Dispersal

What is dispersal?

Dispersal is an ecological process that involves the movement of an individual or multiple individuals away from the population in which they were born to another location, or population, where they will settle and reproduce. The two most common forms of dispersal are:

Natal dispersal. Natal dispersal is the first movement of an organism from its birth site to the site in which it first attempts to reproduce.

Adult dispersal entails changing location in space after reaching reproductive maturity, usually involving movement from one habitat patch to another.

Another type of dispersal that does not fall into these two categories is **gamete dispersal**, which is especially common for non-motile adult individuals, such as plants. Relocation to a new site is a usual part of the life cycle of many plants and animals and is viewed as an adaptive trait in life history.

Active and Passive Dispersal

Individuals can disperse either actively or passively.

Active dispersal involves movement of the entire organism through its own ability and is common in both adult and juvenile animals. The degree of adult and/or juvenile dispersal will vary among species depending on a variety of factors, including (in part) the social structure. For example, social systems that rely on a single adult male for reproduction (e.g., a harem* breeding system) forcing juvenile males born into a particular unit to disperse. Active dispersal, in general, is thought to be a **density-dependent** process in that its magnitude depends on local population size, **resource competition,** and **habitat quality and size**. However, local population conditions may affect juveniles and adults differently, resulting in varying degrees of dispersal between different age groups.

(***Note**:- A **harem** is an animal group consisting of one or two males, a number of females, and their offspring. The dominant male mates with the females as they become sexually active and drives off competitors, until he is displaced by another male.)

Animals that are highly vagile* are considered to be the most efficient at active dispersal. Highly vagile animals include many species of birds, bats, and large insects. The Monarch butterfly (*Danaus plexippus*) is a notable example of a highly vagile insect capable of flying hundreds to thousands of kilometers. Other animals, which cannot fly, are also considered highly vagile. Large aquatic animals are effective dispersers, and some terrestrial animals can disperse large distances on foot. As a result, highly vagile organisms have the greatest capacity for long-distance dispersal. Despite the intrinsic vagility of a species, the extent of dispersal is linked to **restrictions imposed by the habitat**. Flying animals are less affected by habitat changes because they can bypass barriers by flying over or around them. Additionally, there are fewer barriers in the ocean than on land, so large aquatic species can disperse large distances unimpeded. Dispersal by terrestrial animals is generally considered less effective or energy-efficient because individuals are forced to travel through unfavourable habitats, and contend with **potential geographic barriers**.

(***Note-Vagile**-Able or tending to move from place to place or disperse)

Passive dispersal involves both plants and animals that cannot themselves move but use dispersal units called **disseminules** to aid in reproduction or the exploitation of new habitats. Many disseminules are adapted for movement by specific dispersal agents available in the environment, like wind, water, or another animal capable of active dispersal, or species may have a motile larval stage. Sessile adult animals that utilize passive dispersal include marine invertebrates like sponges and corals. Their disseminules are typically specialized buds or cells used in reproduction. For example, most corals sexually reproduce by releasing gametes directly into the water. The male gametes are generally motile, and eggs are moved passively via ocean currents. Other sessile animals exemplify natal dispersal in that they have a free-living, aquatic juvenile stage, wherein larvae drift near the surface and are passively carried by water currents to other locations.

In plants, disseminules include seeds, spores, and fruits, all of which have modifications for movement away from the parent plant via available environmental kinetic energy. Distance traveled by a disseminule is a result of the velocity and direction of movement by the dispersal agent. Winds, flying animals, or water currents are some of the most successful agents of long-distance passive dispersal. Seeds and fruits that have wings, hairs, or inflated processes are carried efficiently by wind. For example, modifications in *Hypochaeris radicata* (Asteraceae) seeds have allowed it to successfully disperse in a fragmented landscape in the Netherlands and counteract the negative effects of population isolation with substantial levels of gene flow. Furthermore, some plants have sticky or barbed seeds, or fruits, that adhere to the feathers or fur of mobile animals. Some disseminules are explosively released over short distances whereas others fall to the ground at the base of the parent plant. On the ground, invertebrates, mammals, and birds compete for fallen seeds and fruits. Seeds and fruits are scattered during feeding and after ingestion are distributed in feces. These seeds are adapted to resist digestive juices and, consequently, can pass through the digestive tract while remaining viable. The distance a disseminule travels by animal transportation, either via ingestion or attachment, is indefinite and depends on the dispersal behavior of their host. For example, some animals may follow a nomadic or brief dispersal trajectory, resulting in variance in the distances traveled.

