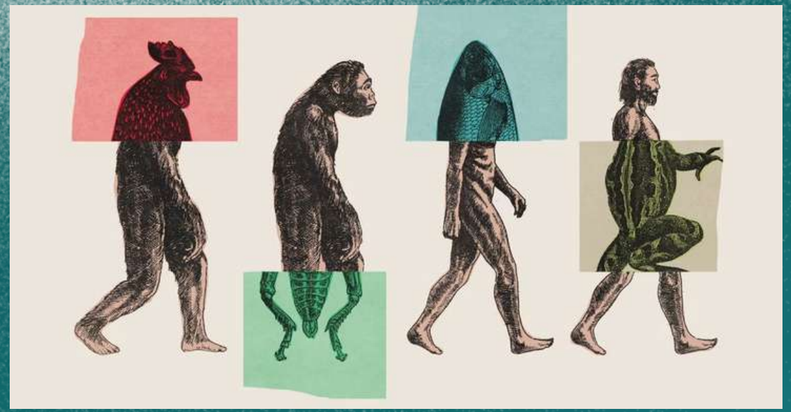
from: Essentials of Conservation Biology. Fifth Edition.

Problems of Small Populations

Presented by : MARIEM BANNOUR



MSC ENVIRONMENTAL SCIENCE

Plan

- Essential Concepts for Small Populations
- Demographic Variation
- Environmental Variation and Catastrophes
- Extinction Vortices
- Problems of small population in Tunisia

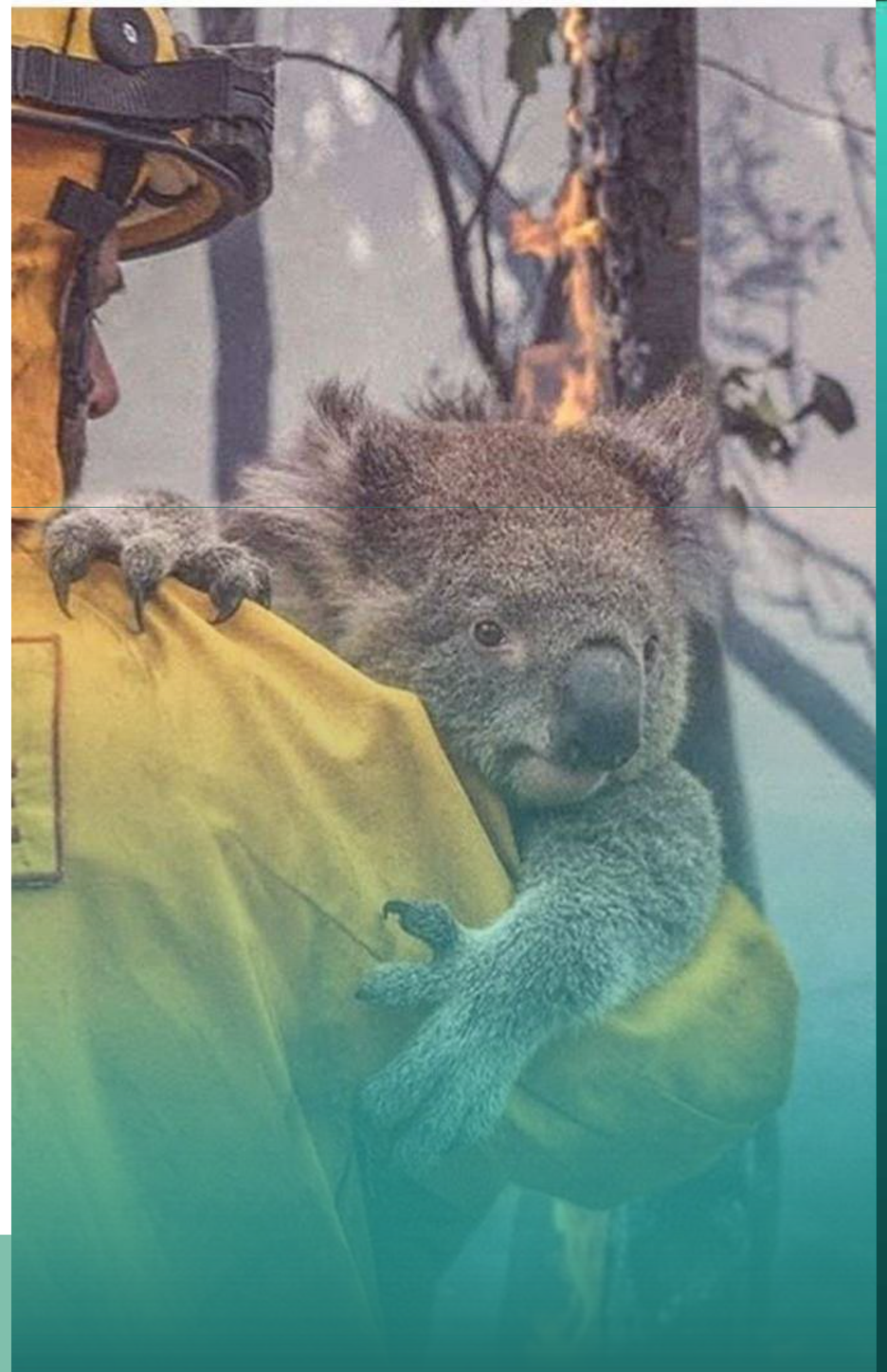
Essential Concepts for Small Populations

