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Who Will Supply World Demands for Fish?

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Abstract

Fish supply and demand is undergoing an unprecedented set of changes affecting the geography and technology of fisheries and aquaculture production, a growth in consumer demand for fish and global corporate revolutions in the fish processing, supermarket and food service industries. Fish supply chains, often reaching across national borders, are very dynamic and, given the strong outlook for fish prices, actors in the sector should be creating value added chains to increase the total benefits from fish. Private sector and government actors in the most influential countries in the fish sector, particularly those from the current F10 top fish countries, are leading the shift to value added chains. To achieve greater benefit, countries need national policies and strategies that position them to integrate actions for managing fish production and trade, and join with neighbouring countries in combating illegal fishing and sharing research outputs. The governments' new role is more strategic, needs to be more focused on the whole supply chain and needs to help create and sustain 'value added' chains. To remain a force in the fish sector, countries must pay particular attention to sustaining their production and making aquaculture more efficient through the use of improved farm breeds and farming practices. In short, those who will supply world fish demands are those countries, producers, policy makers and businesses that heed the call to work in strategic supply chain partnerships. This paper is based on the Keynote Address delivered at the Asian Fisheries Society 2nd International Conference on Cage Aquaculture in Asia, Zhejiang University, China, 3-6 July 2006.

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Introduction

As public and scientific debate resounds with claims and counter-claims on the outlook for fisheries and aquaculture, the question 'who will supply world fish demand' is engaging the attention of more and varied interest groups. The conclusion of the present paper is that those who will supply world demands are the fish farmers and the fishers, and their important policy and business partners who can ensure sustainable production and who, together, can deliver the fish at an affordable price and to consumers' quality standards. These actors are also subject to pressures from special interest groups, including a segment of the scientific community advocating for conservation, environmental and animal welfare organizations. Further, the conclusion implies that supplying world fish demand depends on understanding and creating value throughout fish supply chains. In the future, expert analysis should be framed in the context of supply chains.

Fish supply chains are defined as linear and networked flows of materials, products, funds and information for producing, procuring and delivering fish and other products derived from living aquatic resources to consumers in the marketplace and the post consumption disposal of wastes. In the present paper, the term 'fish' is used to encompass finfish and other aquatic animal species.

The distinction is also made between supply chains and value chains. Value chains are supply chains which focus on producing incremental value through strategic business relationships within the food supply network, and through product differentiation (Agriculture of the Middle 2005). Value chain concepts are particularly suited to fish which is a product limited in volume and with unit values that can vary widely depending on how it is handled and used, e.g. a product such as tuna can be used in different forms that may have very different values, such as mass market canned tuna and high value sashimi tuna. The imperative of the fish value chain is to make the best possible use of the raw material (Williams 1996). Value chains offer such a possibility and are created by supply chain management through key strategic partnerships (Woods 2004). A major challenge is to create such partnerships when often the parties in the chain differ greatly in their power, needs and location.

Using a supply chain framework, this paper breaks the title question down into four component questions.

First, where will the fish be produced and how? Fish production trends are described in terms of geography, the changing balance between technologies of production, namely between capture fisheries and aquaculture, and the main factors that will affect production.

Second, who are the drivers of fish demand? Patterns of fish demand and fish trade will be examined, including consumer trends. Third, how will the fish get to the consumer? This section will examine the supply chain revolutions, including processing and retail changes.

Fourth, which are and will be the most powerful fisheries countries and how can a country make the most out of its fish sector? The lists of dominant fish countries have changed over the decades although some countries have been constantly in the top lists. This final section will speculate on which countries will form the top echelon of fish countries in 2030 and what a country can do to make the most of its fish sector.

Discussion

Where will the fish be produced and how?

The fish supply chain revolves around fish production, once totally dependent on the capture of natural fish stocks, or capture fisheries, but now including production from aquaculture and, to a lesser extent, restocked and stock enhanced fisheries (Bell et al. 2006).

Producers receive a smaller or larger share of the total price of fish, depending on how organized they are and their industry power through rights to fish or farm sites. Two examples, both involving export product, illustrate how the price is shared between producers and other actors in the chain.

In the first example, from India, the fish producers receive a minority share of the final price. In the domestic portion of the Indian marine seafood export chain, fishers receive only 25-35% of the export price, with commission agents, suppliers and exporters taking the rest (Kulkarni 2005). This low producer share reflects the lack of organization and rights of the fishers although they are producing a product in strong demand.

In the second example, from Norway in 2003, salmon and trout farmers fared better than the Indian fishers, reaping over half the value (54.8%) of the 12,400 million Norwegian Kroner industry (Myrseth 2005), the remainder going to the clusters of support industries around aquaculture. In Norway, aquaculture is used as a tool for national and rural development supported by national policy, government programs and partnerships with industry (Ludvigsen 2005).

The changing geography of fish production

Since the 1950s when formal global statistics were first collected, the world's dominant fish producing regions have shifted. The rise of aquaculture has changed further the balance of total fish supply by region and type of product. In a broad sense, the shift has been from production dominated by the developed countries to dominance by the developing countries – from 57% of world production coming from developed countries in 1973 to 27% in 1997. Projections indicate a likely further fall to 21% in 2020 (Delgado et al. 2003). The shift to the developing world has been mainly due to the large growth in Asian production and stagnation in production from developed countries.

In 1950, not long after the end of World War II, Europe produced more fish than any other continent, even Asia, and the only other significant fish producing region was North America which produced about half that of Europe and Asia (Figure 1). Since then, production in Asian countries has risen enormously, due in large measure to the rise of production by China but also supported by major advances in other east and south Asian countries such as India, Vietnam, Bangladesh, Indonesia and Philippines and the continued presence of Japan as a major fish producer. Europe remains prominent, despite its production decline, which was fast at first and then became more gradual. In the late 1980s, the dissolution of the USSR accelerated the fall of European fish production, which has since reached a plateau. South America's production has fluctuated.

