CHAPTER 2

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THE COMPLEX WORLD OF FISHING

The world of fisheries is complex. The terms *fishing* and *fisheries* are used to describe a diverse group of activities from catching fish, to processing fish products and managing fish stocks. These and other common terms are often used interchangeably by different sectors of the industry, leading to public confusion about what fishing is, the relative importance of the different kinds of fishing, and how they affect fish stocks and ecosystems.

Here we provide a brief overview of the different aspects of fishing as background for the chapters that follow. We look at the major fishing sectors; the environments in which fishing takes place; the kinds of fish that are generally caught; and the kinds of fishing gear that are widely used. The category descriptions outlined below are not strict technical definitions; instead these definitions are an attempt to help the readers differentiate amongst broad types of fishing activities that are not always distinct or mutually exclusive. With this information, readers can begin to better understand the dimensions of modern fishing, and to interpret news of the global fishing crisis and questions of fishing policy in more real terms.

FISHING SECTORS

In looking at the world's fish production, a basic distinction must be made between *capture* fisheries and *aquaculture*. The term *production*, which is used frequently throughout this report, refers to the output of both capture fisheries and aquaculture. *Capture* fisheries is the activity that most people think of as true fishing: using traps, lines, nets, or other gear to harvest wild fish, shellfish, and a variety of other aquatic animals. *Aquaculture* is the use of tanks, ponds, pens, or other structures or enclosures to raise fish and shellfish in captivity. Although these seem like very different activities, they often target the same species and aim for the same consumer markets, and are therefore indistinguishable to most consumers. However, the issues regarding management, condition, and policies surrounding these two sectors are quite different. As consumers, the public

Haitian fishermen deploy an illegal fish trap.

has an impact with purchasing choices that favor wild-caught, farmed fish, or both; therefore, understanding the differences and policy implications of these two activities is essential.

Increasingly, the distinction between these two sectors, capture and aquaculture, is becoming more blurred and confusing. Some capture fisheries for instance, are now culture-based, meaning the fish are raised in pens but then released into the wild for later capture by fishers—counting as capture fisheries in the statistics. On the other hand, some aquaculture operations are capture-based, meaning that juvenile fish are captured at sea, and then transferred to pens for fattening and sale as aquaculture products.

In this report, much of the discussion concerns capture fisheries, since this is the activity that employs most fishers and presents the most pressing challenges in terms of sustainable management. But, as discussed above, aquaculture increasingly intersects and influences capture fisheries: ocean-caught fish are used in fishfeed formulations in shrimp and salmon aquaculture, while in the new sea ranching techniques wild-caught juvenile fish (mostly tunas) are fattened up with formulated feed in open sea pens. (See *Chapter 6* for a full discussion of aquaculture and its implications.)

CAPTURE FISHERY CATEGORIES

Fisheries fall into a few major categories depending on the size and sophistication of the fishing vessel used, its crew size, how close it operates to the shore, and what it does with its catch. Each category has its own implications for fishery resources, ecosystems, management, and policies. This report uses the terms described below. In practice, however, definitions vary among countries and there are always some exceptions, particularly regarding small-scale and artisanal fishing. For example, in Taiwan, only fishers using unpowered boats are considered "small-scale," while in a developed country such as the United States, use of a 20-meter trawler might be considered artisanal if it is individually owned and used to fish near-shore waters. This variation in definitions makes it hard to standardize data, make regional or national comparisons, and analyze trends in fishing capacity and employment in the fishing industry.

Industrial Fishery. This is a general term for the kind of mechanized, high-volume fishing we associate with modern commercial fishing fleets, financed and operated by a large commercial enterprise. It is typified by large fishing vessels with high technological input (i.e., sonar technology, satellite navigation systems, and highly mechanized gear such as trawls). These boats frequently employ a large crew and are capable of fishing far from the coast, often in the high seas and for extended periods of time. This term is often used interchangeably with *large-scale* or *commercial fishery*, especially in the popular media, and sometimes used specifically to refer to fisheries that target small pelagic fish for fishmeal production.

