***4.39***	***4.91***	***4.26***	***4.50***	***4.54***
Caribbean	(thousand tonnes)	28.3	39.7	29.9	37.2	28.7	33.2
	(percentage)	*0.12*	*0.12*	*0.07*	*0.06*	*0.04*	*0.05*
Chile	(thousand tonnes)	157.1	391.6	723.9	701.1	1 071.4	1 214.5
	(percentage)	*0.64*	*1.21*	*1.63*	*1.19*	*1.61*	*1.65*
Latin America, excluding Chile	(thousand tonnes)	255.6	407.6	754.6	1 117.0	1 284.6	1 544.2
	(percentage)	*1.05*	*1.26*	*1.70*	*1.89*	*1.93*	*2.09*
North America	(thousand tonnes)	478.7	584.5	668.5	659.0	603.7	559.7
	(percentage)	*1.96*	*1.80*	*1.51*	*1.12*	*0.91*	*0.76*
Asia	**(thousand tonnes)**	**21 677.5**	**28 422.5**	**39 188.2**	**52 439.2**	**58 954.5**	**65 601.9**
	(percentage)	***88.91***	***87.68***	***88.47***	***88.92***	***88.70***	***88.91***
Central Asia	(thousand tonnes)	14.3	6.7	4.0	7.8	15.7	25.5
	(percentage)	*0.06*	*0.02*	*0.01*	*0.01*	*0.02*	*0.03*
China (mainland)	(thousand tonnes)	15 855.7	21 522.1	28 120.7	36 734.2	41 108.3	45 469.0
	(percentage)	*65.03*	*66.39*	*63.48*	*62.29*	*61.85*	*61.62*
Eastern Asia, excluding China (mainland)	(thousand tonnes)	1 549.0	1 371.8	1 555.6	1 572.6	1 532.5	1 545.1
	(percentage)	*6.35*	*4.23*	*3.51*	*2.67*	*2.31*	*2.09*
Indonesia	(thousand tonnes)	641.1	788.5	1 197.1	2 304.8	3 067.7	4 253.9
	(percentage)	*2.63*	*2.43*	*2.70*	*3.91*	*4.62*	*5.77*
Viet Nam	(thousand tonnes)	381.1	498.5	1 437.3	2 670.6	3 084.8	3 397.1
	(percentage)	*1.56*	*1.54*	*3.24*	*4.53*	*4.64*	*4.60*
South-Eastern Asia, excluding Indonesia and Viet Nam	(thousand tonnes)	1 151.7	1 444.4	2 614.9	3 401.0	3 431.7	3 194.8
	(percentage)	*4.72*	*4.46*	*5.90*	*5.77*	*5.16*	*4.33*

TABLE 8

(CONTINUED)

REGIONS AND SELECTED COUNTRIES		1995	2000	2005	2010	2012	2014
Bangladesh	(thousand tonnes)	317.1	657.1	882.1	1 308.5	1 726.1	1 956.9
	(percentage)	*1.30*	*2.03*	*1.99*	*2.22*	*2.60*	*2.65*
India	(thousand tonnes)	1 658.8	1 942.5	2 967.4	3 785.8	4 209.5	4 881.0
	(percentage)	*6.80*	*5.99*	*6.70*	*6.42*	*6.33*	*6.62*
Southern Asia, excluding India and Bangladesh	(thousand tonnes)	*57.1*	*72.8*	*219.7*	*397.5*	483.8	*547.4*
	(percentage)	*0.23*	*0.22*	*0.50*	*0.67*	*0.73*	*0.74*
Western Asia	(thousand tonnes)	51.7	118.0	189.5	256.3	294.5	331.4
	(percentage)	*0.21*	*0.36*	*0.43*	*0.43*	*0.44*	*0.45*
Europe	**(thousand tonnes)**	**1 580.9**	**2 050.7**	**2 134.9**	**2 544.2**	**2 852.3**	**2 930.1**
	(percentage)	***6.48***	***6.33***	***4.82***	***4.31***	***4.29***	***3.97***
Eastern Europe	(thousand tonnes)	183.5	195.9	239.0	251.3	278.6	304.3
	(percentage)	*0.75*	*0.60*	*0.54*	*0.43*	*0.42*	*0.41*
Norway	(thousand tonnes)	277.6	491.3	661.9	1 019.8	1 321.1	1 332.5
	(percentage)	*1.14*	*1.52*	*1.49*	*1.73*	*1.99*	*1.81*
Northern Europe, excluding Norway	(thousand tonnes)	205.6	309.0	327.6	363.5	391.3	402.8
	(percentage)	*0.84*	*0.95*	*0.74*	*0.62*	*0.59*	*0.55*
Southern Europe	(thousand tonnes)	480.6	640.8	541.5	573.5	579.3	595.2
	(percentage)	*1.97*	*1.98*	*1.22*	*0.97*	*0.87*	*0.81*
Western Europe	(thousand tonnes)	433.6	413.7	365.0	336.0	282.0	295.3
	(percentage)	*1.78*	*1.28*	*0.82*	*0.57*	*0.42*	*0.40*
Oceania	**(thousand tonnes)**	**94.2**	**121.5**	**151.5**	**189.6**	**186.0**	**189.2**
	(percentage)	***0.39***	***0.37***	***0.34***	***0.32***	***0.28***	***0.26***
WORLD	(thousand tonnes)	24 382.5	32 417.7	44 297.7	58 972.8	66 465.6	73 783. 7

Notes: Data exclude aquatic plants and non-food products. Data for 2014 include provisional data for some countries and are subject to revisions. For this table, former Sudan and Sudan are included in Northern Africa without being double counted in the custom group of Sub-Saharan Africa Details about countries and territories included in each geographical region for statistics purposes by FAO can be consulted at: UN. 2014. Composition of macro geographical (continental) regions, geographical sub-regions, and selected economic and other groupings. In: *UN* [online]. [Cited 16 March]. http://unstats.un.org/unsd/methods/m49/m49regin.htm.

TABLE 9

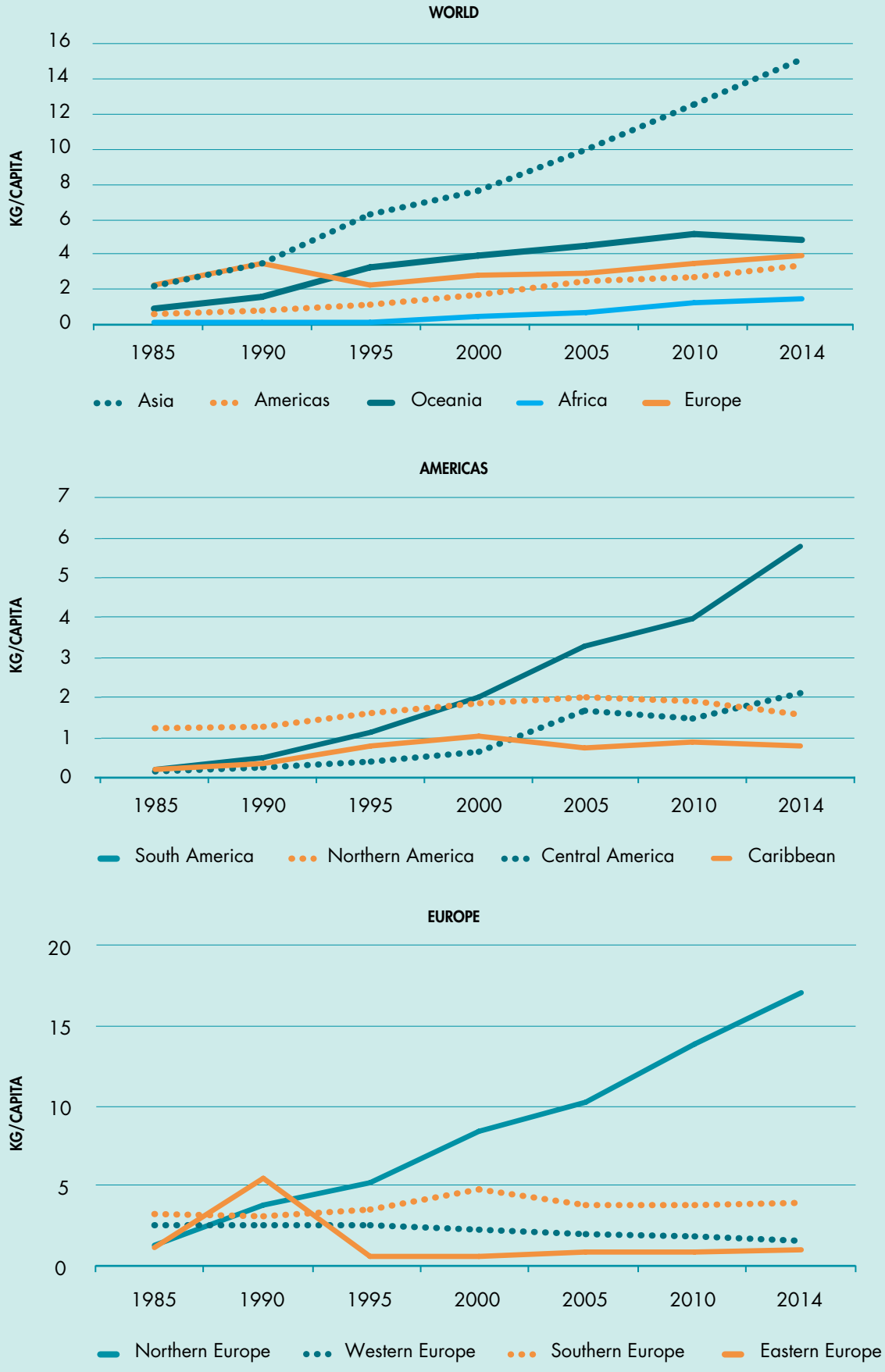
TOP 25 PRODUCERS AND MAIN GROUPS OF FARMED SPECIES IN 2014

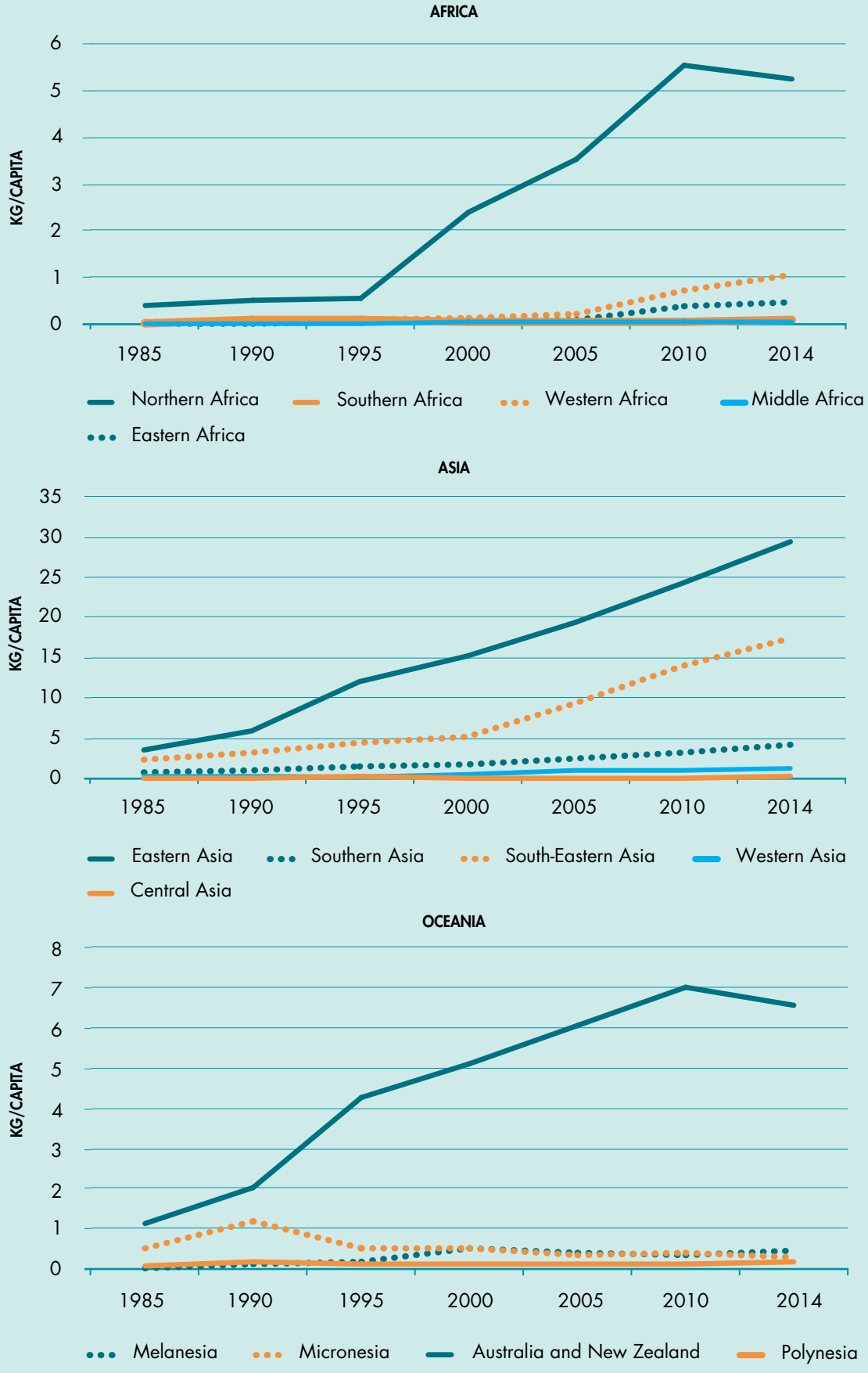
MAJOR PRODUCERS	FINFISH		MOLLUSCS	CRUSTACEANS	OTHER AQUATIC ANIMALS	TOTAL AQUATIC ANIMALS	AQUATIC PLANTS	TOTAL AQUACULTURE PRODUCTION
	INLAND AQUACULTURE	MARINE/ COASTAL AQUACULTURE						
	(Thousand tonnes)							
China	26 029.7	1 189.7	13 418.7	3 993.5	839.5	**45 469.0**	13 326.3	**58 795.3**
Indonesia	2 857.6	782.3	44.4	613.9	0.1	**4 253.9**	10 077.0	**14 330.9**
India	4 391.1	90.0	14.2	385.7	...	**4 881.0**	3.0	**4 884.0**
Viet Nam	2 478.5	208.5	198.9	506.2	4.9	**3 397.1**	14.3	**3 411.4**
Philippines	299.3	373.0	41.1	74.6	...	**788.0**	1 549.6	**2 337.6**
Bangladesh	1 733.1	93.7	...	130.2	...	**1 956.9**	...	**1 956.9**
Republic of Korea	17.2	83.4	359.3	4.5	15.9	**480.4**	1 087.0	**1 567.4**
Norway	0.1	1 330.4	2.0	...	...	**1 332.5**	...	**1 332.5**
Chile	68.7	899.4	246.4	...	...	**1 214.5**	12.8	**1 227.4**
Egypt	1 129.9	...	...	7.2	...	**1 137.1**	...	**1 137.1**
Japan	33.8	238.7	376.8	1.6	6.1	**657.0**	363.4	**1 020.4**
Myanmar	901.9	1.8	...	42.8	15.6	**962.2**	2.1	**964.3**
Thailand	401.0	19.6	209.6	300.4	4.1	**934.8**	...	**934.8**
Brazil	474.3	...	22.1	65.1	0.3	**561.8**	0.7	**562.5**
Malaysia	106.3	64.3	42.6	61.9	0.6	**275.7**	245.3	**521.0**
Democratic People's Republic of Korea	3.8	0.1	60.2	...	0.1	**64.2**	444.3	**508.5**
United States of America	178.3	21.2	160.5	65.9	...	**425.9**	...	**425.9**
Ecuador	28.2	0.0	...	340.0	...	**368.2**	...	**368.2**
Taiwan Province of China	117.3	97.8	99.0	21.9	3.6	**339.6**	1.0	**340.6**
Iran (Islamic Republic of)	297.5	0.1	...	22.5	...	**320.2**	...	**320.2**
Nigeria	313.2	...	...	...	...	**313.2**	...	**313.2**
Spain	15.5	44.0	222.5	0.2	0.0	**282.2**	0.0	**282.2**
Turkey	108.2	126.1	...	...	0.1	**234.3**	...	**234.3**
United Kingdom	13.5	167.3	23.8	...	...	**204.6**	...	**204.6**
France	43.5	6.0	154.5	0.0	...	**204.0**	0.3	**204.3**
TOP 25 SUBTOTAL	42 041.2	5 837.5	15 696.7	6 638.3	890.9	**71 058.2**	27 127.2	**98 185.4**
WORLD	**43 559.3**	**6 302.6**	**16 113.2**	**6 915.1**	**893.6**	**73 783.7**	**27 307.0**	**101 090.7**
PERCENTAGE OF TOP 25 IN WORLD TOTAL	96.5	92.6	97.4	96.0	99.7	**96.3**	99.3	**97.1**

Note: ... = production data not available or production negligible.

FIGURE 9

PER CAPITA PRODUCTION OF AQUACULTURE (EXCLUDING AQUATIC PLANTS)




AFRICA
KG/CAPITA
6
5
4
3
2
1
0
1985
1990
1995
2000
2005
2010
2014
Northern Africa
Southern Africa
Western Africa
Middle Africa
Eastern Africa
ASIA
KG/CAPITA
35
30
25
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1985
1990
1995
2000
2005
2010
2014
Eastern Asia
Southern Asia
South-Eastern Asia
Western Asia
Central Asia
OCEANIA
KG/CAPITA
8
7
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1985
1990
1995
2000
2005
2010
2014
Melanesia
Micronesia
Australia and New Zealand
Polynesia

FISHERS AND FISH FARMERS

Many millions of people around the world find a source of income and livelihood in the fisheries and aquaculture sector. The most recent estimates (Table 10) indicate that 56.6 million people were engaged in the primary sector of capture fisheries and aquaculture in 2014. Of this total, 36 percent were engaged full time, 23 percent part time, and the remainder were either occasional fishers or of unspecified status.

For the first time since the period 2005–2010, the total engagement in fisheries and aquaculture did not increase. Overall employment in the sector decreased, almost entirely due to a decrease of about 1.5 million fishers, while engagement in aquaculture remained more stable. Consequently, the proportion of those employed in capture fisheries within the fisheries and aquaculture sector decreased from 83 percent in 1990 to 67 percent in 2014, while that of those employed in fish farming correspondingly increased from 17 to 33 percent.

The slight decrease in employment appears to signal a stabilization in engagement in the sector. Small-scale operations continue to play a critical role in supporting livelihoods, particularly rural livelihoods, contributing to food security and alleviating poverty. By the nature of small-scale operators' engagement, it is a challenge to accurately account for their participation, which is typically characterized by part-time engagement in multiple sectors, mixed and dynamic temporal engagement (seasonal, occasional or part-time), and with operations in scattered and often remote locations. Moreover, the contributions of small-scale operators are often of greater importance to food security than economic accounting would indicate. Efforts to improve data availability and statistics in support of blue growth and advice on best practice, such as the Guidelines to Enhance Fisheries and Aquaculture Statistics through a Census Framework,[9] should improve reporting by encouraging countries to enhance reporting on small-scale operations through census and survey questionnaires. Greater focus on the socio-economic contributions of even occasional engagement rather than on purely economic contributions should help encapsulate more of the people who engage in the sector.

In 2014, 84 percent of the global population engaged in the fisheries and aquaculture sector was in Asia, followed by Africa (almost 10 percent), and Latin America and the Caribbean (4 percent). More than 18 million (33 percent of all people employed in the sector) were engaged in fish farming, concentrated primarily in Asia (94 percent of all aquaculture engagement), followed by Latin America and the Caribbean (1.9 percent of the total or 3.5 million people) and Africa (1.4 percent of the total or 2.6 million people).

In the past 20 years, the trends in the number of people engaged in fisheries and aquaculture primary sector have varied by region. Table 11 presents the engagement statistics for selected countries, including China, where growth seems to have peaked with more than 14 million people (25 percent of the world total) engaged as fishers (9 million, or 24 percent of the world total) and fish farmers (5 million, or 27 percent of the world total). Europe and North America have experienced the largest proportional decreases in the number of people engaged in capture fishing, and little increase or even a decrease in those engaged in fish farming (Table 10), resembling trends in production from capture fishing and aquaculture. In contrast, Africa and Asia, with higher population growth and increasing economically active populations in the agriculture sector, have shown sustained increases in the number of people engaged in capture fishing and even higher rates of increase in those engaged in fish farming. These trends in engagement also correspond to sustained increases in production from

TABLE 10

WORLD FISHERS AND FISH FARMERS BY REGION

	2000	2005	2010	2012	2013	2014
			(Thousands)			
Africa	4 175	4 430	5 027	5 885	6 009	5 674
Asia	39 646	43 926	49 345	49 040	47 662	47 730
Europe	779	705	662	647	305	413
Latin America and the Caribbean	1 774	1 907	2 185	2 251	2 433	2 444
North America	346	329	324	323	325	325
Oceania	126	122	124	127	47	46
WORLD	46 845	51 418	57 667	58 272	56 780	56 632
OF WHICH, FISH FARMERS						
Africa	91	140	231	298	279	284
Asia	12 211	14 630	17 915	18 175	18 098	18 032
Europe	103	91	102	103	77	66
Latin America and the Caribbean	214	239	248	269	350	356
North America	6	10	9	9	9	9
Oceania	5	5	5	6	5	6
WORLD	12 632	15 115	18 512	18 861	18 818	18 753

capture fisheries and even more so from aquaculture for the regions.

The Latin America and Caribbean region stands somewhere between the trends described above, with a decreasing population growth, a decreasing economically active population in the agriculture sector in the last decade, moderately growing employment in the fisheries sector, decreasing capture production and rather high sustained aquaculture production. However, the region's vigorously growing aquaculture production may not result in an equally vigorously growing number of employed fish farmers as several of the important organisms cultivated in the region are aimed at satisfying highly competitive foreign markets, thus requiring a focus on efficiency, quality and lower costs and greater reliance on technological developments rather than human labour.

In general, employment in fishing continues to decrease in countries with capital-intensive economies, in particular in most European countries, North America and Japan. For example, in the period 1995–2014, the number of people employed in marine fishing decreased by 2 400 in Iceland, 128 000 in Japan, and 13 000 in Norway. Factors that may account for this include policies to cut fleet overcapacity and less dependence on human work owing to technological developments and associated increased efficiencies.

In the period 2005–2014, the quality and frequency of reporting on engagement by gender improved slowly. Table 12 presents gender-disaggregated employment statistics for selected countries. It is estimated that, overall, women accounted for more than 19 percent of all people directly engaged in the fisheries and aquaculture primary sector in 2014. A recent publication estimates that, globally, when primary and secondary fishery sector engagement are combined, women make up half of the workforce.[10] As reporting improves and policies directed at increasing decision-making capacities of women in the sector develop, it is expected that both reporting and actual engagement of women in the sector will increase. The work women engage in is often low-paid or unpaid with unofficial status, and this is a barrier to access to financial resources and policy support for these women. Enhanced statistics for both industrial and small-scale operators, together with data on the secondary post-harvest and service sectors, would greatly improve the understanding of importance of women's contribution to fisheries and aquaculture, food security and livelihoods. ■

TABLE 11

NUMBER OF FISHERS AND FISH FARMERS IN SELECTED COUNTRIES AND TERRITORIES

	FISHERY		2000	2005	2010	2012	2013	2014
World	**FI + AQ**	**(thousands)**	**46 845**	**51 418**	**57 667**	**58 272**	**56 780**	**56 632**
		(index)	***91***	***100***	***112***	***113***	***110***	***110***
	FI	(thousands)	34 213	36 304	39 155	39 412	37 962	37 879
		(index)	*94*	*100*	*108*	*109*	*105*	*104*
	AQ	(thousands)	12 632	15 115	18 512	18 861	18 818	18 753
		(index)	*84*	*100*	*122*	*125*	*125*	*124*
China	**FI + AQ**	**(thousands)**	**12 936**	**12 903**	**13 992**	**14 441**	**14 282**	**14 161**
		(index)	***100***	***100***	***108***	***112***	***111***	***110***
	FI	(thousands)	9 213	8 389	9 013	9 226	9 090	9 036
		(index)	*110*	*100*	*107*	*110*	*108*	*108*
	AQ	(thousands)	3 722	4 514	4 979	5 214	5 192	5 124
		(index)	*82*	*100*	*110*	*116*	*115*	*114*
Taiwan Province of China	FI + AQ	(thousands)	314	352	330	329	374	331
		(index)	*89*	*100*	*94*	*93*	*106*	*94*
	FI	(thousands)	217	247	247	238	285	244
		(index)	*88*	*100*	*100*	*97*	*115*	*99*
	AQ	(thousands)	98	105	84	90	89	87
		(index)	*93*	*100*	*79*	*86*	*85*	*83*
Iceland	**FI**	**(thousands)**	**6.1**	**5.1**	**5.3**	**4.9**	**4.0**	**4.6**
		(index)	***120***	***100***	***104***	***96***	***78***	***90***
Indonesia	**FI + AQ**	**(thousands)**	**5 248**	**5 097**	**5 972**	**6 093**	**5 984**	**6 011**
		(index)	***103***	***100***	***117***	***120***	***117***	***118***
	FI	(thousands)	3 105	2 590	2 620	2 749	2 640	2 667
		(index)	*120*	*100*	*101*	*106*	*102*	*103*
	AQ	(thousands)	2 143	2 507	3 351	3 344	3 344	3 344
		(index)	*85*	*100*	*134*	*133*	*133*	*133*
Japan	**FI**	**(thousands)**	**260**	**222**	**203**	**174**	**181**	**173**
		(index)	***117***	***100***	***91***	***78***	***82***	***78***
Mexico	**FI + AQ**	**(thousands)**	**262**	**279**	**272**	**266**	**273**	**271**
		(index)	***94***	***100***	***97***	***95***	***98***	***97***
	FI	(thousands)	244	256	241	210	216	215
		(index)	*96*	*100*	*94*	*82*	*84*	*84*
	AQ	(thousands)	18	24	31	56	56	56
		(index)	*78*	*100*	*131*	*239*	*234*	*234*
Morocco	**FI**	**(thousands)**	**106**	**106**	**107**	**114**	**103**	**110**
		(index)	***100***	***100***	***102***	***108***	***98***	***103***
Norway	**FI + AQ**	**(thousands)**	**24**	**19**	**19**	**18**	**18**	**18**
		(index)	***130***	***100***	***99***	***96***	***93***	***93***
	FI	(thousands)	20	15	13	12	12	11
		(index)	*138*	*100*	*89*	*83*	*77*	*75*
	AQ	(thousands)	4.3	4.2	5.5	5.9	6.0	6.3
		(index)	*102*	*100*	*131*	*139*	*142*	*151*

Note: FI = fishing; AQ = aquaculture; index 2005 = 100.

TABLE 12

GENDER-DISAGGREGATED ENGAGEMENT IN SELECTED COUNTRIES

COUNTRY	GENDER	2010	2011	2012	2013	2014
				(Thousands)		
Australia	Female	1.2	2.2	1.0	1.3	1.3
	Male	10.2	9.4	9.6	7.3	7.4
Chile	Female	15.7	21.3	22.5	23.7	29.4
	Male	66.5	92.4	95.8	88.9	87.3
Japan	Female	30.0	25.2	24.4	23.9	22.6
	Male	172.9	152.7	149.3	157.1	150.5
Mauritius	Female	1.1	1.0	1.0	1.1	1.1
	Male	28.1	28.1	28.1	28.2	28.3
Saint Lucia	Female	0.0	0.1	0.1	0.2	0.2
	Male	2.5	2.5	2.6	2.7	2.8
Sri Lanka	Female	17.6	20.9	16.5	10.7	14.2
	Male	218.9	248	243.4	257.3	276.5

THE STATUS OF THE FISHING FLEET

Estimate of global fleet and its regional distribution

The total number of fishing vessels in the world in 2014 is estimated at about 4.6 million (Table 13). The fleet in Asia was the largest, consisting of 3.5 million vessels and accounting for 75 percent of the global fleet, followed by Africa (nearly 15 percent), Latin America and the Caribbean (6 percent), North America (2 percent) and Europe (2 percent).

Globally, 64 percent of reported fishing vessels were engine-powered in 2014 (57 percent in 2012). However, rather than representing a shift in the composition of the fishing fleet, this figure more probably reflects a temporary decline in reporting quality on non-motorized vessels. Generally, the motorization ratio is much higher in marine-operating vessels than in the inland fleet. However, data reporting was not of sufficient quality to allow disaggregation of marine and inland fisheries. Figure 10 shows the regional distribution and proportion of motorized and non-motorized vessels. The motorized fleet is distributed unevenly around the world; Asia has 80 percent of the reported motorized fleet, with the remaining regions all having under 10 percent each (Figure 11).

Size distribution of vessels and the importance of small boats

In 2014, about 85 percent of the motorized fishing vessels in the world were less than 12 m in length overall (LOA), and such small vessels dominated in all regions (Figure 12). About 2 percent of all motorized fishing vessels were 24 m LOA or longer (roughly more than 100 gross tonnage), and that fraction was larger in the regions of Pacific and Oceania, Europe, and North America. The estimated number of fishing vessels of 24 m LOA or longer operating in marine waters was about 64 000.[11] However, the number of fishing vessels registered with a unique identification number provided by the International Maritime Organization (IMO),[12] a prerequisite for their inclusion in the Global Record of Fishing Vessels,[13] remains about 23 000.

The dominance of small vessels (less than 12 m LOA) is higher in inland water fisheries, where they have been estimated to represent more than 91 percent of all motorized vessels.[14] Estimations of the relative importance of the small-scale sector are likely to be skewed owing to an inadequate appraisal of the segment. Often, small vessels are not subject to registration as larger vessels are, but even when registered they may not be reported in national statistics. The lack of information and reporting is more acute for

Continues on page 38 »

TABLE 13

TOTAL OF FISHING FLEETS BY REGION, 2014 (POWERED AND NON-POWERED VESSELS COMBINED)

	VESSELS	PERCENTAGE OF TOTAL
	(Thousands)	
WORLD	4 606.0	
Africa	679.2	14.7
Asia	3 459.5	75.1
Europe	95.5	2.1
Latin America and the Caribbean	276.2	6.0
North America	87.0	1.9
Oceania	8.6	0.2

FIGURE 10

PROPORTION OF MARINE FISHING VESSELS WITH AND WITHOUT ENGINE BY REGION IN 2014

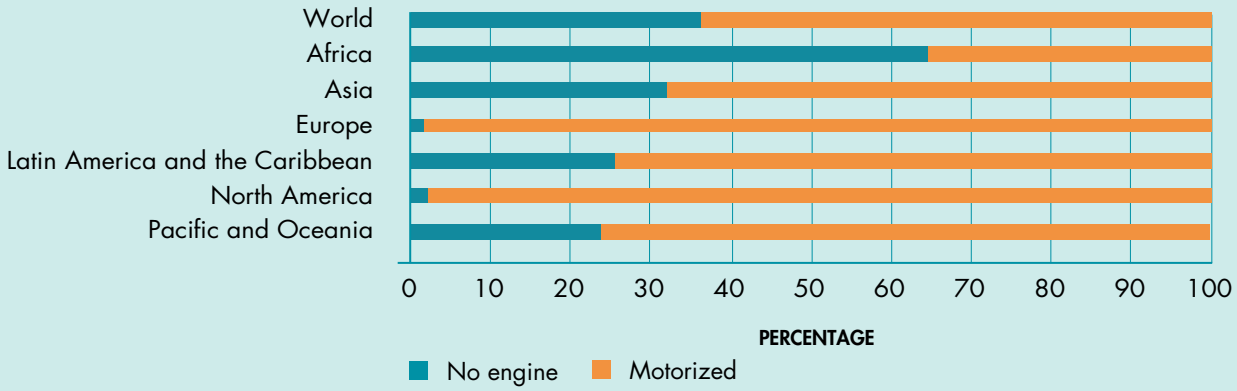


FIGURE 11

DISTRIBUTION OF MOTORIZED FISHING VESSELS BY REGION IN 2014

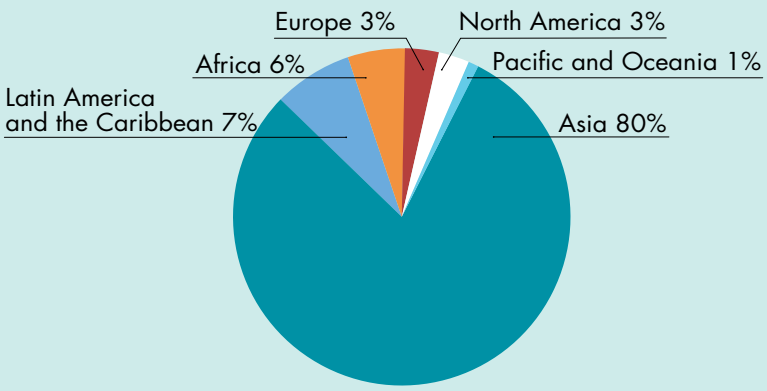


FIGURE 12

SIZE DISTRIBUTION OF MOTORIZED FISHING VESSELS BY REGION IN 2014

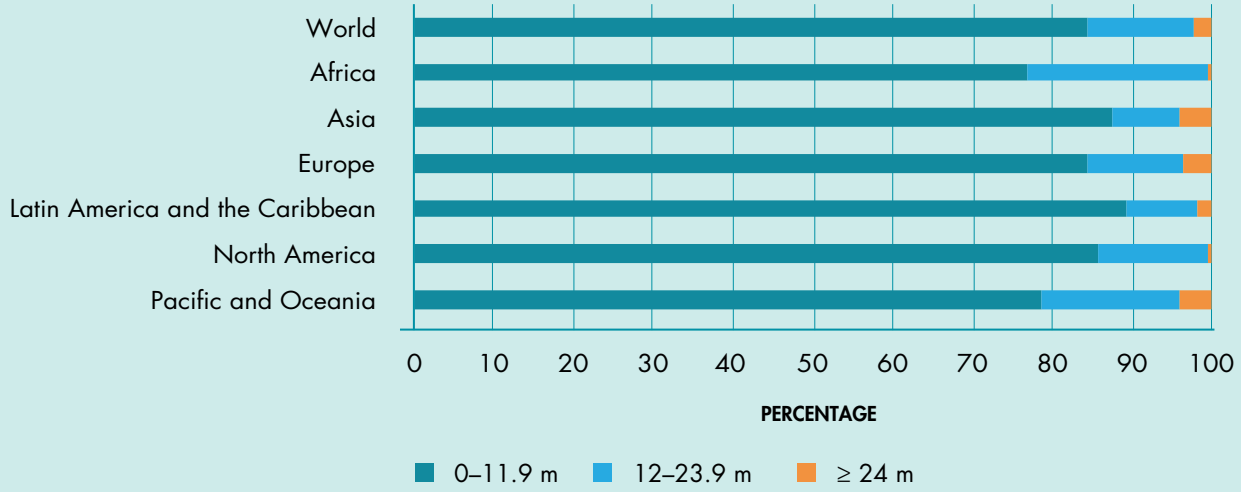


TABLE 14

NUMBERS AND PROPORTION IN TERMS OF LENGTH OF MOTORIZED VESSELS IN FISHING FLEETS FROM SELECTED REGIONS, COUNTRIES AND TERRITORIES

FLAG	DATE OF DATA[1]	POWERED VESSELS	VESSEL LENGTH CATEGORY		
			0–11.9 m	12–23.9 m	≥ 24 m
		(Number)		*(Percentage)*	
Algeria	2014	4 777	69.3	28.5	2.2
Angola	2014	3 815	93.7	2.8	3.5
El Salvador	2014	6 717	99.2	0.7	0.1
Europe, selected countries[2]	2014	93 372	84.3	12.0	3.7
French Polynesia	2014	4 010	98.5	1.4	0.1
Grenada	2014	722	89.9	10.1	0.0
Mexico	2014	75 741	97.4	2.2	0.4
Myanmar	2014	15 224	83.4	12.0	4.6
Oman	2014	18 585	96.0	3.8	0.2
Tonga	2014	816	96.9	2.1	1.0
Uruguay	2014	505	87.9	4.4	7.7

[1] Data sources from response to FAO questionnaires, except for Europe, selected countries.
[2] Data combined from country reporting and: European Commission. 2016. Fleet Register On the NeT. In: *Europa* [online]. [Cited 15 January 2016]. http://ec.europa.eu/fisheries/fleet/index.cfm?method=Download.menu

» *Continued from page 35*

inland fleets, which often entirely fall outside national or local registries. Figure 12 shows the distribution of small motorized vessels regionally, while Table 14 shows the numbers of motorized vessels and their length distribution for selected countries and regions. The smallest length class dominates for all selected countries and regions, ranging from 99 percent for El Salvador to about 70 percent for Algeria. ■

THE STATUS OF FISHERY RESOURCES

Marine fisheries

The world's marine fisheries expanded continuously to a production peak of 86.4 million tonnes in 1996 but have since exhibited a general declining trend. Global recorded production was 80.9 million tonnes in 2013. Of the FAO Major Fishing Areas,[15] the Northwest Pacific had the highest production with 21.4 million tonnes (27 percent of the global marine catch) in 2013, followed by the Western Central Pacific with 12.4 million tonnes (15 percent), the Southeast Pacific with 8.9 million tonnes (11 percent), and the Northeast Atlantic with 8.4 million tonnes (10 percent).

Based on FAO's analysis of assessed stocks,[16] the share of fish stocks within biologically sustainable levels has exhibited a downward trend, declining from 90 percent in 1974 to 68.6 percent in 2013 (Figure 13). Thus, 31.4 percent of fish stocks were estimated as fished at a biologically unsustainable level and therefore overfished. Of all the stocks assessed in 2013, 58.1 percent were fully fished and 10.5 percent underfished (separated by the line in Figure 13). The share of underfished stocks decreased almost continuously from 1974 to 2013, but that of fully fished stocks decreased from 1974 to 1989 before rising to 58.1 percent in 2013. Correspondingly, the percentage of stocks fished at biologically unsustainable levels increased, especially in the late 1970s and 1980s, from 10 percent in 1974 to 26 percent in 1989. After 1990, the number of stocks fished at unsustainable levels continued to increase, albeit more slowly, to 31.4 percent in 2013.

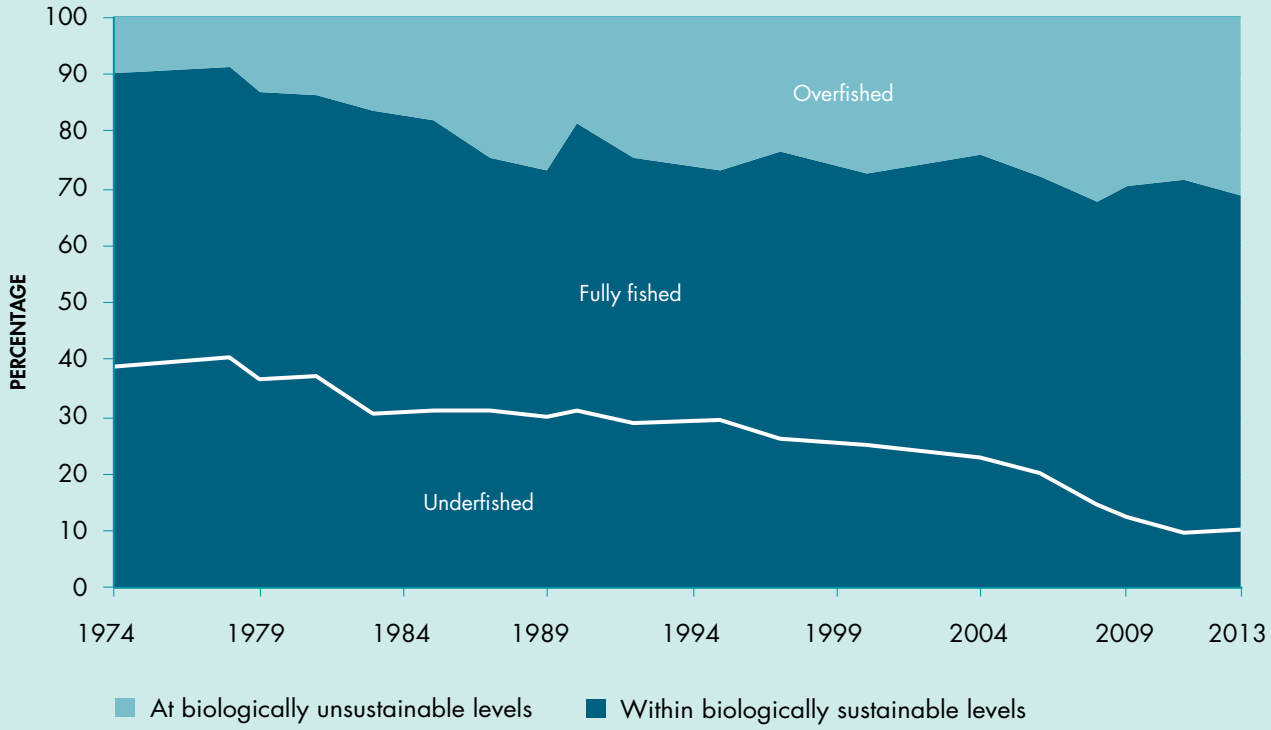
Sustainability of fisheries is the over-riding goal of fisheries management (see Box 2). By a commonly accepted definition, stocks fished at biologically unsustainable levels have an abundance lower than the level that can produce the maximum sustainable yield (MSY), and are therefore being overfished. These stocks require strict management plans to rebuild stock abundance to full and biologically sustainable productivity. The stocks fished within biologically sustainable levels have abundance at or above the level associated with MSY. Stocks fished at the MSY level produce catches that are at or very close to their MSY. Therefore, they have no room for further expansion in catch, and effective management must be in place to sustain their MSY. The stocks with a biomass considerably above the MSY level (underfished stocks) have been exposed to relatively low fishing pressure and may have some potential to increase their production. In accordance with the Code of Conduct for Responsible Fisheries (the Code), and to avoid overfishing, effective and precautionary management plans should be established before increasing the fishing rate of these underfished stocks.

Fishery production varies greatly among species. The ten most productive species accounted for about 27 percent of world's marine capture fisheries production in 2013. Most of their stocks are fully fished and, therefore, have no potential for increases in production, while some stocks are overfished and increases in their production may be possible only after their successful restoration. The two main stocks of anchoveta in the Southeast Pacific, Alaska pollock (*Theragra chalcogramma*) in the North Pacific, and Atlantic herring (*Clupea harengus*) stocks in both the Northeast and Northwest Atlantic are all fully fished.

Atlantic cod (*Gadus morhua*) is overfished in the Northwest Atlantic, but fully fished to overfished in the Northeast Atlantic. Chub mackerel

FIGURE 13

GLOBAL TRENDS IN THE STATE OF WORLD MARINE FISH STOCKS SINCE 1974



Notes: Dark shading = within biologically sustainable levels; light shading = at biologically unsustainable levels. The light line divides the stocks within biologically sustainable levels into two subcategories: fully fished (above the line) and underfished (below the line).

(*Scomber japonicus*) stocks are fully fished in the Eastern Pacific and overfished in the Northwest Pacific. Skipjack tuna (*Katsuwonus pelamis*) stocks are either fully fished or underfished.

The total catch of tuna and tuna-like species was about 7.4 million tonnes (9 percent of the global catch) in 2013. The principal market tuna species – albacore, bigeye, bluefin (three species), skipjack and yellowfin – contributed 5.1 million tonnes in 2013, an increase of half a million tonnes over the two years. About 70 percent of these catches were from the Pacific. Skipjack was the most productive principal market tuna, contributing about 66 percent to the 2013 catch of principal tunas, followed by yellowfin and bigeye (about 26 and 10 percent, respectively).

Among the seven principal tuna species, 41 percent of the stocks were estimated as fished at biologically unsustainable levels, while 59 percent were fished within biologically sustainable levels (fully fished or underfished) in 2013. The landings of skipjack tuna have continued to increase over time, reaching 3.0 million tonnes in 2013. Only for very few stocks of the principal tuna species is their status unknown or very poorly known. Market demand for tuna is still high, and the significant overcapacity of tuna fishing fleets remains. There is a need for effective management to restore the overfished stocks.

World marine fisheries have undergone significant changes since the 1950s. Accordingly, their fishing levels and landings have also varied. The temporal pattern of landings differs from area to area depending on the level of urban and economic development and changes that countries in the surrounding area have experienced. In general, area catches can be divided into three groups: (i) oscillating around a globally stable value; (ii) overall decline following historical peaks; and (iii) continuously increasing trend since 1950.

The first group comprises the Eastern Central Atlantic, Northeast Pacific, Eastern Central Pacific, Southwest Atlantic, Southeast Pacific, and Northwest Pacific. These areas provided about 47 percent of the world's total marine catch in 2013. Several of them include upwelling regions characterized by high natural variability. About 70 percent of fish stocks in this group are fished within biologically sustainable levels.

The second group contributed 21 percent of the global marine catch in 2013, and includes the

Continues on page 42 »

BOX 2

FISHERIES SUSTAINABILITY AND SEAFOOD GUIDES

Defining sustainability

The sustainability of fisheries production is crucial to the livelihoods, food security and nutrition of billions of people. National governments and international organizations such as regional fisheries management organizations and FAO devote considerable resources to trying to ensure the sustainability of fish resources. Moreover, non-governmental organizations, agencies and retailers are increasingly trying to inform consumers, through labelling, as to whether products come from a sustainable fishery. This consumer advice can function both as a reward for well-managed fisheries, and as a lever to improve fisheries management. However, consensus is lacking on a definition of what constitutes fisheries sustainability. The most widely accepted definition comes from the World Commission on Environment and Development: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[1]

The United Nations defines "three pillars" of sustainability: social, economic and environmental.[2] There is general agreement that sustainability is about continuing to produce the benefits to society that natural systems provide in the long term. Actions that decrease the ability of systems to do so are not sustainable. However, the clear emphasis is on producing benefits to society; in terms of fisheries, these are primarily food, employment, income and nutrition. In addition to these, the social aspects of sustainability include maintenance of fishing communities, equity in income and gender, and basic human rights. Thus, the first aspect of sustainability is benefits to society.

For fisheries policy and management purposes, the concept of maximum sustainable yield (MSY) is well established (e.g. in the United Nations Convention on the Law of the Sea, the UN Fish Stocks Agreement and the FAO Code of Conduct for Responsible Fisheries [the Code]). Management objectives are commonly to maintain fishing mortality at or below levels associated with MSY and ensure stock abundance is also at least at the MSY level. The MSY concept is useful in tackling, for example, overfishing and stock depletion. However, it commonly ignores multispecies and ecosystem interactions (whether biological or due to fishing) as well as social and economic considerations. Thus, it has its limitations.

The second major issue is how to measure sustainability and be able to examine a fishery and determine whether it is sustainable. There are two general approaches. The first measures the state of the system:

- Are fish abundant?
- Is nutrition good?
- Are incomes from fishing allowing families to prosper?

The second looks at the management of the system:

- Does the management system change management actions as the state of the system changes?
- If stocks decline, can the management system reduce fishing pressure and allow recovery?
- If incomes are poor, can management actions increase incomes?

A common method for assessing sustainability is to monitor the abundance of fish stocks – high abundance is sustainable, low abundance is not. However, fish stocks fluctuate naturally, often dramatically, and even under the best management system a stock may drop to abundance levels often classified as "not sustainable". The idea that a fishery under the same management system could be judged sustainable one year but not the next, because of poor recruitment to the population, is incorrect and counterproductive.

A second measure of sustainability is the intensity of fishing pressure. If fishing pressure is so high as to threaten the long-term productivity of the resource, then the production of benefits to society cannot be sustained.

Another approach to measuring sustainability is to evaluate the process of management. Sustainable benefits to society arise from the interaction of the management system and the natural system. However, as only the management system can be controlled, the sustainability of a fishery should be judged by whether the management system can provide the benefits the natural system can potentially provide. Key elements in a sustainable fisheries management system are the ability to monitor changes in the state of the resource, and the ability to take effective action to respond to those changes.

Difference between sustainable and responsible

The concept of responsible fishing is closely related to sustainability. The Code is the most widely accepted set of guidelines on how to manage fisheries. Its role is defined thus: "This 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."[3] The management of a particular fishery can be evaluated against the Code, and deficiencies in the management system identified.

The Code describes characteristics of a responsible management system. If those characteristics are implemented, then the outcome is more likely to be a sustainable fishery. In short, responsible fishing leads to sustainability.

Market forces as a driver of sustainability

There are many seafood guides, ecolabels and certification schemes aimed at informing stakeholders along the seafood value chain as to whether a fishery is sustainably managed or not. Several schemes have a third-party certification system whose main aim is to provide retailers and consumers with clear identification of which fish products come from sustainably managed fisheries and which do not. These ecolabels and certification schemes are part of a "market-based" approach to introduce changes in fisheries management practice regulated by the market. Their ultimate goal is that, by distinguishing between sustainable and unsustainable fisheries, markets will force poorly managed fisheries to improve by going through a pre-assessment gap analysis and developing a fishery improvement programme.

With few exceptions, seafood labels are state-based, not process-oriented, with most scoring criteria addressing the state of the resource and characteristics of the fishery. Generally, they do not evaluate the management system. Some include environmental aspects such as bycatch and discards. Bycatch of non-target species may disqualify a fish product from a specific label even where the bycatch species is not depleted. This has nothing to do with the sustainability of the food production but choices made by the specific label. The result is that some labels are contradictory – environmental impacts acceptable for one label may be unacceptable for another.

For the sake of coherence, ecolabels and certification schemes should adhere to FAO guidelines for ecolabelling.[4] Moreover, market drivers of sustainability should integrate social concerns such as labour issues and decent working conditions. Other environmental impacts outside of the marine ecosystem (e.g. greenhouse gas footprints, energy required) can broaden the scope of ecolabels to address the three pillars of sustainability.

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1 World Commission on Environment and Development. 1987. *Our Common Future*. Oxford, UK, Oxford University Press. 383 pp.

2 UN. 2005. *2005 World Summit Outcome* [online]. Resolution adopted by the General Assembly. A/RES/60/1. [Cited 16 June 2016]. http://data.unaids.org/Topics/UniversalAccess/worldsummitoutcome_resolution_24oct2005_en.pdf

3 FAO. 2011. *Code of Conduct for Responsible Fisheries*. Rome. 91 pp. Includes a CD–ROM. (also available at www.fao.org/docrep/013/i1900e/i1900e00.htm).

4 FAO. 2009. *Guidelines for the ecolabelling of fish and fishery products from marine capture fisheries. Revision 1. Directives pour l'étiquetage écologique du poisson et des produits des pêches de capture marines. Révision 1. Directrices para el ecoetiquetado de pescado y productos pesqueros de la pesca de captura marina. Revisión 1. Rome/Roma*. 108 pp. (also available at www.fao.org/docrep/012/i1119t/i1119t00.htm).

FAO. 2011. *Guidelines for the Ecolabelling of Fish and Fishery Products from Inland Capture Fisheries. Directives pour l'étiquetage écologique du poisson et des produits des pêches de capture continentales. Directrices para el ecoetiquetado de pescado y productos pesqueros de la pesca de captura continental*. Rome/Roma. 106 pp. (also available at www.fao.org/docrep/015/ba0001t/ba0001t00.htm).

» *Continued from page 39*

Northeast Atlantic, Northwest Atlantic, Western Central Atlantic, Mediterranean and Black Sea, Southwest Pacific, and Southeast Atlantic. In some cases, lower catches reflect fisheries management measures that are precautionary or to rebuild stocks, and this situation should, therefore, not necessarily be viewed as negative. About 65 percent of fish stocks in this group are estimated to be within biologically sustainable levels.

The third group comprises only three areas: Western Central Pacific, Eastern Indian Ocean and Western Indian Ocean. They contributed 31 percent of the total marine catch in 2013. However, in some regions, there is still great uncertainty about the actual catches owing to the poor quality of statistical reporting systems. This group has the highest proportion (77 percent) of fish stocks within biologically sustainable levels.

The Northwest Pacific has the highest production among the FAO areas. Its total catch fluctuated between about 17 million and 24 million tonnes in the 1980s and 1990s, and was about 21.4 million tonnes in 2013. Small pelagic fish are the most abundant category in this area, with Japanese anchovy providing 1.9 million tonnes in 2003 but then declining to about 1.3 million tonnes in 2013. Other important contributors to the total catch in the area are large-head hairtail, which was considered overfished, as was chub mackerel. Alaska pollock had two stocks fully fished and another overfished. Overall, about 24 percent of fish stocks in the Northwest Pacific were overfished.

The Eastern Central Pacific has shown a typical oscillating pattern in its catches since 1980 and produced about 2.1 million tonnes in 2013. The most abundant species in this area are California pilchard, Pacific anchoveta, and yellowfin tuna, and they are all considered as being fished at biologically sustainable levels. Overall, only 9.1 percent of stocks were fished at unstainable levels in 2013. Its adjacent area – the Southeast Pacific – is also characterized by a large proportion of small pelagic species and considerable fluctuations in catches, but with a clearly declining trend since 1993, from the high of 20 million tonnes to 10 million tonnes in 2013. This area has 41 percent of fish stocks fished at unsustainable levels.

For the Eastern Central Atlantic, total catches, which have fluctuated since the 1970s, were about 3.9 million tonnes in 2013, slightly below the 2010 peak. Small pelagic species constitute almost 50 percent of the landings, followed by "miscellaneous coastal fishes". The single most important species in terms of landings is sardine (*Sardina pilchardus*), at 0.6–1 million tonnes per year over the last decade. Most of the pelagic stocks are considered either fully fished or overfished, with the exception of some stocks such as the sardine stock south of Cape Bojador. The demersal resources are to a large extent fully fished to overfished in most of the area. Overall, the Eastern Central Atlantic has 46.5 percent of its assessed stocks fished at biologically unsustainable levels, and 53.5 percent within sustainable levels.

In the Southwest Atlantic, total catches have fluctuated between 1.7 million and 2.6 million tonnes (after a period of increase that ended in the mid-1980s), and reached 2.0 million tonnes in 2013. The most important species in landings is the Argentina shortfin squid, producing half a million tonnes in 2013, only about half of its peak value, and considered fully fished to overfished. Brazilian sardinella was also an important species, producing about 100 000 tonnes in 2013, and considered overfished. In this area, 50 percent of the assessed stocks were fished at biologically unsustainable levels, and the other 50 percent within biologically sustainable limits.

The Northeast Pacific produced 3.2 million tonnes of fish in 2013, an average level since the early 1970s. Alaska pollock is the single most abundant species representing about 40 percent of the total landings. Cods, hakes and soles are also large contributors to the catch. In this area, 14 percent of fish stocks were estimated to be fished at biologically unsustainable levels and 86 percent fully fished or underfished.

In the Northeast Atlantic, total catch showed a decreasing trend after 1975, with a recovery in

the 1990s, and was 8.7 million tonnes in 2013. Declared landings from blue whiting stock decreased rapidly from the peak of 2.4 million tonnes in 2004 and were 628 000 tonnes in 2013. Fishing mortality has been reduced in cod, sole and plaice, with recovery plans in place for the major stocks of these species. The Arctic cod spawning stock was particularly large in 2008, having recovered from the low levels observed in the 1960s–1980s. The Arctic saithe and haddock stocks are fully fished. The largest sand eel stock remains overfished, while capelin stocks have recovered to a fully fished state. Concern remains for redfishes and deep-water species for which data are limited and which are likely to be vulnerable to overfishing. Northern shrimp and Norway lobster stocks are generally in good condition. In this area, about 21 percent of fish stocks were estimated as being overfished.

The Northwest Atlantic has seen a major decline in landings, down from about 4.2 million tonnes in the early 1970s to1.9 million tonnes in 2013, less than 50 percent of its peak. Intensified management regulations may be in part responsible for this decline. Some stocks have shown signs of recovery in the last decade (e.g. Greenland halibut, yellowtail flounder, Atlantic halibut, haddock, and spiny dogfish). However, some historical fisheries such as cod, witch flounder and redfish still evidence lack of recovery, or are showing only limited recovery. In general, invertebrates remain at near-record levels of abundance. This area has 31 percent of fish stocks overfished.

In the Western Central Atlantic, total catches have shown an overall decreasing trend since 2000, reaching 1.3 million tonnes in 2013, despite a slight increase recorded in 2011 and 2012 to 1.5 million tonnes. Gulf menhaden (*Brevoortia patronus*) is the most productive species in the region, reaching about 1 million tonnes in the mid-1980s, but the catch dropped by half to 0.5 million tonnes in 2013. It is considered fully fished. Round sardinella had high landings in the 1990s, but is classified as overfished. Recent changes in stock status have been recorded for groupers and snappers that appear to be overfished. Northern brown shrimp (*Penaeus aztecus*) seems to have experienced increased fishing pressure, as it is now fully fished. The same situation was reported for American cupped oyster (*Crassostrea virginica*), which seems to be moving progressively towards overfishing unless management action is taken. Overall, the Western Central Atlantic has 44 percent of stocks at biologically unsustainable levels, and so 56 percent of stocks within biologically sustainable limits.

The Southeast Atlantic has shown a decreasing trend in catches since the early 1970s, from a total production of 3.3 million tonnes to 1.3 million tonnes in 2013. Horse mackerel and hake represent the most important species in terms of landings, with 25 and 22 percent, respectively. Stocks of both deep-water hake off South Africa and shallow-water Cape hake off Namibia have recovered to biologically sustainable levels as a consequence of good recruitment and strict management measures introduced since 2006. Southern African pilchard and anchovy stocks have improved and were categorized as fully fished in 2013. Whitehead's round herring is not fully fished. However, the condition of Cunene horse mackerel remained overfished in 2013. The condition of the perlemoen abalone stock, targeted heavily by illegal fishing, has deteriorated and remains overfished.

