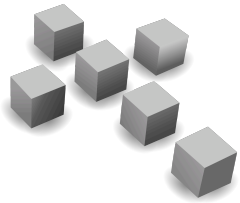
The Big Kill

Module 8 • i2P • Biodiversity

"When the animals come to us,
asking for our help,
will we know what they are saying?
When the plants speak to us
in their delicate language,
will we be able to answer them?
When the planet herself
sings to us in our dreams,
will we be able to wake ourselves, and act?"

-- Gary Lawless



HOLOCENE

It is estimated that 99% of all species to have lived on Earth since life first appeared have gone extinct. While all these species have been disappearing, even more new ones have been forming. That is why it is believed that more different species are currently alive than since life first appeared on the planet.

Figure 1: The dodo bird has been extinct for over 200 years. It is the emblem of human driven extinction (source: Ballista)

The term *geological time* describes the timing of events since the creation of the planet Earth. As we learned in Module 2 the Earth is believed to be 4.6 billion years old, and life first appeared about 3.8 billion years ago. Modern humans have only been present for 200,000 years, and the time since man adopted agriculture is a mere 10,000 years. Yet it is in the last 10,000 years that there has been increasing rates of extinction witnessed. The period of time during which these extinctions have occurred started roughly with the development of agriculture and continues today, and is called the Holocene epoch.

WOOLY MAMMOTH

One of the most remarkable creatures to go extinct during the Holocene epoch is the woolly mammoth, a massive mammal closely related to the modern elephant. First appearing about 150,000 years ago, the wooly mammoth roamed across northern North America,

Did you know?

Extinction in the early Holocene period was particularly high in North America, where animals that survived elsewhere (including horses and camels) became extinct.

Figure 2: Wooly Mammoth (source: Sergiodlarosa)

Europe and Asia. With a long, thick layer of hair, a fine undercoat, and thick layers of fat, they were well insulated against the cold. The mammoth was an omnivore and had teeth that were adapted to eat coarse grasses. It is believed that their long tusks (up to 5 m or 16 ft long) were curved to act as shovels to clear snow from the ground to reach grasses buried beneath (see mammoth) .

The woolly mammoth became extinct about 10,000 years ago. It is believed their disappearance was caused by a combination of climate change and over-hunting by humans. The mammoth had flourished during the last ice age, but when temperatures began to warm their habitat gradually decreased from 7.7 million to less than one million square kilometers. Although mammoths had survived previous climate change, human predation may have tipped the balance, and propelled the depleted species into extinction (see: mammoth).

Extinction

In biology, extinction is defined as the death of the last member of a species. The notion that plants and animals could go extinct was not widely accepted before 1800 (see: extinction). Today discussions on extinction focus mainly on the rate at which species are being lost.

According to the International Union for the Conservation of Nature (IUCN) 32% of all species of plants and animals they have assessed (17,291 species out of the 47,677 species) are currently threatened with extinction (see: IUCN). Since 1948 the IUCN has kept the *Redlist,* a comprehensive, global, and objective list of the conservation status of plant and animal species (see: redlist). Each species evaluated by the IUCN is assigned a conservation risk status that rates their likelihood of extinction. In a recent report (2009), the IUCN concluded:

> "21 percent of all known mammals, 30 percent of all known amphibians, 12 percent of all known birds, and 28 percent of reptiles, 37 percent of freshwater fishes, 70 percent of plants, 35 percent of invertebrates assessed so far are under threat of extinction." (see: threat)

