**5. EXTINCTION PROCESS**

**5.1. Introduction**

Some species are survivors. Even a nuclear apocalypse may be to the benefit of cockroaches. In contrast, other species seem quite fragile. Consider the dodo, a bird that has become a symbol for extinction, as in “dumb as a dodo.” The dodo evolved on Mauritius, an Indian Ocean island so remote that no humans inhabited it until 1644. Yet by about 1681 the dodos were gone, victims of hungry colonists and passing sailors who found the birds tasty and easy to catch; dodos were like giant pigeons and had evolved in the absence of predators to be flightless and tame. Of course, the phrase “dumb as a dodo” is unfair to a species that was probably well adapted to its environment, but it does convey the idea that the dodo was ill-prepared for a significant environmental change wrought by the arrival of humans. In this unit we will seek to understand why some species like the dodo are so vulnerable to human-induced extinction.

This section begin by discussing the general characteristics shared by vulnerable species, environmental changes leading species extinction, mechanisms to reduce extinction and rescue and recovery strategies.

**5.2. Why extinction occurs?**

Extinction occurs due to failure of animals to respond to a changing environment. Nature is not stagnant rather it keeps on changing. Besides, evolution is random. Therefore, some evolutionary changes may fit with changed environment and enhance survival and if not, extinction occurs. Moreover, evolution is a slow process but some environmental changes are too fast and abrupt for evolution to respond. This leads to extinction of animals. Environmental changes become faster as a result of human interference.

Sometimes it is difficult to know why some animals become extinct and why others are not. For example, dinosaurs are said to be extinct around 65 mya by meteorite collision and cooling of temperature. However, these impacts on the earth could have wipe out other organisms too.

Natural selection does not guard against the extinction of species. Many adaptations do indeed promote the continued existence of a species but there are also many that result in extreme specialization to unusual environments, restricted habitats, or isolated areas. These species are vulnerable to environmental change.

Extinction is horrible loss to science because animals become extinct with many millions of evolutionary history and unique genetic composition. Evolution cannot be duplicated. i.e., there is no replacement for extinct animals. That is why we should care about species/ population extinction.

**5.3. Why are some species more vulnerable to extinction than others?**

The simple answer to this question is that some species are rarer than others. This answer is intuitively obvious, and there are some convincing data to support the contention that populations and, by extension, species that are comprised of fewer individuals are more susceptible to extinction.

Rarity influences extinction processes because (1) restriction to an uncommon type of habitat, (2) limitation to a small geographic range, and (3) occurrence only at low population densities. Let us examine each of these further.

First, some species are restricted to a rare type of habitat because they have evolved special characteristics that allow them to live there and nowhere else; blind, unpigmented cave-dwelling invertebrates, fishes, and amphibians are good examples of this.

Such species that are confined to a very specific type of habitat may be vulnerable to environmental change. Studies showed that the habitat specialist animals or plants are much more vulnerable to extinction than the habitat generalists.

Second, many rare species are confined to small ranges by geographic barriers such as islands surrounded by ocean, or lakes surrounded by land. For example, over 500 species of cichlid fishes (some researchers have estimated 1000) are endemic to Lake Malawi in Africa.

Rare species are confined to small ranges by geographic barriers has a greater chance of being pushed into extinction by an environmental change than a common species. This is because an environmental event may encompass the species’ entire range whether it is a specific catastrophe (e.g. a volcano eliminating an island) or a gradual change (e.g. immigration of a competitive species). About three-quarters of all the animal species known to have become extinct since 1600 were island species.

Third, species may occur at low population densities for a variety of reasons. Body size is a key reason because, all other things being equal, a large organism requires more space than a small one. This becomes obvious when you consider the extensive home ranges of large animals. Organisms may also live at low population densities if the resources they require are scarce and dispersed.

Species with low population densities usually affected by demographic problems (e.g. unbalanced sex ratio) and genetic problems (genetic drift, inbreeding, and bottlenecks) can also lead to extinction of small populations.