Artisanal Fishery. This term is the opposite of industrial fishery, and is often used interchangeably with *small-scale* in the non-technical literature. The FAO defines an artisanal fishery as a traditional fishery involving fishing households, as opposed to commercial companies. Artisanal fishing typically takes place using small vessels that make short trips close to shore, with the catch used mainly for local consumption (FAO Fisheries Glossary 2003). Artisanal fishers usually rely on inexpensive (paying very low or no wages), but labor-intensive fishing methods. Most have low and irregular incomes, and many make use of sharing or barter systems rather than fixed wages (Tietze et al. 2000).

Small-Scale Fishery. The term "small-scale" applies to a broad range of smaller fishing vessels with less sophisticated fishing technology. A small-scale fishery is characterized by small-capacity fishing craft with non-mechanized propulsion or low-horsepower engines and the absence of fish-finding and navigation devices. Small-scale fishers often use traditional fishing gear, operated by hand (rather than diesel winch), and tend to fish closer to the shore. The International Labour Organization defines small-scale fishers as "people of both genders who usually operate their own fishing craft and equipment, and go to sea themselves, either alone or with a few crew members (preferably their own relatives)" (Ben-Yami 2000). Nonetheless, in many places small-scale fisheries are populated by small boat owners employing hired hands as crew. In other cases, small-scale fishers may rent boats and gear from local boat owners. (See *Chapter 5* for further discussion on small-scale fisheries).

Commercial Fishery. A commercial fishery is any fishery that sells its catch in the marketplace, either for export or for local consumption. With the exception of subsistence fishers, all modern fisheries are commercial, including most small-scale or artisanal fisheries. However, the term commercial fishery is most often applied to larger-scale operations, marked by at least modest technology and crew size, and capable of venturing into the open seas.

Subsistence Fishery. A subsistence fishery is one where the fish caught are shared and consumed directly by the families of the fishers rather than being bought by middlemen and sold at market. Very few fisheries are truly "subsistence fisheries" because the products are often used for barter. Subsistence fishing is usually a very small-scale activity, undertaken with low-technology—and often traditional—boats and gear (FAO Fisheries Glossary 2003).

Recreational or Sport Fishing. This term refers to fishing or shellfish collection done primarily for pleasure. Recreational fishing takes place in both freshwater and marine environments, encompassing everything from flyfishing or surf fishing with a hook and line, to motorized trolling, skindiving, and clam digging. Recreational fishing is more significant in size and economic impact than most people realize. In many countries, such as the Australia, Canada, Chile, Europe, New Zealand, the United States, and many small island states, it provides an important source of income through the sale of fishing gear, guide services, lodging, and other tourist services. For example, freshwater sport fishers in the United States numbered approximately 30 million in the mid-1990s, generating some $24.5 billion in sales of equipment and services (Revenga et al. 2000). An additional 15-17 million sport anglers fished the U.S. coastal waters (as of 2001), harvesting nearly 190 million marine fish (approximately 120,000 metric tons) (NMFS 2001a).

FISHING ENVIRONMENTS

Fishing activities take place in several distinct environments, which are populated by different fish and shellfish species, and call for different fishing gears and fishing techniques. Although the general public is, for the most part, unaware of this, where the fish they consume comes from is of key importance from an ecosystem and policy perspective, given that different gears and policies impact certain fisheries and environments more than others. The most obvious distinction is between *marine capture fisheries* and *freshwater or inland capture fisheries*. Both are critical to global food security and livelihoods. Marine fishing accounts for some 90 percent of global fish catch, while the freshwater harvest contributes to almost 10 percent of the total catch (FAO 2002a).

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MARINE FISHING ENVIRONMENTS

Marine fishing environments can be categorized by distance from the shore, water depth, and other physiographic characteristics. The following are the major categories that often differentiate the pattern of marine fishery exploitation.

Coastal Waters. Coastal waters extend to the outer edge of the continental shelf, or to a depth of 200 meters. This is the zone where most fishing occurs, and it typically lies within the Exclusive Economic Zone (EEZ) of a given nation—the 200 nautical miles zone within which international law recognizes a nation's right to manage and exploit the marine resources. Fish harvested in coastal waters

typically fall into a few groups: groundfish, such as flounder, redfish, cod, and pollock; molluscs, such as octopus, scallops, clams, and mussels; crustaceans such as shrimps, crabs, and lobsters; and also small pelagic species such as mackerel and herring.