S.No	Plant	Characteristics of Seeds/Fruits	Mode of Dispersal/External Agencies
1	Impatiens(Balsam)	Capsulsular Fruit,Mature Fruit burst Open with Force when touched and seeds are shot several feet away.	Autochory/Explosive mechanism
2.	Viola (Pansy)	Fruit capsule.tension develops in the drying wall of the carpels causing the fruit to Burst open along the line dehiscene.	Autochory/Explosive mechanism
3.	Acer(Maple)Hopea, Tecoma,Heloptelia (Chilbil),Shorea(Sal), Elm ,Moringa,Jacornida, Cinchoria, Albiziz (Siris),Dalbergia (Shisham)	Thin wing like expansion are present in seeds/Fruits,Wings provide large surface area to the wind for their dispersal.	Anemochary/Dispersal by wind.
4.	Dandelion, Sonchus	Fruit single seeded cypsela with a tuft of hair(pappus) ay upper end. Pappus open up like a parchute.	Anemochary/Dispersal by wind.
5.	Calotropis (Ak), Alstonia, Bombax (Sembal)	Seeds have hairy outgrowth to providelarge surface area to the wind	Anemochary/Dispersal by wind.
6.	Chenopodium (Bathua),Polygonum	Seed/Fruit very light,Float on the surface of water.	Hydrochory/Dispersal by water
7.	Nymphea (Water Lily), Nelumbiam (Lotus), Cocus (Coconut)	Spongy thelamus or spongy Mesocarp of the fruit.	Hydrochory/Dispersal by water
8.	Boerhavia,Plumbago,Cleome.	Fruits are sticky and can stick to the body of animals.	Zoochory/Dispersal by animals
9.	Achyranthus (Phuthkanda), Xanthium, Tribulus, Madicago	Fruits and seeds have barbs,hooks,or spines to get attach with fur of the animal.	Zoochory/Dispersal by animals

Means for Dispersal

1. **Land Bridges**
2. **Natural Rafts and Driftwood**
3. **Favouring Gales**

1. **Land Bridges :** Panama (a country that links central and south America; in map it shows like a bridge) opens up the avenue for migration of many animals horses, wolves ans cats.
2. **Natural Ratfs and Driftwood:** Terrestrial animals also takes lift upon drifting (floating) materials which enable them to accomplished over water journeys.
   e.g. Polar bear are also carried by floating shore ice.
   Mass of driftwood creepers and leave and other natural rafts also helps in dispersal of animals .
3. **Favouring Gales :** Many animals like insects, bird, and bats dispersed by strong wind and they get their favorable destinations. e.g. European birds transported to America by way to Iceland and Green land

The Effects of Dispersal on Individuals, Populations and Species

Dispersal affects organisms at individual, population, and species levels. Survival, growth, and reproduction at the level of individuals are intimately tied to both the distance and frequency of dispersal, factors which are typically mediated by aspects of local resource availability.

At the **population level**, patterns of emigration and immigration within and among habitat patches associated with local population density, among other factors, drive temporal and spatial cycles of colonization and extinction. The form of such movements, such as stepping-stone versus one-way migration, ultimately determines the genetic structure of populations, wherein genetic differentiation is directly proportional to the amount of gene flow among populations. For populations exhibiting frequent dispersal, ongoing gene flow within and among populations results in those populations becoming genetically similar to one another and ultimately evolving as a single unit. Finally, over evolutionary time frames, a lack of dispersal among populations impacts organisms at the species level. If dispersal between populations ceases, these newly isolated populations accumulate novel genetic attributes via genetic drift or natural selection potentially leading to local adaptation. Insurmountable landscape features, such as mountains and rivers, typically drive such processes, and in cases where genetic differentiation persists even after dispersal between formerly isolated populations could resume, such entities can then be designated as separate species.

Limits To Dispersal

Species exhibit geographic distributions that are constrained by a range of environmental variables — outside of which individuals may experience reduced survival and reproduction due to physical and physiological constraints.