Until the 1980s, the major South American fluctuations were mainly due to the rise and fall of the anchoveta fishery. More recently, fluctuations still persist but on a base of more stable and diverse production. North America has reached a plateau of production. In Africa, the rise of fish production has been only gradual and total production remains modest.

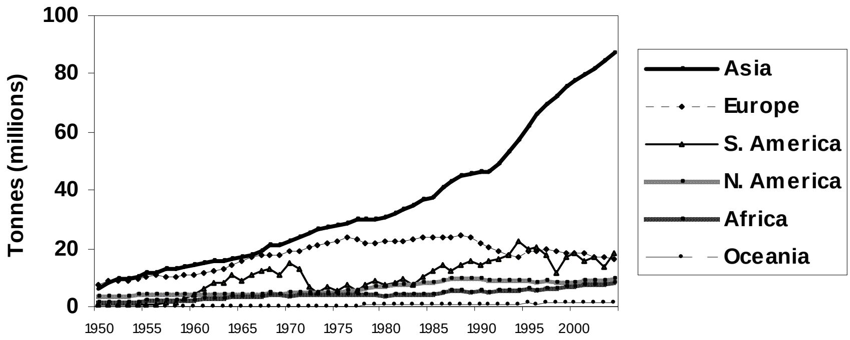

Figure 1. Total annual fish production, capture fisheries and aquaculture 1950-2004 by continent. The totals by continent do not include production of aquatic plants and marine mammals. (Source: FAO FIGIS 2006).

Growth in the importance of aquaculture

The limits of sustainable production from natural fish stocks have been reached or over-reached in most regions. When production from capture fisheries alone is examined (Figure 2), Asian production still dominates but a plateau of aggregate Asian production was reached in the mid 1990s. In Europe, the peak was reached in the mid 1970s and total catch remained fairly stable until the late 1980s, after which it dropped and continues to do so. The plateaus and declines noted in these aggregated statistics mask the changes in catches from the component species and fisheries. Whereas many fisheries are fully and even over-exploited, strong fisheries management, based on good scientific information, has sustained catches and even rebuilt depleted stocks in several developed and a few developing countries, such as the United States, Iceland, New Zealand, Canada and Australia, Namibia and Peru.

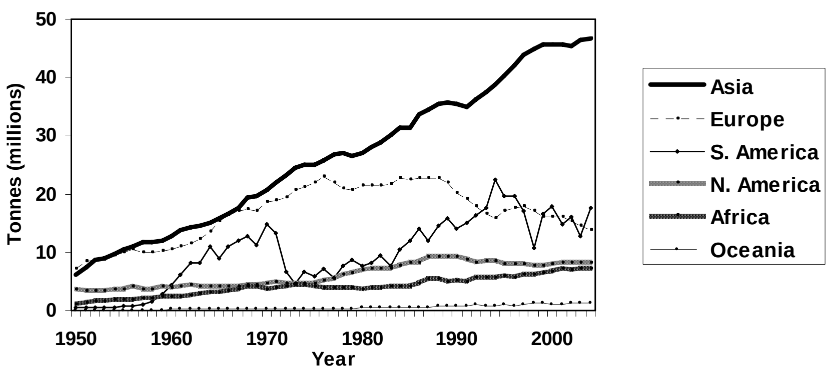

Figure 2. Total annual fish production 1950-2004, capture fisheries by continent. The totals by continent do not include production of aquatic plants and marine animals. (Source: FAO FIGIS 2006)

Making fisheries sustainable, however, has usually meant severely restricting catch levels for the slower growing species, or allowing large changes in catch from year to year for the faster growing species such as the small pelagic species with widely fluctuating population sizes. Therefore, achieving sustainable levels of fish catches cannot be equated simply with maintaining historic or stable catch levels. With respect to the marine capture fisheries component of the total, FAO concluded that the 'global potential for marine capture fisheries has been reached' (FAO 2004).

Given the limitations of capture fisheries production, aquaculture is viewed as one of the main means for meeting future world fish demands. The belief in aquaculture is partly built on the trust in farming that supplies human terrestrial food needs, and partly on the actual achievements of aquaculture in the last three decades. By continent, aquaculture production trends show a different pattern to those for capture fisheries (Figures 3a and 3b).

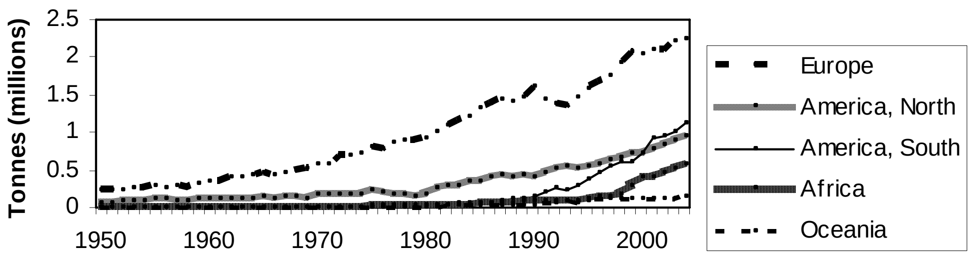

Figure 3a. Total annual fish production 1950-2004 by aquaculture by continent, excluding Asia. The totals by continent do not include production of aquatic plants and marine mammals. (Source: FAO FIGIS 2006)

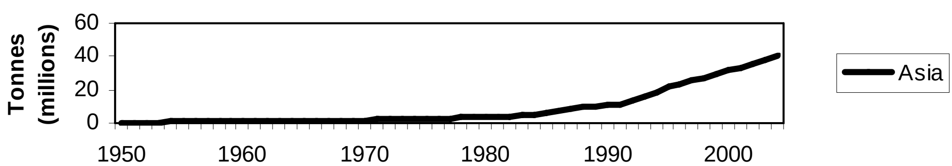

Figure 3b: Total annual fish production by aquaculture for Asia. The totals by continent do not include production of aquatic plants and marine mammals. (Source: FAO FIGIS 2006)

Globally, aquaculture now produces nearly half the world's food fish (FAO 2006). FAO recently renamed its 'Fisheries Department' the 'Fisheries and Aquaculture Department', recognizing the important contribution of aquaculture. Asia dominates world aquaculture production (89% in 2004), led by China. However, aquaculture production is growing on all continents except Oceania. Several studies indicate that these trends will continue.

