PART 4
Outlook

Outlook

INTRODUCTION

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

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

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

TRENDS IN LONG-TERM PROJECTIONS OF FISH PRODUCTION AND CONSUMPTION

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

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

CAPTURE AND AQUACULTURE PRODUCTION

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

[1] FAO. In press. Agriculture towards 2015/30. Rome.
[2] In this section the term “fish” also includes crustaceans and molluscs, unless otherwise stated.
[3] Austria, Belgium-Luxembourg, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.
[4] The results of these five reports will be finalized and published as a series of FAO publications by 2003.

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

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

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

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

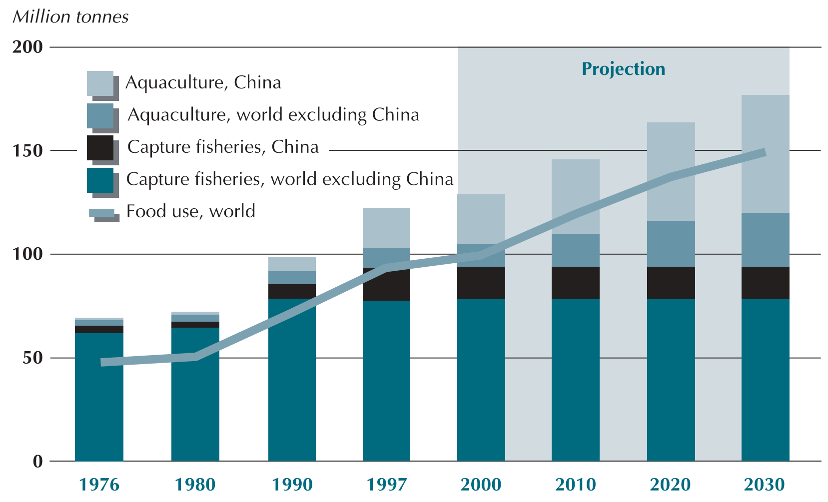
The largest share in the increase of world capture production over the projection period is predicted to come from Latin America, solidifying its position as the leading producer of capture fisheries production and the leading net exporter. Small pelagic and demersal fish will continue as the major fish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

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

Japanese domestic production peaked at 12 millions tonnes in 1974, and has subsequently decreased by almost half to 6.72 million tonnes in 1997; production from capture fisheries is expected to remain at the 1997 level of approximately 6 million tonnes. Aquaculture production is expected to double to 1.5 million tonnes in three decades. Total production is projected to increase by 11 percent over the 30-year period, with small pelagics, demersals and molluscs remaining the top three nationally produced species groups.

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

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



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

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

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

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

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

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

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

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

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

CONSUMPTION

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

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

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

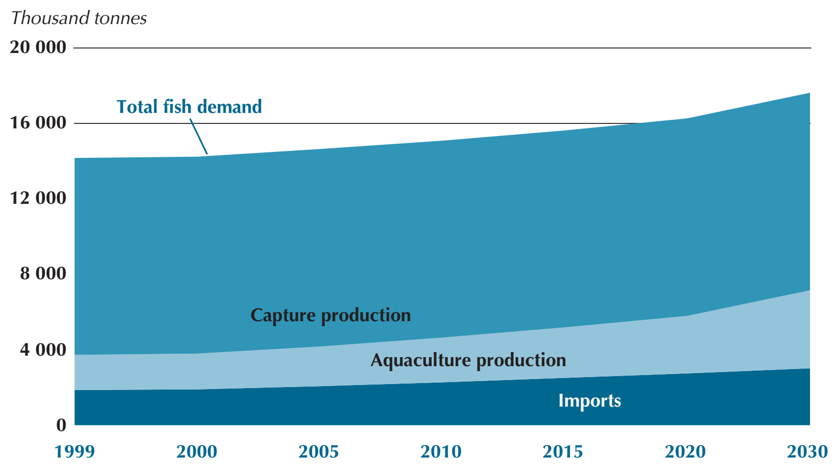
[6] In World agriculture: towards 2015/30 projected annual per capita consumption is between 19 and 20 kg.

