

CONTROL AND REGULATION OF FRESHWATER FISHERIES

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Contents

1. Introduction
 2. History of Fishing
 3. Fishing and Biodiversity: An Additional Source of “Selection”
 4. Repopulation Strategies: Applications of Artificial Insemination
 5. Introduction of Allochthonous Species
 6. Management of Fish Populations and Fisheries
 7. The Need for Control and Regulation
 8. Present Trends
 9. Pacific Salmon Fishing
- Acknowledgements
Glossary
Bibliography
Biographical Sketch

Summary

Although representing almost half of all vertebrate species, fish biodiversity is decreasing at a very fast rate. In fact, it has been estimated that 29 species have become extinct since 1600 and 452 species are officially threatened at the present time. Fish rarefaction is mainly related to environmental pollution, habitat alterations, over-fishing, incorrect restocking programs, and the introduction of allochthonous species. Among these factors influencing the welfare of fish populations, increased fishing activities or over-fishing have often offset the benefits obtained by management programs concerning restocking, protection of spawning biomasses, and restoration of correct ecological conditions. It is noteworthy that, parallel to the human cultural evolution, human attitudes toward fishing have evolved from an ecologically respectful "fish-picking" culture to avoid food deprivation, to modern and technological angling, which often results in overexploitation of resources. Therefore, a lack of equilibrium among rhythms of cultural and biological evolution is certainly one of the major causes responsible for fish-species rarefaction. In relation to this, fishing has been considered an additional source of selection and recently defined as a possible cause of "artificial selection." As increasing amounts of natural habitats are being transformed through the above-mentioned processes, an effective control and regulation of human activities should be established and enforced. Indeed, current legislation often lacks ecological consideration. The importance of an ecosystem approach to the management of fisheries has been ignored for a long time, but this paper demonstrates that this approach is currently gaining increasing attention. Management programs concerning control and

regulation of freshwater sport fisheries are herein discussed with special emphasis on Pacific salmon (*Oncorhynchus* spp.) fishing in the northwestern United States.

1. Introduction

Fishes are a very heterogeneous assemblage among animals and represent almost half of all vertebrate species. They exhibit a wide range of variability in their morphology, in the habitats they occupy, and in their biology. In addition, fish populations are an important source in the economy of many countries. They therefore have always attracted the interest of scientists, economists, and politicians, as well as writers and common people. Nevertheless, the main human occupation category interested in fish life, despite any social-status difference, is fishermen.

In fact, major interest in fish behavior and biology lies not only with ecologists, ichthyologists, and zoologists, but also with fishermen. Besides constituting an important element in the economy of several nations, these vertebrates give incalculable recreational and psychological value to sports enthusiasts.

Since ancient times, fishing has always represented both a recreational and a self-sustaining activity based on the exploitation of such living organisms as molluscs, echinoderms, crustaceans, and fishes. Ancient populations used hand-fishing as a first attempt to catch living aquatic prey, however, sudden elaboration of tools and devices such as arrows, harpoons, clubs, snares, hooks, and rods, as well as nets and traps, demonstrate the importance of fishing in the economy of primitive populations. Obviously, fishing was originally important as a source of easily affordable meat, but fishing as a recreational activity was discovered very early in human history.

Although it is believed that recreational fishers generally place a high value on the lifestyle rather than in the amount of fish caught, this kind of sporting activity is gaining increasing attention and control because of continuous fish population rarefaction due to several environmental problems (mainly pollution, habitat alterations, and introduction of allochthonous species). In addition, even if recreational fishers are restricted to using relatively inefficient gear by regulations, their number can be large enough to seriously affect a fish stock and the surrounding environment. Furthermore, fish rarefaction can have additional impacts on other vertebrate taxa. For example, it has been observed in the Pacific Northwest (USA) that feeding of wintering bald eagles on Pacific salmon was less during the weekends when recreational fishing was high than on weekdays.

Several world organizations and scientific associations are collaborating with the aim of reducing the decline of many fish taxa. Local and national laws and regulations are applied in many countries to preserve rarefaction of fish populations. In parallel, management programs are planned to sustain natural communities of many species. It is noteworthy that the need for control and regulation to avoid over-exploitation of natural resources is stated by the FAO (Food and Agriculture Organization of the United Nations) Code for a responsible management of fisheries. This document, which is available online <<http://www.fao.org/fi/agreem/codecond/codecon.asp>> is based on the assumption that fishing is a recreational, commercial, food, and welfare source and should be preserved for present and future generations. In the publication, international

research programs to support management plans with monitoring and scientific data are encouraged. Furthermore, the involvement of local fishermen by public authorities is firmly advocated.