Dey & Ahmed (2005) reviewed the progress and outlook for fisheries and aquaculture production and consumption in nine Asian countries, representing the majority of world aquaculture production (Bangladesh, China, India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand and Vietnam). Noting the increases for aquaculture achieved to date through technology improvements and spread of uptake to millions of new fish farmers, they concluded that future increases were feasible through further productivity improvements and expansion of the area farmed. Furthermore, although the existing farms had supplied large domestic markets to date, they could rise to also supply international markets.

Brugère & Ridler (2004) examined national aquaculture strategies for 18 major aquaculture producing countries that, in total, were responsible for 94.4% of world aquaculture production. Based on the national projections, the feasibility of attaining national growth targets and the extent of national support for such growth, the authors concluded that total aquaculture production could be expected to grow at 4.5% per year between 2010 and 2030. In the case of several countries and commodities, e.g. Bangladesh and Thailand national projections, and projections for Southeast Asian catfish, actual production has or is likely to exceed projections. However, Brugère & Ridler (2004) assessed national planning processes as still generally weak.

Stock enhancement and restocking programs have been very successful in many inland water systems, and in the cases of individual stocks in marine waters. However, as shown by the papers presented at the special session on stock enhancement at the 7th Asian Fisheries Forum in 2004, such practices are not a panacea and, to be fully effective, need to be based on good research and sound local fisheries management, combining the challenges of aspects of fisheries, e.g., effective management, and aquaculture, e.g., successful hatchery production of fry or juveniles (Bell et al. 2006).

Major factors that will affect future production

Chief among the factors that will shape future fish production are the challenges of fisheries resource and environmental sustainability, the corporatization and concentration of production in the hands of larger companies in many sub-sectors, and the efficiency gains possible in aquaculture production through domestication and genetic improvement of selected species.

Resource and environmental sustainability

Those who will have a major role in supplying world fish demand are certainly those who will have fish to sell. Therefore, sustaining fisheries resources, the aquatic environment and aquaculture ecosystems is key. Yet, as the market demands for fish increase, so too do the pressures against sustainability – the pressures to take greater catches from wild fish stocks and to intensify aquaculture. Taken beyond their limits, both tactics have detrimental effects on the resource base and the natural environment. Good fisheries and aquaculture management is the critical challenge for countries, corporations and people wishing to profit long term from their fish. What are the real prospects for sustainability of fisheries and aquaculture? Are national, regional and global fisheries management responses up to the challenge?

Many nations are making serious and successful attempts at improving fisheries and aquaculture management and closely monitoring the impacts. The fisheries of the United States of America, Canada, Norway, New Zealand, Iceland, Australia, Namibia and some South American fisheries are considered well managed. Others, including many developing countries that are now the world's biggest fish producers, are not yet tackling the central problem of reducing fishing effort and creating alternative sources of income for people currently dependent on fisheries, e.g. Lundgren et al. (2006) describe the serious situation for Asia-Pacific countries. Indeed, in the plans for many countries, the short term need to export fisheries and aquaculture products to generate the foreign exchange that fuels economic growth outweighs the commitment to conserve fish stocks and does not auger well for sustaining fisheries.

Scientists and fisheries managers have debated how to sustain yields from capture fisheries. The recommended solutions, not all of which are mutually exclusive, are (1) management based on scientific fish stock and ecosystem assessments; (2) extended use of systems of aquatic protected areas; (3) rights-based fisheries management systems; (4) consumer-based instruments such as certification of product from sustainable fisheries; (5) aquaculture and stock enhancement; and, (6) reducing fisheries capacity including finding alternative livelihoods (see World Bank 2004) for a good discussion of some of the advocated solutions). All experts agree, however, that achieving sustainable fisheries remains a huge challenge for many countries.

At the regional level, regional fisheries management organizations are of varying effectiveness. Many lack appropriate decision-making capacity (Swan 2004). Experience shows that politics as well as fisheries management capacity are important determinants of success in managing shared stocks. For example, fisheries management in European Union waters is not as effective as the management, enforcement and scientific capacity of the region would suggest, because regional negotiations are used frequently to secure national fishing advantages rather than the long term sustainability of the shared stocks.

On the high seas, fisheries management is not legally feasible (Williams 2005) and yet recent FAO assessments (Maguire et al. 2006) showed that most high seas fisheries are already fully and over-exploited and thus in need of management.

Illegal, unreported and unregulated fishing is a major contributor to unsustainable fisheries at local, national, regional and global scales. Like most illegal activities in other sectors (art theft, people trading, drug smuggling), it is increasing and authorities are playing technology catch-up in attempts to control it (OECD 2005).

The sustainability of aquaculture is also challenging. In countries where aquaculture has developed rapidly, regulations on environmental and product safety usually lag behind. Many types of aquaculture are making progress towards greater sustainability by using integrated approaches such the successful Norwegian approach (Ludvigsen 2005). For most forms of aquaculture, knowledge of how to make aquaculture sustainable is still being created through trial and error experience, scientific research, and as a result of public pressure for environmental responsibility. One of the more controversial forms of aquaculture, shrimp farming, has been subject to all three forces as this heterogeneous industry has been studied and assisted by public sector, private sector, conservation groups and scientific experts to create its *International Principles for Responsible Shrimp Farming* (FAO/NACA/UNEP/WB/WWF 2006). Shrimp farming countries will now need to develop national regulations and monitoring programs to adapt the new international principles to local regulations and operations.