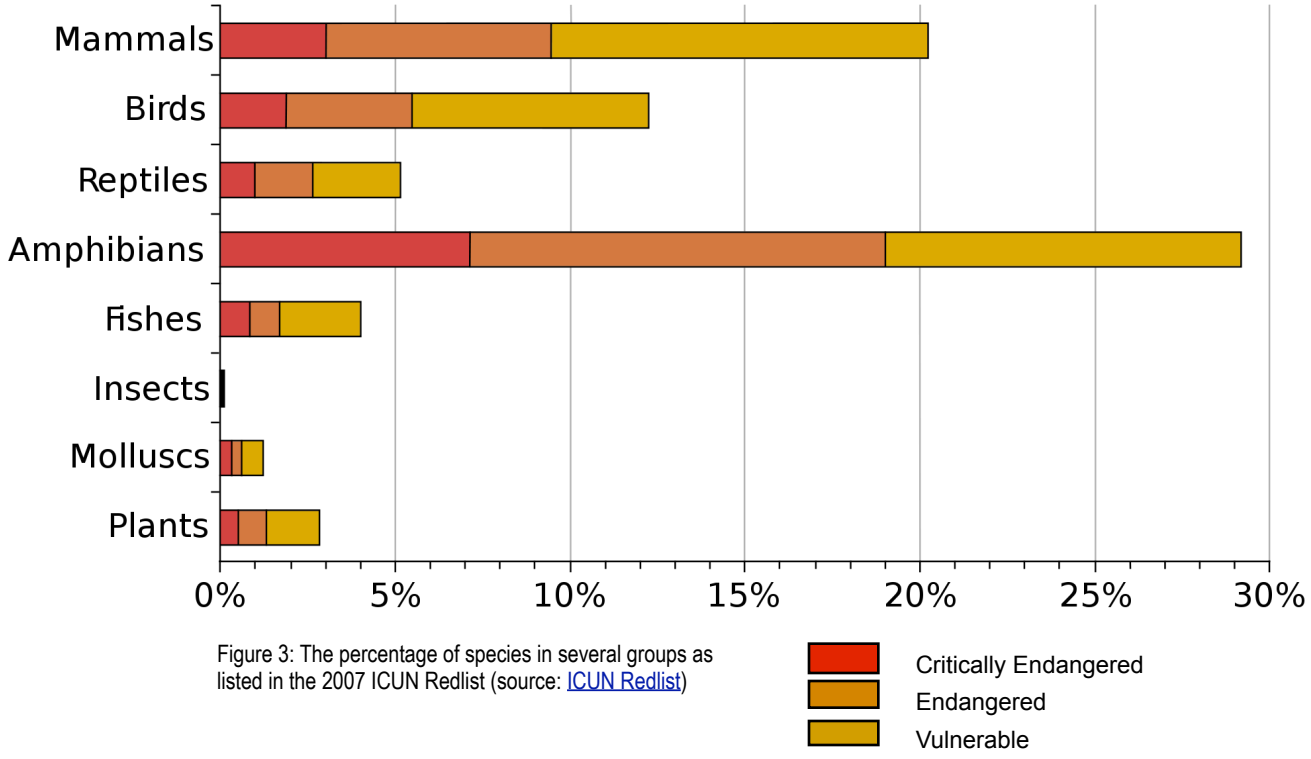


Figure 3: The percentage of species in several groups as listed in the 2007 ICUN Redlist (source: ICUN Redlist)

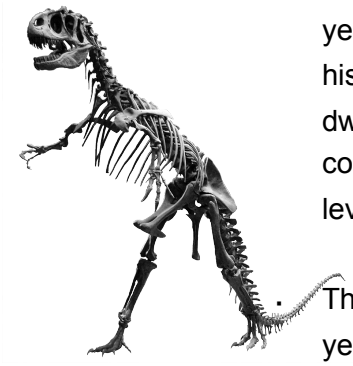
Although the high number of threatened species is alarming, the extinction of large numbers of organisms is not a new phenomenon.

Big Five

The geological record reveals that there have been five mass extinction episodes since the appearance of life on Earth (see: big five and mass extinctions).

- The first mass extinction (Ordovician) occurred about 440 million years ago when life existed only in the ocean. An unstable climate caused the formation, and subsequent melting of glaciers, which resulted in rapidly changing sea levels. This is thought to have caused the extinction of 25% of marine species.

- The cause of the second mass extinction (Devonian) in unknown. It occurred 370 million years ago, and fossil records reveal that 80% of all species were lost.



- The third mass extinction (Permian) occurred 245 million years ago and is the worst mass extinction in the Earth's history. 95% of all marine species, and 70% of land-dwelling species were lost. Several factors may have contributed to this event including climate change, and low levels of oxygen following a massive volcanic eruption.

- The fourth mass extinction (Triassic) occurred 210 million years ago and is thought to have arisen from geological disturbances that lead to the creation of the Atlantic Ocean. 80% of all species were lost during this event.

- The fifth and most recent mass extinction (Cretaceous-Tertiary) occurred 65 million years ago, and resulted in the extinction of the dinosaurs. Many experts agree that the impact of a very large (10 kilometers wide) meteor hitting Earth was responsible for the extinction. Approximately 70% of all species were lost in this event.