Definition:

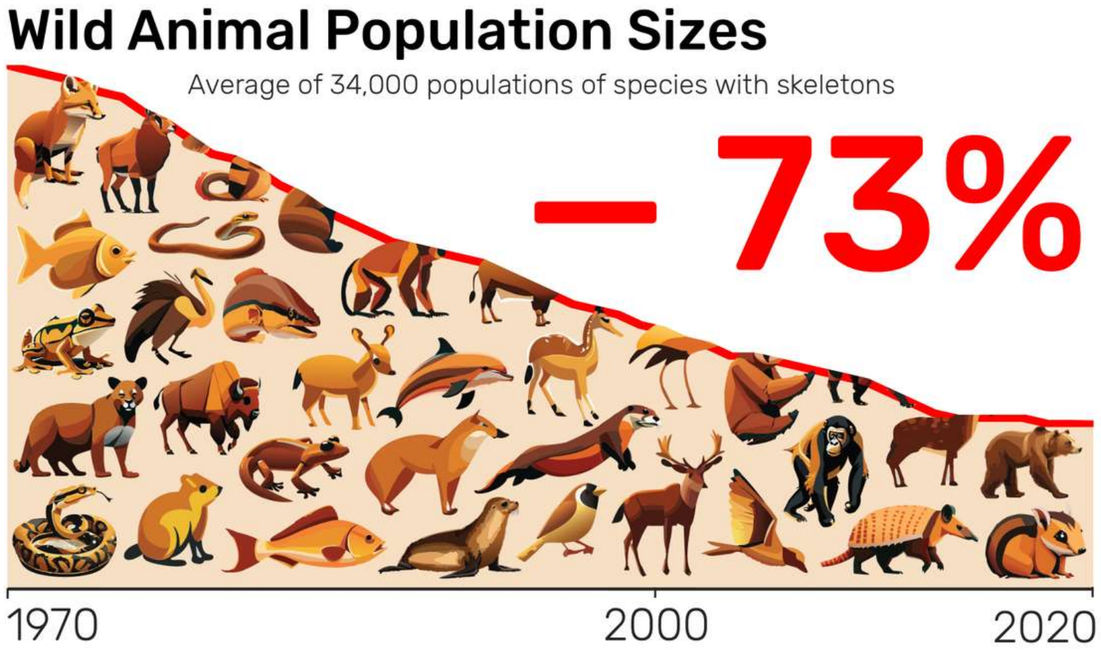
No population lasts forever Changing in climate, succession, disease, and a range of rare events ultimately lead every population to the same fate: extinction.the extinction of species as a result of human activities is now occurring more than 100 times faster than the natural rate of extinction-far more rapidly than new species can evolve. Because an endangered species may consist of just a few populations, or even a single population, protecting populations is the key to preserving species; it is often the few remaining populations of a rare species that are targeted for conservation efforts. In order to successfully maintain species under the restricted conditions imposed by human activities .