Regulatory regimes and responsible producer practices have long been the main thrust of efforts to achieve sustainability. Just over a decade ago, the fishing industry began to develop a new market-based approach pioneered in the agriculture and forest industries, namely, certification schemes whereby corporations and other producers could assure consumers of the environmental and ethical safety of their products. Consumers are seeking assurances on product source and quality and activists are confronting, collaborating and promoting their causes to the large corporations. Certification is a guide for both producers and consumers. Through the certification systems managed by bodies such as the Marine Stewardship Council, countries with strong fisheries management are gaining market advantage by obtaining certification that their products come from well managed fisheries. Where such management does not exist and where the fisheries are small scale and cannot afford the costs, certification does not obviate the need for good fisheries management (Gardiner & Vishwanathan 2004).

External factors such as climate change and aquatic environmental degradation are also threats to good local fisheries management and sustainability of resources and farms. Nevertheless, resources that are well managed are more likely to withstand the additional external threats and so the biggest protection for a resource is to be well managed.

Overall, continuous and often major improvement is needed in efforts to achieve sustainable fisheries and aquaculture production.

Concentration and corporatization in production units

The scale of the average fish production enterprise is also changing. Although small scale fishers and fish farmers continue to dominate in number, many larger scale units and commercial aggregations of units – vessels and fish farms – are being created. In developing countries, the numbers of larger fishing vessels is growing but this growth in large scale fishing capacity usually does not displace the smaller vessels, whose numbers are also growing. For 1996-1998, FAO estimated that the world capture fisheries fleet consisted of 2.8 million undecked vessels compared to 1.3 million decked vessels. Tensions between small and large scale operations are a growing source of conflict and a sign of ineffective fisheries management.

In countries where they exist, fish quotas and other formal fishing rights tend to concentrate in the hands of larger owners, as has been well documented in New Zealand and Iceland (Newell et al. 2002; Iceland Stock Exchange 2004).

In Asian aquaculture, small scale farmers still dominate production and are likely to do so for the foreseeable future (WorldFish Center 2005). These enterprises remain profitable by seizing good opportunities to increase their technical efficiency (WorldFish Center 2005). By contrast, in the highly industrialised salmon aquaculture industry, ownership is highly concentrated and global. In 2004, the world's 30 largest salmon farms produced 1.1 million of the total 1.3 million tonnes (Intrafish 2005a). In 2006, the largest multinational salmon companies consolidated further. In industries such as tilapia farming in the Americas, large scale operations continue to expand and intensify (Fitzsimons 2005).

All forms of fish production are supported by numerous upstream services. These upstream services are also changing, driven by the fish production changes as well as by government policy changes, new technologies, supply chain innovations and consumer trends.

Government agencies have now removed themselves from most service enterprises except in some developing countries where they are still active in fish hatcheries and port facilities. Corporations, many of which are large powerful multi-national companies, now dominate the services sectors. Fish seed, feeds, nets, veterinary drugs, pond aeration pumps, fish cages and fishing boats are frequently provided by competitive, international companies.

Species choice and domestication of species in aquaculture

The choice of aquaculture species is at the center of how an aquaculture enterprise will develop. By selecting a species or set of species to farm, many other farming options or consequences follow. For the fish farmer, the species choice determines the feasible production systems on the chosen farm site and what feeds will be needed. The sources of fish seed, its costs and reliability of supply also follow from the species choice, as does the probability of immediate or long term access to new improved breeds. Species choice also indicates the risk to the environment, for example, if fish escape. The species also determines the sorts of likely products and their markets, long term prices and whether these will enable a profitable business. If the unit price drops because of high production volumes, farmers must consider whether the species can still be grown profitably.

For the policy maker, dealing with the industry in aggregate, additional policy questions surround the farmers' species choices. Conversely, policy makers and researchers often influence the farmers' choices through the technical advice they provide and their support through research, extension, marketing, trade facilitation and credit services. Industry questions that follow from species choices include the economic and production trade-offs in species choice, e.g., between quick gains from introducing a known exotic species versus delayed benefits from domesticating a native species. Decisions that governments and researchers may need to address at the industry level are how to establish a gene bank of breeds and native types to support culture of the popular species and which companies/agencies and partnerships would be responsible.

Once a species life-cycle can be reliably closed in captivity, domestication becomes feasible (Williams 2004). New improved breeds developed for the culture environment, along with better farm management and better feeds that tend to co-evolve with better breeds, are critical to making aquaculture more efficient and productive As is the case with agriculture, domestication and genetic resource conservation also will provide long-term safety nets to help the farms better survive crises such as outbreaks of fish diseases and climate change.

Aquaculture of many species is still in its early stages. Many currently farmed species still have open life-cycles and so seed must be sourced from the wild or from parents taken from the wild. In China, the biggest and one of the most advanced aquaculture countries, Li (2003) estimated that of 64 commonly farmed aquatic species, 43 have fully and reliably closed life cycles and seed can be produced in any quantity desired. Notwithstanding that many species with open life cycles are farmed, the majority of total aquaculture production in China and elsewhere is from species with closed life cycles. For example, FAO estimates that only 20% of marine culture production comes from species whose seed is captured from the wild (ACFR 2006). Furthermore, the top performing aquaculture operations only use domesticated, improved breeds.

At one end of aquaculture development, progress is being made on closing the life cycle of all species under culture, while at the other end, the proportion of total aquaculture production coming from improved breeds of species with closed life cycles is also increasing. Gjedrem (1997) estimated that, in 1994, less than 1% of aquaculture production came from genetically improved stocks. When Gjedrem updated his estimate in 2004, he found the percentage had grown to over 3.7% for 2001 (Table 1). The actual total percentage is likely to be much higher as he was not able to estimate the percentage of carp production from improved stocks. Professor Li Se Fa (personal communication) estimated that 16% of China's 2004 aquaculture production was from improved stock.