For example, species are often accustomed to particular **temperature ranges**, and dispersal to regions with temperatures outside those ranges reduces fitness. Additionally, **resources necessary for population persistence may be insufficient** at range edges and outside the range. **Physical barriers** to dispersal consist of landscape features that prevent organisms from relocating. Mountains, rivers, and lakes are examples of physical barriers that can limit a species' distribution. **Anthropogenic barriers**, like roads, farming, and river dams, also function as impediments to movement.

It has been suggested that anthropogenic barriers are the most serious threats to dispersal. These barriers can effectively divide up a species' range into isolated fragments, and dispersal from one habitat patch to another can prove difficult. Creating dispersal corridors has been suggested as a means to maintain connectivity between habitat patches. For example, Banff National Park in Alberta, Canada, contains 22 underpasses and 2 overpasses to facilitate wildlife dispersal within the park across a busy four-lane highway (the Trans-Canada Highway). Similarly, wildlife crossings, specifically designed for Florida panthers, were constructed along a forty-mile stretch of Interstate 75 in Florida. Corridors are not just for large mammals either: Salamanders have also benefited from miniature underpasses to facilitate dispersal.

Barriers to Dispersal

1 Topographic Barriers: Alps (High and extensive Mountains) – ranges the limit of distribution of some terrestrial forms. e.g. There is marked differences b/w the species of northern and the southern slope of the Alps.

2 Climatic Barriers: Temperature has a marked influence on limiting the animal dispersal, particularly on cold blooded animals e.g. Reptiles and amphibians are tropical and temperate in their distribution.

3 Vegetative Barrier: The forest become barrier for larger terrestial animals because they can't penetrate the forest.

Quantifying Dispersal

Two approaches can be used to estimate dispersal in wild populations: direct or indirect methods. Direct methods consist of mark-recapture (or capture-mark-recapture) using live trapping, individual marking techniques, and/or radio-tracking devices. Interpretation of results from direct measurement can sometimes prove difficult though. Low accuracy of spatial position, disproportionate mortality of marked individuals, labour intensity, and high costs are all deterrents to using direct measurement methods.

In contrast to direct methods, indirect methods infer the degree of dispersal without actually having to observe the dispersal movement. Typically, indirect methods involve utilizing molecular markers to measure gene flow and deduce dispersal patterns based on within and among population genetic differences. Specifically, the differences in allele or genotype frequencies resulting from gene flow between populations reveal patterns and levels of dispersal. Indirect methods are increasingly being used to infer dispersal because of the difficulties involved with direct measurement. Genetic methods, while expensive, can provide larger sample sizes to infer dispersal patterns and are usually less labour intensive.

Human Effects on Dispersal

Human activities have facilitated and impeded dispersal in many ways. As stated previously, **anthropogenic barriers** in the form of human development have disrupted natural dispersal patterns in a variety of species. Conversely, humans have also facilitated dispersal, both deliberately and accidentally. A common inadvertent way organisms have been dispersed is through their transport in the ballast water of ships. Ships emptying ballast water may release foreign organisms. For example, zebra mussels, a freshwater mollusk native to the lakes of southeast Russia, were accidentally introduced into the Great Lakes of North America where they have caused major economic problems by clogging water treatment and power plants through ballast water discharge. As a result of the potential for introduction of non-native organisms via ballast water, new standards have been proposed for ballast tank cleaning. Humans have also transported organisms to areas outside their native ranges for deliberate reasons. The seeds of attractive plants native to areas outside North America are routinely used in gardens and have the capacity to disperse to wild areas if conditions are suitable (e.g., purple loosestrife). Also, bighead and silver carp originating from China were introduced to catfish farm ponds in the United States to control algal growth. Fish accidentally escaped from these ponds and have subsequently colonized the Mississippi, Missouri, Illinois and Ohio rivers where they have had significant negative impact on the native fauna.

Migration

Migration is the movement of large numbers of a species from one place to another, usually leaving none behind. Well-known examples include locust swarms & bird migrations.

Whereas dispersal is the spreading of individuals away from others, often parents or siblings, which are left behind in the original area.

To the individual organism actually moving, there is no distinction between migration and dispersal. Both are movements from an unfavourable situation towards the potentially favourable.

Patterns of migration.

Wide variation between different organisms. The general pattern is that the fundamental niche of the species includes two different types of habitats, each of which is favourable at different times. Migration moves the species between the two habitats. The variation comes in the time scale over which this occurs.