Within coastal waters, we can distinguish between different resource systems:

- ***Near-shore waters***, including estuaries and lagoons. Subsistence, artisanal, and small-scale fishing generally takes place in near-shore waters, often in waters at a depth of 10 meters or less. A variety of habitat types occur in these waters, including coral reefs and seagrasses. Coral reefs thrive in tropical waters, populated by a wide array of specialized species, and are often subject to intensive small-scale fishing.
- ***Soft-bottom shelves***. These are the relatively shallow (10-200 m) productive areas of the continental shelf that sustain most marine fisheries. In the shallower, near-shore areas (10-50 m in depth) strong conflicts can arise between small-scale fishers and large-scale fishing operations.
- ***Upwelling shelves***. These continental shelf regions are marked by an influx—or upwelling—of cold, nutrient-laden water from the ocean depths that fertilizes the sea, allowing it to support large populations of certain fish species such as anchovies, sardines, bonitos, and mackerels. These in turn support substantial populations of sea birds and mammals.

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Dugout canoe used for fishing and transport in Congo.

Open Oceans. The open ocean refers to the waters above the sea bottom that extends beyond the edge of the continental shelf or is deeper than 200 meters. These waters often extend beyond national EEZs into the high seas, and are thus subject to fishing by the commercial fleets of many nations, increasingly regulated by international treaties or regional fishing organizations. Fish caught in the open oceans frequently spend part of their life cycles in coastal waters, and are therefore affected by coastal conditions, land-based activities, and pollution. Typical species fished in open oceans include blue whiting, cod, deep sea crabs, merluccid hakes, orange roughy, sablefish, sauries, shark, squid, swordfish, toothfish, and tuna.

Within open ocean waters, two distinct resource systems can be distinguished:

- ***High Seas*** is a legal term used to describe the areas of water outside of a country's EEZ.
- ***Deep Seas*** is the water columns below the depth of 200 meters. Some biologically productive habitats such as seamounts and deep-sea coral reefs are typically found in these areas. Seamounts are undersea mountains, usually cone shaped and of volcanic origin. These habitats are often targeted for commercial trawl fishery of high-valued demersal species, such as orange roughy and oreo dory.

FRESHWATER OR INLAND ENVIRONMENTS

The importance of freshwater fisheries as a major source of the world's fish catch is often underappreciated, partly because their production is severely underestimated. With a few notable exceptions—such as caviar from river sturgeon or Nile Perch from Lake Victoria—freshwater fish production does not figure significantly in the global fish trade. But fish and shellfish from rivers, lakes, ponds, and even rice paddies are a crucial factor in local food security and livelihoods in many parts of Asia, Africa, and South America, often providing a low-cost source of protein. Even in developed nations in North America and Europe, recreational

fishing for trout, carp, pike, and other freshwater species has become an important source of revenue in many communities.

Freshwater environments are very vulnerable to human degradation from dams, water diversions, and pollution. Fish production in inland environments is also subject to considerable human manipulation through fish stocking of lakes and streams, the introduction of new fish species, and construction of artificial environments for freshwater aquaculture. The freshwater harvest consists mostly of finfish such as carp, catfish, salmon, shad, tilapia, and trout. It also includes a significant amount of molluscs, crustaceans, and even reptiles that are of local and regional importance.

Freshwater environments fall into three major categories:

Rivers, Streams, and Wetlands. These natural waterways are subject to seasonal changes in water flow such as flooding, as well as seasonal fish migrations. Dams and water diversions have altered the natural flow regimes of all but a few of the world's major rivers, often damaging river fisheries in the process. Riverine fisheries may not be as productive as lake fisheries, but are significant in many countries and regions. Carp, catfish, characin, salmonid, shad, and trout are common target fisheries.

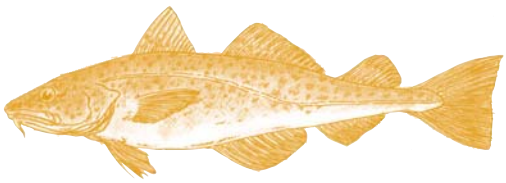
Lakes and Reservoirs. As major dams have increased in number over the last century, reservoirs have become a more common freshwater environment. However, these water bodies and their fisheries have been widely impacted by nutrient and chemical pollution from agriculture and industrial effluent. Nevertheless, fisheries in lakes and reservoirs are the most productive inland fisheries. They are often restocked with introduced species, such as tilapia, Nile perch, and carp, in addition to a variety of native finfish, molluscs, and crustaceans.