The Mediterranean and Black Sea has seen its catch decline from 2.0 million tonnes in 1982 to 1.2 million tonnes in 2013. All hake (*Merluccius merluccius*) and most red mullet (*Mullus barbatus*) stocks are considered overfished, as are probably also the main stocks of sole and most sea breams. On the other hand, small pelagic stocks are on average within sustainable levels of fishing. Stocks in the region are also exposed to other threats, such as the impacts of invasive species from the Red Sea and the impacts of eutrophication and environmental changes in the Black Sea. In the Black Sea, the stocks of turbot and anchovy are considered overfished, while some improvement in the status of sprat has occurred in recent years. The Mediterranean and Black Sea had 59 percent of assessed stocks fished at biologically unsustainable levels and

41 percent fully fished to underfished in 2013. However, the General Fisheries Commission for the Mediterranean (GFCM) estimates that about 85 percent of fish stocks in this area are fished at unsustainable levels. This difference might have arisen due to the different coverages of the two assessments, as stocks assessed by the GFCM represent only 30 percent of landed catches.

Total production in the Western Central Pacific grew continuously to a new high of 12.4 million tonnes in 2013. Major species are tuna and tuna-like species, which contributed about 26 percent of total landings. Sardinellas and anchovies are also major species in the region. This area contributes about 15 percent of global marine production. Most stocks are either fully fished or overfished, particularly in the western part of the South China Sea. The high reported catches have probably been maintained through expansion of fishing to new areas, and possible double counting in the transshipment of catches between fishing areas. Double counting leads to bias in estimates of production, potentially masking negative trends in stock status. The tropical and subtropical characteristics of the area combined with the poor quality of catch data make stock assessment uncertain. This area has 77 percent of its fish stocks fished at biologically sustainable levels.

The Eastern Indian Ocean is still showing an increasing trend in landings, up 50 percent in the last decade to a total of 7.7 million tonnes. Landings from the Bay of Bengal and Andaman Sea regions have increased steadily, with no sign of levelling off. However, about 42 percent of the catches in this area are attributed to the category "marine fishes not identified", which will cause difficulties for the monitoring of stock status and trends. Increased catches may in fact be due to the expansion of fishing to new areas or species. Declining catches in the fisheries within Australia's EEZ can be partly explained by a reduction in effort, structural adjustment to reduce overcapacity, and a ministerial direction in 2005 aimed at ceasing overfishing and allowing overfished stocks to rebuild. The latest assessment shows that 85 percent of species were within biologically sustainable levels in 2013.

In the Western Indian Ocean, total landings continued to increase and reached 4.6 million tonnes in 2013. A recent assessment has shown that narrow-barred Spanish mackerel (*Scomberomorus commerson*) in the Persian Gulf, and off the coast of Pakistan and India, is fully fished to overfished. Catch data in this area are often not detailed enough for stock assessment purposes. However, the Southwest Indian Ocean Fisheries Commission started stock assessment in 2010 for major species in its area of competence based on best available data and information. Overall, 68 percent of fish stocks were estimated to be fully fished or underfished, and 32 percent fished at unsustainable levels.

The world marine fisheries had 68.5 percent of fish stocks fished within biologically sustainable levels in 2013. However, an estimated 31.5 percent of fish stocks classified as overfished present a worrisome situation for fisheries. Overfishing – stock abundance fished down below the level that can produce MSY – not only causes negative ecological consequences, it also reduces fish production, which further leads to negative social and economic consequences. It is estimated that rebuilding overfished stocks could increase fishery production by 16.5 million tonnes and annual rent by US$32 billion,[17] which would certainly increase the contribution of marine fisheries to the food security, economies and well-being of the coastal communities. The situation seems more critical for some highly migratory, straddling and other fishery resources that are fished solely or partially in the high seas. The United Nations Fish Stocks Agreement, which entered into force in 2001, should serve as the legal basis for management measures for the high seas fisheries.

In spite of the challenges facing the world's marine capture fisheries, good progress is being made in reducing fishing rates and restoring overfished stocks and marine ecosystems through effective management actions in some areas. In the United States of America, the Sustainable Fisheries Act has added requirements that overfished fisheries be built to healthy levels. By 2013, 64 percent of the 44 overfished stocks covered by the act's requirements had been

rebuilt or were showing significant rebuilding success, with revenues 92 percent higher than at the start of the rebuilding process.[18] Moreover, Australia ended overfishing in the fisheries managed by the Government of the Commonwealth of Australia in 2014. In the EU, up to 70 percent of assessed stocks had either decreasing fishing rates or increasing stock abundance in the Northeast Atlantic.[19] Similar examples of success also exist in many other fisheries around the world. For example, Namibia has rebuilt its hake fishery, and Mexico has succeeded in restoring its abalone stock.[20] Such success stories prove that overfished stocks can be rebuilt, and rebuilding will lead to higher yields and substantive social and economic benefits. With the ever-strengthening declarations of political will in the international arena and increasing acceptance of the need to restore overfished stocks to ensure resource sustainability, food security and human well-being, the world's marine fisheries can make good progress towards long-term sustainability.

Inland fisheries

The state of inland fishery resources remains one of the most problematic regular global assessments to make due to the scarcity of reliable information and a lack of dedicated resources. A key element for such an assessment is catch data. Of 218 countries and territories with inland water capture fishery production, 96 report their catches to FAO (ranging from 1 tonne to 2.3 million tonnes), and FAO estimates the production for a further 53.[21] An additional 69 countries have production between 0 and 0.5 tonnes per year. Wherever more in-depth analyses have been conducted, e.g. through home consumption surveys, censuses or targeted frame surveys, the indication is that inland capture production is typically underestimated.[22]

Alternative information and data on habitats, population demographics and socio-economic can indicate the contribution that inland fisheries make to livelihoods and food security, but not inform on the state of the resources. In Africa, Asia and Latin America, extensive inland water habitats and inland fisheries provide significant food and livelihoods to riparian and wetland communities. However, without information on the status of the fish populations, it is difficult to manage such fisheries towards sustainability.

FAO has been working with partners and other fishery professionals on developing robust and credible methods to address this issue. Recent plans[23] have yet to prove successful, and a revised practical and cost-effective strategy is needed in order to assess accurately the state of inland fisheries at a global scale. ■

FISH UTILIZATION AND PROCESSING

Fisheries and aquaculture production are very heterogeneous in terms of species and product forms. The many species can be prepared in many different ways, making fish[24] a very versatile food commodity. However, fish is also highly perishable and can spoil more rapidly than almost any other food, soon becoming unfit to eat and possibly dangerous to health through microbial growth, chemical change and breakdown by endogenous enzymes. Therefore, post-harvest handling, processing, preservation, packaging, storage measures and transportation of fish require particular care in order to maintain the quality and nutritional attributes of fish and avoid waste and losses. Preservation and processing techniques can reduce the rate at which spoilage happens and thus allow fish to be distributed and marketed worldwide. Such techniques include temperature reduction (chilling and freezing), heat treatment (canning, boiling and smoking), reduction of available water (drying, salting and smoking) and changing the storage environment (packaging and refrigeration). However, fish can also be preserved and distributed using a wider range of other methods and presentations, including the live form, and various products destined for food or non-food uses. Technological development in food processing and packaging is ongoing in many countries, with increases in efficient, effective and

lucrative utilization of raw materials, and innovation in product diversification. Moreover, the expansion in the consumption and commercialization of fish products in recent decades has been accompanied by growing interest in food quality and safety, nutritional aspects, and wastage reduction. In the interests of food safety and consumer protection, increasingly stringent hygiene measures have been adopted at national and international trade levels.

The share of world fish production utilized for direct human consumption has increased significantly in recent decades, up from 67 percent in the 1960s to 87 percent, or more than 146 million tonnes, in 2014 (Figure 14). Almost all of the remaining 21 million tonnes was destined for non-food products, of which 76 percent (15.8 million tonnes) was reduced to fishmeal and fish oil in 2014; the rest being largely utilized as fish for ornamental purposes, culture (fingerlings, fry, etc.), bait, pharmaceutical uses, and as raw material for direct feeding in aquaculture, for livestock and for fur animals.

In 2014, 46 percent (67 million tonnes) of the forms for direct human consumption were live, fresh or chilled fish, which in some markets are often the most preferred and highly priced forms. The rest of the production for edible purposes was in different processed forms, with about 12 percent (17 million tonnes) in dried, salted, smoked or other cured forms, 13 percent (19 million tonnes) in prepared and preserved forms, and 30 percent (about 44 million tonnes) in frozen form. Freezing is the main method of processing fish for human consumption, and it accounted for 55 percent of total processed fish for human consumption and 26 percent of total fish production in 2014.

However, these global data mask important differences. The utilization of fish and, more significantly, the processing methods vary by continent, region, country and even within counties. Latin American countries produce the highest percentage of fishmeal. In Europe and North America, more than two-thirds of fish used for human consumption is in frozen and prepared and preserved forms. Africa's proportion of cured fish is higher than the world average. In Asia, much fish is still commercialized in live or fresh forms. Live fish is particularly appreciated in Southeast Asia and the Far East (especially by the Chinese population) and in niche markets in other countries, mainly among immigrant Asian communities. Handling of live fish for trade and use has been practised in China and other countries for more than 3 000 years. Commercialization of live fish has grown in recent years as a result of technological developments, improved logistics and increased demand. Transportation of live fish can range from simple artisanal systems of transporting fish in plastic bags with an atmosphere supersaturated with oxygen, to specially designed or modified tanks and containers, and on to very sophisticated systems installed on trucks and other vehicles that regulate temperature, filter and recycle water, and add oxygen. However, live-fish marketing and transportation can be challenging given often-stringent health regulations and quality standards. In parts of Southeast Asia, such commercialization and trade are not formally regulated but based on tradition. However, in markets such as the EU, live fish have to comply with requirements, *inter alia*, concerning animal welfare during transportation.

In recent decades, major innovations in refrigeration, ice-making and transportation have allowed a growing distribution of fish in fresh and other forms. As a result, in developing countries the share of frozen forms in the total of fish for human consumption increased from 3 percent in the 1960s to 11 percent in the 1980s and 25 percent in 2014 (Figure 15). In the same period, the share of prepared or preserved forms also grew (from 4 percent in the 1960s to 9 percent in the 1980s and 10 percent in 2014). However, despite technical advances and innovations, many countries, especially less-developed economies, still lack adequate infrastructure and services such as hygienic landing centres, reliable electricity supply, potable water, roads, ice, ice plants, cold rooms, refrigerated transport and appropriate processing and storage facilities. These factors, especially »

FIGURE 14

UTILIZATION OF WORLD FISHERIES PRODUCTION (BREAKDOWN BY QUANTITY), 1962–2014

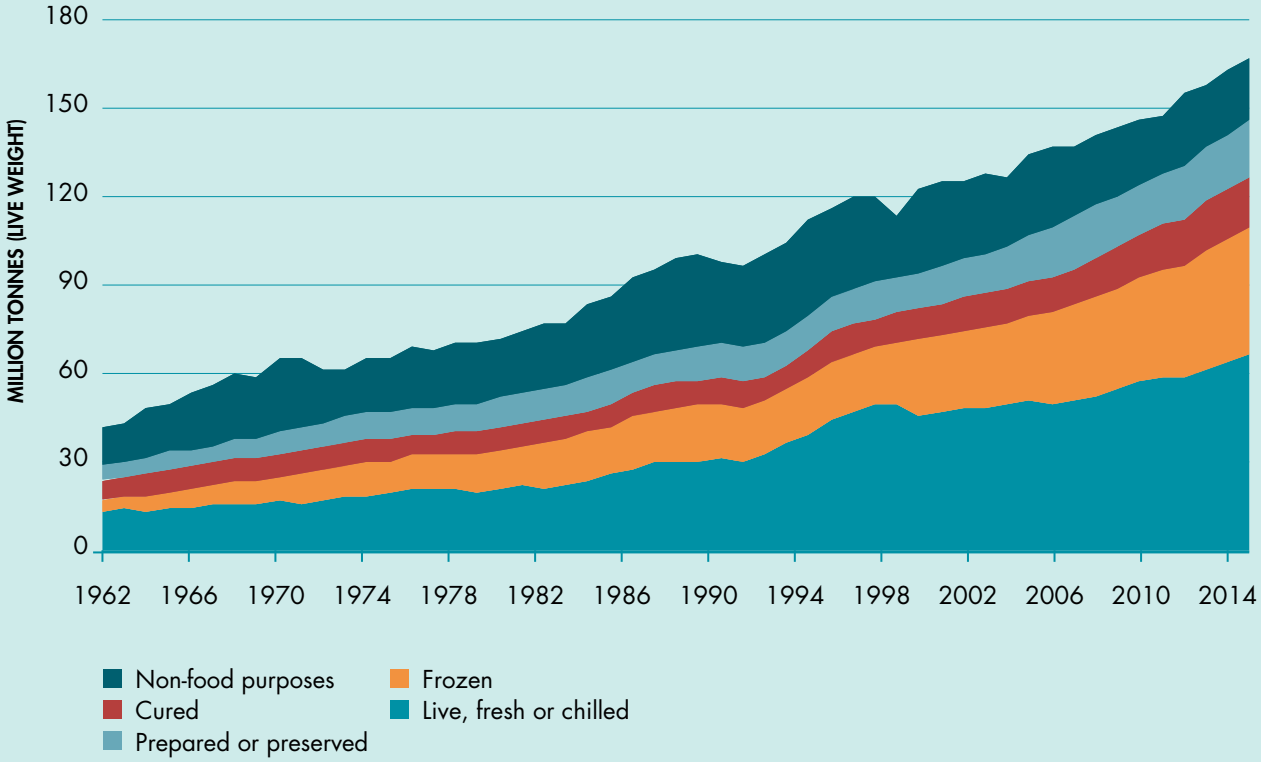
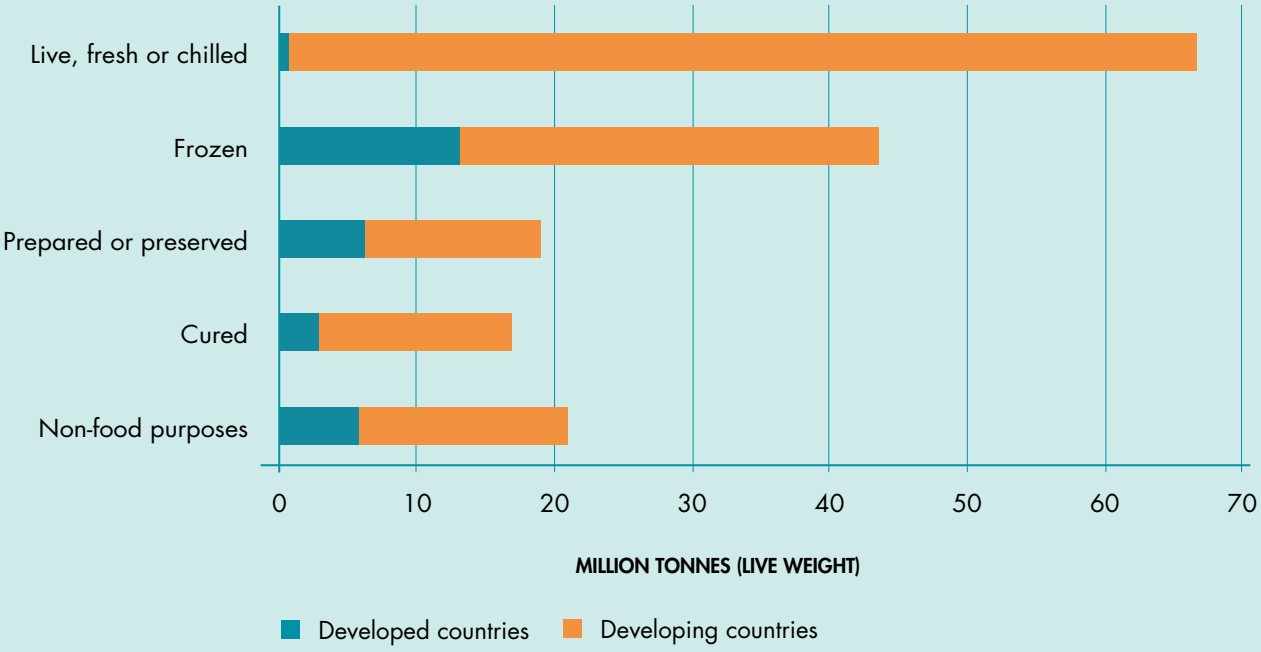


FIGURE 15

UTILIZATION OF WORLD FISHERIES PRODUCTION (BREAKDOWN BY QUANTITY), 2014



» when associated with tropical temperatures, result in high post-harvest losses and quality deterioration, with fish that can spoil in the boat, at landing, during storage or processing, on the way to market and while awaiting sale. In Africa, some estimates put post-harvest losses at 20–25 percent, and even up to 50 percent.[25] Throughout the world, post-harvest fish losses are a major concern and occur in most fish distribution chains, with an estimated 27 percent of landed fish being lost or wasted between landing and consumption. Globally, if discards prior to landing are included, fish losses and waste amount to 35 percent of landings, with at least 8 percent of fish being thrown back into the sea, and hence not utilized[26] (see section Cutting bycatch and discards, p. 118).

Congested market infrastructure can also limit the marketing of fish. The above-mentioned deficiencies, together with well-established consumer habits, mean fish in developing countries is commercialized mainly in live or fresh form (representing 53 percent of fish destined for human consumption in 2014) soon after landing or harvesting or else preserved using traditional methods, e.g. salting, drying and smoking. These methods remain prevalent in many countries, especially in Africa and Asia. In developing countries, cured forms (dried, smoked or fermented) represented 11 percent of all fish destined for human consumption. In many developing countries, processing uses less sophisticated methods of transformation, such as filleting, salting, canning, drying and fermentation. These labour-intensive methods provide livelihood support to many people in coastal areas, and they will probably remain important components of rural economies. However, in the last decade, fish processing has also evolved in many developing countries. This may range from simple gutting, heading or slicing to more advanced value addition, such as breading, cooking and individual quick-freezing, depending on the commodity and market value. Some of these developments are driven by demand in the domestic retail industry, by shifts in cultured species, by outsourcing of processing and by producers in developing countries being increasingly linked with, and coordinated by, firms located abroad.

In recent decades, the fish food sector has become more heterogeneous and dynamic. Supermarket chains and large retailers are increasingly the key players in setting product requirements and influencing the expansion of international distribution channels. Processing is more intensive, geographically concentrated, vertically integrated and linked with global supply chains. Processors are becoming more integrated with producers to enhance the product mix, obtain better yields and respond to evolving quality and safety requirements in importing countries. The outsourcing of processing activities at the regional and world levels is significant, with more countries participating, although its extent depends on species, product form, and labour and transportation costs. For example, whole frozen fish from European and North American markets are sent to Asia (to China in particular, but also other countries such as India, Indonesia and Viet Nam) for filleting and packaging, and then re-imported. Further outsourcing of production to developing countries might be constrained by sanitary and hygiene requirements that are difficult to meet and also by growing labour costs in some countries, in particular in Asia, as well as transport costs. All these factors might lead to changes in distribution and processing practices, and to increases in fish prices.

In developed countries, the bulk of production destined for human consumption is as commercialized frozen products or in prepared or preserved forms. The proportion of frozen fish has risen from 25 percent in the 1960s, to 42 percent in the 1980s, and a record high of 57 percent in 2014. The share of prepared and preserved forms has remained stable and was 27 percent in 2014. In developed countries, innovations in value addition, together with changing in food habits, are converging on convenience foods and a wider range of high-value-added products. These are mainly in fresh, frozen, breaded, smoked or canned forms, and marketed as ready and/or portion-controlled uniform-quality meals. In addition, 13 percent of

the fish production of developed countries destined for human consumption was in dried, salted, smoked or other cured forms in 2014.

A significant, but declining, proportion of world fisheries production is processed into fishmeal and fish oil, thereby contributing indirectly to human consumption when they are used as feed in aquaculture and livestock raising. Fishmeal is the crude flour obtained after milling and drying fish or fish parts, while fish oil is usually a clear brown/yellow liquid obtained through the pressing of the cooked fish. These products can be produced from whole fish, fish remains or other fish by-products resulting from its processing. Many different species are used for fishmeal and fish-oil production, with oily fish, especially anchoveta, the main groups of species utilized. The El Niño phenomenon affects anchoveta catches (see section Capture fisheries production, p. 10), and stricter management measures have reduced catches of anchoveta and other species usually used for reduction. Hence, fishmeal and fish-oil production fluctuates according to changes in the catches of these species. Fishmeal production peaked in 1994 at 30.1 million tonnes (live weight equivalent) and has followed an oscillating and overall declining trend since then. In 2014, fishmeal production was 15.8 million tonnes due to reduced catches of anchoveta. Owing to the growing demand for fishmeal and fish oil, in particular from the aquaculture industry, and coupled with high prices, a growing share of fishmeal is being produced from fish by-products, which previously were often discarded. Non-official estimates of the contribution of by-products to the total volume of fishmeal and fish oil produced indicate it is about 25–35 percent. With no additional raw material expected to come from whole fish catches (in particular of pelagics), any increase in fishmeal production will need to come from recycling by-products, with, however, a possible impact on its composition (see section Outlook, p. 170).

While fish oil represents the richest available source of long-chain highly unsaturated fatty acids (HUFAs), important in human diets for a wide range of critical functions (see section Nutrition: from commitments to action, p. 151), most fish oil still goes into aquaculture feeds. Due to declining fishmeal and fish-oil production and their high prices, alternative sources of HUFAs are being explored, including large marine zooplankton stocks, such as Antarctic krill (*Euphausia superba*) and the copepod *Calanus finmarchicus*. However, the cost of zooplankton products is too high for them to be included as a general oil or protein ingredient in fish feed. Fishmeal and fish oil are still considered the most nutritious and most digestible ingredients for farmed fish feeds. To offset their high prices, as feed demand increases, the amount of fishmeal and fish oil used in compound feeds for aquaculture has shown a clear downward trend, with their being more selectively used as strategic ingredients at lower levels and for specific stages of production, particularly hatchery, broodstock and finishing diets.

The trend towards more processing of fish products within the supply chain is creating increasing quantities of offals and other by-products, which may constitute up to 70 percent of fish and shellfish after industrial processing.[27] Fish by-products are not usually put on the market owing to low consumer acceptance or because sanitary regulations restrict their use. Such regulations might also govern the collection, transport, storage, handling, processing and use or disposal of these by-products. In the past, fish by-products, including waste, were considered to be of low value and used as feed for farmed animals or thrown away. In the last two decades, utilization of fish by-products has been gaining attention also because they can represent a significant additional source of nutrition (see section Nutrition: from commitments to action, p. 151). In various countries, the utilization of by-products has become an important industry, with a growing focus on their handling in a controlled, safe and hygienic way. Improved processing technologies are also enabling more efficient utilization. Moreover, fisheries by-products serve a wide range of other purposes. Heads, frames and fillet cut-offs can be used directly as food or turned into products for human consumption such as fish sausages, cakes,

gelatin and sauces. Small fish bones, with a minimum amount of meat, are also consumed as snacks in some Asian countries. Other by-products are used in the production of feed, biodiesel/biogas, dietetic products (chitosan), pharmaceuticals (including oils), natural pigments (after extraction), cosmetics (collagen), and in other industrial processes. Yet other fish by-product uses are as direct feeding for aquaculture and livestock, pet food or feed for animals kept for fur production, and in silage and fertilizers. Some by-products, in particular viscera, are highly perishable and should therefore be processed while still fresh. Fish viscera and frames are a source of protein hydrolysate, which is receiving growing interest as a potential source of bioactive peptides. Fish protein hydrolysates and fish silage[28] obtained from fish viscera are finding applications in the pet-food and fishfeed industries. Shark cartilage is utilized in many pharmaceutical preparations and reduced to powder, creams and capsules, as are other parts of sharks, e.g. ovaries, brain, skin and stomach. Fish collagens are of interest for cosmetics, but also to the food processing industry as gelatin is extracted from the collagen.

The internal organs of fish are an excellent source of specialized enzymes. A range of proteolytic fish enzymes are extracted, e.g. pepsin, trypsin, chymotrypsin and collagenases as well as lipase enzymes. Protease, for example, is a digestive enzyme used in the manufacture of cleaners to remove plaques and dirt, and in food processing and biological research. A good source of collagen and gelatin, fish bones are an excellent source of calcium and other minerals such as phosphorus that can be used in food, feed or as supplements. Calcium phosphates such as hydroxyapatite present in fish bone can aid rapid bone repair after major trauma or surgery.[29] Fish skin, in particular of larger fish, provides gelatin as well as leather for use in clothing, shoes, handbags, wallets, belts and other items. Species commonly used for leather include shark, salmon, ling, cod, hagfish, tilapia, Nile perch, carp and seabass. In addition, shark teeth are utilized in handicrafts.

The shells of crustaceans and bivalves are an important category of by-products. Their efficient utilization is important due to the high volumes being generated linked to their increased production and processing, and the slow natural degradation rate of shells. Chitosan, produced from shrimp and crab shell, has shown a wide range of applications such as in water treatments, cosmetics and toiletries, food and beverages, agrochemicals and pharmaceuticals. Crustacean wastes yield pigments (carotenoids and astaxanthin) for use in the pharmaceutical industry, and collagen can be extracted from fish skin, fins and other processing by-products. Mussel shells can provide calcium carbonate for industrial use. In some countries, oyster shells are a raw material used in building construction and the production of quicklime (calcium oxide). Shells can also be processed into pearl powder and shell powder. Pearl powder is used in medicine and cosmetics manufacturing, and shell powder (a rich source of calcium) serves as a diet supplement in feeding livestock and poultry. Fish scale is used for processing fish silver, a raw material in medicines, biochemical drugs and paint manufacturing. Scallop and mussel shells can be used in handicrafts and jewellery, and for making buttons.

Research on marine sponges, bryozoans and cnidarians has discovered a number of anticancer agents. However, following their discovery, for conservation reasons, these agents are not extracted from marine organisms directly but chemically synthesized. Another approach being researched is the culture of some sponge species to be used for this purpose.

In addition to the above-mentioned fish quantities, in 2014, about 28.5 million tonnes of seaweeds and other algae were harvested for direct consumption or further processing for food (traditionally in Japan, the Republic of Korea and China) or for use as fertilizer and in pharmaceuticals, cosmetics and other purposes. Seaweeds have long been used to feed livestock and in medicine, e.g. to treat iodine deficiency and as a vermifuge. Seaweeds are industrially processed to extract thickening agents such as alginate, agar and carrageenan or used, generally in dried powder form, as an animal-feed additive. Growing attention is also focusing on the

nutritional value of several seaweed species, due to their abundance of natural vitamins, minerals, and plant-based protein. Many seaweed-flavoured foods (including ice creams) and drinks are being launched, with the Asia and Pacific region as main market, but with increasing interest also being shown in Europe and America. However, seaweeds are characterized by a highly variable composition, depending on species, collection time and habitat. More research is also exploring the use of seaweed as an alternative to salt. Procedures are being developed for the industrial preparation of biofuel from fish waste and seaweeds. ■

FISH TRADE AND COMMODITIES

Trade plays a major role in the fisheries and aquaculture sector as an employment creator, food supplier, income generator, and contributor to economic growth and development, and to food and nutrition security. This section illustrates the main trends in the trade in fish and fishery products only. However, it is important to highlight the important component of trade in fisheries services. These include a wide range of activities: managerial expertise; harvesting and processing; policing and vessel monitoring; the use of ports and port-related services; repair and hiring of crew for vessels and training; chartering of fishing vessels; construction of infrastructure facilities; and research, stock assessment and data analysis. The overall value generated by these fisheries services is not yet available, as usually they are recorded together with services related to other activities.[30]

Fish and fishery products represent one of the most-traded segments of the world food sector, with about 78 percent of seafood products estimated to be exposed to international trade competition.[31] For many countries and for numerous coastal, riverine, insular and inland regions, exports of fish and fishery products are essential to their economies. For example, in 2014, they accounted for more than 40 percent of the total value of traded commodities in Cabo Verde, Faroe Islands, Greenland, Iceland, Maldives, Seychelles and Vanuatu. Globally, in the same year, fishery trade represented more than 9 percent of total agricultural exports (excluding forest products) and 1 percent of world merchandise trade in value terms.

Trade in fish and fishery products has been expanding considerably in recent decades, fuelled by expanding fishery production and driven by high demand, with the fisheries sector operating in an increasingly globalized environment. Fish can be produced in one country, processed in a second and consumed in a third. This is also linked to the increasing outsourcing of processing to countries where comparatively low wages and production costs provide a competitive advantage, as indicated in the section Fish utilization and processing (p. 45). Sustained demand, trade liberalization policies, globalization of food systems, improvement of transportation and logistics, technological innovations as well as changes in distribution and marketing have significantly modified the way fishery products are prepared, processed, marketed and delivered to consumers. Geopolitics has also played a decisive role in advancing and reinforcing these structural trends. The intermingling of these drivers of change has been multidirectional and complex, and the pace of transformation rapid. All these factors have facilitated and increased the shift from local consumption to international markets. This change is manifested most clearly in wider geographical participation in trade. In 2014, more than 200 countries reported exports and imports of fish and fishery products. The structure and pattern of trade differs significantly by commodity and by region.

World trade in fish and fishery products has expanded significantly in recent decades, rising by more than 245 percent in terms of quantity (live weight equivalent) from 1976 to 2014, and by 515 percent if one considers just trade in fish for human consumption. These quantities represent a significant share of total fish production, with about 36 percent (live weight equivalent) exported

in the form of different product forms for human consumption or non-edible purposes in 2014 (Figure 16), reflecting the sector's degree of openness and integration into international trade. This share increased from 25 percent in 1976 to a peak of 40 percent in 2005. Since then, it has slowed, mainly because of reduced production and related exports of fishmeal. If only trade of fish for human consumption is considered, its share in total fishery production has increased continuously, reaching almost 29 percent in 2014.

World trade in fish and fishery products has grown significantly also in value terms, with exports rising from US$8 billion in 1976 to US$148 billion in 2014, at an annual growth rate of 8.0 percent in nominal terms and 4.6 percent in real terms. The two main exceptions were experienced in 2009 and 2012. In 2009, with the general global economic contraction, trade dropped by 6 percent compared with 2008. However, the decline was only in value terms because of falling prices and margins. The decrease was not uniform and, in particular, many developing countries experienced rising demand and imports in 2009. In the following two years, trade rebounded strongly, with overall growth of 15 percent in 2010 and 17 percent in 2011, reaching US$130 billion. In 2012, trade remained rather stable, up only 1 percent on the previous year. This sluggishness was mainly the result of the downward pressure experienced by international prices of selected fish and fishery products for human consumption, in particular of farmed species. In addition, demand in many key markets was also lower because of the economic contraction still affecting consumer confidence. Demand was particularly uncertain in many developed countries. Trade increased again by 7 percent in 2013 and by 6 percent 2014. However, preliminary estimates for 2015 point to a drop of about 10 percent to US$135 billion. Final figures are likely to show that the decline was mainly in value terms, with traded volumes registering a decrease of only 2–3 percent compared with 2014. Reasons for this slowdown include the weakening of many key emerging markets after long periods of strong seafood market growth and lower prices for a number of important species. Moreover, economic contraction in Brazil and the Russian Federation appears to have played a role, at least in US dollar terms, with imports in 2014 down 46 percent for the Russian Federation (14 percent in terms of the Russian rouble) and 23 percent for Brazil (but an increase of 6 percent in terms of the Brazilian real). Since 2014, imports to the Russian Federation have also been affected by its trade embargo on fish imported from certain countries. However, the primary underlying cause of the 10 percent decline in world fishery trade in value terms has been the strengthening of the US dollar against other currencies, particularly those of major seafood exporters such as the EU, Norway and China, which could partly reflect a reduced exchange rate elasticity.

Fishery trade is closely tied to the overall economic situation. World merchandise exports have experienced strong growth in the last 20 years, climbing to US$18 trillion in 2014, almost four times the value recorded in 1995. However, this overall growth has not been regular. There was a gradual rise until the late 1990s, followed by a strong increase from 2002 to 2008, with emerging market economies being the major engine of this global growth. World merchandise trade dropped in 2009 after the 2008 economic crisis, before rebounding strongly in 2010 and 2011 to then grow at a moderate pace in 2012–14. In value terms, growth averaged 1 percent per year, and in volume terms averaged 2.4 percent between 2012 and 2014. Available data for 2015 indicate a further slowdown in emerging markets and a weaker recovery in developed economies, with a contraction in trade, mainly in value terms. Factors contributing to the sluggishness in trade and output in 2014 and in 2015 included: slowing growth in emerging economies' gross domestic product: an uneven economic recovery in developed countries; rising geopolitical tensions; weak global investment growth; maturing global supply chains; the effect of an appreciating dollar; strong exchange rate fluctuations; and slowing momentum in trade liberalization.[32] All these factors also influenced the recent slowdown in overall fishery growth. According to the World Bank,[33] the global economy will need to adapt to a new period of more modest growth in large emerging markets, characterized by lower commodity prices and diminished flows of trade and capital. »

FIGURE 16

WORLD FISHERIES PRODUCTION AND QUANTITIES DESTINED FOR EXPORT

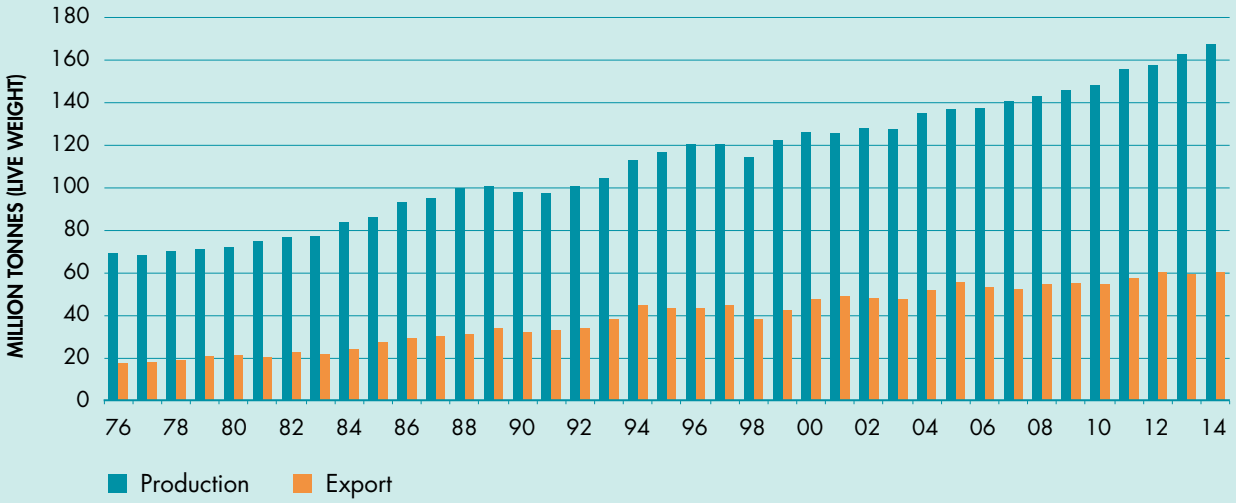


TABLE 15

TOP TEN EXPORTERS AND IMPORTERS OF FISH AND FISHERY PRODUCTS

		2004	2014	APR
		(US$ millions)		(Percentage)
EXPORTERS	China	6 637	20 980	12.2
	Norway	4 132	10 803	10.1
	Viet Nam	2 444	8 029	12.6
	Thailand	4 060	6 565	4.9
	United States of America	3 851	6 144	4.8
	Chile	2 501	5 854	8.9
	India	1 409	5 604	14.8
	Denmark	3 566	4 765	2.9
	Netherlands	2 452	4 555	6.4
	Canada	3 487	4 503	2.6
	Top ten subtotal	**34 539**	**77 801**	**8.5**
	Rest of world total	**37 330**	**70 346**	**6.5**
	WORLD TOTAL	71 869	148 147	7.5
IMPORTERS	United States of America	11 964	20 317	5.4
	Japan	14 560	14 844	0.2
	China	3 126	8 501	10.5
	Spain	5 222	7 051	3.0
	France	4 176	6 670	4.8
	Germany	2 805	6 205	8.3
	Italy	3 904	6 166	4.7
	Sweden	1 301	4 783	13.9
	United Kingdom	2 812	4 638	5.1
	Republic of Korea	2 250	4 271	6.6
	Top ten subtotal	**52 119**	**83 447**	**4.8**
	Rest of world total	**23 583**	**57 169**	**9.3**
	WORLD TOTAL	75 702	140 616	6.4

Note: APR refers to the average annual percentage growth rate for 2004–2014.

» Table 15 shows the top exporters and importers.[34] China is the main fish producer, but also the largest exporter of fish and fishery products since 2002, although they represent only 1 percent of its total merchandise exports. China's imports of fishery products are also growing, making it the world's third-largest importing country since 2011. The increase in China's imports is partly a result of outsourcing of processing from other countries, but it also reflects the country's growing domestic consumption of species not produced locally. However, in 2015 after years of sustained increases, its fishery trade experienced a slowdown, with a decrease of 6 percent in its exports in US dollar terms (4 percent in terms of the Chinese yuan), while its imports slightly declined in US dollar terms, but rose 2 percent in yuan terms. The slowdown was a result of the appreciation of the US dollar and a reduction in its processing sector.

Norway, the second major exporter, supplies diverse products, including farmed salmonids, small pelagic species and traditional whitefish. In 2015, Norway posted record export values in particular for salmon and cod. Its exports increased by 8 percent in terms of the Norwegian krone, but in US dollar terms they declined by 16 percent. In 2014, Viet Nam became the third major exporter, overtaking Thailand. Thailand has experienced a substantial decline in exports since 2013, mainly linked to reduced shrimp production due to disease problems. Its exports further declined in 2015 (by 14 percent in US dollar terms and by 10 percent in terms of the Thai baht) mainly because of its reduced shrimp production and lower prices of shrimps and tunas. Both these Asian countries have important processing industries, which contribute significantly to the economy through job creation and trade.

The EU, the United States of America and Japan are highly dependent on fishery imports to satisfy their domestic consumption. In 2014, their combined imports represented 63 percent by value and 59 percent by quantity of world imports of fish and fishery products. The EU is, by far, the largest single market for fish imports, valued at US$54 billion in 2014 (US$28 billion if intra-EU trade is excluded), up 6 percent from 2013. Estimates for 2015 indicate an 11 percent decline in its import value in US dollar terms; however, in euro terms, its imports increased by more than 6 percent. Japan, traditionally the largest single importer of fish, was overtaken by the United States of America in 2011 and again since 2013. In recent years, Japanese fishery imports have declined, also owing to a weaker currency, which has made imports more expensive. In 2015, its imports of fish and fishery products declined by 9 percent in US dollar terms to US$13.5 billion, but increased by 4 percent in terms of the Japanese yen. In 2015, the fishery imports of the United States of America reached US$18.8 billion, down 7 percent on 2014.

In addition to the above-mentioned countries, many emerging markets and exporters have gained importance. Regional flows continue to be significant, although often this trade is not adequately reflected in official statistics, in particular for Africa. Improved distribution systems, as well as expanding aquaculture production, have enabled increasing regional trade. Figure 17 summarizes trade flows of fish and fishery products for 2014. The overall picture presented is not exhaustive as trade data are not fully available for all countries, in particular for several African countries. However, the available data do indicate general trends. The Latin America and the Caribbean region remains a solid net fishery exporter, as do Oceania and the developing countries of Asia. By value, Africa has been a net exporter since 1985 (with the exception of 2011). However, Africa has long been a net importer in quantity terms, reflecting the lower unit value of imports (mainly for small pelagics). Europe and North America are characterized by a fishery trade deficit (Figure 18).

In the past ten years, international trade patterns moved in favour of trade between developed and developing countries. Developed countries still trade mainly among themselves and, in 2014, in value terms, 78 percent of fishery exports from developed countries were destined for other developed countries. However, in the last three decades, the share of their exports going to developing countries has increased, also owing to their outsourcing the processing of their fisheries

production. At the same time, while developed countries remain their main markets, developing countries have increased trade among themselves, and fishery trade between developing countries represented 40 percent of the value of their exports of fish and fishery products in 2014.

One of the most important changes in trade patterns in recent years has been the growing share of developing countries in fisheries trade, and the corresponding decline in the share of developed economies (Figure 19). Developing economies, whose exports represented just 37 percent of world trade in 1976, saw their share rise to 54 percent of total fishery export value by 2014. In the same period, their exports increased from 38 to 60 percent of the quantity (live weight) of total fishery exports. Fishery trade represents a significant source of foreign currency earnings for many developing countries, in addition to the sector's important role in income generation, employment, food security and nutrition. However, its importance varies considerably among developing countries, and even within a single region. In 2014, exports of developing countries were valued at US$80 billion and their fishery net-export revenues (exports minus imports) reached US$42 billion, higher than other agricultural commodities (such as meat, tobacco, rice and sugar) combined (Figure 20). The fishery industries of developing countries rely heavily on developed countries both as outlets for their exports and as suppliers of their imports for local consumption (mainly low-priced small pelagics as well as high-value fishery species for emerging economies) or for their processing industries. This can be evidenced by comparing the unit values of trade of developing and developed countries. The imports of developing countries present a unit value much lower than that of developed countries (US$2.5/kg vs US$5.3/kg in 2014), while they are similar for exports (at about US$3.8–4.0/kg in the same year), as exports of developing countries consist of a mix of high-value species together with lower-value species/products.

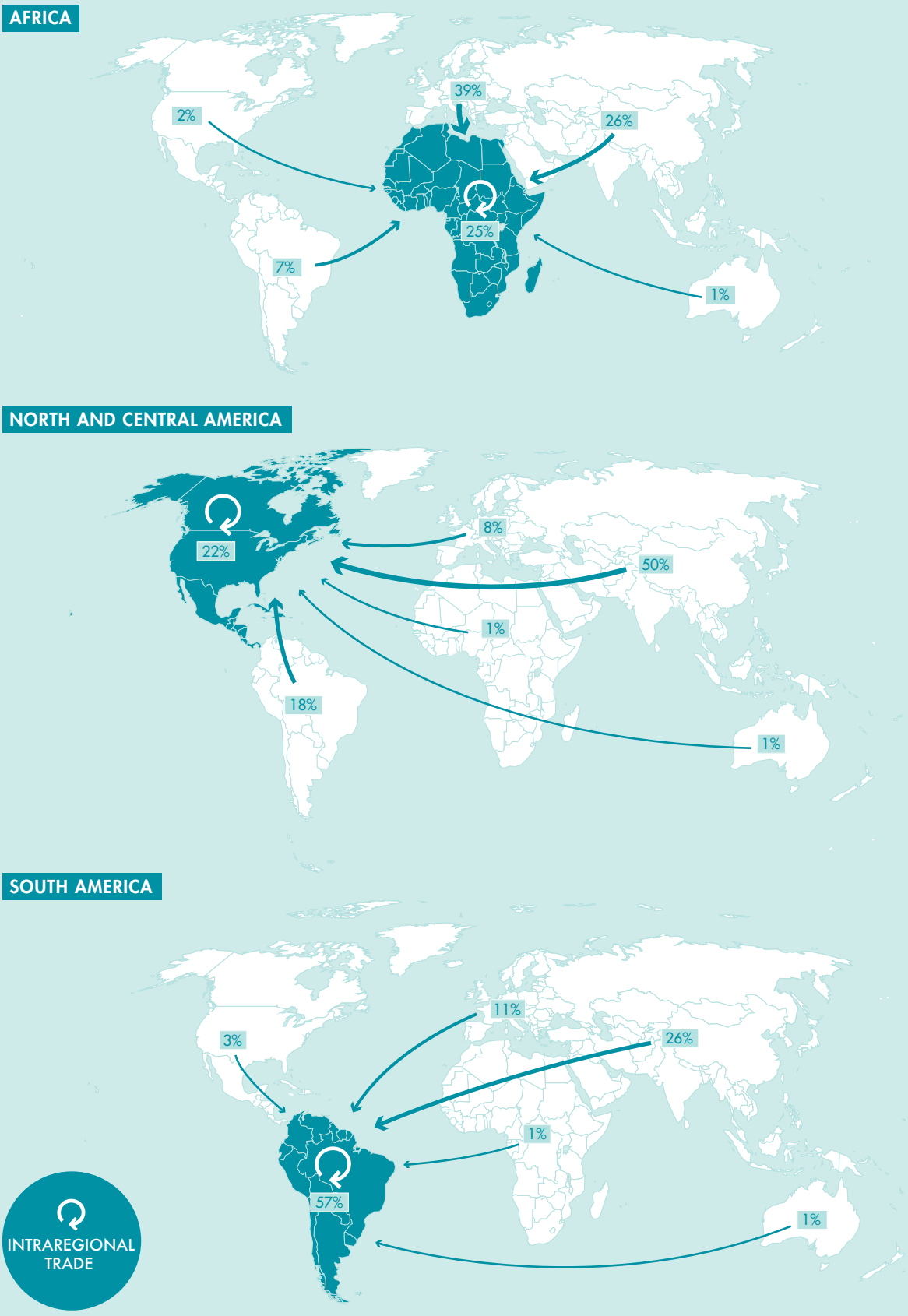
Trade in fish and fishery products is largely driven by demand from developed countries, which dominates world fishery imports, although with a declining share (73 percent of world imports in 2014 vs 81 percent in 2004 and 85 percent in 1994). In terms of quantity (live weight equivalent), their share is significantly less at 57 percent, reflecting the higher unit value of the products they import. Their imports of products from capture fisheries and aquaculture originate from both developed and developing countries, giving many producers an incentive to produce, process and export.

The high dependence on imports to satisfy domestic consumption of developed countries is a major reason for their low import tariffs on fish, especially for the three largest import markets, the EU, the United States of America and Japan, albeit with a few exceptions (i.e. some value-added products and particular species). This has allowed developing countries to supply fishery products to markets in developed countries without facing prohibitive customs duties. This trend follows the expanding membership of the World Trade Organization (WTO) and the entry into force of a number of bilateral and multilateral trade agreements. However, many developing countries continue to apply high import tariffs for fish and fishery products, and although this usually reflects fiscal policy rather than being a protective measure, it does have detrimental effects on regional trade. Over time, thanks to regional and bilateral trade agreements, such tariffs are bound to fall further, also in developing countries (with some exceptions accorded to least-developed countries). The patterns of global trade are determined not only by market fundamentals and international trade rules, but also to a growing extent by other subtler dynamics. Sometimes, the most important barriers facing developing countries in increasing their exports to developed countries relate more to the ability to satisfy constantly evolving import requirements. These include areas such as quality and safety, but are increasingly also related to technical standards and labelling and, more recently, to voluntary certification for biological sustainability as well as social and labour conditions within the industry and its suppliers. Some of these import requirements are regulatory, and therefore binding. However, private companies, whether retailers, processors or restaurant chains, are increasingly setting their own specifications that producers have to meet. Other impacts on trade in developing countries might be linked to

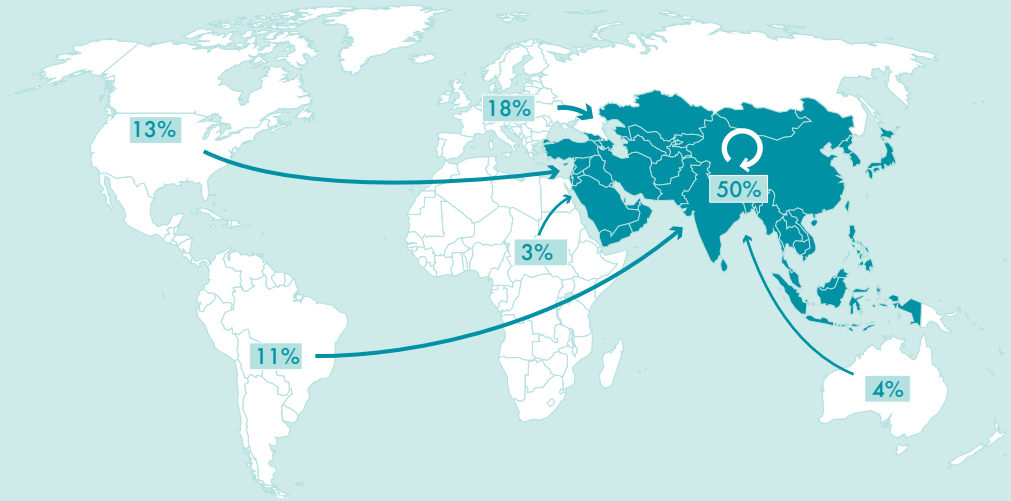
Continues on page 62 »

FIGURE 17

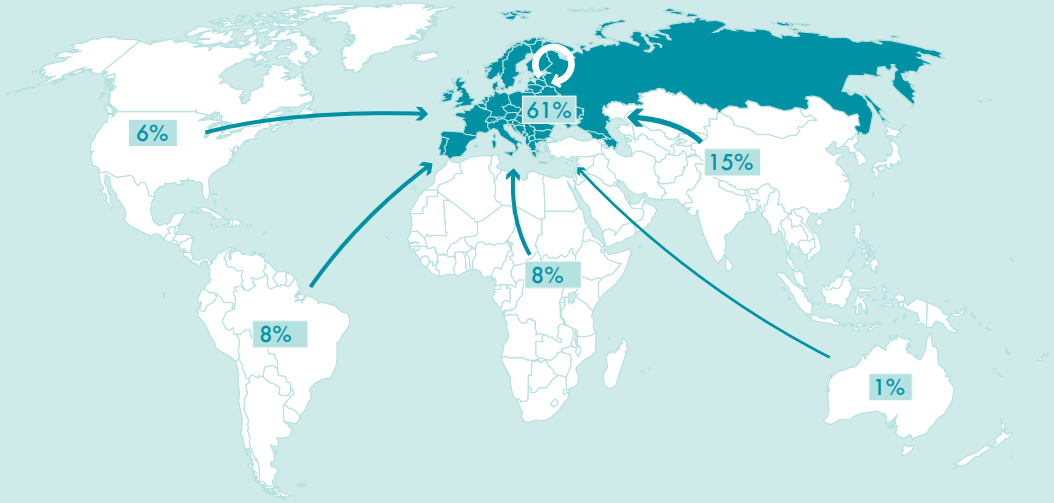
TRADE FLOWS BY CONTINENT (SHARE OF TOTAL IMPORTS IN VALUE), 2014



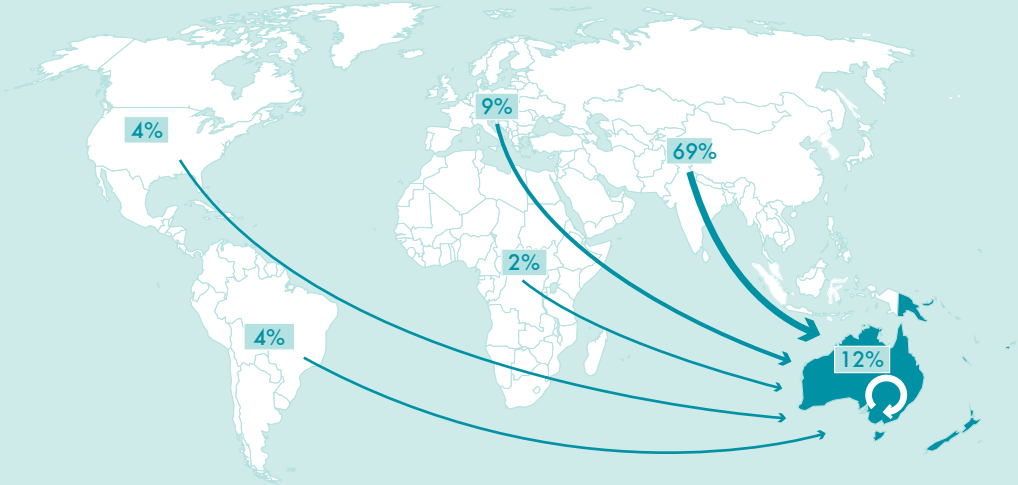
ASIA



EUROPE



OCEANIA



Note: The maps indicate the borders of the Republic of the Sudan for the period specified. The final boundary between the Republic of the Sudan and the Republic of South Sudan has not yet been determined.

FIGURE 18

IMPORTS AND EXPORTS OF FISH AND FISHERY PRODUCTS FOR DIFFERENT REGIONS, INDICATING NET DEFICIT OR SURPLUS

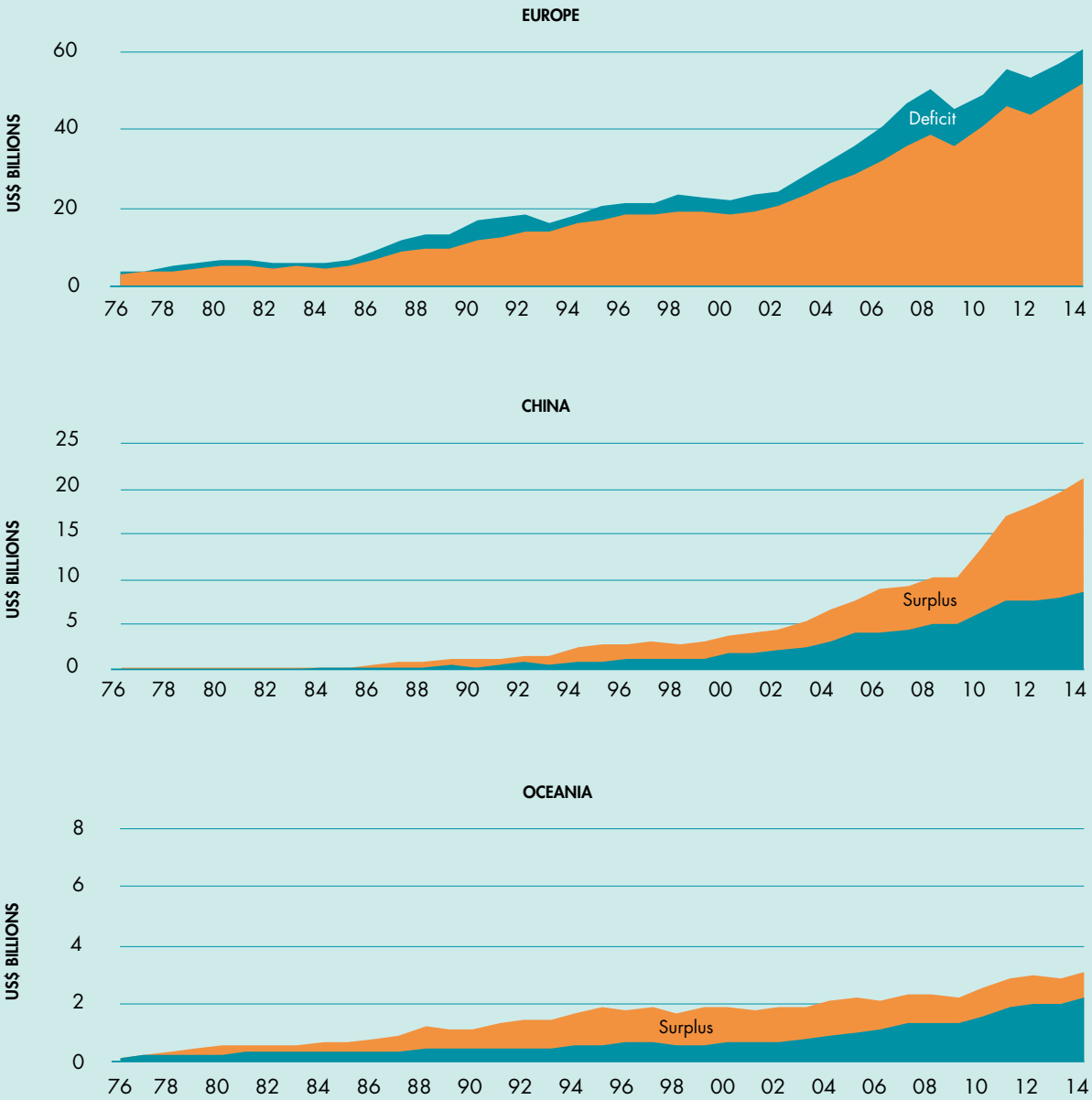

EUROPE
US$ BILLIONS
60
40
20
0
Deficit
76 78 80 82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 12 14
CHINA
US$ BILLIONS
25
20
15
10
5
0
Surplus
76 78 80 82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 12 14
OCEANIA
US$ BILLIONS
8
6
4
2
0
Surplus
76 78 80 82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 12 14
Export value (free on board)
Import value (cost, insurance, freight)

FIGURE 19

TRADE OF FISH AND FISHERY PRODUCTS

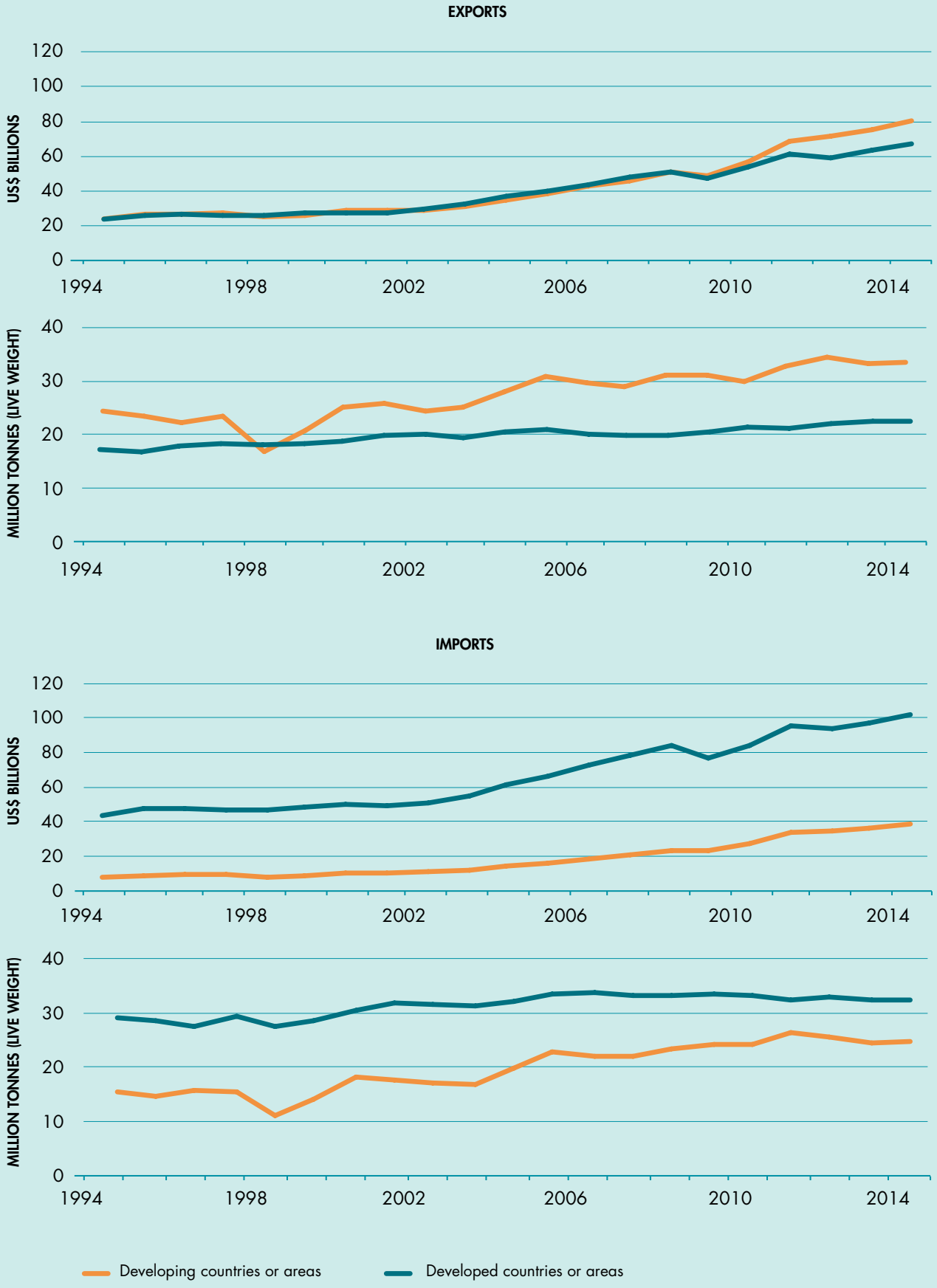
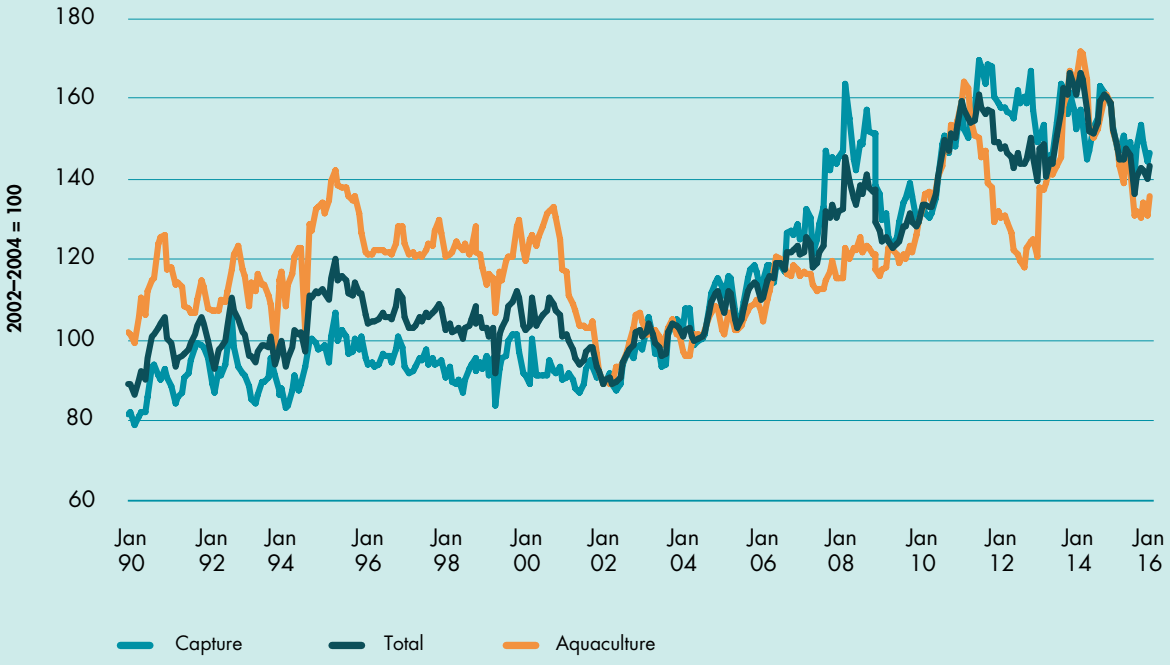


FIGURE 20

NET EXPORTS OF SELECTED AGRICULTURAL COMMODITIES BY DEVELOPING COUNTRIES

FIGURE 21

FAO FISH PRICE INDEX



DATA SOURCE: Norwegian Seafood Council.