The aim of this article is to give a complete view of many activities involved in the management of recreational fisheries. In particular, strategies for limitation of biodiversity loss are not interpreted as the application of strict fishing rules, but are discussed in the framework of an appropriate ecological management of the fish ecosystem.

Although modern recreational fishing is directed mainly to frog, fish, and crayfish species, most of the species reported in this paper are sports fish since they represent the majority of exploited species in freshwater environments. The particular case of Pacific salmon angling is reported in the final chapter, since it represents the main ecotourism source referred to in freshwater fishing.

2. History of Fishing

Rudimentary fishing hooks made of wood, stones, flint, shells, or bones were used during the Paleolithic and Neolithic periods (Figure 1). The most primitive hook type was dated 7000 years ago and was found along the banks of the Somme river in France. More elaborated hooks similar to modern ones were produced as long as 5000 years ago and were discovered during archaeological excavations in the Euphrates Valley.

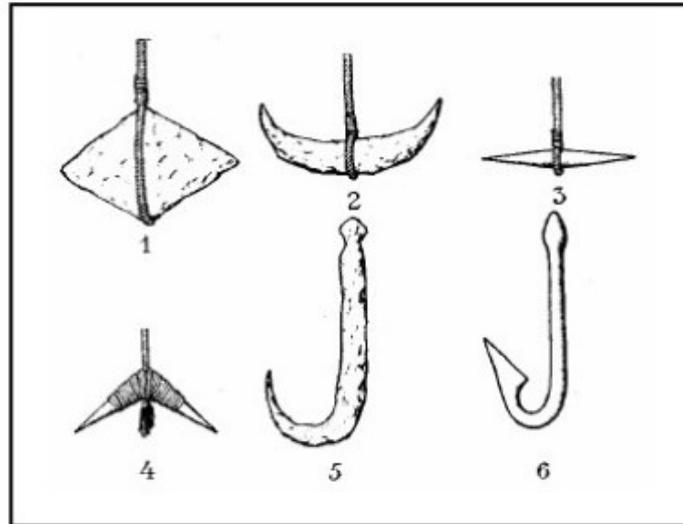


Figure 1. Rudimental fishing hooks used by Scandinavian populations during prehistory Paleolithic hooks made of flint (1, 2) or bone (3); neolithic hooks made with spikes (4), flint (5), and bones (6) from Trecanni (1949). Pesca. *Istituto della Enciclopedia Italiana* Vol. XXVI, pp. 922-939. Rome: Istituto Poligrafico dello Stato.

The most antique representations of populations equipped with rods and lines and experiencing freshwater fishing belong to Assyrian and Egyptian paintings, dated between 2000 BC and 500 BC In these paintings (Figure 2), the vegetation surrounding

the water environment and the animals (cows, birds, and snakes) show the fisherman acting in freshwater. Similar paintings illustrated that rudimentary reels made of wood sticks to wrap around the lines appeared early during the Pharaonic empire.