Ponds and Rice Fields. These artificial freshwater environments are now a major source of fish production, with aquaculture production of carp, catfish, and other species surpassing production from freshwater capture fishing. Small fishpond areas in China increased by 71 percent between 1984 and 2000 (Miao and Yuan 2001). Diversification is also occurring. High-value species such as freshwater crab and prawns are now also cultured in paddies in China, in addition to traditional species such as carp (Miao and Yuan 2001).

FISH TYPES

The global fish catch includes hundreds of species, but they fall into just a few major groups. These groups have different vulnerabilities to fishing activities, and therefore require different management policies to protect them. Greater awareness of these variations can help fish consumers reduce their contribution to unsustainable fishing.

Demersal Fish or Ground Fish. Demersal fish are bottom-feeding fish, found on or near the seabed. Thus, they are often referred to as "ground fish." This group includes many of the most commercially valuable marine species, prized for direct human consumption, such as cod, croaker, flounder, grouper, hake, halibut, pollock, seabream, and some deepwater sharks and skates. The wild catch of demersal fish accounts for approximately 35 percent of the world's marine finfish capture[3] by weight, but about 62 percent of the total value of that catch (Fishstat 2003). There is also some aquaculture production of demersal fish, but in relatively small quantity.



Demersal or ground fish: Atlantic Cod, *Gadus morhua*

Pelagic Fish. These ocean fish spend most of their life swimming in the water column with little contact with or dependency on the sea bottom. They often travel and feed in large groups or schools. The catch of pelagic fish represents about 65 percent of the total marine finfish catch[3]. *Small pelagics*, such as anchovies, sardines, mackerels, herrings, and pilchards, are low in commercial value, and are often used as raw material for fishmeal and fish oil rather than for direct human consumption. In contrast, *large pelagics*, such as tunas, swordfish, and other billfish, command high prices from consumers. Some shark species also have substantial commercial

[3] Excludes the catch of molluscs, crustaceans and other invertebrates and marine animals.

value as large pelagics, as their fins are considered delicacies in Asian countries.

Pelagic fish: Tuna, *Thunnus thynnus*; and European anchovy, *Engraulis encrasicolus*; above.

Deep Sea Fish. These are normally found in waters deeper than 400 m. Large-scale exploitation of deepwater species is relatively recent, but has quickly attained commercial importance. Among the more valuable deepwater species are angler fish, blue ling, orange roughy, Patagonian toothfish (often marketed as Chilean sea bass) and some deep water sharks. Deepwater species tend to be long-lived and slowly maturing fish, with low fecundity rates relative to other fish. Orange roughy, for example live longer than 100 years and take up to 25-30 years to reach maturity and start reproducing (Stevens 2003). These species are therefore highly susceptible to overfishing and slow to recover once overfished.

Deep sea fish: Patagonian toothfish, *Dissostichus eleginoides*

Freshwater Fish. These species spend their entire lives in freshwater. They include barbell, black bass, carp, catfish, perch, pike, snakehead, tilapia, trout, and many others. Although freshwater fish account for less than 10 percent of world capture, they contribute about 90 percent of all aquaculture production (FAO 2002a).

Freshwater fish: Brown trout, *Salmo trutta fario*

Diadromous Fish. Species that spend part of their life in freshwater and part in saltwater are known as diadromous. They fall into two groups:

Semi-industrial fishing boat in Indonesia.

Anadromous fish, such as salmon and sturgeons, spend their adult life in the open oceans or inland seas but swim upriver to freshwater to breed and spawn. In contrast, *catadromous* fish, such as eels, spawn in seawater but feed and spend most of their adult life in estuarine or freshwater environments.

Diadromous fish: Sturgeon, *Acipenser sturio*

Shellfish. This is a general term for a variety of edible invertebrates. These include both *molluscs*, such as clams, oysters, scallops, squids, cuttlefish, octopuses, and mussels; and *crustaceans*, such as lobster, shrimp, crayfish, and crabs. Crustaceans and molluscs represent 7 and 8 percent respectively of the world's marine catch by volume; but 26 and 11 percent respectively in terms of value (Fishstat 2003). Shell-less animals such as sea cucumbers, sea urchins, or jellyfish are sometimes included in the category of shellfish.