* 1. **Why are some species particularly sensitive to human induced threats?**

Population size and distribution are not perfect predictors of a species’ vulnerability to extinction, especially when human impacts are involved. In 1813 when John James Audubon camped on the shore of the Ohio River, watching a flock of passenger pigeons that stretched from horizon to horizon and took three days to pass, he could not have guessed that just 70 years later the species would be decimated and by 1914 extinct. Conversely, consider another species from the same region, the Virginia round-leaf birch, which was so rare that it remained undiscovered until 1914, when four individuals were found. Despite this precarious state – it was lost by scientists from 1914 to 1976 – it persists today in spite of its rarity. Here are *four* primary characteristics that tend to predispose a species, even one that is not necessarily rare, toward problems with changes people make to the environment.

1. *Limited adaptability and resilience*

Some species have a limited ability to adapt to change or to recover from a disturbance because of their low reproductive capacity (small number of progeny, long generation time, etc.), limited dispersal capabilities, inflexible habitat requirements, and so on. Contrast an African elephant that can produce only one young every five years with various insects. For example, a female fruit fly can lay 100 eggs and have 25 generations per year, theoretically leading to 1041 progeny in one year. Moas, giant flightless birds of New Zealand, likely were vulnerable to loss of adults, primarily through hunting, rather than as a result of habitat destruction, because they laid few eggs and bred very slowly..

1. *Human attention*

Some species suffer because they are singled out for attention from people. In the case of dodos, passenger pigeons, and many other species, being deliciously edible was their enemy. A turtle – the diamond-backed terrapin – thrived at remarkable densities in salt marshes along the eastern and southern US coastline until the early twentieth century, when a crazy craving for the turtle soup nearly killed it off.

On the other hand, some species are persecuted because they are very unpopular. Witness what happens to most bats, snakes, spiders, and wild canines (especially wolves, African wild dogs, and dholes (Asian wild dog)) when they are unfortunate enough to have a close encounter with a human.

Consider also the aye aye, a lemur of Madagascar, which is burdened with a nearly island-wide taboo that associates the act of seeing the animal with ensuing ill fortune. Rural Malagasy kill aye ayes that leave the forest and approach villages, particularly when farm plots attract aye ayes during seasons of food shortage.

1. *Ecological overlap*

Many species are threatened with extinction because they are tied to the types of ecosystems preferred by people. Humans have thrived in places with fertile soils and benign climates, and organisms that are restricted to these sites have usually lost out to our agriculture and cities. For example, rivers are focal points of human activity because they provide water, transportation corridors, waste disposal, and hydroelectric facilities, and as a consequence, many riverine species (such as fishes) are in great jeopardy.

1. *Large home-range requirements*

Conflicts caused by overlapping habitat will be exacerbated if the organism requires large areas of land to roam. For example, a wolf pack needs hundreds of square kilometers to survive. But they cannot allow co-existence with human.

* 1. **Major factors caused by humans leading wildlife population to extinction**

The extinction of a species does not differ in kind. The species goes extinct because the last population of that species goes extinct. Here we review actual extinctions or near extinctions to show what are the commonest causes of extinction in practice.

Much extinction occurs as a result of human interference. Adverse human interferences influence population density negatively and lead them to extinction by other factors. The most common man made causes of extinction are:

1. *Habitat change*

Habitats supply numerous attributes: food, protective cover from predators, denning sites, shelter from inclement weather, and access to mates. This means that habitat needs are probably unique for every species. The most serious challenge currently facing most threatened bird and mammal species is habitat contraction and loss. It is specialists (those species whose survival depends critically on particular, usually rare habitats for survival and successful reproduction) than generalist animals for whom habitat loss is most crucial.

Forms of habitat loss are:

* Fragmentation of continuous habitats in to patches
* Decrease in patch sizes, and
* Distance between patches of habitats

Fragmentation is seen most commonly in the transformation of forest or woodland or grassland into farmland, or residential area, or other land use system.

