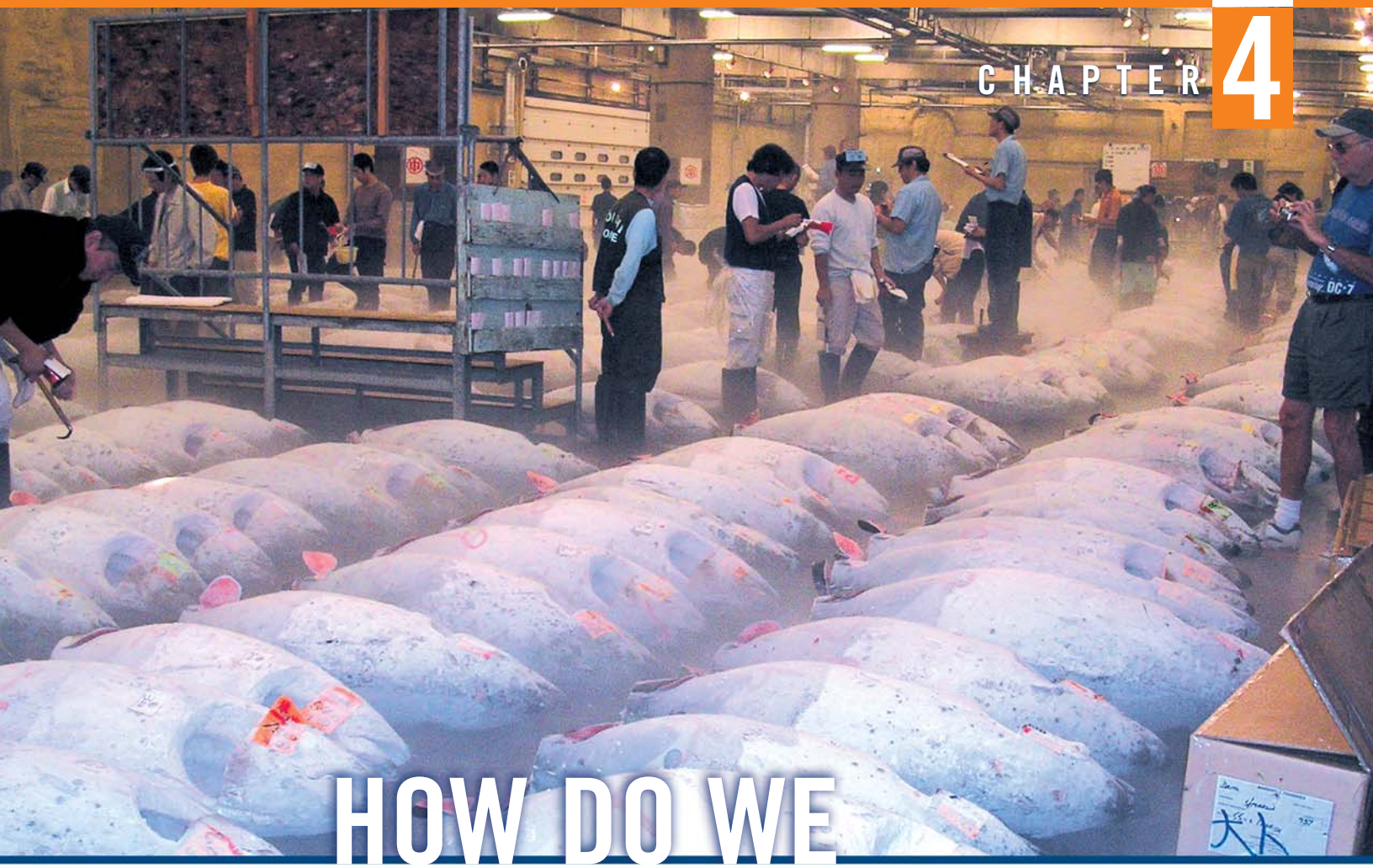
CHAPTER 4



E. HOSHINO, WRI 2003

HOW DO WE CATCH, USE, AND TRADE FISH?

This chapter traces the world's "fish flows" to give readers some insight into the real globalization of fishing as well as some perspective on the geographic impacts of the purchasing choices they make. We address the issues of who produces and consumes fish, which fish consumers prefer, what is done with the fish once it is caught, and how the global fish trade figures into this balance.

To facilitate the reader's understanding of this chapter, the differences between the terms fish production and fish capture are explained. Within the fisheries context *production* refers to marine and inland capture fisheries as well as aquaculture; while *capture or harvest*, refers exclusively to wild caught fish. Top fish producing nations, therefore are those with the highest tonnage of capture and aquaculture fish combined; while the top marine fishing nations are those countries that have the highest tonnage from marine capture fisheries alone. The chapter highlights the change over time in the ranking of fishing nations from both a production and wild harvest perspective.

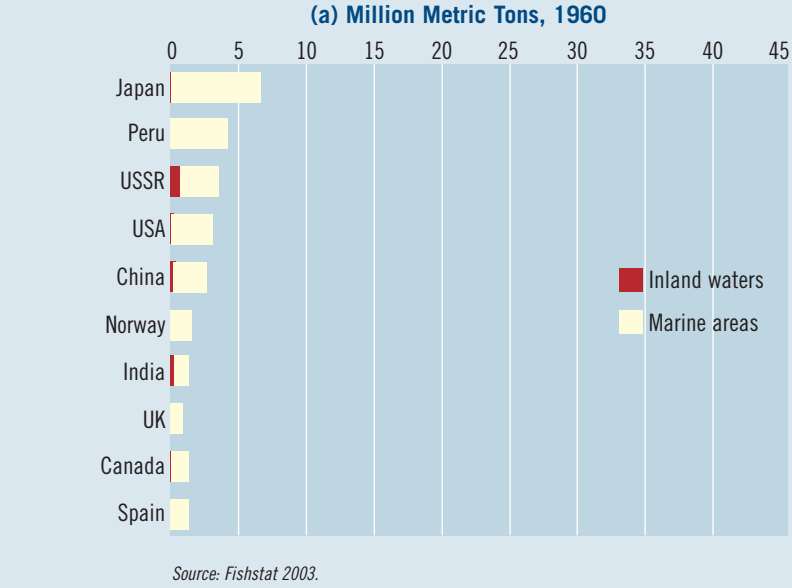
WHO ARE THE TOP FISH PRODUCING NATIONS AND WHAT TYPES OF FISH ARE PRODUCED?

