A HISTORY OF FISHING

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Contents

Summary

Fishing has been part of the human experience since the earliest stages of human evolution. This chapter traces the human/fish interaction in all its forms throughout history. Not only have fish played an important role in human nutrition, but also in numerous other ways, including forming a basis for commerce and for human social behavior.

For the purposes of this article, "fish" includes all animals that live predominantly in water. "Fishes" then include scale/fin fishes; cartilaginous fishes (sharks and rays); amphibians; reptiles such as water snakes, tortoises, and turtles; and marine mammals—seals, whales, dugong, and manatees—which have provided food, fuel, and covering. "Fishes" also includes mollusks (used for their meat, shells, pearls, and dyes such as Tyrian purple), crustaceans—shrimp, crabs, lobster from fresh and marine waters—and echinoderms—sea urchins and trepang.

This article highlights important developments in fishing and the rapid increases in harvesting technology and efficiency, particularly over the last 150 years. The concepts underlying fisheries management, surplus production, over-exploitation, collapse of fish stocks, and extinction of species are examined.

The important parts played by fisheries for whales and cod in the development of fisheries are outlined.

The scope of this chapter extends from the earliest interactions of humans with fish, involvement of humans in fishing over recorded history, and the development of large-scale industrial fishing about the time of the Industrial Revolution.

The rapid growth of fishing power and fish production in the last 50 years of the twentieth century receives particular attention. The article traces the causes and consequences of over-fishing and attempts to envisage what the future may hold for human/fish interaction.

The article offers examples of management that should prevail against increasing demand for fish. Projections for management are based on maximizing all kinds of satisfactions from the yield that could be sustained from each stock.

Trends in global production from wild fish stocks, which has peaked and is now declining, the major fish-producing countries, and the role and demand for fish in human nutrition are discussed.

Major threats to fisheries such as environmental impacts of fishing practices and pollution are identified.

1. Introduction to Fish

1.1. Fish/Human Interaction

At Olduvai in eastern Africa, fragments from the cichlid *Tilapia*, and catfish appear with remains of *Homo habilis* and the later *Homo erectus*, who lived near a shallow lake more than 500 000 years ago. From that time, and particularly since the earliest pictures on rock walls about 40 000 years ago, there is ample evidence that, in addition to serving as food, fish satisfied a wide range of human wants and needs, both physical and spiritual. The capture, preparation, and consumption of food have so many social aspects that we cannot imagine a worthwhile human society that does not include such cultural enrichment. A *companion*, literally, is one with whom we take bread.

Any history of fisheries must acknowledge the role of fishes as a commodity for trade and impetus for exploration, the range of human uses of fishery products, the essential nature of fishes as an important source of food, and how the customs and rituals of fishing fit into the entire human experience of the world. The scope of this article extends from the earliest interactions of humans with fish, involvement of humans in fishing over recorded history, the development of large-scale industrial fishing around the time of the Industrial Revolution, and the rapid growth of fishing power and fish production in the last half of the twentieth century. We will also trace the causes and consequences of over-fishing and try to envisage what the future may hold for human/fish interaction.

1.2. Definition of "Fishes"

Our definition of fishes for this article includes all animals that live predominantly in water. Fishes then include scale/fin fishes; cartilaginous fishes (sharks and rays); amphibians; reptiles such as water snakes, tortoises, and turtles; and marine mammals—seals, whales, dugong, and manatees— which have provided food, fuel, and covering. Fishes also includes mollusks (used for their meat, shells, pearls, and dyes such as Tyrian purple), crustaceans—shrimp, crabs, lobster from fresh and marine waters—and echinoderms—sea urchins and trepang.

Aquatic animals (fishes as defined above) have also provided building materials (coral, and shells for lime in mortar and for road building), tools from bone and spines, and sponges for housekeeping and padding; it was an essential item in the age of personal armor. Many cultures have used mollusk shells and pearls as items of exchange in all kinds of trade, commercial and symbolic. Toxins from some fish have been implicated in the "zombie" culture as it moved from West Africa to the Caribbean.

In addition, nutrients concentrated from fish in bird droppings (guano) have been of critical significance to the dramatic boost in production in agriculture in the nineteenth century. The increased production of food allowed the human population to expand rapidly from about one billion to about 6 billion over 190 years (see *Food and Agriculture and the Use of Natural Resources*).