1. Daily movements.

Most snails clump together in groups in humid microhabitats during the day, then migration into foraging areas at night. planktonic algae sink to deep water in the night and then rise to surface in the day (where they photosynthesise).

2. Seasonal movements.

Grazing animals of mountains move up in the summer and down in the valleys in winter. This movement is reflected in traditional livestock management in mountain regions. amphibians move from an aquatic breeding area to a land feeding area. Each year they return to the same breeding ground and the pattern is repeated.

Some seasonal movements involve very long distances. In the northern hemisphere, we are familiar with a spring movement north, to where food is abundant in the summer, and an autumn movement south, to where food is abundant after the rainy season.

Here the productivity of each habitat is seasonal. The low-productivity period is insufficient to support the population, so it has to migrate.

Some birds fly south to Britain in winter, e.g. some curlew, then north to Iceland, Norway and the Arctic in summer.

Animals other than birds show long-distance seasonal migration. Baleen whales feed in summer in the Antarctic, then breed in winter in tropical seas to the north. Caribou migrate between the tundra and the boreal forests.

Another way of classifying patterns of migration is to look at how many times an individual can make the journey (see diagram)

1. One way only.

These migrate in one direction, but never come back. Butterflies like the red admiral and painted lady are most familiar. Individuals fly here from the Mediterranean in summer, breed and die. Their offspring fly south in autumn, breed and die. Their offspring come back next summer.

2. One return journey.

These species are born in one habitat, migrate to another, then return to breed and die in the habitat where they were born. Best known in eels and salmon
Salmon are thought to recognise their birthplace by the smell of chemicals in the water. Each river has a chemical 'fingerprint' which the fish learns as a juvenile.
This pattern is also common in insects. Butterflies, for example, are born on the larval food plant, migrate away and then return to the same type of plant to lay eggs. Aquatic insects like the caddis fly spend the larval stage in water, migrate away as adults, then return to breed.

3. Multiple return journeys

These include most of the examples we looked at earlier - the daily migrations of plankton, or the seasonal movements of birds, whales etc. Most are made several times in a lifetime.

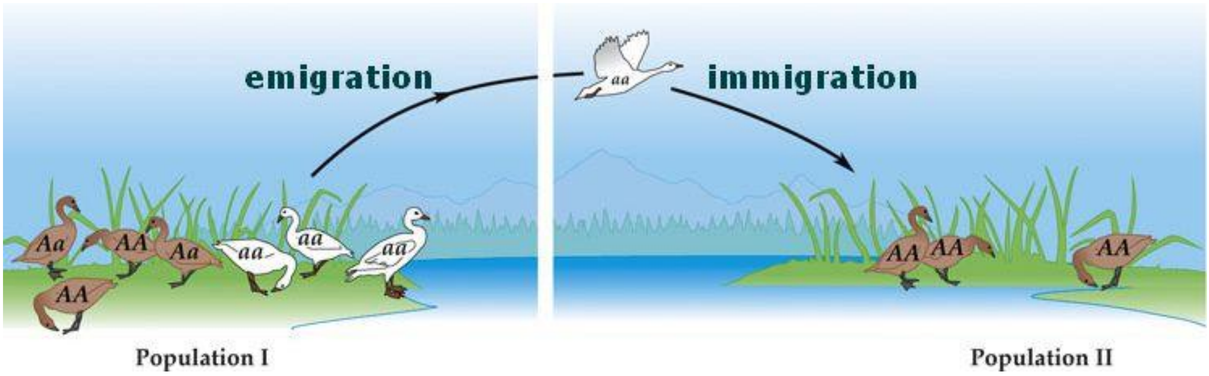
Summary.