» *Continued from page 55*

technical barriers to trade, which refer to technical regulations and standards that set out specific characteristics of a product. The WTO Agreement on Technical Barriers to Trade contains rules expressly aimed at preventing these measures from becoming unnecessary barriers, but they still exist and create difficulties for traders.

The difficulties in satisfying such import requirements can be also closely linked to internal structures in some countries. Despite technical advances and innovations, many countries still lack adequate infrastructure and services, which can affect the quality and/or safety of fishery products, contributing to their loss or difficulty in marketing. Some developing countries may have inadequate regulatory frameworks and institutional capacity for sustainable governance of the fishery sector, as well as limited access to credit and a lack of accurate and reliable market information. Trade in developing countries can also be influenced by how customs classification, valuation and clearance procedures are handled, including lengthy or duplicative certification procedures and burdensome entry requirements. Fishery products, which are often perishable, suffer particularly from delays, which may be one of the most significant contributing factors to post-harvest losses (in addition to inefficient harvesting, packaging and storage). High customs fees may also negatively affect trade. Overall, the impact of non-tariff barriers to trade and economic welfare is difficult to evaluate, but they are considered potentially significant. Complementary and compatible policies (education, governance, business environment, and macroeconomic stability) are very important for trade expansion and economic growth.

Some major issues in the past biennium that continue to affect international trade in fishery products are:

- the relationship between fisheries management policy, allocation of rights and the economic sustainability of the sector;
- the growing concern of the general public and the retail sector about overfishing of certain fish stocks;
- the role of the small-scale sector in fish production and trade;
- increasing concern about social and labour conditions within the industry and its suppliers;
- illegal, unreported and unregulated (IUU) fishing and its impact on the value chain as well as on labour conditions within the sector;
- the impact on the domestic fisheries and aquaculture sector from a surge in imports of farmed products;
- globalization of supply chains, with growing outsourcing of production;
- the significant increase in ecolabels and their possible effect on market access for developing countries;
- economic instability and the risk of increased protectionism using non-tariff barriers or high import tariffs;
- the impact of mega-regional trade agreements in the international flow of fishery products;
- the volatility of commodity prices in general and the impact on producers and consumers;
- currency exchange volatility and its impact on trade in fishery products;
- prices and distribution of margins and benefits throughout the fisheries value-chain;
- the incidence of fraud in the denomination of commercial names of fish and fishery products;
- difficulties for several countries in meeting stringent rules on quality and safety;
- the disparity between perceived and real risks and benefits to human health of fish consumption;
- stakeholders' perception of aquaculture.

The supply chain for fish and fishery products can involve a large number of stakeholders between the fisher/fish farmer and the final consumer. The above-mentioned issues can affect stakeholders to varying degrees, depending on their position in the value chain and their contractual relationship and relative negotiating strength with suppliers and clients.

Main commodities

Trade in fish and fishery products is becoming more complex, dynamic and highly segmented,

with greater diversification among species and product forms. This reflects both better-informed consumers exhibiting their tastes and preferences, and markets offering more diversity ranging from live aquatic animals to a wide variety of processed products. An important share of fishery trade consists of high-value species, such as salmon, shrimp, tuna, groundfish, bass and bream. However, some high-volume, but relatively low-value, species are also traded in large quantities not only nationally, but also at the regional and international level. For example, small pelagics are traded in large quantities, mainly being exported to low-income consumers in developing countries. However, emerging economies in developing countries have increasingly are also importing species of higher value for their domestic consumption.

Accurate and detailed trade statistics are essential for monitoring the fishery sector and to help provide a basis for appropriate fisheries management. Notwithstanding improvements in national trade statistics, many countries still provide little breakdown of information by species in their reporting of their international trade in fish. However, since 2012, this situation has improved thanks to the development of more appropriate classification schemes for internationally traded seafood (see Box 3). These developments are expected to improve the accuracy of the data on international trade in fish and fish products.

In recent decades, the dramatic expansion in aquaculture production has contributed significantly to increased consumption and commercialization of species that were once primarily wild caught, with farmed products representing a growing share of international fish trade. Despite recent improvements in trade classifications, international trade statistics do not distinguish between wild and farmed origin of the products. Hence, the exact breakdown between products of capture fisheries and aquaculture in international trade is open to interpretation. Estimates indicate that aquaculture products represent between 20–25 percent of traded quantities but 33–35 percent in value terms, indicating that an important segment of the industry is export-oriented and a producer of relatively high-value products destined for international markets. If only fish products for direct human consumption are considered, the share increases to 26–28 percent of traded quantities and 35–37 percent in value.

The rise of aquaculture has also had a profound impact on logistics and distribution. The larger volumes of farmed products have created the need for new transportation solutions, but the related transport costs have been more than offset by the higher volumes reducing the cost of distribution due to economies of scale, thereby increasing the competiveness of farmed fish products compared with other food and protein sources. This has enabled farmed seafood to create new markets and reach new consumers all over the world. This is especially the case for fresh, chilled and smoked products where both regional distribution by truck and inter-regional and international distribution by air, especially of fillets, have facilitated access to markets and consumers with regular supplies of farmed products. The distribution of frozen aquaculture products has also expanded dramatically, facilitated by increased volumes and much-reduced transportation costs. One example is the success of frozen whole tilapia and catfish from Asia, which have gained access to new markets in all regions of the world.

While many studies have analysed the degree of integration between wild and farmed fish in a range of markets, there is no overall consensus as to whether farmed fish prices will always respond to those of wild fish or vice versa, and whether one commands a natural premium. This depends on the species, the product form and the market being analysed. However, some heavily traded species such as salmon and shrimp do appear to display a significant degree of integration in terms of prices, suggesting that increased supply from aquaculture in these markets has been and will remain a major influencing factor in price trends. In recent years, with the exception of the period from mid-2013 to mid-2014, prices for species from capture fisheries increased by more than those for farmed species, as indicated by the FAO Fish Price Index,[35] which describes price

developments in a relatively heterogeneous sector (Figure 21).

Overall, international prices of fish were relatively high in 2014, declining slightly during part of 2015, although remaining on a high plateau. With a base year of 2002–04 = 100, the aggregated FAO Fish Price Index indicates that, after the peak in March 2014 (at 164), prices showed an overall downward trend reaching, 135 in July 2015, due to reduced consumer demand in key markets and increased supply of certain fishery species. Some of the most important traded species such as tuna, salmon and shrimp have all saw overall price declines in the first half of 2015. Other species such as herring, cephalopods, oysters and scallops saw price increases. By late 2015, prices had started to recover slightly.

Owing to their high perishability, 92 percent of trade in quantity terms (live weight equivalent) in fish and fishery products consisted of processed products (i.e. excluding live and fresh whole fish) in 2014. Fish is increasingly traded as frozen food (40 percent of the total quantity in 2014, compared with 22 percent in 1984). In the last four decades, prepared and preserved fish, including many value-added products, have doubled their share in total quantity, going from 9 percent in 1984 to 18 percent in 2014. Notwithstanding their perishability, trade in live, fresh and chilled fish has increased due to consumer demand and represented about 10 percent of world fish trade in 2014, also thanks to innovative chilling, packaging and distribution technology. Trade in live fish also includes ornamental fish, which is high in value terms but almost negligible in terms of quantity. In 2014, 78 percent of the quantity exported consisted of products destined for human consumption. Much fishmeal and fish oil is traded because, generally, the major producers (South America, Scandinavia and Asia) are distant from the main consumption centres (Europe and Asia).

The US$148 billion of exports of fish and fishery products in 2014 do not include an additional US$1.8 billion represented by seaweeds and other aquatic plants (62 percent), inedible fish by-products (27 percent), and sponges and corals (11 percent). Trade in aquatic plants increased from US$0.1 billion in 1984 to more than US$1 billion in 2014, with Indonesia, Chile and the Republic of Korea the major exporters, and China, Japan and the United States of America the leading importers. Owing to the increasing production of fishmeal and other products deriving from fishery residues from processing (see the section Fish utilization and processing, p. 45), trade in inedible fish by-products has also surged, up from just US$90 million in 1984 to US$0.2 billion in 2004 and US$0.5 billion in 2014.

Salmon and trout

The share of salmon and trout in world trade has increased strongly in recent decades, becoming the largest single commodity by value in 2013 (Table 16). Overall, demand is growing steadily, in particular for farmed Atlantic salmon, and new markets being opened up also through new types of processed products. Prices of farmed salmon have fluctuated during the last two years, but overall remained at high levels, in particular for Norwegian salmon, which is expected to represent a growing share in major markets. In contrast, in Chile, the second major producer and exporter, the salmon industry is facing falling prices and higher production costs than most other producing countries, with Chilean aquaculture companies incurring substantial losses in 2015. In addition to farmed production, catches of wild Pacific salmon have been particularly good during 2015, in particular in Alaska, where the total recorded wild harvest was the second highest of all time. These plentiful harvests drove down prices for all the major wild-caught species. It is also interesting to highlight that the recent approval of genetically modified salmon production by the Food and Drug Administration of the United States of America has been the subject of much public debate around the world.

Shrimps and prawns

After being the most-traded product for decades, shrimp now ranks second in value terms. Shrimps and prawn are mainly produced in developing countries, and much of this production enters international trade. However,

as economic conditions improve, growing domestic demand in these countries is leading to lower exports. In recent years, although global farmed shrimp production has increased, major producing countries, in particular in Asia, has experienced a decline in output because of shrimp disease. However, in 2015, for the first time since 2012, farmed shrimp production recovered in Thailand, a major producer and exporter. Global shrimp prices have fallen significantly year-on-year, although in 2014 they reached record highs (Figure 22). In the first half of 2015, shrimp prices plummeted by 15–20 percent compared with the first half of 2014, as a result of the supply and demand disparity in the United States of America, the EU and Japan. Lower prices have hit export revenues and negatively affected margins for producers in many developing regions.

Groundfish and other whitefish

The market for groundfish species, such as cod, hake, saithe and pollock, is widely diversified and is currently behaving quite differently from the norms of the past. Overall groundfish supply was higher in 2014 and 2015, thanks to the recovery in several stocks as a result of good management practices. However, there were differences according to species, with, for example, abundant supply of cod and a shortage of saithe and haddock. In general, groundfish prices have firmed in the last two years. Cod has remained one of the most expensive groundfish, despite experiencing slightly declining prices (Figure 23) while prices of haddock, saithe and hake have firmed.

Groundfish species used to dominate the world whitefish market but they are now experiencing strong competition from aquaculture species. Farmed whitefish species, in particular less-expensive alternatives such as tilapia and *Pangasius*, have entered traditional whitefish markets and are enabling the sector to expand substantially by reaching new consumers. *Pangasius*, with Viet Nam the main exporter, is a relatively recent species in international trade, but it is now being exported to a growing number of countries. Steady demand from across the globe for this relatively low-priced species is expected to drive its production development in other producing countries, particularly in Asia. In the last two years, demand has remained strong in the United States of America, the largest market, as well as in Asia and Latin America. In contrast, imports into the other major market, the EU, have shown a downward trend.

Tilapia remains a popular product in the retail sector in the United States of America, the largest market for this species, with countries in Asia (frozen product) and Central America (fresh product) the main suppliers. Demand in Europe for this species remains limited and imports declined slightly in 2015. Tilapia production is expanding in Asia, South America and Africa with a growing volume of supply entering domestic markets in the major producing countries. However, in 2015, China, a major producer, experienced rather sluggish production and reduced processing, reflecting a slow market. Overall, due to steady supply, import prices declined in most markets. For bream, 2015 saw lower supply and higher prices, while for bass supply was generally flat with only marginal price increase in some markets.

Tuna

In the last two years, tuna markets have been unstable owing to large variations in tuna landings, with consequent fluctuations in prices (Figure 24). In 2014, as a result of lower catches, global tuna prices increased, despite moderate demand. Traditionally the largest sashimi tuna market, Japan has been less active in recent years. In 2015, for the first time in history, imports of air-flown fresh tuna by the United States of America were higher than those by Japan. Japan's weak currency has had negative impacts on tuna imports, and imports of fresh tuna declined in 2015 compared with 2014. Competition has also been strong from the cheaper and popular salmon in the supermarket trade, where salmon sales seem to be exceeding sales of sashimi tuna. The canned tuna market experienced lower imports in some of the main markets including the United States of America, Italy and France, despite lower raw material price. This has led to a significant decline in frozen raw material imports into Thailand, the world's largest tuna-canning

Continues on page 70 »

BOX 3

IMPROVEMENT OF INTERNATIONAL CLASSIFICATIONS ON FISHERY COMMODITIES

Fishery and aquaculture production is processed and traded into a wide range of species and product forms. Detailed statistics on production and international trade of fishery commodities are important to help manage fisheries and to monitor the flow of fish from producers to consumer markets for food security and other purposes. It is possible to pursue such aims only if statistics are accurate and show, to the extent possible, the specification of the species and product forms being traded. In recent years, FAO has worked to improve the coverage of species and products in two main international organizations.

The Harmonized Commodity Description and Coding System (HS) serves as a basis for the collection of customs duties and international trade statistics by more than 200 countries, with more than 98 percent of the merchandise trade classified by the HS. This classification has been developed, introduced and maintained by the World Customs Organization (WCO).[1] Since its introduction and general adoption in 1988, the HS classification has undergone regular reviews.

Since 2007, FAO has worked with the WCO to improve the quality of fish trade coverage through improved specification for species and product forms in the HS. The current version, HS 2012, and the next one, HS 2017, both reflect modifications proposed by FAO. Earlier HS versions presented an insufficient coverage of fishery species, in particular of those originating in developing countries. Compared with HS 2007, for fish and fishery products, HS 2012 saw the implementation of about 190 amendments and the introduction of about 90 new commodities (species by different product form). Within the limits of the available codes, the classification was restructured according to main groups of species of similar biological characteristics.

On 1 January 2017, HS 2017 will enter into force for all parties to the HS convention. It will include further amendments for fishery species and/or product forms that need to be monitored for food security purposes and/or for better management of fisheries, in particular for conservation of potentially endangered species, including sharks, skates and rays and stromboid conchs. In total, 36 new subheadings have been created and 36 subheadings amended.

The process leading to an updated HS 2022 has just started. FAO is considering continuing its cooperation with the WCO to further improve the coverage and scope of the agriculture, forestry and fishery products for enhanced monitoring of trade flows.

FAO has also worked with the United Nations Statistics Division on the revision of the Central Product Classification (CPC) for goods and services. The CPC is an international standard for organizing and analysing data on industrial production, national accounts, trade, prices, etc. On 11 August 2015, CPC Version 2.1 was released.[2] It includes modifications proposed by FAO to improve the breakdown for fish and fishery products, with the separation of primary commodities by wild and farmed origin.

1 World Customs Organization. 2012–2016. Overview. In: *World Customs Organization* [online]. [Cited 5 April 2016]. www.wcoomd.org/en/topics/nomenclature/overview.aspx

2 UN. 2015. Central Product Classification (CPC) Ver.2.1. In: *United Nations Statistics Division* [online]. [Cited 5 April 2016]. http://unstats.un.org/unsd/cr/registry/cpc-21.asp

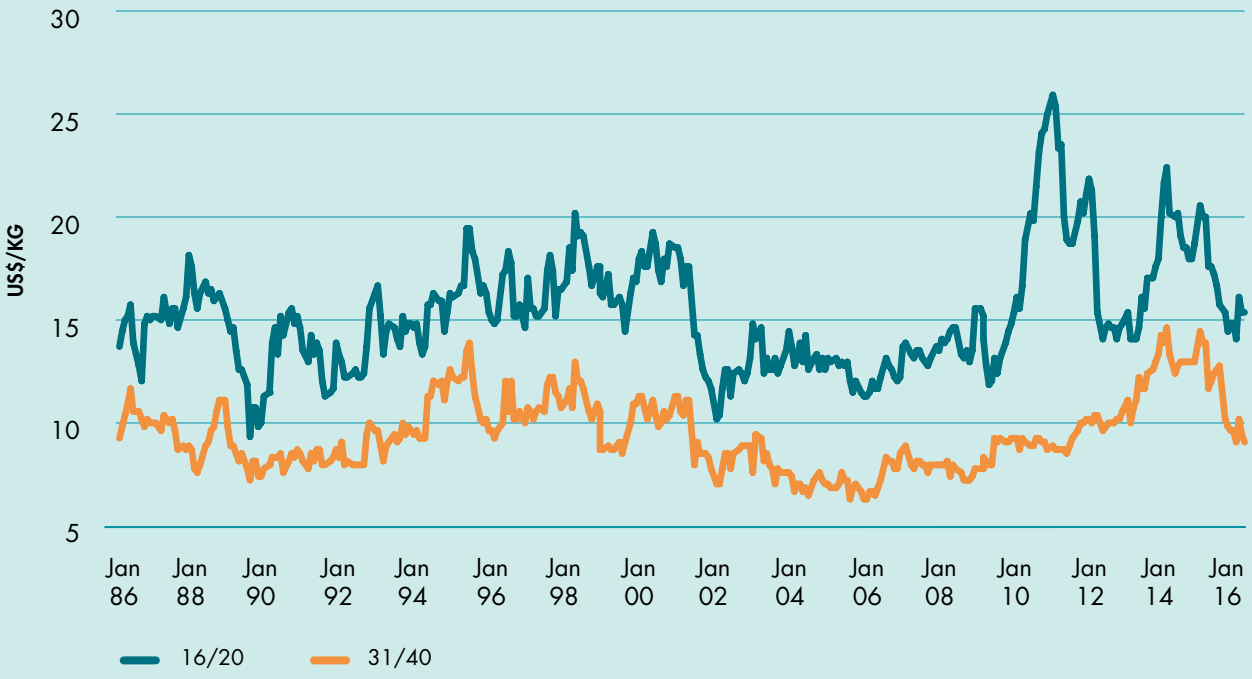
TABLE 16

SHARES OF MAIN GROUPS OF SPECIES IN WORLD TRADE, 2013

	SHARE BY VALUE	SHARE BY QUANTITY (LIVE WEIGHT)
	(Percentage)	
Fish	**67.7**	**80.6**
Salmons, trouts, smelts	16.6	7.2
Tunas, bonitos, billfishes	10.2	8.3
Cods, hakes, haddocks	9.6	14.4
Other pelagic fish	7.5	12.7
Freshwater fish	4.0	4.8
Flounders, halibuts, soles	1.6	2.1
Other fish	18.1	31.2
Crustaceans	**21.7**	**8.2**
Shrimps, prawns	15.3	6.0
Other crustaceans	6.4	2.1
Molluscs	**9.8**	**10.4**
Squids, cuttlefishes, octopuses	5.6	4.0
Bivalves	3.0	5.6
Other molluscs	1.1	0.7
Other aquatic invertebrates/animals	**0.8**	**0.9**
TOTAL	100.0	100.0

FIGURE 22

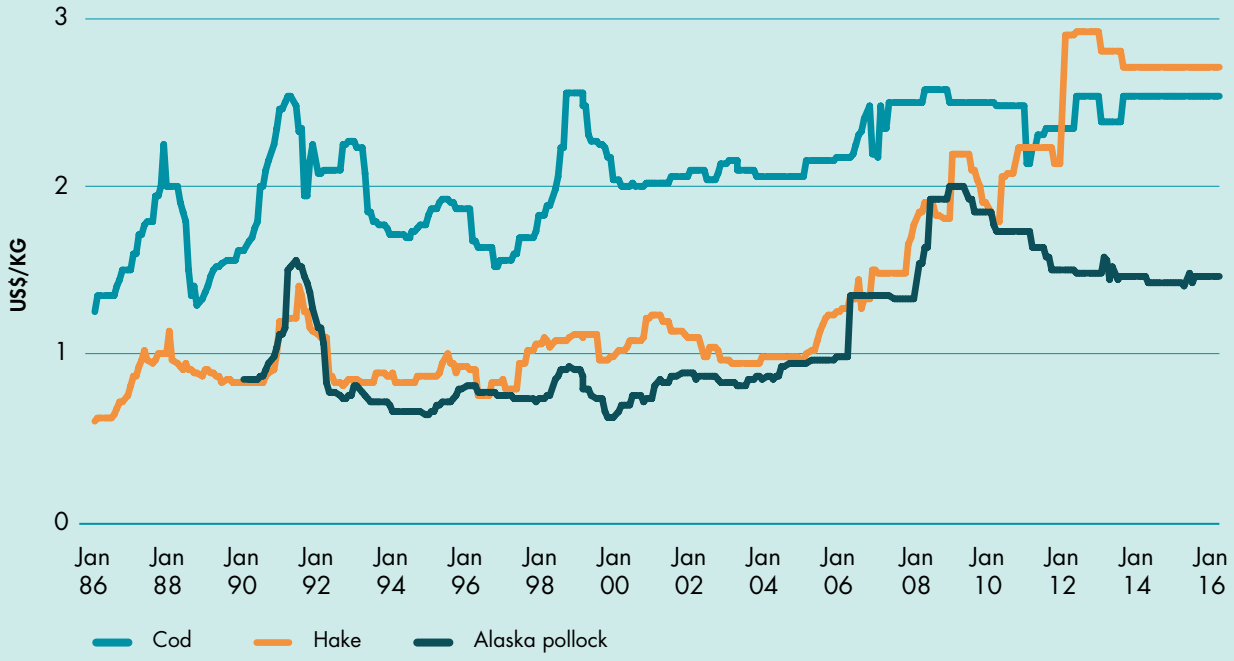
SHRIMP PRICES IN JAPAN



Note: 16/20 = 16–20 pieces per pound; 31/40 = 31–40 pieces per pound.
Data refer to wholesale prices for black tiger, headless, shell-on shrimps. Origin: Indonesia.

FIGURE 23

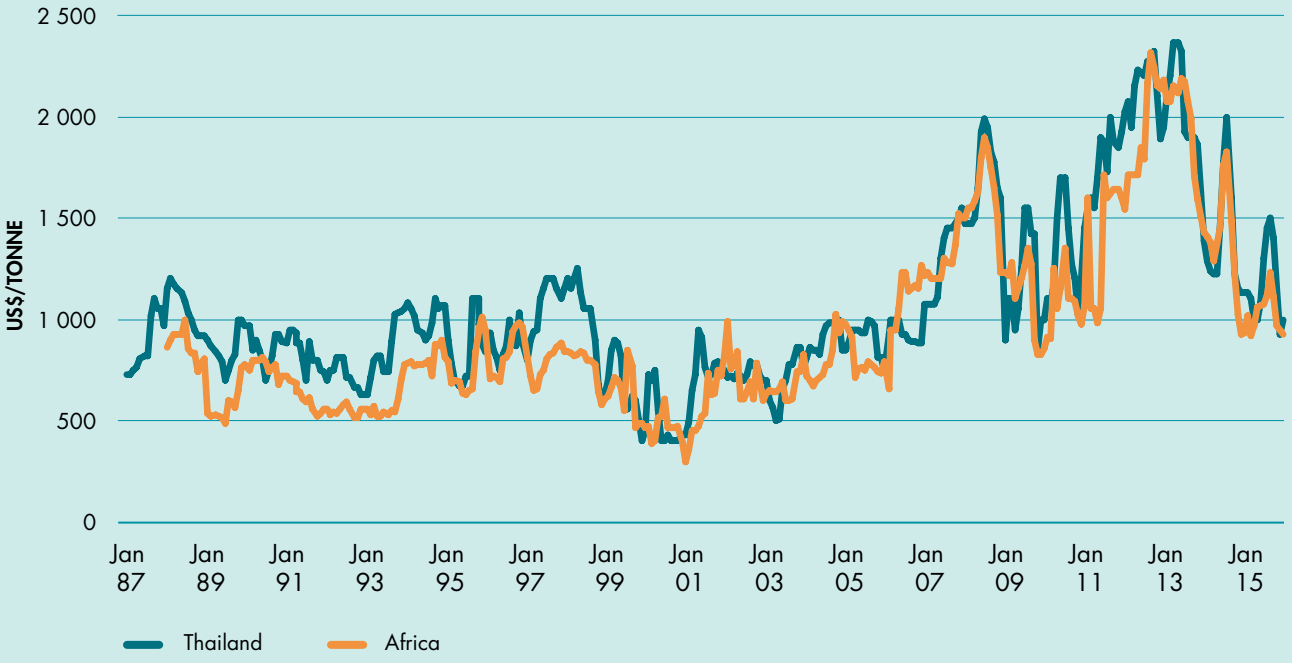
GROUNDFISH PRICES IN THE UNITED STATES OF AMERICA



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

FIGURE 24

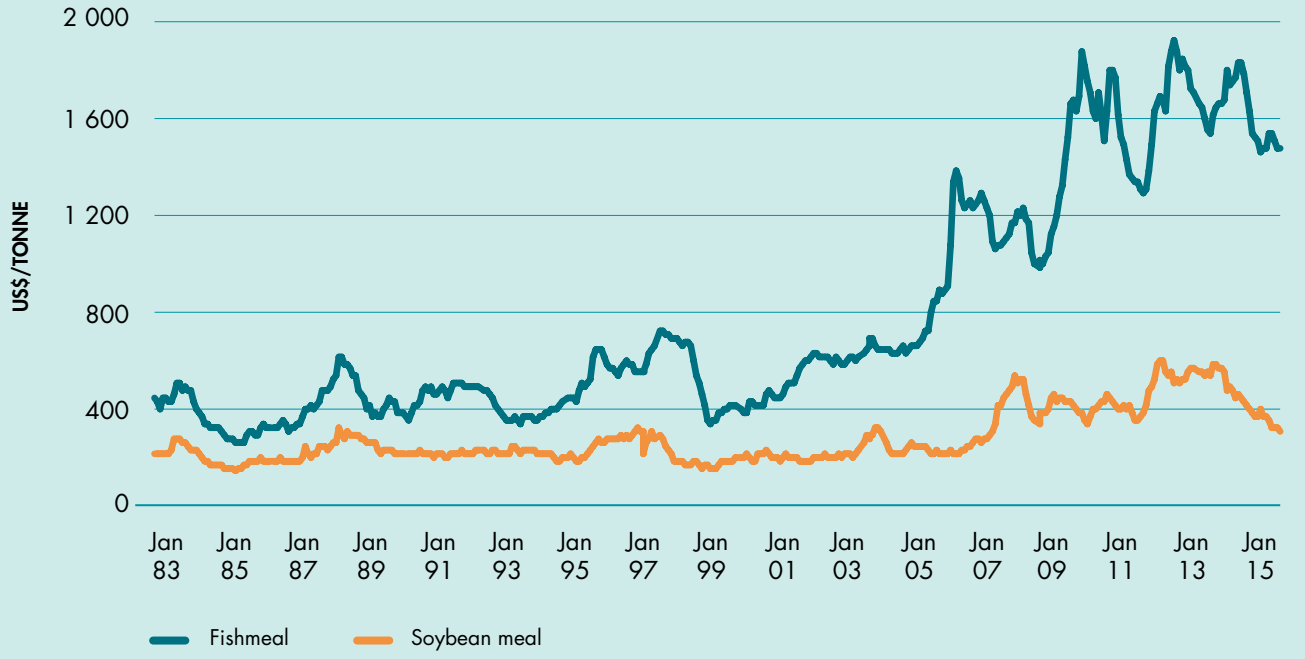
SKIPJACK TUNA PRICES IN AFRICA AND THAILAND



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

FIGURE 25

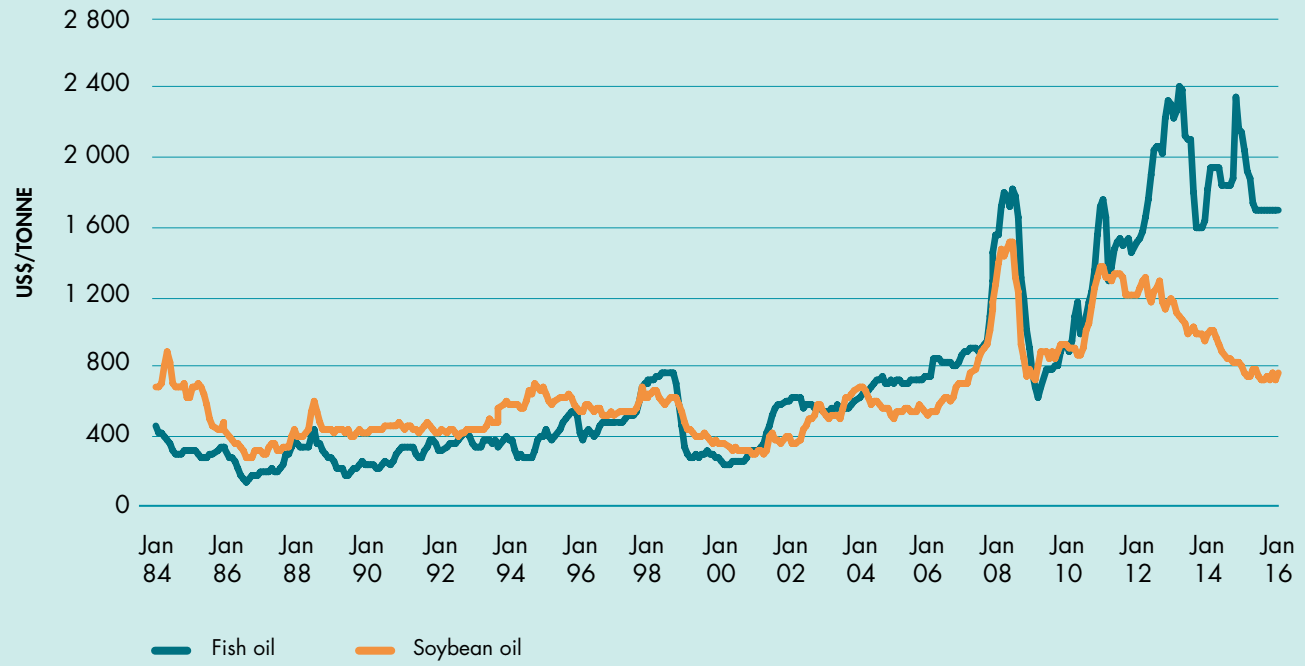
FISHMEAL AND SOYBEAN MEAL PRICES IN GERMANY AND THE NETHERLANDS



Note: Data refer to c.i.f. prices. Fishmeal: all origins, 64–65 percent, Hamburg, Germany. Soybean meal: 44 percent, Rotterdam, the Netherlands.
SOURCE: Oil World; FAO GLOBEFISH.

FIGURE 26

FISH OIL AND SOYBEAN OIL PRICES IN THE NETHERLANDS



Note: Data refer to c.i.f. prices. Origin: South America; Rotterdam, the Netherlands.
SOURCE: Oil World; FAO GLOBEFISH.

» *Continued from page 65*

producer. In contrast, demand for canned tuna improved in the Near East, East Asia, and in non-conventional markets, especially in Asia and in Latin America as prices fell. Lower prices also resulted in strong demand for cooked tuna loins by canning processors in the EU.

Cephalopods

Demand and consumption of cephalopods (cuttlefish, squid and octopus) has increased slightly in recent years. Spain, Italy and Japan remain the largest consumers and importers of these species. Thailand, Spain, China, Argentina and Peru were the largest exporters of squid and cuttlefish, while Morocco, Mauritania and China were the principal octopus exporters. Viet Nam is expanding its markets for cephalopods, including squid, in Southeast Asia. Other Asian countries such as India and Indonesia are also important suppliers. In 2014–15, major market increases were recorded for octopus rather than squid and cuttlefish. Slow for some time, the cuttlefish market showed signs of recovery in late 2015, also in response to the tight squid supplies. While octopus prices declined in 2015 as a result of an improved supply situation, squid prices also dropped, mainly because of low demand.

Fishmeal

With annual oscillations mainly caused by El Niño phenomena, fishmeal production has declined gradually since 2005, while overall demand has continued to grow, pushing prices to historic highs through late 2014. Prices then declined until mid-2015 (Figure 25) when high expectations for a strong El Niño started to push up prices again. Fishmeal prices are expected to remain high in the long term because of sustained demand. In 2015, total production was higher compared with 2014, but Chile produced less. In 2015, both Peru and Chile, the main exporters, recorded the lowest export volumes in the past six years. China remained the leading importer of fishmeal with 2015 import volumes at the same levels as 2014.

Fish oil

Fish-oil production is also declining, mainly because of lower production in Latin America, and more stringent quotas on raw materials, contributing to price pressure and increased volatility. In 2015, fish-oil production slightly declined compared with 2014, with reduced contributions from Peru and in particular from Chile. Fish-oil prices peaked in 2014, then decreased until mid-2015 (Figure 26) before rising slightly for the rest of the year. Demand for fish oil is high because it is used as a human nutritional supplement as well as an important ingredient in feeds for selected carnivorous fish species. Due to the steady and growing demand, long-term fish oil prices are not expected revert to lower levels. ■

FISH CONSUMPTION[36]

The significant growth in fisheries and aquaculture production in the past 50 years, especially in the last two decades, has enhanced the world's capacity to consume diversified and nutritious food. A healthy diet has to include sufficient proteins containing all essential amino acids, essential fats (e.g. long-chain omega-3 fatty acids), vitamins and minerals. Being a rich source of these nutrients, fish can be nutritionally very important (see section Nutrition, p. 151). It is rich in various vitamins (D, A and B) as well as minerals (including calcium, iodine, zinc, iron and selenium), particularly if eaten whole. It is a source of easily digested, high-quality proteins containing all essential amino acids. While average per capita fish consumption may be low, even small quantities of fish can have a significant positive nutritional impact on plant-based diets, and this is the case in many LIFDCs and least-developed countries. In addition, fish is usually high in unsaturated fats, particularly long-chain omega-3 fatty acids. Fish provides health benefits in protection against cardiovascular diseases and assists in development of the brain and nervous system in the foetus and infants. Experts agree that the positive effects of high fish consumption largely outweigh the potential negative effects associated with contamination/safety risks.[37]

In terms of a daily global average, fish provides only about 34 calories per capita. However, it can

exceed 130 calories per capita in countries where there is a lack of alternative protein food and where a preference for fish has been developed and maintained (e.g. Iceland, Japan, Norway, the Republic of Korea and several small island States). The dietary contribution of fish is more significant in terms of animal proteins, as a portion of 150 g of fish provides about 50–60 percent of the daily protein requirements for an adult. Fish proteins can represent a crucial component in the diets of some densely populated countries where total protein intake levels may be low. The dietary pattern in many of these countries can reveal heavy dependence on staple foods, with fish consumption becoming particularly important in helping to improve the calorie/protein ratio. In addition, for these populations, fish often represents an affordable source of animal protein that may not only be cheaper than other animal protein sources, but preferred and part of local and traditional recipes. For example, fish contributes, or exceeds, 50 percent of total animal protein intake in some small island developing States, as well as in Bangladesh, Cambodia, Ghana, Indonesia, Sierra Leone and Sri Lanka. In 2013, fish accounted for about 17 percent of animal protein, and 6.7 percent of all protein, consumed by the global population. Moreover, fish provided more than 3.1 billion people with almost 20 percent of their average per capita intake of animal protein (Figure 27).

Overall, world supply of fish for human consumption has kept ahead of population growth over the past five decades, growing at an average annual rate of 3.2 percent in the period 1961–2013, compared with 1.6 percent for world population growth. Hence, average per capita availability has risen. World per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 19.7 kg in 2013, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg. Production increases alone do not explain such an expansion. Many other factors have contributed, including reduced wastage, better utilization, improved distribution channels and growing demand, interlinked with population growth, rising incomes and urbanization. International trade has also played an important role by providing wider choices to consumers.

The distribution of the increase in fish consumption has been unequal among countries and within countries and regions in terms of quantity and variety consumed per head. For example, per capita fish consumption has remained static or decreased in some countries in sub-Saharan Africa (e.g. Côte d'Ivoire, Liberia, Nigeria and South Africa) and, albeit from a high level, in Japan in the last two decades. It has grown most substantially in East Asia (from 10.8 kg in 1961 to 39.2 kg in 2013), Southeast Asia (from 13.1 to 33.6 kg) and North Africa (from 2.8 to 16.4 kg). China has been responsible for most of the growth in world per capita fish availability in the last two decades, owing to the dramatic expansion in its fish production, in particular from aquaculture, with a significant share of this production being exported. Per capita apparent fish consumption in China has increased steadily, reaching about 37.9 kg in 2013 (14.4 kg in 1993), with an average annual growth rate of 5.0 percent in the period 1993–2013. In the last few years, fuelled by growing domestic income and wealth, consumers in China have experienced a diversification of the types of fish available owing to a diversion of some fishery exports towards the domestic market as well as an increase in fishery imports. If China is excluded, annual per capita fish supply in the rest of the world was about 15.3 kg in 2013, higher than the average values of the 1960s (11.5 kg), 1970s (13.4 kg) and 1980s (14.1 kg). In the 1990s, world per capita fish supply, excluding China, was relatively stable at 13.1–13.6 kg and lower than in the 1980s, as population grew more rapidly than the supply of fish for human consumption (at annual rates of 1.6 and 0.9 percent, respectively). However, since the early 2000s, supply has again outpaced population growth (at annual rates of 2.5 and 1.4 percent, respectively). Table 17 (p. 77) summarizes per capita fish supply by continent and major economic group. Of the 140.8 million tonnes available for human consumption in 2013,[38] Asia accounted for more than two-thirds of the total, with 99 million tonnes (23.0 kg per capita), of which 46.5 million tonnes outside China

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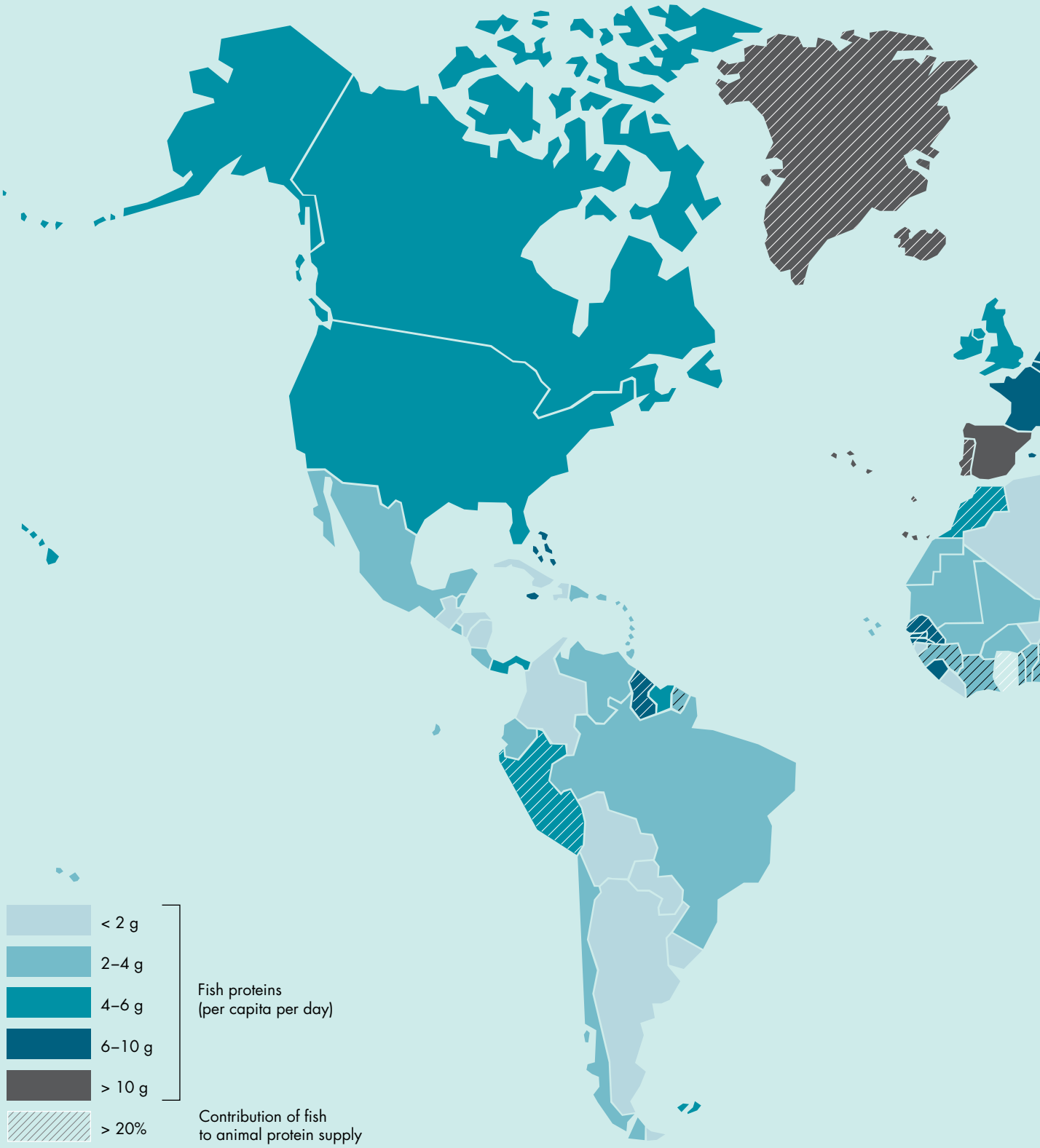
FIGURE 27

CONTRIBUTION OF FISH TO ANIMAL PROTEIN SUPPLY (AVERAGE 2011–2013)



Note: The map indicates the borders of the Republic of the Sudan for the period specified.
The final boundary between the Republic of the Sudan and the Republic of South Sudan has not yet been determined.

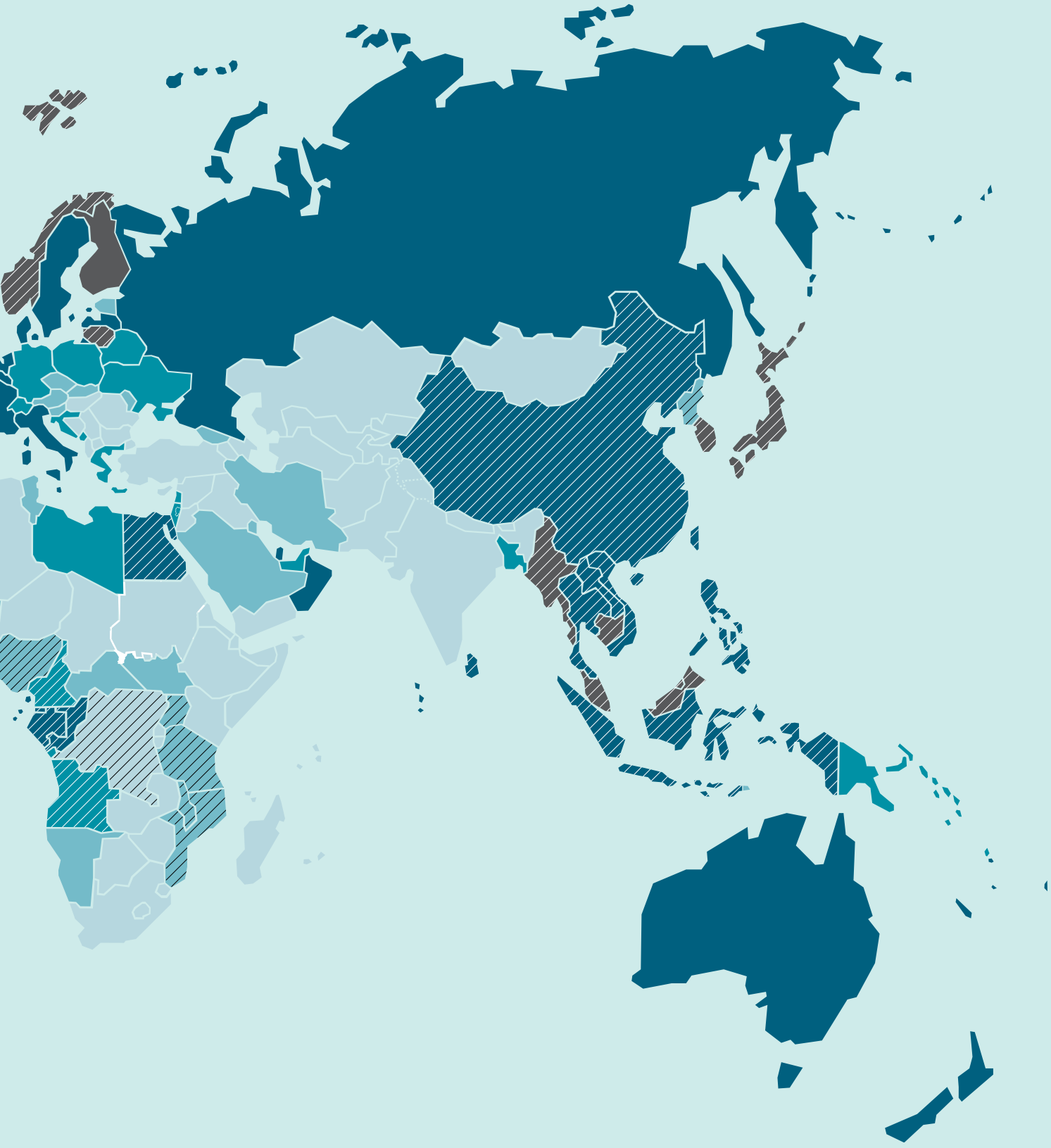
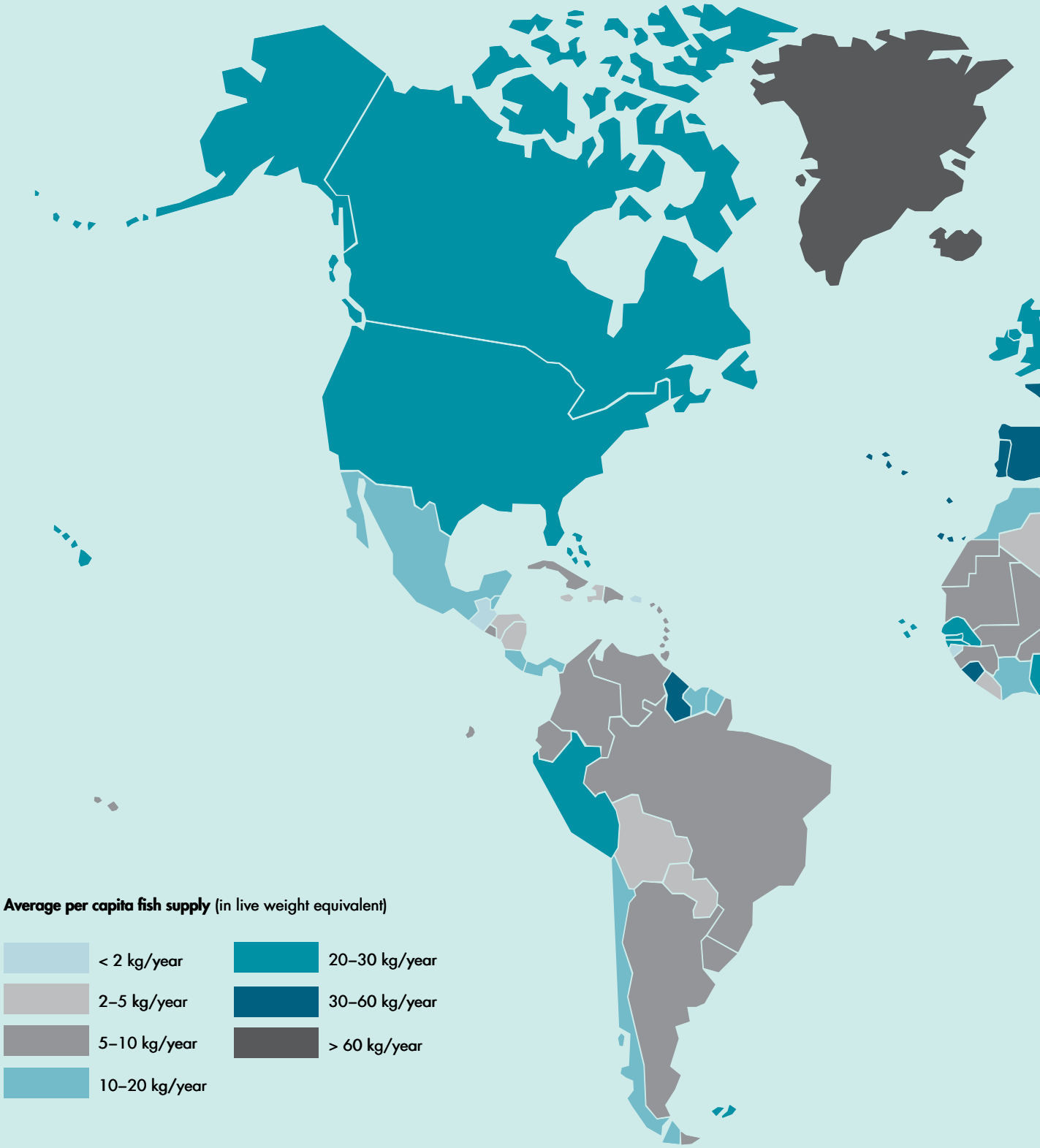
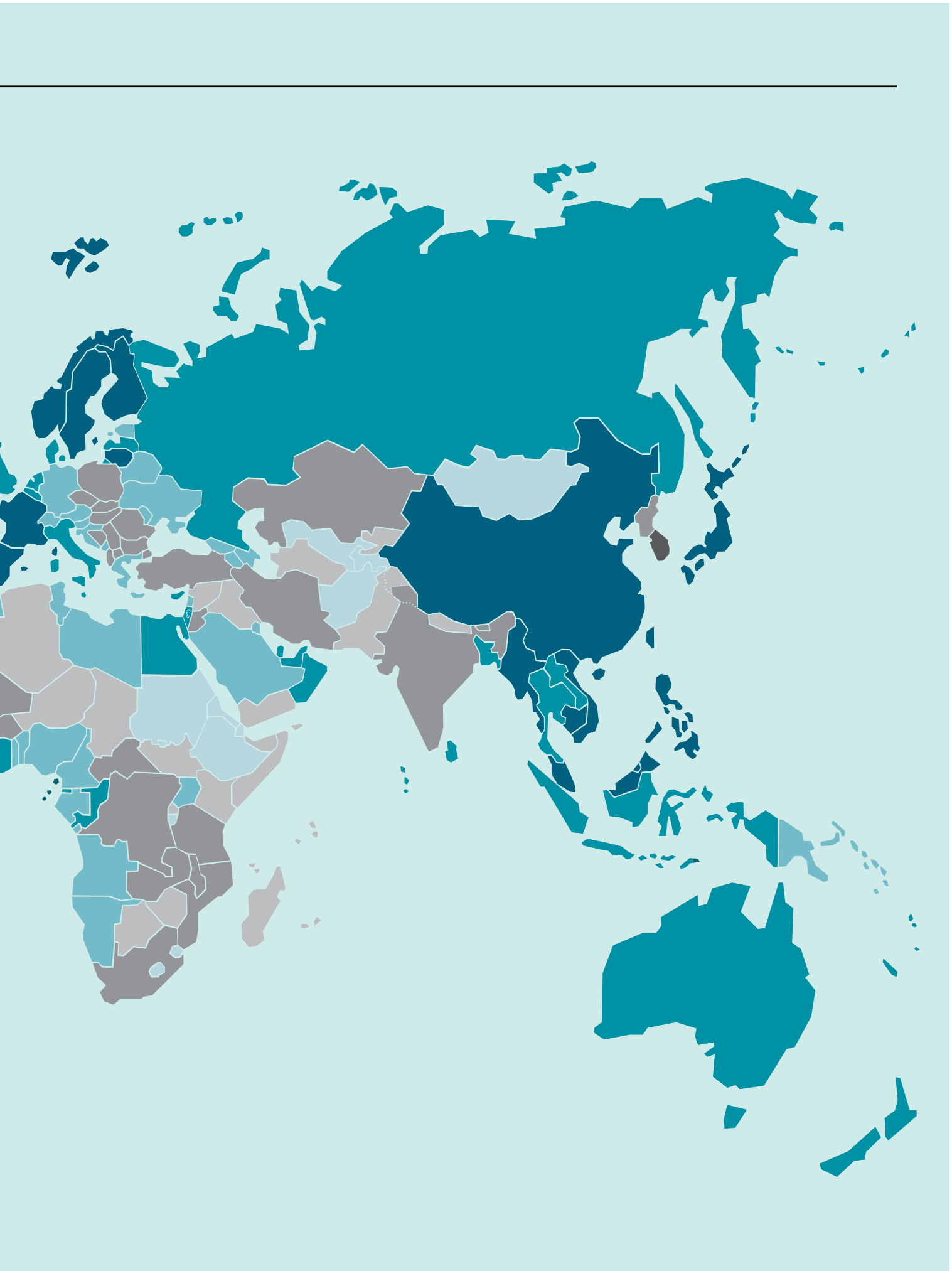


FIGURE 28

FISH AS FOOD: PER CAPITA SUPPLY (AVERAGE 2011–2013)



Note: The map indicates the borders of the Republic of the Sudan for the period specified.
The final boundary between the Republic of the Sudan and the Republic of South Sudan has not yet been determined.



» *Continued from page 71*

(16.0 kg per capita), while fish supply was far lower in Oceania (although per capita consumption was high) and in Africa.

The contribution of fish to nutritional intake varies considerably between and within countries and regions in terms of quantity and variety consumed per capita (Figures 27 and 28). These dissimilarities in consumption depend on the availability and cost of fish and alternative foods, as well as the accessibility of fishery resources in adjacent waters, disposable income and socio-economic and cultural factors such as food traditions, eating habits, tastes, demand, seasons, prices, marketing, infrastructure and communication facilities. Annual per capita apparent fish consumption can vary from less than 1 kg in one country to more than 100 kg in another (Figure 28). Differences may also be significant within countries, with consumption usually higher in coastal, riverine and inland water areas.