Shellfish: Japanese flying squid, *Todarodes pacificus*

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FISHING GEARS

Commercial fishing gears are classified into two main categories—active gears and passive gears. Active gears involve a vessel or a group of people towing a net or dredge in pursuit of one or more fish species. Passive gears consist of nets or traps set in one location or drifting with the current, with the target species entangling themselves in the net or swimming into the trap. Below are some of the most common fishing gears used on a commercial scale (FAO Fisheries Glossary 2003; Morgan and Chuenpagdee 2003).

All types of fishing gear are associated with some level of bycatch—the accidental harvest of untargeted species, such as marine mammals, seabirds, or other fish species. But the level of bycatch and the species affected vary greatly by gear type used. Chapter 7 presents further discussion on bycatch.

ACTIVE GEARS

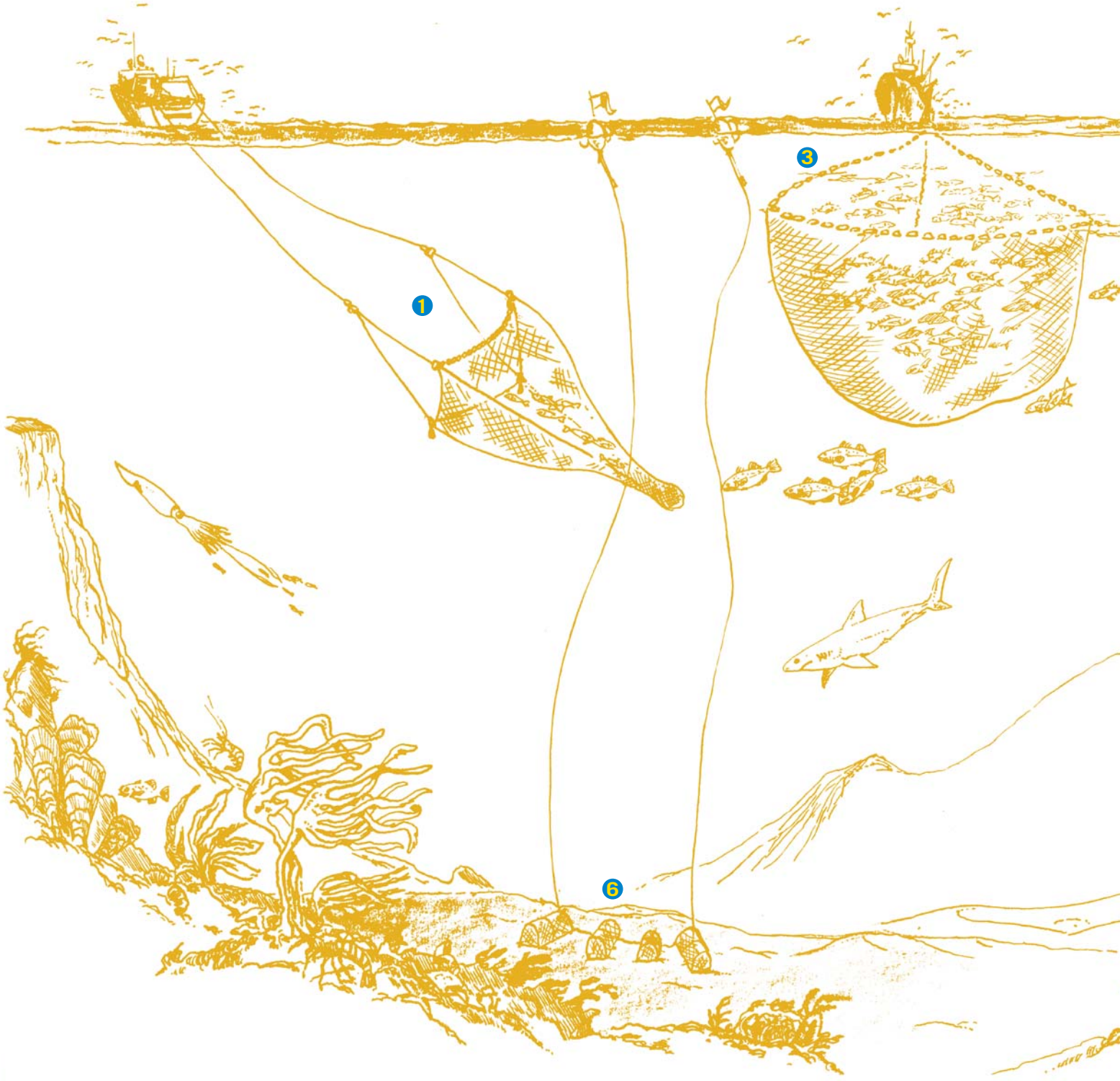
1 **Trawls.** A trawl is a bag-like net with a large mouth, tapering to a narrow end. The mouth is held open by a solid beam or steel doors. Bottom trawls are towed by a trawler along the sea bottom to catch demersal species such as flounder, sole, cod, rockfish, and shrimp. As they make contact with the sea floor, bottom trawls can seriously disturb the habitat, damaging or removing vegetation and organisms such as sea sponges, worms, and other bottom-dwelling species. Midwater trawls target species such as pollock, herring, hake, and mackerel that live higher in the water column.

