Marine and Estuarine Resource Management

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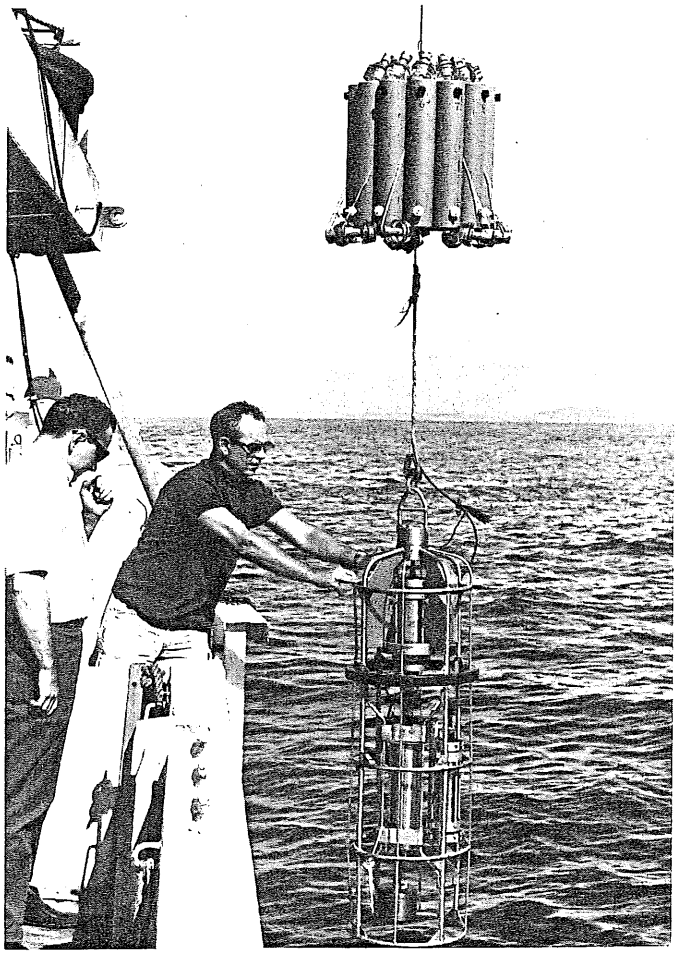
Worldwide demand for fish as food for man and domestic animals, as raw material for industrial processes, and as the target of recreation is growing rapidly. For example, use of fish in Western Europe and North America has increased more than 50 percent since the late 1950s, an increase that demonstrates the expanding importance of the oceans and their estuaries as current and potential sources of protein. Increased use of fish has brought about a need for managing these resources to conserve our present reserves and insure adequate supplies for the future. Marine and estuarine resources management is the scientific profession which addresses the problems of using fisheries resources for the good of society based upon biological, economic, and sociological principles. This chapter provides a broad view of marine and estuarine resource management for those who may seek careers in this field.

The term fish means all the consumable, renewable living natural resources of the oceans and estuaries, including finfish, molluscs,



Lowering an electronically operated instrument that measures salinity, temperature, and depth, and takes water samples to determine the ocean's fertility. (Photo by National Marine Fisheries Service.)

crustaceans, marine worms, sea urchins, marine mammals and reptiles, and seaweeds.

Fisheries resources can be divided into three main categories, according to the areas in which they are found: *estuaries* at the mouths of streams and rivers; *coastal waters* over continental shelves, and *offshore waters* above continental slopes and deep ocean basins.

An estuary refers to a semienclosed coastal body of water with a free connection to the opean ocean, where the saline waters are measurably diluted by freshwater drainage from land (i.e., a stream or river emptying into the ocean). Estuarine ecosystems are characteristically inhabited by unique plant and animal populations that have adapted to the special seasonal and nutrient cycles of this environment. Because an estuary has both marine and freshwater characteristics, it overlaps freshwater resources (see chapter on Freshwater Resource Management), but is arbitrarily included in this chapter.

Coastal waters are the shallow, near shore areas over continental shelves. A continental shelf is the ocean floor formed by underwater extensions of the continents, starting from land and extending oceanward to a depth of 200 meters.