Disparities in fish consumption also exist between the more-developed and less-developed countries. Although annual per capita consumption of fishery products has grown steadily in developing regions (from 5.2 kg in 1961 to 18.8 kg in 2013) and in LIFDCs (from 3.5 to 7.6 kg),[39] it is still considerably lower than in more developed regions, although the gap is narrowing. Actual values may be higher than indicated by official statistics in view of the under-recorded contribution of subsistence fisheries and some small-scale fisheries. In 2013, per capita apparent fish consumption in industrialized countries was 26.8 kg, while for all developed countries it was estimated at 23.0 kg. A sizeable and growing share of fish consumed in developed countries consists of imports, owing to steady demand and static or declining domestic fishery production. In developing countries, fish consumption tends to be based on locally and seasonally available products, and the fish chain is driven by supply rather than demand. However, fuelled by rising domestic income and wealth, consumers in emerging economies are experiencing a diversification of the types of fish available owing to an increase in fishery imports.

Differences among developed and developing countries exist also with reference to the contribution of fish to animal protein intake. Despite their relatively lower levels of fish consumption, developing countries and LIFDCs have a higher share of fish protein in their diets compared with developed countries and the overall world average. In 2013, fish accounted for about 20 percent of animal protein intake in developing countries and about 18 percent in LIFDCs. This share had been increasing but has stagnated in recent years due to the growing consumption of other animal proteins. In developed countries, the share of fish in animal protein intake, after consistent growth up to 1989, weakened from 13.9 percent in 1989 to 11.7 percent in 2013, while consumption of other animal proteins continued to increase.

In the last two decades, dramatic growth in aquaculture production has boosted average consumption of fish and fishery products at the global level. The shift towards relatively greater consumption of farmed species compared with wild fish reached a milestone in 2014, when the farmed sector's contribution to the supply of fish for human consumption surpassed that of wild-caught fish for the first time. This represents an impressive rise as the share of fish from aquaculture in total supply was 7 percent in 1974, 26 percent in 1994 and 39 percent in 2004 (Figure 29). China has played a major role in this growth as it represents over 60 percent of world aquaculture production. However, even if China is excluded, it is estimated that the share of aquaculture in fish for human consumption was about 33 percent in 2013, up from about 15 percent in 1995. This further underscores how the aquaculture sector has made a significant impact in all regions, supplying local, regional and international markets with nutritious and attractive products.

Species such as shrimps, salmon, bivalves, tilapia, carp and catfish (including *Pangasius*) have been instrumental in driving global demand and consumption, thanks to the shift from being primarily wild-caught to aquaculture-produced, with a decrease in their prices and a strong increase in their commercialization. Aquaculture »

TABLE 17

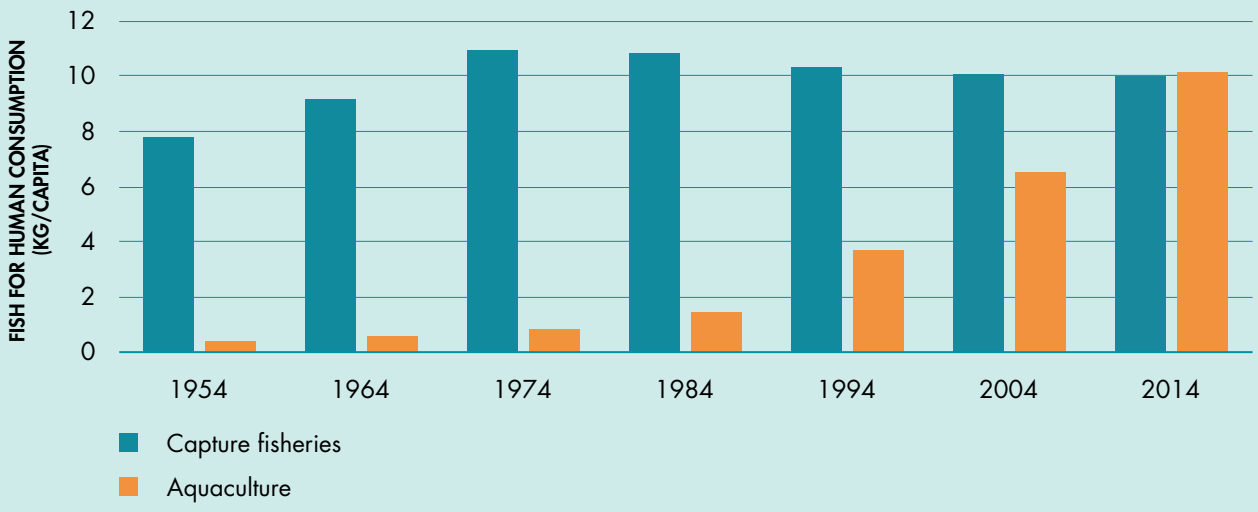
TOTAL AND PER CAPITA FOOD FISH SUPPLY BY CONTINENT AND ECONOMIC GROUPING IN 2013[1]

	TOTAL FOOD SUPPLY	PER CAPITA FOOD SUPPLY
	(Million tonnes live weight equivalent)	*(kg/year)*
World	**140.8**	**19.7**
World (excluding China)	88.3	15.3
Africa	10.9	9.8
North America	7.6	21.4
Latin America and the Caribbean	5.8	9.4
Asia	99.0	23.0
Europe	16.5	22.2
Oceania	1.0	24.8
Industrialized countries	26.5	26.8
Other developed countries	5.6	13.9
Least-developed countries	11.1	12.4
Other developing countries	97.6	20.0
LIFDCs[2]	18.6	7.6

[1] Preliminary data.
[2] Low-income food-deficit countries.

FIGURE 29

RELATIVE CONTRIBUTION OF AQUACULTURE AND CAPTURE FISHERIES TO FISH FOR HUMAN CONSUMPTION



» is also important for food security through the significant production of some low-value freshwater species (also through integrated farming) destined mainly for domestic consumption.

Owing to the rising production of shrimps, prawns and molluscs from aquaculture and the relative decline in their price, annual per capita availability of crustaceans grew substantially from 0.4 kg in 1961 to 1.8 kg in 2013, and that of molluscs (including cephalopods) rose from 0.8 to 3.1 kg in the same period. The increasing production of salmon, trout and selected freshwater species has led to a significant growth in annual per capita consumption of freshwater and diadromous species, up from 1.5 kg in 1961 to 7.3 kg in 2013. In recent years, no major changes have been experienced by the other broader groups, with many species still originating overwhelmingly from capture fisheries production. Annual per capita consumption of demersal and pelagic fish species has stabilized at about 2.9 and 3.1 kg, respectively. Demersal fish remain among the main species favoured by consumers in Northern Europe and in North America (annual per capita consumption of 9.2 and 4.3 kg, respectively, in 2013). Cephalopods are mainly preferred by Mediterranean and East Asian countries. Of the 19.7 kg of fish per capita available for consumption in 2013, about 74 percent came from finfish. Shellfish supplied almost 25 percent (or about 4.9 kg per capita, subdivided into 1.8 kg of crustaceans, 0.5 kg of cephalopods and 2.6 kg of other molluscs). At present, seaweeds and other algae are not included in the FAO Food Balance Sheets for fish and fishery products. However, an important portion of their production is consumed as food in several cultures, notably in Asia. For example, in Japan, the red seaweed, nori (*Pyropia* and *Porphyra*), is a traditional wrapping for sushi and used in soups. In addition, wakame (*Undaria pinnatifida*), Japanese kelp (*Laminaria* / *Saccharina japonica*) and mozuko seaweed (*Nemacystus* spp.) are cultivated for food.

In the last two decades, the consumption of fish and fishery products has also been considerably influenced by globalization in food systems and by innovations and improvements in processing, transportation, distribution, marketing, and food science and technology. These factors have led to significant enhancements in efficiency, lower costs, wider choice, and safer and improved products. Owing to the perishability of fish, developments in long-distance refrigerated transport and large-scale and faster shipments have facilitated the trade and consumption of an expanded variety of species and product forms, including live and fresh fish. Consumers can benefit from increased choice, with imports boosting the availability of fish and fishery products in the domestic markets. Global dietary patterns, while still highly diverse, have become more homogeneous and globalized, with a tendency to shift away from staples such as roots and tubers towards more proteic food products, in particular, meat, fish, milk, eggs and vegetables. Protein availability has risen overall, but this increase has not been equally distributed. The supply of animal protein remains significantly higher in industrialized and other developed countries than in developing countries. However, having attained a high level of consumption of animal protein, more developed economies are reaching saturation levels and are less reactive than low-income countries to income growth and other changes.

Consumer habits are also changing, and issues such as overindulgence, convenience, health, ethics, variety, value for money, sustainability and safety are becoming more important. Health and well-being are increasingly influencing consumption decisions, and fish has a particular prominence in this respect, as mounting evidence confirms the health benefits of eating fish. The food sector in general is facing structural changes as a result of growing incomes, new lifestyles, globalization, trade liberalization and the emergence of new markets. World food markets have become more flexible, with new products entering them, including value-added products that are easier for consumers to prepare. The rise in fish consumption has been further boosted by growth in modern retail channels such as supermarkets and hypermarkets, and in many countries more than 70–80 percent of retail purchases of seafood take place there. This is a

major shift from a few decades ago when traditional fishmongers and municipal markets were the main retail outlets for such purchases in most countries. Retail chains, transnational companies and supermarkets are also increasingly driving consumption patterns, particularly in developing countries, offering consumers a wider choice, reduced seasonal fluctuation in availability and, often, safer food. Several developing countries, especially in Asia and Latin America, have experienced a rapid expansion in the number of supermarkets.

Growing urbanization is also markedly influencing food consumption patterns, with an impact also on demand for fishery products. Urbanization stimulates enhancements in marketing, distribution, cold chains and infrastructure, and the subsequent availability of and accessibility to a wider choice of food products. Moreover, compared with the inhabitants of rural areas, city dwellers tend to spend a greater share of their income on food and to consume a more diversified typology of food, richer in animal proteins and fats. In addition, they generally eat out of the home more frequently, and consume larger quantities of fast and convenience foods. According to the United Nations,[40] the urban population has grown rapidly since 1950, from 746 million to 3.9 billion in 2014, or from 30 percent to 54 percent of the world's population. This share is expected to reach 66 percent by 2050. Disparities in urbanization levels persist among countries and regions of the world. In 2014, the most urbanized regions included Northern America (82 percent living in urban areas), Latin America and the Caribbean (80 percent), and Europe (73 percent). In contrast, Africa and Asia remain mostly rural, with 40 and 48 percent of their respective populations living in urban areas, and together they are home to almost 90 percent of the world's rural population. However, Asia, despite its lower level of urbanization, is home to 53 percent of the world's urban population, followed by Europe (14 percent) and Latin America and the Caribbean (13 percent). Despite the shift towards urban living, the rural population of the world has grown slowly since 1950 and is projected to peak in a few years. The global rural population is now almost 3.4 billion and expected to decline to 3.2 billion by 2050. India has the largest rural population (857 million), followed by China (635 million).

The majority of undernourished people live in the rural areas of developing countries. Despite improvements in per capita availability of food and positive long-term trends in nutritional standards, undernutrition (including inadequate levels of consumption of protein-rich food of animal origin) remains a huge and persistent problem. According to *The State of Food Insecurity in the World 2015*,[41] many people still lack the food they need for an active and healthy life. The report indicates that in 2014–16, about 795 million people (10.9 percent of the world's population) were undernourished, of whom 780 million in the developing regions. This represents a drop of 167 million over the last decade, and 216 million fewer than in 1990–92. The decrease has been more pronounced in developing regions, despite their significant population growth. In recent years, progress in the fight against hunger has been hindered by slower and less inclusive economic growth as well as by political instability in some regions, such as Central Africa and Western Asia. In the developing regions as a whole, the share of undernourished people in the total population has decreased from 23.3 percent in 1990–92 to 12.9 percent in 2014–16. Different rates of progress across regions have led to changes in the distribution of undernourished people in the world. Most of the world's undernourished people are still to be found in Southern Asia, followed closely by sub-Saharan Africa and Eastern Asia. At the same time, many people around the world, including developing countries, suffer from obesity and diet-related diseases. This problem is caused by excessive consumption of high-fat and processed products, as well as by inappropriate dietary and lifestyle choices. Fish, with its valuable nutritional properties, can play a major role in correcting these unbalanced diets. ■

GOVERNANCE AND POLICY

Global agenda – global ambitions

Sustainable Development Goals and the 2030 Agenda

The international community has made unprecedented commitments to face one of the greatest challenges of the twenty-first century – how to feed more than 9.7 billion people by 2050 in a context of climate change, economic and financial uncertainty, and growing competition for natural resources.

In September 2015, the UN's 193 Member States adopted the 2030 Agenda for Sustainable Development.[42] The 2030 Agenda comprises 17 Sustainable Development Goals (SDGs) as a framework to guide development actions of governments, international agencies, civil society and other institutions over the next 15 years with the ambitious aim of eradicating extreme poverty and hunger. Elements that form the very core of FAO's work – food security and nutrition, and sustainable management and use of natural resources – feature across the SDGs. An integrated approach across the multiple goals that addresses all three dimensions of sustainable development (economic, social and environmental) is crucial to achieving the 2030 Agenda.

The 2030 Agenda offers a vision of a fairer, more prosperous, peaceful and sustainable world in which no one is left behind. It not only calls for an end to poverty, hunger and malnutrition and for universal access to health care and education – all with major emphasis on gender issues – but it also demands the elimination of all forms of exclusion and inequality everywhere. Lasting, inclusive and sustainable economic growth, as well as full and productive employment and decent work for all, are to be promoted.

At the 2015 Financing for Development Conference, countries agreed on the Addis Ababa Action Agenda, establishing a strong foundation for supporting the 2030 Agenda. The Addis Ababa Action Agenda[43] supports, complements and helps to contextualize the 2030 Agenda's means of implementation targets. It relates to: domestic public resources; domestic and international private business and finance; international development cooperation; international trade as an engine for development; debt and debt sustainability; addressing systemic issues; science, technology, innovation and capacity building; and data, monitoring and follow-up.

The 2030 Agenda emphasizes people, planet, prosperity, peace and partnership. FAO[44] highlights that food and agriculture are key to achieving the 2030 Agenda because of the fundamental connection between people and the planet, and the path to inclusive and sustainable growth.

The holistic vision of FAO's Strategic Framework on food security, nutrition and sustainable agriculture and management of natural resources link intimately to several SDGs, in particular SDG 2 ("End hunger, achieve food security and improved nutrition and promote sustainable agriculture"), SDG 12 (consumption and production), SDG 14 (oceans), and SDG 15 (biodiversity). The outcome targets of SDG 2 address food access, malnutrition, smallholder productivity and incomes, sustainable and resilient agriculture, and agricultural biodiversity, while its "means of implementation" targets address investment, trade and food price volatility.

Several targets for SDG 14 ("Conserve and sustainably use the oceans, seas and marine resources for sustainable development") are explicitly fisheries-related, while its others may have implications for fisheries. The fisheries-related targets call for actions to: effectively regulate harvesting; end overfishing and illegal, unreported and unregulated (IUU) fishing and destructive fishing practices; address fisheries subsidies; increase economic benefits from sustainable management of fisheries and »

BOX 4

BLUE GROWTH: TARGETING MULTIPLE BENEFITS AND GOALS – OVERCOMING COMPLEX CHALLENGES

Oceans and inland waters (lakes, rivers and reservoirs) can provide significant benefits to humanity if restored to and maintained in a healthy and productive state. Fisheries and aquaculture supply 17 percent of global animal protein in people's diets and support the livelihoods of some 12 percent of the world's population. An estimated 40 percent of the carbon in the atmosphere that becomes bound in natural systems is cycled into the oceans and wetlands. Almost 80 percent of global trade in goods is transported by sea. Coastal tourism is a key engine of economic growth for many coastal countries, in particular in Small Island Developing States. Ocean revenues include some US$161 billion annually from marine and coastal tourism. Experts predict that "ocean energy" (including aquatic biofuels and renewable energies), which is still in its early stages of development, could be key for meeting the world's energy demands. There are also new and potentially valuable industries deriving products from the sea such as pharmaceuticals, antibiotics, antifreezes and antifouling paints.

According to the Convention on Biological Diversity, "Inland water ecosystems are often extensively modified by humans, more so than marine or terrestrial systems, and are amongst the most threatened ecosystem types of all. Physical alteration, habitat loss and degradation, water withdrawal, overexploitation, pollution and the introduction of invasive alien species are the main threats to these ecosystems and their associated biological resources".[1] Stresses caused by human activity on the oceans' life support systems are now widely acknowledged to have reached unsustainable levels. Evidence points to over-exploitation of resources, pollution, degrading habitats, declining biodiversity, expansion of invasive species, climate change and acidification. Wetlands,[2] mangroves, salt marshes and seagrass beds are being cleared at an alarming rate, exacerbating climate change and global warming. Poor governance, management and practices, including illegal, unreported and unregulated fishing and inefficient aquaculture operations, as well as poverty and labour abuses of fish workers communities, continue to be major obstacles to achieving sustainable fisheries and aquaculture. At risk are hundreds of millions of people who depend on fisheries, aquaculture and fish processing for their livelihoods, food security and nutrition.

Management of marine, coastal and inland water ecosystems, including habitats and living resources, is imperative for ensuring sustainable fisheries and aquaculture. FAO's Blue Growth Initiative not only emphasizes the ecosystem approach to capture fisheries and aquaculture, it also embraces the promotion of sustainable livelihoods for coastal fishing communities, recognition and support to small-scale fisheries and aquaculture development, and fair access to trade, markets, social protection and decent work conditions along the fish value chain.

"The health of our planet as well as our own health and future food security all hinge on how we treat the blue world," states FAO Director-General José Graziano da Silva.[3] "We need to ensure that environmental well-being is compatible with human well-being in order to make long-term sustainable prosperity a reality for all. For this reason, FAO is committed to promoting 'Blue Growth,' which is based on the sustainable and responsible management of our aquatic resources."

1 Convention on Biological Diversity. 2016. Inland Waters Biodiversity. In: *Convention on Biological Diversity* [online]. [Cited 8 May 2016]. www.cbd.int/waters

2 Convention on Biological Diversity. 2015. *Wetlands and the Sustainable Development Goals* [online]. Press brief. [Cited 8 May 2016]. www.cbd.int/waters/doc/wwd2015/wwd-2015-press-brief-sdg-en.pdf

3 FAO. 2014. Report highlights growing role of fish in feeding the world. In: *FAO* [online]. [Cited 8 May 2016]. www.fao.org/news/story/en/item/231522/icode/

» aquaculture; and provide access for small-scale artisanal fishers to marine resources and markets. Other targets cover marine pollution prevention, management of marine and coastal ecosystems, and implementation of the United Nations Convention on the Law of the Sea and applicable existing regional and international regimes of high priority for fisheries and aquaculture. The protection, restoration and management of inland water resources and ecosystems are addressed under other SDGs (e.g. SDGs 2, 6 and 15). Further analysis on how the 2030 Agenda and SDGs relate to the fisheries and aquaculture sector is provided in Part 4 Outlook (p. 170).

As agreed by the UN Statistical Commission in March 2016, a set of global indicators will monitor implementation of the SDG targets. FAO has contributed to the development of such indicators for a range of targets, including those in SDG 14. The UN High-Level Political Forum on Sustainable Development[45] will have the central role in overseeing the follow-up and review processes at the global level.

Furthermore, recognizing that climate change is a fundamental threat to global food security, sustainable development and poverty eradication, in late 2015 the world came together at the twenty-first session of the Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change for the adoption of the Paris Agreement.[46] Agriculture, including forestry and fisheries, needs to adapt to the impacts of climate change and improve the resilience of food production systems in order to feed a growing population. These issues also need to be addressed as an integral part of the 2030 Agenda, which calls for the widest possible international cooperation aimed at accelerating the reduction of global greenhouse gas emissions and addressing adaptation to the adverse impacts of climate change. Specifically, SDG 13 pledges "to take urgent action to combat climate change and its impacts".

FAO's Blue Growth Initiative

In support of the new global agenda and responding to the growing international movement for action to support blue growth and food security in tandem, FAO launched the Blue Growth Initiative (BGI) in 2013. Through the BGI, FAO will assist countries in developing and implementing blue economy and growth agendas.

The concept of a "blue economy" came out of the 2012 Rio+20 Conference.[47] It emphasizes conservation and sustainable management, based on the premise that healthy aquatic ecosystems are more productive and a must for sustainable economies (Box 4).

The BGI is aligned and contributes fully to FAO's new Strategic Framework, its strategic objectives and outputs. The BGI is designed around sustainable capture fisheries and aquaculture, livelihoods and food systems, and economic growth from aquatic ecosystem services. It brings support and focus to enhance the implementation of the FAO Code of Conduct for Responsible Fisheries (the Code) and the ecosystem approach to fisheries and aquaculture (EAF/EAA). Reflecting the targets of SDG 14 and other SDGs, it especially focuses on the many vulnerable coastal and fisheries-dependent communities where ecosystems are already under stress from pollution, habitat degradation, overfishing and other harmful practices. Looking to harness the potential of oceans, seas and coasts, as well as that of rivers, lakes and wetlands, the BGI's aims are:

- Eliminate harmful fishing practices and overfishing and instead incentivize approaches that promote growth, improve conservation, build sustainable fisheries and end IUU fishing.
- Ensure tailor-made measures that foster cooperation between countries.
- Act as a catalyst for policy development, investment and innovation in support of food security, poverty reduction, and the sustainable management of living aquatic resources.

Within this framework, FAO focuses its work on a variety of activities:

- advancing aquaculture to promote policies and good practices for farming of fish, shellfish and aquatic plants in a responsible and sustainable manner;

- supporting implementation of the Code and related instruments to restore fish stocks, combat IUU fishing and promote good fish production practices and growth in a sustainable manner;
- encouraging efficient seafood value chains and improved livelihoods and decent work conditions, especially for women and youth;
- promoting regulatory regimes and approaches to restore vital coastal habitats, biodiversity and ecosystem services (carbon sequestration, water filtration, temperature regulation, protection from erosion and from extreme weather events, ecotourism, etc.).

To support the BGI, FAO is working at the global, regional and national levels, partnering with international organizations (e.g. United Nations Environment Programme [UNEP], Organisation for Economic Co-operation and Development, Global Environment Facility [GEF], and World Bank), fisheries and aquaculture organizations (e.g. Network of Aquaculture Centres in Asia-Pacific, and WorldFish Center), civil society (e.g. International Collective in Support of Fishworkers, and World Forum of Fish Harvesters and Fish Workers) and the private sector.

The Blue Growth Initiative – gaining traction

FAO has been working with Members to expand the BGI's scope. Regional Initiatives,[48] complemented by country-level work, have been launched to help develop and implement national policies and strategies for blue growth. In 2015, the Government of Kenya and FAO adopted the BGI to benefit select coastal areas in Kenya. Indonesia, one of the largest archipelagos in the world, has adopted a master plan for economic development in line with the BGI. Similarly, work is under way in Algeria, Bangladesh, Cabo Verde, Madagascar, Mauritania, Morocco, Senegal and Seychelles to anchor BGI concepts in national policy plans and actions. In December 2015, Cabo Verde, which recently signed a blue growth charter,[49] showcased the BGI at the high-level Lima–Paris Action Agenda – Focus on Agriculture as part of the COP21 events.

To build public awareness of the blue growth concept, FAO has stepped up its outreach efforts and partnerships. In April 2014, the Global Oceans Action Summit for Food Security and Blue Growth,[50] held in The Hague, the Netherlands, brought together a wide range of ocean stakeholders. The summit focused on how governance, partnerships and financing can help scale up blue growth activities. The summit emphasized the central role of the oceans, seas and coastal areas for sustainable development and for achieving the 2030 Agenda under the BGI umbrella.

Building on this momentum and a global mobilization for oceans, the Blue Growth Global Action Network kicked off in March 2015 to facilitate partnerships, deal-making and scaled-up action. It also seeks to catalyse investments in blue growth to support governments, businesses, developers, fishers, aquaculturists, scientists, environmentalists and civil society, as well as regional and international organizations.

Integrating fisheries and aquaculture into broader governance frameworks

The need for fisheries management, and more broadly fisheries governance, manifested itself soon after it became clear that unregulated fisheries were often leading to resource depletion. In many instances, fishery resources have been unable to sustain an uncontrolled increase in fishing accompanied by ever-increasing sophistication in fishing technology. Fisheries governance can be understood as the ensemble of institutions, instruments and processes ranging from short-term operational management to long-term policy development and planning.[51] Initially, its main objective was to mitigate the impacts of fisheries on target species. However, conventional fisheries management and the science underpinning it have tended to focus on target fish populations, without accounting for the externalities of fishing, and without considering the impacts of other human activities and environmental drivers (e.g. climate variability and change) in their assessments. The EAF[52] builds on conventional fisheries management but broadens its scope while

explicitly taking into account also social and economic aspects of sustainability.

Aquaculture development has followed a similar path to that of fisheries. The aquaculture sector grew very rapidly after 1980. It aimed largely at maximizing productivity and economic returns while focusing mostly on increased production within a very short time scale. Such an approach can yield satisfactory production and income results in the short term. However, in the medium and longer term, net results can often be negative from social, environmental and economic perspectives. Therefore, aquaculture planning and development need to consider in a balanced way the social, economic and environmental objectives, with adequate governance in place to achieve these. Moreover, aquaculture is a relatively new sector, and the aquatic space it uses can be a matter of dispute with other more established economic sectors. Fisheries, agriculture, urban and industrial development, transport and tourism are examples of sectors that can directly and indirectly affect the status of natural resources. They can conflict with aquaculture for the use of the aquatic environment. Where multiple users compete for resources and aquatic spaces, social relationships can degenerate to a point of confrontation and tension unless norms for regulating access and use are well established and enforced. Aquaculture also faces risks from other human activities such as contamination of waterways by agriculture and industrial activities.

The EAA provides a planning and management framework for integrating the aquaculture sector effectively into local planning. It also provides mechanisms for engaging with producers and regulatory authorities for the effective sustainable management of aquaculture operations by taking into account environmental, socio-economic and governance objectives.[53] With increasing activities in the coastal and offshore areas, the need for coordination across sectors utilizing marine ecosystems has become a requirement for sustainable use of these ecosystems, with a consequent emphasis on the need for integrated management of human activities (Figure 30).

Various approaches have emerged to improve sector-based management approaches (such as the EAF and EAA), while others focus on integration across sectors, such as ecosystem-based management (EBM), the ecosystem approach to management,[54] and marine spatial planning.[55] This proliferation of approaches can create confusion in relation to their relevance or comparative advantages in any given context. Here, a model is proposed showing the relationship between fisheries and aquaculture management on the one hand, and broader and multisectoral management frameworks on the other, with neither being mutually exclusive.

Integrated aquatic governance approaches

Human population growth, dwindling resources, and development in coastal areas (including of fisheries and aquaculture), coupled with weak governance and the undervaluing of the economic contribution of coastal resources to society, have often resulted in habitat degradation, user conflicts, and increased vulnerability of coastal communities. This has been a concern for the past 40 years. In the 1980s, the concept of integrated coastal zone management emerged to address sustainability issues in coastal areas as a general framework for resolving conflicts arising from interactions among various users.[56]

The concept of EBM has recently gained considerable momentum. For example, EBM is being promoted by UNEP[57] and by the large marine ecosystem movement,[58] and marine spatial planning by the Intergovernmental Oceanographic Commission of UNESCO. The rationale is similar to integrated coastal zone management, but EBM applies to any ecosystem, recognizing that human activities (mining and oil extraction, shipping, fisheries, mariculture, etc.) are growing considerably also in offshore areas. Both EBM and the related marine spatial planning are being advocated to address sustainability issues of aquatic ecosystems. At the same time, approaches such as the EAF and EAA are being promoted to »

FIGURE 30

EVOLUTION FROM CONVENTIONAL FISHERIES AND AQUACULTURE MANAGEMENT TO CROSS-SECTORAL INTEGRATED APPROACHES

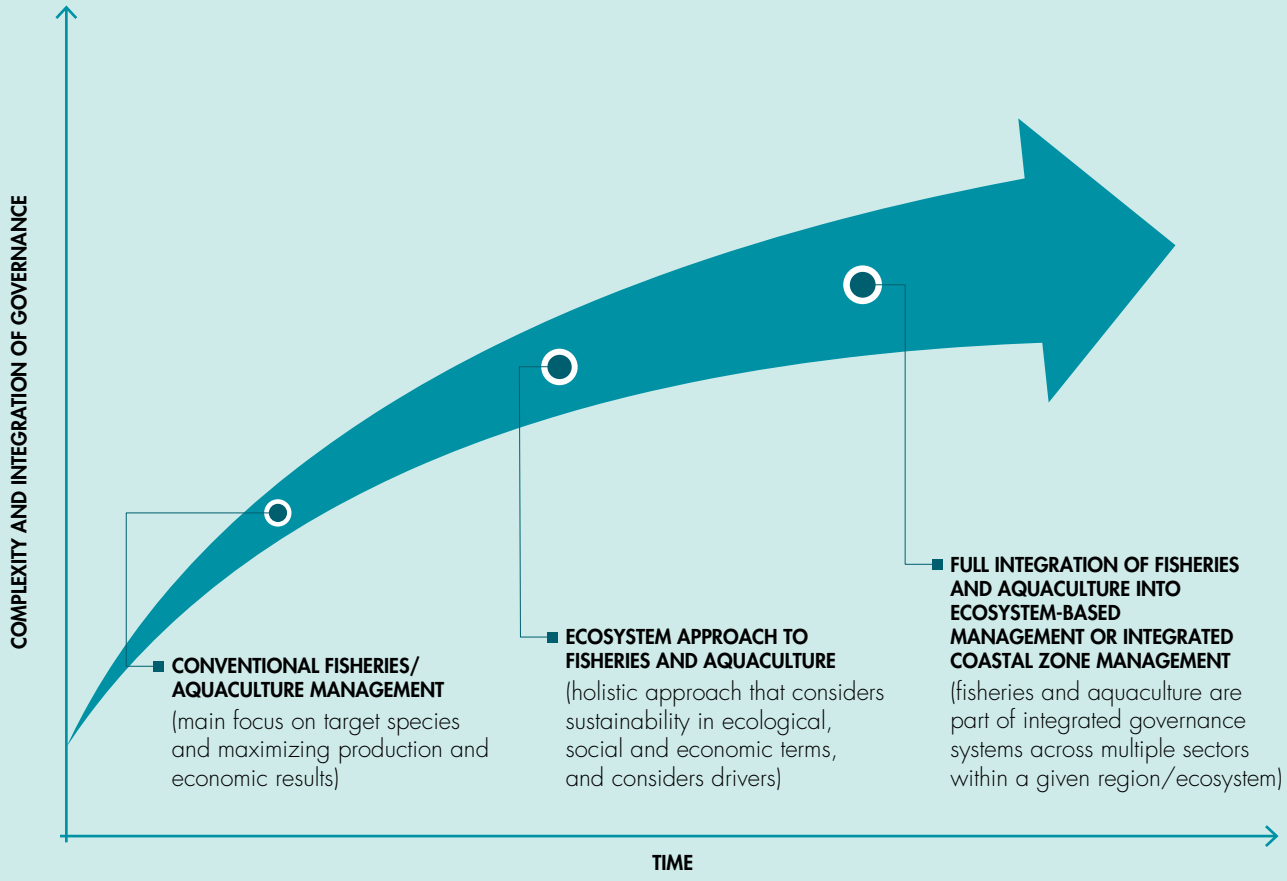
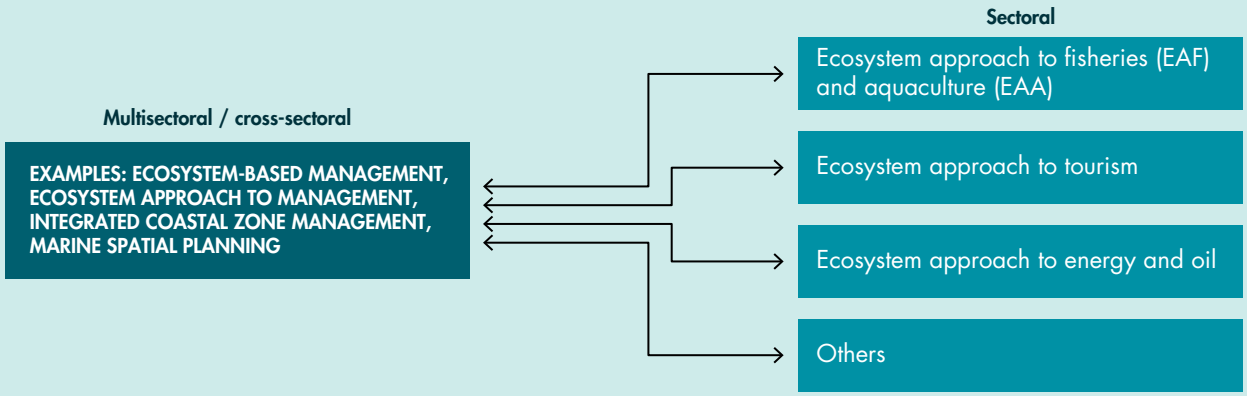


FIGURE 31

MODEL OF INTEGRATED OCEAN GOVERNANCE THAT RECOGNIZES THE NEED FOR INTEGRATION ACROSS SECTORS WHILE MAINTAINING SECTORAL IDENTITY



» enhance fisheries and aquaculture management practices. Although seemingly similar, these approaches address different levels of governance, i.e. multisectoral (EBM) and sectoral (EAF and/or EAA), and both are required.

One model emphasizes the diverse components or roles in a coherent and integrated system of ocean governance.[59] It shows how different institutional players can participate in integrated management, keeping their specialized knowledge, legal foundations and standards, but with common foundations and goals for decision-making. Thus, the model sees robust sectoral management as an important part of an integrated governance system (Figure 31).

At the multisector level, integrated plans for a given region/ecosystem are developed that regulate access and use by different stakeholders, and common conservation and development goals are set. Allocation of user rights across sectors also takes place at this level. At the sectoral level, each sector is managed in a way that is consistent with overall sustainability principles and the goals set for the given region, using its own management tools, legal frameworks and institutions (Box 5).

Examples of this type of governance arrangement are still few, but some have been implemented.[60] Norway has developed integrated management plans for the Barents Sea and the Norwegian Sea. Implementation is ensured through a system of multisectoral groups headed by a steering group coordinated by the Ministry of Environment, which also has overall responsibility for implementation of the plan. However, the formal organizational sector-based structure has not changed, i.e. sector-based management remains the pillar of EBM.

FAO is implementing a new vision for sustainable food and agriculture,[61] one in which food is nutritious and accessible for everyone, and natural resources management maintains ecosystem functions to support current as well as future human needs. In this vision, fishers, fish farmers and other stakeholders have the opportunity to actively participate in, and benefit from, economic development, have decent employment conditions and work in a fair-price environment. FAO recognizes the need to strengthen each sector sustainably, but also to utilize opportunities for cross-sectoral governance. This implies the analysis of trade-offs and cost/benefits of different resource uses of aquatic environments, guided by the overall national (and possibly international) development policies as part of an ecosystem approach. Analysis of trade-offs across sectors, including time-dependent scenarios and spatial/geographical aspects is essential for decision-making in implementing EBM. Tools that may be useful in this respect range from qualitative cost–benefit analyses carried out through participatory approaches, to models that support ecosystem accounting and decision-support tools that help explore outcomes and scenarios of alternative decisions.[62] However, considering that in most cases data availability will be limited for this type of analysis, the most useful tools will probably be use of best available knowledge, the precautionary approach, and approaches for negotiation and conflict resolution. Final decisions will have to be taken at the political level in relation to overall societal objectives. In any case, such analyses and related decision-making require cross-sectoral governance systems to be in place. This is also needed to address climate change threats as adaptation often requires cross-sectoral and landscape approaches.

Conclusions

There is a need to strengthen aquatic ecosystem governance to deal with the increasing use of ocean space and resources (eventually extending to inland waterbodies). It is necessary to coordinate various activities taking place in a given region, recognize their cumulative impacts, and harmonize sustainability goals and legal frameworks, as promoted, for example, under EBM. This requires adding a layer of governance to deal with coordination across sectors and to ensure that common sustainability goals of environmental protection and ecosystem and biodiversity conservation are met while addressing social and economic development goals. However, it is important to note that good sectoral governance will remain a core element of EBM.

BOX 5

PETROLEUM AND FISHERIES

The world's oceans are under increasing stress from human activities and their consequences, e.g. overfishing, microplastics pollution, offshore oil and gas operations, and deep-sea mining. However, owing to the unique and complex nature of marine ecosystems, the impacts of human activity are not fully understood.

Integrated ocean governance aims to plan ocean spaces and activities, taking all marine industries into account, with the goal of maximizing collective benefits while minimizing negative impacts on the environment and ecosystems. In integrated ocean governance, it is important to consider the relative influence, power and time horizon for each industry in order to ensure that planning processes give equal voice to all industry and environmental concerns. The petroleum and fisheries industries have different relative power and different time horizons. Petroleum extraction requires major investment and can be highly lucrative, giving the industry much influence; however, the time horizon for each well ranges in the decades. Fisheries, although often lucrative, do not have the same level of influence in most countries, but if operated sustainably can provide benefits for future generations from renewable resources. In order to optimize benefits and minimize negative impacts, the interactions between the industries must be studied and understood so that effective management plans can be developed and implemented.

The main impact of offshore oil and gas operations, from seismic surveys to production operations, on fisheries is the displacement of fish stocks (during spawning and normal migrations).[1,2] In the planning phase of oil operations, integrated ocean governance can significantly reduce the displacement impact, and there may be benefits such as the exclusion zones around oil platforms serving as marine protected areas.

The local impacts of water and chemical discharge from the platforms and leakages can cause alterations in fish biochemistry, both locally and in the open seas.[2] Although the impact of the chemicals cannot be changed, the quantity and quality of discharge can be managed effectively through regulations. For example, Norway has strict regulations on all things released into the ocean.[1] Such best practices can be applied through integrated ocean governance to minimize the impact of oil operations.

The most drastic impacts are from large-scale oil spills and blowouts. These can be instantly fatal or fatal in the long term to fish and other species. They can damage habitats and impair ecosystem services. Moreover, the chemicals used to clean up a spill (e.g. dispersants) can be highly toxic when in direct contact with fish.[3] Integrated ocean governance can play a role in contingency planning to best manage the response and clean-up of such extreme events for the entire ecosystem.

Integrated ocean governance can help fisheries and petroleum activities coexist in marine spaces. Although much remains to be discovered about the interactions between these two industries, incorporating future research discoveries into an integrated ocean governance planning framework will enable countries to optimize the benefits of both industries.

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The FAO Code of Conduct for Responsible Fisheries – 20 years on

For the past 20 years, the Code has served as the global reference instrument for the sustainable development of the fisheries and aquaculture sectors. Despite implementation shortfalls and stakeholder constraints, there have been considerable developments in relation to the Code's six core chapters (discussed below) the since its adoption at the national, regional and global levels. There has been notable progress in the monitoring of the status of several fish stocks, compilation of statistics on catch and fishing effort and the application of the EAF. The control of fishing operations within exclusive economic zones is now considered much stronger (while less so in areas beyond national jurisdiction [ABNJ]). Steps are being taken to: combat IUU fishing (see section Illegal, unreported and unregulated fishing, p. 97); prevent the further build-up of fishing overcapacity and/or reduce it; and implement plans for the protection and conservation of sharks and seabirds. Food safety and quality assurance have progressively been given prime importance, and there is increasing worldwide application of mitigation measures to address post-harvest losses, bycatch problems, and illegal processing and trading. The growth of responsible aquaculture has been remarkable, with several countries now having procedures to conduct environmental assessments of aquaculture operations, to monitor operations and to minimize harmful effects of alien species introduction.

Fisheries management

Article 7 of the Code touches upon all key elements of a fisheries management system. However, for many of the principles, it has been necessary to develop additional guidance to support their practical implementation through a robust fisheries governance[63] framework. The precautionary approach[64] explains how prudent foresight should guide fisheries management and highlights the need to take management action also in situations of uncertainty. An important advance in operationalizing the precautionary approach has been the development and use of comprehensive and robust harvest strategies, including data collection and monitoring protocols, assessments of stock status, definition of reference points and harvest control rules.

The guidelines on fisheries management[65] highlight key elements of a fisheries management system and provide guidance on the management process itself. The EAF[66] was developed to reorganize and highlight the principles of sustainable development (including ecological, social and economic aspects) of fisheries management, and make their implementation more compelling. The EAF details the steps to be taken in practical fisheries management to ensure that decisions are coherent with those principles.

The guidelines on inland fisheries[67] recognize how inland fisheries differ from marine capture fisheries for the degree of inter-relatedness with other users of the aquatic resource. A key priority identified more recently is the rehabilitation of degraded freshwater habitats.[68] Stewardship of shared fishery resources has benefited from the expanded coverage and strengthening of regional fishery bodies (RFBs). The development and implementation of regional and national fisheries management plans, including important elements of the international plans of action (IPOAs) adopted under the Code, have produced benefits (Box 6). Sustainability of fisheries targeting, or causing a high level of mortality among, particularly vulnerable species such as sharks has also been dealt with through the adoption of the IPOA–Sharks and supporting guidelines).[69] Reporting on capture statistics of shark species to FAO increased fourfold between 1995 and 2013, reaching 173 species and 1 656 data series. Overall, the quality of fisheries statistics can be considered to have improved, with the number of species in the FAO capture database almost doubling to 2 004 species between 1996 and 2013. This indicates that national data collection systems have been enhanced. However, an evaluation[70] of data quality in the submission of 2000–09 catch statistics to FAO found that less than 40 percent of developing countries were submitting adequate data sets. »

BOX 6

IMPLEMENTING FAO CONCEPTS FOR RESPONSIBLE MANAGEMENT IN THE MEDITERRANEAN AND THE BLACK SEA

The General Fisheries Commission for the Mediterranean (GFCM)[1] is an FAO body responsible for the sustainable development of fisheries and aquaculture in the Mediterranean and the Black Sea (FAO Major Fishing Area 37). Through the coordination of its 24 contracting parties, the GFCM tailors and adapts general concepts introduced by FAO to the particularities of the region's fisheries and ecosystems. The GFCM has often been at the forefront of embracing concepts such as an ecosystems approach to fisheries management, guidelines for the management of deep-sea fisheries, and guidelines for sustainable small-scale fisheries. Instances of this practice are: the GFCM guidelines for fisheries management in the Mediterranean and Black Sea;[2] binding recommendations on fisheries management plans; the establishment of four fisheries restricted areas; and the prohibition of bottom-trawling activities in waters below 1 000 m. The GFCM has also organized and coordinated activities such as a symposium and regional conference on small-scale fisheries and the adoption of a roadmap to fight illegal, unreported and unregulated (IUU) fishing. Other examples include the adoption of recommendations on port state measures, on the establishment of a list of IUU vessels, and on the use of vessel monitoring systems.[2]

In response to a call from its contracting parties and a proposal from its scientific advisory committee, the thirty-seventh session of the GFCM requested regular reports on the status of fisheries in its region with the overall objective to support strategic decision-making towards fisheries management. The first report, *The State of Mediterranean and Black Sea Fisheries*,[3] designed as a companion to *The State of World Fisheries and Aquaculture* with a specific focus on the GFCM area of application, incorporates information submitted by contracting parties and cooperating non-contracting parties, complemented by other sources such as bibliographic reviews.

The report provides an analysis on fishing activities, with a description of the fleet and socio-economic variables, the characteristics of the catches and ecological information on stocks, including their status, as well as a summary of conservation and management measures in place. About 1.5 million tonnes of fish are caught annually in the area, with fisheries characterized by a high diversity of target species and fishing gear types. The small-scale fleet constitutes about 80 percent of the more than 87 000 vessels reportedly operating in the GFCM area. However, purse seiners produce the highest landings by weight, and trawlers produce the highest landings by value.

Fisheries production in the Mediterranean and the Black Sea is an important source of both food and income. The total value of landings from capture fisheries in the region in 2013 is estimated at US$2.94 billion. Annual exports of fish products from the area's littoral States averaged about US$25 billion in the period 2010–13 (including re-exports of value-added products derived from imported primary products). The GFCM estimates that the area's fisheries directly employ almost one-quarter of a million people, not counting those employed in secondary industries such as fish processing.

1 FAO. 2015. General Fisheries Commission for the Mediterranean. In: *FAO* [online]. Rome. [Cited 27 February 2016]. www.fao.org/gfcm

2 For a complete list of GFCM decisions, see: FAO. 2014. *Compendium of decisions of the General Fisheries Commission for the Mediterranean* [online]. [Cited 27 February 2016]. www.fao.org/fileadmin/user_upload/faoweb/GFCM/Compliance/GFCM-CompendiumDecisions-en.pdf

3 FAO. 2016. *The State of Mediterranean and Black Sea Fisheries*. General Fisheries Commission for the Mediterranean. Rome, Italy. 134 pp. (also available at www.fao.org/3/a-i5496e.pdf).

» Following the adoption of a strategy to improve information on status and trends in capture fisheries,[71] the FishCode-STF Project was conducted to assist its implementation. Along with the Fisheries and Resources Monitoring System,[72] this has facilitated the global monitoring of stock status and fisheries trends. Various other initiatives to improve data collection are being implemented worldwide, the most recent being the Pan-African Strategy.[73]

Fishing operations

Fishing remains one of the most dangerous occupations in the world. Thanks to long-standing cooperation between FAO, the International Labour Organization and the IMO, international instruments now apply to fishing vessels of all sizes and to the personnel working on board those vessels.

Monitoring, control and surveillance (MCS) systems have acquired a central role in sustainable fisheries management, especially given the increased international concern about IUU fishing. In 2001, FAO Members adopted the IPOA–IUU, providing a complementary specific "toolbox" to the Code to address IUU fishing. In 2014, COFI adopted the Voluntary Guidelines for Flag State Performance, which are expected to prove valuable in strengthening compliance by flag States with their international duties and obligations. In addition to vessel monitoring systems and traditional MCS systems, new technologies such as satellite imagery, cell phone applications or electronic monitoring systems, as well as collaborative mechanisms for coordinated operations and information exchange, are developing and creating synergies that make MCS operations more effective and targeted.

Through technical assistance projects, FAO has provided guidance on measures for more efficient bycatch management and discard reduction in key fisheries around the world (see section Cutting bycatch and discards, p. 118). It has also provided technical guidance on how to mitigate the impacts of ghost fishing caused by abandoned, lost or otherwise discarded fishing gear (ALDFG).

Marking of fishing gear is closely linked to the issue of ALDFG, a long-standing concern for FAO and its Members. An accepted standard for marking fishing gear would benefit coastal States in addressing problems associated with ALDFG. Other reasons for the appropriate marking of fishing gear include maritime safety and deterring IUU fishing. With its Members and other interested parties, FAO is striving to develop best practice technical guidelines that will provide: (i) a workable and enforceable means of identifying the ownership and position of fishing gear; and (ii) a system that can be universally adopted and support fisheries management in meeting international obligations.

Despite investment in infrastructure, many fishing harbours in developing countries are not properly maintained due to inadequate revenue collection and a lack of effective management. FAO provides technical assistance to Members on cleaner fishing harbours, disseminates experiences and good practices, produces manuals, facilitates capacity development of managers and users, and promotes stakeholder participation in the management of fishing harbours and landing centres.

Aquaculture development

Since the adoption of the Code, aquaculture production has increased dramatically and today contributes about half of food fish globally. FAO has made significant efforts to facilitate adoption of the Code in the aquaculture sector through the provision of information and publications,[74] including specific technical guidelines,[75] as well as through the implementation of the Strategy and Outline Plan for Improving Information on Status and Trends of Aquaculture endorsed in 2007.[76] Significant efforts have also been made to assist countries in developing and implementing national aquaculture strategies and plans for the sustainable development of the sector.

Most countries have elaborated appropriate policies, development plans and regulations to ensure the sustainable development of the sector. More than 90 percent of the countries[77] have established food safety regulations and norms to support farms registration and user rights. At least 70 percent have implemented environmental

impact assessment regulations, and about 50 percent indicate good implementation of regulations to control the use of exotic species, together with fish health. As supporting mechanisms, the implementation of good or better management practices is found in 70 percent of the countries, although implementation is still deficient in some countries, especially where aquaculture is new. At the global level, the limited attention to the social role of aquaculture and the recurring insufficient support to small farmers appear to be major obstacles to implementation of the Code. Increased efforts are needed to improve supporting and enhancing mechanisms, such as integrating aquaculture in watershed and coastal zone management plans, ensuring positive impacts of aquaculture in local communities and livelihoods, improving credit to small farmers, and improving government assistance in the event of disasters.

Integration of fisheries into coastal area management

High rates of population growth, dwindling resources, and development in coastal areas (including of fisheries and aquaculture) coupled with weak governance and poor understanding of the economic contribution of coastal resources to society have often resulted in habitat degradation, user conflicts, and increased vulnerability of coastal communities. As a result, the concept of integrated coastal zone management emerged in the 1980s to address sustainability issues in coastal areas, as a general framework for dealing with conflicts arising from user interactions.

In 1996, detailed guidelines were produced on integrating fisheries into coastal area management,[78] presenting approaches considered innovative at the time, such as allocation of user rights and valuation of coastal resources as a way of developing common standards against which to compare management outcomes across sectors. To support the integration of fisheries in evidenced-based management, FAO has engaged in efforts to integrate fisheries data collection and statistics into international and national classifications and statistical systems, e.g. the System of Environmental-Economic Accounting of the United Nations.[79]

Post-harvest practices and trade

The Code also addresses fish trade and utilization. Its relevant provisions have guided recent initiatives such as the development of catch documentation scheme guidelines and ecolabelling guidelines. FAO supports Members in the implementation of Article 11 of the Code to facilitate, promote, coordinate and partner in standard setting within the framework of the FAO/WHO Codex Alimentarius Commission.

Results of the most recent self-assessment by FAO Members show that some governments are reporting gradual improvements and a good overall level of implementation of measures related to post-harvest practices and trade. However, substantial regional and intra-regional differences remain. Regional and international fora, workshops, research projects and meetings are used to encourage dialogue among the key players of the global seafood market, and to promote better coordination between countries, international organizations and private-sector institutions in adopting the relevant provisions of the Code.

GLOBEFISH has been operating since 1984 to provide accurate and unbiased marketing and trade information, with a focus on ensuring that developing countries and economies in transition have the tools, knowledge, and information to compete globally in seafood markets. FAO has provided guidance on voluntary seafood certification as a market measure to promote sustainable fisheries management and trade. FAO guidelines on ecolabelling form the baseline for a recently developed global benchmarking tool to evaluate voluntary certification schemes against the Code and other FAO instruments. The Global Sustainable Seafood Initiative (see section Market-driven governance and policy, p. 93) is expected to reduce confusion in the seafood market, where there are many and diverse voluntary certification schemes.

Fisheries research

The Code promotes scientific research in biology, ecology, technology, environmental science, economics, social science, aquaculture and nutritional science. Programmes have been developed to enhance capacity in stock

assessment using methodologies particularly suited for tropical regions,[80] bioeconomic analyses, resource assessments using research vessels, ecosystem modelling[81] and assessing fishing capacity.[82] Major programmes have also sought to enhance knowledge on abundance and distribution of fishery resources. Recently, the Norway-funded EAF-Nansen Programme has been conducting research on habitats and marine ecosystems. Through the application of the Code, other important research programmes have been carried out on the human dimensions of fisheries, including the social and economic aspects, allowing new insights into the elements necessary for achieving sustainable fisheries.

Small-scale fisheries: a new international instrument to improve governance and development

Small-scale fisheries contribute to food security and the eradication of poverty by providing food, income and employment to millions of people. Women account for about 50 percent of the workforce in small-scale fisheries, particularly in processing and trade. However, the sector is facing challenges such as: declining fisheries resources; degraded aquatic habitats; other more-powerful sectors outcompeting small-scale fishing communities for access to land and water; unequal power relations; lack of access to services; and limited participation in decision-making, often leading to unfavourable policies and practices within and beyond the sector. Moreover, inadequate governance structures often struggle to provide the necessary support. However, some fora and policy processes are increasingly recognizing and addressing these issues:

- The report by the Special Rapporteur to the UN General Assembly on the right to food recognizes that fisheries provide livelihoods, incomes, food security and nutrition to a vast number of people. It also identifies challenges facing global fisheries, including environmental sustainability and the globalization of the fishing industry.[83]
- The UN Conference on Sustainable Development outcome document *The Future We Want* strongly emphasizes the role of small-scale fisheries as catalysts of sustainable development, and stresses the need for empowerment of all to make a full contribution to development.[84]
- The Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security recognize the role of tenure security in achieving human rights and the progressive realization of the right to food.[85]
- The report of the High Level Panel of Experts on Food Security and Nutrition on sustainable fisheries and aquaculture acknowledges fish as one of the most nutritious food products. It stresses the many interactions between environmental, development, policy and governance issues that influence fisheries development. It also highlights the importance of social security, decent employment, gender equity and overall sector governance.[86]

The SSF Guidelines

A landmark event for small-scale fisheries occurred on 10 June 2014. On that day, representatives of more than 100 countries and observers from civil society organizations (CSOs), regional organizations, and non-governmental organizations (NGOs) endorsed the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication[87] (SSF Guidelines) at COFI, the only global intergovernmental forum on fisheries and aquaculture issues. This new international instrument represents a global consensus on principles and guidance for small-scale fisheries governance and development.

The SSF Guidelines provide an important tool for enhancing the contribution by small-scale fisheries to food security and nutrition. They aim to contribute to and improve the equitable development and socio-economic condition of small-scale fishing communities alongside sustainable and responsible management of

fisheries. They are directed at those involved in the sector, and intend to guide and encourage governments, fishing communities and other stakeholders to work together and ensure secure and sustainable fisheries for the benefit of small-scale fishing communities and society at large. They complement other international instruments and have a grounding in human rights principles.

From policy to action: towards the application of the principles of the SSF Guidelines

Implementation of the SSF Guidelines will be based on participation and partnerships, and anchored at the national and local levels within a framework of regional and international collaboration, awareness raising, policy support and capacity development. The application of the principles of the SSF Guidelines will require continued commitment and investments from donors, governments, CSOs and other relevant stakeholders in order to make them effective tools for change.

Implementation is unlikely to be an easy and linear process, but there is already evidence of important steps in the right direction. At the global level, the SSF Guidelines have been incorporated in the Principles for Responsible Investment in Agriculture and Food Systems, adopted by the Committee for Global Food Security in 2014. In addition, CSOs such as the International Collective in Support of Fishworkers and World Forum of Fisher Peoples have organized workshops to strategize in relation to their role in implementing the SSF Guidelines. Researchers have connected through the Too Big To Ignore network on small-scale fisheries, which has a cluster for implementing the SSF Guidelines.

A number of regional organizations have integrated the SSF Guidelines in their strategies,[88] and some countries have initiated implementation processes. FAO is available to support its partners in these processes.

Market-driven governance and policy

Various seafood stakeholders wish to promote sustainable resource management and reward responsibly sourced seafood products with preferred market access. To this end, they have developed market-based measures commonly known as ecolabels. The number of voluntary certification schemes and their uptake by the major import markets of the EU, the United States of America and Japan have increased dramatically since the first seafood ecolabel appeared in 1999.[89]

The most recent development in seafood labelling is the Global Sustainable Seafood Initiative. A group of 32 seafood companies and 1 government have financed a 3-year project to develop a global benchmarking tool to assess whether voluntary certification schemes align with global best practices. The Code and FAO certification guidelines[90] are the basis for the requirements used in this tool. Pilot testing took place on a voluntary basis and the tool was launched in October 2015.

In the last 15 years, the rapid increase in the number of private certification schemes and their diversity has raised costs and confusion along the seafood value chain. In response, some governments have created public certification schemes, e.g. Iceland Responsible Fisheries, Marine Eco-Label Japan, Alaska Seafood, and U.S. Department of Commerce Dolphin Safe. This option is gaining popularity, especially with developing countries dependent on fish exports and with small-scale sectors that may not be able to afford the high cost of certification on an individual basis. In some cases, governments have joined with private certifiers to develop national versions of private ecolabels, particularly in the small-scale aquaculture sectors of developing countries, e.g. Vietnamese Good Agriculture Practices and ThaiGAP.

Voluntary labels in the seafood market have been a concern for the WTO. This is because voluntary standards are not covered under the General

Agreement on Tariffs and Trade or other relevant WTO agreements,[91] even though ecolabels have the potential to affect market access. There is room within the WTO agreements to interpret public labels as technical standards, which could lead to more dispute cases coming before the WTO as more countries adopt national labels. A recent example is the WTO panel decision on the U.S. Dolphin Safe label.[92]

Traceability is defined at the Codex Alimentarius level: the ability to follow the movement of a food through specified stage(s) of production, processing and distribution.[93] More recently, seafood traceability has become a key component in the fight against IUU fishing. One deterrent to IUU fishing is to deny access to markets for illegal fish products. Thus, ratification of the FAO Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (PSMA) is an important step in the fight against IUU fishing. In two major fish-importing markets, market access is used to combat IUU fishing, i.e. documented traceability of legal fish products are core components of both the reformed Common Fisheries Policy of the European Union[94] and the action plan of the United States President's task force on IUU fishing.[95]

Another overarching market-based approach to combating IUU fishing is seafood traceability along the whole chain of custody, from vessel to final consumer. This will require significant international coordination and cooperation. In this regard, FAO developed draft guidelines for catch documentation schemes[96] in 2015 based on the following principles: be in conformity with the provisions of relevant international law; not create unnecessary barriers to trade; equivalence; risk-based; reliable, simple, clear and transparent; and electronic if possible. The guidelines are voluntary and provide guidance to States, intergovernmental organizations and other stakeholders for the development, implementation, review, harmonization and enhancement of catch documentation schemes for capture fisheries.

Twenty years on: regional fishery bodies in the context of international agreements

International context

The international community has increasingly recognized that strengthening governance of shared fisheries is best achieved by enhancing the role of RFBs. There are some 50 RFBs worldwide, most providing only advice to their members. However, regional fisheries management organizations (RFMOs), an important subset of RFBs, do have a mandate and the capacity for their members to adopt binding conservation and management measures based on best scientific evidence.

