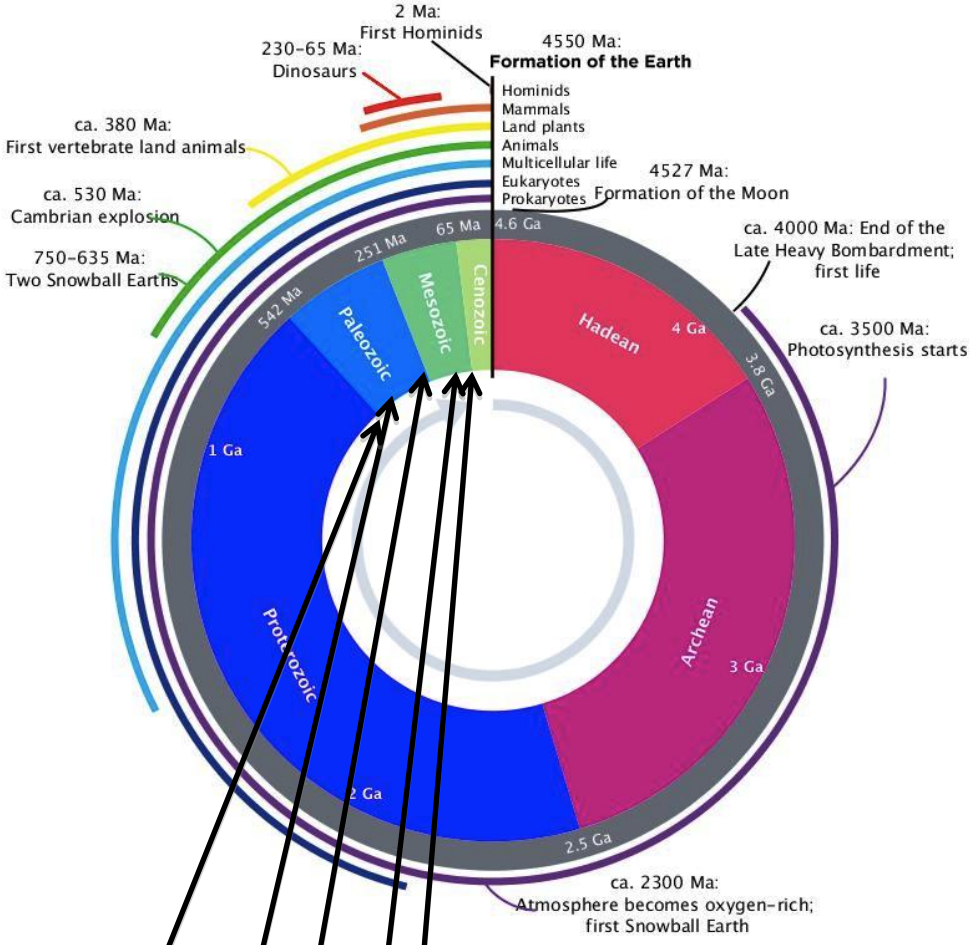
Diagram interpretation and using research data

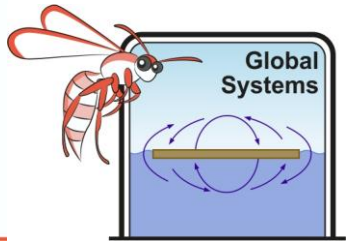
Biodiversity relates to the variety of life found in an area. This includes the different plants, animals and microorganisms, their genes and the ecosystems of which they are a part. The number and variety of species is a simple measure of its "health" i.e. its ability to respond to change at a natural rate. Extinction reduces both the number of species and variation within each species.

During the geologic past of our planet Earth has suffered many greater and lesser periods of extinction of life. The end of the Permian period was marked by the greatest known extinction on Earth, The Great Dying. We lost 96% of all species, 6% of all marine species and it is the only extinction that affected insects. The event occurred slowly over tens of millions of years rather than in rapid response to a single event and recovery took ten to twenty million years. Those organisms that survived are the ancestors of all organisms present on Earth today. Only the genes of those who survived were available to provide the variety of new species to fill the ecological niches left.



Major extinctions are designated as those in which more than 50% of species alive at that time became extinct. There are five major extinctions. Find information to fill the table below using the Internet or reference books. Mark when each extinction occurred on the diagram above.