Offshore waters are the deep, mid-ocean areas above the continental slopes and deep ocean basins. Continental slopes (200 to 3000 meters deep) are sea floors that extend beyond the continental shelves at an average inclination of about 4 degrees to the deep ocean basins (3000 to 6000 meters deep). Continental slopes support the largest portion (73 percent) of the earth's water cover.

Most of the marine fish harvest (by weight) is from coastal and offshore waters. The catch from offshore waters consists primarily of finfish and is taken mainly by commercial fishing. Offshore resources are typically harvested with open water fishing gear. Many nations participate in the fisheries and many are regulated by international treaties.

Recreational fishing in the United States and Canada often plays a more important role than commercial fishing in coastal and estuarine harvests and includes more crustaceans and molluscs. Estuaries are also important spawning and nursery areas for many coastal and some offshore fishes. Coastal and estuarine waters usually come under the sovereignty of individual nations, and methods of fishery harvests in these areas consist primarily of inshore fishing fleets.

HISTORY OF THE PROFESSION

Use of marine and estuarine resources dates back thousands of years to man's initial habitation of coastal areas. Oriental and Egyptian cul-

tures heavily exploited ocean resources by about 200 B.C. Fish populations in the Mediterranean Sea were harvested by numerous other nations by about 1000 B.C. Further use of marine resources was evident when European fisheries became prominent about 950 A.D. in the North Sea. The Newfoundland fisheries were developed in the early 1500s.

Marine finfish were the first natural resource to be used on a large scale in America, and fishing was one of our first industries. The first conservation measure in North America was adopted by the pilgrims in the early 1600s when they restricted the use of striped bass for making fertilizer. There was little management of marine resources before the 1800s, however, and harvest was essentially unregulated.

The idea that marine and estuarine resources could be overharvested and might need management arose during the 19th century and precipitated much interest. The modern scientific roots of marine and estuarine resource management might be traced back to the oceanic expeditions of the research vessel *Challenger* in 1873. These expeditions were the first major step toward understanding the oceans. Several resource conservation organizations were created in the United States during the later part of the 19th century. The American Fisheries Society, established in 1870, became the first professional natural resource society of North America. In 1872, the U.S. Fish Commission was formed and instituted fish propagation as its main policy.

During the early 1900s, marine fishing fleets were characterized by rapid expansion and advances in gear technology. The beginning of the 20th century was also marked by the general acknowledgment that some ocean resources had been depleted. Several fisheries commissions and treaties, such as the International Halibut Commission, the International Pacific Salmon Fisheries Commission, and the Bering Sea Fur Seal Treaty were established during this period, primarily to regulate the fisheries. A few, such as the International Council for the Exploration of the Sea, formed in 1902, dealt only with research.

The American Fisheries Society adopted *Maximum Sustainable Yield* as the first North American fisheries policy in 1938. Simply stated, this policy encouraged biological management of fish populations to provide the maximum sustainable number or weight of fish

indefinitely into the future. Implementation of the policy in the 1940s and 1950s revealed that nonbiological factors, such as economics, politics, and social issues, also needed to be considered. One of the most important of these nonbiological factors was that of allocating property or fishing rights for marine fishes, which are a common property natural resource (i.e., a resource which belongs to no single individual or group, but to society as a whole). One of the first efforts at designating these property rights, and thus assuming the cost of using the resources, occurred at the United Nations Law of the Sea Conference in 1958. Satisfactory solutions to the property rights issue have been slow in developing, and serious conflicts still persist.

During the late 1960s and early 1970s, the maximum sustained yield policy underwent conceptual changes and evolved into the policy now being widely endorsed, *Optimum Sustainable Yield*. Theoretically, optimum sustained yield takes into account those factors that maximum sustained yield ignore, such as economical, political, and social considerations of the resource as well as biological factors. With growing concern about the adequacy of U.S. fisheries policy, Congress passed several laws in an attempt to legislate mandatory consideration of certain factors. Two of the most important acts are the Coastal Zone Management Act (1972), which attempts to protect our coastal shorelines from overdevelopment, and the Fishery Conservation and Management Act of 1976, which expanded U.S. territorial fisheries jurisdiction from a 12-mile limit to a 200-mile limit, and legally instituted the policy of optimum sustained yield.