Table 1. Impact of breeding programs on aquaculture production (Gjedrem 2004, quoted in Myrseth 2005)

	Production from improved stock ('000 t)	World production 2001 ('000 t)	% from improved stock
Arctic charr	1.5	1.5	100
Atlantic salmon	994	1,025	97
Rainbow trout	137	510	27
Coho/chinook	39	174	22
Tilapia	121	1,385	9
Shrimp	101	1,270	8
Scallop	20	1,219	2
Oysters	2	4,207	1
Carp	?	16,427	?
Seabass/seabream	3	219	?
Cod	2	1	?
Turbot	?	5	?
Mussel	?	1,371	?
Abalone	?	5	?
Crayfish	?	14	?
Sum	1,416	27,834	5.1
Total production		37,851	3.7

The end result of greater use of domesticated farm species will be more efficient aquaculture production from existing resources such as feed and water. The costs incurred to achieve this will be the up front financial investments and more comprehensive planning, including careful strategies to protect natural genetic diversity of cultured species. Fortunately, much can, and has, been borrowed and adapted from the long history of genetic improvement and genetic resource conservation in terrestrial agriculture. The special benefits and risks of aquatic species breeding and conservation are also being determined as experience grows for fish and other aquatic organisms (Penman 2005).

What drives fish demand?

World growth in demand for fish is being driven by population growth, growing numbers of affluent consumers and the perceptions of fish as a healthy source of protein and micronutrients such as omega-3 fatty acids and Vitamin A. The growth in demand has been modelled by economists. The geography of supply and demand for fish differ somewhat, and thus fish trade is, and will continue to be, a major factor in redistributing fish.

Outlook for fish demand

Three different projections of future world fish demands have been made in recent years to help inform policy makers (Ye 1999; Delgado et al. 2003; Wijkström 2003). Each used quite different methods for making projections and also used different projection horizons.

In the first, Ye (1999) projected fish needs out to 2030. He used statistical relationships for historical and future per capita consumption and Gross Domestic Product (GDP) for 17 groups of countries to project potential demand for fish. He held fish prices constant and used 2 scenarios for his projections, one in which the per capita consumption remained at the 1995 levels and one that incorporated an increase due to GDP growth. In the latter case, between 1995 and 2030, he estimated that 60% of the increase in fish demand would come from economic growth and 40% from population growth.

In the second, Delgado et al. (2003) projected to 2020. They allowed fish prices to be flexible and used fish supply, demand and trade relationships in the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) to project fish demand according to 6 different scenarios. These scenarios were: baseline (or most likely), slower aquaculture expansion, faster aquaculture expansion, lower Chinese production, more efficient use of fish feed and ecological collapse of capture fisheries. The last scenario was specified as a 1% annual decline in capture fisheries production.

In the third, Wijkström (2003) projected to 2010 and 2050. He set fish prices as constant and assumed a small (0.7% per year) growth in capture fisheries production.

Although the different projections used different approaches, their results are reasonably consistent (Figure 4). The most comprehensive of the three is that of Delgado et al. (2003) (Table 2). In the ecological collapse scenario, aquaculture growth is assumed to progress at the same rate as in the baseline scenario but the projections show that this will not be sufficient to compensate for the loss of capture fisheries. The faster aquaculture expansion scenario assumes the same capture fisheries production expansions as the baseline scenario. Therefore, given the rising demands for seafood, we could assume that a positive outlook for future seafood supply requires both the sustainability of capture fisheries and good progress in the expansion of aquaculture.

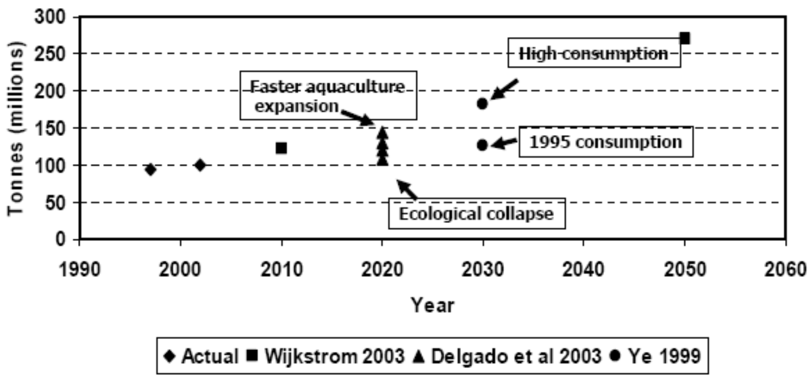

Figure 4. Projections of world food fish demand and production from 3 studies – Delgado et al. (2003), Wijkström (2003) and Ye (1999)

Table 2. Projections of world food fish production in 2020 under 6 different scenarios. Note that the ecological collapse scenario includes the same rate of aquaculture expansion as in the most likely (baseline) scenario. Extracted from Delgado et al. 2003 Table 4.5.

	Actual 1997	Most likely (baseline)	Faster aquaculture expansion	Lower China production	Fishmeal and fish oil efficiency	Slower aquaculture expansion	Ecological collapse
Projected World Production (mil MT)	93.2	130.1	144.5	122.7	130.8	119.1	108.2

For food fish consumption under the baseline projections, and allowing for the redistribution of fish via trade, the baseline scenario projections by major countries and regions show a shift towards greater consumption in the developing countries, except in Africa (Table 3).

Trade patterns

To satisfy fish demands, fish trade is a major global activity. Forty percent of fish is internationally traded (FAO 2004) and therefore fish supply chains are frequently international. Indeed, the supply chains are shaped strongly by their markets. Dual domestic and international systems of distribution and product standards are common. Typically, international fish supply chains are endowed with good information, new technologies and efficient logistics to ensure safe products. International markets may additionally demand that the fish is produced in a manner that is environmentally sustainable and ethical. Domestic chains often lack good information, are less well organized and suffer high transaction costs. However, they too are benefiting from the product quality improvements in international supply chains, e.g. the cross fertilization is described for Vietnam (Ministry of Fisheries and World Bank 2005), Thailand (Suwanrangsi 2002), and from local supply chain changes such as the advent of new retail outlets.