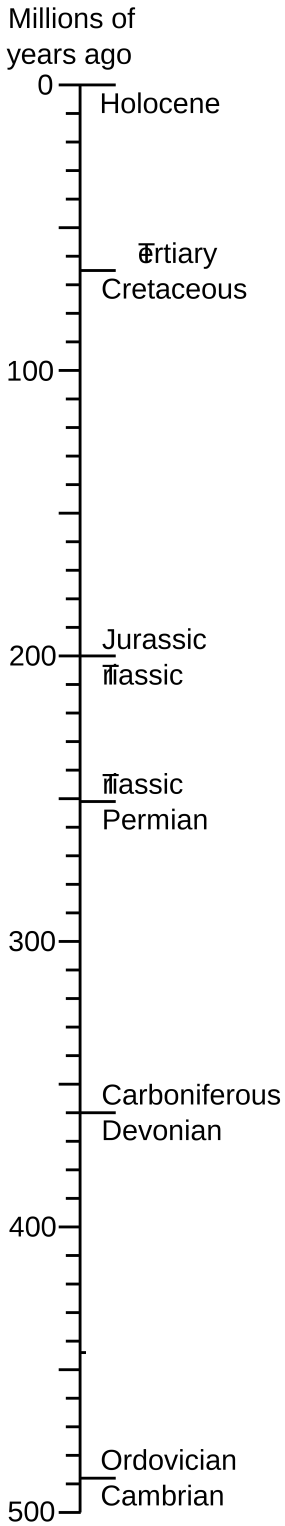


Figure 4: A timeline of the largest mass extinctions on Earth in the past 500 million years (source: Bryan Derksen)

Did you know?

The Queen of the Andes (*Puya raimondii*) is an endangered palm found in the Andes Mountains that produces seeds once in its 80 year lifespan, and then dies. Climate change may be impairing its ability to flower and cattle may trample or eat young plants

See: Puya

Holocene Extinction

Extinction is a natural byproduct of the passage of time, and throughout the history of life on Earth species have been lost.

Extinction is caused by the failure of species to adapt to environmental change over time. Scientists have calculated an average rate of extinction over time. This baseline is used to compare extinction rates during different periods of time. What make the five periods of mass extinction unique, is that the rate at which extinctions occurred was much higher than the baseline.

Did You Know?

The Convention on Biological Diversity Estimates that average abundance of species world-wide has declined by 40% between 1970 and 2000. Species present in rivers, lakes and marshlands have declined by 50%. Declines are evident in amphibians, African mammals, birds in agricultural lands, corals and commonly harvested fish species.

see: decline

Today, in the Holocene epoch, the rate of extinction is greater than ever before. The death toll is so high scientists believe we are living during the