THE PROFESSION DEFINED

Marine and estuarine fishes are harvested by commercial and recreational fishing. Although relative use varies from nation to nation, the monetary value of commercial catches worldwide almost always exceeds that of sport catches. In some areas, such as the United States, however, the expenditures related to recreational fishing are at least as high in total value as is the commercial catch. In the past, conflicts between these primary types of fishing have been evident. Use of nonliving marine natural resources (i.e., oil, coastal development, areas for military uses) has also become progressively more impor-

tant in the management of commercial and recreational fishes since the demand for both types of resources (living and nonliving) has increased.

Management of any natural resource system can be defined as the judicious use of available methodology to accomplish a desired goal. This goal is generally considered the best possible use of the resource, but often varies according to what is being managed and the patterns of use.

Management goals, such as "best possible use of the resource," often resist explicit definitions because they are vague and complicated. As an example, the best possible use of a fishery may call for maximizing commercial catch, profit, or recreational use on a sustained basis, as well as simultaneously protecting the resource and environment from overuse. Since some of these goals may conflict with each other, problems arise in their practical application. In addition, managing marine and estuarine resources is difficult because of the vast size of the oceans, the high commercial value of the resources, and the complications that result because these resources overlap many international boundaries.

Nevertheless, the following general tactics and alternatives are now being applied to management of the oceans and estuaries: control and regulation of harvest and other factors affecting mortality within fish populations; providing, improving, and protecting the habitat from pollution and degradation; propagation and culture of fish to replace or supplement native populations; manipulation of the resource socially, economically, and politically for man's benefit.

Because of the complexity of marine and estuarine resource management, most management plans consist of a combination of these management tactics.

Marine and estuarine fisheries are composed of three basic interacting components: marine and estuarine *habitat* (abiotic component); marine and estuarine *organisms* (biotic component); and *man's use* of these abiotic and biotic components. Because the interactions of the major ecosystem components play a vital role in the way a system will react to various management practices, management of the whole aquatic ecosystem, rather than individual segments of a fishery, is often necessary. Therefore, understanding the principles that govern the overall system is necessary for effective natural resource manage-

ment. This approach to management requires that managers have considerable formal education as a background for contributing to decision-making.

EDUCATION FOR THE PROFESSION

The level of education necessary for careers in marine and estuarine resource management often depends on the type of work desired. Guidance publications on marine and estuarine-related career opportunities describing the kinds of work available are listed in Appendix B. Resource management jobs can generally be grouped according to the type of work involved: technical work; analytical work; administration; extension; consulting; teaching, and research.

Technical level jobs involving routine field or laboratory activities, such as assisting hatchery operations, water quality determinations, or chemical analysis, usually require a bachelor's degree, or sometimes only a high school diploma. Most positions consisting of analytical work, administration, extension, consulting, teaching, or research require at least a master's degree.

Analytical work involves the mathematical analysis and interpretation of fisheries phenomena, and administration consists mostly of overseeing and directing management programs. Fisheries or marine extension agents disseminate and clarify resource management information. Both administration and extension positions often require applicants with Ph.D. degrees and the background for analytical work usually necessitates considerable graduate-level education. Teaching positions are basically restricted to the university level, but research can involve all of the work listed above. Although it is not always restricted to universities, research, as well as teaching, often requires that the candidate have a Ph.D. degree. Consulting problems are typically related to environmental issues and the development of means for reducing damage to the aquatic environment.

Thus, graduate training is often required for the more advanced careers in marine and estuarine resource management, and serious students with ability should include graduate school in their educational plans. Experience and training during the undergraduate years should be directed toward requirements for graduate admission if a higher

level position is desired. On-the-job training, however, still remains an important part of the preparation for marine and estuarine resource managers.

Prospective students in marine and estuarine resource management often are confused when they are attempting to choose an appropriate college or university. Course requirements depend to a large extent on the type of curricula offered at the particular university. Basic courses usually offered in a marine and estuarine resource curriculum include: life sciences; physical and chemical sciences; social sciences, such as psychology and sociology; mathematics; statistics; humanities, including English, technical writing, and public speaking, and economics. The number of courses offered and required within these general areas also varies with the individual college or university.