Table 3. Total per capita consumption of food fish, 1973 to 2020. From Delgado et al (2003), extract of Table 4.6. Actual data were calculated from FAO historic data and projections to 2020 are from the baseline scenario of the Fish to 2020 study. Actual data are 3-year averages centered on 1973 and 1997.

Region	Total consumption (kg•capita^{-1}•year^{-1})		
	Actual		Projected
	1973	1997	2020
China	5.5	26.5	36.9
Southeast Asia	17.6	23.0	25.8
India	3.1	4.7	5.8
Other South Asia	6.2	6.0	6.1
Japan	70.2	62.6	60.2
South America	7.0	7.8	8.6
West Asia and North Africa	3.4	6.2	6.4
Sub-Saharan Africa	9.0	6.7	6.6
United States of America	13.5	19.7	19.7
European Union 15	18.2	23.6	23.7
Eastern Europe and former Soviet Union	20.3	10.6	11.6
Other developed countries	11.2	14.7	14.0
Developing world	7.3	14.0	16.2
Developed world	22.6	21.7	21.5
World	11.6	15.7	17.1

By region, fish imports and exports are dominated by Europe, Asia and North America, and South America which has substantial exports but imports little (Figure 5). Total world exports and imports have grown in value since 1976 when trade statistics were first compiled. Fish is an important commodity in agricultural trade. In 2004, world fish exports were equivalent in value to 11% of total agricultural exports (WTO 2005).

Fish trade disputes are also prominent in the work of the World Trade Organization, including current disputes on shrimp, swordfish, salmon, scallops and sardines (http://www.wto.org/english/tratop_e/dispu_e/dispu_subjects_index_e.htm) and in debate on how fish trade should be managed in the global policies under negotiation in the Doha round.

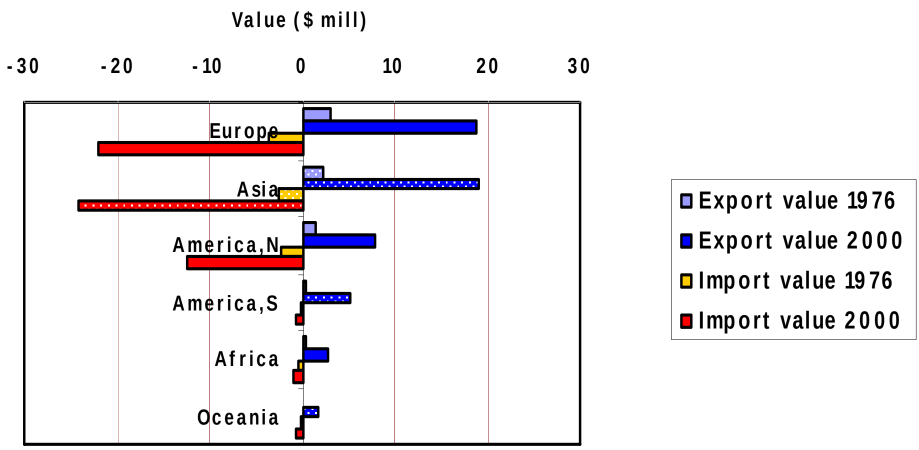

Figure 5. Growth in international fish trade aggregated by continent, 1976 and 2000 (Source: FAO FIGIS 2006).

Meeting consumer preferences and needs

As the target of the fish supply chains, consumers' preferences and needs, including for affordable fish, are of particular interest to those concerned with managing the supply chains.

Delgado et al. (2003) modelled the impact of fish supply and demand on fish prices, and therefore the affordability of fish to different income groups (by quartiles). Whereas demand for livestock is also undergoing a 'revolution' (Delgado et al. 1999), prices of terrestrial animal products are projected to decline by 2-9% out to 2020, in contrast to the large price increases for aquatic products – from 4-18% (Table 4). The lowest income quartile of consumers will only maintain or achieve access to the lower value fish, and hence the production of such fish from aquaculture will be key to affordability by poorer consumers (Delgado et al. 2003; Dey & Ahmed 2005). Fish consumption by higher income consumers in developing countries and consumers in developed countries is driven more by taste preference, convenience, status, health and environmental considerations. Consumption patterns are also influenced by cultural practices, as witnessed, for example, by the great difference in per capita fish consumption between Japan and other developed countries (Table 3).

Consumers' preferences are not fixed but are influenced by lifestyle and, directly and through the media and education programs, by product advertising campaigns, health recommendations – for and against fish, the outreach efforts of environmental and social advocacy organizations and their desires for safe, high quality and even prestigious foods, especially in the festive seasons.

Table 4. Changes projected in prices of fish, other animal protein products and vegetable meals, 1997-2020, baseline scenario. (Adapted from Delgado et al. 2003 Table 4.2).

Products	Projected % price change 1997-2020
Fishmeal	18
Fish oil	18
Crustaceans	16
High value finfish	15
Low value food fish	6
Molluscs	4
Vegetable meals	-1
Poultry meat	-2
Beef	-3
Pig meat	-3
Sheep meat	-3
Eggs	-3
Milk	-8

In some countries, a growing consumer trend is the concern for the welfare of the target animals. In countries such as Norway, research and development is being targeted at the humane mass handling and slaughter of salmon so as to achieve, simultaneously, better quality products and fish welfare (Erikson & Svenniveg 2006). However, some animal welfare researchers and activists advocate a more extreme consumer position. Singer & Mason (2006), in examining the ethics of food choice, concluded that: 'If we add to the environmental issues the ethical obligation to avoid causing unnecessary suffering to beings who are, or may be, capable of feeling pain, it begins to seem better, as well as simpler, not to buy seafood at all, with the exception of sustainably obtained simple molluscs like clams, oysters and mussels.'