2 **Dredges.** Dredges are specifically designed to harvest bottom-dwelling species such as scallops, clams, oysters, and sea urchins using a metal frame lined with a metal net. Because the dredge occasionally digs into the sediments as it is dragged along, it can disturb and damage the sea bottom ecosystem, in the same way as the bottom trawls.

3 **Surrounding or Encircling Nets.** Surrounding or encircling nets are large netting walls used for surrounding fish both from the sides and from underneath. *Purse seines* are a widely used type of surrounding net requiring one or two boats to deploy; one of the boats or a buoy remains stationary while the other encircles a school of fish. Purse seines are used to target schooling pelagic fish such as anchovies, sardines, mackerel, herring, salmon, and tuna.

PASSIVE GEARS

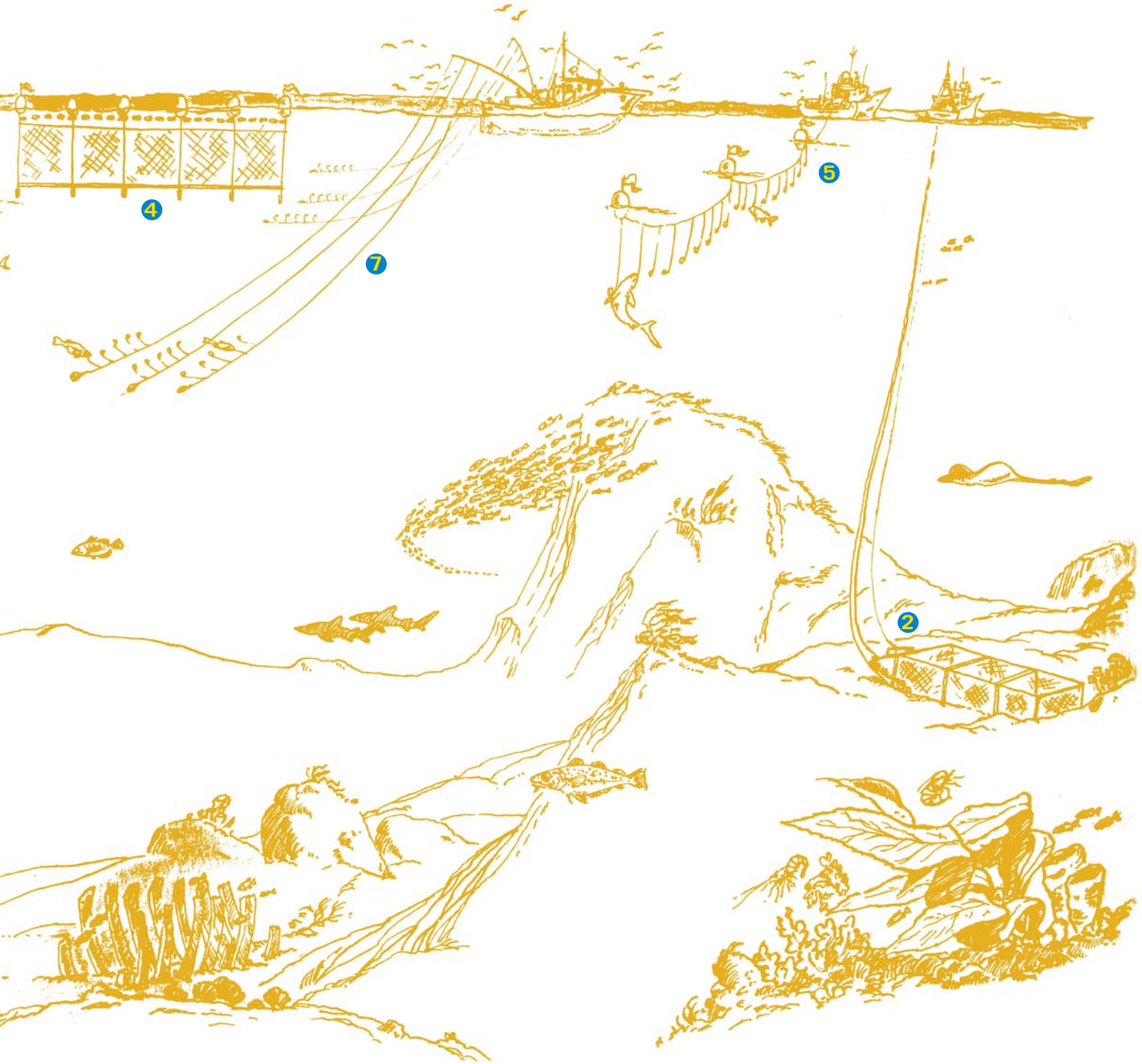
4 Gillnets. Gillnets consist of large panels of nearly transparent monofilament netting that hang vertically from floats like a curtain in the water. Because they can't see the netting, fish swim into the gillnet, entangling themselves. Bottom gillnets target demersal fish like cod, flounder, and pollock, while midwater gillnets target pelagic fish like mackerel, herring, swordfish, salmon, and sharks. Gillnets frequently entangle many non-target animals such as marine mammals and seabirds. *Driftnets* consist of many panels of gillnets strung together to make extensive walls of netting. Because of the high mortality rate of nontarget animals in driftnets, the use of large-scale driftnets (in excess of 2.5 km) in the high seas was banned by a United Nations resolution in 1992 (FAO 1998).