A clear shift in the role of RFBs has occurred in the past half-century, starting first with the United Nations Convention on the Law of the Sea, and then the United Nations Fish Stocks Agreement, and the Code. In this period, attention has been given to the emerging role of RFBs, requiring States to establish regional organizations to fulfil their duty to cooperate to ensure the long-term conservation of fish stocks and the management of their fisheries. The overall principle of sustainability underlying RFBs, aimed at properly conserving, managing and developing aquatic resources within the regions, is a core element of the BGI (see section Global agenda – global ambitions, p. 80).

Regional cooperation and current challenges

Regional cooperation has the potential to: increase efficiency in terms of knowledge sharing and the capacity to adopt science-based management measures; promote scientific research; provide technical and financial support, as well as transfer knowledge and technology; and avoid duplication of costs, and make efforts more cost-effective.

Cooperative partnerships, coordination and synergies should become a central tenet for all regional fishery management and environmental conservation mechanisms. Mindful of their respective mandates, this goal should also be pursued among RFBs, as well as

with UN Agencies, intergovernmental organizations, multilateral environmental agreements, NGOs, large marine ecosystem programmes, and long-running field programmes (e.g. the Nansen Programme).

The current state of many shared fishery resources has led to criticism of the RFBs concerned, which, in turn, has led to debates on how to strengthen and reform the international fisheries management regime. However, RFBs can only be as effective as their member States allow them to be, and their performance depends directly on their members' participation, engagement and political will.

In particular, RFMOs face substantial challenges, including:

- Decision-making: Most RFMOs require a consensus among their members in order to adopt regulations, and some are reluctant to resort to voting procedures. Hence, decision-making is slow, and final binding decisions are often diluted to satisfy the lowest common denominator.
- Uncertainty on the status of the resources: Many RFMO members receive scientific advice that is uncertain due to a lack of data, scientific research on target species, or insufficient knowledge about ecosystem structure and functions. In such situations, a precautionary approach to management is not always applied.
- Geographical coverage: Significant high seas areas are not covered by RFMOs with a mandate to regulate fishing activities such as bottom fisheries. Indeed, many RFMOs only regulate the fishing of particular species, such as tunas, salmon and halibut.
- Lack of political commitment and comprehensive compliance by members: The enforcement of rules adopted by RFMOs, left to each individual member, is ineffective due to a lack of resources, capacity or political will.
- Lack of effective control of non-member activities: Control of the activities of vessels of flag States that are not collaborating with the regional arrangement is essential.
- Limited funding and capacity of secretariats can constitute significant impediments.

As the functioning of RFMOs continues to suffer from these challenges, various processes are under way to address them. These include performance reviews and revisions of these bodies' constitutive instruments, often leading to improved performance. Whatever the level of support regional mechanisms may provide, it is worth reiterating that implementation is largely in the hands of States.

Additional considerations

The current debate on the role and performance of RFBs seems to neglect the fact that a growing number of them have included sustainable development of aquaculture in their mandate. The merit of addressing aquaculture development at the regional scale is not always fully appreciated. It encompasses production and market aspects, ecosystem considerations, interactions between aquaculture and wild fisheries, and, importantly, impacts of transboundary aquatic animal diseases.

Moreover, the international fishery agenda often fails to fully appreciate the work of RFBs with a mandate on inland fisheries and tasked with promoting cooperation among riparian countries of international freshwater bodies. In some regions, inland water RFBs are the only transboundary mechanisms protecting freshwater biodiversity and promoting fishery sustainability. Particularly in tropical areas, RFBs' role in food security, nutrition, employment and income is crucial and invaluable.

Recently, market action has provided incentives for improving RFBs' performance. An example of a negative incentive is the limited access to major markets for fisheries products from non-compliant or non-participating States. Conversely, markets can provide a positive incentive by actively seeking products that originate in fisheries certified as sustainable.

Statements by CSOs, including international NGOs, have contributed to raising political and public awareness of the need for change. It is also clear that economic crises in fishing fleets, rather than resource crises, tend to drive change that can lead to the strengthening of RFBs. A stronger

understanding of the costs of delaying action can help RFB members to overcome inertia.

Diverse national agendas and economic priorities do not facilitate the process for strengthening RFMOs. For example, when discussing allocation issues, coastal States and distant-water fishing nations often have opposing views, so making discussion very difficult. The challenge lies in addressing the aspirations of the diverse member countries with respect to sharing the benefits of RFMO membership.

Learning from successful experiences is a useful mechanism for considering best practices across RFBs. Following performance reviews, some RFBs have undergone significant changes. These changes have variously focused on: modernizing the conventions regulating RFBs; improving conservation and management measures (particularly in relation to reducing the impacts of IUU fishing); and incorporating principles such as the precautionary approach and ecosystem approaches to management.

Moreover, effective cooperation and coordination among different competent authorities may well prove key to the success of regional initiatives. Relevant regional organizations now need to make this cooperation effective through formal mechanisms and joint activities, especially by creating linkages between existing fisheries management and biodiversity conservation initiatives, while avoiding the proliferation of institutions with sometimes-conflicting mandates. Increasingly and where appropriate, the international community should pursue coordination, cooperation and integration among regional governance mechanisms, as there is an evident nexus between fisheries and environmental management.

FAO's role as a key partner

For many years, FAO has promoted and supported RFBs. It participated directly in the establishment of many of them, formalizing existing opportunities for sharing experiences within a given region, or implementing the processes needed for sustainable management of shared resources. These RFBs have benefited from FAO's advice on technical matters, as well as administrative, legal, process and technical secretariat support.

FAO has traditionally supported the activities of advisory RFBs established under Article VI of the FAO Constitution in a number of different ways – providing secretariat services, process guidance, and additional technical and financial support. However, the situation is different for management bodies (i.e. RFMOs) established under Article XIV of the FAO Constitution. These have more autonomy; many of them are not under the FAO framework and are financially and functionally independent. Nevertheless, FAO collaborates closely with RFMOs, providing information and support as needed, including supporting the Regional Fishery Body Secretariats Network.

The supporting role played by FAO is especially important in the process of establishing new regional fisheries management agreements and in assisting in the evolution of existing advisory RFBs into RFMOs. This is often the case where regional management needs to be formalized to deal with transboundary issues, in particular the management of fishery resources shared by two or more States. FAO's experience in intergovernmental processes, and the fact that most potential member parties of the RFBs are also FAO Members, means it is only natural that FAO plays a major role during the inception and early stages of evolution of an RFB. In regions without a strong tradition of joint management of shared resources, FAO has provided essential capacity building for the process of establishing and reinforcing new fisheries bodies, supporting the development of the basic texts and the infrastructure needed for them to operate.

In summary, RFBs continue to evolve in response to greater demand for sustainability, and thanks to lessons learned and stronger commitment by their member States. FAO accompanies its Members in this evolution through firm partnerships and support where necessary.

Illegal, unreported and unregulated fishing

Characteristics

The term illegal, unreported and unregulated (IUU) fishing is broadly defined in the relevant IPOA.[97] However, due to the diversity in governance frameworks, national legislation, fishing operations throughout the globe, and the conservation and management measures of RFMOs, there are a number of grey areas and overlapping situations among the three components of IUU fishing.

A recent study[98] has examined the three components of IUU fishing and found practical challenges in developing working "definitions" of I, U and U fishing. However, the study concludes that broad characteristics of each can be described, taking into account developments since the adoption of the IPOA–IUU, as follows:

- "Illegal fishing" can cover many types of offences in contravention of national laws or RFMO conservation and management measures, especially where a wide definition of fishing and related activities is included.
- "Unreported fishing" could be recast as "non-reporting of all information related to the fishing activity". This term would refer to, and be restricted to, activities that are not "fishing" *sensu stricto* but that are distinct yet associated to fishing and can occur during or after the act of fishing. It includes non-reporting, misreporting or under-reporting in contravention of laws and RFMO conservation and management measures (illegal) and reporting that is not required by law or an RFMO conservation and management (unregulated) but is advisable.
- "Unregulated fishing" relates largely to the activities of stateless vessels and non-parties to RFMOs and the failure by States to regulate certain activities that cannot be easily monitored and accounted for.

Progress in combating IUU fishing

The above study proposes a pragmatic approach to determining the magnitude of IUU fishing based on listing activities that fall within the "I", the "U" and the "U" categories individually or, alternatively, developing a combined list of IUU activities. Measurements or estimates of the extent of fishing attributable to each listed activity could then help to prioritize actions to counter IUU fishing through legislation, regulation, MCS and effective enforcement. Weak legal and governance frameworks, together with the lack of sufficient political will, have been major impediments to tackling IUU fishing. However, a new focus on implementing internationally agreed instruments could prove effective (see below). Moreover, there are immense challenges in strengthening the capacity of developing States to monitor and control fishing activities of their own and foreign vessels in their waters and ports. The development of globally accepted standards for market access, trade and traceability mechanisms also represents a key requirement for addressing IUU fishing.

Several States have acted to develop and implement national plans of action in line with the IPOA–IUU. However, there is worldwide consensus that the coming into force (on 5 June 2016) and implementation of the PSMA is an important milestone in the fight against IUU fishing. This is now possible with more than 25 Members having deposited their instrument of adherence to the Agreement with the FAO Director-General. FAO has continued with the delivery of regional capacity development workshops to raise awareness and understanding of the PSMA and support its implementation at the national and regional level.

The global application of the 2014 FAO Voluntary Guidelines for Flag State Performance[99] is an important complement to the PSMA. The aim of these guidelines is to prevent, deter and eliminate IUU fishing through, *inter alia*, monitoring, assessing and encouraging the implementation of flag State responsibilities. Better performance by flag States and the implementation of the PSMA, supported by effective MCS and supplemented by market access and trade measures (such as traceability, catch

documentation and ecolabelling schemes), would translate into tangible eradication of IUU fishing. Progress by market States in developing appropriate schemes has generally been slow, and greater appreciation of their potential role in the fight against IUU fishing is required. The current development of international guidelines for catch documentation schemes, coordinated by FAO, is expected to make headway in this regard.

The Global Record of Fishing Vessels, Refrigerated Transport Vessels and Supply Vessels[100] could be a vital tool in the fight against IUU fishing in support of existing binding and voluntary fisheries instruments. Currently under development, this tool will not be restricted to an authorized list of vessels but also include vessel details, historical and authorization information, inspection and surveillance data, and port entry denials to support the implementation of international instruments, such as the PSMA.

The collaboration of intergovernmental organizations in addressing issues on IUU fishing also contributes significantly to the development and promotion of approaches to tackle the problem. For example, the FAO/IMO Ad Hoc Joint Working Group on IUU Fishing and Related Matters has recently addressed, *inter alia*: progress on the uptake of the PSMA; the use of the IMO ship identification number scheme in the context of the Global Record; vessel identification, monitoring and tracking; and the assessment of the performance of flag States.

Global Aquaculture Advancement Partnership

Defeating hunger remains a chief challenge for policy-makers, and a corporate social responsibility. World leaders at the highest level of governance understand the urgency of addressing this issue; a swift defeat of hunger is at the forefront of their declared political agendas.

Sustainable aquaculture development can help society to achieve this goal. Today, aquaculture supplies more than 50 percent of all fish consumed. It provides an income to small-scale producers and enables large-scale farmers and corporations to generate millions of well-paid jobs for resource-poor individuals. It also enhances households' nutritional status and their access to adequate housing, health and education services.[101] Thus, aquaculture has shown that it can contribute towards eradicating hunger, food and nutrition insecurity, and poverty in many parts of the world.

For aquaculture to continue its growth and so yield more of these socio-economic benefits, various obstacles need to be overcome through, *inter alia*, sound policies and strategies backed by strong research programmes and by national, regional and global information and knowledge sharing. Aware of the importance of active collaboration and synergies among public and private sector expertise and resources, as well as information and knowledge exchange, FAO has established the Global Aquaculture Advancement Partnership (GAAP) programme. Its aim is to bring partners together to channel their technical, institutional and financial resources effectively and efficiently in support of global, regional and national aquaculture initiatives. Specifically, GAAP seeks to promote and enhance strategic partnerships, and use them to gather resources to develop and implement projects at the various levels.

This partnership approach is in line with the Busan Partnership for Effective Development Co-operation,[102] the recommendation of the Asia Regional Ministerial Meeting on Aquaculture for Food Security, Nutrition and Economic Development to create a global fund for aquaculture,[103] and recent UN-sponsored partnership initiatives, including the UN Partnership Facility. Moreover, one of the seven core functions in FAO's revised strategic framework is to "facilitate partnerships for food and nutrition security, agriculture and rural development between governments, development partners, civil society and the private sector."[104]

Adopted by the Thirty-first Session of COFI in 2014, the GAAP programme[105] covers five broad areas: development and technical assistance; policy dialogue; norms and standard setting; advocacy and communication; and information and knowledge management and dissemination. It targets six major outputs:

1. Global, regional and national aquaculture policies, strategies, laws, codes and guidelines are adapted, and institutions are strengthened, to meet emerging needs and ensure sustainable production.
2. Environmental and biodiversity risks from and to aquaculture are minimized, and the aquaculture sector becomes a more efficient producer of animal source foods.
3. A partnership approach to address aquaculture issues and promote sustainable aquaculture development is fostered and enhanced.
4. Global and regional trade in aquaculture, which is profitable, fair, safe and equitable, and safeguards the interests of smallholders, is enhanced.
5. Mitigation and adaptation measures to address climate change impacts, as agreed at the global and regional level, are proactively implemented.
6. Innovations in aquaculture production systems (for an example, see Box 7) and financial services delivery mechanisms, including addressing smallholders' needs, are promoted and enhanced.

The short-run effect of GAAP will be higher and more-sustainable global aquaculture production, and a contribution to eliminating hunger, food and nutrition insecurity, and poverty worldwide. In the longer term, it will make a sustained contribution to a hunger-free, healthier and wealthier world.

Designed for a 10–15 year period from 2016, implementation of GAAP will follow a phased-project approach, take place at the global, regional and national levels, and involve a wide range of partners.[106] It will avoid duplication of effort and facilitate links, synergies and complementarities among partners.

Each phase will cover a five-year period during which a batch of projects will be developed and implemented. Each project will contribute to achieving one or more of the programme's six outputs, which, in turn, will contribute to ensuring GAAP's positive outcome and impact, and, thereby, to FAO's Strategic Objectives.

The main vehicles for implementing GAAP will be technical cooperation among developing countries, South–South cooperation, private–public partnerships and national initiatives. To this end, and subject to funding availability, two projects (Aquaculture for Youth Employment in Africa and Southeast Asia, and Aquaculture, Culture-based Fisheries and Stock Enhancement Practices for Food, Income and Employment in Small Island Developing States) could be implemented. Their objective is to generate youth employment, reduce poverty (especially in rural areas) and enhance food and nutrition security and rural livelihoods through small- and medium-scale sustainable aquaculture enterprises while reducing pressure on natural aquatic resources.

Common Oceans – global sustainable fisheries management and biodiversity conservation in areas beyond national jurisdiction

Areas beyond national jurisdiction (ABNJ) are those areas of ocean for which no one nation has the specific or sole responsibility for management. Achieving sustainable management of the fisheries resources and biodiversity conservation in ABNJ is extremely difficult given the complexity of the ecosystems as well as the many and diverse actors involved. The benefits of managing ABNJ effectively also extend to coastal countries, as fisheries resources often straddle into their exclusive economic zones.

Focusing on tuna and deep-sea fisheries, and with an emphasis on creating valuable partnerships and enhancing global and regional coordination on ABNJ issues, the Common Oceans ABNJ Program[107] aims to promote

efficient and sustainable management of fisheries resources and biodiversity conservation in ABNJ to achieve internationally agreed global targets. The innovative five-year ABNJ Program, which started in 2014, is funded by GEF and coordinated by FAO in close collaboration with three other GEF implementing agencies,[108] and a variety of partners.[109] The ABNJ Program consists of the following four complementary projects.

Sustainable management of tuna fisheries and biodiversity conservation in the ABNJ

This project's activities are divided into three components. The first component facilitates: (i) implementation of the precautionary approach, via the adoption of harvest strategies, for the major tuna stocks; and (ii) formulation of management plans based on an EAF. The second component seeks to reduce IUU fishing by developing best practices in MCS, and by reinforcing the capacity of developing States to comply with existing regulations and combat IUU fishing. The project has provided key support to processes such as port State controls, catch documentation schemes, and the automation of a global record of authorized vessels. Pilot activities in Ghana and Fiji are evaluating how to incorporate electronic monitoring systems in the control of fishing fleets by developing States. The third component aims to reduce the ecosystem impact of fishing by encouraging: (i) formulation of Pacific-wide shark management plans; (ii) mitigation of incidental mortality of seabirds, marine turtles, small tuna and sharks; and (iii) assessment of incidental mortality by gillnet gear.

Sustainable fisheries management and biodiversity conservation of deep-sea living marine resources and ecosystems in the ABNJ

The project aims to achieve efficient and sustainable use of deep-sea living resources and strengthen biodiversity conservation in the ABNJ through the systematic application of an ecosystem approach to:

- improve sustainable management practices for deep-sea fisheries, also considering impacts on related ecosystems;
- improve the protection of vulnerable marine ecosystems and enhance the conservation and management of components of ecologically or biologically significant areas;
- test area-based planning tools.

Many project activities will focus on the Southeast Atlantic, the Western Indian Ocean, and the Southeast Pacific, working directly with relevant stakeholders (including countries through RFMOs) and with industry partners and the Regional Seas Programme. To execute the project, FAO is partnering with UNEP, supported by the World Conservation Monitoring Centre.

Ocean partnerships for sustainable fisheries and biodiversity conservation: models for innovation and reform

This project, under World Bank coordination, aims to catalyse pilot investment into transformational public–private partnerships that mainstream the sustainable management of highly migratory stocks spanning areas within and beyond national jurisdictions. It will be largely regionally executed among subprojects:

- Bay of Bengal region – small-scale tuna longline fisheries;
- Western Central Pacific Ocean – tuna fisheries prosecuted mainly by distant-water fishing nations;[110]
- West/Central Atlantic and Caribbean – recreational and commercial small-scale fisheries targeting billfish;
- Eastern Pacific Ocean – increasing the sustainability of the skipjack tuna purse seine fisheries.

In addition, a global think tank will support inter-regional coordination, outreach and collaboration, with a global innovation grant facility supporting a range of innovative activities.

Strengthening global capacity to effectively manage ABNJ

This project, co-executed by the Global Ocean Forum and FAO with a wide range of partners, aims to facilitate global and regional cross-sectoral policy dialogue and coordination, improve knowledge management and outreach, and contribute to increased capacity for decision-

BOX 7

AQUAPONICS – INTEGRATING AQUACULTURE AND HYDROPONICS

Aquaponics is a symbiotic integration of two mature food production disciplines: (i) aquaculture, the practice of fish farming; and (ii) hydroponics, the cultivation of plants in water without soil. Aquaponics combines the two within a closed recirculating system.

A standard recirculating aquaculture system filters and removes the organic matter ("waste") that builds up in the water, so keeping the water clean for the fish. However, an aquaponic system filters the nutrient-rich effluent through an inert substrate containing plants. Here, bacteria metabolize the fish waste, and plants assimilate the resulting nutrients, with the purified water then returning to the fish tanks. The result is value-added products such as fish and vegetables as well as lower nutrient pollution into watersheds.

Aquaponics has the potential for higher yields of produce and protein with less labour, less land, fewer chemicals and a fraction of the water usage. Being a strictly controlled system, it combines a high level of biosecurity with a low risk of disease and external contamination, without the need for fertilizers and pesticides. Moreover, it is a potentially useful tool for overcoming some of the challenges of traditional agriculture in the face of freshwater shortages, climate change and soil degradation. Aquaponics works well in places where the soil is poor and water is scarce, for example, in urban areas, arid climates and low-lying islands.

However, commercial aquaponics is not appropriate in all locations, and many start-ups have failed. Before investing in large-scale systems, operators need to consider all factors carefully, especially the availability and affordability of inputs (i.e. fish feed, building and plumbing supplies), the cost and reliability of electricity, and access to a significant market willing to pay premium prices for locally produced, pesticide-free vegetables. Aquaponics combines the risks of both aquaculture and hydroponics, and thus expert assessment and consultation are essential.

To support aquaponic development, FAO has produced a technical manual on small-scale aquaponic food production.[1] At the Thirty-first Session of the FAO Committee on Fisheries (June 2014), four Members (the Cook Islands, Indonesia, Kenya and Mexico) cited aquaponics as an opportunity warranting greater attention. Moreover, a related side event presented yumina, a form of aquaponics used across Indonesia. As a follow-up, Indonesia, with support from FAO and the South–South Cooperation team, held a regional technical workshop on aquaponics in late 2015 to train trainers from countries around the world. Separately, FAO also convened a training workshop on aquaponics for countries in the Near East and North Africa region.

In the future, the agriculture sector will need to produce more with less. Following the principles of efficient resource use, synergistic benefits can be realized by integrating food production systems and reducing inputs, pollution and waste, while increasing efficiency, earnings and sustainability. Thus, aquaponics has the potential to support economic development and enhance food security and nutrition through efficient resource use, and become an additional means of addressing the global challenge of food supply.

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making at various levels of ABNJ management. It seeks to accomplish these aims through:

- convening cross-sectoral multistakeholder workshops and high-level dialogues, and coordinating ABNJ Program messaging and outreach;
- developing relevant communities of practice and a regional fellowship programme to strengthen leaders' capacity to manage ABNJ resources and participate more effectively in international discussions;
- establishing a public outreach network and web portal.[111]

Summing up the ABNJ Program

The Common Oceans ABNJ Program offers an opportunity to move further – and to move together with all partners – by leveraging resources, knowledge and experience to bring about transformational changes leading to improved global sustainable fisheries management and biodiversity conservation in ABNJ. ■

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88 Examples of regional organizations that have integrated the SSF Guidelines in their strategies:
African Union Commission – New Partnership for Africa's Development. 2014. *The policy framework and reform strategy for fisheries and*

aquaculture in Africa [online]. [Cited 27 February 2016]. http://rea.au.int/en/sites/default/files/AU-IBAR%20-%20Fisheries%20Policy%20Framework%20and%20Reform%20Strategy.pdf
FAO & Western Central Atlantic Fishery Commission. 2014. *Resolution WECAFC/15/2014/10 on the strategic action programme for the sustainable management of the shared living marine resources of the Caribbean and north Brazil shelf large marine ecosystems (CLME+ SAP)* [online]. [Cited 27 February 2016]. www.wecafc.org/en/recommendations-and-resolutions/resolutions.html
FAO & General Fisheries Commission for the Mediterranean. 2014. *Concept note for the first regional programme on small-scale fisheries, thirty-eighth session of the Commission, FAO HQ, Rome, Italy, 19–24 May 2014* [online]. [Cited 27 February 2016]. www.fao.org/3/a-ax856e.pdf

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93 FAO. 2016. Traceability. In: *FAO Agriculture and Consumer Protection Department* [online]. [Cited 27 February 2016]. www.fao.org/ag/againfo/themes/en/meat/quality_trace.html

94 European Commission Council Regulation No. 1005/2008 "establishing a Community system to prevent, deter and eliminate illegal, unreported and unregulated fishing", entered into force in 2010.

95 Presidential Task Force on Combating IUU Fishing and Seafood Fraud. 2015. *Action Plan for Implementing the Task Force Recommendations* [online]. Washington, DC. [Cited 27 February 2016]. www.nmfs.noaa.gov/ia/iuu/noaa_taskforce_report_final.pdf

96 FAO. 2015. *Report of the Expert Consultation on Catch Documentation Schemes. Rome, 21–24 July 2015.* FAO Fisheries and Aquaculture Report No. 1120. Rome. Italy. (also available at www.fao.org/3/a-i5063e.pdf).
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97 FAO. 2001. *International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing.* Rome. 24 pp. (also available at www.fao.org/docrep/003/y1224e/y1224e00.htm).

98 Tsamenyi, M., Kuemlangan, B. & Camilleri, M. 2015. Defining illegal, unreported and unregulated (IUU) fishing. *In* FAO. *Report of the Expert Workshop to Estimate the Magnitude of Illegal, Unreported and Unregulated Fishing Globally, Rome, 2–4 February 2015*, pp. 24–37. FAO Fisheries and Aquaculture Report No. 1106. Rome, FAO. 53 pp. (also available at www.fao.org/3/a-i5028e.pdf).

99 FAO. 2014–2016. Voluntary Guidelines on Flag State Performance. FI Institutional Websites. In: *FAO Fisheries and Aquaculture Department* [online]. Rome. Updated 30 June 2014. [Cited 27 February 2016]. www.fao.org/fishery/topic/16159/en

100 FAO. 2009–2016. Global Record of Fishing Vessels Refrigerated Transport Vessels and Supply Vessels. In: *FAO Fisheries and Aquaculture Department* [online]. Rome. Updated 12 February 2015. [Cited 27 February 2016]. www.fao.org/fishery/global-record/en

101 FAO. 2006. *Improving the socio-economic impacts of aquaculture* [online]. Committee on Fisheries. Third Session of the Sub-Committee on Aquaculture, New Delhi, India, 4–8 September 2006. COFI:AQ/III/2006/5. [Cited 27 February 2016]. ftp://ftp.fao.org/docrep/fao/meeting/013/j7988e.pdf

102 Formed following the Fourth High Level Forum on Aid Effectiveness in Busan, the Republic of Korea, in 2011.

103 Made in Colombo, Sri Lanka, in July 2011.

104 FAO. 2013. *Reviewed Strategic Framework* [online]. FAO Conference. Thirty-eighth Session, Rome, 15–22 June 2013. C 2013/7. [Cited 27 February 2016]. www.fao.org/docrep/meeting/027/mg015e.pdf

105 FAO. 2013. *Global Aquaculture Advancement Partnership (GAAP) Programme* [online]. COFI:AQ/2013/SBD.2. [Cited 27 February 2016]. www.afdf.org/wp-content/uploads/12d-Global-Aquaculture-Advancement-Partnership-GAAP-Program.pdf

106 Potential partners include United Nations agencies, intergovernmental and international financing institutions, international and national research institutions and academia, the private sector, civil society, non-governmental organizations, and governmental and other relevant networks.

107 FAO. 2016. *Common Oceans* [online]. Rome. [Cited 27 February 2016]. www.commonoceans.org/

108 United Nations Environment Programme, World Bank and World Wide Fund for Nature.

109 Partners include governments, regional management bodies, civil society, academia and industry.

110 Vessels operating under the Vessel Day Scheme of the Parties to the Nauru Agreement.

111 Op. cit., note 107.

PART 2
SELECTED ISSUES

GUAYAQUIL, ECUADOR
Nets rolled up on the beach and fishing boats in the background. The United Nations Special Fund and FAO have supported the fisheries institute in Guayaquil, which has developed a fish sauce as one use of local catches.
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SELECTED ISSUES

DATA NEEDS FOR BLUE GROWTH

The issue

FAO's Blue Growth Initiative (BGI) is an integrated approach across multiple goals that addresses all dimensions of sustainable development – economic, social and environmental (see section Global agenda, p. 80). As a fact-based management approach, its successful implementation will require timely and reliable cross-disciplinary information in order to establish baselines, monitor changes, and support decision-making towards social, economic and environmental sustainability.

Possible solutions

BGI focus: achieving sustainable fisheries, reducing habitat degradation, and conserving biodiversity

Here, data are needed to assess and monitor the state of natural resources (e.g. fish resources, aquatic ecosystems, water and land, aquatic genetic resources), and the performance and sustainability of fisheries.

Assessing and monitoring fish stocks

The BGI recognizes that healthy fish resources are of primary importance for sustainable fisheries, and assessments of fish stocks are vital to understanding the overall status of fishery resources (see section The status of fishery resources, p. 38).

Stock assessment is a data-demanding process, and one that is often undertaken in a context of data-poor situations. However, various methods[1] that use estimation procedures, including expert judgement, can help in precautionary management. Data availability and quality issues often constrain the accuracy of assessment results. Moreover, management action lags behind assessment conclusions. To address this, an adaptive management approach based on a predetermined-harvest model has become more commonly used. It is important that high-quality catch, effort and other data be made available in a timely manner and shared among stakeholders, e.g. scientists, decision-makers and fishers. Assembly of such data into integrated databases prior to assessments can greatly facilitate analysis. Knowledge bases such as FishBase[2] and SealifeBase[3] already provide easy access to comprehensive ecological and biological knowledge. Similarly, catch and effort data could be assembled, although a lack of agreed data-sharing and confidentiality policies remains a hindrance. Enhanced information technology and data management capacities can also help.

The sharing of stock assessment results is another important step towards more effective fisheries management. At scientist level, well-documented data sets allowing reproduction of the assessments would increase transparency and empower developing countries in resource assessment and advice to fishery managers. Moreover, stakeholders need to receive assessment outputs in an easily understandable format.[4] Various national examples[5] testify that decisive policy action on tackling overfishing was triggered by a clear and comprehensive overview of the status of fishery resources, the management options and their associated consequences.

Examination of the numbers for assessed stocks compared with all known stocks, and comparison of the status of assessed fishery resources across stocks, species and regions, can be instructive,

particularly for setting priorities for fishery monitoring. The Fisheries and Resources Monitoring System[6] facilitates such work by assembling stock assessment results on the basis of a comprehensive inventory of known fish stocks, although the system still requires inputs of more assessment results to provide a comprehensive picture.

Preserving biodiversity and restoring habitats

The BGI recognizes the imperative of restoring degraded habitats and preserving biodiversity in order to improve the productivity and sustainability of fishery systems. Efforts are ongoing to develop a comprehensive repository of biodiversity information, such as aquatic species inventories and occurrences, in order to better monitor changes and describe diversity and ecological footprints. The Ocean Biogeographic Information System[7] brings together the efforts of taxonomists and ecologists worldwide to provide a unique global source of species occurrences. Many analytical models are being developed on top of this repository to map species distributions (e.g. AquaMaps)[8] and analyse the distribution and evolution of biodiversity richness, so furthering understanding of species range shifts in the climate change context and their environmental and socio-economic impacts. Although fishery research surveys constitute rich sources of species occurrence data, there are currently only a few data-sharing agreements to make this knowledge available to repositories such as the Ocean Biogeographic Information System.

In order to minimize adverse impacts of fishing on biodiversity (e.g. emblematic marine mammals in tuna fisheries, or sponges and corals in vulnerable marine ecosystems), data are required for the design of management strategies. Such data include individual observations of bycatch species or "encounters" of indicator species during fishing operations. This activity generally requires the deployment of scientific observers on board vessels, or involving fishers in data collection. The former is costly and prone to biases, while the latter presents confidentiality and privacy issues. Automated systems based on image recognition offer potential but are unlikely to see widespread application soon.

In general, progress towards data sharing will depend on data owners (States and the fishing industry) adopting more open policies and practices. Encouragingly, the deep-sea fishing industry is now working with scientists and managers in the context of the ecosystem approach to fisheries (EAF).

Regarding coastal habitats (e.g. mangroves and marshes), geographic information systems (GIS) and remote sensing are increasingly facilitating the distinction and mapping of vegetation types – important for establishing baselines and monitoring change. However, further effort is needed in order to make these tools user friendly for managers of the aquatic sector.

Combating IUU fishing

The BGI sees the fight against illegal, unreported and unregulated (IUU) fishing as a high priority. Here, information technology developments have revolutionized data collection. The main technologies are: shared databases on vessel registries and licences for evaluating fishing authorizations; automatic identification systems and vessel monitoring systems (VMS) for monitoring vessel movements; e-logbooks for prompt reporting of catches; onboard camera inspections for fully observing fishing operations; port-in port-out communications for enforcement; e-transaction of market information for traceability; and catch documentation schemes for catch information. These technologies should

enable stringent and efficient monitoring, control and surveillance (MCS), trade certification for tracing fish throughout the distribution chain, and the generating of overall statistics based on data from the operational sources.

However, confidentiality concerns combined with a lack of standards and trust in data security hinder direct data integration among different systems. Sharing information among responsible users through globally standardized electronic MCS is essential to eliminating gaps in coverage that could facilitate IUU activities. Progress towards global harmonization is slow, and the level of commitment varies widely among States and regions due to cost and technical capacity requirements. Small-scale fisheries with their many vessels pose the greatest challenge for implementation, so typically such technologies and schemes are first introduced for larger vessels and later to smaller ones, with mobile phone applications offering new opportunities.

Monitoring performance for sustainability

Fisheries performance can be described in socio-economic, environmental and management terms. Inventories can provide the starting point to characterize and disseminate the socio-economic importance of fisheries in terms of people's participation, economic investments (vessels size and numbers), and returns (landings in volumes and currency). FAO recommends fisheries inventories as a way to improve visibility of small-scale fisheries and related livelihoods in order to influence policy and management decisions. Inventories can also be used to characterize fisheries in terms of their potential impacts on biodiversity (e.g. by itemizing bycatch species). In aquaculture, inventories of farming installations[9] can provide policy-makers with the knowledge to enable effective planning and management. Box 8 looks at the use of GIS and remote sensing for facilitating this work.

Finally, inventories can be used to describe the effectiveness of fisheries management in achieving sustainability.[10] In turn, this can influence consumers' purchases and thus provide incentives for management improvements, as indicated by the growing practice of fish ecolabelling.

Water availability for inland fisheries and aquaculture

Inland fisheries and aquaculture provide many important ecosystem services. However, these services are seldom properly valued and their contributions are usually underestimated. Hence, policy-makers often neglect these sectors when determining access to water resources for various uses (see sections Improving the valuation of inland fisheries, p. 114, and Ten steps to responsible inland fisheries, p. 147).

The central framework of the System of Environmental-Economic Accounting (SEEA) of the United Nations[11] serves as a global standard for monitoring sustainable natural-resource use. It provides a framework for compiling information on water availability and utilization, and then for analysing trade-offs among different uses. However, for freshwater, its application faces practical difficulties, mainly due to a paucity of data and the challenges of producing internationally comparable statistics. Remote sensing and GIS could be valuable tools but their application to inland fisheries and aquaculture is lagging far behind that in other sectors.

BGI focus: maximizing socio-economic benefits

Achieving this objective involves monitoring the performance and sustainability of activities relating to the use of aquatic resources throughout the whole value chain, and separately from other agricultural and commercial activities. However, information on the social and economic contributions of the sector is fragmented, often aggregated with other sectors, and with a focus on commercial (rather than artisanal and subsistence) activities of the primary production sector, not fully recognizing the full value chain or associated activities. Such data deficiencies can result in mistaken policies. For example, the SmartFish project[12] pointed out that some African countries' food security and nutrition policies overlooked fish despite its importance in people's diets as evidenced through dedicated surveys. Moreover, the contribution of women is poorly assessed and, thus, gender-aware policies cannot be adequately formulated. The under-reporting of the impacts of disasters on the fisheries and aquaculture sector is another example of where data are currently deficient (see section Building resilience, p. 155). »

BOX 8

AQUACULTURE MAPPING AND MONITORING

Inventories and monitoring of aquaculture facilities provide decision-makers with important baseline data on production, area boundaries, and environmental impacts. Mapping facilitates such work and improves the effectiveness of interventions for disaster assessment and emergency preparedness.

The mapping of aquaculture facilities can be performed accurately, regularly (i.e. minutes, days, months or years) and at selected scales by remote sensing. Remote sensing – using satellites, aircraft, drones or fixed sensors – enables observations of vast and often remote or inaccessible areas at a fraction of the cost of traditional surveys. It provides a large range of observation data that complement and extend data acquired from in situ observations to support aquaculture management.

Challenges for aquaculture mapping include: (i) limited awareness of its benefits for decision-makers and technical personnel; (ii) limited knowledge on how to conduct inventories and analysis; (iii) limited number of innovative mapping applications; and (iv) limited human resources, infrastructure and financing.

FAO assists countries in recording the location and type of aquaculture facilities so they can improve their aquaculture zoning, site selection and area management. These facilities and their evolution can be assessed against locations of sensitive ecosystems and habitats to highlight potential impacts. They can also be linked to the licensing process to identify unregistered or illegal facilities.

FAO's National Aquaculture Sector Overview map collection provides a spatial inventory of aquaculture with attributes including species, culture systems and production.[1] Based on Google Earth/Maps technology, its aim is to develop ways to assist developing countries and so encourage them to conduct their own inventories, at minimal cost, as part of their strategic planning for sustainable aquaculture development. Some have already begun creating their own farm-level inventories by creating atlases and/or Web mapping applications.

Google Earth is a good starting point for spatial inventories of aquaculture as it makes high-resolution data (e.g. satellite images or historical aerial photographs) freely available to the general public, without requiring any remote-sensing expertise. Despite some limitations (e.g. obsolete/undated imagery or other layers, insufficient resolution for some aquaculture applications, and incomplete coverage owing to cloud cover), such mapping applications should be the first stop in a spatial data search where base maps and specialized layers are lacking. However, ground-based data gathering remains important for validation, and here global positioning systems (GPS) are essential for digitally recording the location of aquaculture facilities and assessing the accuracy of remote-sensing sources.

More advanced approaches based on image analysis require the use of geographic information systems (GIS) or remote-sensing software and access to satellite images in their original format. Digital data (such as from remote sensing) pertaining to any aspect of aquaculture can be assembled in a GIS. These systems perform a wide range of spatial and statistical analyses, providing informed answers to aquaculturists, local managers, government officials and other groups promoting sustainable aquaculture development. Advances in remote-sensing and mapping technologies and spatial analyses will enable improved and more informed opportunities in aquaculture, especially as these technologies and analyses become increasingly powerful, cheaper and more accessible to all. In this respect and thanks to partnerships mobilized through projects around the world, FAO continues to promote the adaptation and tailoring of innovative methodologies and capacities to facilitate concurrent access to remote sensing, field data-collection devices (e.g. GPS, smartphones and tablets), GIS and spatial analysis by aquaculture stakeholders.

1 FAO. 2015. NASO aquaculture maps collection. In: *FAO* [online]. Rome. [Cited 18 February 2016]. www.fao.org/fishery/naso-maps/naso-maps/en/

» There is a need for guidelines and standard methodologies to evaluate the specific contribution of aquatic biological resource use throughout the value chain. Recent attempts have used census-type surveys to obtain snapshots of social and economic contributions (including non-commercial activities) throughout the value chain. However, this approach requires further testing and refinement before global standards can be established. The FAO Fish Price Index serves many fish-specific food security and economic assessments and projections, and so can help in this regard.

BGI focus: assessing ecosystem services

Examples of ecosystem services provided by aquatic living resources are recreational fisheries and fish-related tourism, and biodiversity and habitat contributions to ecosystem resilience (e.g. mangroves to protect shoreline biota). These services also include climate change mitigation, such as carbon recycling by algae, and carbon sequestration by mangroves or coral reefs.

It is necessary to advance the understanding of the roles of natural capital and ecosystem services in national economies in order to better account for the economic contributions of renewable aquatic resources (e.g. through the SEEA). Regarding climate change, work[13] is in progress to transpose to aquatic resources the general methodologies developed for assessing carbon footprints in the agriculture and forestry sectors.

Recent actions

There is increasing recognition of the data needs for blue growth. For example, the European Marine Board has urged that European public research funding investments target fundamental scientific research of the poorly understood deep-sea system and the establishment of environmental baselines.[14] Another example is the strategic action plan for the Caribbean and North Brazil Shelf large marine ecosystems to address the threats jeopardizing the region's opportunities for blue growth. A support project to this plan will focus on governance and collaborative arrangements, and will foster synergies among the many independent initiatives addressing habitat degradation, unsustainable fisheries practices and pollution. This project will also assemble its outputs on the state of the marine ecosystems and shared living marine resource in the region as a comprehensive web-based dashboard.

Furthermore, the iMarine[15] initiative (funded by the European Commission) demonstrates that data needs for blue growth could be met through Science 2.0, an approach that uses information sharing and collaboration made possible by innovative network technologies. By enabling the pooling of data repositories, software, methodologies and expertise, iMarine aims to deliver cost-efficient data services. The recently launched BlueBRIDGE project[16] will use iMarine's virtual research environments to address multiple objectives in support of the EAF. It will also expand its scope to other areas of blue growth, such as traceability of fishery products, spatial planning, and socio-economic and environmental performance of aquaculture.

Outlook

The limited availability of information often constrains policy-making and planning for blue growth. Information often exists but is very fragmented, inaccessible (and often lost) or collected according to different standards. In many cases, the information is collected in isolation and without keys for connecting pieces with one another. This constitutes a major challenge to the implementation of cross-sectoral management as called for by the BGI.

There is a need for integration among different data collection initiatives, across different sectors, and throughout the entire value chain, in particular for social and economic valuation in relation to sustainability. Such integration also entails the exchange of expertise and related methods and tools, while catering for particular requirements of aquatic resources.

In a context where information resources, expertise and tools are scattered among multiple

organizations, mechanisms enabling efficient information networking are vital. In this respect, the following three components are deemed essential.

First, enhancing information standards and harmonization capacities will facilitate information exchange by enabling the use of common classifications, concepts and data structures. Existing standards such as SEEA can be extended and adjusted in order to ensure visibility of the fisheries sector in environmental accounting while allowing comparability with other sectors. Wider application of successful geospatial and statistical standards[17] is essential to fostering information exchange, a precondition for wide-scale integrated analyses of remote sensing and GIS sources, for example. In areas such as fishery operations where information technology developments open new avenues for data collection, the emergence of new standards[18] is welcome. Without them, the risk is that institutional and industry stakeholders will not be able to bear the costs of multiple reporting formats. Finally, bridges and connectivity need to be established among adopted standards so that information can flow across domains.

Second, it is important to provide global, regional and national data and information-sharing platforms. Existing technologies can manage and analyse huge amounts of data collected through a diversity of methods and sensors including satellite imagery, VMS and other transmission systems, smartphones and videos. Leading-edge developments can use distributed data infrastructures to provide specialized communities of practice with a broad range of data services including data sharing, harmonization, analysis and dissemination. Such data infrastructures also offer great potential to operationalize information standards and achieve synergies among platforms at all scales.

Finally, enhancing partnerships and other networking arrangements is vital as no single organization in isolation can cover all BGI requirements.

While FAO's existing strategies[19] remain valid and provide the guiding principles for addressing data needs for blue growth, the above-mentioned constraints indicate where emphasis is now required in order to achieve real progress. Accordingly, FAO is calling for a global partnership/alliance to forge a global data framework for blue growth. Through this framework, FAO will be able to coordinate the partnerships assembling the foundations (data repositories, information standards, methodologies, tools, expertise, and collaborative data infrastructure) required for the collection and integrated use of data across initiatives and disciplines. The framework will participate in the Open Science[20] movement and, as such, is expected to boost capacities to produce indicators inclusive of developing countries for the Sustainable Development Goals (SDGs). In this context, fisheries policy-making and management should benefit from the experience of the agriculture, biodiversity and environmental communities by reusing their analytical and mapping methodologies. ■

IMPROVING THE VALUATION OF INLAND FISHERIES: ADVANCES IN EMPIRICAL YIELD MODELLING

The issue

The Global Conference on Inland Fisheries, held at FAO in Rome in January 2015, underscored an increasingly recognized need for new methods to assess inland fisheries – in space, time and taxonomically (see section Ten steps to responsible inland fisheries, p. 147). At the global scale, there is as yet no reliable dataset on inland fishery yields that encompasses all freshwaters, whether fast-flowing (e.g. rivers and streams) or slow-flowing (e.g. lakes and reservoirs). Many countries and national agencies lack the means to directly collect fishery data from the varied small-scale and dispersed fisheries that constitute the bulk of inland fishery production. Robust estimates of current and potential yields are essential for informing effective food security and environmental conservation efforts by governments as well as by international aid, development and conservation groups such as the UN and non-governmental organizations (NGOs).

Inland fisheries are typically small-scale and subsistence or recreational in nature. This makes it difficult and costly to track their yields using conventional landing-based methods. Nations report annual capture statistics to FAO with variable accuracy (e.g. identical yield values reported several years in a row, suggesting lack of new data collection), with 151 nations reporting inland catches for 2013. This means FAO has to estimate missing data for global statistics. Several reports suggest these statistics underestimate catches by at least 50 percent.[21] For example, the sum of all yields reported for nations covering part of the Mekong Basin – including non-Mekong waters – is less than the Mekong River Commission reports for that basin alone.[22] The same pattern holds for reports from the nations around Lake Victoria and independent reports of yield for that lake.[23]

Underestimating inland yields and the ecosystem services they provide means water management plans often ignore the needs of these fisheries. Demands on freshwater systems from hydropower, irrigation and industry feature more prominently in policy discussions, especially in developing regions where people's dependence on fisheries is greatest. This inadequate consideration of fisheries threatens human communities and biodiversity and is a major issue facing the Mekong and Amazonian systems, as well as many smaller subsistence fisheries worldwide.

Given the challenges facing on-the-ground data collection for inland fisheries, there is a need for broad-scale assessment tools that can inform national and international policy. Numerical models can provide estimates of yield over broad geographic scales. Improved estimation of current and potential yields is needed to reliably gauge fishery status and justify inland fisheries' role in policy discussion. Moreover, fishery management can use these estimates to ensure sustainable resource use and ecosystem conservation as well as prevent "fishing down" effects, where which preferential harvest of large fish causes community shifts in species and size composition, potentially causing fishery collapse.

Possible solutions

To estimate inland fish yields, models should: (i) consider the factors sustaining production, such as primary production, hydrologic regime and physical form of the aquatic habitat; (ii) address adverse human impacts (e.g. fishing pressure, dams, water diversions, abstractions and irrigation); and (iii) be spatially scalable and readily updatable. For a given fishery, it may be possible to capture these factors with sophisticated process-driven models involving

data-rich parameterization. However, such models' data requirements are incompatible with the data-poor diverse fisheries represented at the global scale. Instead, it is preferable to employ empirical yield models that use environmental predictors to explain variation in observed yield from multiple fisheries. These empirical models rely on observation data originating from scientific surveys or stock assessments in a few waterbodies, but then applied more widely to other waters based on more-readily available predictor variables.

Empirical yield modelling

The development of empirical yield models began in the mid-1900s using linear regressions involving lake depth or easily surveyed water chemistry as surrogates for primary production. Combining these predictors evolved into the morphoedaphic index initially applied to Canadian lakes and later to tropical lakes and reservoirs in Africa.[24] Surface area alone later proved a reliable sole predictor of lake yield,[25] and since then lake surface area as measured from maps has dominated yield models for broad-scale applications. However, these data typically represent annual average or snapshot surface area, thereby precluding derivation of relationships between seasonal water-level variation and fishery yield, which are critical for many productive waterbodies (e.g. Tonle Sap of the Mekong).

There are fewer approaches for estimating riverine catch. The most widely recognized offers riverine analogues to slow-flow models, relating channel length and/or floodplain area to yield based on observed catch data, mostly for Africa.[26] These relationships between physical habitat and reported yield are reasonably good (with correlation coefficients above 0.9 for African rivers), but require testing across a larger model domain – in both space and time – before robust broad-scale application.

Recent actions

The use of GIS and remote sensing has expanded the suite of modelling approaches to include higher-resolution and more reliable predictors of yield, including direct measures of primary production and hydrologic regime. For example, researchers have established relationships between chlorophyll concentrations as a measure of freshwater primary production and fishery yields worldwide (Figure 32A),[27] and are now using remotely sensed chlorophyll data at the global scale to predict lake yields. While currently limited to slow-flow systems, application to riverine systems is planned.

Earlier riverine models were limited to predictors measurable from maps (e.g. channel length). However, researchers have now developed a model for estimating potential and actual riverine yields as a function of streamflow based on high-resolution global discharge maps using observed catch data for 40 basins worldwide (Figure 32B).[28] Discharge has proved a better predictor than energy proxies such as terrestrial net primary production and temperature. Comparison of the modelled potential yields with FAO's national statistics corroborates suggestions of under-reporting for many parts of the world.

Higher-resolution analyses relating freshwater habitats to current fish abundance, including landscape and human impact data, are under way for both slow- and fast-flowing waters in the United States of America. A similar approach – incorporating both biotic and abiotic influences on production – could serve well for modelling potential yields. While data requirements may preclude global application, a coarser version could be feasible.

Outlook

Increasing availability of surrogate data is allowing yield models to consider more predictors and be spatially scalable and readily updatable. Several global datasets – in particular remote sensing and hydrographic databases – mean existing yield models can now be updated and expanded, and novel models can be developed for comparison with nationally reported catch statistics, also helping to improve their reliability.

Novel data and approaches

Data on the global area covered by surface freshwaters and the distribution of waterbody types have remained patchy and uncertain, limiting understanding of fishery yields at multiple scales. Bridging this gap, several datasets have recently been developed from remotely sensed surface waters including a wide range of waterbody types. For example, a very recent data map on global inundation[29] classifies remotely sensed surface waterbodies as inundated wetland, river channel, lakes, reservoirs or irrigated rice paddies, whereas previous datasets typically focused on lakes alone. Deriving this map seasonally would offer additional advantages in relating water-level fluctuations to fishery yields. Given the range of average yields among waterbody types worldwide (Figure 33), such products can now advance yield models beyond just lakes and rivers, in particular by including floodplains and other wetlands, which can be very productive and ecologically sensitive.

Yield models based on hydrologic regime can take advantage of recent high-resolution global discharge maps.[30] Using these new maps, it is possible to integrate predicted changes in streamflow into yield models, addressing critical questions related to changes in climate and water use. Advances in remote sensing of autotrophic activity, such as the use of remotely sensed chlorophyll for lakes, are improving physiochemical yield models such as the morphoedaphic index. Perhaps most importantly, the combined use of global-scale primary production data and high-resolution surface water and river discharge maps provides the opportunity to develop scalable holistic yield models.

In addition to improved environmental datasets, future modelling efforts should attempt to include fishing effort. Fishing effort directly determines catch and varies over large geographical scales, representing an important opportunity for refining yield model outputs at multiple scales. Future approaches will need to distinguish between categories of fishing activity and associated variation in individual effort, as well as full-time, part-time, subsistence and recreational effort. This addition to yield models remains limited by data collection constraints.

In terms of numerical modelling approaches, the relationship between yield and predictors has most often been quantified with generalized linear models, limiting the ability to deal with complex non-linear patterns typical of natural systems. Future efforts can benefit from exploring alternative modelling approaches, such as machine learning methods, which are used to predict various aspects of fish communities[31] and can outperform traditional methods in predicting yield.[32]

Scalable approaches

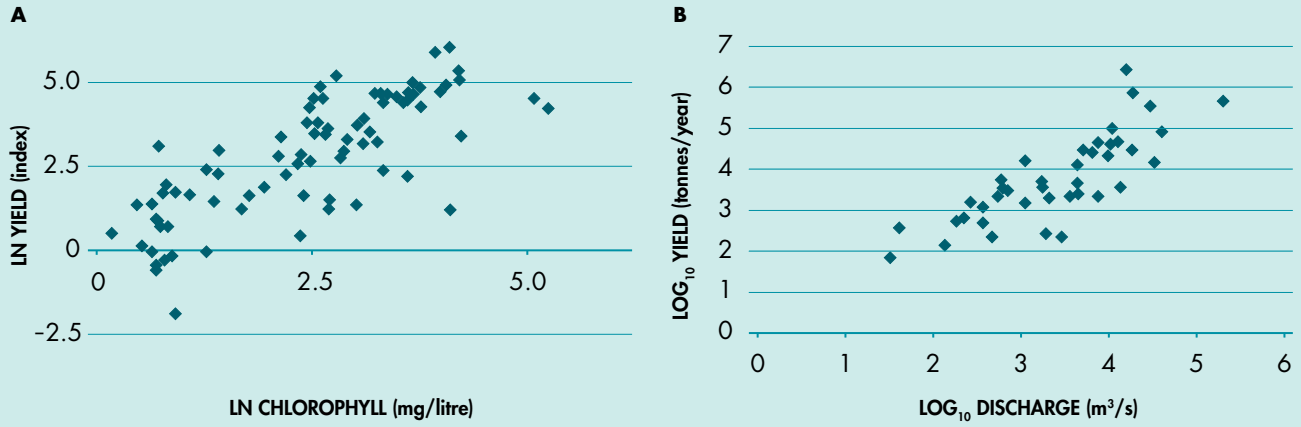
High-resolution yield modelling would allow for multiscale assessment of yields, including use of political boundaries (e.g. national and regional) and ecological units (e.g. river basins or freshwater ecoregions). This ability to estimate yields across scales would allow governmental and intergovernmental management bodies of any size, such as the Mekong River Commission or other transboundary water management organizations, to utilize the framework, encouraging spatially nested management approaches. Predictions from the global model may not be locally accurate, but they can illustrate broad geographical patterns and should be used in concert with locally derived information. Such a scalable modelling approach could enhance sustainable management of inland fisheries in larger water management frameworks through improved spatial planning and policy guidance.

Updatable approaches

The need for improved data collection and analysis of inland fisheries is all the more acute in a context of global changes in climate, land use and water consumption. Cost and difficulty usually preclude sufficient on-the-ground data collection such as stream or fisher surveys, necessitating improved modelling. In addition to being scalable, any meaningful new yield model should be updatable. There is an immediate need for improved utilization of »

FIGURE 32

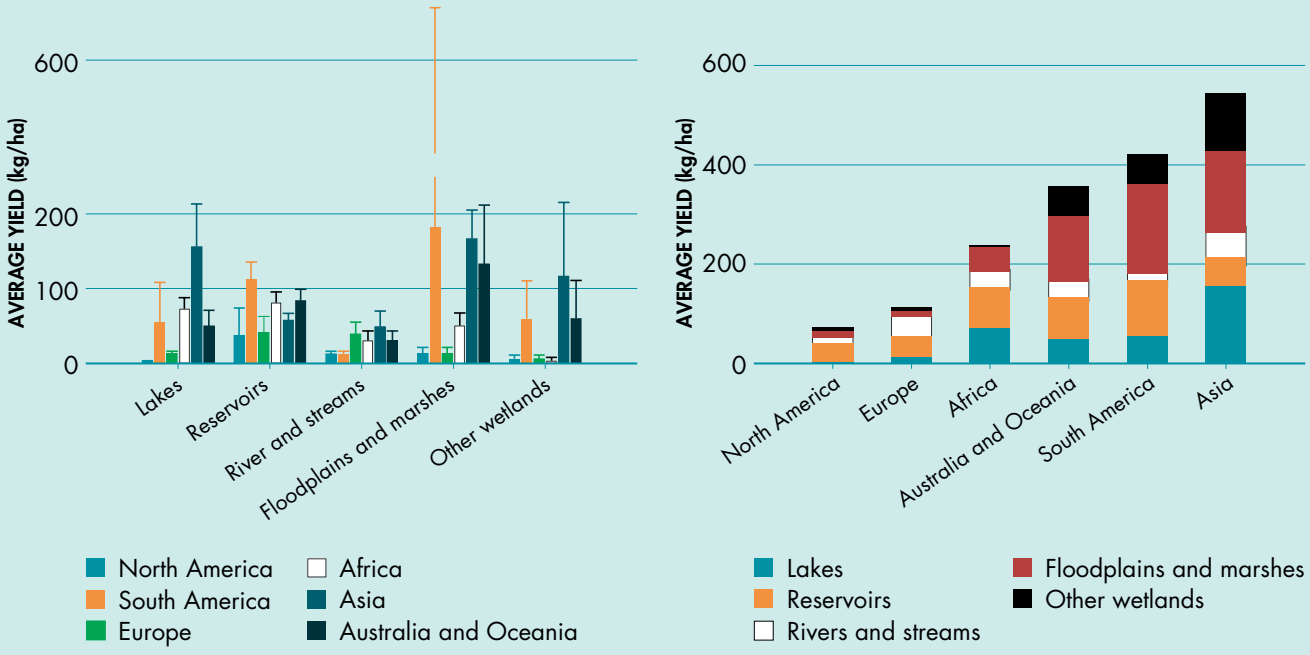
PREDICTORS OF INLAND FISH YIELD



Notes: A) Relationship between primary production as measured by chlorophyll (mg/litre) and inland fish yield (index; from Deines, A.M., Bunnell, D.B., Rogers, M.W., Beard, Jr, T.D. & Taylor, W.W. 2015. A review of the global relationship among freshwater fish, autotrophic activity, and regional climate. *Reviews in Fish Biology and Fisheries,* 25(2): 323–336). B) Relationship between streamflow (cubic metres per second) and yield (tonnes/year; data from the literature representing 40 basins worldwide).

FIGURE 33

AVERAGE ANNUAL INLAND FISHERY YIELDS BY WATERBODY TYPE AND CONTINENT



Note: Error bars show 95% confidence intervals.
SOURCE: Data from: Lymer, D., Marttin, F., Marmulla, G. & Bartley, D. (forthcoming). A global estimate of theoretical annual inland capture fisheries harvest. *In* W.W. Taylor, D.M. Bartley, C.I. Goddard, N.J. Leonard & R. Welcomme, eds. *Freshwater, Fish and the Future: proceedings of the global cross-sectoral conference.* Rome, FAO, and Bethesda, USA, American Fisheries Society.

» available technology in creating a global online data community for inland fisheries. For example, an online data portal could be established for uploading validated datasets from local to broad scales, allowing analysts to compare yield data across similar domains or time frames. Yield models could be automatically updated with new data feeds. As production data become available with more taxonomic definition, these can be added to the database for consideration in larger questions of biodiversity conservation. These advances are technologically possible, yet require greater investment and education within the inland fisheries communities. In line with recommendations from the Global Conference on Inland Fisheries, new partners could be enlisted to share in this investment, including but not limited to development agencies and international conservation NGOs.