How will fish get to the consumer?

Whereas most of the substantial changes occurring and projected in fish production and demand are gradual, changes in other parts of the supply chain are much more dramatic, especially in the processing and retail segments of the chains.

The supply chain: business and retail revolutions

The form and complexity of fish supply chains vary greatly but, notwithstanding their variety, some common trends are emerging due to the global demand for fish and also to the greater incorporation of fish into the retail food sector. Fisheries are experiencing greater corporate investment and a higher level of international ownership of businesses in the supply chain.

Fish processing has been changing rapidly as aquaculture has grown and as trade has shifted towards greater sourcing from developing countries and towards preferences for different forms of fish products, such as more fresh rather than frozen, canned and dried fish and for convenience food packs. To meet the changing market needs, ownership in the corporate fish processing sector is very dynamic and companies, especially in Europe, are variously consolidating, expanding, merging, de-merging and being acquired. For example, in 2006 the top three European fish product companies, Unilever (e.g. Findus brand), the Bolton Group (e.g. Rio Mare tuna brand) and Heinz (e.g. Greenseas brand) all bought and sold fish processing company units and product brands. The degree of concentration is reflected by the statistics that, in 2005, the top 25 European seafood companies accounted for US$ 9.8 b in turnover and the top 10 companies for US$ 5.2 b (Intrafish 2005b).

Driven by requirements in importing countries and on domestic markets, the technology and market changes have destroyed and created jobs for workers in fish processing. As with much factory work in other manufacturing industries, fish processing is moving out of developed countries to developing countries with low labor costs. Women are particularly important in the fish processing industries of all countries, making up more than 50% of workers and sometimes over 90% (Williams et al 2002).

Work for women has been created in many export processing plants in developing countries, but many traditional, close to home processing jobs have disappeared as product shifts into the export chains.

The types of fish processing factories have changed over the last 20 years, as illustrated by information from Thailand, a major fish exporting country (Table 5). The number of modern freezing and canning plants increased but the more traditional processing plants such as those smoking and drying fish decreased in number.

Table 5. Changes in the numbers of different types of fish processing plants, Thailand from 1979 to 1999 (Source: WorldFish Center 2005, Table 3.17).

Type of Processing Plants	1979	1982	1987	1992	1997	1999
Freezing (modern)	na	41	80	120	130	134
Canning (modern)	13	24	41	49	44	42
Traditional (steaming, smoking, dried shrimp)	193	618	340	287	215	187

Fish retailing, including retail food services, is experiencing a revolution that presents strong competition to more traditional sellers of fish such as small and large wet markets. International and national supermarket chains are expanding in all countries, even in some of the poorest, bringing their much greater buying power, their quest for lower prices, and their high product quality standards. Through competition, multi-national supermarkets are influencing local retailers as well as their direct customers. Successful domestic, regional and international chains are adept at reflecting local tastes and styles. They stock domestic as well as imported fish products and thus their practices and policies could have an impact on local fisheries as well as international sources.

Most importantly, however, the large supermarket chains are now retailing a large share of the total fish sold in some countries, e.g. in 2005 in the United Kingdom, supermarkets sold over 85% of all retail fish (quoted in Greenpeace 2005). The concentration of buying power through consolidations among and growth of the biggest supermarket companies is capable of having a major impact on fish supply chains. Many companies are introducing or have recently introduced sustainable sourcing policies, partly in response to public urging by conservation groups (Connelly 2006; Greenpeace 2006). Many of these policies will be phased in over the next 5 years and therefore their effect on fisheries and aquaculture is yet to be felt. Sourcing policies in the more developed markets, such as the United Kingdom and the United States include environmental, animal welfare and other ethical criteria. These criteria, however, will not necessarily be applied immediately by the major retailers in all their country outlets.

The food service sector is also growing rapidly in most countries and having an impact on the way fish is eaten. Fish sold through restaurants and as take-away meals are gaining market share. An early seafood takeaway menu – fried fish and chips – which originated in England in the 1880s (Bairoch 1973), is still popular and spreading in new forms, especially as variations in fast food outlets. American style fast food chains and their local imitators, such as Jollibee in the Philippines and other countries, increasingly serve fish-based menu items. As with supermarkets, fish sourcing policies being introduced by the large multi-national fast food chains, such as McDonald's (McDonald's Corporation 2006), are starting to emphasize responsible product sourcing.

As fish supply chains become more complex, they potentially also produce greater quantities of supply chain waste, including in processing, transport and packaging. With more of the fish being processed, packaged and sold in distant markets, managing supply chain waste is a growing problem. The fish supply chain is both the victim of more general environmental waste problems, e.g., through pollution of the fish in the environment, and the cause of significant amounts of pollution. All parts of the supply chain, from the production and distribution of fishing nets to the packaging, transport and consumption of final product pollute the environment and atmosphere. In developing countries with strong economic growth, more people are rich enough to afford plastic bags and styrofoam boxes but their towns and cities have not yet developed waste disposal systems to handle the discarded packaging.

Fish and other food supply chains are served by a wide array of logistics providers, including for information technology, transport and product storage. Fish supply chains are making more use of the integrated, information technology-based approaches to move product through the supply lines. More markets and companies in fish supply chains are becoming internet driven or make use of internet technology at some stage. For example, PEFA.COM is an internet fish auction system in Europe. Large fish processing and wholesaling companies and the large retailers and food service vendors make extensive use of information technology in their businesses. Small and medium size enterprises in developed and many developing countries also use information technology, especially the Internet, to keep costs low, as Chao et al. (2006) well illustrated with case studies of women entrepreneurs in Taiwan.