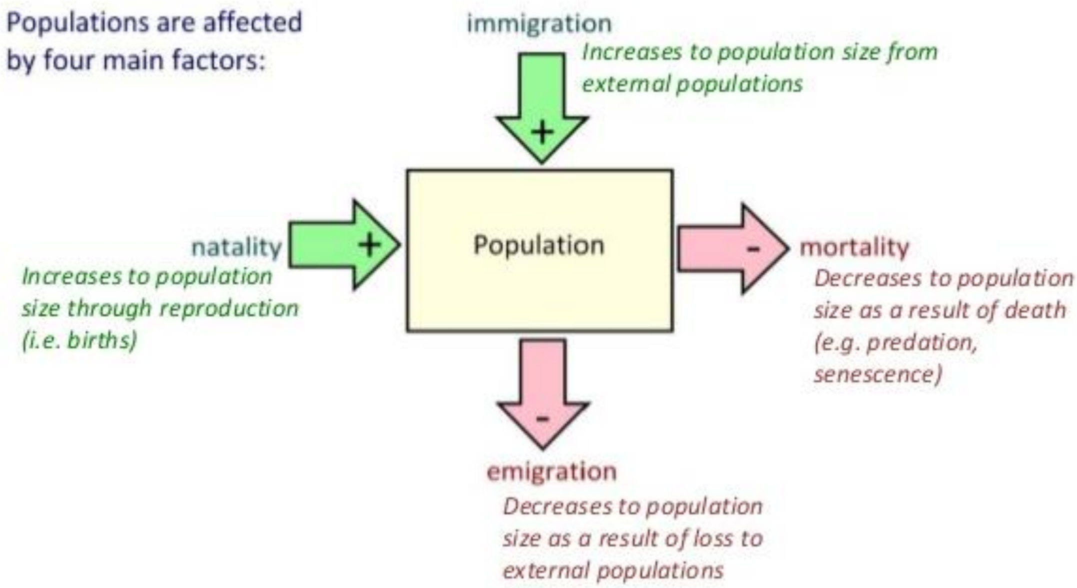
1. Migration: whole population movement
2. Dispersal: some of population left behind
3. Affect size of realised niche
4. Migration is between two habitats. Occurs over different time scales. Different species can do a half migration, one, or several.
5. Some species explore for new dispersal sites, some rely on chance.
6. All species must disperse, some disperse more than others.
7. Variation in dispersal occurs between species in different habitat types, between sexes, body forms and individuals of different social status.

Immigration

Immigration is simply to movement of an organism to an area. For example, a bird may immigrate to a new island from another island. It is important to note that if you were to describe this differently - an organism moving from an area, then the term emigrate would apply. So the example would then be, a bird emigrated from the old island to a new island.

The concept of immigration is used particularly in the field of population ecology (the ecology of species that co-exist at the same time and place, and consist of only one species e.g. a pride of lions sharing the same habitat). Immigration is used as a factor in various mathematical approaches to create population models that indicate how populations will grow or decline