Prior to the 1950s, only a handful of countries had industrial fishing fleets. They operated mostly in the North Atlantic and the North Pacific, and only a few harvested more than 1 million metric tons (MT) of fish per year. Today, more than 20 countries regularly produce 1 million MT or more per year, either through wild harvest of fish or aquaculture (Fishstat 2003).

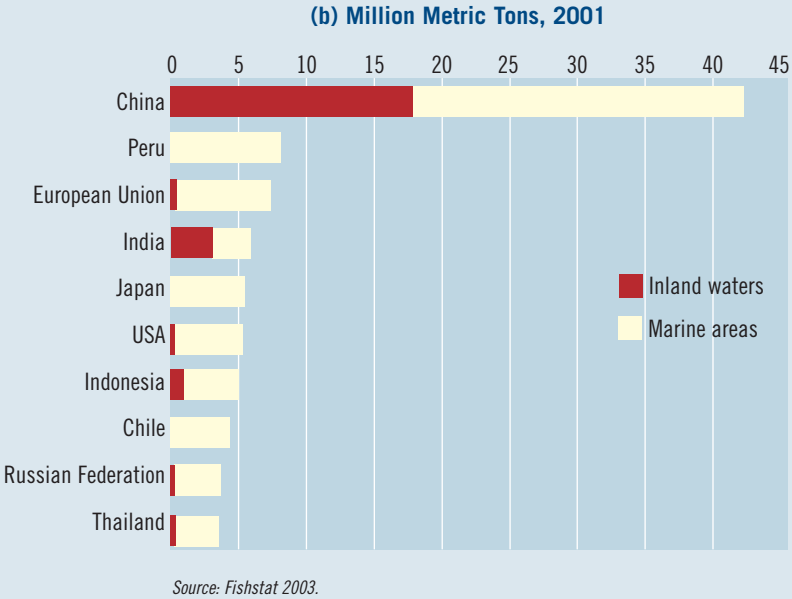
While in 1960 only three developing nations—Peru, China and India—made the list of top ten fish-producing countries (see *Figure 4-1a*), developing nations now account for half of the top producers. This is a measure of the profound shift in fish production that occurred through the 1970s and 1980s: developing nations now produce more than 70 percent of the fish consumed by humans (Delgado et al. 2003). In 2001, the top ten fish-producing nations

were China, Peru, the European Union (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, The Netherlands, Portugal, Spain, Sweden, and UK), India, Japan, United States, Indonesia, Chile, the Russian Federation, and Thailand (see *Figure 4-1b*).

Figure 4-1a and 4-1b: Top Ten Fish Producing Nations (marine and inland, wild capture and aquaculture), 1960 and 2001



Source: Fishstat 2003.



Source: Fishstat 2003.

Changes in national fish production over the years reflect a variety of influences, from changes in international maritime law to national investments in fleet expansion. For example, in 1960 and up until the late 1980s, Japan caught and farmed by far the largest quantity of fish in the world (see *Figure 4-1a* for 1960s production figures). This reflected its strong cultural, dietary, and economic reliance on fish, and a substantial "distant water" fleet that fished well beyond Japanese coastal waters, off other nations' coasts and in the high seas. But by 1990, the Japanese catch started to drop, due in large part to adoption of the United Nations Convention on the Law of the Sea (UNCLOS) (see *Chapter 9* for discussion on UNCLOS and its effect on distant water fleets). This treaty gave coastal nations exclusive rights to exploit the resources in waters within 200 nautical miles[5] of their coast, a zone where Japanese distant water fleets had formerly operated extensively but were now increasingly displaced by local fleets.

As Japan's wild catch declined, other countries filled the gap (see *Figure 4-1b*). The most notable increase in production has occurred in China over the last 15 years. In 1960, China's fisheries production totaled less than 5 million MT; by 2002, that had skyrocketed to some 43 million MT, mostly on the strength of a huge surge in inland aquaculture production. Recent analysis shows that China's fish production data are probably somewhat overestimated, but no one disputes that the country's fisheries expansion far exceeds that of other nations, allowing it to greatly increase both its internal consumption of fish as well as its fish exports (Watson and Pauly 2001; FAO 2002b). Other nations also made quantum leaps to join the top ranks of fish producers. Both Chile and Indonesia, for example, have quadrupled their fish catches since 1970 (Fishstat 2003).

Although all the top fishing nations produce millions of tons of fish, the types of fish that dominate production varies (see *Tables 4-1 and 4-2*). For example, freshwater fish, primarily carp and other pond-raised fish, dominate production in China and India. The Chilean and Peruvian catch, on the other hand, depends mostly on the harvest of anchoveta—a small pelagic fish used to make fishmeal. Because the anchoveta population can swing widely depending on natural conditions, the harvest from these nations varies widely as well. Fish production from Japan, the United States, Norway, and the European Union relies more heavily on demersal species including groundfish from the cod family, but also on a variety of small pelagics (e.g., herring), and migratory and diadromous species such as tunas and salmonids (see *Table 4-1*).

[5] One nautical mile equals 1.85 kilometers or 1.15 miles.

WHAT FISH DO THE TOP FISHING NATIONS HARVEST FROM THE WILD?

The majority—about two thirds—of the world's fish production comes from marine capture fisheries or wild harvest. In 2001, the top marine fishing nations were China, Peru, the European Union, the United States, Japan, Indonesia, Chile, the Russian Federation, India, and Norway—all the same nations, with the exception of Norway, that dominate total fish production (including inland fishing and aquaculture). (See *Table 4-1*).

