# ECONOMICS OF FISHERIES AND AQUACULTURE

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## Contents



## Summary

Archaeological evidence indicates that fishing was one of the earliest human production activities. Early fishing seems to have been mainly hunting and gathering along shores and inlets with fish farming emerging somewhat later in time. Capture fisheries expanded rapidly in the 19$^{th}$ and 20$^{th}$ centuries AD reaching the peak annual production of over 90 million metric tonnes in the early 1990s. Since then, there has been little or no increase in capture fishery production. By contrast, fish farming production has grown very fast since the 1970s and continues to do so. Currently it accounts for over third of global fish production and close to half of the production for direct human consumption.

With rising global incomes, demand for fish products will almost certainly continue to grow. A corresponding increase in supply cannot come from capture fisheries, which are already close to the maximum sustainable production. It can only come from fish farming which is not subject to the same binding constraints. An integrated production and market analysis predicts more than doubling of the global fish production during the current century with virtually all the increase coming from fish farming. Global fish farming production is predicted to exceed that of capture fisheries in the 2020s.

While fish farming is basically subject to the same economic laws as traditional farming, capture fisheries deal with certain quite specific and deep-rooted economic problems. The most fundamental of these problems are the inherent dynamic complexities of wild fish stocks and the traditional common property arrangement of

most capture fisheries. In combination, these problems have led to extremely wasteful fisheries often to the point where the fisheries yield virtually no net economic benefits to society. According to recent estimates, the total economic waste in the capture fisheries is of the order of 50 b. US$ annually.

## 1. Introduction

This chapter serves as an introduction to the section on the economics of fisheries and aquaculture. It provides a summary of the evolution and current state of the global fishery and aquaculture and points out certain key features of these production activities. The intention is to set the stage for the more detailed examination of the issues in the chapters that follow.

The global fish production industry is highly varied with respect to species, production technology, geographical location and various other aspects. Therefore, it may be helpful to start with some classifications. First, it is useful to distinguish between the so-called capture fisheries and fish farming. Second, it is customary in international fisheries statistics to distinguish between inland and ocean fisheries.

| | **Inland** | **Marine** |
|---|---|---|
| **Fish farming** | Aquaculture | Mariculture |
| **Capture fisheries** | Inland fisheries | Marine fisheries |

This classification gives rise to four types of fish production as illustrated in the following matrix. Inland fish farming is referred to as aquaculture and ocean fishing farming as mariculture. Inland fisheries take place in rivers and lakes; some of which, e.g. Lake Victoria, the Black Sea and the American great lakes, are the size of small oceans. Ocean fisheries take place in what is e traditionally characterized as oceans.

Of course, the borders between these four categories are not very precise. How for instance should once classify fisheries from stocks that have been enhanced by releases from hatcheries? Is that fish farming or capture fisheries? Are fisheries in river mouths and brackish waters inland or ocean fisheries?

In spite of these practical difficulties, the above classification is most useful. Thus, for instance, totally different economic principles apply to fishing on the one hand and fish farming on the other. The former almost always involves extraction from common stocks while the latter is more like agriculture in that the farmed stock is typically the exclusive property of the fish farmer. Therefore, it makes little sense to bunch the two together. Similarly, the administrative and legal aspects of inland fisheries are often quite different from those of ocean fisheries. Thus, most inland fisheries, although by no means all, enjoy the simplicity of a single national sovereignty. Many ocean fisheries, by contrast, take place on the high seas under international sovereignty. Even fisheries mostly conducted within national exclusive economic zones (EEZs) are subject to migrations of the stocks to other EEZs. Moreover, even ocean fish stocks that are confined to one fisheries jurisdiction are generally subject to much more pervasive ecosystem and habitat influences originating from different jurisdictions than inland fish

stocks. Thus, there is an analytical reason to distinguish between the two types of fisheries.

Fish production, irrespective of the category, always depends on the availability of many natural resources. In fisheries, the immediately most crucial are of course the fish stocks and their aquatic habitat. In fish farming, the availability of suitable sites and the interaction of fish farming with the environment are often the most binding constraints. Many other environmental variables are involved. This high degree of dependence on natural and environmental variables leads to special constraints on the production of fish many of which will be dealt with in subsequent chapters.

## 2. Fisheries and fish farming in a historical context

Fishing seems to have been one of the earliest human production activities. This can be inferred from several sources. Archaeological research abounds with evidence of fish and other aquatic organisms featuring in human diets virtually from the origins of the human race. Discarded shells and fish bones in domestic middens (waste dumps) and cave paintings show that sea food was important for survival and consumed in significant quantities. Anthropological research similarly reveals that fishing and gathering of marine organisms in inter-tidal waters and water bodies constituted a vital part of the sustenance activities of many primitive tribes. Finally, the historical record shows that fishing has been an important human production activity as far back in time as we can see.

