Chapter 14

WILDLIFE, FISHERIES, AND ENDANGERED SPECIES

CASE STUDY: Threats to Major World Fisheries
Five major ocean bottom fish species are nearing extinction. Two are taken commercially, the other three are 'by-catch'. All are long-lived, ujp to 60 yr, and are slow to reach sexual maturity.

14.1 INTRODUCTION

● Wildlife, fisheries and endangered species have a common history of exploitation, management and conservation. Similar approaches are applied to their management. There are several reasons for wanting to save a species including symbolism and practical concerns about the species as a resource (both realized and potential). The latter could include the potential or realized genetic resources of a species, or as a key member of a biological community.

A CLOSER LOOK 14.1: Reasons for the Conservation of Endangered Species (and Life on Earth)

● The reasons can be classified as utilitarian, ecological, aesthetic, moral and cultural. The utilitarian justification is based on the assumption that many wild species might be useful to us. Considering that most drugs are first found in plants, many of which have not been discovered, and many useful gene products are yet to be discovered, the utilitarian argument is a good one. The ecological justification is based on the idea that every species has a role in a complex web of life, and that ecosystem functions and the stability of ecosystem functions rely on this diversity.

14.2 TRADITIONAL SINGLE-SPECIES

● Species management and conservation began with the single species approach and assumed that a population could be characterized by its population size, that undisturbed the population would stabilize at its carrying capacity, and that the environment was constant. The single species approach failed as none of the assumptions are true. Today goals are stated in terms of the minimum viable population, sometimes the carrying capacity, or sometimes optimum sustainable population size.

● The concept of maximum sustainable population size can be explained by the logistic growth curve: $dN/dt = rN(1-N/K)$, where K is the carrying capacity and r is the intrinsic rate of natural increase. The population size is N and dN/dt is its rate of change. The maximum sustainable yield (MSY) is a rate of harvest, also equivalent to dN/dt, at which N can be sustained at some stable size, and it can be shown that the maximum sustainable yield occurs when N is ½K. Of course the carrying capacity K is not really constant. These concepts are found in legislation such as the 1972 Marine Mammal Protection Act, which includes language about maintaining an optimum sustainable population (OSP). However, the MSY concept has a number of practical limitations, including that it rarely has ever been established for a populations using legitimate scientific methods and is not a constant.

14.3 WILDLIFE MANAGEMENT

● Management of the endangered grizzly bear provides a classic example. This species became endangered because of hunting and habitat destruction. The goal is restoration sounds simple, but restore to what? There is little historical information about its population size, and its present abundance is difficult to ascertain. Its range and approximate population density can be estimated from the records of early explorers. Lewis and Clark recorded 37 encounters with grizzlies over a distance of 1,000 miles. Assuming that sightings were within a 0.5 mile radius, its density can be worked out to be 3.7 per 100 square miles. Working through the numbers, its population across its ranges would have been about 12,000 bears. However, this cannot be proven, so we can only state this as an assumption or premise. Another approach is to ask what is the minimum viable population size. This can be determined with the appropriate experiments and enough time to make the observations. And we can hypothesize that the minimum viable size is X, and we can test this hypothesis, but it is impractical.

● The buffalo provides us with another good management example. This animal was endangered because of hunting pressure. The bison has recovered today, in part because ranchers have found it profitable. Early accounts of their populations indicate that a single herd in the mid 1800s was the size of the entire population today. Making projections based on early accounts, it seems that the original population was probably about 50 million, and the density probably varied quite a bit from year to year.

14.4 IMPROVED APPROACHES

● The International Union for the Conservation of Nature (IUCN) and others have proposed for principles of wildlife conservation: 1) allow for a margin of error in setting a target population size; 2) have concern for the entire biological community and all renewable resources; 3) maintain the ecosystem upon which the species depends; and 4) continuously monitor, analyze and assess.

● One would like to have an estimate of population size over a number of years (a time series) to provide estimates of the historical range of variation. Few such records exist. One exception is the American whooping crane, which declined to a single population of 14 birds in the late 1930s. The crane population is growing and is now up to 420 in the wild and captivity. Based on the natural variation in population density, the probability of extinction can be estimated.