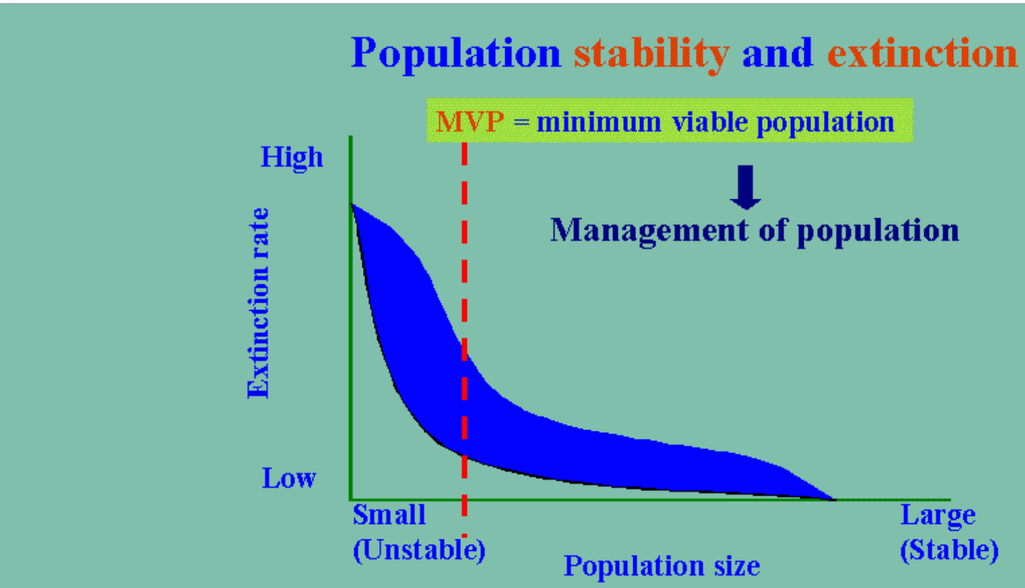
Many national parks and wildlife sanctuaries have been created to protect II charismatic" megafauna such as lions, tigers, rhinos, bison, and bears, which are important national symbols and attractions for the tourist industry.

An ideal conservation plan for an endangered species would protect as many individuals as possible within the greatest possible area of high-quality, protected habitat.



conservation plan





Plans for protecting a species must determine the number of individuals-the minimum viable population necessary to maintain the species in both average and harsh years. Protected habitats of adequate size to maintain the MVP can then be established.

In a groundbreaking paper, Shaffer (1981) defined the number of individuals necessary to ensure the long-term survival of a species as the minimum viable population, or MVP it is a minimum viable population for any given species in any given habitat is the smallest isolated population having a 99% chance of remaining extant for 1000 years despite the foreseeable effects of demographic, environmental, and genetic stochasticity, and natural catastrophes." In other words, the MVP is the smallest population size that can be predicted to have a very high chance of persisting for the foreseeable future

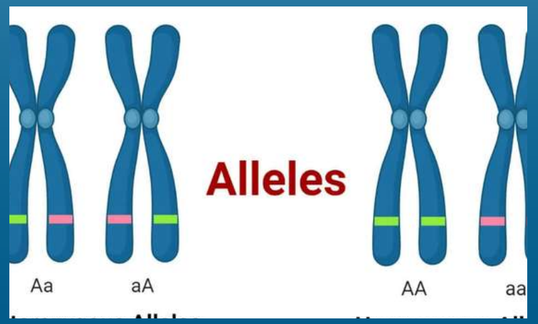
The key point is that the MVP size allows a quantitative estimate to be made of how large a population must be to ensure long-term survival.

Loss of Genetic Variability

a population's ability to adapt to a changing environment depends on genetic variability, which occurs as a result of individuals' having different alleles-different forms of the same gene. Individuals with certain alleles or combinations of alleles may have just the characteristics needed to survive and reproduce under new conditions