The bulk of the inland fishery harvest comes from developing countries, and it plays a vital yet largely unrecognized role in supporting the livelihoods and nutritional health of millions of men, women and children worldwide. Improved inland yield estimates will help to: (i) improve the valuation and accounting of these contributions and many other important ecosystem services provided by fish populations and fisheries; (ii) facilitate more effective policy-making and management for sustainable fisheries; and (iii) support the implementation of several steps in the Rome Declaration on Responsible Inland Fisheries (see Table 21, p. 149). ■

CUTTING BYCATCH AND DISCARDS IN TRAWL FISHERIES TO SLASH FOOD LOSS AND BOOST SUSTAINABILITY

The issue

Shrimp and other types of bottom trawling provide employment, income and livelihoods for hundreds of thousands of people in tropical and subtropical countries. However, in addition to targeted species, these fisheries also catch other fish and marine life. This incidental catch is called bycatch – or discards if thrown overboard rather than landed.[33] The quantity of this bycatch can be several times that of the targeted species. Often, a significant part of the bycatch consists of small-sized and low-value fish, but it can also include juveniles of commercially important fish species as well as highly vulnerable animals such as sea turtles, sharks and rays. Bottom trawling can also damage sea-bed habitats, and it often causes conflicts with coastal small-scale fisheries.

Progress has been made worldwide in managing bycatch and reducing discards. Nonetheless, trawl bycatch and discards still constitute a sustainability threat by inflicting undue mortalities that jeopardize livelihoods and long-term food security. In tropical and subtropical countries, most shrimp and bottom trawl fisheries are poorly managed, and enforcement of management regulations is often weak, in particular with regard to bycatch and discards.

Although bycatch and discards may represent significant economic losses to the communities at large, fishers have few incentives to avoid bycatch. Fishers may have a different perspective of the magnitude of the problem and may consider that the potential conservation benefits

do not go to them. They may also see adoption of mitigation measures as meaning significant loss of income, and fail to appreciate possible long-term benefits. However, excessive bycatch is often a problem for fishers as it slows their catch sorting operations considerably, causing inferior catch quality. It also increases fuel consumption, thereby posing a risk to the viability of their fishing. Better communication of solutions and their positive impact on the fishing economy, combined with enforcement of regulations, can create incentives for bycatch and discards reduction.

Possible solutions

Tools available to manage bycatch and reduce discards include: fishing capacity and effort controls; improving the design and use of fishing gear; spatial and temporal closures; and enforceable limits on bycatch and discards. Technological measures aim to improve the selectivity of fishing gear and thereby reduce bycatch and discards. These measures include changes in the design or rigging of fishing gear, installation of bycatch reduction devices and/or using particular operational techniques during fishing. Spatial and temporal measures often aim to reduce bycatch by prohibiting or limiting the use of certain gear types in defined areas (e.g. no-trawl areas) or seasons to protect vulnerable life stages (e.g. spawning or nursery area closures). Spatial measures may include zones reserved for traditional fishing activities or for specific gear types. The performance of different measures to manage bycatch varies among fisheries as do the costs associated with their effective implementation. Using several measures in concert may increase their overall effectiveness (e.g. bycatch reduction devices combined with area closures).

Experience has shown[34] that bycatch and discards issues should not be addressed in isolation but preferably as a component of overall fisheries management systems and according to the principles and operational guidance recommended by the Code of Conduct for Responsible Fisheries (the Code) and the EAF. This approach is reflected in the International Guidelines on Bycatch Management and Reduction of Discards.[35] Introducing better management to reduce bycatch and discards may entail not only changing practices but also fishing less (i.e. reduction of overall fishing effort), potentially leading to lower landed catches, at least initially.

Fishers' behaviour will ultimately determine the success or failure of bycatch management measures. Therefore, all such measures require the full cooperation and involvement of the fishing sector at all stages of their development and implementation, as well as effective monitoring and control and surveillance. For the measures to be effective, they have to be practical, enforceable, effective and compatible with other measures. All of this is dependent on an enabling environment in the form of appropriate legal and institutional frameworks. Governance arrangements have to engage the fisheries sector and all other key stakeholders in the participatory management process in order for management actions to be successful.

Positive incentives will enhance the uptake of bycatch management measures. Therefore, the creation of effective incentives for transitioning to more responsible fishing practices is fundamental. For example, the uptake of bycatch reduction measures can be encouraged by rewarding compliant fishers with preferential access rights to resources. It is also essential to raise awareness on bycatch problems and provide clear explanations to fishers on why it is necessary to manage bycatch and reduce discards in their fisheries, the benefits of doing so, and the long-term consequences of failing to do so. Similarly, policy-makers, special interest groups and the general public should be better informed about the causes and conditions that lead to bycatch and discards.

Mechanisms that contribute to effective communication, cooperation and coordination among stakeholders in the development and implementation of bycatch management measures are vital. Appropriate and reliable data and information are essential for monitoring progress and taking corrective actions where necessary.

Finally, finding successful solutions for bycatch and trawl management requires not only taking local circumstances into account but also sharing lessons and communicating good practices across fishers, countries and even regions.

Recent actions

The FAO and Global Environment Facility (GEF) project Strategies for Trawl Fisheries Bycatch Management (REBYC-II CTI) (2012–16) has been conducting socio-economic studies to understand fishing communities' dependence on trawl fisheries livelihoods for income, food security and nutrition, the gender dimension of such dependence, as well as other economic activities dependent on trawl fisheries. The knowledge gained (Box 9) will contribute to the preparation of trawl fisheries management plans informed by the ecosystem approach to fisheries management.

The FAO–GEF project Sustainable Management of Bycatch in Latin America and Caribbean Trawl Fisheries (REBYC-II LAC) (2015–19) aims to reduce food loss[36] and support sustainable livelihoods by improving bycatch management and minimizing discards and sea-bed damage, thereby turning bottom trawl fisheries into responsible fisheries. The project will investigate the role of bycatch in food security and livelihoods, and explore alternative income-generation opportunities for those affected by the management action, including women (often involved in processing and selling products from bycatch). Capacity development for livelihoods diversification is critical to ensuring decent job opportunities and incomes.

In tropical and subtropical fisheries, gillnets and trammel nets are among the main gear types. A food loss and waste reduction project, initiated by FAO and focusing on the harvesting stage of the fish supply chain, has been started with gillnet and trammel net fishing operations, the results of which should be of wider interest. This separate and new project has developed a methodology to estimate fish loss during fishing operations, which complements an already standardized methodology for assessing post-harvest fish losses, thereby completing the fish loss assessment from harvesting and post-harvesting stages. Case studies using the methodology are under way to understand the extent of fish loss during harvesting and identify technological and management options for reducing fish loss.

Assessments of bycatch and discards by fishery type are key to understanding the extent of the problem and monitoring progress in how it is being addressed. The third global assessment of bycatch and discards is under way and due for completion in 2017 (Box 10).

Outlook

On 25 September 2015, the United Nations General Assembly adopted 17 SDGs for the next 15 years. Two of them resonate very closely with the management of bycatch, reduction of discards, and reduction of food loss and waste. One is Goal 12 (Ensure sustainable consumption and production patterns), specifically 12.3, which states: "By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses." The other is Goal 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development), particularly 14.2, which states: "By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans."

This is the latest initiative in a trend that is increasingly placing the reduction of bycatch and discards in broader contexts of both sustainable consumption and production and sustainable ecosystems. Building on progress being made through technical advances, fisheries management and the EAF, the hope is to address the long-standing issue of food loss and undue damage to the ecosystems caused by bycatch and discards. Success will depend on combined efforts by governments, civil society, the private sector, fishers and consumers in applying context-specific solutions. ■

BOX 9

LESSONS LEARNED IN THE REBYC-II CTI PROJECT

In Southeast Asia, the FAO and Global Environment Facility (GEF) project Strategies for Trawl Fisheries Bycatch Management (REBYC-II CTI) is making a significant contribution to emerging marine fisheries policies. These policies aim to restore badly overfished and damaged marine and coastal resources in the respective countries. A crucial element in this development has been capacity building of key stakeholders through the processes of the ecosystem approach to fisheries (EAF). Project support in the development of trawl fisheries management plans that incorporate EAF principles will contribute to the restoration and sustainable management of marine stocks in the project countries.

The project has supported the partner countries in compiling improved data sets and developing data management systems for improved trawl fisheries management. Experiences and lessons learned from addressing issues are shared regularly with stakeholders in all of the participating countries, and this in turn has helped in designing a strategy[1] for trawl bycatch management at a regional level. The project is also making a contribution to the development of trawl fisheries management policies on a regional level through work with the Asia-Pacific Fishery Commission. Through this work, the partners in all participating countries have been exposed to key international guidelines on trawl fisheries management.

The main lesson learned in this project is that the strategy for meeting the key environmental and socio-economic objectives requires effective incorporation of EAF principles in supporting the development of fisheries management plans and their implementation at all stages. The challenge now is in sustaining the progress made towards this objective beyond the life of the project, and there are already clear signs that this will be achieved in some of the countries participating in the project.

1 FAO. 2014. *APFIC/FAO Regional Expert Workshop on "Regional guidelines for the management of tropical trawl fisheries in Asia", Phuket, Thailand, 30 September – 4 October 2013*. RAP Publication 2014/01. Bangkok. 91 pp. (also available at www.fao.org/3/a-i3575e.pdf).

BOX 10

HOW MUCH FISH IS DISCARDED WORLDWIDE?

FAO has previously commissioned two global assessments of fisheries bycatch and discards. The first study (1994) provided a yearly mean global estimate of 27 million tonnes of discards.[1] A decade later, an update estimated global average yearly discards at 7.3 million tonnes.[2] These two assessments, while not directly comparable owing to their different methodologies, suggest a significant decline in global discards in the ten years between the studies. This probably reflects changes in fisheries management in terms of the implementation of more selective fishing technologies, requirements of ecolabelling standards, and growing markets for previously discarded fish. It is considered timely to conduct another update on this vital fisheries and food security issue via a project planned for completion in early 2017. In particular, it is important to have current information on how the world is performing in reducing discards and seafood wastage, and how this is enhancing global food security. An expert workshop in Morocco in May 2015 discussed, validated and agreed on the project approach, methodology and issues to address in order to identify and quantify the current extent and impact of fisheries' discards throughout the world. The workshop also identified a range of potential data sources for the project.

1 Alverson, D.L., Freeberg, M.H., Pope, J.G. & Murawski, S.A. 1994. *A global assessment of fisheries bycatch and discards*. FAO Fisheries Technical Paper No. 339. Rome, FAO. 233 pp. (also available at www.fao.org/docrep/003/t4890e/t4890e00.htm).

2 Kelleher, K. 2005. *Discards in the world's marine fisheries. An update*. FAO Fisheries Technical Paper No 470. Rome, FAO. 131 pp. Includes a CD–ROM. (also available at www.fao.org/3/a-y5936e/index.html).

SUSTAINING FISHERIES THROUGH FISHERFOLK ORGANIZATIONS AND COLLECTIVE ACTION

The issue

The fight against hunger and poverty remains a major challenge worldwide. More than one billion people in the world are estimated to be living in extreme poverty, and 70 percent of the world's poor are women. In most developing countries, fishing communities are at the bottom of the socio-economic ladder. The root causes of poverty in small-scale fishing communities are associated with a number of factors. Among these factors are: the harvest nature of the production process; the high perishability of the product; the relatively higher capital investment needed for production, and the associated higher risks; the relative isolation of fishers' work space from mainstream society; and the dangerous nature of the occupation and the uncertainties associated with the state of resources, which create fears and vulnerability. All these factors contribute significantly to small-scale fishers' dependence on intermediaries. These intermediaries are in a position to take advantage of fishers throughout the whole food chain – buying their fish; providing them with credit; offering them land on which to build their homes; and extending consumption loans. This dependence can easily trap fishing communities in a web of exploitative relationships. The issue then is how small-scale fishing communities can improve and sustain their livelihoods by working together more effectively to conserve the resources, better manage their fishing and post-harvest operations, and optimize their long-term gains.

Possible solutions

Empowering fishing and fish-farming communities through strengthened fisherfolk organizations and collective action is one strategy that FAO and others are pursuing to address challenges and to enable poor communities to gain access to resources, services and markets as well as to have their voice heard in the decision-making process. This strategy is aligned to specific actions for improving opportunities for the rural poor to access decent employment and social protection. Together, they form the three pillars of the FAO's strategic programme to reduce rural poverty and to promote blue growth in an inclusive way.

Fishers' organizations, both formal and informal, provide a platform through which fishers and fish workers exercise their right to organize, participate in development and decision-making processes, and influence fisheries management outcomes. For small-scale fishers and fish workers, the benefits of being part of an organization include: (i) experiencing a sense of belonging and identity; (ii) generating market power for better opportunities as well as for devising the ways and means to obtain the best return for the products of their labour; (iii) being involved in developing policies to improve the fisheries sector; and (iv) conservation of the fishery resources and protection of their ecosystems.

However, many obstacles to collective action still exist, and action to overcome difficulties in building organizational development is key to changing the path of rural development in small-scale fisheries. The difficulties include: (i) fishing as an independent and competitive activity and the hunting mindset of being a fisher are in themselves major challenges to undertaking collective action and forming organizations; (ii) the weak political–economic influence of small-scale fisheries as a social class can be an impediment owing to their dispersed distribution and limited opportunities to discuss issues; (iii) small-scale fish workers have a low literacy rate; and (iv) the average age of fish workers is rising.

The need to address these challenges is one reason for collective action to empower fish workers to pursue their shared objectives more effectively. The wide diversity in typology of organizational development shows the need for »

BOX 11

COSTA RICA

STRENGTHENING FISHERS ORGANIZATIONS TO SCALE UP AND IMPLEMENT MARINE AREAS FOR RESPONSIBLE FISHERIES

CoopeTárcoles R.L. is a cooperative enterprise in Costa Rica. Founded in 1985 by a group of small-scale fishers, its goals are to improve both working conditions for artisanal fisheries and the positioning of their products in the market. Its objectives include:

- Improve working conditions.
- Enhance incomes among group members and their families.
- Eliminate the intermediaries in the marketing of fish and other marine products.
- Create sources of employment.
- Obtain the best prices for products.
- Allow rapid growth of the cooperative enterprise by opening new markets for products.
- Raise the level of organization and participation of fishers.
- Promote approaches to sustainable management of natural and cultural resources.

In 2001, CoopeTárcoles R.L. formed a strategic alliance with CoopeSoliDar R.L., a self-managed cooperative of professionals from various disciplines and people interested in environmental issues who provide professional services regarding the conservation of natural resources, cultural identity and social solidarity. This process revealed that the link between the Tárcoles fishing community and its marine resources was not limited to a dependence on them as a source of income and livelihood. Rather, it was recognized that there were underlying deep traditions and cultural ties, such that the activity of small-scale fishing represents a nucleus that binds together an entire way of life and marine fishing culture. The two cooperatives subsequently identified an initiative for responsible artisanal fishing as one of the lines of work to safeguard fishery resources, social welfare and a cultural way of life (including local knowledge), as well as to enable organizational strengthening of the community and, above all, its cultural identity. In recent years, and with the support of CoopeSoliDar R.L., CoopeTárcoles R.L. has promoted a series of participatory strategies for sustainable management of fishery resources, including the generation of new knowledge. On the basis of these strategies, an initiative for responsible artisanal fishing in the area was proposed. Among the most important results have been the drafting of a code for responsible fishing, participatory zoning of marine areas, the formation of the consortium Por La Mar R.L., and the establishment of a fisheries database to collect information about the characteristics of fishing activities. This database constitutes a unique initiative in the region, and also serves as a concrete example of how to integrate local and traditional knowledge of fishers with scientific knowledge to guide decision-making for the management of small-scale fisheries.

As a result of the information generated for this database, it was possible to affect negotiations for the recognition of a marine area for responsible fisheries (MARF) in Tárcoles. Based on analyses of data from the database, the board of INCOPESCA (Costa Rica's national fisheries authority) recognized the need to permanently remove shrimp boats from the coastal zone as requested by fishers. The negotiations leading up to this action took several years, but in 2011 INCOPESCA temporarily banned shrimp boats from the Tárcoles MARF, with only hook-and-line fishing being allowed. The study of the effects of the ban showed recovery in the two most exploited species (snapper and shrimp).

SOURCE: Solís Rivera, V., Madrigal Cordero, P., Chacón, D. & Naranjo, G. (forthcoming). Institutions and collective action in small-scale fisheries: the case of CoopeTárcoles R.L., Costa Rica. *In* FAO. *Strengthening organizations and collective action in fisheries: case studies and workshop report.* FAO Fisheries and Aquaculture Proceedings No. 41. Rome.

» creativity and local adaptation, confirming that solutions are context-specific (Table 18). For example, lessons have been learned from: customary organizations in Timor-Leste; cooperatives in Barbados, Belize, Brazil, Costa Rica (Box 11) and Norway; hybrid organizations in Indonesia and the United Republic of Tanzania; and new supported organizational forms in the United States of America. These represent success stories where fishers have created organizational arrangements to engage in responsible fisheries practices while improving their livelihoods and developing mechanisms to tackle the drivers of poverty. Such examples show that a combination of state intervention, public welfare programmes, intervention by social activists and collective action by the fishers themselves can improve the situation of fishing communities, creating opportunities for these communities to cope with the adverse risks and other sources of vulnerabilities that constrain fishers' empowerment.

Organizations have the potential to address the power imbalance within the fisheries sector and *vis-à-vis* other sectors. The actors in the fisheries supply chain have different socio-economic backgrounds, interests, perceptions and aspirations. Their relationships with one another may vary depending on the issue and may be harmonious, collaborative or conflictual. Among the drivers that galvanize fisherfolk to organize are: changing the distribution of benefits along the supply chain in their favour; accessing new domestic and international markets; and participating in fisheries management.

These actors' desire to organize and improve their situation depends not only on their own volition, but also on the existence of enabling policies as well as the support of NGOs and academic and other institutions. In Belize, the idea of a cooperative movement started from a brainstorming session between a priest and the government's cooperation department.[37] On the Tanzanian side of Lake Victoria, fisheries authorities saw that the non-involvement of fishers was a weakness in the enforcement of fisheries laws, and this led them to embrace the idea of co-management, which was operationalized through the establishment of beach management units.[38]

The case of Norway shows how a law can shift the balance of power in favour of fishers. At a time when fishers were poor and had little bargaining power, the passage of the Raw Fish Act in 1938 granted fishers' sales organizations the exclusive right to decide the raw fish price, leading to the empowerment of fishers and lifting them out of poverty.[39]

A revival of customary institutions is emerging, including an appreciation of their role in conflict resolution and fisheries management. In Timor-Leste, a community's initiative to revive "tara bandu", a regulatory mechanism governing the relationship among humans and between humans and the environment, was supported by a regional project (FAO Regional Fisheries Livelihoods Programme) as well as the National Directorate of Fisheries and Aquaculture.[40] Tara bandu has proved successful in terms of resource protection, increased transparency, and recognition from the state administration (albeit informally).

The act of organizing is a challenge, but an even greater challenge is sustaining the organization, keeping the members active and committed, and adapting to new challenges. Policies to enable fisherfolk to engage in collective action and form associations are essential, but so too are organizational development and strengthening. It is necessary to identify and address internal organizational weaknesses. Such weaknesses can include and affect leadership and succession, lack of clarity regarding membership and organizational structure, poor record-keeping, lack of autonomy, achieving financial self-sustainability, how to integrate and nurture the youth, how to address free-riding, and being models of practice, particularly with respect to responsible fishing practices. Mainstreaming gender is a key challenge for many organizations. Women often play significant roles both in the fisheries value chain and in supporting and sustaining organizational activities, but they often have less say in the organization.

BOX 12

SUPPORTING DIALOGUE, PARTNERSHIP AND ORGANIZATIONAL STRENGTHENING AMONG FISHERFOLK ORGANIZATIONS

In the Caribbean, a platform for dialogue and partnership among different stakeholders on strengthening fisherfolk organizations has been established. To facilitate empowerment of rural poor, training of fisherfolk leaders and exchange and study visits among fishers have been delivered in three small island developing States. The purpose of these actions is to help develop the capacities of fisherfolk leaders to manage primary and secondary fisherfolk organizations in their countries. The scope of the learning exchange has covered three main areas of operation: (i) business planning and field operations for financial sustainability; (ii) fisheries development and conservation for sustainable livelihoods; and (iii) collective action at the secondary level for sustainable institutions.

Small-scale fisherfolk leaders from communities in Brazil are preparing to engage in exchange visits to experience and learn how cooperatives are successfully managed. Moreover, a networking and organizational capacity programme has been initiated to strengthen beach management units in the United Republic of Tanzania.

TABLE 18

HISTORY OF FORMS OF FISHWORKER ORGANIZATIONS AND COLLECTIVE ACTION IN DEVELOPING COUNTRIES

ORGANIZATIONAL FORM	APPROXIMATE TIME PERIOD	NATURE OF COLLECTIVE ACTION	CURRENT STATUS OF INITIATIVES
Customary organizations	At least from 1500 onward	Based on collective action that was identity-oriented, consensual and community-initiated.	Old forms still exist in many countries. In some countries, efforts are being made to revive them within the context of new sociopolitical and cultural realities.
Cooperatives and societies	Some from early 1900s onward, but largely formed during "development decades" – 1950s, 1960s and 1970s	Based on collective action that was sector-oriented and supported/coopted by the State.	Most of the older "supported top-down" forms now defunct or dormant. New ones being organized with more "bottom-up" approaches.
Associations and unions	Largely post-1980 onward	Based on collective action that was sector-oriented, class-based and largely adversarial to State.	Some have lost their earlier vibrancy and strength. Many survive at the federated – national and global – levels.
New "supported" organizational forms	Largely 2000 onward	Based on collective action that is cooperational, multi-interest (cross-class) and multilayered with revived interest from the State, international organizations and non-governmental organizations.	Many interesting initiatives that need to be observed closely.
Hybrid and networked arrangements	Largely post-2010	Based on collective action by a mix of "face-to-face" and "virtual" organizations aided by support groups and even the State with important use of information and communication technology for collective action and organizational management.	Too early to make assessment of status.

SOURCE: Based on Kurien, J. 2014. Collective action and organisations in small-scale fisheries. *In* D.C. Kalikoski & N. Franz, eds. *Strengthening organizations and collective action in fisheries: a way forward in implementing the international guidelines for securing sustainable small-scale fisheries, FAO Workshop, 18–20 March 2013, Rome, Italy,* pp. 41–104. FAO Fisheries and Aquaculture Proceedings No. 32. Rome, FAO. 168 pp. (also available at www.fao.org/3/a-i3540e.pdf).

Recent actions

Activities are under way to build organizational capacity (Box 12) among fishing communities following the recommendations from a 2014 workshop on lessons learned from in-depth case studies.[41] The capacity development strategy includes a strong focus on developing human capital, with particular attention to capacity development for youth, specific leadership training, business and administrative capacities, negotiating a more creative role for women, finding alternative market solutions, soliciting support from organizations of civil society, and greater international support for fisher organizations as well as legal and institutional framework support for creating economies of scale and scope. The aim should be to increase the capability of fisherfolk organizations to be self-reliant, self-organizing, and able to build strategic partnerships in small-scale fisheries through networking to further empower rural people to move out of poverty.

Outlook

In June 2014, the FAO Committee on Fisheries endorsed the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines). The SSF Guidelines support the establishment and strengthening of fisherfolk organizations along the value chain. The major challenge now is effective implementation of these guidelines, and building on experience can facilitate this. Where fisherfolk are unorganized, the guidelines provide them with a powerful tool in negotiating with their own local governments and fisheries authorities for policy support and technical assistance in establishing their own organizations. Moreover, strong fisherfolk organizations can become champions for the implementation of the SSF Guidelines in their community, country and region.

There is a diversity of organizational forms in the fisheries sector, and new organizational designs are being created that are responsive to the specific social, cultural, historical and economic context of fisherfolk. Experience shows that policies to enable fisherfolk organizations to flourish and become equal partners in development have to catch up with these organizational forms, including through the provision of appropriate technical advice and support from NGOs, academic institutions, and fisherfolk's own network of organizations. ■

PROMOTING DECENT WORK IN FISHERIES AND AQUACULTURE

The issue

The fisheries and aquaculture sector is an important source of employment and income, supporting the livelihoods of 12 percent of the world's population.[42] Almost 60 million people are employed in the primary sector alone (see section Fishers and fish farmers, p. 32) and a further 140 million are employed along the value chain from harvesting to distribution.[43] Women directly engaged in primary production account for more than 15 percent of people engaged in fisheries and aquaculture, and 90 percent of those engaged in processing activities.

Fishing, fish processing, aquaculture operations and related activities generally feature many important characteristics of decent working conditions for fishworkers. However, employment in the sector often still provides insufficient income, commonly exploits fishworkers, occurs under hazardous conditions and is characterized by gender inequality. In particular, there are major concerns worldwide about the presence of child labour and forced labour, as well as the exploitation of migrant workers. The protection of labour rights in fishing and aquaculture is limited. Internationally recognized labour standards are often not applied or enforced. The reasons for these decent work deficits are often linked to other factors that impede the full enjoyment of human rights, including civil,

political, social and cultural rights. In fact, there are common factors in the sector that hinder the achieving of decent working conditions. Among these are seasonality, informality, remoteness and the hazardous nature of work as well as particularly complex value chains.

The International Labour Organization (ILO) defines decent work as "productive work for women and men in conditions of freedom, equity, security and human dignity".[44] This definition has been endorsed by the international community.[45] To implement the definition, the decent work agenda[46] was developed and agreed by ILO members and the international labour community. It represents a programmatic framework to operationalize the decent work definition around four pillars:

1. employment creation and enterprise development;
2. social protection;
3. standards and rights at work;
4. governance and social dialogue.

FAO supports and contributes to the implementation of the ILO decent work agenda in rural areas. It specifically included promotion of decent rural employment (Box 13) under its new Strategic Framework 2010–2019. In fact, promoting decent employment in the agriculture, forestry and fisheries sectors is increasingly seen as essential to achieving food security and eliminating poverty in rural areas.

Decent work deficits

Employment creation and enterprise development

A large share of fishers, fish farmers and people employed in fish processing activities live in developing countries, where employment in the sector is characterized by very low incomes, high seasonality and low productivity. While low earnings and productivity result from a wide variety of context-specific causes, common challenges facing fishworkers include poor access to vocational training, extension services, markets and advanced technologies. Operations are often concentrated in areas with poor infrastructure, which affects the range of activities and unit production costs. Moreover, high post-harvest losses of already low production are caused by lack of proper handling of fish, as well as by low-quality collection, processing and storage facilities. In this context, landless households dependent on daily wage labour from fisheries activity are particular vulnerable and exposed to risks.

The continuous expansion of some fisheries and aquaculture operations, and intra- and inter-sectoral competition for resources and markets, means that the risks of overfishing and unsustainable natural resource use are tending to increase despite efforts to promote sustainable fishing and fish farming worldwide. Pollution, environmental degradation, climate change, diseases and natural and human-induced disasters add to the threats to fishworkers' livelihoods. Shrinking catches and declining fish stocks, combined with pressure from growing coastal populations, are particularly affecting small-scale capture fishing communities in many developing countries, where social protection and other employment opportunities are often lacking.[47]

Lack of data

Fisheries and aquaculture statistics largely fail to capture the youth and children working in the sector, and the limited data available are rarely disaggregated by gender. This is largely a result of the sector's fragmented reality and policy-makers' failure to attach due significance to it, but also of the low institutional capacity for statistical data collection and use. Lack of data and related low sector visibility affect policy decisions. For this reason, fisheries and aquaculture policies often fail to integrate employment concerns and recognize the potential of the sector to reduce rural poverty and contribute to local development.

Social protection

Fishers and fish farmers are particularly prone to a large set of vulnerabilities, also because of the hazardous nature of work on board fishing vessels. Many countries where fisheries and aquaculture are important occupations for low-income groups do not offer affordable or non-contributory social protection for all. Where social security coverage does exist, the

informality of the sector, the small scale of operations and the associated institutional transaction costs make it difficult for fishworkers to be included in social security systems, leaving them and their families exposed to high levels of economic, social and environmental risks. Particularly vulnerable are those households dependent on capture fisheries, owing the hazardous work involved.

Occupational safety and health concerns depend on the activities performed and the specific circumstances. Sector-specific risks can also be exacerbated by additional factors such as migration, HIV/AIDS, gender-based violence and drug abuse. Overcapacity and overfishing lead fishers to take greater risks, work longer shifts, ignore fatigue, reduce crew sizes and disregard safety standards, making fisheries one of the most dangerous occupations with 24 000 casualties per year and high rates of occupational diseases and injuries.[48]

Standards and rights at work

The fisheries and aquaculture sector is often characterized by ineffective labour regulation. In 2007, to provide specific response to the needs of people working in capture fisheries, the ILO developed the Work in Fishing Convention. The convention aims to ensure that decent work is promoted on board fishing vessels, including in particular: conditions of service, accommodation and food, occupational safety and health protection, medical care and social security. To enter into force, the convention needs at least ten countries to ratify it; to date, five have done so. Vessel inspections for compliance with fishery regulations usually focus on gear and catch with little consideration of decent work conditions. Moreover, labour inspectorates are often weak and fail to carry out inspections, especially in remote and isolated areas.

Abusive labour conditions may well be associated with IUU fishing practices. The vessels involved may operate outside the jurisdiction of any State, making law enforcement even more difficult. Moreover, modern fishing operations can result in complex relations between vessel owners and workers. The State of registration of vessel owners, country of residence of fishers and area of operation of the vessel may all be different. Some flag States, known as "open registers", allow fishing operators to register vessels owned by shell companies, which facilitates anonymous ownership of vessels (and operations under so-called flags of convenience).

Migrant fishers may benefit from increased work opportunities and higher pay, but migrant status often means decent work deficits and increases vulnerability. Migrant workers are especially exposed to exploitation as they may not be aware of their rights on foreign vessels. They may not be in a position to demand adherence to contract agreements or access legal advice and justice in the case of violation of labour rights. They may not have acceptable written work agreements, may not be paid at due times, or may lack access to medical care. Often, language barriers or lower education levels make migrants less aware of occupational safety and health standards. Moreover, they are more likely to contract HIV/AIDS and other sexually transmitted infections, also as a consequence of their lifestyle and living conditions away from home.[49]

Although labour surveys fail to capture its prevalence, child labour is a compelling issue in fisheries and aquaculture. Case studies demonstrate that child labour can be prevalent in the small-scale fisheries sector, in aquaculture and in post-harvest activities.[50] Despite the ILO Minimum Age Convention (1973) and the ILO Worst Forms of Child Labour Convention (1999), there is little law enforcement. Countries usually omit fisheries and aquaculture activities from their hazardous work lists that specify the areas of work to which these conventions apply.

Governance and social dialogue

Fishers, fish farmers and fish processors often lack adequate forms of organization and participation in social dialogue (see also section Sustaining fisheries through fisherfolk organizations, p. 122). Membership of fishworkers' organizations is even lower in informal small-scale operations, which provide the vast majority of jobs in fisheries and aquaculture. Levels of unionization of workers in

fish processing and other stages of the value chain often depend on the scale of operation and on whether workers have formal contracts. In general, at sectoral level, unionization is very low. This hampers workers' capacity to influence policy development and governance mechanisms, and makes them more dependent on intermediaries and the informal sector for services such as credit access.

Possible solutions

Fisheries and aquaculture are complex and diverse realities. They are influenced by global value chain arrangements and characterized by the coexistence of commercial operators alongside subsistence fisherfolk, artisanal fishers and fish farmers. Awareness of the concept of decent work is increasing but is still fairly low, particularly in small-scale fisheries and aquaculture. Decent work deficits in fisheries and aquaculture require interventions that are country- and context-specific.

Data and information

Promoting productive and profitable employment in the sector is essential. This requires greater coherence between employment policies and fisheries and aquaculture policies to foster employment and enterprise development. Increasing the visibility of small-scale fishers, fish farmers and fish processors through improved national and international statistics on employment in the sector is an essential element for enabling more-informed decision-making. Important data gaps to be filled include employment data disaggregated by gender and age. Practical interventions should focus on creating sustainable and inclusive value chains, with a particular focus on small-scale operators, women and youth. To tap the full employment and productivity potential of the sector, access to services, market and training should be made available. To decrease overcapacity in the fishing sector, appropriate alternative/complementary employment opportunities should be sought.

Vulnerability

Decreasing the vulnerability of operators to economic, environmental and social shocks is also a compelling need. Systems providing access to basic social protection services for fishworkers and their families should be extended to include formal and informal employees. Moreover, health and safety measures should be improved and implemented based on assessments of occupational safety and health needs in the workplace, transportation, distribution, households, etc.

Standards

International labour standards should be extended to fisheries and aquaculture, and countries should strive to ratify and enforce the ILO Work in Fishing Convention. Regional and international instruments on fisheries should be implemented (codes of conduct, voluntary guidelines and conventions). Regional cooperation and coordination should be strengthened to address decent work deficits related to flags of convenience and IUU fishing. Child labour in fisheries and aquaculture needs to be prevented and reduced. In particular, hazardous child labour occupation needs to be tackled by including the fisheries and aquaculture sector in national hazardous work lists.

Organizations

There should be recognition of the rights of fishworkers to organize, bargain collectively and participate in fisheries and aquaculture planning, development and management of pre-harvest, harvest and post-harvest operations. Supporting self-organized local professionals and cooperatives also helps to favour the integration of small-scale operators in value chains and reduce their vulnerability and political, economic and social marginalization.

Recent actions

Recent policy processes and developments reflect growing recognition of the issue of decent work in fisheries and aquaculture. In 2014, the Committee on World Food Security recommended that stakeholders "strive to improve the working conditions of the fisheries and aquaculture sectors, including safety at sea, promoting decent work, eliminating forced and child labour and

developing social protection systems".[51] Similarly, the FAO Committee on Fisheries (COFI) addressed decent work issues in fisheries in 2014.[52]

The recently endorsed SSF Guidelines (see section Small-scale fisheries, p. 92) represent an important tool at the service of member countries. The guidelines have a dedicated section on social development, employment and decent work, and another on gender equality. Regional consultation workshops have been held in Southeast Asia and East Africa to draft implementation plans.

FAO also promotes dialogue and coordination between governments, private sector and civil society. In 2014, a COFI side event focused on the issue. In 2015, decent work in fisheries and aquaculture was put forward as a pressing issue at the "Vigo Dialogue", and the COFI Sub-Committee on Aquaculture also discussed decent work issues.

In close collaboration with the ILO, FAO is engaged in efforts at all levels in supporting policy development, advocacy, communication and partnerships to promote decent work in fisheries and aquaculture. FAO's collaboration with the ILO has also facilitated the preparation of a technical guide on how to tackle child labour in the sector.[53] Since 2010, Cambodia's fisheries administration has worked closely with FAO to develop a ten-year framework plan for fisheries with a dedicated indicator on child labour prevention and a related national action plan. This case represents a stepping stone in the process of eliminating child labour in Cambodia, and is a good example of interagency cooperation and policy development support at country level. FAO is continuing to work with Cambodia's fisheries administration to raise awareness at the local level on decent work issues and gender equality.

Outlook

Above all, access to decent working conditions represents a human right for all fishworkers (fishers, fish farmers and fish processors) as a means to achieve decent lives. The growth of decent employment opportunities is increasingly recognized as an integral and essential condition of sustainable development. The 2030 Agenda for Sustainable Development includes SDG 8 dedicated to "… economic growth, full and productive employment and decent work for all."[54] In 2015, in Addis Ababa, governments committed to generating full and productive employment and decent work for all, and promoting micro, small and medium enterprises.[55] Today, decent work can be seen as a key intrinsic element of sustainability, trade and governance ethics.

In close collaboration with its partners, and under its mandate of reducing rural poverty, FAO has an important role to play in promoting decent employment in fisheries and aquaculture. For example, multidisciplinary fishing vessel inspections involving fisheries, labour and maritime port authorities are increasingly being undertaken to address IUU fishing and associated labour abuse. The BGI fostering "blue communities" represents a key opportunity for advancing the decent work agenda in rural areas with respect to fisheries and aquaculture. It aims to promote resilient coastal, riparian and fish-dependent communities (based on sustainable natural resource use, decreased vulnerability to environmental, social and economic shocks, including migrations), and to enable poverty reduction through higher incomes. Implementing the decent work agenda, i.e. addressing labour abuse and other decent work deficits in the communities concerned, is therefore an integral part of blue growth. ■

BOX 13

HOW FAO DEFINES DECENT RURAL EMPLOYMENT

FAO defines decent rural employment as any activity, occupation, work, business or service performed by women and men, adults and youth, in rural areas that:

- respects the core labour standards as defined in ILO conventions, and therefore:
  - is not child labour,
  - is not forced labour,
  - guarantees freedom of association and the right to collective bargaining and promotes organization of rural workers,
  - does not entail discrimination on the basis of race, colour, sex, religion, political opinion, national extraction, social origin or other;
- provides an adequate living income;
- entails an adequate degree of employment security and stability;
- adopts minimum occupational safety and health measures, which are adapted to address sector-specific risks and hazards;
- avoids excessive working hours and allows sufficient time to rest;
- promotes access to adapted technical and vocational training.

SOURCE: Adapted from FAO. 2014. *Decent rural employment toolbox: applied definition of decent rural employment* [online]. [Cited 20 October 2015]. www.fao.org/3/a-av092e.pdf

TABLE 19

AVERAGE SCORES IN THE 2015 CODE QUESTIONNAIRE ON AQUACULTURE ON THE PRESENCE OF MEASURES FOR REDUCING VULNERABILITY TO CLIMATE CHANGE

REGIONS	AFRICA	ASIA	EUROPE	LATIN AMERICA & CARIBBEAN	NEAR EAST	NORTH AMERICA	SOUTHWEST PACIFIC	GLOBAL
NO. OF COUNTRIES	14	10	18	19	5	2	2	70
ESSENTIAL MEASURES TO ADDRESS CLIMATE CHANGE								
General preparedness to manage risks from climate change	1.7	2.7	2.9	1.6	2.6	3.5	3.0	2.3
General preparedness to respond to disasters	2.2	2.9	3.1	2.2	2.6	4.0	3.0	2.6
Aquaculture zoning to address all risks to production, environment and society	2.6	3.0	2.6	2.4	3.0	3.5	4.0	2.5
Farms are covered by government assistance schemes in case of disasters	2.3	1.9	1.1	1.3	2.0	0.0	1.5	1.2
Farmers have access to commercial insurance	1.3	1.3	1.1	1.3	0.3	0.0	1.0	0.8
Fish health management in place	2.7	3.5	4.0	3.2	3.2	4.5	3.5	3.3
RELEVANT MEASURES TO ADDRESS CLIMATE CHANGE								
Farmers have access to institutional credit as well as microcredit	2.8	1.3	1.2	1.5	2.5	0.0	1.0	1.2
Aquaculture is integrated to coastal management plans	2.8	3.7	2.9	2.5	2.6	3.5	3.5	2.6
Aquaculture is integrated in watershed management or land-use development plans	2.4	3.3	2.9	2.1	3.6	3.5	2.0	2.5
Ecosystems functions are considered in aquaculture planning and development	2.4	3.8	3.6	2.6	2.4	4.0	3.0	2.9
There are incentives for farmers to restore or rehabilitate ecosystem services and resources	1.8	2.7	1.7	1.8	2.0	4.0	3.0	1.5
BMPs[1] implemented	2.5	4.0	3.0	3.0	2.8	4.5	3.0	3.0

Note: The score for each statement ranges from 0 (measure non-existent) to 5 (measure in place, fully implemented and enforced at field-level nationwide).
[1] BMPs = better management practices.

AQUACULTURE AND CLIMATE CHANGE: FROM VULNERABILITY TO ADAPTATION

The issue

Climate change will have a range of impacts on aquaculture. In developing adaptation strategies for the sector, it is essential to understand the drivers resulting from climate change (biophysical changes), their pathways, their variability and the risks they pose.

The main drivers that could have direct or indirect impacts on aquaculture and the evidence of such impacts have been well described.[56] The drivers include warming of waterbodies, sea-level rise, ocean acidification, weather pattern changes and extreme weather events. The Fifth Assessment Report from the Intergovernmental Panel on Climate Change (AR5) offers evidence of the certainty of global warming and of the effects on oceans, coastal areas and inland waterbodies. There is high confidence that coastal systems and low-lying areas will be increasingly exposed to submergence, coastal flooding, coastal erosion, and saltwater intrusion. Most at risk will be the coastal systems.

The links between each driver to its impacts on aquaculture have been broadly and, in a few cases, specifically established by numerous studies with varying degrees of strength. For example, the predicted rise in seawater carbon dioxide (CO_2), and consequent acidification, will affect the physiology of bivalves in terms of growth and reproduction and may affect the quality of shells. However, warming can also increase spatfall[57] and growth rates as well as extend the latitudinal range of farming and, therefore, climate change could also bring benefits. There are reports of farmers and researchers attributing mass die-offs of oyster larvae in hatcheries to higher water acidity.[58]

Impacts of acidification on marine finfish need more study, but it seems that embryos and larvae are more sensitive than juveniles and adults to elevated CO_2, and there could be sublethal effects such as impaired growth rates.[59] Links have been shown between climate-induced temperature variability and growth rates, disease susceptibility, timing of spawning, mortality at certain life-cycle stages, as well as economic impacts related to direct impacts on the culture process. Finally, extreme weather events are linked to physiological impacts through changes in salinity and temperature on metabolic response and some extended physiological change. There can also be various socio-economic impacts including escapes from aquaculture facilities, and damage to infrastructure and other livelihood assets.

Indirect effects of climate change occur through direct impacts on feeds, seed, freshwater and other inputs. These include impacts on fishmeal fisheries, sources of wild seed, and terrestrial feed sources such as soybean, maize, rice, wheat and other crops. Disease can be another indirect impact. AR5 recognizes the increased threat of disease to aquaculture under climate change, and many authors have examined the indirect effect of climate change on the spread and occurrence of disease in farmed aquatic organisms and shifts in the distribution of parasites and pathogens. For example, vibriosis is a disease that may be profoundly affected by climate change as Vibrio species grow preferentially in warm waters (> 15 °C) and at low salinity (< 25 ppm). Warming patterns have been linked to Vibrio outbreaks in molluscs in temperate and cold regions.[60] Because the culture environment for fish and shellfish can be modified to some extent, especially in ponds or recycle systems, it would seem possible to address the climate-related risks through controlled environments, albeit at additional cost. However, global aquaculture is largely conducted by small- and medium-scale farmers with limited capacity to control the conditions of farmed systems.

Vulnerability of regions and countries

Projections in AR5[61] indicate higher vulnerability of tropical ecosystems to climate change, with negative impacts on their dependent communities.

Climate change will affect food security in Asia by the middle of the twenty-first century, with South Asia most severely affected. Almost 90 percent of aquaculture production takes place in Asia, most of it in the tropical and subtropical belts. Using a series of indicators of exposure, sensitivity and adaptive capacity in a GIS model, one study[62] identified Bangladesh, Cambodia, China, India, the Philippines and Viet Nam as the most vulnerable countries worldwide. Recently, another study[63] has repeated the exercise with better modelling and data, and concluded that most aquaculture countries in Asia are very vulnerable with Bangladesh, China, Thailand and Viet Nam among the most vulnerable considering all environments (freshwater, brackish-water and marine). In other regions, Costa Rica, Honduras and Uganda appear among the 20 most vulnerable in freshwater aquaculture, Ecuador and Egypt are very vulnerable regarding brackish-water production, and Chile and Norway appear vulnerable regarding mariculture. In these vulnerability models, sensitivity is estimated through aquaculture production and contribution to gross domestic product (GDP), although by ignoring sensitivity authors also provide comparative vulnerability estimates for countries where aquaculture is only beginning but where there is a potential, for example, countries in Africa.

Vulnerability of species and systems

Several different approaches to assessing the vulnerability of species and systems are possible for devising farmer- and local-level institutional and structural adaptation strategies. However, the most practical approach is probably to categorize aquaculture units by geography, such as inland, coastal, arid-tropical, and then by farm density and intensity of production. Within the same location and with the same farmed species, it is the combination of technology, farm management practice, and area management that influence a system's vulnerability.

Poor and small-scale stakeholders are less well placed than larger-scale commercial actors to seize opportunities and adapt to threats. Thus, a strong focus should be on building general adaptive capacity that supports poor and small-scale aquaculture producers and value chain actors to make the most of new opportunities and cope with the challenges related to climate change.[64]

Possible solutions

There are practical adaptation measures ("no regret" actions) that can effectively address climate variability and trends at the farm, local and national levels and even at a global scale. With these measures, fish farmers and other local stakeholders can play a proactive role in addressing both long-term changes/trends and sudden changes (e.g. extreme weather events):

- aquaculture zoning to minimize risks (for new aquaculture), and relocation to less-exposed areas (existing farms);
- appropriate fish health management;
- increasing efficiency of water use, water recycling, aquaponics, etc.;
- increasing feeding efficiency to reduce pressure and reliance on feed resources;
- developing better-adapted seed stock (e.g. tolerance to lower pH, broader salinity resistance, faster-growing strains and species, and other attributes);
- ensuring high-quality, reliable hatchery production to facilitate outgrow in more stressful conditions, and to facilitate rehabilitation of production after disasters;
- improvement of monitoring and early warning systems;
- strengthening farming systems, including better holding structures (e.g. sturdier cages, depth-adjustable cages [for fluctuating water levels], deeper ponds) and management practices;
- improving harvesting methods and value addition.

Some countries are already taking action. For example, in Viet Nam, there are efforts to select for salinity-resistant catfish strains, and in Bangladesh the government and its partners are exploring options such as using salinity-resistant species, deepening aquaculture ponds, using depth-adjustable cages, and integrating fish farming with agriculture.

Recent actions

FAO monitors implementation of the 1995 Code of Conduct for Responsible Fisheries (the Code) with an aquaculture-specific questionnaire for its Members.[65] The assessment includes elements relevant to institutional climate-change adaptation approaches and resilient governance (Table 19). The latest assessment highlights many institutional and governance weaknesses in addressing climate change, especially where aquaculture is starting to develop. Governments' preparedness to mitigate climate change risks requires a good understanding of the sector's vulnerability at local and national scales. This remains as a global gap and should be a priority in order to build preparedness and foster adaptation measures.

An essential measure, aquaculture zoning, is weak globally, especially where the sector is yet to grow. The physical location of aquaculture facilities is one of the most relevant determinants of exposure and, hence, of vulnerability. For example, the location of fish cages in the coastal zone needs to consider: exposure to weather events; changes in currents or a sudden influx of freshwater from upstream; and longer-term trends, such as rising temperature and salinity and decreasing oxygen levels. Such information is essential in defining zones for aquaculture and deciding on the location of individual farm sites. In much of the world, the spatial distribution of inland and coastal ponds has responded more to land and water access opportunities than protection from external threats. Inclusion of climate change and other risks into spatial planning and aquaculture zoning is an urgent need in areas and countries where aquaculture is beginning to develop. Where it is difficult to relocate aquaculture systems, the concept of risk-based area management is essential.[66] Two additional essential measures – government assistance in case of disasters, and farmers' access to commercial insurance – are especially limited in Asia, the most vulnerable region and the major producing area.

As fish disease is a frequent cause of significant losses in aquaculture, adequate fish health management and biosecurity are essential to the sector's resilience. The global scoring is higher than for the other measures, indicating higher implementation. However, as climate change may increase disease frequency and impacts, much better implementation is required especially in Asia, where aquaculture is more concentrated with a higher density of farms per unit area.

A relevant, or "good to have", measure that is scored very low is farmers' access to institutional credit. This may be a major obstacle for small farmers as they seek to improve their farming conditions and invest in climate-resilient technologies such as sturdier cages, deeper ponds, better water systems, or improved seed.

The scoring also indicates a limited integration of aquaculture into coastal zone and watershed management schemes. This undermines efforts to build resilience; adaptation measures in other sectors (e.g. agriculture) could be detrimental to aquaculture (e.g. water diversion, coastal walls and levees, and even roads).

Implementation and enforcement of ecosystem function considerations (such as mangrove coastal protection) and providing incentives for their restoration and rehabilitation receive low and very low scores, respectively. This highlights the need for better understanding of threats and the importance of ecosystems services to the long-term success of aquaculture under climate change by users and planners of the sector's development.

Better management practices (BMPs), also "good to have" to increase resilience of farmed organisms and farming systems, have slightly higher scores, and this is a good baseline for building resilience. However, BMPs should be evaluated broadly, and climate change threats should be incorporated and adjusted in the BMPs.

Outlook

While progress has been made in understanding the vulnerability of aquaculture to climate change, much more research is needed to identify

the driving processes and develop alterative aquaculture approaches and practices accordingly. However, policy-making and planning cannot wait for the improved knowledge. They must proactively address the major challenges based on what is known by developing adaptation strategies to minimize vulnerability to climate change. Many of the measures required (as identified above) are part of existing best practices for aquaculture. Thus, they entail no major change in direction for stakeholders, but rather a renewed focus on priorities. For example, increased focus is required on climate-resilient aquaculture zoning, ensuring that the farms are located in areas that less exposed or that the farms in more-exposed zones adopt resilience measures (deeper ponds, more resilient strains, etc.).

A practical measure for local-level adaptation (yet to be included in the above assessment) is local environmental monitoring. Aquaculture is very sensitive to sudden climate changes as well as to long-term trends. However, beyond some forms of industrial aquaculture, there are very few cases of integrated monitoring systems providing information for fish farmers to use in their decision-making. Simple data collected on a permanent basis (e.g. fish behaviour, salinity and water temperature, transparency and level) can provide a very useful basis for decision-making, especially when changes can have dramatic consequences. Locally collected and shared information can help farmers to better understand biophysical processes and become part of the solution, e.g. through rapid adaptation measures, early warning, and long-term behavioural and investment changes. To implement such monitoring systems, key activities include training local stakeholders on the value of the monitoring and how to use the feedback for decision-making. It is also necessary to implement a simple network/platform to: receive, share and analyse the information; coordinate and connect with broader forecasts; and provide timely feedback to local stakeholders. ■

AGADIR, MOROCCO
A worker at a local sardine factory.
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PART 3

HIGHLIGHTS OF SPECIAL STUDIES

ABIDJAN, CÔTE D'IVOIRE
Smoking fish in an oven
in the suburban area of Port-Bouet.
©FAO/Sia Kambou

PART 3

HIGHLIGHTS OF SPECIAL STUDIES

AQUATIC INVASIVE ALIEN SPECIES IN EUROPE AND PROPOSED MANAGEMENT SOLUTIONS

Invasive species – drivers of ecological change

Globally, invasive alien species (IAS) of plants and animals are considered a major threat to native biodiversity, with the International Union for Conservation of Nature (IUCN) citing their impacts as "immense, insidious, and usually irreversible".[1] Whether introduced accidentally or deliberately into a natural environment, IAS threaten the ecological stability of invaded habitats and native species therein, as these are highly sensitive to various interactions with these non-native species (e.g. predation, competition and herbivory). Impacts include serious biodiversity loss (sometimes even the extinction of native species), transmission of disease to humans, and economic damage, for example, crop losses and infrastructure damage. It is estimated that 11 percent of the about 12 000 alien species in Europe are invasive, causing significant environmental, economic (estimated at US$13 billion annually for the European Union [EU])[2] and social damage. Considering recent trends, it is reasonable to expect that the rate of biological invasions into Europe will increase in the coming years. A multiplicity of pathways (e.g. increased international trade and travel) and vectors (e.g. crop seed, angling equipment) currently exist to facilitate and indeed hasten the introduction and spread of potential IAS throughout the globe. Climate change may exacerbate the problem. Although not all non-native species introductions result in harmful or damaging outcomes, current evidence indicates that the increasing scale of IAS introductions necessitates serious scrutiny and, moreover, a coordinated international response.

Examples of aquatic IAS – the case of Ireland

A great deal of research and control work has been conducted on specific aquatic IAS threats in Ireland, some examples of which are presented below. Although the issues and solutions are country-specific, they are also of wider relevance to other countries around the world.

Chub (*Leuciscus cephalus*) is a non-native fish species with the potential to become invasive in Irish rivers.[3] One serious consequence of introducing chub into Irish rivers is the possibility of introducing pathogens to which native species have no resistance. Moreover, if populations of chub species were to become established, they could adversely effect indigenous fishes, including salmon (*Salmo salar*) and brown trout (*Salmo trutta*), via direct predation and competition for food and space. Chub were illegally introduced to the Inny River, a tributary of the Shannon River, by anglers in the early 2000s, and their presence was confirmed in 2005. Inland Fisheries Ireland commenced an eradication programme in 2006, employing electric fishing to physically remove chub from the river. This programme continued until 2014. All chub removed were euthanized. Between 2010 and 2014, electric fishing operations recovered no further chub, and anglers did not report any chub in the river. Therefore, it

is presumed that the species has been successfully eradicated from this river.

Water primrose (*Ludwigia grandiflora*) is a wetland and aquatic plant species that is highly invasive in the British Isles and mainland Europe. It was first reported in Ireland in 2009 in an ornamental pond. Subsequent investigations revealed its presence in other ponds in the vicinity. Inland Fisheries Ireland commenced a programme of herbicide control at all infested ponds in 2010 and this continued until 2012. Monitoring at all of the treated sites (and many others in the area) in 2013, 2014 and early 2015 revealed no specimens of water primrose.

In 2005, the first record of curly leaved waterweed (*Lagarosiphon major*) in a natural lake (Lough Corrib, 18 000 ha) in Ireland was confirmed.[4] *Lagarosiphon* is a highly invasive submerged aquatic plant that rapidly overgrows suitable habitats and competitively excludes native biota. Inland Fisheries Ireland acquired EU funding, and a comprehensive research and management programme was put in place. By the end of this programme (2013), using traditional and novel weed control methods,[5] the lake area covered with this weed had declined from 92 ha to less than 10 ha, and significant habitat rehabilitation had been achieved. Weed control operations have continued on the lake, although currently there is minimal impact on native biota and recreational activities in this large watercourse.

Zebra mussels (*Dreissena polymorpha*) have wide-scale impacts on water quality and ecology in Irish waters.[6] Following ecotoxicological testing on non-target organisms,[7] an open water trial in Ireland in 2013 demonstrated that, under optimum conditions, zebra mussels can be effectively controlled using a natural, environmentally friendly product comprised of *Pseudomonas fluorescens*.

In an effort to regularize the response to the recognized threat posed by IAS across all EU countries, the EU published a draft Regulation in September 2013, and this entered into force across the EU in January 2015.[8] The Regulation aims to prevent, minimize and mitigate the adverse impacts of IAS on biodiversity and ecosystem services, as well as limiting social and economic damage through prevention, early detection and rapid eradication, and management. The Regulation requires the provision of a list of IAS of concern to the EU and its member countries. This list, which contains 37 species, was issued in January 2016.

An international conference (Freshwater Invasives – Networking for Strategy, Galway, Ireland, April 2013) was designed as a think-tank to determine the most urgent and pressing IAS issues in Europe (28 countries of the EU and other European countries) and to provide focus to the Regulation prior to its publication. More than 100 delegates, including international expert academics, applied scientists, policy-makers, politicians, practitioners and representative stakeholder groups, attended expert presentations and then spent two days contributing to collaborative workshop sessions in order to elucidate the "Top 20" IAS issues in Europe (Table 20). Workshops used a horizon-scanning and issue-prioritization approach[9] to develop this list, with all delegates involved in developing the process in the lead-in months before the conference. Essentially, each registrant prioritized IAS through an iterative scoring system prior to and during the conference, with all submissions finally collated into four broad pillars: (i) biosecurity; (ii) management and risk assessment; (iii) policy; and (iv) economics.

Further discussions and scoring resulted in the "Top 20" issues that the EU faces with regard to IAS (Table 20).[10] An examination of these issues revealed a number of important cross-cutting themes that will help focus the response within Europe to these issues, as well as being relevant more globally.

Important cross-cutting IAS themes

Although the workshop sessions were divided into four distinct pillars (above), several important cross-cutting themes that warranted further discussion did emerge from the "Top 20" issues.

Knowledge exchange requirements

Each of the four pillars highlighted the need for consolidation of knowledge. In fact, more than 50 percent of the issues concerned knowledge requirements. This varied from diverse education and training needs required for biosecurity and risk assessment, to the development of communication networks for early warning systems. There is an identified requirement for increased awareness of IAS among both the public and the legislature. Outreach programmes for the public are needed to minimize accidental introductions of IAS. Knowledge exchange between scientists, practitioners and policy-makers should be encouraged in order to: improve channels of communication; improve understanding of individual roles; and develop a coordinated approach to IAS management. There is also a need to disseminate the advantages of new technologies. Policy-makers also require education on the existence of non-market costs and, in order to evaluate these costs, biologists need to network effectively with socio-economists to develop combined analyses. Coordinated international best practice for biosecurity and risk assessment has to be developed through a consistent and informed approach. This requires knowledge sharing and networking among international experts. A similar approach could address knowledge gaps in risk assessment methods. Knowledge requirements identified in the "Top 20" list can be broadly categorized under two headings, training and networking, each of which has associated resource issues.

Financial and human resource issues

Resource issues were identified on both the national and international levels of scale. The conference delegates explicitly stated the need for a centralized funding source at EU level to remediate the current lack of funding, specialist staff and appropriate equipment needed for IAS management. Evidence of the total pecuniary and societal costs of invasions allows for better decision-making in IAS management and could increase necessary resourcing. In order to leverage funding, effective cost analysis and non-market evaluations need to become part of IAS management. Financial resourcing is also required in order to target the research and development needed to increase the confidence levels in risk assessment methods. Funding is required for all of the "Top 20" IAS issues. However, investment in priority actions including networking (to inform management), outreach (to mitigate accidental spread), new technologies (for control) and cost analysis (to inform priorities for management decisions) will substantially reduce the economic and ecological long-term costs of invasions.