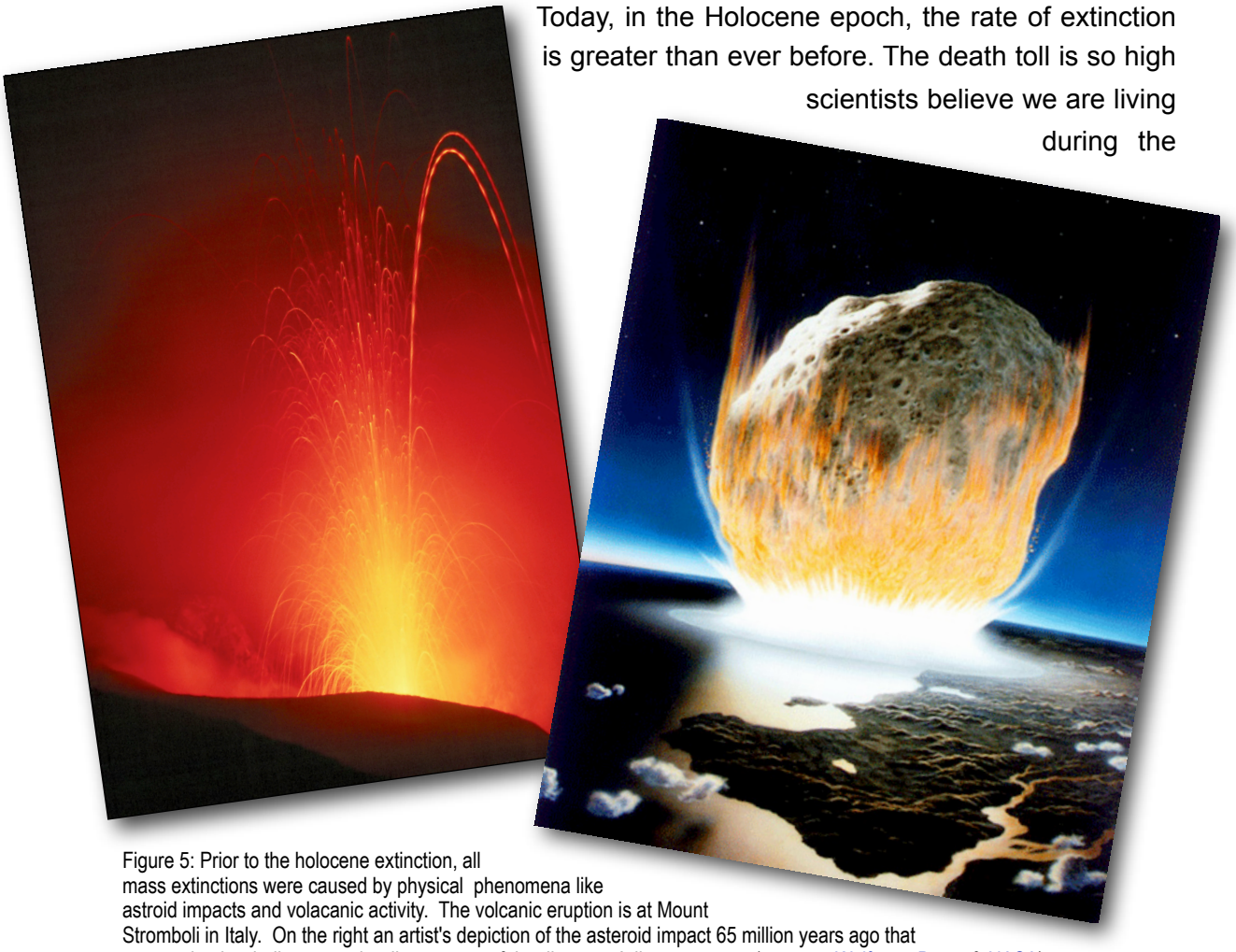


Figure 5: Prior to the holocene extinction, all mass extinctions were caused by physical phenomena like astroid impacts and volacanic activity. The volcanic eruption is at Mount Stromboli in Italy. On the right an artist's depiction of the asteroid impact 65 million years ago that many scientists believe was the direct cause of the dinosaurs' disappearance (sources: Wolfgang Beyer & NASA)

sixth, and perhaps greatest mass extinction. The current rate of species extinction is 10,000 times higher than the baseline rate observed in the geological record (see: sixth).

Almost 900 known species have been declared extinct over the last 500 years. Given that the majority of organisms on Earth have not been catalogued, scientists believe this number represents the tip of the iceberg. Considering the proportion of undocumented species, it is possible that in the last 100 years between twenty thousand and two-million species have gone extinct.

Did You Know?

The growth of fishing has led to a decline of large fish. In the North Atlantic, their numbers have declined by 66% in the last 50 years.

see: fish

Human Touch

The geological record indicates that past mass extinctions were caused by physical phenomena such as meteorites, volcanic activity, or atmospheric or climatic changes that caused significant environmental shifts. Why then are so many species perishing

Figure 6: Humans use a range of tools and technology, from the hammer to the computer to manage the natural world (sources: Evan-amos and Darkone)

now? According to Peter Raven, past President of the American Association for the Advancement of Science, mankind is the cause. He states:

> "we have driven the rate of biological extinction, the permanent loss of species, up several hundred times beyond its historical levels, and are threatened with the loss of a majority of all species by the end of the 21st century."

The current period of extinction started about 10,000 years ago in conjunction with the human adoption of agriculture. As it aligns with the Holocene epoch it has been named the Holocene Extinction, and is the first global extinction that is caused by a living organism (biotic) and not a physical event. Humans are altering environments so quickly that other life forms are unable to evolve or adapt soon enough to survive, resulting in what has been called an *accelerated anthropogenic extinction.*

Figure 7: This arial view of terraced rice fields in Yunnan Province, China, are spectacular evidence of the human capacity to alter ecosystems for the purposes of food production (source: Jialiang Gao).

Humans are the first species on Earth with the ability to completely alter an ecosystem to meet their needs. Rather than live off the natural bounty of an ecosystem, humans completely transform the environment in order to produce the goods they seek. This is the principle of agriculture, which has been described as:

> "war on ecosystems - converting land to produce one or two food crops, with all other native plant species all now classified as unwanted "weeds" — and all but a few domesticated species of animals now considered as pests". (see: war)

As described in Module 5, The Wolf at the Door, the capacity of humans to transform ecosystems is driving extinction through five principle processes:

- habitat transformation
- climate change
- over-exploitation
- pollution
- introduction of exotic species

Looking Forward

There are grim statistics about the number of extinctions taking place today and even grimmer predictions about what the future holds for biodiversity. Thirty years ago Harvard biologist Edward O. Wilson poignantly described the consequences of the Holocene Extinction:

> "The worst thing that can happen during the 1980s is not energy depletion, economic collapses, limited nuclear war, or conquest by a totalitarian government. As terrible as these catastrophes would be for us, they can be repaired within a few generations. The one process ongoing in the 1980s that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly that our descendants are least likely to forgive us for."

Unfortunately in the ensuing thirty years the situation has only changed for the worse.

Student Exercise:

Please take a moment and review the IUCN list of endangered species

see: redlist

Figure 8: A White Stork corpse (source: Boby Dimitrov).