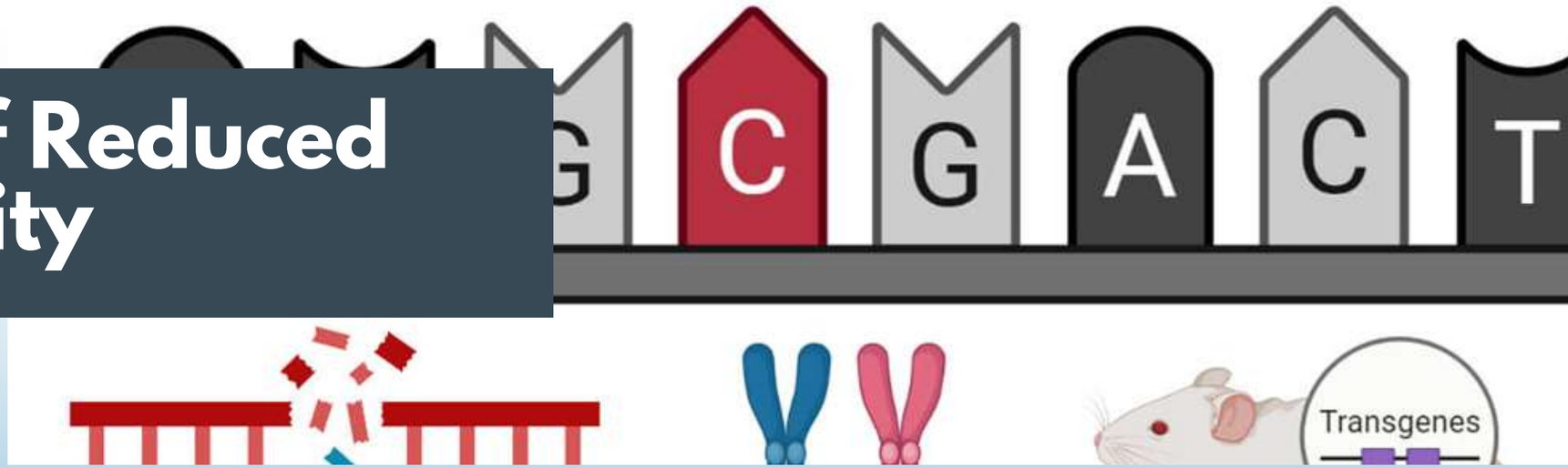
In small populations, allele frequencies may change from one generation to the next simply because of chance-based on which individuals survive to sexual maturity, mate, and leave offspring. This random process of allele frequency change is known as genetic drift, and it is a separate process from changes in allele frequency caused by natural selection (Hedrick 2005) .When an allele occurs at a low frequency in a small population, it has a significant probability of being lost in each generation

However, in a population of 10 individuals, only 1 copy of the allele is present and it is possible that the rare allele will be lost by chance from the population in the next generation.



Genetic variability is lost randomly over time through genetic drift. This graph shows the average percentage of genetic variability remaining after ten generations in theoretical populations of various effective population sizes (Ne). After ten generations, there is a loss of genetic variability

Consequences of Reduced Genetic Variability



- Once a small population loses genetic variation, it is likely to enter a downward spiral of reduced population size and even less genetic variation in each generation. This loss of diversity, often caused by small population sizes or bottlenecks, increases the risk of extinction due to the accumulation of harmful mutations.

- Key Consequences of Reduced Genetic Variability:

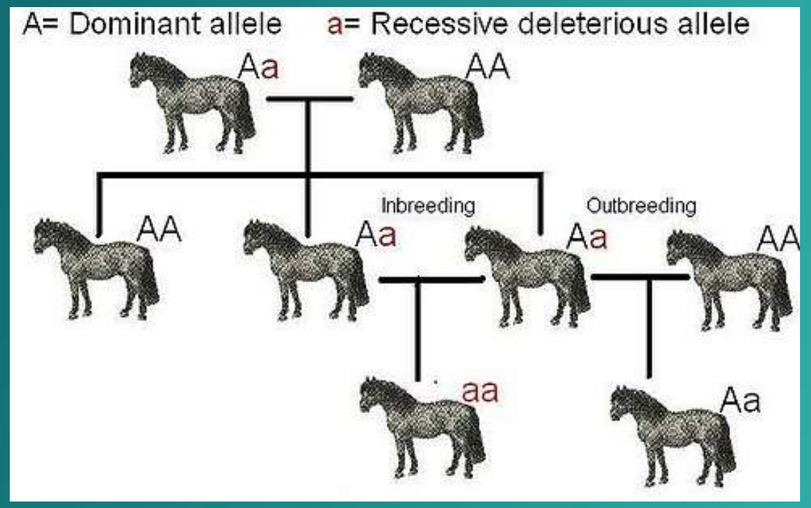
  INBREEDING DEPRESSION

  OUTBREEDING DEPRESSION

  LOSS OF EVOLUTIONARY FLEXIBILITY

INBREEDING DEPRESSION

Inbreeding depression occurs when closely related individuals mate, causing offspring to inherit harmful recessive alleles from both parents. This leads to higher mortality, fewer or weaker offspring, sterility, and reduced reproductive success. It is common in small populations where individuals cannot find unrelated mates. Studies in humans, animals, and plants show that inbreeding reduces fitness. For example, small populations of plants and animals often show lower fertility and survival, but introducing individuals from genetically diverse populations can restore health and reproduction.