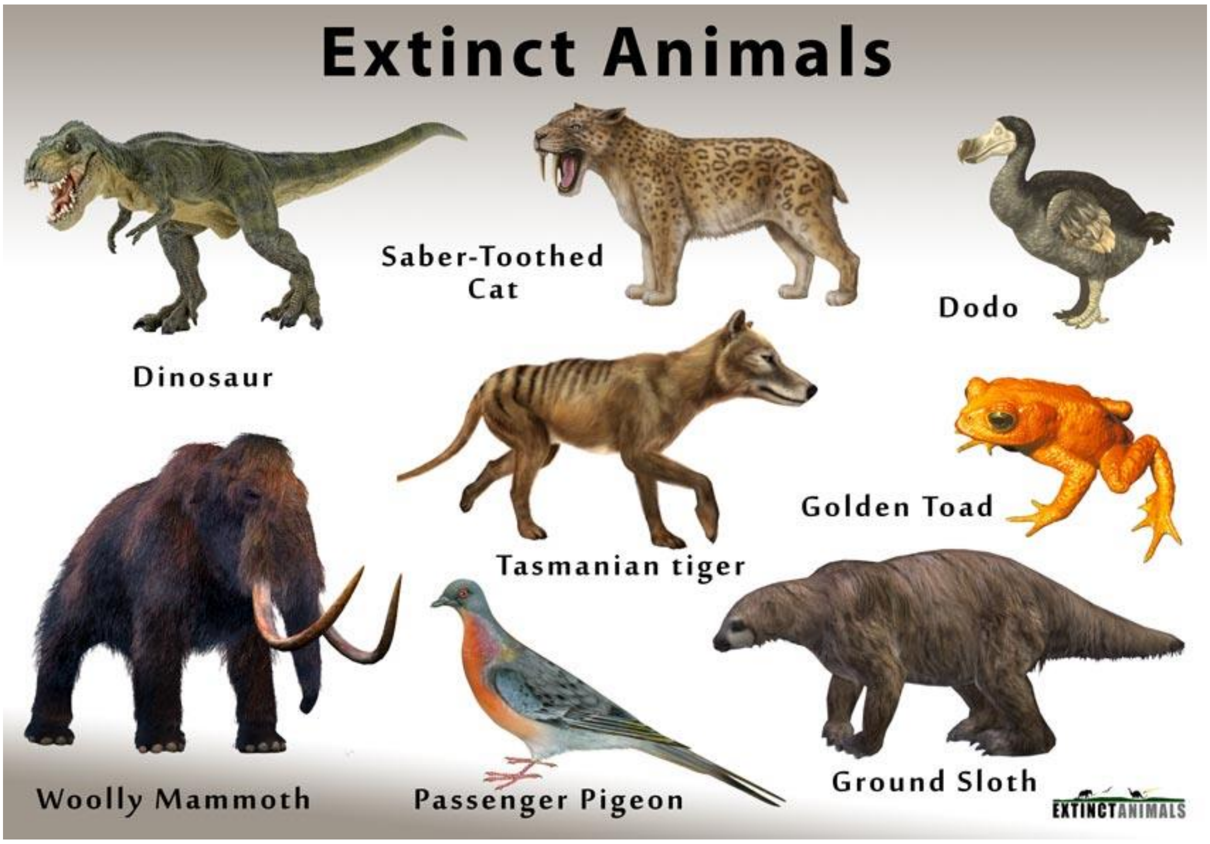




Population Size = (**N**atality + **I**mmigration) - (**M**ortality + **E**mmigration)

Extinction

In biology and ecology, extinction is the cessation of existence of a species or group of taxa, reducing biodiversity. The moment of extinction is generally considered to be the death of the last individual of that species (although the capacity to breed and recover may have been lost before this point).



Extinction occurs when species are diminished because of environmental forces (habitat fragmentation, global change, natural disaster, overexploitation of species for human use) or because of evolutionary changes in their members (genetic inbreeding, poor reproduction, decline in population numbers).

Through evolution, new species are created by speciation - where new varieties of organisms arise and thrive when they are able to find and exploit an ecological niche - and species become extinct when they are no longer able to survive in changing conditions or against superior competition.

Rates of extinction vary widely. For example, during the last 100,000 years of the Pleistocene Epoch (about 2.6 million to 11,700 years ago), some 40 percent of the existing genera of large mammals in Africa and more than 70 percent in North America, South America, and

Australia went extinct. A typical species becomes extinct within 10 million years of its first appearance, although some species, called living fossils, survive virtually unchanged for hundreds of millions of years.

Ecologists estimate that the present-day extinction rate is 1,000 to 10,000 times the background extinction rate (between one and five species per year) because of deforestation, habitat loss, overhunting, pollution, climate change, and other human activities—the sum total of which will likely result in the loss of between 30 and 50 percent of extant species by the middle of the 21st century.

Although extinction is an ongoing feature of Earth’s flora and fauna (the vast majority of species ever to have lived are extinct), the fossil record reveals five unusually large extinctions, each involving the demise of vast numbers of species. These conspicuous declines in diversity are referred to as **mass extinctions**; they are distinguished from the majority of extinctions, which occur continually and are referred to as background extinction. Ranked in descending order of severity, they are:

1. Permian extinction (about 265.1 million to about 251.9 million years ago), the most dramatic die-off, eliminating about half of all families, some 95 percent of marine species (nearly wiping out brachiopods and corals), and about 70 percent of land species (including plants, insects, and vertebrates).

2. Ordovician-Silurian extinction (about 443.8 million years ago), which included about 25 percent of marine families and 85 percent of marine species, with brachiopods, conodonts, bryozoans, and trilobites suffering greatly.

3. Cretaceous-Tertiary (K-T), or Cretaceous-Paleogene (K-Pg), extinction (about 66.0 million years ago), involving about 80 percent of all animal species, including the dinosaurs and many species of plants. Although many scientists contend that this event was caused by one or more large comets or asteroids striking Earth, others maintain that it was caused by climatic changes associated with the substantial volcanic activity of the time.