In ancient Egypt, one of the oldest cultures for which there is reliable historical information, fisheries seem to have been of major economic and nutritional importance. For instance, early Egyptian stone reliefs (2-3000 BC) show fishers bringing in fish, and splitting the fish for salting. The most important fish seem to have been Nile perch and catfish, interestingly still the main species harvested today in the Nile river and lake system. From scenes illustrated in tombs, drawings, and papyrus documents it appears that ancient Egyptians invented various implements and methods for fishing. Simple reed boats served for fishing. Woven nets, weir baskets made from willow branches, harpoons and hook and line were all used. Later cultures such as the Greeks and the Romans also pursued fishing as evidenced in their writings and pictorial art. Similar evidence may be found in what is known of early Asian, Indian and Inuit cultures. Subsequent historical evidence from all continents of the globe also establishes that fishing was an extremely widespread and often a crucial economic activity long before the modern era.

According to the available evidence, aquaculture in ponds and enclosed inlets also emerged early on in human existence. Note, however, that since aquaculture requires capital investment, which is not moveable, it requires fixed settlement and some defensive ability. Thus, aquaculture is not really compatible with a hunter-gatherer lifestyle. It basically requires same kind of organization and property rights technology as agriculture. Therefore, aquaculture probably, emerged somewhat later than fishing.

None of this, of course, is surprising. Humans everywhere are constantly trying to improve their economic well-being. Therefore, wherever conditions were favourable,

i.e., accessible inland water bodies or inter-tidal and sheltered inshore areas rich in aquatic life, people naturally tried to take advantage. In fact, it appears that human populations converged on and multiplied at such areas just as other economically favourable areas

Much of today's greatest source of fish, the oceans and large lakes, were, due to technological limitations, inaccessible to human harvesting until the last one or two centuries. As a result, the global volume of fish production was very small compared to what has since happened and significant overexploitation of stocks and habitat probably limited to the most accessible areas.

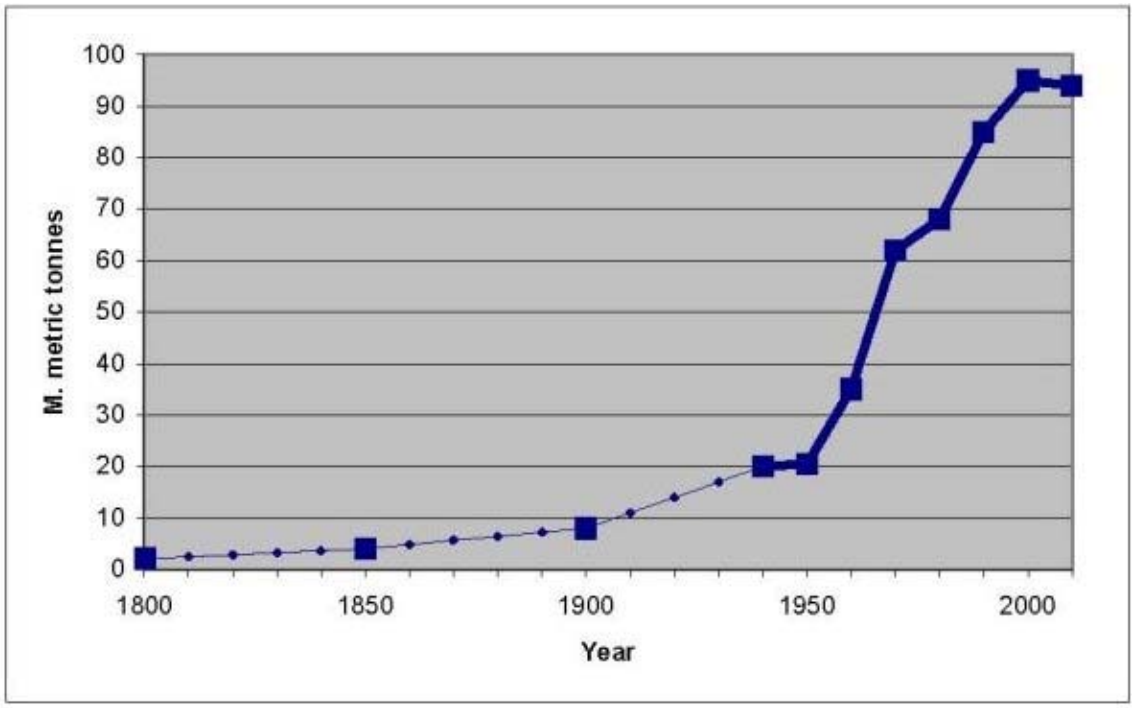


Figure 1: Capture fisheries evolution 1800-2000
(Fine line indicates estimates. Sources: Hilborn 1990, Garcia and Newton 1997and FAO 2004)

Numerical data on the global volume of fish production are extremely sketchy before the establishment of FAO following the end of World War II. The diagram in Figure 1 depicts the approximate evolution of global capture fisheries production (i.e. including ocean and inland fisheries but excluding fish farming) since 1800. As can be inferred from this diagram, the volume of global fish production is believed to have been less than two million metric tonnes, until the 19$^{th}$ century. Since then, however it has expanded fast. It reached about 10 million metric tonnes just after 1900, 20 million metric tonnes in 1950 and the 95 million metric tonnes in the year 2000. During the period from 1800 to 2000 the average rate of growth in capture fish production was almost 2% per year. With greatly improved harvesting technology and increasing demand for fish products, the rate of growth was particularly high in the period after 1950. However, since about 1990, the global production volume from capture fisheries

has at best stagnated or even contracted slightly. This, no doubt, is primarily the consequence of fully and overexploited fish stocks.