Fragmentation of habitat has a number of consequences such as:

1. Species that require interior forest habitats (many bird species), away from the edge, experience reduced habitat and hence population reductions
2. Species that need to disperse through intact habitat (many reptiles, amphibians, ground-dwelling insects) are prevented from doing so and their populations are reduced to isolated pockets with potential demographic and genetic consequences.
3. The greater length of habitat edge allows incursions of predators from outside the patch, increasing the predation rate on interior forest species

On the other hand, small patches can support only small number of individuals. Usually if population size is small, that population is liable to extinction due to various extinction agents. Besides, colonization rates tend to be low when patches are widely spaced.

1. *Pollution or pesticide contamination*

Prairie dog a squirrel-like rodent, was extinct in North America by being poisoned since it is seen as pests by ranchers, competing sheep and cattle for grass and their burrow create problem for horse riders. The Black-footed ferret also extinct as the result of extinction of its prey, the prairie dog, which constitute about 90 % of its food. They also had known to use their burrows.

1. *Introduction of exotic species (predators or competitors)*

The first major way in which humans wreak havoc on threatened species is through modification of trophic relationships within a pre-existing community. Often this is via introduction of a competitor and/or predator for which an endemic species is poorly prepared. This is particularly common for endemic species on islands that have evolved for considerable periods without risk of predation. Such species are poorly equipped to cope with a novel predator, because no adaptation has been developed for so. This sets the scene for a brief, but sadly inevitable, slide into extinction once a novel predator has arrived.

A particularly graphic example is the brown tree snake (*Boiga irregularis*), that was introduced onto the island of Guam in the 1950s. In the course of two decades, this generalist predator has spread rapidly across the island. This range expansion coincided with the rapid decline and (in some cases) disappearance of 11 native species of forest birds on the island.

1. *Infectious disease such as avian malaria*

Extinctions caused by disease are particularly difficult to identify in retrospect. Moreover, on theoretical grounds disease is unlikely to be a common agent of extinction. In their review of pathogens and parasites as invaders, researchers noted the improbability of a parasite or pathogen driving its host to extinction unless it had access to alternative hosts.

Avian malaria and avian pox have been suggested as contributing to the decline of the Hawaiian birds. Migratory waterfowl may have provided a reservoir for avian malaria on the Hawaiian Islands, and the continuous reintroduction by migration may have maintained a high level of infection in the face of a decline in host numbers. Originally, there were no mosquitos on Hawaii capable of spreading malaria. The accidental introduction of mosquitos in 1826 and their rapid spread throughout the islands coincided with the decline of many species of birds.

1. *Unregulated or poorly regulated commercial and recreational hunting*

Species, whose male ornaments (horn, tusks, antlers, or other body parts) make them particularly attractive to humans, render them prone for hunting. There are several obvious examples: black rhinos, elephants, and big cats (lions, leopards, and tigers). When the profit from a rhino horn can exceed a rural African’s expected income for a decade, it is not surprising that overharvesting occurs.

In many cases, the ornaments of interest appreciated in value as animals get mature (breeding age). When successful breeding depends on having adequate numbers of mature males, it may make a good deal of conservation sense only to harvest the oldest males, who have already bred, rather than harvest indiscriminately. Unregulated commercial hunting reduced the muskoxen (*Ovibos moschatus*) on the arctic mainland of Canada to about 500 animals by 1917.estimated that a minimum of 21,000 muskoxen were taken between 1860 and 1916.

* 1. **How to reduce rate of extinction**

The first step in averting extinction is *to recognize the problem.* Many species have slid unnoticed to the brink of extinction before their virtual absence was noticed. The smaller mammals and birds, and the frogs and reptiles, are more likely to be overlooked than are the large ungulates and carnivores.

The second step is *to discover how the population got into its present mess*.

• Is the cause of decline a single factor or a combination of factors?

• Are those factors still operating?

• If so can they be nullified?

The cause of a decline is established by application of the researcher’s skill: the listing of possible causes and then the sequential elimination of those individually or in groups, according to whether their predicted effects are observed in fact. This is the standard toolkit of hypothesis production and testing.