5 Longlines. Longlines use a stationary mainline to which are attached as many as 12,000 hooks on shorter branching lines. Longlines, which may be several miles in length, may be left in place from hours to days, and can be deployed on the sea bottom to catch demersal fish or in midwater to catch large pelagic species such as swordfish and tuna.

6 Traps and Pots. Traps and pots that rest on the sea bottom are used to catch crustaceans such as lobsters, crabs, prawns, and whelks, as well as some fish species such as Pacific cod and black sea bass, and even some tunas in the Mediterranean.

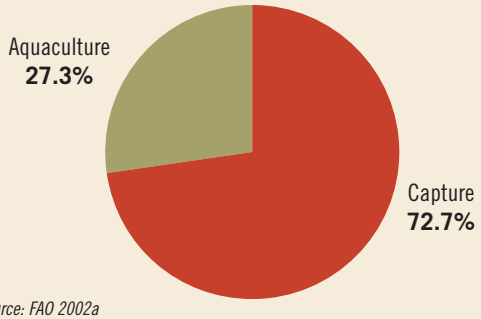
7 Hook and Line. Individual lines with baited hooks are still used in commercial fishing for a variety of pelagic and demersal fish, especially in small-scale and sport-fishing operations.



Box 2-1: Key Fishing Contrasts

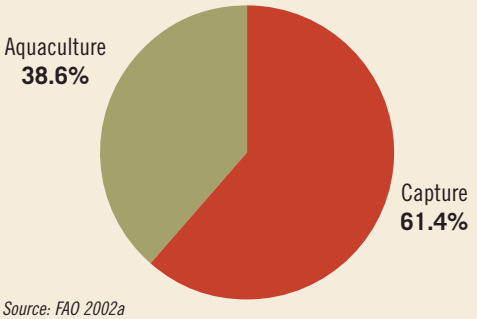
Global Production: Capture Fishing vs. Aquaculture