Data on the historical development of fish faming production are even more limited than those for capture fisheries. Reasonably reliable global statistics are only obtainable from about 1980. Substantial fish farming certainly existed before, especially in south-east Asia, but the quantity of production is largely guesswork. The available information is summarized in Figure 2. As is made clear in graph, since 1980, fish farming production has expanded at a very rapid rate. Broadly fish farming production has grown from less than 5 million metric tonnes in 19890 to over 45 million metric tonnes in 2005. This represents an average annual growth rate of well over 9% per year. It is interesting to note that the growth in fish farming production since 1980 is similar in shape to growth in capture fisheries production from 1950 to 1970, only faster. In 2005, the volume of fish farming production had reached approximately half of that of capture fisheries.

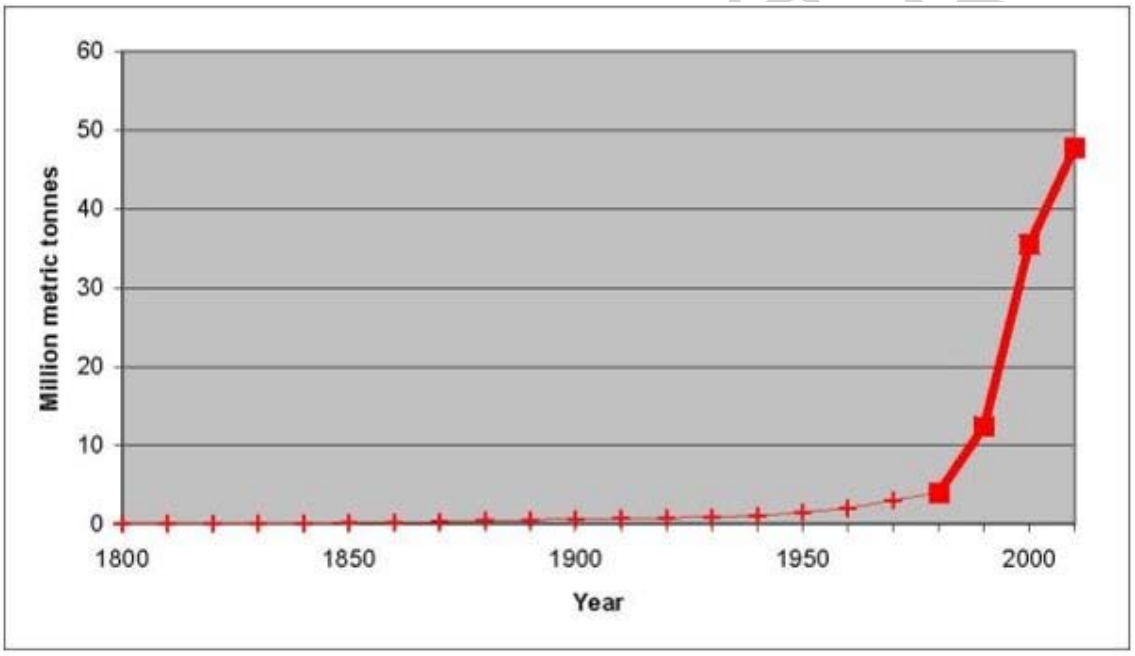


Figure 2: Fish farming production 1800-2000
(Fine line indicates estimates. Sources: FAO 1998, 2005, 2007. Anonymous 2002.)

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## Biographical Sketch

**Ragnar Arnason** is a professor of fisheries economics at the University of Iceland. With a master's degree in mathematical economics and econometrics from the London School of Economics, he received his Ph.D in natural resource economics from the University of British Columbia in 1984. He has been the chairman of the Institute of Economic Studies at the University of Iceland since 1994. Since becoming a professor in fisheries economics in 1989, professor Arnason has primarily conducted his research in the

area fisheries economics and fisheries management where he has an extensive publication record with over 130 scientific articles and several books to his name. Professor Arnason has been a visiting scholar in several universities and international organizations including the FAO. He has organized a number of large scale research projects in fisheries including some funded by the EU. He has organized and participated in numerous international conferences on natural resource utilization including those sponsored by the World Bank, OECD, FAO, EU, WWF and many others. Professor Arnason has played an important role in the development of the Icelandic fisheries management system and was a member of the country's Committee on Natural Resources which was charged with the responsibility of proposing the best arrangements for natural resource utilization including the environment. Professor Arnason has also provided advice on fisheries management and environmental issues to the governments of several countries in Europe, America, Africa and Asia.