Whereas production from marine capture fisheries seems to have reached its maximum potential, production from inland capture fisheries and inland aquaculture has dramatically increased in recent years. As mentioned in Chapter 3, this is partly due to extensive enhancement efforts such as stocking and introduction of new fish species in lakes and rivers, and an increase in aquaculture production (see *Chapter 6*).

In terms of inland capture fisheries, China is the modern powerhouse, accounting for about one quarter of the world's inland catch. However, it is important to note the prevalent underreporting of inland catch in many developing and developed countries.

Other countries with significant inland catches are India, Bangladesh, Cambodia, Indonesia, Egypt, Tanzania, Myanmar, Uganda, and Thailand—all developing or transition economies where production has rapidly increased over the last 10-15 years. Table 4-2 presents the top ten countries in terms of inland capture and inland aquaculture. In both cases, "inland" refers to both inland and brackish waters.

WHICH NATIONS CONSUME THE MOST FISH AND WHAT FISH DO THEY EAT?

Once caught, fish are used in a variety of ways. A portion—some 77 percent in 2001—are directly consumed by humans, while most of the remaining 23 percent are processed into fishmeal and fish oil that are primarily used for livestock and aquaculture feed (FAO 2002a). Nearly all the fish used for fishmeal and oil come from small pelagics such as anchoveta and pilchard.

Of the fish consumed directly by humans, 54 percent are marketed as fresh fish and the rest are processed—through freezing, canning, or curing—to preserve them. The percentage of preserved fish has been falling in recent years as the desire for fresh fish has surged. Between 1990 and 2000, the quantity of fresh fish sold rose 85 percent, driven by the popularity of seafood for its health benefits, particularly in developed countries (FAO 2002a).

According to FAO (2003c), the countries that consume the most fish in terms of total quantity are China, Japan, United States, India, Indonesia, the Russian Federation, South Korea, Philippines, Thailand, and the European Union (particularly Spain) (see *Figure 4-2*). But comparing per capita fish consumption tells a different story. Among the countries on the top 10 fish-consuming list, each Japanese eats 2.5 times as much fish as each Chinese does, and three times as much as an American or a Russian does. In fact, if countries are ranked by per capita fish consumption, many of the top fish-consuming countries are small island nations, such as Tokelau, Maldives,

Table 4-1: Top Marine Fishing Nations, 2001

	Country/Region	Marine Capture (metric tons)	Share of Total %	Top Species Caught
1	China	14,379,457	17.2	Miscellaneous marine fishes, molluscs and crustaceans*, large head hairtail, Japanese anchovy
2	Peru	7,950,450	9.5	Anchoveta, Chilean jack and chub mackerel, anchovies, South Pacific hake
3	European Union	6,031,308	7.2	Sandeels, Atlantic herring, Atlantic mackerel, European sprat, blue whiting
4	USA	4,915,128	5.9	Alaska pollock, Gulf and Atlantic manhaden, Pacific cod, pink salmon
5	Japan	4,659,716	5.6	Chub mackerel, Japanese anchovy, Japanese flying squid, Yesso scallop, skipjack tuna
6	Indonesia	3,898,271	4.7	Marine fishes nei*, scads, skipjack tuna, kawakawa, Indian mackerels
7	Chile	3,797,143	4.5	Chilean jack mackerel, anchoveta, chub mackerel, Araucanian herring, Patagonian grenadier
8	Russian Federation	3,422,117	4.1	Alaska pollock, blue whiting, Pacific herring, Atlantic cod, capelin
9	India	2,787,940	3.3	Marine fishes nei*, Indian oil sardine,croakers, drums, giant tiger prawn, hairtails, scabbardfishes
10	Norway	2,686,733	3.2	Atlantic herring, blue whiting, capelin, Atlantic cod, sandeels
	Other	29,153,771	34.8	
	Total	83,682,034	100.0	

* Much of the catch by some countries is not reported at the species level, but grouped in a general class of "marine fish nei.," which stands for "not elsewhere included."

Source: Fishstat 2003.

Kiribati, and the Seychelles, along with other traditional fishing nations in the developed world such as Iceland, the Faeroe Islands, Japan, Norway, Portugal, and Spain (Laureti 1999; Laurenti 2002).

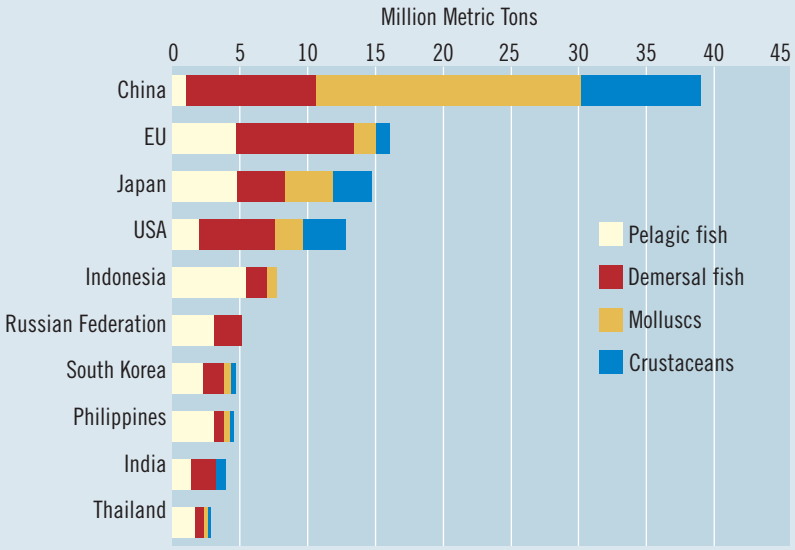
Market studies and household surveys provide a glimpse of the kinds of fish consumed in many countries. In Asia, freshwater fish play a large role in the national diet, comprising over 50 percent of the fish eaten in India and around 40 percent in China (as of 1997) (Laureti 1999). Almost all the fish—freshwater and marine—consumed in China used to be entirely domestically produced, but that may be changing as personal incomes rise. A recent survey in Shanghai indicates an increasing demand for high-value imported seafood, such as salmon, among more affluent households. Overall, the market for imported high-value seafood in China is still "in the initial stages of growth," according to analysts (Zhang 2002).