OUTBREEDING DEPRESSION

Outbreeding depression happens when individuals from different species or distant populations mate and produce offspring that are weak, sterile, or poorly adapted to their environment. This occurs because the genetic systems of the parents may be incompatible. A common example is the mule, a hybrid of a horse and donkey, which is usually sterile. In conservation, mixing very different populations can sometimes reduce survival if hybrids are not suited to local conditions.

LOSS OF EVOLUTIONARY FLEXIBILITY

Genetic variation is essential for the long-term survival and adaptability of a species. Evolution does not anticipate future environmental conditions; therefore, populations rely on existing genetic diversity to adapt when conditions change. Rare alleles or unusual combinations of genes may not provide any immediate advantage and may even be slightly harmful under current conditions. However, if environmental conditions change, these rare genetic traits might become beneficial, allowing the individuals that carry them to survive and reproduce more successfully. Natural selection would then increase the frequency of these advantageous alleles in the population.

When populations become small and genetic variation is lost, their ability to adapt to new challenges decreases. Environmental changes such as pollution, emerging diseases, or climate change may require specific genetic traits that a small population no longer possesses. According to the fundamental theorem of natural selection, the rate at which a population can evolve depends directly on the amount of genetic variation it contains. For example, some plant populations contain individuals with genes that allow them to tolerate high levels of toxic metals like zinc or lead. If pollution introduces these metals into the environment, individuals with such genes will survive and reproduce better. However, if a population has already lost these genes due to reduced genetic diversity, it may not be able to adapt and could eventually become extinct.

Demographic Variation

as long as population size is large, the average birthrate provides an accurate description of the population. Similarly, the average death rate in a population can be determined only by examining large numbers of individuals, because some individuals die young and other individuals live a relatively long time. This variation in population size due to random variation in reproduction and mortality rates is known as demographic variation or demographic stochasticity. Population size may fluctuate over time because of changes in the environment or other factors without ever approaching a stable value. In general, once population size drops below about 50 individuals, individual variation in birth and death rates begins to cause the population size to fluctuate randomly up or down

POPULATION DENSITY AND THE ALLEE EFFECT

Many small populations are demographically unstable because social interactions (especially those affecting mating) can be disrupted once population density falls below a certain level