Developing common strategies

There is currently no consistency of approach to or coordination of biosecurity between EU and non-EU countries. This is unacceptable as biosecurity activities need to start offshore or pre-border in order to reduce the risks of invasion. The conference outcomes recommended the sharing of best practice in Europe and further afield via established fora (e.g. New Zealand Bio-Protection Research Centre; South Africa Centre for Invasion Biology; Australian Department of Agriculture and Water Resource; Great Britain Non-native Species Secretariat). These fora could also be used to develop standards to prevent the introduction of IAS and to provide an international system for early warning mechanisms. A lead organization is required at the national level within each EU country to coordinate rapid response, and expert panels are »

TABLE 20

"TOP 20" INVASIVE ALIEN SPECIES (IAS) ISSUES IN EUROPE

ISSUE	RECOMMENDATION/COMMENT
Biosecurity awareness	Routine and rigorous application of biosecurity is essential to minimize new introductions, spread and impacts. However, application needs to be consistent across sectors (e.g. agriculture, pet trade) and among European Union (EU) countries.
Coherent EU legislation for effective biosecurity	Fragmented EU legislation needs to be unified and include an agreed framework for risk assessments, border checks and requirements for rapid reaction to new IAS.
International biosecurity best practice	The EU needs to learn salient lessons from other countries with effective IAS strategies, such as New Zealand and Australia.
Regulatory framework to prevent introduction of IAS	Gaps in international trade rules need to be plugged to prevent new IAS introductions.
Dedicated and appropriate resources for IAS	Adequate resources to appropriately tackle IAS and prevent new IAS introductions are essential. They include suitably experienced staff and finances for equipment, and there should be an emphasis on both long- and short-term initiatives.
New technologies for early detection	Detecting IAS incursions at the earliest possible time, when populations are still small, provides the best opportunities for rapid response; hence, drones, cameras, environmental DNA detection and other technologies are urgently required.
Early warning mechanisms	Early detection and appropriate rapid response are acknowledged as vital components in invasive species management; hence, information sharing and alert systems need to be rapid and effective.
Rapid risk assessment methods to prioritize future invasion events	As resources to tackle IAS will always be limited, it is necessary that streamlined and focused risk assessments common to all EU countries be in place to inform management decisions.
Standardized pan-European risk assessment to underpin EU IAS black list[1]	
Knowledge gaps in risk assessment	
The importance of economic analysis in risk assessment	Economic considerations should form part of risk assessments such that IAS that are more likely to cause an economic problem, for example, by disruption of ecosystem services, can be given a higher priority.
Rapid response – a vital tool in IAS management	While IAS prevention is preferable and less costly than IAS management, early detection (e.g. through horizon-scanning programmes and close collaboration with IAS experts internationally) and rapid response (e.g. by having available contingency measures, protocols and resources to tackle incursions immediately) are the next-most cost-effective lines of approach and are currently badly lacking in the EU generally.
Emergency powers to manage IAS	Barriers to measures for tackling IAS, such as herbicide bans and lack of powers of land entry, need to be removed to ensure effective IAS management.
Novel control in IAS management	New methodologies in IAS control, such as biocontrol, electric barriers, encapsulated poisons, and integrated multipronged approaches, show promise but need to be developed and embraced.
Knowledge transfer to improve IAS management	There is often a lack of communication between policy-makers, practitioners and researchers, which, if overcome, could greatly improve IAS prevention, control and mitigation.
Outreach to foster improved IAS management	As IAS usually spread as the unintended consequence of people's activities, better education of the public and stakeholders (including fishers) could enhance prevention and early detection; hence, aiding rapid reaction to new IAS introductions.
Effective communication to raise awareness of IAS	
Non-market valuation in IAS economic assessment	As well as direct economic costs of IAS that are easy to quantify, such as fisheries values, other non-market measures, such as impacts on carbon sequestration, should be incorporated in assessments of IAS threats and costs of action vs inaction.
Cost analysis in IAS management	
Single responsible agency – the answer to national IAS management	A single agency with a clear national responsibility for IAS is required within each EU country, while a coordinated approach to the control and spread of IAS to island States, which have a unique control advantage, is imperative.

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» required in order to develop and conduct risk assessments, as currently the responsibility for IAS management is often fragmented with blurred lines of responsibility between agencies. At EU level, a single responsible agency, with representation from the EU countries, could provide a mechanism to achieve effective oversight of IAS management within the EU.

The "Top 20" IAS issues in Europe

Although the 20 identified issues relate primarily to freshwater habitats, they are also directly relevant to marine and terrestrial ecosystems. In addition to the "Top 20" list, measures to mitigate the threats posed by each issue were discussed at length and distilled into firm recommendations. These "Top 20" issues and management measures represent an important tool for IAS management throughout Europe. They also provide support to policy-makers throughout the EU as preparations are made to implement the new European legislation on IAS. Table 20 summarizes the "Top 20" IAS issues identified during the workshop sessions. These are not presented in order of priority, and no priority ranking was sought during the workshops.

The way forward

Although IAS are widely recognized as a major threat to biodiversity, there is a real and present danger that not enough priority will be given to either prevention or management of their introduction and spread. Without sustained effort and resourcing, there will be further declines in native species and habitats, loss of natural capital, and threats to animal, plant and human health.

The 2013 Galway conference contributed significantly to shedding more light on how to address aquatic and other IAS. Based on the identified issues, the proposed options for solutions can serve as a tool for IAS management and are meant to support policy-makers as they implement the EU Regulation on IAS. The "Top 20" IAS issues, their associated threats and recommendations indicate that knowledge requirements are the main driver for developing management strategies. A new global network of invasive species experts is being set up to develop practical and consistent IAS management advice throughout Europe, using the new Regulation as a core instrument. Resourcing is vital for all 20 IAS issues, but long-term investment in knowledge resourcing and for the development of common strategies will provide a more sustainable approach to IAS management, provided that effective legislation and enforcement are in place.

It is still unclear how EU countries will resource effective implementation of the Regulation on IAS within or between jurisdictions, particularly in the light of trade movement agreements. However, one recent positive indicator is the proposed global assessment of IAS and their control by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services[11] to harness a global network of IAS experts to advise and support policy for decision-making on the critical issue of IAS management. There needs to be informed buy-in by all sectors of society in order to develop effective IAS management and stem further losses to global biodiversity. ■

TEN STEPS TO RESPONSIBLE INLAND FISHERIES – OUTCOMES FROM A GLOBAL CONFERENCE

In recognition of the vital role inland fisheries play in global food security and livelihoods, the Thirty-first Session of the FAO Committee on Fisheries (COFI) endorsed the convening of the Global Conference on Inland Fisheries: Freshwater, Fish and the Future (26–28 January 2015). The conference was part of a memorandum of understanding between FAO and Michigan State University, and brought together about 200 scientists, resource managers and representatives from civil society from around the globe to address four main areas of concern:

- biological assessment of inland fishery resources;
- social and economic assessment of inland fisheries' contribution to development;
- the drivers affecting inland aquatic ecosystems and their fisheries;
- governance and policy implications for land, water and fishery resource use and conservation.

By addressing these areas at a global level, the conference sought to help ensure that freshwater ecosystems and the rich biodiversity contained therein continue to provide ecological, social and economic benefits to present and future generations. The conference adhered to and built on the Code of Conduct for Responsible Fisheries and its technical guidelines on inland fisheries.

History

Inland fisheries have been a significant source of food since prehistoric times. Hooks, harpoons and fish remains are present in many archaeological sites, and many early river-based civilizations even have records of management practices. Recreational fishing is a more recent activity, and one that has motivated systematic investigations of inland fisheries in North America and Europe since the late nineteenth century.

Since the Industrial Revolution, external factors have strongly influenced the status, development and management of the inland fishery sector. Pollution, alteration of habitat, damming rivers, water abstraction and the introduction of non-native species have all affected fisheries resources, the people who depend on them, and the institutions mandated with their oversight. Fishing pressure – largely unquantified but known to be almost universally high and frequently unsustainable – has diminished the productive capacity of inland fisheries and continues to have an impact on the sector.

Today, despite the considerable contribution inland fisheries make to society, the sector is often neglected in national and international development discussions. Consequently, in the competition for freshwater, other more organized sectors, such as hydroelectricity and agriculture, often sideline inland fisheries. The demands placed on fisheries resources by a growing human population's desire for fish also compete with the need for restrictive management to conserve stocks.

Recognizing the importance of inland fisheries

The conference acknowledged the complex environment within which inland fisheries operate and examined what is needed to make the sector more visible in national and regional development plans. Inland fisheries provide many important ecosystem services (e.g. food, recreation and livelihoods), but these services are seldom properly valued or included in government statistics. As a result, the sector's contributions and importance are usually unrecognized or overlooked by policy-makers and governance structures. To meet today's challenges, the conference addressed the four major areas of concern listed above.

Biological assessment

In inland fisheries, the challenges and opportunities in determining their biological status are different from those encountered in marine fisheries. Inland fisheries are highly dispersed and most are of an artisanal and/or subsistence nature, which makes them very difficult to monitor. They are also often characterized by seasonality of fishing activity and a lack of institutional capacity and financial and human resources for assessment. As a result, estimates on what and how much is being harvested are often very poor.

The conference participants identified the critical need to develop and validate a variety of biological assessment tools that are flexible, robust and applicable at the appropriate scale to inform fisheries managers and policy-makers. Implicit here is the need to build capacity for such assessments and to incorporate their data into fisheries management and decision-making frameworks. Promising assessment tools include:

- remote sensing to help estimate fisheries productivity and yield;
- proxies for productivity based on environmental metrics;
- empirical models on fish production based on habitat characteristics;
- new technologies such as environmental DNA, hydroacoustics and mobile phone applications;
- household or market surveys.

Social and economic assessment

The vast bulk of the inland fishery harvest comes from developing countries. Inland fisheries play an important role in countries' social and economic development. They support the livelihoods of tens of millions of people globally and contribute significantly to the diets of billions of people in nutrition-sensitive areas such as the African Great Lakes, Nile and Niger basins, and the Ganges–Brahmaputra, Mekong and Amazon catchments. Often, inland fish production does not enter the formal economy and may be locally consumed or bartered. This local trade and consumption gives policy-makers the impression that the fisheries have little economic value. However, there are some extremely high-value inland fisheries, e.g. Lake Victoria Nile perch and the Mekong River dai fishery. Studies presented at the conference showed that the economic value of fish from some rice fields exceeds that of the rice. In addition, recreational fisheries have been estimated to involve more than 100 million people in North America, Europe and Oceania, and the value of recreational fishing in the United States of America alone exceeds US$40 billion.[12] Whether commercial, subsistence or recreational in orientation, freshwater fisheries also contribute to defining and sustaining diverse cultures, societies and ways of life. Fish such as Pacific salmon, hilsa and carp also have spiritual and symbolic value, and the consumption of freshwater fish is central to some religious festivals.

Inland fish also contribute to child development and human health. Fish add high-quality protein, beneficial fatty acids, vitamins and minerals such as vitamin A, iodine, zinc and iron, and provide diversity and palatability to people's diet. With many small freshwater species, it is customary to eat the entire fish, thus delivering additional nutrition to that available from consuming only fish fillets (see section Nutrition, p. 151).

Conference participants identified the critical need to boost the contribution of freshwater fish to human nutrition. Possible approaches include:

- Improved utilization, especially of small fish and during early childhood development (a critical period is the "1 000 day window" from the start of a woman's pregnancy to the child's second birthday).
- Improved management of inland fisheries to boost availability for food-insecure populations.
- Improved awareness of nutritional benefits, particularly where supply is good but consumption limited (e.g. education programmes to highlight the importance of fish for the 1 000 day window).
- Strengthened collaboration between inland fisheries and nutrition sectors to facilitate fish consumption either from direct consumption or in processed products.

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TABLE 21

THE ROME DECLARATION ON RESPONSIBLE INLAND FISHERIES: TEN STEPS TO RESPONSIBLE INLAND FISHERIES

Step	Action	Rationale
1	Improve the assessment of biological production to enable science-based management	Accurate and complete information about fishery production from inland waters is lacking at local, national and global levels. Governments often lack the resources or capacity to collect such information due to the diverse and dispersed nature of many inland fisheries. There is much scope for developing and refining biological assessment tools to facilitate science-based management.
2	Correctly value inland aquatic ecosystems	The true economic and social values of healthy, productive inland aquatic ecosystems are often overlooked, underestimated or not taken into account in decision-making related to land and water use. Economic and social assessment is often difficult and valuation often limited. In most cases, especially in the developing world, inland fisheries are part of the informal or local economy, so their economic impact is not accurately measured in official government statistics.
3	Promote the nutritional value of inland fisheries	The contribution of inland fisheries to food security and nutrition is higher in poor food-insecure regions of the world than in many developed countries that have alternate sources of food. Good nutrition is especially critical in early childhood development (i.e. the first 1 000 days). Loss of inland fishery production will undermine food security, especially in children, in these areas and put further pressure on other food-producing sectors.
4	Develop and improve science-based approaches to fishery management	Many inland waterbodies do not have fishery or resource management arrangements that can adequately address sustainable use of resources. Where management arrangements exist, compliance and enforcement are often minimal or non-existent. This may result in excessive fishing pressure, decreased catch per unit effort, and conflicts between fishers, as well as changes in the productivity of fishery resources. In some areas, reductions in fishing capacity will be required. To facilitate fishery management, it will be important to improve access to and promote better sharing of data and information about inland fisheries supporting the assessment–management cycle.
5	Improve communication among freshwater users	Information on the importance of the inland fishery and aquaculture sectors is often not shared with or accessed by policy-makers, stakeholders and the general public, thereby making it difficult to generate political will to protect inland fishery resources and the people that depend on them. Moreover, many misconceptions exist on the needs and desires of fishing communities.
6	Improve governance, especially for shared waterbodies	Many national, international and transboundary inland waterbodies do not have a governance structure that holistically addresses the use and development of the water and its fishery resources. This often results in decisions made in one area adversely affecting aquatic resources, food security, and livelihoods in another.
7	Develop collaborative approaches to cross-sectoral integration in development agendas	Water-resource development and management discussions very often marginalize or overlook inland fisheries. Therefore, trade-offs between economically and socially important water-resource sectors and ecosystem services from inland water systems often ignore inland fisheries and fishers. Development goals based on common needs, e.g. clean water and flood control, can yield mutually beneficial outcomes across water-resource sectors.
8	Respect equity and rights of stakeholders	Lack of recognition of the cultural values, beliefs, knowledge, social organization, and diverse livelihood practices of indigenous peoples, inland fishers, fishworkers, and their communities has often resulted in policies that exclude these groups and increase their vulnerability to changes affecting their fisheries. This exclusion deprives these groups of important sources of food as well as cultural and economic connections to inland aquatic ecosystems.
9	Make aquaculture an important ally	Aquaculture is the fastest-growing food production sector and an important component in many poverty alleviation and food security programmes. It can complement capture fisheries, e.g. through stocking programmes, by providing alternative livelihoods for fishers leaving the capture fisheries sector, and by providing alternative food resources. It can also negatively affect capture fisheries, e.g. introduction of invasive species and diseases, through competition for water resources, pollution, and access restrictions to traditional fishing grounds.
10	Develop an action plan for global inland fisheries	Without immediate action, the food security, livelihoods and societal well-being currently provided by healthy inland aquatic ecosystems will be jeopardized, risking social, economic and political conflict and injustice.

» Drivers

The drivers affecting fisheries today include some that are familiar, e.g. pollution and overfishing, and some that are novel, e.g. competition for water, and climate change. Less than 3 percent of the world's water is freshwater, and more than half of the world's people live within 3 km of a surface freshwater source.[13] Thus, a small fraction of all water provides a large range of economically, culturally and ecologically valuable services. Moreover, there is strong competition for freshwater services from among a growing human population. Competition for freshwater has been a source of conflict, but it could also become a catalyst for confidence building, cooperation and, perhaps, conflict prevention.[14]

As a result of this competition for water resources, many other sectors influence management and allocation decisions for inland water systems, and this affects the quality and magnitude of fish production and the resulting benefits. The development and management of hydropower, transportation, agriculture, mining, oil and gas extraction, forestry, tourism, recreation and aquaculture all exert their influence on freshwater systems and their fishery resources.

Climate change is another key factor affecting inland aquatic ecosystems. In 2010, global energy-related greenhouse gas emissions reached a record high of 49 billion tonnes. The Organisation for Economic Co-operation and Development projects that such emissions will increase by almost four times by 2050, thereby changing environmental conditions, including temperature, precipitation and river runoff.[15] These changes will certainly have an impact on fisheries.

The conference noted that addressing the drivers affecting inland fisheries will require that communities and resource managers, *inter alia*:

- become aware of the impacts other sectors have on inland fisheries and take action to address those impacts;
- promote a catchment and ecosystem approach to integrated management of land, water and natural resources;
- understand that adaptive measures will be necessary to enhance resilience to climate change.

Governance and policy

Good governance comes from good information, meaningful stakeholder involvement, and commitment from government, non-government stakeholders and private industry. Mainly due to a lack of resources and relevant information, current national institutions and governance systems are generally ill-equipped to deal with the above drivers and increasing pressures on inland fish and fisheries. Only by effectively demonstrating and recognizing their value and contribution will these fisheries be appropriately represented in the governance process. The conference highlighted that good governance encompasses both ecological as well as human well-being. However, achieving both is challenging, due in part to the tendency to divide freshwater resource users into sectors that do not coordinate their use of these waters.

To systematically explore how governance of inland water systems and their associated fisheries can be made more effective, the conference addressed the following three components:

- guiding principles of governance – the values and ideals;
- governing institutions – those overseeing and controlling the governance processes for solving problems and creating opportunities;
- opportunities and solutions – the manners, methods and systems for governing the sector, including the use of policies and management that are the immediate tasks of fishery managers and policy-makers for this sector, and the need for stakeholder involvement and integration among sectors.

The participants identified the key issues for improving governance of freshwaters and their fisheries:

- cross-sectoral integration in the development agendas for freshwater ecosystems;
- governance mechanisms on shared waterbodies;

- the rights of indigenous people and other stakeholders dependent on inland fisheries;
- the role of aquaculture;
- fisheries management;
- communication among institutions and stakeholders.

Ten steps – the Rome Declaration on Responsible Inland Fisheries

The ten steps to responsible inland fisheries (Table 21) were derived from more than 120 oral and poster presentations representing a wide global coverage,[16] focused discussions and interventions at the conference. They build on internationally accepted guidelines and principles.[17] The steps are general and not targeted to specific groups; however, numerous entities at various levels of government and society will need to work together to implement them.

The ten steps are presented in an order that represents a logical progression. For example, it is first necessary to know what exists and how valuable it is before information can be communicated cogently and the sector optimally managed (in the absence of such information, a precautionary approach[18] is required). Moreover, fisheries cannot be integrated into cross-sectoral governance if they cannot be effectively managed within the sector. The steps will be submitted to the next session of COFI for endorsement. Follow-up recommendations for implementation of the steps will be published in the conference proceedings and in a brief for policy-makers.[19] Taking these ten steps will be part of a path towards a world where people can responsibly use and enjoy freshwater ecosystems and their fishery resources today and for years to come. ■

NUTRITION: FROM COMMITMENTS TO ACTION – THE ROLE OF FISH AND FISHERIES

The Second International Conference on Nutrition (ICN2), a high-level intergovernmental meeting held in Rome on 19–21 November 2014, addressed malnutrition in all its forms in a global perspective. Participating governments endorsed the Rome Declaration on Nutrition and a framework for action, committing world leaders to establishing national policies aimed at eradicating malnutrition and transforming food systems to make nutritious diets available to all. The world community has to address great challenges in order to provide adequate food and nutrition security to a growing human population, expected to top 9.7 billion in 2050.[20]

Hunger and malnutrition are the world's most devastating problems, and inextricably linked to poverty. About 795 million people are undernourished globally.[21] Since the 1992 International Conference on Nutrition, there has been a significant improvement in reducing hunger and malnutrition among the world's population. However, such progress has been uneven and unacceptably slow. The fundamental challenge today is to improve nutrition sustainably through the implementation of coherent policies and better coordinated actions across all relevant sectors.

The Rome Declaration on Nutrition, adopted by ICN2, lists 60 recommendations addressed to government leaders.[22] This declaration is a framework for action, adopting global targets for improving maternal, infant and young child nutrition to be achieved by 2025.

Traditionally, nutritionists have focused on the macronutrients that provide energy and protein. Today, the role of micronutrients – vitamins and minerals – in diet is increasingly recognized as having a significant effect on development and

health. Micronutrient deficiencies affect hundreds of millions, particularly women and children in the developing world. More than 250 million children worldwide are at risk of vitamin A deficiency, 200 million people have goitre, and 20 million are mentally retarded as a result of iodine deficiency. Almost 2 billion people (nearly 30 percent of the world's population) are iron deficient, and 800 000 child deaths per year are attributable to zinc deficiency.

This then is the context in which the ICN2 deliberations took place. More than 20 countries highlighted the important role that fish products play, or should play, in meeting the nutritional requirements in people's diets. What follows is a brief account of the issues, developments, opportunities and guidance for future action that ICN2 considered in relation to the role of fish and fisheries in improving human nutrition.[23]

Fish in food and nutrition security

In recent years, the initiatives Scaling Up Nutrition and 1,000 Days (the impact of nutrition during the first 1 000 days of life) have helped focus on fish as a rich animal-source food containing multiple nutrients for growth, development and well-being, and specifically as a source of essential fats for brain development and cognition. Foods from the aquatic environment are an excellent source of both the macronutrients and micronutrients needed for a healthy diet. However, whether a community eats fish is strongly ingrained in its traditional food habits as well as its purchasing power.

Fish is one of the most important sources of animal protein, accounting for about 17 percent at the global level, but exceeding 50 percent in many least-developed countries. It also provides other valuable nutrients such as the long-chain omega-3 fatty acids docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) – important for optimal neurodevelopment in children and for improving cardiovascular health. There is convincing evidence of beneficial health outcomes from fish consumption for reducing the risk of death from coronary heart disease and improving neurodevelopment in infants and young children, when the mother consumes fish before and during pregnancy.[24]

In addition to the health benefits of these macronutrients, fish also provides micronutrients not widely available from other sources in the diets of the poor. Greater attention is focusing on fisheries products as sources of vitamins and minerals. Small-sized fish species consumed whole, with heads and bones, can be an excellent source of many essential minerals such as iodine, selenium, zinc, iron, calcium, phosphorus, potassium, and vitamins such as A, D and B.[25] The levels of these nutrients are also high in larger fish, but highest in the parts that are usually not eaten, such as heads, bones and viscera. Fish products are the main natural source of iodine and long-chain omega-3 fatty acids. Fatty fish can also be an important and unique source of vitamin D, which is essential for bone health. In areas lacking sun in winter and in cultures where the skin is not exposed to sunshine, vitamin D deficiency is increasingly acknowledged as a serious health problem.

Furthermore, the fisheries and aquaculture sector is an important source of employment (see section Fishers and fish farmers, p. 32), especially in developing countries. The income from fisheries contributes significantly to sustainable rural livelihoods and, therefore, indirectly to improved nutrition too.

Focus on nutrition from fish

If supported and developed in an environmentally and socially responsible manner, fisheries can further contribute towards eradicating hunger, food insecurity and malnutrition. Fisheries management has traditionally focused on maximizing benefits from capture fisheries in terms of employment, income and exports, while trying to ensure sustainability of the resource. More recently, the focus has turned more towards fish as food and a source of essential nutrients while sustaining the

ecosystem. This is evidenced by agenda items on fish and nutrition at recent sessions of COFI's aquaculture and fish trade subcommittees.

The most obvious constraint to increasing fish consumption is availability at affordable prices to the poor. Prices have risen as a result of population growth, increased demand and supply constraints. Aquaculture has helped to close the gap, but the price of some farmed species tends to be higher than that of the small low-value species traditionally consumed. However, farming of herbivorous fish such as some carps is a significant contribution to affordable fish products. There is growing awareness that consumption of even small quantities of fish makes a significant contribution to the nutritional quality of people's diets.

Increasing production and diversification

In recent years, capture fishery production has stabilized at about 90 million tonnes per year (about 70 million tonnes for food use), while aquaculture has continued to show sustained growth, outpacing all other food-producing sectors.[26] In 2014, aquaculture production was about 74 million tonnes, all assumed to go for food use. While significant increases in capture fisheries production are unlikely, aquaculture could provide another 16–47 million tonnes of fish by 2030.[27]

More research and development of technologies (particularly in aquaculture) will also yield positive results, as shown in Bangladesh and Cambodia with small traditional species (rich in vitamin A, iron, zinc and calcium) being grown in polyculture with high-value fish. It is also essential that the population in general, but specifically pregnant women, be advised of the need for and sources of micronutrients, especially for infants.[28]

Improving utilization of existing fisheries resources

The amount of the captured fish destined for non-food use has fallen, down from 34.2 million tonnes in 1994 to 20.9 million tonnes in 2014 (22.4 percent of total catches). The reasons for this drop range from the increased use for human consumption and a decrease in dedicated fishing for feed production (due to tighter quota setting and additional controls on unregulated fishing). Another factor is the increased use of fish residues and by-products, increasingly replacing whole fish for fishmeal and fish-oil production (see below).

More emphasis on production, consumer access, distribution and utilization of low-cost nutrient-rich fish (e.g. small pelagic species), and better utilization of often-wasted nutrient-dense parts of fish could boost availability and consumption of fish nutrients. This would require policy changes, infrastructure investment and more research (including on how to cut post-harvest losses in fisheries), as well as consumer education.

More from less

A persistently high volume of post-harvest losses removes large quantities of fish from the market – up to 25 percent in many developing countries. The reasons include: lack of infrastructure; lack of access to credit; lack of knowledge (limited education); and little or no access to technology. There are physical losses due to inadequate preservation or storage facilities, additional losses when processing waste is not converted to edible by-products, as well as nutritional losses due to a reduction in quality caused by damage during storage and processing.

Reducing post-harvest losses and discards is technically easy but requires far-reaching policy change and infrastructure investment. Before expecting industry to invest in bringing fish to market with efficient transport and functioning cold chains, it is essential to build landing

centres and roads linking production areas to population centres. Access to credit must be assured in order to encourage participation from small-scale operators, and comprehensive educational and technology programmes are needed to change perceptions.

Bycatch and discards of non-commercial species in capture fisheries represent a substantial loss in both developed and developing countries (see section Cutting bycatch and discards, p. 118). Discarded bycatch is estimated to exceed 7 million tonnes of fish (see Box 10, p. 121). Bycatch should be reduced to the absolute minimum; however, fisheries resources already captured should not be discarded and could make a significant contribution to food security. Tackling post-harvest waste and losses could add 15 million tonnes of fish to the food chain.[29]

In industrial fish processing, 30–70 percent of the fish ends up as by-products, e.g. heads, viscera and backbones.[30] These by-products are usually further processed into fishmeal and fish oil, primarily used for feed purposes and indirectly contributing to food security. The 35 percent of raw material for producing fishmeal and fish oil now based on by-products and waste rather than whole fish is expected to continue growing.[31] Fishmeal and fish oil are highly traded products, an important source of revenue for some countries, and a very important feed ingredient for the aquaculture sector, the world's fastest-growing food production sector.

As more fish is processed at an earlier stage and on an industrial scale, more of the by-product and residual raw material can be processed into valuable products for direct human consumption. For example, there is growing demand for fish heads as food in Asian and African markets, a product not considered as food elsewhere. Nile perch from Lake Victoria are processed locally and high-value fresh fillets exported out of the region. However, by-products such as fish frames have become popular on the local market and are now important products traded at regional level.

In terms of nutrition, by-products might be of higher value than the main product, particularly in terms of essential fatty acids and micronutrients. The growing demand for fish oil as a nutritional supplement has made it profitable to extract fish oil from by-products such as tuna heads. Although not yet widely done, mineral supplements can be made out of fish bones. A pilot project for a fish-bone-based mineral product showed high levels of most essential minerals (e.g. 85 mg/kg of zinc, 350 mg/kg of iron and 84 g/kg of calcium). The product was successfully mixed into traditional school meals and much appreciated by school children in Ghana.[32]

Innovative and available technologies can make larger amounts of these nutrients available for human consumption, allowing low-cost fish products to play a greater role in achieving nutrition and food security for all.

The way forward

All stakeholders, including industry, research institutions, governments and universities, need to work to develop the technologies and facilities to promote the use not only of fillets but also other parts of fish for human consumption. Similar effort is needed to slash post-harvest losses at production and processing levels and fish waste at consumer level. Processing low-cost stable products from fish by-products and fish unavoidably caught but currently discarded could boost food supply significantly, if accepted both culturally and from an organoleptic point of view. Here, it is important to match product characteristics to local food habits. It is not enough to try to transfer products that are successful in one region to another. Product development efforts must be accompanied by progress in substituting fishmeal and fish oil in animal feeds. This is a prime goal for industry and academic research, and promising results are emerging, including the selection of genetically modified plants to produce EPA and DHA that could replace fish oil in feed.

However, with dramatic rises and increased volatility in food prices, the diets of the poor risk becoming even less diverse and more dependent on starchy staples. Therefore, there is now

renewed emphasis on the production, distribution and utilization of common micronutrient-rich foods that are readily accessible to consumers. Fish, especially nutrient-rich small fish, from the wild and from aquaculture can play a vital role in improving human nutrition. Micronutrient-dense products from underutilized parts of larger fish, such as heads, bones and liver, could also play a much more important role for better nutrition. However, this will require changes to government policies, investment in infrastructure and more research. The means must be found to reduce post-harvest losses in fisheries, better utilize processing waste, and make use of the large quantities of small pelagic fish for direct human consumption. ■

BUILDING RESILIENCE IN FISHERIES AND AQUACULTURE THROUGH DISASTER RISK MANAGEMENT

The Sendai Framework

From 14 to 18 March 2015, high-level representatives of 187 Member States of the United Nations met in Sendai, Japan, for the Third UN World Conference on Disaster Risk Reduction. Their aim was to agree on a new disaster risk reduction framework to succeed the Hyogo Framework for Action 2005–2015.[33] Adopted in the aftermath of the Indian Ocean tsunami, the Hyogo Framework expired at the end of 2015. The location chosen for this latest conference was the site of another overwhelming event, the great east Japan earthquake and tsunami, which struck in March 2011 and triggered the Fukushima Daiichi nuclear accident. The conference opened on 14 March, as cyclone Pam was devastating Vanuatu, stressing, with a renewed sense of urgency, the need for a post-2015 framework on disaster risk reduction.

The Sendai Framework for Disaster Risk Reduction 2015–2030[34] (the Sendai Framework) was adopted on 18 March 2015, with the expected outcome to achieve, by 2030, a "substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries."[35] One of the main features of the Sendai Framework is the shift in focus from managing disasters to managing risks.[36] This is also reflected in its overall goal: "Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive (…) measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience."[37]

To assess progress made towards achieving the above mentioned goal and outcome, the Sendai Framework also contains 7 global agreed targets, which were absent from the Hyogo Framework, and a set of 13 guiding principles to inform its implementation, including:

- the primary responsibility of States to prevent and reduce disaster risk, including through international cooperation;
- an all-of-society engagement and partnership, requiring the empowerment, inclusion and participation of people disproportionately affected by disasters, especially the poorest;
- addressing underlying disaster risk factors, such as climate change and variability, and compounding factors, such as unsustainable uses of natural resources;
- Building Back Better, an approach articulated by the evaluation of the response to the 2004 Indian Ocean tsunami and one that the fisheries community is very familiar with;
- the provision of adequate, sustainable and timely support (finance, technology and capacity development) from developed countries.

The Sendai Framework, which is the first major agreement of the post-2015 development agenda,[38] has four priorities for action:

1. Understanding disaster risk.
2. Strengthening disaster risk governance to manage disaster risk.
3. Investing in disaster risk reduction for resilience.
4. Enhancing disaster preparedness for effective response and Building Back Better in recovery, rehabilitation and reconstruction.

Finally, the Sendai Framework encompasses a broader range of hazards than did its predecessor. It applies to small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters caused by natural or human-induced hazards, as well as related environmental, technological and biological hazards and risks.

The human and economic costs of disasters

Why is there the need for change? In the past ten years of implementation of the Hyogo Framework, there has been some progress in reducing losses from disasters in certain countries and for some hazards. Cyclone Phailin, which hit the State of Odisha, India, in October 2013 and killed 47 people, is an example of this. Fourteen years earlier, in October 1999, another cyclone had struck the same area with the same intensity but killing 9 848 people. However, losses from disasters remain high. Between 2005 and 2015, more than 700 000 people lost their lives, more than 1.4 million were injured, and 23 million were displaced as a result of natural disasters. The total economic loss for the period 2005–2015 exceeded US$1.3 trillion.[39] It is estimated that natural and human-induced disasters caused US$113 billion in economic damage in 2014.[40] Disaster risks are also increasing due to climate change.[41] In the Caribbean, it is estimated that climate change will contribute an additional US$1.4 billion to expected annual losses from cyclone wind damage alone.[42] This figure excludes additional losses from storm surges due to sea-level rise.

Developing countries are disproportionally affected by disasters. The period 2004–2013 includes three years with more than 200 000 people reported killed in major events affecting developing countries: the India Ocean tsunami in 2004 (226 408 deaths); cyclone Nargis in Myanmar in 2008 (138 366 deaths); and the earthquake in Haiti in 2010 (225 570 deaths).[43] In 2013, most disaster victims were due to typhoon Haiyan in the Philippines, which ranked among the world's most serious disasters that year, affecting 16.1 million people.[44]

Disasters in many developing countries undermine their capacity to invest and achieve sustainable development. Speaking at the Third World Conference on Disaster Risk Reduction, Baldwin Lonsdale, President of Vanuatu, told delegates that the damage on the Pacific island nation caused by the category-five cyclone Pam had been "unprecedented": "This is a major calamity for our country. Every year we lose 6% of our GDP to disasters. This cyclone is a huge setback for the country's development. It will have severe impacts for all sectors of economic activity including tourism, agriculture and manufacturing. The country is already threatened by coastal erosion and rising sea levels in addition to five active volcanos and earthquakes."[45]

According to a recent assessment conducted by FAO in the period 2003–2013, the agriculture sector – including fisheries and aquaculture – absorbs 22 percent of the economic impact caused by medium- and large-scale natural disasters in developing countries.[46] More specifically, disease outbreaks have reportedly cost the aquaculture industry tens of billions dollars in the last 20 years.[47] The fisheries and aquaculture sector is particularly vulnerable to disasters. It was one of the sectors most severely affected by typhoon Haiyan, in 2013, with up to 400 000 fisherfolk affected and an estimated 30 000 fishing vessels damaged or destroyed.[48] The vulnerability of small-scale and artisanal fisheries to disaster risks and climate change is recognized in the Voluntary

Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (the SSF Guidelines), which were adopted at the Thirty-first Session of COFI in June 2014. In particular, the SSF Guidelines underline the need to build resilience to disasters and climate change along the seafood value chain using a human-rights-based approach, in full and effective consultation with fishing communities, and to develop appropriate policies and plans and ensure access to funds.[49]

However, in order to decide on appropriate investment and measures to reduce or prevent disaster risks, there is a need to better determine the types of hazards that cause the greatest losses to the fisheries and aquaculture sector. In an attempt to do so, FAO reviewed 78 post-disaster needs assessments undertaken in 48 countries in Africa, Asia and Latin America between 2003 and 2013.[50] Of the economic impacts caused by medium- and large-scale natural hazards absorbed by the agriculture sector (22 percent of the total, as stated above), economic impacts on fisheries and aquaculture represented 6 percent of all damage and losses within the agriculture sector, for an estimated cost of US$1.7 billion. The FAO review found that the 2004 tsunami had had the greatest economic impact on fisheries and aquaculture, at more than US$500 million in India and Indonesia.[51] In Indonesia, the disaster almost paralyzed the sector and the livelihoods of communities that depended on it, with extensive damage to boats, harbours and fish ponds.[52] Fisheries also tend to suffer more in small island developing States, because of the dependence of these States' economies on the fisheries sector as well as the role the sector plays in food security and employment. In Maldives, the sector was badly hit by the 2004 tsunami, with 70 percent of the economic impact on the agriculture sector from fisheries. Fishing harbours, boatsheds, fishing vessels and equipment, ocean cages, fish processors and equipment, fishery institutes and other assets were lost or seriously damaged.

Storms and severe weather events can also have severe impacts on fisheries and aquaculture. According to the above FAO review, storms (including hurricanes and typhoons) cause about 16 percent of the economic impact of disasters on fisheries, followed by floods with 10 percent. In Myanmar, cyclone Nargis (2008) affected about 2.4 million people out of an estimated 7.35 million people living in the townships hit, mainly in the country's Ayeyarwady River delta. The people of the delta area are primarily farmers, fishers and labourers, with a smaller proportion engaged in service industries and as traders.[53] The damage to capture fisheries, both marine and inland, and aquaculture was mainly caused by the high winds and the storm surge, and was estimated at US$27 million. This included damage to post-harvest capabilities, i.e. the loss of ice plants and cold storage facilities, fish processing, marketing and transport infrastructure, and substantial damage to commercial intensive aquaculture. In addition to this, total losses from production forgone amounted to US$117 million.[54] Inland fisheries suffered the largest damage in terms of number of lost or damaged boats, although the overall damage value of the inland boats was significantly less than for the marine fisheries fleet. In addition to this, the massive loss of these (inland fisheries) small multipurpose boats had a serious impact on the livelihoods of the households involved.

Fisheries and aquaculture are also affected by droughts. In Kenya, the sector was one of those affected by the 2008–2011 droughts. At the time of the disaster, the fisheries sector contributed about 5 percent of gross domestic product and played a significant role in the social and economic development of the country through employment creation, revenue generation and food.[55] The sector supported about a million people directly and indirectly, working as fishers, traders, processors, suppliers and merchants of fishing accessories, and employees and their dependants. The total values associated with fisheries due to the rainfall deficit and high temperatures amounted to KES4 163.6 million (US$52 million), consisting of KES3 661 million (US$46 million) in losses and KES502.6 million (US$6 million) in damage. The damage represented the value of destroyed fish ponds,

pond liners and fishing gear, while losses occurred from a reduction in catches by the fishers, reduced harvests from the ponds, and higher production costs from repair of fishing craft.[56] Other consequences from the drought also included: distances of landing sites / beaches from lake shore increasing by up to three kilometres, causing fishers to incur extra costs to transport fish to the landing sites; increased fishing intensity caused by receding lake levels and reduced fishing area as well as by the influx of farmers into fishing after their crops failed and livestock died; and food insecurity as production levels fell and the price of fish increased due to lower catches.[57]

What needs to be done

While there are clear indications that disasters have impacts on the fisheries and aquaculture sector, as noted in the FAO review (above), the sector tends to be under-reported in post-disaster needs assessments. Further efforts are needed to quantify and report damage and losses to the sector in order to understand and address the main challenges. At the global level, FAO is taking steps to develop a methodology to monitor damage and losses suffered by agriculture, including fisheries and aquaculture. The overall objectives are to gain a more complete and comprehensive understanding of disaster impacts on the agriculture sector and to provide appropriate responses. Policies and measures to strengthen the resilience of marine capture fisheries, for example, would need to consider storms, waves and surges or tsunamis, which tend to cause the greatest impact; whereas for inland fisheries and aquaculture, it is necessary to consider the impact of floods and droughts.

Furthermore, fishers and fish farmers need to understand more fully the different threats and associated risks posed by climatic variability, climate change and other external threats likely to have disastrous effects on the sector and on their livelihoods. They must be empowered to assess the changes to local conditions, through, for example, simple environmental indicators (such as water temperature, salinity, water level, water transparency, and fish health indicators) and to respond accordingly. Local, district, national and regional knowledge networks are needed to analyse and share the information collected/provided, and to assess the risk level and potential responses.

Progress has still to be made in strengthening disaster preparedness and response. Fisheries and aquaculture constitute a complex sector. With appropriate attention to the specific characteristics of the sector, and appropriate guidance and specific expertise, responding to the needs of the sector in a disaster situation can also bring significant dividends in terms of relatively rapid recovery, vital contributions to food security, generating significant economic spin-offs and restoring livelihoods in a sector that often employs significant numbers of people. The process of rehabilitation and reconstruction in fisheries and aquaculture can also create significant opportunities for Building Back Better and for addressing some of the weaknesses and issues in the sector, particularly in terms of overexploitation of resources and damage to fisheries ecosystems. It can also enhance the contribution of the sector to long-term economic growth. In this regard, FAO has developed guidelines to respond to emergencies affecting the fisheries and aquaculture sector. It has also produced a training programme and material with the overall purpose of improving the quality of the design, implementation and assessment of fisheries and aquaculture interventions. The guidelines and the training programme draw on best practice and experience in responding to disasters that have affected fisheries and aquaculture and in supporting people working in the sector to rebuild their livelihoods.[58]

Another important consideration highlighted in the guiding principles of the Sendai Framework is the need to reduce and manage underlying risks. One underlying driver of disaster risk is the health of the aquatic ecosystem and associated biodiversity, including of wetlands, coral reefs, mangroves and threatened species and marine stocks.[59]

Conclusions

Promoting sustainable aquatic resource management through the development and implementation of ecosystem friendly and participatory policies, strategies and practices should be given priority in order to reduce, prevent or mitigate impacts from disasters. Prevention and mitigation activities, before and after disasters, are also key to reducing risks. For example, a more diverse and lengthy seafood value chain can increase livelihoods resilience and facilitate a quicker recovery from emergencies and protracted crises. Recognizing the importance of fisheries and aquaculture in resilience building and in food security and nutrition, regions and countries have developed good practices in disaster risk reduction and management. These examples need to be captured, validated, replicated and upscaled.

Finally, fisheries and aquaculture sector development plans and investments should systematically include disaster risk reduction and management. This is especially important in countries facing recurrent disasters and where the sector is important for food security, nutrition, livelihoods and overall development. Humanitarian and development aid should reflect more consistently the impacts that disasters have on fisheries and aquaculture, and the opportunities the sector offers for rapid recovery and for Building Back Better. While the disaster burden is often all too real and at times may seem inescapable, risks and losses to the sector can be reduced and even prevented if appropriate policies, measures and investment are implemented. ■

GOVERNANCE, TENURE AND USER RIGHTS: A GLOBAL FORUM ON RIGHTS-BASED APPROACHES FOR FISHERIES

FAO and the Government of Cambodia co-organized Tenure and Fishing Rights 2015: A Global Forum on Rights-based Approaches for Fisheries[60] in Siem Reap, Cambodia, from 23 to 27 March 2015.[61] The purpose of the forum was to foster mutual understanding of the challenges facing fisheries stakeholders and to find common ground and options for empowering fishers and fisheries now and in the future. The forum was, in part, inspired by two earlier global conferences – FishRights99[62] and Sharing the Fish '06[63] – and sought to broaden those previous discussions beyond commercial/industrial fisheries and to cover more fisheries stakeholders and types of fisheries. Key points identified by the forum are discussed below and summarized in Box 14.

The forum's 140 participants (from 38 countries) discussed the importance of tenure and rights for environmentally, socially and economically responsible resource management in fisheries. Participants identified various practices and lessons learned based on their own experiences in a wide range of fisheries and rights-based management systems. Case studies presented at the forum featured both developing and developed countries, and included testimonies of individually based and community-based fishing rights.

Designed as an interactive event, the forum programme consisted of: (i) scene-setting presentations, which focused on the main elements, challenges and practices of tenure and rights in fisheries; (ii) discussion panels, which provided a diverse range of perspectives from

various stakeholders from all over the world, including governments, gender specialists, civil society organizations (CSOs), fishers, fishing and indigenous communities, academics, non-governmental organizations (NGOs), and industry; and (iii) working groups, which reported back to plenary sessions on the results of their deliberations. A common thread throughout the forum discussions was that there is no single best example of rights-based approaches and that there are many options for empowering fishers and clarifying their rights.

Key points

Broad norms

There is a suite of broad norms applicable to user rights discussions. A holistic approach is increasingly becoming the basis for discussions on fisheries management, and this was evident throughout the forum. Since the approval of the Code of Conduct for Responsible Fisheries in 1995, several new complementary instruments have been approved: the Right to Food; the UN Declaration on the Rights of Indigenous Peoples; the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security (VG Tenure); and the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines).

Participants affirmed that all of the principles and norms in these texts are important when talking about tenure rights in fisheries. Indeed, many participants highlighted that the SSF Guidelines and the VG Tenure should be the basis for clarifying or implementing user rights in fisheries. The SSF Guidelines describe the overarching context within which rights-based systems should be developed; and the VG Tenure provide the guidance for communities engaging in the clarification, development and/or operation of rights-based systems. What also became clear at the forum is that there is still a need for additional practical advice to help fisheries stakeholders in tailoring user rights systems to specific contexts.

Language and terminology

Precise terminology matters. The concept of tenure has multiple interpretations, and questions exist regarding the use of terms such as "fishing rights", "user rights" and "rights-based approaches for fisheries." These terms can – and will – mean different things to different people depending on culture, context and technical backgrounds, making shared understandings and locally appropriate definitions of them essential. Moreover, the term "rights" can be defined so as to better balance the trend towards commoditization of fisheries and the people in them with the more recent trend on human rights that is at the heart of the VG Tenure and the SSF Guidelines. The term "user rights" is applicable across the entire spectrum of resource users and beneficiaries.

Gender considerations

Issues of women's rights must be considered. Socio-economic and cultural factors that either explicitly or implicitly favour men – for example, as captains or vessel owners – can create problems in tenure systems when transfers of rights take place. There is a need to more clearly target and empower women throughout the value chain so that they have rights they can exercise on a sustainable basis. Explicit empowerment of women can strengthen the fisheries value chain and resolve intergenerational rights issues.

Inclusivity

Inclusive consultation processes are essential. The forum noted that there is a collective responsibility to manage fisheries resources by involving the State, fishers and all resource stakeholders from all stages of the value chain.

The forum emphasized the importance of meaningful widespread stakeholder involvement in the planning, development and/or implementation of user rights systems as an essential ingredient for success. It is important that those directly involved (participants from small-scale fisheries, industrial fisheries, NGOs, CSOs and government) contribute to a common understanding of existing institutions, the analysis of options and the identification of specific actions. Extra care is often required in order to involve groups such as women that may be »

BOX 14

KEY POINTS FROM THE FORUM TENURE AND FISHING RIGHTS 2015

Broad norms. The Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication[1] (especially section 5a) describe the overarching context in which rights-based systems should be developed. In addition, the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security[2] provide guidance about the principles and the legal, administrative and operational details of user rights systems. However, there is still a need for additional practical advice to help fisheries stakeholders make sustainable decisions in specific contexts.

Language and terminology. Careful use of words is needed in this fisheries management paradigm. The term "user rights" is applicable not only to fishing but across the entire spectrum of resource users and beneficiaries. Decisions about the impacts of user rights, especially on other fisheries and resource users, should be clearly thought through and properly articulated.

Gender considerations. Explicit empowerment of women can strengthen the fisheries value chain and resolve transfer-related rights issues.

Inclusivity. The processes to reach user rights agreements are long and require patience, focus, commitment and extensive stakeholder and resource-user consultation and involvement.

A balancing act. When clarifying or developing user rights, the full suite of options – which may be territorial rights, community or other group rights, catch shares or individual transferable quotas, or other systems – should be considered in the decision-making process as part of balancing incomes and economic growth with considerations of fairness and preserving traditions. In selecting any fisheries management system, limiting fishing access is critical. Open access and uncontrolled fishing for any capture fisheries should not be considered.

Effective dynamic governance. No management system is perfect. Therefore, stakeholders, resource users and beneficiaries should look for the system that best suits them and the environment.

Challenges beyond the fisheries sector. Intersectoral approaches are still much needed to address the interface – and potential overlapping claims and impacts – between fisheries and other sectors.

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» disadvantaged or overlooked and so ensure their perspective is properly considered. Consensus-driven processes, involving stakeholders tasked to achieve clearly defined objectives, facilitate outcomes that the majority of stakeholders can support. Because the development of user rights systems can be protracted, the process requires patience, focus and commitment.

Indigenous peoples encounter problems preserving their traditional rights, including fishing rights. Such rights are not written into formal law and are often disregarded by legal authorities and their representatives. It is essential to ensure inclusion and involvement of indigenous peoples in decision-making, so that traditional knowledge is not overlooked when formulating laws and policies on fisheries.

A balancing act

There will always be trade-offs. There is no such thing as the "perfect" management system, as there will always be a need to balance social, economic and environmental objectives. Every fishing community is different. These differences must be taken into consideration in order to develop an effective fisheries management system and to reconcile economic development with environmental sustainability.

Elements of the balancing act will include: improved human welfare; the use of natural resources – including fisheries – in a sustainable and balanced manner; food security; community development; and the need to clarify the difference between common access and community rights. Nonetheless, the experiences of the case studies presented to the forum revealed a pattern. That is, where fishing rights are individual, then economic and biological results tend to be achieved while the social outcomes in terms of social stability and coherence may not be. In contrast, for cases of community fishing rights, the economic and biological outcomes tend to be weak while the social outcomes are achieved.

In the developing world, very extensive small-scale artisanal fisheries are typically composed of a very large number of fishers employing low-level fishing technology and requiring minimal infrastructure for landing. It is particularly difficult to introduce, enforce or even define strong individual fishing rights in such contexts. In these cases (which may constitute up to half of the landings of the world's fisheries), some form of communally held fishing rights and community fisheries management seems the best option. To be successful, the subsequent clarification of a user rights system and the decision-making processes associated with it must be based on the characteristics of these communities. Whatever fisheries management system is selected, limiting fishing access is critical. Open access and uncontrolled fishing should not be considered for any capture fisheries. When clarifying or developing user rights, the full suite of options – which may be territorial rights, community or other group rights, catch shares or individual transferable quotas, or other systems – should be considered in the decision-making process as part of balancing incomes and economic growth with considerations of fairness and preserving traditions.

Effective dynamic governance

Rights systems have to be built into law to result in stability and security for all, and this includes effective enforcement as well as access to justice and judicial control. Fisheries governance needs to be aware of, and able to address, challenges such as population increase, migration and economic crisis, which all affect securing tenure in small-scale fisheries. Fishery management systems cannot be set in stone; rather, they need to be able to evolve and adapt to changing circumstances. Supranational approaches may be required in some circumstances because access to and management of fisheries can be a multijurisdictional issue. At other times, devolving management to local levels and co-management approaches may be better governance options.

The forum recognized that approaches will have to vary and that no single solution is possible, but common themes are: stakeholder inclusion; the need for better transparency and accountability; and the need for cross-sector dialogue.

Challenges beyond the fisheries sector

Cross-sectoral issues remain unresolved. In looking at the interface between the fisheries and other sectors, several recurring themes emerged that were common to all the participating countries. These included: limited coordination between government ministries involved in user rights and tenure decisions beyond the fisheries sector; the relative lack of secure tenure in small-scale and artisanal fisheries compared with other sectors; limitations associated with traditional top-down hierarchical management; and a historical tendency for governments to work with more established industrial and economic sectors.

The forum noted that in inland fisheries there are complex systems of overlapping and sometimes competing rights with economic interests from other users of water resources, such as the electric power production industry or farming sector (see sections Improving the valuation of inland fisheries, p. 114, and Ten steps to responsible inland fisheries, p. 147). In such cases, these other sector interests can affect the rights of inland fishers to access water and fisheries resources. In coastal settings, other sectors such as shipping, oil and gas (see Box 5 Petroleum and fisheries, p. 87), tourism and tourist centres may have similar overlapping claims and impacts.

Incorporating these other sectors into the decision-making process requires the political will to do so, and it can often take a long time to bring about such a change. However, such consultative processes are important for creating successful management and tenure systems.

Conclusions

The forum provided a platform for sharing ideas on how to improve tenure and user rights in fisheries. The forum noted that, although there is no particular "one size fits all" rights-based system, there are common challenges that most fisheries stakeholders face. With regard to these common challenges, differences will arise depending on whether a fishery is inland, coastal, community-based, small-scale, large-scale or offshore. The different cases presented demonstrated the need to adapt the design and implementation of fishing rights to local circumstances.

In many developing countries, governance conditions differ markedly from those in developed countries, greatly affecting the range of fishery reforms that may be successfully implemented. In particular, power structures and the rule of law are important considerations in many developing countries, which are also often characterized by poverty, a greater reliance on subsistence fishing, and limited rights for women. Decision-making processes need to address equity and efficiency, taking into account power imbalances.

Ultimately, any successful user rights system must have stakeholder support and involvement. When fishery reforms are being considered, it is important that those directly involved contribute to a common understanding of existing institutions, the analysis of options, and the identification of specific actions. Extra care is often required in order to involve groups that may be disadvantaged and so ensure their perspective is properly considered.

In sum, the forum recognized that key elements of sound fisheries policy and related management approaches include the need to: accept the interdependence of social, cultural, economic and ecological needs; recognize communal rights through shared governance and management responsibilities; build on customary and traditional practices; incorporate local and indigenous knowledge systems; encourage value chain approaches; support gender, disability equity and youth development; and streamline or coordinate intragovernmental responsibilities to address broader sectoral requirements as well as social needs in fishing communities.

Next steps

More work needs to be done on the topic of governance, tenure and rights-based fisheries management systems – especially for the world's extensive small-scale fisheries sector. In this

regard, the forum marked a turning point in the dialogue about fishing rights, which previously had focused more on developed country experiences and industrial fisheries.

In the weeks following the forum in Cambodia, participants were surveyed to gather ideas on the way forward on the subject of governance and tenure in fisheries. The top three areas indicated by respondents for future work were:

- allocation – not only allocation processes for recognizing rights, but also the implications thereof;
- the political economy of adopting and implementing rights-based systems for fisheries;
- training for capacity development related to rights-based systems.

Additional areas of work included:

- tools for capacity development relating to rights-based systems – particularly for actions on the ground – are essential and should be developed for fishers, managers, communities and politicians;
- financing transitions to rights-based systems and sustainable fisheries;
- identifying diversification possibilities as well as alternative business or livelihood strategies for communities directly and indirectly dependent on fisheries.

Participants emphasized the importance of continuing the dialogue on fishing and tenure rights, suggesting that regional meetings could be held every one to three years, with a global meeting every five years. ■

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PART 4
OUTLOOK

ACEH BESAR, INDONESIA
Fishers building boats.
FAO partners with the NGO Austin International Rescue Operations in rebuilding fishing fleets following the 2004 tsunami.
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PART 4

OUTLOOK

ALIGNING THE FUTURE OF FISHERIES AND AQUACULTURE WITH THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

Food security and nutrition represent a global challenge, as hunger and malnutrition remain among the most devastating problems facing the world. The Millennium Development Goals (MDGs) included a target of halving the proportion of people who suffer from hunger between 1990 and 2015. According to *The State of Food Insecurity in the World 2015*,[1] this target was almost met at the global level, but progress was uneven across countries and there remained almost 780 million undernourished when the MDGs concluded in 2015. The 2030 Agenda for Sustainable Development and the new Sustainable Development Goals (SDGs), which succeed the MDGs, have the ambitious aim of ending poverty and hunger by 2030. Food security goes beyond guarding against hunger and malnutrition as it exists when "all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life."[2] In this regard, in 1996, the Rome Declaration on World Food Security and the World Food Summit Plan of Action laid the foundations for diverse paths to the common objective of food security, at the individual, household, national, regional and global levels. They indicated that each nation needed to adopt a strategy consistent with its resources and capacities to achieve its individual goals and, at the same time, cooperate regionally and internationally in order to organize collective solutions to global issues of food security. They stressed that, in a world of increasingly interlinked institutions, societies and economies, coordinated efforts and shared responsibilities are essential.[3] According to a UN report,[4] the current world population of more than 7.4 billion is projected to reach 8.5 billion in 2030 and 9.7 billion in 2050, with most of the increase occurring in developing regions. Ensuring adequate food and nutrition security to this growing population is a daunting challenge. The fisheries and aquaculture sector plays and can continue to play a prominent role in world food security. Fish is a vital source of food including micronutrients, particularly for many low-income populations in rural areas, and the sector also contributes to economic growth and development by being a source of employment, livelihoods and income to millions of people engaged in fish harvesting, culturing, processing and trade. This key role has become even more important through the significant changes being experienced by the sector in recent decades, and especially in the last two. With differences among regions and countries, these transformations include: the stabilization of total capture fisheries production at 90–95 million tonnes since mid-1990s; the rapid increase in global aquaculture production, reaching about 74 million tonnes in 2014 and outpacing all other food-producing systems; the globalization of the industry, with substantial growth in world trade in fish and fisheries products, particularly in value terms; and the rising demand for fish and fishery products.

Whether the present trends in the sector continue will depend on a number of important uncertainties. A key question is: Which will the

future perspectives of development for this sector be? Population and income growth, together with urbanization and dietary diversification, are expected to create additional demand and to continue to change the composition of food consumption towards a growing share of animal products, including fish, in developing countries. New and traditional demand for fishery products from both capture fisheries and aquaculture will put growing pressure on fisheries resources, and the future of the sector, being influenced by internal and external driving forces, is complex and uncertain.

This Outlook section is composed of two distinct parts. The first part describes the most plausible trends for the fishery and aquaculture sector in the next decade, while the second part outlines the expectations and roles of the 2030 Agenda, the SDGs and FAO's Blue Growth Initiative (BGI) in shaping future developments.

Expected trends in fish supply and demand

As indicated in the Outlook of *The State of World Fisheries and Aquaculture 2014*,[5] presenting the results of specific fish projections is a standard feature of this publication. This edition presents the key results for the period 2016–2025 for the FAO fish model.[6] This model was developed by FAO in 2010 in collaboration with the Organisation for Economic Co-operation and Development (OECD) with a view to gaining insights as to the potential path of development for the fisheries and aquaculture sector.[7] The dynamic policy specific partial equilibrium model on fish is at present a stand-alone model using the same macroeconomic assumptions and the same feed and food prices employed or generated by the agricultural market model Aglink-Cosimo elaborated jointly by the OECD and FAO. The projections are elaborated annually and published in the OECD-FAO Agricultural Outlook publication.[8] They provide, for a ten-year horizon, an outlook for the sector in terms of potential production, use (human consumption, fishmeal and fish oil), prices and key issues that might influence future supply and demand. They also highlight regional vulnerabilities, changes in comparative advantage, price effects, and potential adaptation strategies in the sector. However, the results should not be considered as forecasts but plausible trends that provide insights into how the sector may develop, taking note of specific assumptions regarding: the future macroeconomic environment; international trade rules and tariffs; frequency and effects of El Niño phenomena; absence of other severe climate effects and of abnormal fish-related disease outbreaks; fishery quotas; longer-term productivity trends; and the absence of market shocks. Should any of these assumptions change, the resulting fish projections would be affected.