On the other hand, Japan now imports almost 50 percent of the fish it consumes as food—a figure that increased from less than 20 percent in the early 1980s. A wide variety of fish species are still consumed in Japan, but preferences have changed over the last 40 years. Consumption has shifted from relatively low-value species like scad, mackerel, and squid that were domestically produced to high-value fish including tuna, salmon, shrimp, and crab that are largely imported (JMAFF 1999 and 2002a).

Spain consumes a relatively balanced list of fish species as food. These include white fish such as hake and whiting (18%), pelagics such as sardine and anchovy (14.4%), cephalopods such as octopus and squid (9.1%), flat fish such as flounder (7.5%), shrimp (5.4%), and salmon (3.5%). Farmed mussels are a popular item for domestic consumption and are also the top seafood for export (World Fishing Companies 2002).

For the last 30 years the United States has imported almost 50 percent of the fish it eats. According to the U.S. National Fisheries Institute, the ten most popular seafood species are almost all high-value fish, including shrimp, tuna, salmon, pollock, and catfish.

Figure 4-2: Top Ten Food Fish Consuming Nations and Regions, 2001



Source: FAOSTAT 2003.

Table 4-2: Top Inland Fish Producing Nations, 2001

	Country/ Region	Inland Capture* (MT)	Share (%)	Country/ Region	Inland Aquaculture (MT)	Share (%)	Top Cultured Species
1	China	2,149,932	24.7	China	15,949,588	73.3	Grass, silver, common, and bighead carps
2	India	974,710	11.2	India	2,098,447	9.6	Roho labeo, Catla, Mrigal, grass, and common carp
3	Bangladesh	670,000	7.7	Bangladesh	598,500	2.8	Roho labeo, silver carp, Catla, common carp
4	Cambodia	360,000	4.1	Indonesia	401,029	1.8	Milkfish, common carp, Mozambique and Nile tilapia
5	Indonesia	306,560	3.5	Viet Nam	390,000	1.8	Unspecified freshwater fish and crustaceans
6	Egypt	295,422	3.4	USA	331,957	1.5	Channel catfish, rainbow trout, red swamp crawfish, tilapias, cyprinids
7	Tanzania	283,000	3.3	Thailand	289,631	1.3	Nile tilapia, catfish hybrid, Thai silver barb, snakeskin gourami, giant river prawn
8	Myanmar	235,376	2.7	EU	250,505	1.2	Rainbow trout, common carp, European eel.
9	Uganda	220,726	2.5	Taiwan	184,338	0.8	Tilapias, milkfish, Japanese eel, Asian clam, giant river prawn
10	Thailand	209,977	2.4	Brazil	164,000	0.8	Common carp, tilapias, cachama, characins
	Other	2,987,055	34.4	Other	1,089,558	5.0	
	Total	8,692,758	100.0	Total	21,747,553	100.0	

* Top species caught in inland waters are not included in this table because wild-caught inland fisheries are rarely reported at the species level. They are usually reported as "freshwater fish," "freshwater crustaceans," etc. The European Union catch does not appear in the production statistics that are shown in the first 3 columns of this table because the majority comes from recreational fishing.

Source: Fishstat 2003.

Of all fish consumed, demersal fish account for over 40 percent. Shrimp consumption is also climbing rapidly—increasing by more than 50 percent per person in the last 10 years—making shrimp the most popular seafood in the United States (National Fisheries Institute 2002).

HOW IMPORTANT IS THE INTERNATIONAL FISH TRADE?

More than one third of all the world's fish production now enters international trade—more than three times the percentage of global meat production that is traded (Delgado et al. 2003; FAO Yearbook of Fishery Statistics 2003). For this reason, understanding the trade flow of key fish products is essential to understanding the dynamics of the fishing industry, and ultimately the pressures on fish stocks. Global trade in fish products has expanded considerably in the last two decades, both in terms of quantity and value. Improvements in preservation and refrigeration technology, transport, and communication, as well as a sustained growth in demand, have made this possible.

Japan, the United States, and the European Union are the "Big Three" consumer markets for internationally traded seafood, consuming about 80 percent of all the fishery products traded (Sabatini 2001). The fish most popular in these three markets inevitably account for a large proportion of the total value of the trade.

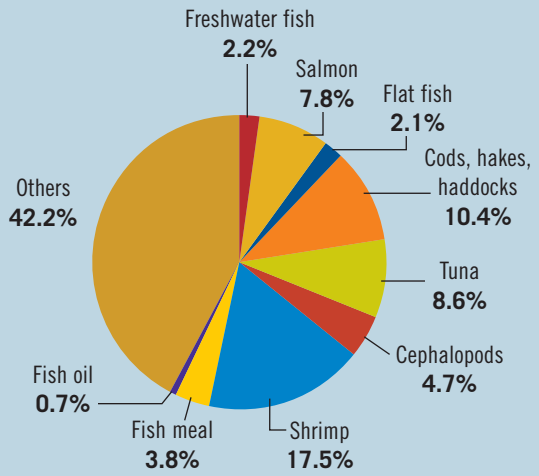
In terms of supply, developing countries as a whole generate around 50 percent of total fish exports, in both value and quantity. Thailand and China are the top exporters of fish by value, exporting respectively US$4.4 and US$3.7 billion worth of fishery products in 2000 (Fishstat 2003). Developing countries also consume about one third of all fish imports in terms of quantity, but these are often lower-priced items, so these imports only account for 17 percent of the total value of the international fish trade (Sabatini 2001). This means that the majority of internationally traded seafood is destined for developed countries and consists largely of high-priced products, such as frozen shrimp and prawns.