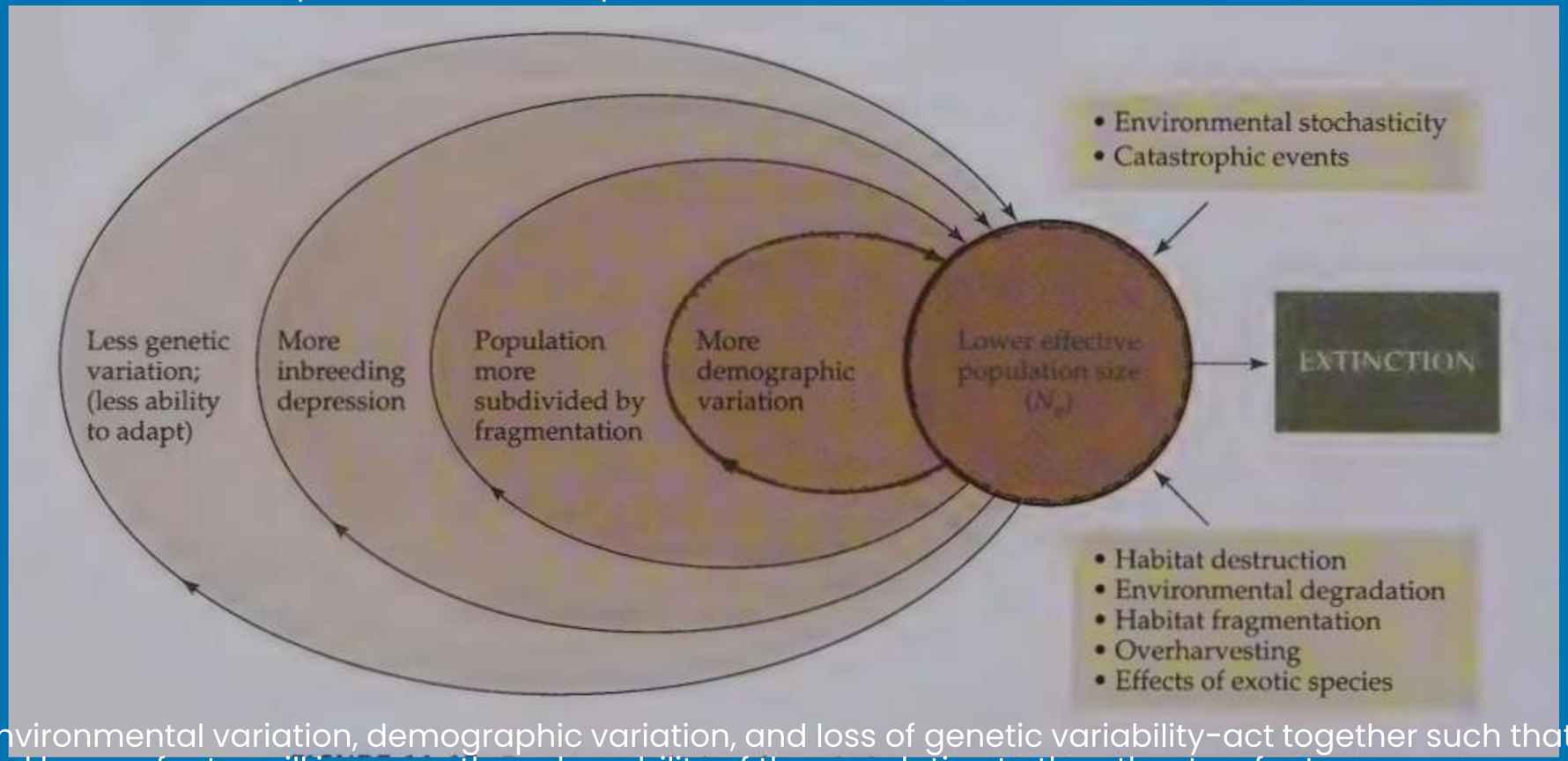
Demographic variation refers to random differences in survival and reproduction among individuals in a population. Even when environmental conditions remain stable, individuals may produce different numbers of offspring, die at different ages, or fail to reproduce at all. These chance differences cause fluctuations in population size from one generation to another.

Demographic variation has the greatest impact on small populations. In a small group, random events such as several individuals failing to reproduce or dying early can significantly reduce the population size. In contrast, large populations are less affected because the effects of chance differences are balanced by the large number of individuals.

Because of these random fluctuations in births and deaths, small populations face a higher risk of population decline or extinction. For example, if a small population produces very few offspring in a particular year, it may not be able to recover easily. Therefore, demographic variation is an important factor influencing the survival and stability of small populations.

EXTINCTION VORTICES

The smaller a population becomes, the more vulnerable it is to further demographic variation, environmental variation, and genetic factors that tend to lower reproduction, increase mortality rates, and so reduce population size even more, driving the population to extinction. This tendency of small populations to decline toward extinction has been likened to a vortex, a whirling mass of gas or liquid spiraling inwardthe closer an object gets to the center, the faster it moves. At the center of an extinction vortex is oblivion: the local extinction of the species. Once caught in such a vortex, it is difficult for a species to resist the pull toward extinction



These three forces-environmental variation, demographic variation, and loss of genetic variability-act together such that a decline in population size caused by one factor will increase the vulnerability of the population to the other two factors

It is also important to remember that as a population becomes smaller, it also tends toward becoming ecologically extinct: once the oranguta population drops below a certain size, for example, the species would not be an effective seed disperser in the community.