Production

Under the set of assumptions used in the fish model and as stimulated by technological improvements and higher demand for fish,[9] total world fishery production (capture plus aquaculture) is projected to expand over the period, reaching 196 million tonnes in 2025 (Table 22). This represents an increase of 17 percent between the base period (average 2013–15) and 2025, but indicates a slower annual growth compared with the previous decade (1.5 percent versus 2.5 percent). The absolute growth will be about 29 million tonnes by 2025 compared with the average 2013–15 level. Almost all of the increase in production will originate from developing countries. Their share in total output will increase from 83 percent in

the base period to 85 percent in 2025. A more marked expansion is expected in Asia, with its share in total production rising from 70 percent to 73 percent. Of the additional 29 million tonnes of output by 2025, 25 million tonnes will be produced in Asia, 1.8 million tonnes in Latin America and the Caribbean, 1.6 million tonnes in Africa, 0.7 million tonnes in Europe, and the rest in Oceania and North America. About 91 percent of total fishery production, or 178 million tonnes, is estimated to be destined for direct human consumption.

Surging demand for fish and fishery products will mainly be met by growth in supply from aquaculture production, which is expected to reach 102 million tonnes by 2025, 39 percent higher than the base period level. Aquaculture will remain one of the fastest-growing sectors for animal food production, although its annual growth rate is estimated to decline from 5.4 percent in the previous decade to 3.0 percent in the projection period. This slowdown in expansion will be mainly due to: constraints on the availability and accessibility to water of good quality; competition from alternative uses for optimal production locations; availability of fish seeds and feeds in the requisite quality and quantities; insufficient investments in infrastructure in regions endowed with natural resources for aquaculture production; capital constraints; and challenges in governance and regulatory framework. Furthermore, even if slightly declining, the still high costs of fishmeal, fish oil and other feeds will remain a constraining factor (as only about 30 percent of the species do not need any feed concentrates to grow). Developing countries will maintain their key role in aquaculture production, with a share of 95 percent of total production. They are expected to capture 96 percent of the additional fish output growth in the projection period. However, aquaculture production should continue to expand also in developed countries (rising 26 percent in the next decade) and in all continents, with variations across countries and regions in the product range of species and products. Asian countries will remain the main producers, representing 89 percent of total production in 2025, and with China alone accounting for 62 percent of world output. Other major increases are expected in Latin America, in particular in Brazil (104 percent higher) due to significant investments in the sector. African production will also expand over the projected period by 35 percent (reaching 2.3 million tonnes) due partly to the additional capacity put in place in recent years, but also in response to rising local demand from higher economic growth, and local policies promoting aquaculture.

Freshwater species, such as carp, catfish (including *Pangasius*) and tilapia, will account for most of the increase in aquaculture production and represent about 60 percent of total aquaculture production in 2025. Production of higher-value species, such as shrimps, salmon and trout, is also projected to continue to grow in the next decade.

The share of aquaculture in total fishery production will grow from 44 percent on average in 2013–15 to surpass capture fisheries in 2021. In 2025, this share will reach 52 percent (Figure 34). This development highlights a new era, indicating that aquaculture will increasingly be the main driver of change in the fisheries and aquaculture sector. Nonetheless, the capture fisheries sector will remain dominant for a number of species and vital for domestic and international food security. Capture fishery production is projected to increase by about 1 percent, reaching more than 94 million tonnes in 2025. This slight improvement is expected to be due to a combination of factors, several of which will be dependent on progress towards meeting SDG targets (see below), including: the recovery of certain stocks following improved management regimes by some countries; some growth in harvests in those few countries not subject to strict production quotas; declining oil prices; and enhanced utilization of fishery production through reduced onboard discards, waste and losses as required by changes in legislation or stimulated by high fishery prices (including for fishmeal and fish oil). At the beginning of the outlook period, capture production is not expected to increase very much, due mainly to the El Niño effect on South American fisheries. In El Niño years,[10] this »

TABLE 22

MAIN RESULTS OF THE FISH MODEL: COMPARISON 2025 VS 2013–15: PRODUCTION (LIVE WEIGHT EQUIVALENT)

	PRODUCTION			OF WHICH AQUACULTURE		
	AVERAGE 2013–15	2025	GROWTH OF 2025 VS 2013–15	AVERAGE 2013–15	2025	GROWTH OF 2025 VS 2013–15
	(Thousand tonnes)		*(%)*	*(Thousand tonnes)*		*(%)*
WORLD	166 889	195 911	17.4	73 305	101 768	38.8
DEVELOPED COUNTRIES	29 018	29 305	1.0	4 393	5 521	25.7
North America	**6 582**	**6 617**	**0.5**	**584**	**717**	**22.9**
Canada	1 020	1 011	–0.9	159	211	32.8
United States of America	5 562	5 606	0.8	425	506	19.1
Europe	**16 637**	**17 362**	**4.4**	**2 911**	**3 737**	**28.4**
European Union	6 654	6 810	2.3	1 273	1 385	8.9
Norway	3 586	4 263	18.9	1 325	1 963	48.1
Russian Federation	4 419	4 516	2.2	161	216	34.5
Oceania developed	**778**	**815**	**4.8**	**183**	**237**	**29.5**
Australia	228	229	0.4	76	91	20.6
New Zealand	550	586	6.5	108	146	35.8
Other developed	**5 022**	**4 510**	**–10.2**	**716**	**830**	**15.9**
Japan	4 318	3 728	–13.7	651	743	14.1
South Africa	549	601	9.5	4	4	–1.5
DEVELOPING COUNTRIES	137 871	166 606	20.8	68 911	96 247	39.7
Africa	**9 699**	**11 208**	**15.6**	**1 696**	**2 287**	**34.8**
North Africa	*3 071*	*3 192*	*3.9*	*1 153*	*1 284*	*11.3*
Egypt	1 498	1 646	9.9	1 138	1 268	11.4
Sub-Saharan Africa	*6 628*	*8 015*	*20.9*	*543*	*1 002*	*84.6*
Ghana	332	365	9.9	38	75	97.0
Nigeria	1 055	1 394	32.1	306	579	89.3
Latin America and Caribbean	**14 424**	**16 245**	**12.6**	**2 702**	**3 780**	**39.9**
Argentina	840	906	7.9	4	6	53.9
Brazil	1 327	1 972	48.6	560	1 145	104.4
Chile	3 084	3 514	13.9	1 138	1 314	15.5
Mexico	1 730	1 876	8.4	193	297	54.2
Peru	4 914	5 111	4.0	117	111	–5.1
Asia and other Oceania	**113 748**	**139 154**	**22.3**	**64 513**	**90 180**	**39.8**
China	62 094	78 717	26.8	45 263	62 962	39.1
India	9 434	11 570	22.6	4 830	6 880	42.4
Indonesia	10 543	12 411	17.7	4 211	5 761	36.8
Philippines	3 142	3 429	9.1	795	982	23.5
Republic of Korea	2 039	1 980	–2.9	470	536	14.1
Thailand	2 719	2 965	9.0	942	1 191	26.4
Viet Nam	6 257	7 816	24.9	3 361	4 802	42.9
LEAST-DEVELOPED COUNTRIES	13 950	17 181	23.2	3 328	5 470	64.4
OECD[1]	31 135	31 842	2.3	6 165	7 628	23.7

[1] Organisation for Economic Co–operation and Development.
SOURCE: OECD and FAO.

» climatic phenomenon is expected to cause a 2 percent decline in world capture fisheries, with stronger effects on catches of anchoveta harvested by Peru and Chile.

The portion of capture fisheries yield used to produce fishmeal will be about 16 percent by 2025, about 1 percent less than in the base period. This will be due mainly to the growing demand for human consumption of fish species previously used for reduction, as well as more limited availability of raw material and more fishmeal produced from by-products. The share of capture production reduced into fishmeal and/or fish oil will be slightly smaller in El Niño years owing to lower anchoveta catches. In 2025, fishmeal and fish-oil production, in product weight, should be 5.1 million tonnes and 1.0 million tonnes, respectively. In that year, fishmeal production will be 15 percent higher compared with the 2013–15 average, but about 96 percent of the increase will stem from improved use of fish waste, cuttings and trimmings. As more fish is consumed as fillets or in other prepared and preserved forms, a growing share of its residual production, such as heads, tails, bones and other offal resulting from processing, is expected to be reduced into fishmeal and fish oil. Fishmeal produced from fish waste will represent 38 percent of world fishmeal production in 2025, compared with 29 percent for the 2013–15 average level. The use of fish by-products can affect the composition and quality of the resulting fishmeal and/or fish oil with, in general, less protein, more ash (minerals) and increased levels of small amino acids (such as glycine, proline, hydroxyproline) compared with those obtained from whole fish. This difference in composition may hinder increased use of fishmeal and/or fish oil in feeds used in aquaculture and livestock farming. However, the fish model and its projections do not take these changes into consideration.

Prices

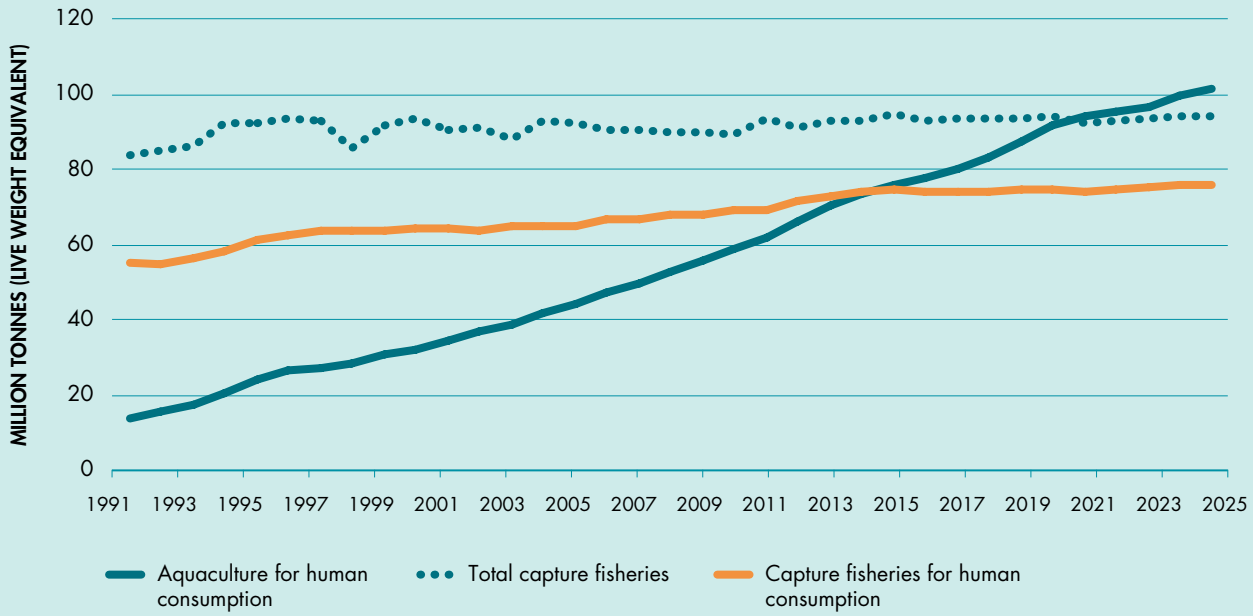
On average, fish prices were lower in 2015 compared with the peaks recorded in 2014. In the next decade, the main drivers affecting world fish prices for capture, aquaculture and internationally traded products will be: income, population growth and meat prices on the demand side; and limited increase in capture fisheries production and costs for feed, energy and crude oil on the supply side. In nominal terms, average fish prices are all expected to decline further in the first part of the projection period due to slower economic growth, sluggish demand in some key markets, and lower input costs. However, in the last five years of the outlook period, prices are expected to subsequently stabilize and grow slightly, and then remain on an elevated plateau by the end of the decade. In 2025, average producer prices are projected to be slightly higher than during the 2013–15 base period, as demand growth is expected to outpace supply. However, the average prices for traded products for human consumption, fishmeal and fish oil are projected to be slightly lower in 2025 relative to the base period. Yet, in real terms, all prices are projected to decline somewhat from the peak of 2014, but then remain on a high plateau (Figure 35).

Capture fisheries are expected to remain under restrictive production quotas while demand for certain species continues to be sustained. In nominal terms, the average price for wild fish (excluding fish for reduction) is projected to grow by more than that for farmed fish (7 percent compared with 2 percent) between the base period and 2025, with average annual growth rates of 1.0 percent and 0.8 percent, respectively, over the projection period. However, the overall price of fish caught in the wild will remain lower than that for farmed fish. This is partially explained by the increasing share of lower-value fish in overall catches. The limited increase in the average aquaculture price is also due to the decline of feed prices from the high levels recorded in 2011–12 as well as better feed conversion ratios and continuing productivity gains (even though at a slower pace than in previous decades). In real terms, both capture and aquaculture prices are expected to decline by about 13 percent and 17 percent, respectively, during the outlook period.

Fishmeal prices increased significantly from 2006 to 2013, peaking at US$1 747 per tonne in 2013. Since then, there has been a slight decline, but »

FIGURE 34

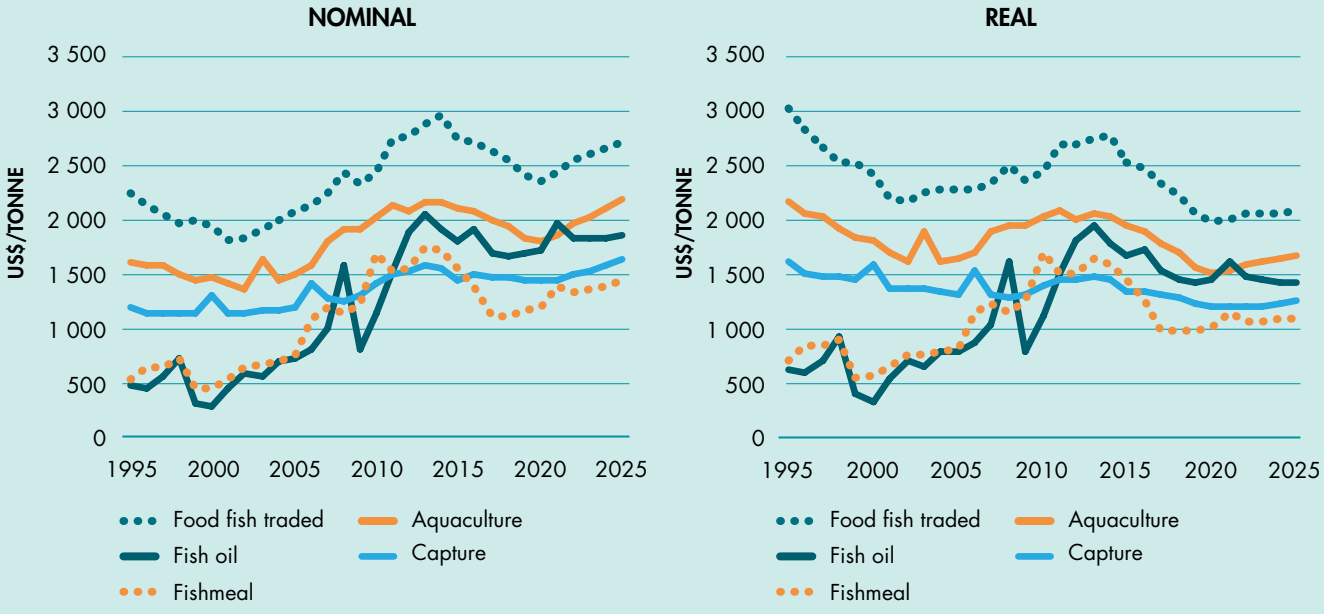
GLOBAL CAPTURE FISHERIES AND AQUACULTURE PRODUCTION TO 2025



SOURCE: OECD and FAO.

FIGURE 35

GLOBAL FISH PRICES IN NOMINAL AND REAL TERMS TO 2025



Note: Food fish traded: world unit value of trade for human consumption (sum of exports and imports). Aquaculture: FAO world unit value of aquaculture fisheries production (live weight basis). Capture: FAO estimated value of world ex-vessel value of capture fisheries production excluding for reduction. Fishmeal: 64–65% protein, Hamburg, Germany. Fish oil: any origin, Northwest Europe.

SOURCE: OECD and FAO.

» prices have remained high. By 2025, the average fishmeal price is expected to be 14 percent lower in nominal terms and 30 percent lower in real terms compared with the base period. The only exceptions will be in El Niño years due to reduced catches in South America, in particular for anchoveta, which is mainly used for reduction into fishmeal and fish oil. Starting from very high levels, fish-oil prices are expected to decline in the period 2016–2025, but still remain higher than fishmeal prices. The average fish-oil price is projected to decline by 3 percent in nominal terms, and by 21 percent in real terms, between the base period and 2025.

The average price of traded fish products will also decline over the outlook period, with a 5 percent decrease in nominal terms and a fall of about 23 percent in real terms by 2025. The main drivers for this decline will be the competitive prices of substitutes, in particular chicken, the slowdown in demand from key markets due to sluggish economic growth, and the reduced production and marketing costs of aquaculture products due to lower transport and feed costs. Owing to the already low or minimal import tariffs in the main importing developed countries, international fish trade is projected to remain relatively liberal, and global price changes should continue to be readily transmitted from one market to another. However, in many developing countries, import tariffs and licences can continue to play a significant role. Price changes in international markets will have spillover effects on non-traded species as well. For individual fishery commodities, price volatility could be more pronounced due to supply swings caused by drastic changes in catch quotas and disease outbreaks in the aquaculture sector as well as fluctuations in feed costs.

Consumption

Fish is expected to remain predominantly utilized for human consumption, making a valuable and nutritious contribution to diversified and healthy diets. The main utilization for non-food uses will continue to be reduction into fishmeal and fish oil, and other uses will be for ornamental purposes, aquaculture purposes (fingerlings, fry, etc.), bait, pharmaceutical purposes and as direct feed for aquaculture, livestock and other animals. World apparent fish consumption is projected to increase by 31 million tonnes (Figure 36) in the next decade to reach 178 million tonnes in 2025 (Table 23). On a per capita basis, apparent fish consumption will be 21.8 kg (live weight equivalent) in 2025, 8 percent above the base period level of 20.2 kg. The driving force behind this increase will be a combination of rising incomes and urbanization interlinked with the expansion of fish production and improved distribution channels. However, consumption will grow at a slightly slower pace than in the historical period, in particular in the second half of the outlook period, when fish will start to become more expensive in comparison with meat. The annual growth rate of per capita apparent fish consumption is projected to decline from 1.9 percent in the past decade to 0.8 percent over the next ten years. With human consumption of farmed species exceeding that of capture fisheries for the first time in 2014 (see section Fish consumption, p. 70), aquaculture is expected to further increase its share and provide 57 percent of fish for human consumption in 2025.

Per capita fish consumption is expected to increase in all continents, with Asia, Oceania and Latin America and the Caribbean showing the fastest growth. In particular, major increases are projected in Brazil, Peru, Chile, China and Mexico. Apparent fish consumption will remain static or decrease in a few countries, including Japan, the Russian Federation, Argentina and Canada. A slight increase (2 percent) is projected for Africa. This growth will be enhanced by increasing African aquaculture production and imports. Disparities in fish consumption will remain between developed and developing countries, with the latter having lower levels of consumption, although the gap is narrowing. In developing countries, annual per capita fish consumption will rise from 19.6 kg in the base period to 21.5 kg in 2025. In the same period, per capita fish consumption in developed countries is estimated to increase from 22.7 kg to 23.4 kg. However, if sub-Saharan Africa is excluded, per capita fish consumption in 2025 in developing countries will reach 24.3 kg, being higher than consumption in developed countries. Overall, developing countries »

TABLE 23

MAIN RESULTS OF THE FISH MODEL: COMPARISON 2025 VS 2013–15: FOOD FISH SUPPLY (LIVE WEIGHT EQUIVALENT)

	FOOD FISH SUPPLY			PER CAPITA FISH CONSUMPTION		
	AVERAGE 2013–15	2025	GROWTH OF 2025 VS 2013–15	AVERAGE 2013–15	2025	GROWTH OF 2025 VS 2013–15
	(Thousand tonnes)		*(%)*	*(kg)*		*(%)*
WORLD	146 648	177 679	21.2	20.2	21.8	7.9
DEVELOPED COUNTRIES	31 917	33 950	6.4	22.7	23.4	3.1
North America	**8 381**	**9 339**	**11.4**	**23.6**	**24.3**	**3.0**
Canada	801	851	6.2	22.5	21.8	–3.1
United States of America	7 580	8 488	12.0	23.7	24.6	3.8
Europe	**15 568**	**16 605**	**6.7**	**20.8**	**22.2**	**6.7**
European Union	11 082	12 181	9.9	22.0	23.9	8.6
Norway	274	317	15.7	53.3	55.3	3.8
Russian Federation	3 171	2 979	–6.1	22.1	21.1	–4.5
Oceania developed	**760**	**1 014**	**33.4**	**27.0**	**31.7**	**17.4**
Australia	646	893	38.2	27.3	33.0	20.9
New Zealand	115	122	6.1	25.5	24.7	–3.1
Other developed	**7 207**	**6 992**	**–3.0**	**26.5**	**24.6**	**–7.2**
Japan	6 362	6 035	–5.1	50.2	49.1	–2.2
South Africa	417	430	3.1	7.7	7.4	–3.9
DEVELOPING COUNTRIES	114 732	143 730	25.3	19.6	21.5	9.7
Africa	**10 881**	**14 655**	**34.7**	**10.0**	**10.2**	**2.0**
North Africa	*2 803*	*3 553*	*26.8*	*15.6*	*16.7*	*7.1*
Egypt	1 875	2 446	30.5	20.9	22.5	7.7
Sub-Saharan Africa	*8 078*	*11 102*	*37.4*	*8.9*	*9.1*	*2.2*
Ghana	639	656	2.7	23.9	19.5	–18.4
Nigeria	2 097	2 910	38.8	11.8	12.5	5.9
Latin America and Caribbean	**6 302**	**8 476**	**34.5**	**10.0**	**12.2**	**22.0**
Argentina	207	192	–7.2	4.8	4.0	–16.7
Brazil	1 972	2 841	44.1	9.6	12.7	32.3
Chile	253	314	24.1	14.2	16.0	12.7
Mexico	1 610	2 117	31.5	12.8	14.9	16.4
Peru	675	969	43.6	21.8	27.6	26.6
Asia and other Oceania	**97 549**	**120 599**	**23.6**	**23.5**	**26.4**	**12.3**
China	54 128	66 747	23.3	39.5	47.2	19.5
India	7 755	9 758	25.8	6.0	6.7	11.7
Indonesia	8 896	11 206	26.0	35.0	39.4	12.6
Philippines	3 091	3 703	19.8	31.2	31.9	2.2
Republic of Korea	2 924	3 340	14.2	58.4	64.3	10.1
Thailand	1 859	1 879	1.1	27.5	27.4	–0.4
Viet Nam	3 275	3 846	17.4	35.4	37.7	6.5
LEAST-DEVELOPED COUNTRIES	12 170	15 978	31.3	13.2	13.6	3.0
OECD[1]	32 314	35 410	9.6	24.7	25.8	4.5

[1] Organisation for Economic Co–operation and Development.
Source: OECD and FAO.

» are projected to eat 93 percent of the additional fish available for human consumption during the projected period. The 10 percent increase in their apparent per capita fish consumption will be due to the combination of several factors affecting the intake of animal proteins at expense of other food. These factors include: rising living standards; population growth; rapid urbanization; growing recognition of fish as healthy and nutritious food; and technological developments in food, processing, packaging and distribution. The slight increase in the high rates of per capita consumption in developed countries reflects, among other things, slowing population growth and dietary shifts that are already under way. Moreover, consumers, especially in more-developed economies, are increasingly concerned about sustainability issues, animal welfare and food safety, which may also affect their consumption patterns, including for fishery products. A sizeable and growing share of fish consumed in developed countries will be met by imports.

Notwithstanding the increased availability of fish to most consumers, the rise in fish consumption will not be homogenous among countries and within countries in terms of quantity and variety consumed. As the fisheries and aquaculture sector will remain one of the most globalized of all food sectors, consumers will also be exposed to the impacts of global trends as supply chains lengthen and as growing urbanization and improved distribution increase the range of products available.

Consumption of fishmeal and fish oil will remain characterized by the traditional competition between aquaculture and livestock for fishmeal, and between aquaculture and dietary supplements for direct human consumption for fish oil, but will be constrained by the rather stable production. Due to still high prices and major innovation efforts, it is expected that the percentage of fishmeal and fish oil in compound feeds in aquaculture will continue its downward trend (Figure 37), and fishmeal and fish oil will be more frequently used as strategic ingredients to enhance growth at specific stages of fish production. Being rich in omega-3 fatty acids, fish oil is expected to be increasingly processed for direct human use as it is considered beneficial for a wide range of biological functions.

Trade

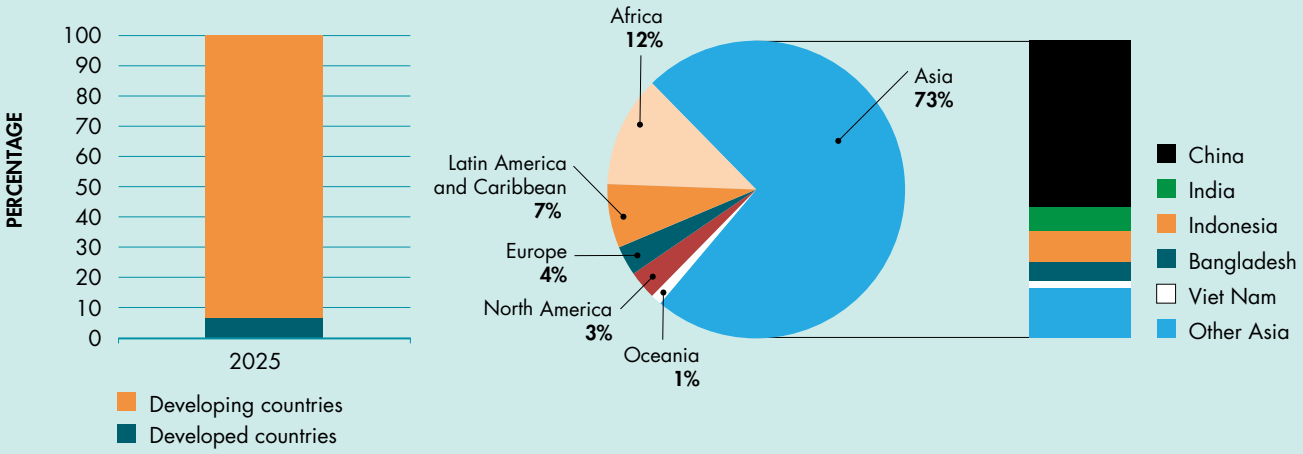
Fish and fishery products will continue to be highly traded, fuelled by increasing consumption of fishery commodities, trade liberalization policies, globalization of food systems, and technological innovations in processing, preservation, packaging and transportation. About 36 percent of total fishery production including trade between member States of the European Union (intra-EU trade) is expected to be exported[11] in the form of different products for human consumption or non-edible purposes in 2025 (excluding intra-EU trade, the figure is 31 percent). A share of this trade might consist of species traded in different stages of processing among countries and regions. This makes the fisheries and aquaculture sector rather complex and globalized.

World trade in fish for human consumption is expected to exceed 46 million tonnes in live weight equivalent in 2025, up 18 percent from the base period (Table 24), with a slowdown in its annual growth rate from 2.3 percent in 2006–2015 to 1.9 percent in 2016–2025. This decline will be caused by high prices, slower growth of fishery production and stronger domestic demand in some of the major exporting countries. Aquaculture will contribute to a growing share of the international trade in fishery commodities for human consumption.

The next decade will be characterized by an increasing role of developing countries in fishery trade, and a corresponding decline in the share of developed economies. In the next decade, developing countries will continue to lead fishery exports of fish for human consumption, notwithstanding a slight decline in their share in total trade of fish for human consumption (from 67 percent in the base period to 66 percent in 2025). Due to their primary role in fishery production, the bulk of the growth in fish exports is projected to originate from Asian countries, which will account for about 67 percent of the additional exports by 2025. In the same year, »

FIGURE 36

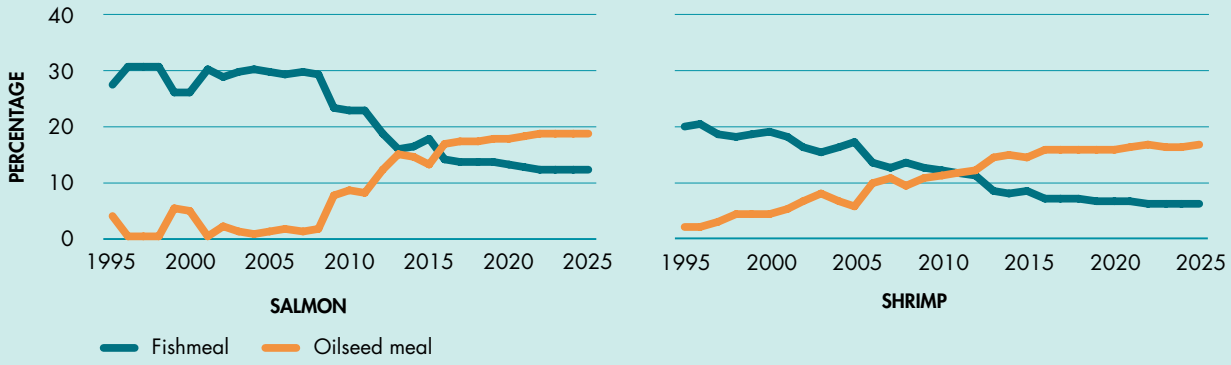
ADDITIONAL FISH CONSUMED IN 2025



SOURCE: OECD and FAO.

FIGURE 37

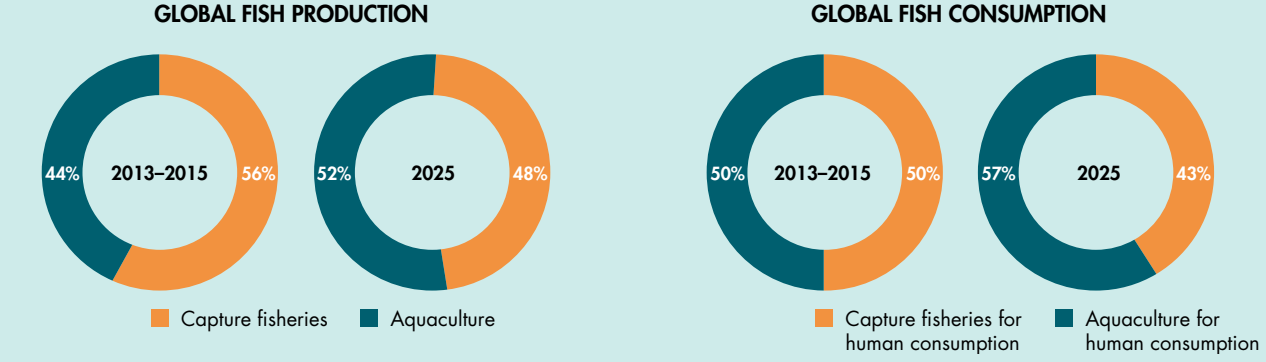
SHARE OF FISHMEAL USED AS FEED IN AQUACULTURE PRODUCTION OF SALMON AND SHRIMP



SOURCE: OECD and FAO.

FIGURE 38

RELATIVE SHARES OF AQUACULTURE AND CAPTURE FISHERIES IN PRODUCTION AND CONSUMPTION



SOURCE: OECD and FAO.

» Asian countries are expected to slightly increase their share in world exports for human consumption from 50 to 53 percent as a result of further expansion of their aquaculture production. At the country level, China, Viet Nam and Norway will be the world's largest fish exporters.

Owing to their slow but continuous economic recovery, demand for seafood in major developed economies in Japan and in Europe and North America is expected to be revitalized, with growing imports of fish for human consumption. Due to stagnating domestic fishery production, overall, developed countries will remain highly dependent on external supplies to satisfy their domestic demand, with their imports expected to increase by 20 percent over the Outlook period. However, although developed countries will continue to dominate world imports of fish and fishery products for human consumption, their share in global imports will decrease from 54 percent in 2013–15 to 53 percent in 2025. Import expansion for developing countries will consist of supplies of raw material for their processing sectors for subsequent re-export and, increasingly, of products destined to meet surging domestic consumption, in particular for species not produced locally. Increasing imports are expected to be recorded by several Asian countries (including Indonesia, the Philippines and Viet Nam), Brazil, and selected countries in the Near East and in Africa.

Exports of fishmeal are projected to remain steady at base period levels (3.0 million tonnes in product weight), with an overall increase of 15 percent in 2016–2025. Developing countries will remain the main exporters and importers of fishmeal. Owing to their leading role in aquaculture production, Asian countries will remain the main importers of fishmeal. Peru will be the leading exporter of fishmeal, followed by the United States of America, Chile and Thailand. Fish-oil exports are expected to increase (by 9 percent) over the period 2016–2025. Due to salmon farming and growing demand for fish to be consumed as food, European countries will represent the main importers, with a 57 percent share of global fish-oil imports in 2025.

Main uncertainties

Many factors can affect the fish projections reported in this section. The next decade is likely to see major changes in the environment, resources, macroeconomic conditions, international trade rules and tariffs, market characteristics, and social conduct. Their effects may influence production and fish markets in the medium term.

Climate change, variability and extreme weather events are also compounding threats to the sustainability of capture fisheries and aquaculture development in marine and freshwater environments.[12] Impacts occur as a result of both gradual atmospheric warming and associated physical (sea surface temperature, ocean circulation, waves and storm systems) and chemical changes (salinity content, oxygen concentration, and acidification) of the aquatic environment.[13] This could lead to: warming water temperatures; changing ocean currents and Southern Oscillation; sea-level rise; changes in rainfall, river flows, lake levels, thermal structure, and storm severity and frequency; and ocean acidification. These impacts could result in changes in catch quantity and composition, and in fish distribution. Moreover, extreme weather events and sea-level rise are anticipated to affect fisheries-related infrastructure such as ports and fleets, further raising the costs of fishing, processing and distribution activities. These possible events would take place in the context of other global social and economic pressures on natural resources and ecosystems, including environmental degradation and increasing land and water scarcity.

In the coming decade, capture fisheries production is projected to remain rather stable. However, the real prospects for capture fisheries are rather difficult to determine because they depend on the natural productivity of fish stocks and ecosystems, and are subject to many variables and uncertainties. Moreover, illegal unreported and unregulated (IUU) fishing and the overcapacity of fishing fleets globally are other important threats affecting the sustainability of fisheries resources. In addition, the ongoing practice of »

TABLE 24

MAIN RESULTS OF THE FISH MODEL: COMPARISON 2025 VS 2013–15: TRADE (LIVE WEIGHT EQUIVALENT)

	EXPORTS			IMPORTS		
	AVERAGE 2013–15	2025	GROWTH OF 2025 VS 2013–15	AVERAGE 2013–15	2025	GROWTH OF 2025 VS 2013–15
	(Thousand tonnes)		*(%)*	*(Thousand tonnes)*		*(%)*
WORLD	39 149	46 359	18.4	38 340	46 359	20.9
DEVELOPED COUNTRIES	13 097	15 707	19.9	20 793	24 447	17.6
North America	**2 978**	**3 685**	**23.7**	**5 747**	**7 348**	**27.9**
Canada	792	781	–1.4	650	701	7.8
United States of America	2 186	2 905	32.9	5 097	6 647	30.4
Europe	**8 783**	**10 422**	**18.7**	**10 252**	**11 699**	**14.1**
European Union	2 470	3 001	21.5	7 818	9 137	16.9
Norway	2 930	3 700	26.3	285	180	–36.8
Russian Federation	1 983	2 448	23.4	1 079	1 133	5.0
Oceania developed	**483**	**487**	**0.8**	**568**	**799**	**40.7**
Australia	61	40	–34.4	516	748	45.0
New Zealand	422	447	5.9	52	51	–1.9
Other developed	**854**	**1 112**	**30.2**	**4 225**	**4 601**	**8.9**
Japan	639	864	35.2	3 668	3 841	4.7
South Africa	165	183	10.9	234	351	50.0
DEVELOPING COUNTRIES	26 052	30 652	17.7	17 547	21 912	24.9
Africa	**2 110**	**1 483**	**–29.7**	**3 949**	**5 527**	**40.0**
North Africa	*622*	*603*	*–3.1*	*687*	*1 247*	*81.5*
Egypt	26	20	–23.1	404	820	103.0
Sub-Saharan Africa	*1 488*	*880*	*–40.9*	*3 263*	*4 280*	*31.2*
Ghana	31	30	–3.2	335	321	–4.2
Nigeria	11	9	–18.2	1 053	1 525	44.8
Latin America and Caribbean	**4 430**	**5 194**	**17.2**	**2 431**	**3 272**	**34.6**
Argentina	680	762	12.1	58	60	3.4
Brazil	40	48	20.0	757	991	30.9
Chile	1 512	1 767	16.9	120	118	–1.7
Mexico	185	161	–13.0	407	750	84.3
Peru	649	879	35.4	148	203	37.2
Asia and other Oceania	**19 513**	**23 975**	**22.9**	**11 166**	**13 113**	**17.4**
China	7 759	11 257	45.1	3 413	2 884	–15.5
India	1 063	947	–10.9	25	25	0.0
Indonesia	1 320	1 408	6.7	182	509	179.7
Philippines	413	322	–22.0	359	596	66.0
Republic of Korea	662	410	–38.1	1 637	1 870	14.2
Thailand	2 082	2 624	26.0	1 694	1 867	10.2
Viet Nam	2 651	3 669	38.4	278	413	48.6
LEAST-DEVELOPED COUNTRIES	1 462	1 178	–19.4	1 018	1 089	7.0
OECD[1]	13 266	15 415	16.2	20 760	24 800	19.5

[1] Organisation for Economic Co–operation and Development.
Source: OECD and FAO.

» fleets moving their operations from depleted areas to new areas can cause a long-term decline in global catches as overfishing spreads. These situations are also linked with, and exacerbated by, the poor governance characterizing several fisheries activities.

It is expected that future growth in fish production and related fish consumption will mainly originate from aquaculture (Figure 38). However, many factors might affect the prospects for this sector. These include: land and water and associated conflicts; feed, seed[14] supply and genetic resources; environmental integrity and disease problems; development and adoption of new and improved farming technologies; market, trade and food safety; climate change; investment capital impediments; and problems that can originate from unguided and unmonitored aquaculture practices. Aquaculture is also expected to continue to grow through intensification, species diversification, expansion into new milieus (including moving farther into offshore marine waters) and through the introduction of innovative, more-resource-efficient farming technologies. Well-advised policies and strategies backed by strong research programmes will be of paramount importance in overcoming production constraints.

Consumer concerns related to issues such as animal welfare, food quality, production and processing methods may cause further uncertainties in the fish sector. Especially in more-affluent markets, consumers are increasingly requiring high standards of quality assurance and demanding guarantees that the fish they purchase are produced sustainably. Stringent quality- and safety-related import standards, together with requirements for products meeting international animal health and environmental standards and social responsibility requirements, might act as barriers to small-scale fish producers and operators attempting to penetrate international markets and distribution channels. Future prices might be influenced not only by higher feed prices but also by the introduction of more rigorous regulations on the environment, food safety, traceability and animal welfare.

Summary of main outcomes from projections

The following major trends for the period up to 2025 emerge from the analyses:

- World production, total consumption, food demand and per capita food consumption will increase over the next decade; however, the rate of these increases will slow over time.
- World capture production is projected to increase only slightly if overfished stocks are well managed, while expanding world aquaculture production is projected to fill the supply–demand gap, albeit growing more slowly than in the past.
- The major changes in demand are in developing countries, where continued but slowing population growth, rising per capita incomes and urbanization will all increase the demand for fishery products.
- Prices will decline in real terms but remain on a high plateau.
- Trade in fish and fishery products is expected to increase more slowly than in the past decade, and the share of fish production being exported is projected to remain stable.
- Progress in ensuring the sustainability of capture fisheries and aquaculture and their contribution to the fight against hunger and poverty and to economic and social development is critical, emphasizing the crucial importance of integrated approaches to the implementation of the 2030 Agenda and all its relevant SDG targets.

The 2030 Agenda for Sustainable Development and the fisheries and aquaculture sector

At the United Nations Sustainable Development Summit on 25 September 2015, leaders of UN Member States adopted the 2030 Agenda for Sustainable Development,[15] which includes a set of 17 Sustainable Development Goals (SDGs). The 2030 Agenda defines global sustainable development priorities and aspirations for 2030 and seeks to mobilize global efforts to benefit

people, planet, prosperity, peace and partnership. It not only covers the SDGs but also the Addis Ababa Action Agenda[16] on financing for development as well as the Paris Agreement[17] on climate change. The SDGs aim, by 2030, *inter alia*, to: end poverty and hunger; further develop agriculture; support economic development and employment; restore and sustainably manage natural resources and biodiversity; fight inequality and injustice; and tackle climate change. The SDGs are truly transformative.[18] They are interlinked, calling for new combinations in the ways policies, programmes, partnerships and investments pull together to achieve the common goals.

The 2030 Agenda strives for a world that is just, rights-based, equitable and inclusive.[19] It commits stakeholders to work together to promote sustained and inclusive economic growth, social development and environmental protection, and to benefit all, including women, children, youth and future generations. The new agenda envisages a world of universal respect for human rights, equality and non-discrimination, and the over-riding message of the new agenda is "to leave no one behind", to ensure "targets met for all nationals and peoples and for all segments of society", and "to reach the furthest behind first", with two dedicated goals on combating inequality and discrimination.

Through the 2030 Agenda, nations acknowledge the imperative of a revitalized global partnership: "an intensive global engagement in support of implementation of all the goals and targets, bringing together Governments, civil society, the private sector, the United Nations system and other actors and mobilizing all available resources." The revitalized global partnership will endeavour to deliver the means of implementation of the 2030 Agenda through "domestic public resources, domestic and international private business and finance, international development cooperation, international trade as an engine for development, debt and debt sustainability, addressing systemic issues and science, technology, innovation and capacity-building, and data, monitoring and follow-up."

FAO emphasizes that food and agriculture are key to achieving the 2030 Agenda.[20] FAO's tasks and work are in fact already contributing to progress towards almost all SDGs. Both the SDGs and FAO's Strategic Framework are geared towards tackling the root causes of poverty and hunger, building a fairer society, and leaving no one behind. In particular, SDG 1 (End poverty in all its forms) and SDG 2 (End hunger, achieve food security and improved nutrition and promote sustainable agriculture) reflect FAO's vision and mandate. Other SDGs covering gender (SDG 5), water (SDG 6), economic growth and employment and decent work (SDG 8), inequality (SDG 10), production and consumption (SDG 12), climate (SDG 13), oceans (SDG 14), biodiversity (SDG 15), and peace and justice (SDG 16) are also highly relevant, while the agreed means of implementation and the revitalized global partnership (SDG 17) provide the basis for realization of the 2030 Agenda in all food and agriculture sectors, including fisheries, aquaculture and post-harvest fisheries.

The importance of oceans, seas and coasts as well as rivers, lakes and wetlands – including their resources and ecosystems as utilized by fisheries and aquaculture – for sustainable development is now widely recognized by the international community. This was evident at the 1992 Rio Summit, as embodied in Chapter 17 (as well as in Chapters 14 and 18) of Agenda 21, and runs through the historic 1995 Code of Conduct for Responsible Fisheries (the Code). It has been promoted most recently in the Rio+20 outcome document,[21] where Members called for "holistic and integrated approaches to sustainable development that will guide humanity to live in harmony with nature and lead to efforts to restore the health and integrity of the Earth's ecosystem."

Several SDGs are relevant to fisheries and aquaculture and to the sustainable development of the sector (see section Global agenda – global ambitions, p. 80). Indeed, SDG 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development) expressly focuses on the oceans, underlining the importance of the conservation and sustainable use of the

oceans and seas and of their resources for sustainable development, including through their contributions to poverty eradication, sustained economic growth, food security and creation of sustainable livelihoods and decent work.

To allow oceans, seas and marine resources to continue to contribute to human well-being, SDG 14 recognizes the need to manage and conserve marine resources while supporting those ecosystem services that are of crucial importance for humans. A more sustainable use of resources, changes in production and consumption patterns, and improved management and regulation of human activities can help reduce negative environmental impacts and allow current and future generations to benefit from aquatic ecosystems. Promoting sustainable fishing and fish farming practices will not only contribute to resource and ecosystem management and conservation but ensure the world's oceans and seas are able to deliver nutritious food.

Along with important contributions to global food and nutrition security, livelihoods and national economic growth, oceans, seas and inland waters provide valuable ecosystem goods and services for the planet. About 50 percent of carbon in the atmosphere that becomes bound in natural systems is cycled into the oceans and inland waters. However, these same oceans and inland waters are under threat from overexploitation, pollution, declining biodiversity, expansion of invasive species, climate change and acidification. Stresses caused by human activity on the oceans' life support systems have reached unsustainable levels.

Today, 31 percent of commercially important assessed marine fish stocks worldwide are overfished (see section The status of fishery resources, p. 38). Mangroves, salt marshes and seagrass beds are being cleared at an alarming rate, exacerbating climate change and global warming. Aquatic pollution and habitat degradation continue to threaten fisheries and aquaculture resources in both inland and marine waters. At risk are hundreds of millions of people who depend on fisheries and aquaculture for their livelihoods, food security and nutrition. Furthermore, the vital contributions of fisheries and aquaculture to the world's well-being and prosperity are being compromised by poor governance, management and practices, while IUU fishing remains an obstacle to achieving sustainable fisheries.

Several SDG 14 targets call for specific actions in fisheries *inter alia*: effectively regulate harvesting; end overfishing and IUU fishing; address fisheries subsidies; increase economic benefits from sustainable management of fisheries and aquaculture; provide access for small-scale fishers to resources and markets; implement provisions of the United Nations Convention on the Law of the Sea (UNCLOS). Other SDG 14 targets cover marine pollution prevention and reduction, management and protection of marine and coastal ecosystems all of which are also important priorities for sustainable fisheries and aquaculture. Thus, SDG 14 spells out the need for cooperation and coordination among all stakeholders for more sustainable fisheries management and better conservation of resources. It creates a framework to sustainably manage and protect marine and coastal ecosystems.

Today's holistic approach to sustainable management and development of fisheries and aquaculture, as promoted by FAO's Blue Growth Initiative (see below), aims at reconciling economic growth with improved livelihoods and social equity. It balances the sustainable and socio-economic management of natural aquatic resources with an emphasis on efficient resource use in capture fisheries and aquaculture, ecosystem services, trade, livelihoods and food systems.

National, regional and global efforts by fisheries and aquaculture stakeholders aiming to achieve the 2030 Agenda will benefit from past and ongoing processes of collaboration, mutual support and international consensus building. Measures aiming at the implementation of the Code will prove the basis for implementation of relevant SDG targets. Reporting on Code implementation efforts to FAO's Committee on Fisheries (COFI) and its Sub-Committees on

Trade and Aquaculture will demonstrate progress made towards the 2030 Agenda as reported by national fisheries administrations, regional fishery bodies (RFBs), and international civil society organizations (CSOs) and intergovernmental organizations. The international fisheries community can build on a solid framework of international instruments, including the Code, supporting fisheries governance worldwide.

The 2030 Agenda highlights the importance of building partnerships and strengthening stakeholder participation as key to progress and success to promote and effectively implement activities in support of specific as well as interlinked SDG targets. International examples of such ongoing initiatives in the fisheries and aquaculture sector include:

- the Global Partnership for Climate, Fisheries and Aquaculture[22] (covering SDGs 2, 13 and 14);
- the promotion and implementation by local, national and international CSOs and multiple governments of the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication[23] (SDGs 1, 2, 5, 8 and 14);
- cooperation between national institutions and between FAO, the International Maritime Organization, and the International Labour Organization (ILO) in the fight against IUU fishing and other crime associated with fishing through: support to national and regional plans of actions to combat IUU fishing; implementation of the Voluntary Guidelines for Flag State Performance;[24] development of the Global Record of Fishing Vessels;[25] and implementation of FAO's Port State Measures Agreement,[26] ILO's Work in Fishing Convention 188[27] and other instruments on safety at sea and decent work in fisheries (SDGs 14 and 8);
- support to implementation, monitoring and review of efforts related to SDG 14.c on UNCLOS and other relevant binding and voluntary oceans governance instruments through consultation and coordination within and beyond the UN-Oceans[28] interagency collaboration mechanism (SDGs 14 and 17).

The 2030 Agenda places an emphasis on capacity-development efforts, especially those strengthening the policy environment, institutional arrangements and collaborative processes that will help empower fishing and aquaculture communities, CSOs, seafood value-chain actors and public entities. Given the multidimensional and interlinked nature of the SDGs, effective coordination and strategic integration of policy and implementation efforts addressing multiple SDG targets will be key to achieving lasting and constructive changes in policies and institutions, as well as participation in and commitments to actions at the local, country and international levels. In many cases, developing solutions to challenges in fisheries and aquaculture will require interactions and collaboration with, and support from, stakeholders and institutions outside the sector. The 2030 Agenda encourages such interactions and processes that will lead to more integrated, efficient, inclusive and better coordinated initiatives as they address multiple SDG targets.

It will be of paramount importance for governmental and non-governmental stakeholders in fisheries and aquaculture to familiarize themselves with the 2030 Agenda and the SDGs, and to further promote awareness and action towards their achievement. Of significant relevance is SDG 17 (means of implementation and global partnership for sustainable development), which covers commitments on finance, technology, capacity building, trade, policy and institutional coherence, multistakeholder partnerships and data, monitoring and accountability.

FAO is advising Members on SDG implementation policies and processes, including follow-up, monitoring and review. It is collaborating with UN-Oceans, the UN Statistical Division, the Inter-Agency Expert Group on SDG indicators, the Inter-Agency Task Force on Financing for Development outcomes and means of implementation of the 2030 Agenda, and other partners. FAO is also contributing to the High-level Political Forum on Sustainable Development,[29] which is the main platform for SDG follow-up and review and which may draw on the work of other intergovernmental bodies

and fora that review progress and discuss policies in specific areas, including the Committee on World Food Security and FAO's Technical Committees such as COFI.

Monitoring progress

Through an unprecedented consultative process driven by UN Members, the adopted SDG framework contains a set of 169 targets and 231 indicators to measure and monitor progress at the global level.

Sustainable Development Goal 14 comprises ten targets – with several explicitly addressing fisheries-related issues and others with direct implications for the fisheries sector. The fisheries-related targets call for actions to: effectively regulate harvesting and to end overfishing, IUU fishing and destructive fishing practices; address fisheries subsidies; increase economic benefits from sustainable management of fisheries and aquaculture; and secure access for small-scale artisanal fishers to fishery resources and markets. The other targets relate to marine pollution prevention and reduction, management and protection of marine and coastal ecosystems, and implementation of UNCLOS and applicable existing regional and international regimes.

All targets are supported by agreed indicators established by the Inter-Agency and Expert Group on SDGs and adopted by the UN Statistical Commission.[30] FAO has been identified as custodian for some 20 indicators, while contributing to some 5–6 additional indicators. FAO is custodian agency for three SDG 14 targets, namely:

- Target 14.4: By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics.
  Indicator 14.4.1: Proportion of fish stocks within biologically sustainable levels.
- Target 14.6: By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation.
  Indicator 14.6.1: Progress by countries in the degree of implementation of international instruments aiming to combat illegal, unreported and unregulated fishing.
- Target 14.b: Provide access for small-scale artisanal fishers to marine resources and markets.
  Indicator 14.b.1: Progress by countries in the degree of application of a legal/regulatory/policy/institutional framework which recognizes and protects access rights for small-scale fisheries.

FAO will collaborate with and support custodian agencies for other SDG 14 targets, for example, SDG 14.c (collaboration between UN Division for Ocean Affairs and the Law of the Sea, FAO and other members[31] of UN-Oceans):

- Target 14.c: Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in the United Nations Convention on the Law of the Sea, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of "The future we want".
  Indicator 14.c.1: Number of countries making progress in ratifying, accepting and implementing through legal, policy and institutional frameworks, ocean-related instruments that implement international law, as reflected in UNCLOS, for the conservation and sustainable use of the oceans and their resources.

The indicators expected to help monitor progress on the above SDG targets 14.6, 14.b and the fisheries component of 14.c are composite

indicators developed on the basis of the existing mechanism for monitoring implementation of the Code by COFI Members through biennial Code surveys. They will therefore contribute to and support the reporting process for global monitoring of fisheries-related targets of the 2030 Agenda. Recently, response rates by COFI Members have increased dramatically, following the launching of the more accessible online Code reporting system.

Additional efforts to assess progress in fisheries management are ongoing. These could assist related national, regional and global initiatives, and also support national and global SDG monitoring measures. In this context, FAO actively contributed to the 2016 Expert Meeting[32] on improving progress reporting and working towards implementation of Aichi Biodiversity Target 6, which developed a draft conceptual framework that could be used as guidance by parties to the Convention on Biological Diversity (CBD) in reporting on their implementation towards the achievement of Target 6 on sustainable fisheries. The meeting identified a set of actions and potential indicators related to achieving Target 6 and discussed ways to facilitate this through improved coordination among the CBD, FAO and RFBs.

In addition, within the framework of the FAO/GEF Coastal Fisheries Initiative, specific efforts are ongoing to develop and implement a fisheries performance evaluation system that can be used to: (i) effectively evaluate the impacts of coastal fisheries projects; (ii) monitor changes in environmental, social and economic benefits of fisheries; and (iii) support knowledge sharing through identifying pathways for implementation of management strategies to achieve sustainable fisheries.

The FAO Blue Growth Initiative and the SDGs

The FAO Blue Growth Initiative (BGI),[33] based on the sound principles of the Code, directly contributes to a wide range of SDGs (see section Global agenda – global ambitions, p. 80). It prioritizes balancing the sustainable environmental, social and economic aspects of use of our living aquatic resources. Through the BGI, FAO mobilizes international support to provide incentives and assistance to developing countries so they can adapt and upscale implementation of blue growth strategies at the local, national and regional levels to secure political commitment and governance reform. The BGI brings together policies, investment, innovation and public–private partnerships that underpin sustained growth and give rise to new economic opportunities in fish harvesting and utilization and in ecosystem goods and services.

In order to help achieve the SDGs,[34] FAO and its Members and partners have been mainstreaming the BGI across both the Near East and North Africa region and the Asia and Pacific region.[35] The Asia and Pacific BGI currently focuses on sustainable aquaculture development to reverse environmental degradation and ameliorate competition for mangrove space and freshwater resources. Responsible management and sustainable development of aquaculture can also offer good work opportunities to Asian fish farmers, in particular youth, while simultaneously boosting their income and nutrition security, and safeguarding their natural resources. This initiative is a good example of the type of actions required to ensure aquaculture becomes environmentally sound and truly sustainable in line with the SDGs.

Similarly, a comprehensive study is under way with a view to unleashing the potential of blue growth in the Near East and North Africa. In this region, activities include: promoting desert aquaculture in Algeria; assessing livelihoods of fishing communities along the Nile River in Egypt and the Sudan; improving value chains in Tunisia to ensure that women harvesting clams receive greater and diversified income; and promoting the Nouakchott Declaration on the reduction of losses and waste in the fisheries sector. Fisheries and aquaculture also provide an excellent opportunity to create rural employment, especially for youth, thereby allowing them to remain in their own villages with gainful employment, rather than having to migrate to urban areas or abroad in search of work. This study should provide valuable information on the feasibility of developing aquaculture in arid

zones and assessing the potential social and economic benefits that can accrue from improved value chains and reductions in losses and waste, which in turn will be important factors in meeting the SDGs and delivering blue growth.

Blue growth is especially relevant for Small Island Developing States (SIDS) and coastal areas around the globe. Cabo Verde is extremely vulnerable to the effects of climate change and climate-related disasters, which have direct impacts on food and nutrition security and livelihoods. However, SIDS such as Cabo Verde are best poised to develop and promote economically viable, technically feasible and culturally acceptable development strategies that support conservation and sustainable use of the oceans. Cabo Verde worked with FAO to develop a blue growth charter, recently adopted by the Government of Cabo Verde, for implementation at the national level.[36] The charter highlights the country's commitment to blue growth, and places increased emphasis on the services provided by coastal, oceanic and freshwater ecosystems, while simultaneously minimizing environmental pollution, loss of biodiversity and unsustainable use of aquatic resources. Moreover, the charter aims to maximize economic and social benefits for the population, and fully engages key sectors as partners, including fisheries and aquaculture, the seafood industry, marine and coastal tourism, scientific research and shipping. Successful implementation of this charter would be a good example for other SIDS as a means to meet SDG targets and benefit from blue growth.

The 2030 Agenda provides the framework, processes, stakeholder engagement and partnerships that can: (i) allow present and future generations to benefit from aquatic resources; and (ii) help the fisheries and aquaculture sector to feed a growing population with nutritious food and provide economic prosperity, employment opportunities and well-being. ■

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2016

THE STATE OF WORLD FISHERIES AND AQUACULTURE

CONTRIBUTING TO FOOD SECURITY AND NUTRITION FOR ALL

This issue of *The State of World Fisheries and Aquaculture* aims to provide objective, reliable and up-to-date data and information to a wide range of readers – policy-makers, managers, scientists, stakeholders and indeed all those interested in the fisheries and aquaculture sector. As always, the scope is global and the topics many and varied.

This edition uses the latest official statistics on fisheries and aquaculture to present a global analysis of trends in fish stocks, production, processing, utilization, trade and consumption. It also reports on the status of the world's fishing fleets and analyses the make-up of human engagement in the sector.

Twenty years on from the introduction of the Code of Conduct for Responsible Conduct, and now with the recently adopted Sustainable Development Goals, 2030 Agenda for Sustainable Development, Paris Agreement, and the Small-Scale Fisheries Guidelines, the focus on governance and policy has never been greater. This edition covers recent developments as they relate to fisheries and aquaculture, and reports, *inter alia*, on the Common Oceans ABNJ Program, FAO's Blue Growth Initiative and efforts to combat illegal, unreported and unregulated fishing. It also discusses issues such as valuing inland fisheries, cutting bycatch and promoting decent work. Other topics highlighted include: nutrition; aquatic invasive alien species; responsible inland fisheries; resilience in fisheries and aquaculture; and governance of tenure and user rights.

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