An important factor in the growth of the fish trade has been the advances made in freezing technology, allowing exporters to deliver a fresher, tastier product. In the past, due to its highly perishable nature, fish had to be canned, dried, cured, or otherwise preserved before it could be traded. Today, fish and shellfish for human consumption are traded mostly as a frozen food, although canning and curing are still important. Trade of live, fresh, or chilled fish—about 15 percent of fish exports—has also increased as the capacity for air shipment has grown (Sabatini 2001).

Until recently, developing countries primarily exported raw materials for processing in developed countries. Their role in producing value-added products—such as canned fish and frozen fillets—was limited partly because of the high energy requirements; inability to meet quality control and hygiene standards required by developed country markets; and in the view of some, because of protectionism of developed country markets. However, with upgraded facilities now available, developing countries are increasingly exporting semi-processed products, especially to Europe, for further value-added processing there (Sabatini 2001).

The commodities that are traded in largest quantities are fish meal, frozen fish fillets, frozen shrimp, frozen squid, and canned tuna and bonito. In terms of value, however frozen shrimp rank the highest, by far, although they are not traded in as great a quantity as fish meal and fish fillets (Fishstat 2003) (see *Figure 4-3*).

Figure 4-3: Most Traded Species by Value, 2001



Source: Vannuccini 2003.

OVERVIEW OF THE TOP TRADED FISH PRODUCTS

Among the top traded fish products are shrimp, tuna, and fish meal. The top producers and consumers for each are listed below.

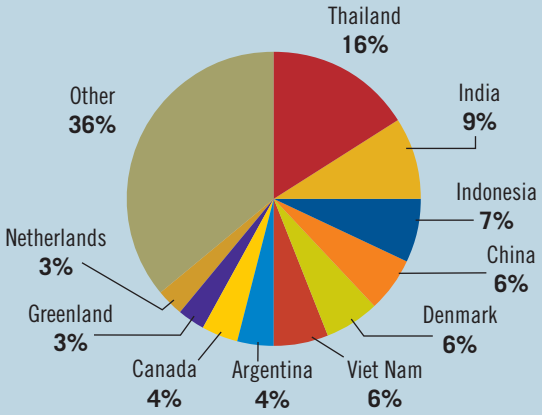
Shrimp. Shrimp are one of the most popular seafood items in developed countries, and an important source of revenue for many developing countries. Although traded in smaller quantity than ground fish or tuna, shrimp bring in over US$12 billion per year in trade revenue—about 20 percent of the total import value of the international seafood trade (Fishstat 2003). In fact, shrimp—whether wild caught or farmed—are mainly produced for export and, on average, 90 percent of the global harvest is exported. The top producers are centered in South

and Southeast Asia, while the top markets for shrimp are Japan, the United States, and Europe (Sabatini 2001) (see *Figures 4-4a and 4-4b*).

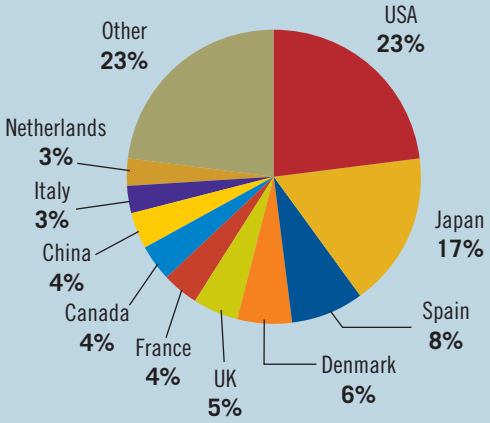
World shrimp production reached 4.2 million MT in 2000, including both wild capture and farmed. China remains the world's largest producer by far, harvesting some 1.2 million MT annually. Other top producers include India, Thailand, and Indonesia, each averaging over 300,000 MT throughout the 1990s. Thailand is the world's leading shrimp exporter, commanding 16 percent of the export market in 2001 (Fishstat 2003) with exports more than tripling over the last 10 years. India and Indonesia are also major exporters, each with around 7-9 percent of the export market (Fishstat 2003).

Figure 4-4a and 4-4b: Top Shrimp Exporters and Importers, 2001

(a) Top 10 Shrimp Exporters by Weight, 2001



(b) Top 10 Shrimp Importers by Weight, 2001



Source: Fishstat 2003.

The United States is the largest import market, importing over 80 percent of the shrimp it consumes. That means U.S. shrimp imports make up nearly one quarter of the world's shrimp trade. The second largest market is Japan, with a 17 percent share. Spain and Denmark follow, with much smaller shares. The European Union as a whole, however, accounts for roughly one third of the shrimp import market (Sabatini 2001; Fishstat 2003).

Tuna. Tuna, another widely consumed seafood, is a cornerstone of the global fish trade. The world tuna market can be divided into two distinct types: the high-priced "sashimi" market, which is consumed fresh and uncooked; and the low-priced canned tuna market. The sashimi market relies on bluefin, bigeye, and yellow fin tuna, while the canned tuna market uses mostly skipjack, albacore, and bonito.

Global capture of tuna was about 3.6 million MT in 2000 (Globefish 2002a). Japan remained the world's top producer in 2000, harvesting 630,000 MT—a slight decline from its peak in the late 1980s. Eighty percent of the tuna imported by Japan is used for sashimi (OPRT 2002) and it consists mainly of fresh or frozen bigeye, yellow fin, and bluefin tuna flown in from Indonesia, one of Japan's major suppliers. The Japanese also import a large quantity of frozen skipjack tuna that is processed primarily into canned and dried products (Heibonsha 2000). In contrast, Taiwan and Indonesia, who are also top producers, more than doubled their production during the 1990s (Globefish 2002a) (see *Figures 4-5a and 4-5b*).

During the 1980s and 1990s, Thailand grew into a leading producer of canned tuna, second only to the United States. But Thailand does not always catch all the tuna that it cans. Much of its canned production originates as imported, frozen skipjack tuna, which it then cans and re-exports, primarily to the United States (see *Figure 4-5a*). The United States and the European Union are the largest markets for canned tuna. In fact, the United States accounts for about one third of the world's canned tuna consumption, although this figure has dropped in recent years (FAO 2000a).