Figure 2-1a: Production by Volume from Capture Fisheries and Aquaculture
(World Total 130.4 million metric tons, 2000)



Source: FAO 2002a

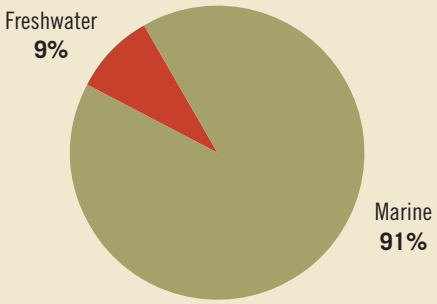
Figure 2-1b: Production by Value from Capture Fisheries and Aquaculture
(World Total US$130.1 billion, 2000)



Source: FAO 2002a

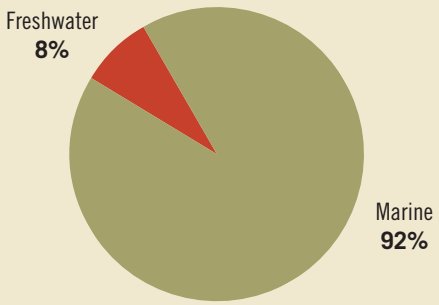
Global Catch: Marine vs. Freshwater

Figure 2-2a: Global Catch by Volume from Marine vs. Freshwater Environments
(World Total 93 million metric tons, 2001)



Source: Fishstat 2003

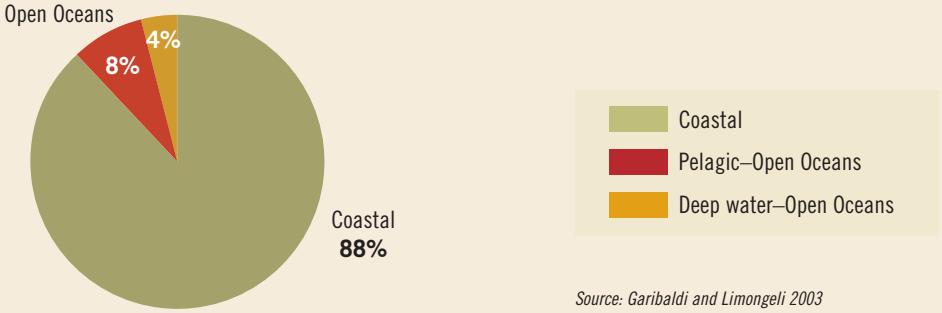
Figure 2-2b: Global Catch by Value from Marine vs. Freshwater Environments
(World Total US$79 billion, 2001)



Source: FAO Yearbook of Fisheries Statistics 2003

Global Catch: Coastal Waters vs. Open Ocean

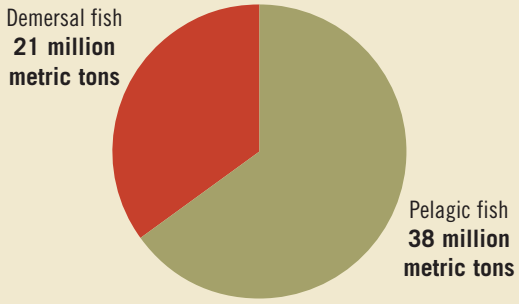
Figure 2-3a: Catch by Volume from Coastal Waters (Continental Shelf) vs. Open Oceans, 2002



Source: Garibaldi and Limongeli 2003

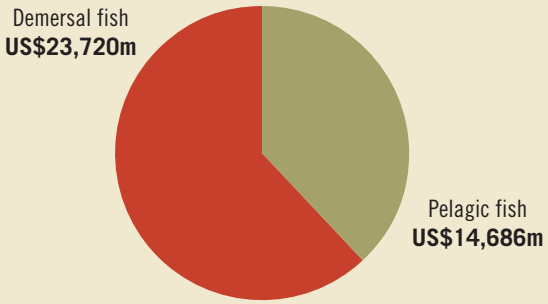
Global Catch: Pelagic vs. Demersal Fish

Figure 2-4a: Pelagic vs. Demersal Marine Fish Catch by Volume (metric tons, 2001)



Source: Fishstat 2003

Figure 2-4b: Pelagic vs. Demersal Marine Fish Catch by Value (million US$, 2001)



Source: Fishstat 2003