About 200 colleges and universities teach courses in marine and estuarine resource management. Rapid expansions of curriculums, especially at the undergraduate level, make listing all programs difficult. Accordingly, Appendix A lists only the colleges and universities offering major marine science graduate programs. This list is intended as a general guide rather than an all-inclusive list. Schools offering programs in freshwater resource management (see chapter on Freshwater Resource Management) should not be overlooked, because many of the management principles can be applied to any aquatic environment.

Graduate schools generally require a student to have academic standing in the upper 25 percent of his graduating class, three recommendations, and high scores on verbal, quantitative, and biological Graduate Record Examinations. Skill in writing and public speaking and practical experience can also have a significant influence on admittance to graduate school, especially for those who have less than exemplary academic records.

PERSONAL QUALIFICATIONS

In assessing personal attitudes, prospective employers often look for good academic ability in combination with such factors as enthusiasm, dedication, ambition, ability to work with others, and common sense. These factors are often intangible and are particularly difficult to

evaluate. A strong sense of enthusiasm and dedication can often overcome deficiencies in other qualifications. Personal recommendations are probably the most important barometer of personal attitudes and usually play a decisive role in acquiring a job or gaining admission to a graduate school.

Good physical condition is often a prerequisite for positions requiring extensive field work, such as making field collections, participating in extended cruises, and SCUBA diving. The work is sometimes so strenuous that high physical standards must be met. Most positions, however, such as those in management, administration, and research, do not require unusual physical condition or skills.

EMPLOYMENT

Employment opportunities in marine and estuarine resource management depend on the type of work desired and level of education, as well as the general economic condition of the country. State, federal, and local governments offer all the kinds of work discussed in the previous section, except for teaching. International governmental organizations, such as the Food and Agriculture Organization of the United Nations (FAO) and the Agency for International Development (AID) also afford similar opportunities for general marine work. Careers at universities are basically restricted to teaching, research, and extension. Employment with utilities (power companies), manufacturing industries, and engineering and consulting firms involves administration, some research and analytical work, and extension-type public relations.

Requirements for most jobs in the field of marine and estuarine resource management are being raised as the number of people qualified for positions increases beyond the number of jobs available. It was possible to qualify for a marine research position with a bachelor's degree 10 to 15 years ago, but now a master's degree is often the minimum requirement.

The American Fisheries Society does not now accredit fisheries programs but does certify qualified individuals as fisheries scientists. Minimum certification standards include specified minimum education backgrounds (at least to the bachelor's level) and certain specific course requirements (see Chapter on Freshwater Resource Manage-

ment). Relevant professional experience is also required for certification. The American Institute of Fishery Research Biologists elects qualified individuals to membership as fisheries research biologists. Its standards are similar to those of the American Fisheries Society, but specific professional experience and accomplishments in research are stressed.

The number of active workers in marine and estuarine resource management is difficult to estimate because of the diversity of the work force. In the United States, the number certainly exceeds 10,000. It may be several times this number worldwide.

In assessing job opportunities in marine and estuarine-related careers, compared with certain other fields in natural resources, one can now be cautiously optimistic. Recent legislation dealing with coastal zone management and management of marine fisheries should increase the number of jobs in private industry, as well as in some state and federal agencies. The outlook for the future is uncertain, however, due in part to the dependence of marine resource budgetary allocations of state and federal agencies on the current economic trends in the country. Although some jobs can be expected to become available, the number may be limited.

COMPENSATION AND REWARDS

The financial rewards of careers in marine and estuarine resource management generally follow standards set by civil service agencies and vary depending on workers' education, experience, and geographical location. In recent years, the status of marine and estuarine resource managers has been popularized in the United States by television. Some of these television presentations have portrayed the profession in a glamorous light. It would be an injustice not to note that most of the activities of marine and estuarine resource managers (like all people engaged in scientific professions) are not glamorous, but often consist largely of data collection, analysis, and office work. Careers in marine and estuarine resource management can provide significant personal gratification and offer an opportunity to work outdoors, at least part of the time, in a fascinating field that promises to be of increasing importance in the future.