Fish Meal. Fish meal and fish oil are increasingly valued trade commodities, largely because of their importance to the ever-expanding aquaculture industry. The source of these protein and fat-rich commodities is generally the small pelagic species that are oily and bony, and therefore less desirable for human consumption—species such as herring, sardine, mackerel, anchovy, pilchard, sand eel, and menhaden. Low-value bycatch species and waste from fish processing plants are also important source materials. Fishmeal and oil are used mainly as feeds for poultry, pigs, and in aquaculture operations for carnivorous species, such as salmon and shrimp.

Around 29.4 million MT of fish—nearly one third of the world's total capture fisheries production—were reduced to fish meal and fish oil in 2001 (FAO 2002a). This yielded some 6.5 million MT of fish meal after processing. Peru ranks as the world's top fishmeal processor, producing more than 1.5 million MT in 2001. Chile and China followed, each producing close to 800,000 MT (Fishstat 2003).

Peru is also the top exporter of fish meal, commanding almost half of the global export market in 2001 (Fishstat 2003). Chile, Denmark, and Iceland are also major exporters. Peruvian fish meal exports are directed mainly to China for animal feed production and to other countries for aquaculture. More than one third of the world's fish meal exports now end up in the Far East (Globefish 2001).

WHAT ARE THE MORE RECENT ADDITIONS TO THE FISH TRADE?

As traditionally marketed fish dwindle due to overfishing, several non-traditional species have been introduced into world trade to accommodate rising demand for fresh or frozen fillets. Typically, these fish are targeted at high-end markets in developed countries.

Some of these are fast-growing exotic species introduced to freshwater environments. Others are deep-sea fish that, until recent technical advances, were not economically viable to harvest. Unfortunately, commercial exploitation is often accompanied by significant environmental impacts, including displacement of native species by exotic species, and rapid depletion of vulnerable fish stocks.

Nile Perch: The Nile perch is a large freshwater fish found in the rivers and lakes of Africa. It is also known as Lake Victoria perch, *capitaine, mputa,* or *sangara*. The introduction of this species to Lake Victoria in the 1950s is a good illustration of a trade-off between economic gain and biodiversity loss. The perch soon established itself in Lake Victoria, the world's largest tropical lake, and a commercial fishery developed. Production of Nile perch increased dramatically in the 1980s, giving rise to a robust export market for the delectable white-fleshed fish.

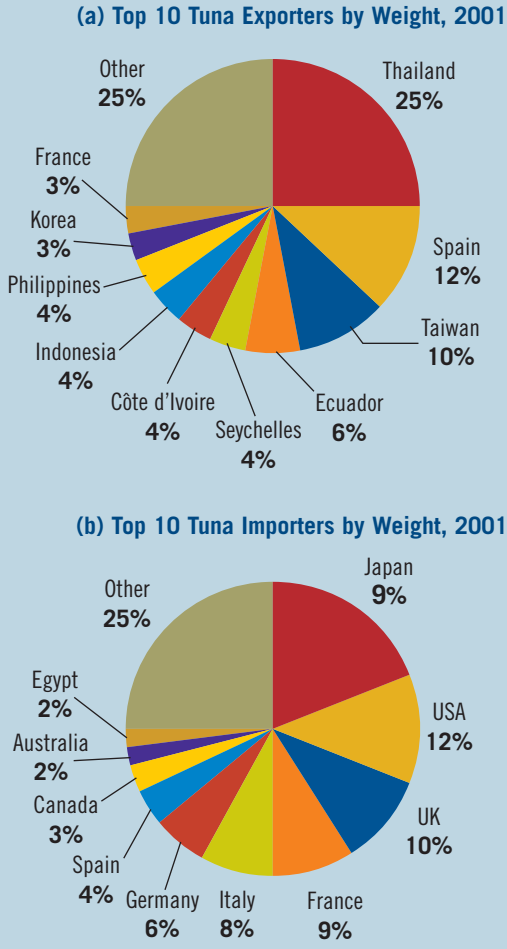
The Nile perch fishery in Lake Victoria produced an average of 320,000 MT in the 1990s (Fishstat 2003), generating between US$280 and US$400 million in export earnings (Kaufman, pers. comm. 2000). Kenya, Tanzania, and Uganda account for over 90 percent of total production. Their success in tapping export markets is a result of efforts to develop domestic processing capacity so that the exported fillets meet the quality standards of markets in Europe, Israel, Australia, the United States, and Japan. Europe has become a particularly good market for perch. The export of fresh or frozen fillets to Europe expanded rapidly to average around 18,000 MT in 1994-1996. Nile perch prices compare favorably with other white fish such as cod and haddock, which have become scarcer and more expensive (Megapesca 1997).

As production of Nile perch rose, it became apparent that some of the victims of the exotic perch's success were the native fish species known as cichlids, which the carnivorous perch preyed on. More than 350 species of cichlids were endemic to Lake Victoria and had been one of the mainstays of the traditional subsistence and commercial fishery. After the introduction of the perch and another exotic species, the Nile tilapia, more that half of the cichlid species have gone extinct or are found in very small populations (Witte et al. 1992). Furthermore, the impacts of the "success" of the Nile perch fishery can be seen in the deforested landscapes surrounding Lake Victoria. Unlike the cichlid fish, which can be air-dried to preserve their flesh, the oily Nile perch requires firewood, which has led to increased deforestation in areas surrounding the lake, and, in turn, has created more siltation and eutrophication of the lake's waters furthering the ecosystem's imbalance (Kaufman 1992).

Unfortunately, local communities and fishers who had depended on the native fish for decades did not benefit from the Nile perch fishery either. Nile perch fishing requires more advanced gear that local fishermen cannot afford. In addition, because most of the perch's catch is destined to the export market, the availability of fish for local consumption has actually declined; in fact local communities now show signs of protein malnutrition (Kaufman pers. comm. 2000).