small population problems in Tunisia

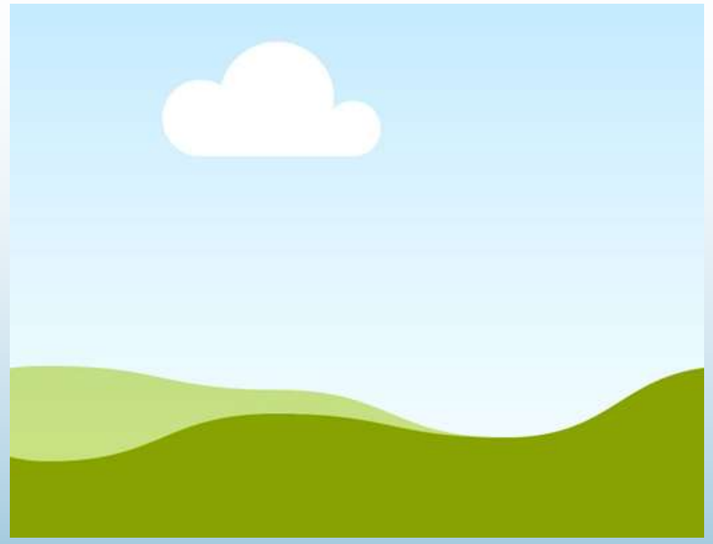
LAST OF THE MHORR GAZELLES DIES IN TUNISIA, ANOTHER SPECIES EXTINCT

The last of the Mhorr gazelles has died, and the species has been snuffed from life in the wild and declared extinct in Tunisia.

The Tunisia Wildlife Conservation Society (TWCS) reported that the gazelle, which lived in the Bou-Hedma National Park in Tunisia, died of natural causes. The Mhorr or Dama gazelle, once common in the arid and semi-arid Sahara desert, used to roam Tunisia, Chad, Mali and Niger but little was done to ensure the survival of this now extinct species.

The extinction of the Mhorr gazelle was far from natural: it was driven by overhunting and habitat loss.

Spokesperson for the Animal Survival International (formerly Political Animal Lobby), Nicolette Peters, mourns the loss of the Mhorr gazelle, saying, “ASI is devastated that we have lost yet another species from earth. Again, we are reminded that it is humans that are driving ecological devastation on the planet. We must redouble our efforts to preserve ecosystems and animals in the face of a voracious and uncaring world economy.”



Tunisia’s Endangered Water Birds

Tunisia’s coasts and islands serve as an important breeding ground for a variety of sea birds. These birds migrate from the north of the Mediterranean to the Tunisian shores to nest and reproduce, taking advantage of the diverse array of habitats and resources available in the region. Among these sites, Zembra Island stands out as a hotspot for many bird species.

despite their captivating existence, these winged wonders find themselves ensnared in the clutches of threats that mirror the challenges faced by their land-dwelling counterparts.

A recent report titled State of the World’s Birds 2022, presented by BirdLife International, reveals a shocking truth: seabirds stand among the most imperiled avian groups on our planet. The statistics paint an alarming picture, revealing that a staggering 30% of seabird species are teetering on the precipice of extinction. Within this group, the situation is even more dire, as 19 species cling desperately to survival in the Critically Endangered category, 34 hover on the edge of Endangered, and 58 teeter on the brink of Vulnerable. Additionally, an alarming 11% of species are classified as Near Threatened, while a disheartening 57% face a downward trajectory, their populations dwindling.

AQUATIC BIRDS CAUGHT BETWEEN POLLUTION AND THE MENACE OF GHOST FISHING

Alongside habitat loss and pollution are other major threats to aquatic birds in Tunisia. Industrial and agricultural runoff, sewage and oil spills can contaminate water sources, making it difficult for birds to find clean water for drinking and bathing.

Oil pollution in the sea can be devastating for aquatic birds, causing them significant distress and suffering. The oil sticks to their feathers, making them heavy and impairing their ability to fly, swim, and find food . Furthermore, “Birds can easily mistake plastic debris for food, which can lead to ingestion and death. “Plastic can entangle birds, making it difficult for them to move and feed, ultimately leading to their demise.”

Despite being illegal, hunting and poaching continue to pose a significant risk to aquatic bird populations in Tunisia. Birds are often hunted for their meat by hunters and sometimes fishermen

CONCLUSION

In conclusion, animals in Tunisia and around the world are facing many serious threats such as extinction, pollution, and illegal hunting. These dangers are causing many species to disappear and disturbing the natural balance of ecosystems. If these problems continue, wildlife and biodiversity in Tunisia could be greatly damaged.
Therefore, it is very important for people to protect animals and their habitats. Governments should enforce stronger laws against hunting and pollution, while communities should become more aware of the importance of wildlife. By working together to reduce pollution, stop illegal hunting, and protect natural environments, we can help ensure that animals survive for future generations. Protecting animals means **protecting the balance of life on Earth.**