1.3. The Earliest Interactions between Humans and Fish

Kathlyn Stewart of the Canadian Museum suggests that fishing may be overlooked in studies of early human cultures because it did not require specific tools. There is also the general problem in archaeology that fabrics, wood, and some hides and leathers decay readily. Against this are the findings of remains such as fish bones, spines in tools, mollusk shells—particularly in middens—that attest to the significance of fish in prehistoric culture. For example, the date of human occupation of the Torres Strait Islands between Australia and New Guinea has recently been extended to 3200 years ago based on dates obtained from discarded shellfish—spider conch, clam, and trochus—dug from ancient middens. This is at least 1000 years earlier than had previously been recorded.

It is a highly significant characteristic of fish that they can be taken with relatively little effort or special equipment. Hunter/gatherers could, and still do, take oysters and similar bivalves at low tide for no more than the effort of carrying them back to a campsite. In freshwaters, finfish concentrate as ephemeral pools shrink, and can be taken by groups with baskets, or simply cast up on the bank. It is the personal experience of one author that three or four people can herd groups of tuskfish, parrotfish, and wrasse (families Scaridae, Coridae, Labridae) across coral flats, then panic them into trying to wedge themselves under flat pieces of coral, where fish of 1 kg to 2 kg can be caught by hand with minimal effort.

Anadromous species such as salmon, while strongly seasonal, were taken quite easily as they moved up rivers to breed. For example, recent studies by Yoshiyama and colleagues show that, before European settlement, in the Central Valley drainage of California, Native Americans caught 3.8 million kg of chinook salmon from four breeding migrations over the course of the year.

Fish traps where fish are guided into a small pool or chamber where they can be taken conveniently (and, in many cases, kept as a food reserve) are common along many coasts and rivers. Channels and stone walls have been found running off rivers and in inlets and estuaries around the world—many of them having been maintained for centuries.

Where the effort might be greater, marine mammals gave a high return in meat, oil, skin, and bone sufficient to support entire communities in Arctic regions. Not that the effort necessarily was great; there were easy ways to take whales. The people now known as the Makah of the Pacific coast of North America used fast dugouts to pursue whales when they came inshore. One hunter would push a lance into the whale. A line of inflated sealskins was attached to the lance. The whale then tired trying to submerge these floats. Similarly, manatees, dugong, and turtles enriched human communities in temperate and tropic areas.

Sidney Holt, one of the founders of mathematical analysis of fish populations and fisheries, developed models and equations which fishery managers might apply to fisheries. He cautions that such models must simplify the real world and that managers using these models must not forget that humans apply knowledge accumulated over

centuries, of seasons, weather, and behavior of fish, to minimize effort and maximize reliability of take. "Primitive" tools and methods should be viewed in the context of such knowledge and the wisdom distilled from it in regulating the affairs of each human community.

Human economic history is best explained through the principle of parsimony of effort. Adam Smith saw it as "naturally to be expected that some…should soon find out easier and readier methods of performing their own particular work." That principle applies well in fisheries and will be traced in the context of each of the major developments in fisheries.

2. Fishing Methods, Trawling, and Influential Fish

2.1. Traditional Fishing Methods

Most of the major methods of fishing—other than those requiring power from combustion engines—had been brought close to their present development by the time humans started to write records. Spear, net, line, and rod occur synchronously in Egyptian history about 3500 BC (about 5500 BP). It still is unclear which method fishermen adopted first in historical times.

Along the Pacific Coast of what is now Peru, about 2000 BP to 3000 BP, coastal communities using boats made of reeds took anchovies with cotton nets, suspended from dried gourds as floats, in sufficient quantity to maintain local town populations of about 2000 inhabitants. The fish supported that population directly, and through trade inland of this otherwise arid coast, provided the other wants of those communities, numbered in the "dozens."

Experiments with replicas have confirmed that, for thousands of years, coastal dwellers have had the capacity to put to sea and take fish in whatever way was convenient. Craft could be made of reeds, wood, skin, and bone, or combinations of such materials. Wind or human muscle powered them. Fishing gear included spears, lines with hooks, bait or lures, and nets. Baskets were used to take and carry fish, with no sharp distinction between what was unmistakably a basket and what was a net. Nets were woven from human or animal hair or wool, all kinds of plant fibers, leather, and, in one area of New Guinea, spider webs.

Where the incentive was high enough, free divers could take items, such as sponges, at depths approaching 20 m. It is difficult to distinguish between speculation and fact in interpreting drawings of divers apparently using some kind of air reservoir to extend their time underwater. However, within the last century sponge divers have been observed performing controlled descents to more than 20 m, using flat rocks as planes, and doing useful work at such depths. Earlier illustrations showing long breathing tubes are quite fanciful, flouting the laws of physics and principles of human anatomy and physiology. Illustrations of diving bells, where inverted barrels were weighted sufficiently to get them to the work area, could well be based on fact. There are accounts and illustrations of methods of adding to the supply of air in such bells with

small buckets on a conveyer line, which are consistent with laws of physics and practicalities of operation.