In addition to the ecological destruction and the impact on local communities caused by this introduced species, the economic sustainability of the Nile perch fishery is now in question. According to the Lake Victoria Environmental Management Project—an intergovernmental initiative by Kenya, Tanzania, and Uganda—stocks of Nile perch have declined over 30 percent between 1999 and 2001, and fishers are increasingly catching immature fish (LVEMP 2001). The average weight of a commercially caught fish has dropped from over 50 kg in 1980 to less than 10 kg in 1996. Fisheries scientists believe that the Nile perch fishery is now being sustained by cannibalism

Figure 4-5a and 4-5b: Top Tuna Exporters and Importers, 2001



* Thailand has a large tuna cannery that contributes to its large percentage of exports. Unlike other countries in the top exporter list, which catch their share of tuna, Thailand imports much of its tuna for processing and re-export.

Source: Fishstat 2003.

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Tsukiji fish market in Tokyo, Japan.

of young perch by larger individuals, due to the decline in native cichlids—the perch's original prey (Megapesca 1997). In order to combat the decline in perch catches, regulations such as seasonal fishing bans, gear specifications, and minimum size limits for fish are now beginning to be adopted (AllAfrica Global Media 2002).

Tilapia: Tilapias, consisting of several species of fast-growing, white-fleshed fish, are one of the world's major groups of farm-raised freshwater species. Tilapia readily adapt to new environments and have high rates of reproduction. Until a few years ago, most tilapia were grown and consumed locally in Africa and Asia. In recent years, improved tilapia strains and better aquaculture techniques have made large-scale production of tilapia possible and fueled an international trade in the fish. The price of tilapia makes it very competitive as a substitute for ocean fish that are in short supply, and some experts predict that the biggest growth in tilapia production is still to come (Sabatini 2001).

China is the world's top producer of tilapia, followed by Egypt, and Thailand. These three producers have rapidly ramped up their production over the last decade: China's harvest has increased sixfold, Egypt's eightfold, and Thailand's has tripled (Fishstat 2003). The environmental implications of such rapid expansion and intensification of tilapia farming have become a cause for concern (see *Chapter 6* for a discussion of the environmental impacts of aquaculture). First, over-application of feeding mixtures often acts as a source of water pollution. Second, non-native tilapias that are intentionally introduced, or that escape from culture facilities into the wild, tend to re-establish and quickly proliferate in the adopted environment, preying on and outcompeting native fish species. These impacts can significantly alter the ecosystem structure (McKaye et al. 1995) and put native species at risk of extinction.

The United States is the single major market of fresh and frozen tilapia fillets, with China and Taiwan supplying three quarters of this amount, and smaller quantities coming from Ecuador, Costa Rica, and Indonesia (NMFS 2003). European countries are emerging as new markets for tilapia, although European imports are small in comparison to United States imports.

Orange Roughy: The orange roughy fishery provides a textbook example of the "boom and bust" pattern of overfishing. Orange roughy is a deepwater marine species of the southern oceans that is particularly vulnerable to overfishing due to its biology. It typically lives for 100 years, does not sexually mature until it is 25 years old, and probably doesn't spawn every year even when mature (Lack et al. 2003). With such a low reproductive rate, scientists believe that, to be sustainable, annual harvest levels for orange roughy should be low—probably not exceeding 1-2 percent of the stock's biomass (Lack et al. 2003). Unfortunately, catches are currently far above this level.

Commercial fishing for the species began in the early 1980s, when New Zealand and the former Soviet Union targeted stocks in the Southwest Pacific. Exploitation rapidly expanded to the East Indian Ocean when Australia became a major producer at the end of the 1980s, and to the Southeast Atlantic when Namibia joined the top producers in 1995. Orange roughy has become a popular export, with nearly half the catch going to the United States in 2001.

The exact status of orange roughy stocks is difficult to determine due to a lack of accurate assessments for most stocks. However, available data and a

continuing drop in orange roughy landings make it clear that the species is being overfished. One recent analysis found that nearly half of 30 orange roughy stocks assessed had been fished below 30 percent of the original biomass of the stock. In other words, less than one third of the original stock remained (Lack et al. 2003). Total global production of orange roughy peaked at 91,500 MT in 1990 but has sharply declined since, falling to some 25,000 MT in 2001, in part because New Zealand has set catch quotas. Namibia's catch reached 18,000 MT in 1997 and dropped by over 90 percent to 1,600 MT in 2000. Catches of newly discovered stocks often decline within a few years of their discovery, in some cases resulting in the closing of the fishing grounds (Smith 2001).

Patagonian Toothfish (Chilean Sea Bass): The Patagonian toothfish has gained the attention of a number of conservation groups in recent years because of its vulnerability to stock depletion and the prevalence of illegal fishing, which has greatly aggravated the overfishing problem. Patagonian toothfish is a deepwater species that has become popular since the 1980s as a restaurant-quality white fish. It is subject to the same biological vulnerabilities as orange roughy: it is relatively slow-growing, slow maturing, and has a low reproductive rate. The responsibility for the conservation and management of Patagonian toothfish in international Antarctic waters falls to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), an international organization created by the Antarctic treaty. CCAMLR, however, depends on member organizations to enforce its regulations and combat illegal fishing—an effort that is proving much harder than anyone imagined.

The overfishing and illegal fishing problem is partly masked by the fact that the fish is marketed under different names in order to make it sound more attractive to consumers: as Chilean seabass in the United States and Canada, as Chilean or Antarctic sea bream in the United Kingdom, as *merluza negra or bacalao de profundidad* (deep-sea cod) in Spain, and as *Magellan ainame, ginmutsu,* or *mero* in Japan. An added problem is that the countries where the fish is caught, landed, and consumed all differ. Toothfish is commonly exported from the country where it is landed to an intermediate country for processing into different derived products (e.g., fillets), and then re-exported to its final consumer market (Willock 2002). For example, while China is the major importer and processor of toothfish, it is almost all re-exported and consumed in the United States, Japan, and the European Union (Willock 2002).