4. End-Triassic extinction (about 201.3 million years ago), possibly caused by rapid climate change or by an asteroid striking Earth. This mass extinction event caused about 20 percent of marine families and some 76 percent of all extant species to die out, possibly within a span of about 10,000 years, thus opening up numerous ecological niches into which the dinosaurs evolved.

5. Devonian extinctions (407.6 million to about 358.9 million years ago), which included 15–20 percent of marine families and 70–80 percent of all animal species.

Roughly 86 percent of marine brachiopod species perished, along with many corals, conodonts, and trilobites.

In essence, mass extinctions are unusual because of the large numbers of taxa that die out, the concentrated time frame, the widespread geographic area affected, and the many different kinds of animals and plants eliminated.

Man-Induced Extinctions

Many species have become extinct because of hunting and overharvesting, the conversion of wetlands and forests to croplands and urban areas, pollution, the introduction of invasive species, and other forms of human-caused destruction of their natural environments. Indeed, current rates of human-induced extinctions are estimated to be about 1,000 times greater than past natural (background) rates of extinction, leading some scientists to call modern times the sixth mass extinction. This high extinction rate is largely due to the exponential growth in human numbers: growing from about 1 billion in 1850, the world's population reached 2 billion in 1930 and more than 7.7 billion in 2019 and is expected to reach about 10 billion by 2050. As a result of increasing human populations, habitat loss is the greatest factor in current levels of extinction. For example, less than one-sixth of the land area of Europe has remained unmodified by human activity, and more than half of all wildlife habitat has been eliminated in more than four-fifths of countries.

In addition, increased levels of greenhouse gases have begun to alter the world's climate, with slowly increasing surface temperatures expected by the middle of the 21st century to force many species to migrate toward the poles and up mountain slopes in order to remain in habitats with the same climate conditions. Most ecologists, conservation biologists, and climate scientists worry that global warming will contribute greatly to species extinctions. For example, one study released in 2015 that examined 130 extinction models from previous studies predicted that 5.2 percent of species would be lost as a result of global warming alone with a rise in average temperatures of 2 °C (3.6 °F) above temperature benchmarks taken before the start of the Industrial Revolution. The study also predicted that about 16 percent of Earth's species would be lost if surface warming increased to about 4.3 °C (7.7 °F). Changes in ocean temperatures and increasing ocean acidification also threaten many marine species, especially corals and mollusks .

Overexploitation from hunting and harvesting also has adversely affected many species. For example, about 20 million tropical fish and 12 million corals are harvested annually for the aquarium trade, depleting natural populations in some parts of the world.

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All these factors have increased the numbers of threatened species. Almost one in four mammal species, including four of the six remaining species of great apes, and one in eight bird species were considered at significant risk of extinction at the start of the 21st century. In addition, the World Wildlife Fund noted in a 2016 report that vertebrate populations overall declined by 58 percent between 1970 and 2010.

Consequences of extinction

Loss of Trophic Interactions

Loss of species results in the disruption of trophic interactions, which has consequences for ecosystem structure and function.

Loss of Predators

Ecological consequences of the loss of predators can be broadly classified into two categories:

i) **Increased herbivory** due to higher densities of herbivorous prey following the loss of their predators; and

ii) **Increased densities of smaller predators** known as mesopredators.

Increased herbivory

There is considerable evidence to suggest that the removal of top predators results in increased herbivory, and ultimately affects primary productivity. McLaren and Peterson (1994) investigated tree growth in Isle Royale National Park in Michigan, U.S.A. They found that plant growth rates were regulated by cycles in animal density, and trees increased in primary productivity only when released from herbivory due to predation by wolves on herbivores. It has also been shown that sea otters can have a profound effect on the structure of marine communities by controlling densities of herbivorous sea urchin populations, which feed on kelp beds. Absence of sea otters resulted in high densities of sea urchins, increased herbivory, and depletion of kelp beds (Estes and Palmisano, 1978; Estes and Duggins, 1995; Estes et al., 1998).

Mesopredator release

Loss of predators may also lead to increased densities of smaller predators, a phenomenon known as ‘mesopredator release’. This release has been implicated in the decline and extinction of prey species. Crooks and Soulé (1999) describe a study of urban habitat fragments in coastal southern California. They test the hypothesis that the decline of the most common large predator (coyote) would result in the ecological release of mesopredators, both native (striped skunk, raccoon, grey fox) and exotic (domestic cat, opossum), and that increased predation by these mesopredators would result in higher mortality and local extinction rates of scrub-breeding birds. They found that bird species diversity decreased with total mesopredator abundance and was higher in fragments where coyotes were either present or more abundant.