● A population's age structure is also valuable information. In the case of the Columbia River salmon population, a change in age structure was observed over a period of two decades. At first the catch was mostly made up of four-year-olds. Twenty years later, half the catch consisted of three-year-olds and the number of five year olds had declined. The total catch had also declined. These facts suggest that the populations was being exploited to the point where fish were not surviving as long.

● Another method to estimate population size is based on the number harvested, and historical records, or the efforts of different individuals, can be standardized by correcting for differences and changes over time in catch per unit effort. This technique has been used to reconstruct the population of the bowhead whale (Fig. 14.11).
● Summarizing: the modern approach to wildlife management encompasses information on historical range of abundance, estimation of the probability of extinction, use of age structure information, and better use of harvest data.

14.5 FISHERIES

● Fish are an important resource accounting for 16% of the world's dietary protein. The global fish harvest continues to climb due to increases in effort, technological improvements, and aquaculture from 35 million metric tons in 1960 to 72 MT in 1980 and 130 MT in 2001. Commercial fisheries are concentrated in relatively few areas of the world and are dominated by about ½ dozen nations including the U.S. The areas of abundant fish are near shore where nutrient runoff from the land stimulates algal production. Although the global catch has increased, so has the effort, and the catch of individual species has declined (see Fig. 14.15) as has the biomass per fish caught. Evidence that the overall fish populations are declining (80% in 15 yrs, see Fig. 14.15) comes from the catch per unit effort data. Predatory fish populations appear to be about 10% of pre-industrial levels. Species such as codfish are in serious decline and this has led to scientists calling for a total ban on cod fishing in the North Atlantic.
● There are specific regions that have witnessed major declines in fin and shellfish populations. The Chesapeake Bay is one. In addition to the pressure from harvesting, there are additional complications related to eutrophication and species interactions that make cause and effect difficult to determine. See Fig. 14.16 and 14.17. Here, problems have arisen in species despite intensive management efforts that have failed in part because they are based on the logistic growth curve and because fisheries are an open resource subject to the problems of the 'tragedy of the commons'.
● Can fishing ever be sustainable? Possibly not, considering the economic pressure placed on resources by a society that expects growth. Sustainable use requires zero growth, zero growth in utilization that is, and that is not a successful business model.
● Aquaculture is becoming more important, but it has environmental problems too related to water pollution, introductions of disease into native populations, introductions of alien species, and destruction of wetlands.

14.6 CURRENT STATUS OF ENDANGERED SPECIES

● The number of animal species listed as threatened or endangered increased to 5,400 in 2000 (Table 14.2). The IUCN reports that about 25% of all known mammal species, 11% of known birds, and 34% of fish are at risk. In addition over 33,000 species of vascular plants or 12.5% of those known are at risk or have become extinct. Of about 100,000 tree species, about 9% are threatened. 1,000 tree species are threatened in the U.S.

●The words endangered and threatened are defined in the U.S. Endangered Species Act of 1973. The term endangered means any species which is in danger of extinction throughout all or a significant portion of its range, other than a species of the Class Insecta determined … to be a pest and risk to man. The term threatened means any species that is likely to become endangered within the foreseeable future.

A CLOSER LOOK 14.2: Conservation of Whales and Other Marine Mammals

● There is a long history of human exploitation of whales. Included in the group are many species of small whales, or dolphins and porpoises. Conservation of whales has been a concern for many years and attempts to regulate whaling began with the League of Nations in 1924. In 1946 a conference in Washington, D.C. initiated the International Whaling Commission (IWC), and in 1982 the IWC established a moratorium on commercial whaling. Currently, 12 of 80 species of whales are protected. Since the formation of the IWC, no species has become extinct, the harvest has decreased, and some species are recovering. The blue whale is still rare and threatened. The goal of marine mammal management is to prevent extinction and maintain large population sizes, rather than to maximize production.

14.7 HOW SPECIES BECOME ENDANGERED OR EXTINCT

● Extinction is the rule of nature and the ultimate fate of all species. The average longevity of a species has been about 10 million years and the rate of extinction about 1/yr, though there have been mass extinction events in the past, such as the mass extinction of about 53% of marine life that occurred 250 MYBP and the extinction of dinosaurs about 65 MYBP. As recent as 10.000 yrs ago (the end of the last glacial cycle) there were mass extinctions of large birds and mammals (33 genera). These species communicate by sound, and noise pollution from sonar and boat engines is suspected of being a new kind of threat that could disrupt communication.