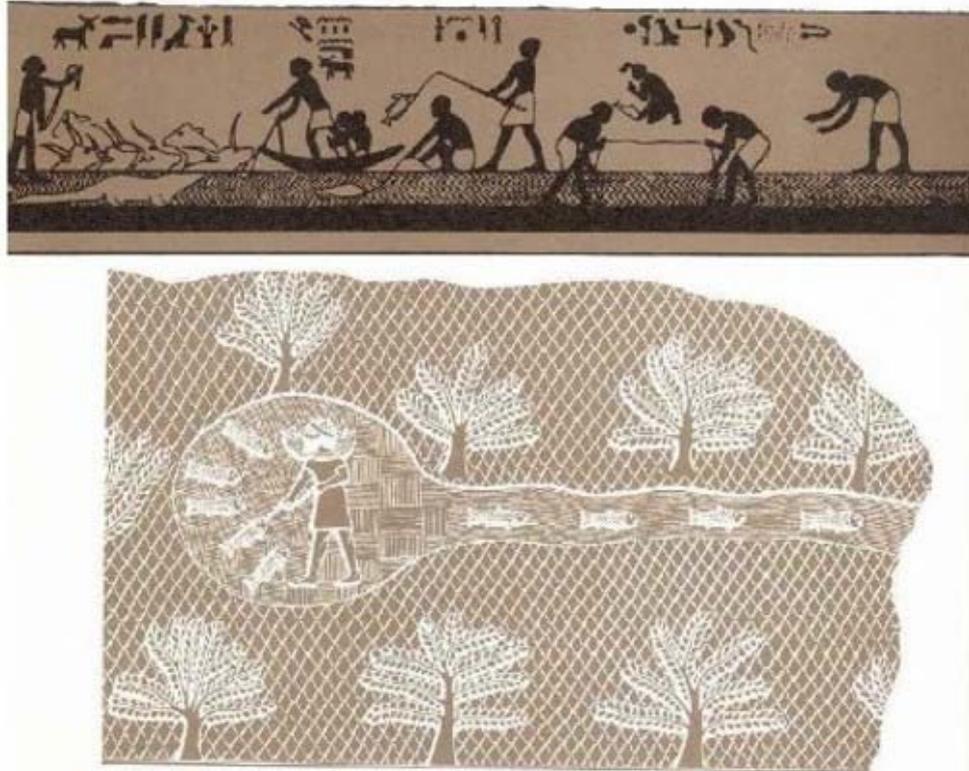


Figure 2. Egyptian (top) and Assyrian (bottom) paintings representing freshwater fishing with rod and line (adapted from Koller L. (1966). History of fishing. *The Treasury of Angling*, pp. 11–21. London: Paul Hamlyn Ltd.)

The first historically documented description of angling, the term used to describe recreational fishing with rod and line, belongs to the Roman rhetorician Claudius Elianus who reported in the *De animalium natura* (about the third century BC) a personal explanation of fly-fishing: “...by wrapping red wool around a hook and fixing it with two reddish feathers taken underneath the cock’s wattles. The fisherman casts the bait, and the fish, suddenly attracted and excited by the colors, approaches and bites: sad and non-joyful the fish sensation but rapid and easy the catch....” These fishermen were Macedonian people fishing on the Astreo river to catch a particular species of trout. Whether or not these Macedonian people were fishing to feed themselves or were fishing just for recreational purposes is not clear. The latter seems more likely, since fishing for population sustenance was generally carried out with more efficient devices, such as traps and nets.

During ancient times, several other authors and wise people mentioned fishing in their treatises. Some of them even suggested different technical approaches to fishing, like the ones mentioned by the Greek writer and philosopher Plutarchus (second century BC), who reported that fishing lines made with horsehair of a stallion were much more

resistant than the ones obtained from a gelding. Furthermore, he was disappointed with people using lines made from mare's tail since these were weakened by the urine.

In general, since ancient times, angling has always been an activity of the rich and wealthy classes. Even antique anglers already knew the four basic features that characterize a real sports fisherman: experience, ecological knowledge, patience, and fantasy. The latter referred to the capability of fishermen of relating strange adventures and enlarged sizes of their own fish.

From a technological point of view, the evolution of fishing has been quite slow. Most of the techniques used during ancient times were also used during the subsequent centuries. As a matter of comparison, hunting has been a more fast-changing sport, particularly after the advent of fire powder and sophisticated guns. For many years, the only variation that occurred in fishing was rod length, which reached 4 m during the fifteenth century AD.

The fifteenth century is considered the beginning of modern fishing as stated in the book written in ancient English *Treatyse of Fysshynge wyth an Angle*, written in 1496 by Juliana Berners, a Mother Superior of the Benedict Convent near St. Albans (England). It was quite curious and disturbing for the male vanity that a woman was the first writer on the "art of fishing." Several other authors copied parts of this book in later years. For example, many fishing strategies suggested by Mother Juliana were reported 20 years later in the book, *The Pleasures of Princes*, written by G. Markham, who was also famous for being the first to introduce Arabian horses into England. The importance of Mother Berners' book resides in the precise ecological observations about insect life and related feeding strategies of fishes. Therefore, a successful angler would have been a man able to use artificial lures similar to natural organisms of the corresponding season. However, as already reported above, Claudius Elianus had already emphasized the importance of proper colors to catch brown trout during the month of May. Whether the Mother Superior had read *De animalium natura* or not is unknown. It must be noted that around the same period recreational fishing was beginning to be abandoned by aristocratic people and became a more popular activity.