Large-scale production of Patagonian toothfish rapidly increased in the early1990s to replace overfished stocks from the northern hemisphere, as well as collapsed stocks of Austral hake and golden kingclip (Lack and Sant 2001). Chile, Ukraine, and Russia were the top toothfish producers in the 1980s, but Argentina and France have replaced the latter two since 1994 as exploitation spread from the stocks in the southeast Pacific and southern Atlantic to the Indian Ocean. Total production peaked in 1995 with over 40,000 metric tons (Fishstat 2003). Since then the catch has declined slightly (Fishstat 2003), but it is still seen as a very profitable fishery, especially because of its high market value—informally referred to by fishermen as "white gold" (Lack and Sant 2001). Patagonian toothfish is heavily traded internationally, with a global import value exceeding US$200 million in 2000 (Fishstat 2003). By far the largest markets for toothfish are Japan and the United States, but Canada and the European Union are also significant consumers.

The high demand and profitability of this fishery has also encouraged a robust illegal fishing enterprise. In 1999, CCAMLR estimated that "in most areas 30 to 100 percent of the toothfish [catch] is taken by illegal and unregulated longliners." (ENS 2002). In 1997 alone, the total illegal catch of Patagonian toothfish was valued at over US$500 million— around 100,000 metric tons of fish (ENS 2002). Currently the estimated illegal catch accounts for half of the toothfish traded internationally (Lack and Sant 2001).

The level of illegal fishing is putting this fishery at serious risk. Some stocks have reportedly declined to 25 and 30 percent of their original levels (Lack and Sant 2001) and according to the Australian government, "if illegal and unregulated fishing continues at the current level the population of Patagonian toothfish will be so severely decimated that within the next two to three years the species will be commercially extinct. Some areas are already showing signs of this." (ENS 2002).

The member countries of CCAMLR, especially Chile and Argentina, have made significant strides in reducing the illegal fishing activity of their nationally-flagged vessels, and Australia and France have signed a maritime cooperation agreement to strengthen actions against illegal fishing in the Southern Ocean (ENS 2003). CCAMLR members have also established a document system to track catches and monitor trade. For example, the United States no longer allows Chilean sea bass imports without proper

documentation and a valid dealer permit issued by its National Oceanic and Atmospheric Administration (NOAA). However illegal fishing by non-CCAMLR member countries continues (Lack and Sant 2001) (see *Chapter 7* for further discussion on illegal, unregulated and unreported [IUU] fishing). Because of the prevalence of illegal fishing and the vulnerability of the toothfish stocks, some groups suggest that the species be included under the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)—a treaty designed to prevent trade from contributing to global biodiversity loss and species extinction (Willock 2002).

The Growing Trade in Shark Fins

While certainly not a recent addition to the fish trade, the rapid increase in trade of shark fins is noteworthy because of its contribution to the threatened status of many shark species. Sharks are long-lived, slow-maturing species with relatively low reproductive rates, making them more vulnerable to excessive fishing pressure. Shark fin is a traditional delicacy among Chinese communities the world over. Consumption dates back thousands of years as a key ingredient in shark fin soup, a dish associated with high social status. Shark fins are also one of the most expensive seafood products in the world—a powerful incentive for their harvest and trade.

After the shark fins are cut off and retained for sale, the rest of the animal is usually thrown overboard to die.

In the last 15 years trade in shark fins has risen dramatically because of the increased affluence associated with economic growth in China, as well as the reduction in Chinese tariffs on the import of shark fins (Vannuncini 1999). Statistics submitted to FAO show that trade has doubled from approximately 3,000 MT in 1985 to more than 7,000 MT in 1997. But this figure is certainly an underestimate, given the high level of underreporting in shark fin trade (Vannuncini 1999). For instance, research comparing FAO statistics with customs trade data from Hong Kong—the world's center for shark fin trade—shows that the FAO figures are at least two orders of magnitude lower than those reported in Hong Kong (Clarke 2002). If one adds the customs data for internationally traded shark fins from China, Hong Kong, Singapore, and Taiwan, the major centers of trade, for the year 2000, the total amount is higher than 11,500 MT—and this is still considered an underestimate (Clarke 2002). This same research also shows that shark fin imports into Hong Kong are growing exponentially at a rate of 5.3 percent per year (Clarke 2002).

One explanation for the high level of underreporting is that many sharks are caught as bycatch in regular fishing operations (Bonfil 1994; Vannuncini 1999) (see *Chapter 7* for further discussion on bycatch). Since the commercial value of shark meat is very low, there is an incentive to cut off the fins, retaining them for sale, and throwing the dying shark back into the sea—a practice known as shark finning. The Hawaii long-line fishery that traditionally targets tuna and swordfish is an example of the recent increase in this practice. Records show that finning in this particular fishery has increased from less than 2 percent in 1991 to 65 percent in 1999 (NOAA 2001). Shark finning is not only inhumane, but also wasteful since practically the entire animal is thrown overboard and not utilized. The proliferation of this practice, its wastefulness, and the pressure on shark populations has led some countries, such as Australia, Brazil, Canada, and the United States to adopt legislation that bans finning or at least the landing of shark fins without carcasses (WildAid 2001). However, the growing purchasing power in China will most certainly continue to fuel demand for this commodity (Clarke 2002).

The major suppliers of shark fin to Hong Kong between 1998 and 2000 include Spain, Indonesia, the United Arab Emirates (UAE), and Taiwan. The UAE and Singapore do not domestically harvest shark fins but are believed to serve as transshipment points for shark fins from Africa, India, and Sri Lanka (Clarke 2002). The majority of shark fins imported to Hong Kong are exported to mainland China for further processing at lower labor costs, and re-exported back to Hong Kong for sale (Clarke 2002).

Direct and indirect (i.e., bycatch) fishing pressure for shark fins, meat, and other shark-derived products (e.g., liver oil, cartilage extracts), have placed 22 shark species on IUCN's *Red List of Threatened Species* as of 2002 (see *Table 3-2 in Chapter 3* for partial listing of threatened species). In addition, the basking shark and the whale shark were listed under Appendix II of the CITES in 2002. This listing requires trade permits and monitoring of these species to avoid their endangerment through international trade (Clarke 2002).