One remarkable piece of equipment is the apparatus used by inhabitants of Vancouver Island, Canada, about 2500 years ago. They manipulated sets of prongs through 20 m or more of water, into the seabed, to retrieve shells of scaphopod mollusks for use in trade. A weighted collar wedged shells of the required kind between the prongs, with practically no by-catch.

Ports in the Mediterranean Sea built more than 2000 years ago include works that would have been difficult to undertake without divers. Sponge diving probably maintained a supply of divers who, by a mixture of natural physiological ability and the training of regular work on sponge beds could have reached a high level of proficiency. The Ama divers of Japan have followed a similar lifestyle at least since its description in a Noh play 1300 years ago.

However, free diving beyond about 10 m consistently throughout a day is physically demanding in direct effort and in energy losses to the cold water. It is not, and probably never has been, able to provide major sources of food for humans.

Perhaps the only significant technological improvement in fishing gear up to the eighteenth century was the reel. While rods had been used long before that time, a running line offered many advantages in allowing the bait to be cast farther and in tiring fish for landing. The earliest published description of a reel appears in 1651 AD.

Even during the early to mid-nineteenth century, commercial fishing as often as not involved using simple handlines. Although the British are recorded as using long-lines to fish off Iceland in 1482, the usual technique of fishing for cod and other groundfish in the North Atlantic up to the 1930s was for fishermen to go out to the banks under sail. There they would be dropped off from the schooner in one-man or two-man dories to fish using handlines.

Speed of vessels was not a limiting factor in development of new fishing methods. For thousands of years sea craft propelled by human muscle—with paddles or oars, sometimes supplemented by sails, being fine (length:breadth ratios of 10:1) and easily driven—were capable of reaching hull speed relatively easily. Larger craft such as the final evolution of the Viking long ship, from about 1000 years ago, could have maintained better than 10 knots, with bursts to higher speeds to close on prey.

Although a boat might be easily driven by human muscle and wind power, a bottom dredge or net virtually acted as an anchor. In other parts of the world, baskets of perhaps 1 m diameter could be hauled across the bottom to take shellfish and other relatively sessile species, but human muscle did not offer the power to work a trawl. In any case, applying the principle of minimizing effort, there was no particular incentive to develop trawls and other mass harvesting methods until greater power became available from combustion engines.

Figure 1. Traditional fishing method: dugout canoe and hand-held "throw net," Amazon River, Brazil

In summary, the general pattern of fishing around the world, more or less until the last 200 years, was that women and children could take shellfish and small fin fish regularly in wading depth or from tidal flats, sufficient to provide for the extended family or clan. Men used larger nets (made by women) or lines to work water deeper than wading depth for fin fish, and spears to take larger turtles and mammals. For the hunter/gatherer, fish (or virtually any food category) were taken only if that required less effort than alternatives. Stocks of forage fish and shellfish were protected because women essentially took the "cream" of the local stock, and switched to alternatives when the easily gathered surplus had been taken. Similar dynamics applied to the larger fish and aquatic mammals and turtles, with the added control of ritual and custom to provide best distribution of the allowable catch, and to avoid damage to the stock.

Fishing as hunting, rather than gathering, offered satisfactions beyond supply of protein. Consistently successful male hunters in some communities were well regarded by women. It is tempting to speculate on the rituals adopted even today by "game" fishers, posing beside their catch. There is ample evidence that fish hunters had high status, and the custodians of particular species, great authority.

At all times the principle of maximizing return for effort (energy) was paramount. Turtles and mammals were taken much less frequently than the "forage" species inshore. This reflected the needs of the group. With large land animals, the minimum number of men went out to hunt. The animal was taken where it was convenient to get the carcass back to the group (or, in some cases, the group followed the hunters and camped at the site of the kill to process the carcass). The carcass was divided according to custom and/or the direction of a person who was steward or trustee of that species. Fishes were either a minor (i.e. not the limiting) component of the mixed diet of hunter/gatherers in the tropic and temperate areas or, where they were the major food resource, the human culture evolved to local sustainability.

There are indications that the fishing settlements on the coast of Peru were there for thousands of years—and ultimately became uninhabitable only through relative change in sea level. Many of the settlements that have been excavated and which depended on fish or marine mammals show similar duration of existence. Fishes or mammals were

available for little outlay of energy by the entire group, and, with care, must have been reliable sources.