Afterwards, Izaak Walton (1653) described in *The Complete Angler* the use of natural baits and new strategies to catch trout, pike, carp, bream, and tench. He firmly asserted that the real art in fishing was to discover new tricks to deceive fishes. He neglected the general convictions that each month deserves a precise bait, particularly for artificial flies, and differences in temperature and water transparency over short periods of time must be considered. A complete fisherman must have wise environmental and ecological knowledge. A new chapter about fly-fishing for trout and grayling was added by Charles Cotton in the fifth edition of the book (1676). He defined fly-fishing as a kind and gentle way of attending streams and rivers. That was the beginning of the still existing "snobbism" in fly-fishing.

Fishing in the United States started in South Hadley, Massachusetts along the Connecticut River at the beginning of the eighteenth century. Recently settled farmers changed their economy from land cultivation to salmon fishing. However, they were too busy to organize their pioneer life, and fishing could not be considered a recreational

activity. In fact, salmon fishing with nets during the fish migration was important to catch large quantities of meat without wasting too much time. On the other hand, the beginning of angling in America was further delayed because of religious beliefs. In fact, at that time inflicting pain on God's creatures was considered evil, unless it was necessary for getting food.

As the time passed by, more and more people started refusing the old moral concepts and different fishing associations were founded. Angling became a gathering occasion for people. Shad, catfish, and perch were caught, to be immediately cooked in outdoor banquets along the river.

A real surge in fishing happened in 1830 along with improving population welfare due to industrial development. The impact of chemical pollution was starting to affect some ecosystems so that wealthy areas had rich fishermen but with poor fish populations whereas wild and unexplored lands had consistent species diversity and richness.

The population of trout and salmon species decreased consistently both in Europe and the United States in the second half of the 1800s because of increasing pollution and over-fishing. In particular, salmon species disappeared in the southern part of New England after 1850. Fish rarefaction favored the discovery and development of new techniques, such as artificial insemination of fish eggs and the building of hatcheries (see Section 4) to support population-enhancement programs. In addition, electric fishing was first officially used in London in 1863. This was an innovative way to catch fish to be farmed or transferred to different areas.

During the same period, fish rarefaction stimulated the introduction of new species. Actually, introduction of non-native fishes all over Europe had started during the Roman Empire, however the phenomenon increased in the 1800s, in connection with the development of artificial insemination techniques. Hence, the problem of the introduction of allochthonous species has an ancient history (see Section 5 for more details on the ecological relevance of the problem). It is interesting to observe that, after the introduction of the English brown trout in the USA around 1870 (the native American trout is the rainbow trout), fishing techniques became very similar on both continents. Nevertheless, the original American anglers usually preferred more colorful flies and spinners because of the efficiency of colorful prey experienced during black bass fishing.

Besides variations in the composition of the fish communities, the fishing culture changed a lot during the second half of the nineteenth century because of technological improvements. For example, flexible bamboo rods made with plants imported from India and Indochina replaced the nonflexible cedar ones. Additional improvements came from the multiplying winch constructed by a Pennsylvania watchmaker with the aim of improving the cast distances to catch bigger bass. After the advent of short flexible rods and the multiplying winch, pike fishing became a successful popular activity, and fewer fishermen were devoted just to salmonids. Concerning artificial lures, the “Skinner Spoon” and the “Four Brothers Spinner” were the first metal spinners to be sold on the market. At that time, fishermen were more concerned about equipment innovations and efficiency, rather than paying real attention to the welfare of

water courses and the fish communities. Although the carbon fiber rod was introduced more than a century later, the modern fisherman was already born and the need for regulation was emerging as a real necessity to preserve life in the water courses.

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Biographical Sketch

Francesco Nonnis Marzano is a biologist and senior researcher at the University of Parma in Italy. He earned his PhD degree in Marine Sciences at the University of Genoa (Italy) in 1994 and had a postdoctoral fellowship in Environmental Pollution in 1996. His academic career has always been devoted both to research and teaching. Main topics of research have dealt with the transfer of radioactive pollutants in marine and freshwater trophic webs. The impact of the Chernobyl accident and nuclear atmospheric tests on Mediterranean and Antarctic ecosystems has been widely investigated by the author. Since 1999, scientific interests have changed and have been mainly directed to the application of molecular genetics to the characterization of animal populations. In particular, molecular taxonomy and conservation genetics of fish populations are the main topics of research. He also teaches Animal Biology at the Pharmacy Faculty of University of Parma and Fish Physiology at the Catholic University of Milan. He is author of more than 50 papers published both in Journal Citation Reports and other journals. He is member of the Italian Ecology Society, the Italian Association of Freshwater Ichthyologists, and the Commission Internationale pour l'Exploration Scientifique de la Mer Mediterranee.