Which are the most powerful fisheries countries and how can a country make the most out of its fish sector?

The national importance of fisheries varies greatly across countries. Natural resource endowments and long held preferences for fish have formed the basis of how important a country is in the global fish picture. Deliberate efforts to take advantage of natural endowments and technical capacity have added to the fisheries power and influence of many countries. In the future, national policies and strategies will play crucial roles in maintaining the influence of countries in their own and in world fish supply and demand.

The F6, F10, F14 fisheries countries

In terms of world political and economic influence, the G8 group of countries, earlier the G5 and perhaps soon to be the G9 with the inclusion of China, is familiar in international affairs. If we were to apply a similar concept to name a group of the most influential fish countries, which countries would be in the 'F' group? In 1950, the group would have been small, the F4 – Japan, Norway, USA, USSR (see Table 6), comprised of those countries with production of 1 million tonnes and more. In addition, China, Canada, the United Kingdom and India each produced more than 700,000 tonnes.

Table 6. The most influential fisheries countries in 1950 (F4), 2000 (F10) and projected in 2030 (F14)

1950	2000	2030: The F14?
• Japan • Norway • USA • USSR + • China, Canada, UK, India	• China • Chile • India • Japan • Norway • Peru • Russian F. • Thailand • USA • Vietnam + • Australia, Canada, Iceland, Morocco, Namibia, NZ, UK (fisheries) • Bangladesh, Brazil, Egypt, Indonesia, Iran, Philippines, Turkey, UK (aquaculture)	• Bangladesh • Brazil • China • Chile • India • Indonesia • Japan • Norway • Peru • Philippines • Russian F • Thailand • USA • Vietnam

By 2000, the group would have expanded to the F10, using a rough rule of including countries producing more than 5 million tonnes annually, and/or major importers or exporters of fish, and/or major aquaculture producers. The original F4 would all be members of the F10. If the F10 wanted to hold expanded discussions with countries offering interesting fisheries insights, they might have invited Australia, Canada, Iceland, Morocco, Namibia, New Zealand and the United Kingdom; or, for aquaculture discussions, Bangladesh, Brazil, Egypt, Indonesia, Iran, Philippines, Turkey and the United Kingdom.

By 2030, we could speculate that the group might have expanded to be the F14, selected as countries with large sustained capture fish or aquaculture production, and/or are major fish importers/exporters. Note the addition of Bangladesh, Brazil, Indonesia and Philippines to the F10. The original F4 are all still included, indicating the fundamental strength of these countries in fisheries and aquaculture. The F14 comprises 8 Asian countries.

National fisheries policies

With the broad outlines of the dynamics of future fish supply and demand known, and the trends in supply chains becoming clearer, countries should be looking to new strategic approaches to make the most of their fish sectors. These new approaches which should be encoded in new national policies and strategies, must recognize the whole supply chain and how to turn this into a ‘value chain’, where rights and responsibilities are shared more fairly throughout the chain. With the global nature of fish supply chains, responsibilities go beyond national governments and their fisheries departments and take into account the power and needs of producers, corporations, consumers and special interest groups, many of which may be operating across national border.

As governments withdraw more and more from direct service delivery such as managing landing ports, fish markets and hatcheries, it is fashionable to think that the government role is reducing. This is not true but the role is changing dramatically. The governments’ new role is more strategic, needs to be more focused on the whole supply chain and needs to help create and sustain ‘value added’ chains.

Governments need to develop and implement faster, more complex and knowledge-based policies and regulations. In addition to the fisheries departments, other ministries covering agriculture, quarantine, commerce, trade, foreign affairs, industry development, health, environment, water, energy, science and technology, have an interest in the development of the value added fish supply chains. National fisheries policies will need to integrate different policy domains. Particularly important are integrating fisheries management policy and trade policy to ensure sustainable management of traded resources. For seafood standards, countries can elevate the quality and value of domestic fish products by ensuring that the practices adopted to satisfy international markets are also transferred to the benefit of domestic market chains.

Not only should key national policy matters be integrated, but countries should carefully consider where their fisheries policies would benefit from coordination and integration with those of other countries. Critical areas for attention are managing shared stocks and coordinating efforts to eliminate illegal fishing.

Fisheries policy makers and regulators are frequently in catch-up mode because new challenges in the fish supply chains develop rapidly – witness, for example, the rapid intensification of fish farming and the accompanying environment and disease problems, the spread of pathogens through trade-related movement of animals and plants and the greater energy intensity of the new fish supply chains. Rarely are adequate policies in place before the onset of such problems.

A major government responsibility is still to support public good fisheries and aquaculture research for the sustainable development of the sector. International collaborative research is particularly important because many of the problems to be solved are common across countries and many solutions can be shared for mutual benefit.

In short, national policies and strategies that are well formulated and well implemented are a critical factor for success in the fish sector.

Conclusions

World fish production has undergone a major transition in its technology, locus and its economics. Natural fish stocks are at or beyond their sustainable limits, increasing quantities of fish are now farmed, the developing countries have become dominant fish suppliers, and fish prices are strong relative to those for other foods and will continue to strengthen. Although small scale fishing and fish farming dominates employment in capture fisheries and aquaculture, large enterprises are consolidating control of production in such fields as quota managed fisheries and high technology aquaculture.

As the above overview shows, fish supply chains are undergoing enormous changes due to changes in fisheries and aquaculture production as well as more general technological and market changes. Countries such as the F10 and the potential F14 fish powers have recognized the national advantages to be gained from the sector. Others, even with more modest fish endowments, could reap greater rewards from the sector if they paid greater attention to how to turn their fish supply chains into value added chains. Critical steps to achieve greater value are integrated national policies and strategies, strong and urgent measures to achieve sustainability of fish production, and greater aquaculture efficiency from using improved breeds of carefully chosen farmed species. Therefore, those who will supply world fish demand will increasingly be those who create and sustain the fish value chains.

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