This does not mean that the same species necessarily was sustained in that area for that time. Changes in proportions of bones in old waste dumps show that the fish taken to Eboracum (York) in England changed from salmonids to cyprinids then back to salmonids, possibly reflecting loss of water quality in the river as the human population grew. In New Zealand it is claimed that the Maori people did not regard freshwater mussels highly until they had greatly reduced the bigger land game, at which stage the easily harvested and reliable mussel was no longer viewed with contempt.

Traditional approaches to fishing most likely developed from a time when the global human population did not exceed 5 million. A large settlement contained only 2000 inhabitants. Yet these approaches have lessons for fishery management relevant to the twenty-first century, when those numbers have increased one thousand times each.

2.2. The Development of Trawling

The nature of fishing changed dramatically with the introduction of steam-powered fishing vessels. These vessels enabled a net to be dragged along the bottom of the sea behind the boat, and the boats became known as draggers (see *Development of Marine Fisheries*).

The principle of trawling was known from beach seines, which were used to take species that school along the coast. For centuries, the British and Flemish had been using beam trawl nets to catch shrimp, dragging the nets to shore with horses. Horsepower also had been used to drag nets in rivers. In the Central Valley of California in the mid-nineteenth century (during the Gold Rush era), horses were used to pull beach seines in rivers to harvest salmon. Pair trawling—where a deep net was worked between two sailing vessels—was known from the Baltic in the sixteenth century. Single vessel trawling at that time involved a bag net, held open with a bar, and kept on the bottom with weights. In this method and in pair trawling, power came from sail. Sail-powered trawlers known as *smacks* had been working the North Sea banks since the early 1800s.

But it was the British who vastly increased fishing power through the development of driving vessels with mechanical power from steam. Once steam-powered engines were fitted on vessels, the decline of sail power became inevitable. From the introduction of the first specially built steam-powered trawler at Hull in 1881, it took little more than ten years for steam-powered trawlers to become common in the North Sea (*see The Development of Specialized Ships, Nets, and Equipment*).

Many of the early engine-powered trawlers—initially steam reciprocating—used sail for assistance on passages, and to set and stabilize the vessel. The engines were inefficient, and fuel (coal or wood) was expensive, so the rate of return also had to be high. Trawlers worked close to port to contain costs. Otter board trawls, which had less resistance and offered better control of net characteristics while it was fishing, improved both fuel efficiency and catch, from the late nineteenth century.

The next major changes came after World War II, when internal combustion engines, particularly diesel, had become much cheaper, as had shipbuilding. That war had also refined echo sounding. Although expensive technology, it was taken up by the fishing fleet first to determine depth to set a net, then to locate fish, and finally to target the net to the fish.

Since the 1950s the relative cost of fuel has dropped markedly, and by the 1970s much of the fleet was effectively converting a weight of fuel (diesel) into an equivalent weight of fish on a successful trip. Hull design changed from the easily driven lines derived for sail, to fuller sections propelled by larger, more powerful engines, which became economic to operate with the relatively cheap fuel. The fuller hull profiles had the advantage of providing more storage and working space.

Figure 2. Modern prawn (shrimp) trawler from eastern Australia, with large deck working area

These developments saw the final expansion of fisheries on wild stocks. The principle of parsimony of effort still applied—petroleum had substituted for human muscle, and it took relatively little of the yield of the fishery to cover the cost of the fuel even for fishing in distant waters. The other important side of the operation, gathering information, was boosted by electronic aids. Information on where fish were concentrated was spread by radio. Vessels reached the grounds in the shortest time possible. On those grounds, higher concentrations were found by echo sounding. Nets of capacity, limited more by the space on deck to receive catch than by the power needed to tow and retrieve the net, were positioned with echo sounders. Catch was

brought up with power winches, requiring no more human effort than that necessary to loop a line and press a button.

Figure 3. "Industrial" fishing: purse seine netting of Australian salmon (*Arripis trutta*) off South Australia

In vessels of thousands of tons displacement, catch could be reduced to fillets on board, maximizing the value of product even from species that brought relatively low prices in the market. Preservation did not limit the catch that could be taken—fuel was cheap enough to drive refrigeration plants capable of freezing tens of tons per hour.

Commercial fishing still took fishers into bad weather and good, and its occupational safety record compares poorly with most land industries. But the principles of parsimony of human effort, and application of information to taking fish when they were conveniently available, still applied. It should be emphasized that catches increased, however, not because of successful management of fish stocks, but because vessels could work farther away from port and in deeper water, thus gaining access to stocks that previously had been untouched.

This was the final expansion. Recorded catches have peaked and declined. Almost half the known stocks of fish are classed as over-fished or have collapsed, and, for the first time in human history, there are no unexplored waters for speculators to venture into.

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Biographical Sketches

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