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

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

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

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



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

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

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

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

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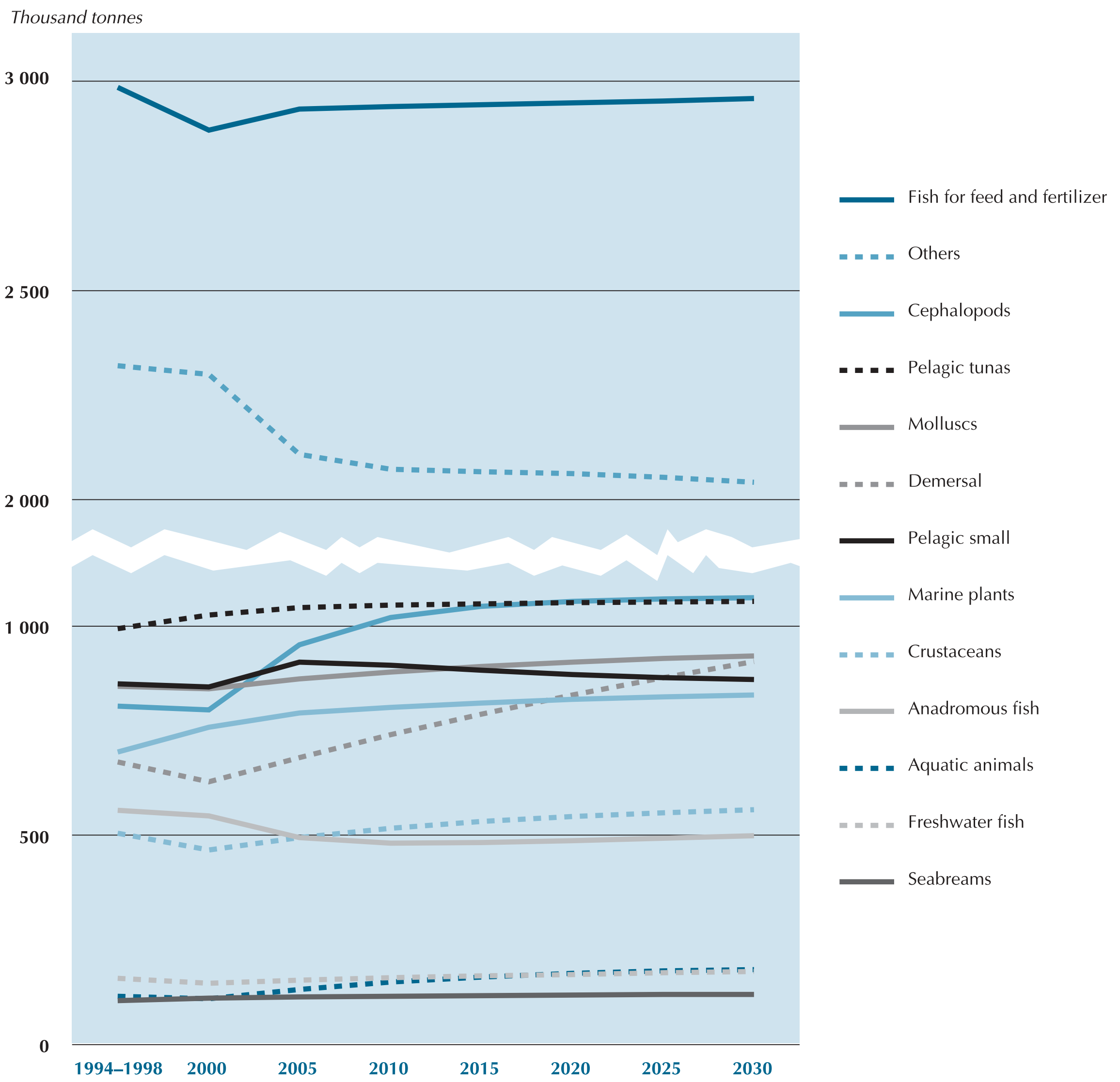
[9] In 1986, United Kingdom fishmongers had a 51 percent market share of fresh fish, while supermarkets' share was 15 percent. By 1996, the situation was dramatically different: fishmongers' market share had fallen to 30 percent, while that of supermarkets had increased to approximately 50 percent. In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

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

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

FIGURE 49
Japanese demand for fish to 2030



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

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

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

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

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

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

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

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

WORLD TRADE FLOWS

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

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

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

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

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

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

[13] See footnote 11, p. 115.

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

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

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

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

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

THE LONG-TERM OUTLOOK

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

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

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

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

FOOD AND EMPLOYMENT: THE PROSPECTS

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

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

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

CAPTURE FISHERS

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

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

BOX 12

Limitations inherent in long-term fish projections

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

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

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

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

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

Source: C. de Young, FAO Fisheries Department.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

AQUACULTURISTS

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

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

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

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

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

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

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

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

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

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

POLICY-MAKERS

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

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

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

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

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

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

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

In summary its seems likely that many policy-makers will find that, on balance, aquaculture conforms better than capture fisheries to public policy objectives for food production, employment, environment and non-food use of aquatic resources. In concrete terms, fish produced by capture fishers are likely to become increasingly costly, and in some instances more rare, while fish produced through aquaculture will become more common and price trends for cultured species may start high but are then likely to fall.

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

CONCLUSIONS

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

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