It is essential that the logic of the exercise is mapped out before the task is begun. The listing of potential causes is followed by a formulation of predictions and then a test of those predictions. The efficiency of the exercise is critically dependent on the order in which the hypotheses are tested. Get that wrong and a 3-month job may become a 3-year project. In the meantime, the population may have slid closer to the threshold of extinction, so time is important.

Use the following example of the decline of caribou on Banks Island in the Canadian arctic and try to arrive on the cause of extinction by hypothesis production and tasting.

The first aerial surveys of the island in 1972 revealed an estimated population of 11,000 caribou. Subsequent surveys in the 1980s traced a dwindling population that numbered barely 900 caribou by 1991. Since then the population has stabilized, being 1,195 in 2001. The muskoxen during the same time increased from 3000 to 46,000, leading to fears that there were too many muskoxen for the good of the caribou. The population continued to increase to 64,600 by 1994, and then slowed to about 69,000 by 2001. Particularly severe winters restricted foraging for the caribou and caused die offs, at least in 1972–73 and 1976–77. The frequency of severe winters with deep snow and freezing rain increased during the 1970s and 1980s. Caribou and muskoxen differ in lifestyles and responses to winter weather.

**Table 5.1.** Hypotheses to be tested to discover the cause of the decline of caribou on Banks

Island, Northwest Territories of Canada.

|  |
| --- |
| Hypotheses to account for the decline of caribou:  Either:  A Food shortage  B Increased predation  If (A) then mechanisms may be  A1 Increase in weather events such as freezing rain that affect availability of food  A2 Competition for food with muskoxen which are increasing  A3 Caribou themselves reducing the supply of food  If (B) then mechanisms may be  B1 Wolf predation  B2 Human predation  The food shortage hypotheses (A) may be tested against the predation hypotheses (B) by checking body condition. Hypotheses A predict poor body condition and low fecundity during a population decline; hypotheses B predict good condition and high fecundity during a decline.  If this test identifies the A hypotheses as the more likely, then A1 is separated from A2 and A3 by its predicting a positive rate of increase in some years. A2 and A3 predict negative rates of increasein all years.  A2 (competition with another species) is separated from A3 (competition between caribou) by checking for concomitant **decline of caribou where muskoxen are not present in the same climatic zone.** |

* 1. **Rescue and Recovery of Near Extinctions**

Once a decline in a species is recognized and the causes are determined, the problem can be treated. There are ranges of management actions available to rescue a species from the risk of extinction. Sometimes, all it takes is a legislative change such as a ban on hunting (as with the Canadian muskoxen). More usually, active management (such as predator control and captive breeding) is necessary. The management actions needed to reverse the fortunes of a declining species is seldom more than conventional management techniques unless a species is in desperate straits. However, if the species is in desperate straits, then a whole new set of techniques may be called under the heading of *ex situ*. *Ex situ* techniques preserve and amplify a population of an endangered species outside its natural habitat. Thereafter it can be reintroduced. The Lord Howe Island woodhen and the Arabian oryx are examples of such reintroductions. Reintroducing a species to the area from which it died out should not be attempted without some understanding of why the species went extinct there in the first place.

Before and during reintroduction

1. the number of introduce animals should be large enough to avoid demographic stochasticity. In any event, the number of introduced animals should be large enough to avoid demographic stochasticity.
2. a trial liberation should precede any serious attempt to repopulate the area, especially when the cause of extinction is unknown and when we do not know the factors still operating or not. The first individual animals forming the probe are instrumented where possible (e.g. with radiocollars) and monitored carefully to determine whether they survive and multiply or, if not, the cause of their decline. If they decline, the factors operating against the species can be identified and countermeasures can then be formulated.
3. a closely related species may be used as a probe when it is too risky to use individuals of the endangered species. For example, a successful probe release of Andean condors (*Vultur gryphus*) cleared the way for the release of two California condors from a captive breeding population.