Name	Time	Major groups lost	Animals benefitting
Cretaceous-Palaeogene (K-T)	65Ma	75% loss. Tropical marine animals, non-avian dinosaurs, plants	Mammals & birds
Triassic-Jurassic	200Ma	70-75% loss. Non-dinosaurian archosaurs, theraspids & most large amphibians	Dinosaurs
Permian-Triassic	251Ma	96% See above	Archosaurs
Late Devonian	450-400Ma	70% loss. Life in shallow seas	Marine life
Ordovician-Silurian	430Ma	Trilobites, brachiopods & graptolites	No "winners"



Extinctions & Climate Change – Teacher Notes

Forcing factors contributing to mass extinctions

When we study extinctions, corals can give us critically important information as to some of the forcing factors. Coral reefs endure a long time and their fossil history is relatively well known, as they are excellent reservoirs for oil and gas.

If extinctions were caused by ***meteorite or asteroid impact***, all coral species would be equally affected by heat and dust and would become extinct in a very short time, perhaps even within a few years. Fossil records show that in all major extinction events the coral loss took place over geologically long periods. So although meteorite impacts may be a contributing factor, they are not the only cause of major extinctions. Many past meteorite impacts had little effect on biodiversity.

Similarly ***increasing ocean temperature*** could have caused coral bleaching due to its effect in enzyme efficiency but again the extinction event was over geologically long periods of tens of millions of years.

Scientists suggest that the critical factor was an ***increase in CO_2 in the atmosphere*** from volcanic outgassing. NOAA scientists (National Oceanic and Atmospheric Administration – USA government research body) used information gained from natural outgassing of the Mauna Loa volcano in Hawaii to support this proposition. They followed the geological concept that "The present is the key to the past" as suggested by James Hutton.

1. Describe what effect an increase of atmospheric CO_2 would have on corals?
    1. Corals have internal skeletons to support the animals' bodies.
    2. Coral skeletons are made from calcium carbonate.
    3. CO_2 dissolved in water produces carbonic acid (hydrogen carbonate ions).
    4. Carbonic acid would remove calcium carbonate and weaken the skeletons
    5. Corals would weaken and die as the ocean became progressively more acidic.

$$CO_2 + H_2O + CO_3^{2-} = 2HCO_3^-$$

2. Would increased ocean acidity also affect shelled organisms such as mussels, oysters and clams? Yes

More recent threats to species diversity

Since the beginning of the Industrial Revolution powered by burning fossil fuels, we have released increasing amounts of CO_2 to be absorbed and shared by both ocean and atmosphere. Carbon dioxide enhances the greenhouse effect causing atmospheric temperature rise.

NOAA scientists assert that the pH of surface waters has fallen 0.1 pH units.

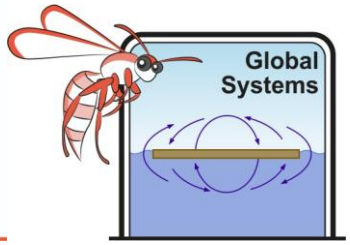
Have ocean surface waters become more or less acidic? They have become more acidic.

However since pH is registered on a logarithmic scale, 0.1 pH units represents a 30% increase in the rate of ocean acidification.

Some scientists suggest that the increased acidification may benefit marine photosynthetic algae.

Why is this so? Photosynthetic organisms use CO_2 with water and energy from the Sun to create sugars for their energy needs. The increased levels of CO_2 may increase the rate of photosynthesis.

Initial studies suggest that with land plants, increasing CO_2 initially produces a growth spurt but the increase is not sustained. More research is required.