Loss of Herbivores and Frugivores

There is a large body of research documenting the important role played by mammals and large birds in herbivory, seed dispersal, and seed predation. In Mexico, Dirzo and Miranda (1991) compared two tropical forests, one with a full complement of large mammals (peccaries, deer and tapir) and another in which these species had been extirpated by hunters. A striking differences between the two forests exists; the hunted forest was typified by seedling carpets, piles of uneaten rotting fruits and seeds, and herbs and seedlings undamaged by mammalian herbivores — phenomena much less evident in the non-hunted forest. Similarly, in central Panama, a study by Wright (2000) showed that poachers reduce the abundance of herbivorous mammals, which in turn alters seed dispersal, seed predation, and seedling recruitment for two palms (*Attalea butyraceae* and *Astrocaryum standleyanum*)

A number of studies have highlighted the role of primates in forest regeneration. A study in a rainforest in southeastern Peru by Andresen (1999) showed a complex web of interactions among seed dispersers, seed predators, and secondary dispersers that influence the fate of seeds. The study documented the significance of primates for seed dispersal by showing that spider monkeys (*Ateles paniscus*) and howler monkeys *(Alouatta seniculus*) dispersed the seeds of 71 and 14 plant species respectively.

In a dry deciduous forest in Madagascar, Chapman and Onderdonk (1999) assess the potential importance of primates as seed dispersers in tropical forests and evaluate the possible consequences of hunting primates for recruitment in tropical tree communities. They use a case study in the Kibale National Park, Uganda to show that disrupting the complex interactions among primates and fruiting trees can have negative and possibly cascading effects on ecosystem processes.

Loss of Pollinators

Many studes have documented exclusive mutualisms between plant species and their pollinators, and highlighted the potential consequences of disruptions of mutualisms for plant regeneration and food crop yields. Pollinator loss can affect plants in several ways, including loss of, or reduced, seed set. In addition, a scarcity of pollinators may affect a plant's mating system, resulting in the production of less vigorous offspring. This is because in the absence of pollinators, a higher percentage of seeds may be set through self-pollination, decreasing **heterozygosity** and increasing the expression of **deleterious traits** associated with **inbreeding** (inbreeding depression).

On a broader scale, loss of pollinators or disruption of pollination systems may cause reduced seed and fruit production and ultimately, **plant extinction**. Any of these events will affect the organisms that consume seeds, fruits, or plants, or that use plants for nest construction. The plants most at risk from the loss of a pollinator are those that are self-incompatible, those that have a single pollinator, and those that propagate only by seeds.

Tropical Cascade

All of the above changes in communities that follow species loss, especially changes in trophic interactions, can lead to extended cascading effects throughout ecosystems due to species interactions. Trophic cascades result in inverse patterns in abundance or biomass across more than one trophic link in a food web. For a three-level food chain, abundant top predators result in lower abundances of mid-level herbivores and higher abundance of basal producers. In this case, removing a top predator would result in a greater abundance of consumers and fewer producers. Global extinction of a species or local extinction of a population can result in disruptions of trophic cascades leading to dramatic shifts in community composition, structure, and function.

Given accelerated human alteration of ecosystems, increased management of species and ecosystems may become necessary to either prevent cascading effects or remedy the disruption of cascades responsible for maintaining ecosystem structure and function.

Species Co-extinctions

The term “co-extinction” has been used to describe the process of the loss of parasitic insects with the loss of their hosts. The concept has been expanded to describe the demise of a broader array of interacting species including predators with their prey and specialist herbivores with their host plants. Co-extinction can be defined as the loss of a species (the affiliate) upon the loss of another (the host).

Human domination of Earth’s ecosystems is accelerating the extinction of species and is significantly changing the structure and dynamics of biological communities worldwide. Within this context, a relevant and pragmatic question that arises is the extent to which this loss of biodiversity matters and whether stability, productivity, and other aspects of the functioning of both managed and natural ecosystems are dependent on biodiversity. Overall, increasing research and understanding of the ecological consequences of species loss has led to the emergence of urgent and extensive conservation planning and management.