14.8 HOW PEOPLE CAUSE EXTINCTIONS AND AFFECT DIVERSITY

● Humans cause extinctions by over hunting or harvesting, modifying or eliminating habitats, introducing exotic species (incl. disease, new predators, etc.), and by polluting. About 75% of bird and mammal extinctions since 1600 have been caused by humans.
● Some species have recovered. These include the elephant sea, which was down to a dozen animals around 1900 and now numbers in the 1000s; the sea otter, many bird

A CLOSER LOOK 14.3: Causes of Extinction

● The risk of extinction can be summarized as being due to population risk, environmental risk, natural catastrophe, or genetic risk. The population risk results from the random variations in birth and death rates, which can cause a species in low abundance to become extinct. Population size can decline to dangerous levels due to environmental change (environmental risk) or natural catastrophe. Finally, there is risk from loss of genetic diversity from small population size, which leaves a species vulnerable and unable to adapt.

species, and the blue and grey whales. Since the U.S. Endangered Species Act of 1973, 43 species have recovered.

● Sometimes conservation efforts succeed too well. The sea lion for instance is now a nuisance in some areas. Mountain lions are another example of an animal that has become locally overabundant.

14.9 KIRTLAND'S WARBLER

● Many species adapt to environmental change and require it. The Kirtland's warbler population was seriously depressed in the 1960s when only 201 nesting males were found. This species is known to nest only in jack-pine woodlands in trees that are 6-21 years old, a fire adapted tree species that requires periodic fire in order to survive. Thus, the Kirtland's warbler requires periodic fire in order to renew its habitat, and this was only recently understood. The introduction of controlled burning is now called for in the Wildlife Service's Kirtland's Warbler Recovery plan.

14.10 ECOLOGICAL ISLANDS

The Kirtland's warbler example illustrates how species many inhabit 'ecological islands', in this case in the form of isolated jack pine stands of the right age. Mountain tops, isolated ponds, patches of uncut forest, and parks also serve as ecological islands. How large must an island be to ensure the survival of a species? The size varies by species, but can be estimated. For example, a male lion has a territory that is about 130 km^2 in size, and a viable population would need several males with similar territories, so an adequate preserve would be 640-1,300 km^2.

14.11 SPATIAL RELATIONSHIPS

● The red cockaded woodpecker (RCW) is an endangered bird native to the SE U.S. that makes its cavity in dead or dying pine trees. One of its foods is the pine bark beetle, which is a major pest of the pine trees and an economic liability. How can one manage for the RCW without jeopardizing the pine, which is a major resource with direct economic benefits? It can be done by designing a landscape in consideration of the requirements of each species.

● Spatial relationships are also important in designing corridors between ecological islands and parks for the migration of species.

Critical thinking Issue

● Should wolves be reestablished in the Adirondack Park? This park is the largest in the lower 48 states, but it is a mixture of public and private land and has a population of 130,000 people. The grey wolf is not endangered globally, but it was once a native of the Adirondacks. Coyotes have moved into the park and are potential competitors for prey. The wolf has been introduced into other parks. In the Adirondacks there is suitable wolf habitat, but the prime habitat area that could support about 155 animals, but the area is less than that needed for long term survival of a population. Moreover this prime habitat area is surrounded by human habitation, including cows that could attract wolves. The area is also used by hikers and hunters.

Who should make the decisions about wildlife management?

Should wolves be introduced into this particular park?
● Never Cry Wolf (1963), by Farley Mowat, is an outstanding book that would make an excellent assignment as an accompaniment to Chapter 14. More than a 50 yr ago the Canadian Wildlife Service assigned the naturalist Farley Mowat to investigate why wolves were killing arctic caribou. Mowat's account of the summer he lived on the tundra while studying the wolf population (who were of no threat to caribou or man) is a work that has become a classic of environmentalists.

Web Resources

http://www.iucn.org/ This is the home page of the World Conservation Union.

http://www.iucnredlist.org/ The World Conservation Union list of threatened species.

http://www.fws.gov/ The U.S. Fish and Wildlife Service homepage with the latest on the status of threatened and endangered species in the U.S.