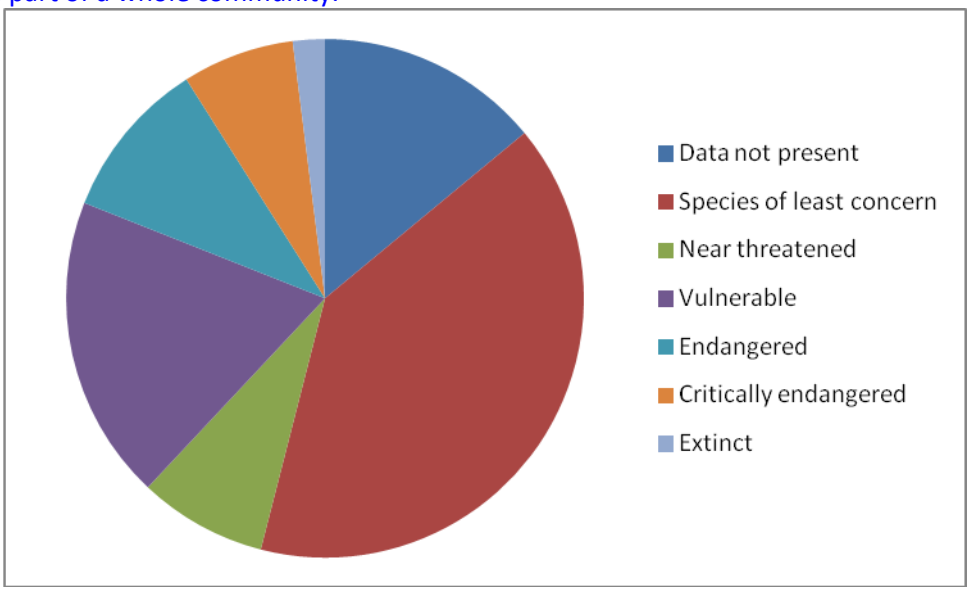


Extinctions & Climate Change – Teacher Notes

Scientists studying present species loss in their research area have collected the following data.

Species classification	Number	Percentage
Data not present	6,584	14%
Species of least concern	19,032	40%
Near threatened	3,931	8%
Vulnerable	9,075	19%
Endangered	4,891	10%
Critically endangered	3,325	7%
Extinct	373	2%

Using this data, calculate the percentage species loss for each classification and draw a suitable graph to present the data in a simpler form. A pie chart would be best because it demonstrates species as part of a whole community.



Why would the researchers include species for which they have no data? Because they are still part of the whole community being studied. Not including them would skew results.

Does this information represent a mass extinction is taking place? Explain your answer. No. A mass extinction requires 50% species loss.

Past Ice Ages and extinction events

Several times during Earth's geological history our planet has become much colder. Not all of these Ice Ages led to extinctions however. Our most recent (Pleistocene) Ice Age stretched from about 2.6 million years ago to about 20,000 years ago. It varied in time of onset, geographic spread and intensity across the planet and included several warm interglacial periods. We suspect some of these variations result from a combination of:

- Variable sun output activity
- Variable path of the Earth round the sun due to gravitational pull from other planets
- Variations of axial tilt

During the Pleistocene the population of modern humans (Homo sapiens sapiens) in the world was reduced to about 600 breeding pairs living in tropical Africa as great glaciers covered most of the landmasses except between the tropics. Life was harsh and food scarce. We know this from genetic evidence collected during National Geographic's human genome project. Other hominid species such as Neanderthal man (Homo neanderthalensis) and Denisovan man (Homo denisova) died out around the end of the last glacial maximum or soon after. Genetic evidence suggests that all these

groups interbred, as we share common genes. After the ice retreated modern humans spread out to cover the great plains of the world hunting game and collecting fruits, seeds and berries. Another hominid (Homo sapiens floresiensis) commonly known as "The Hobbit", perished more recently.
Are modern humans, Neanderthals and Denisovans separate species? Explain your answer. They are the same species as they could interbreed.
Did Ice Age events increase or decrease hominid species variation or numbers? Variation decreased within the one species as sub-groups died out. Numbers decreased also.

Although there is evidence of this last Ice Age glaciation in the Eastern States, in Western Australia only a little is found as glacial moraines south of the Stirling Range. Some remnant Gondwanaland vegetation is found here as well as remnants of Ice Age vegetation on the Range. However we do have evidence of earlier Permian glaciation near Minginew in the Central Wheat Belt. Rocks frozen into glacier ice scraping over them produced the white scratches visible on this rock surface.
If you found these scratches when studying these rocks would they be primary data, secondary data or proxy data?
They would be proxy data, as glaciation would be inferred.

Snowball Earth

There have been three major occasions when Planet Earth has been almost covered by ice threatening a major extinction event. These are called "Snowball Earth" events.
Using the first diagram on this worksheet, list below when these extinctions took place.
2,300 Ma One extinction
750 – 635Ma Two extinctions