Science Topics 09-18-23

Updated 04-13-24 at end

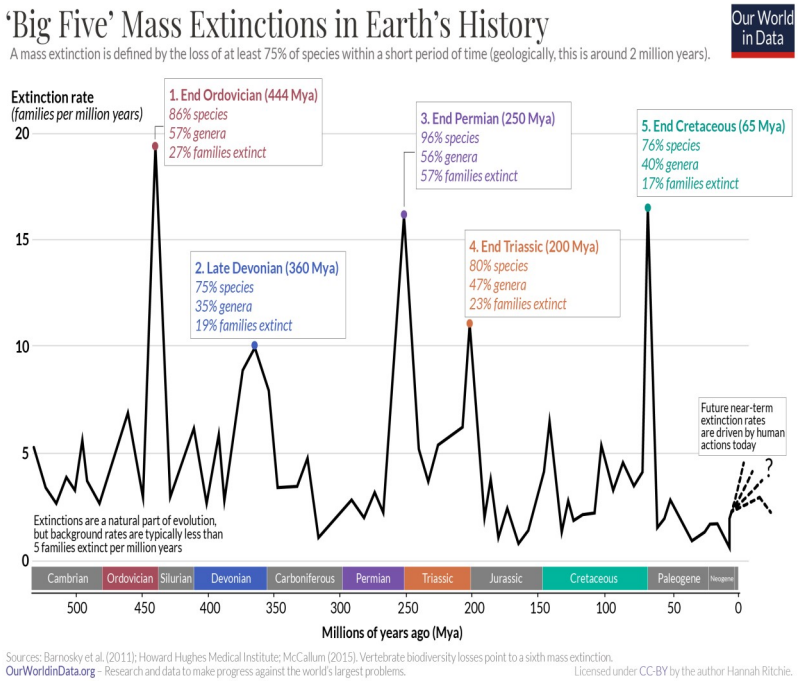
CliSciPol

Climate Science and Policy for Nonscientists

One picture is worth a thousand words.

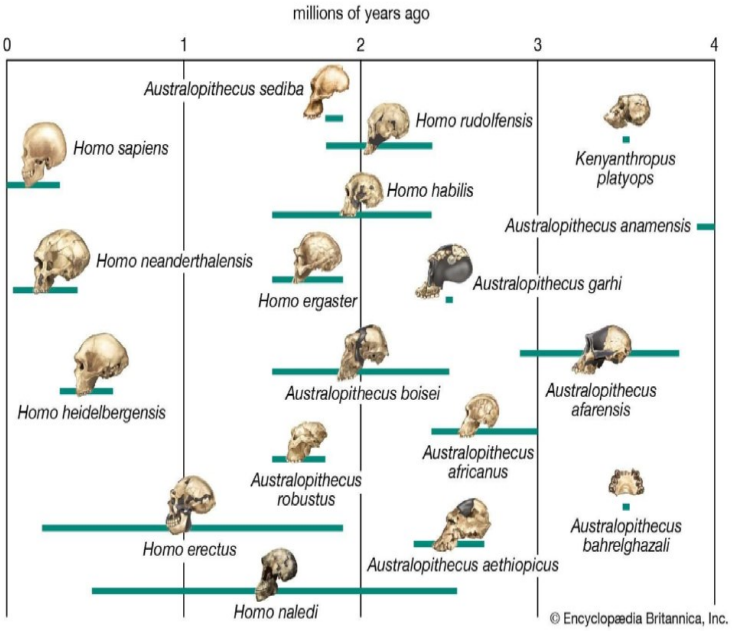
Extinctions - Are We in the Midst of a Sixth Mass Extinction?

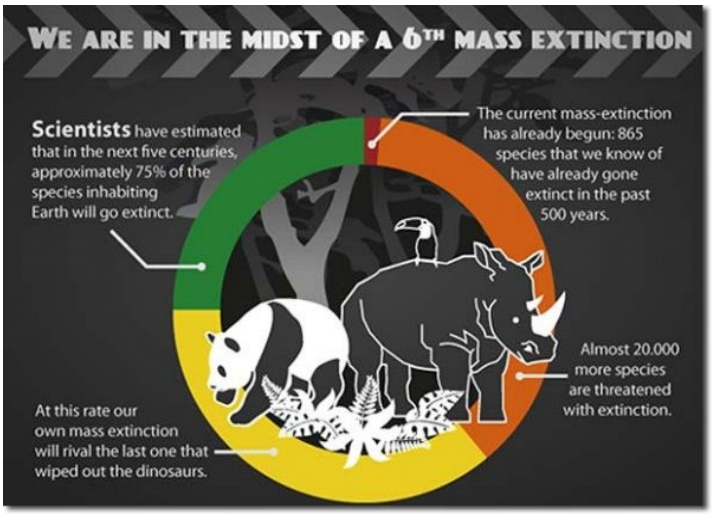
The idea of a Sixth Mass Extinction goes back at least to an article appearing in 2008. This idea was given a major boost in 2014 with the publication of a book, The Sixth Extinction, by Elizabeth Kolbert, a staff writer for the New Yorker. As one might expect given the author's background, this book is long on anecdotes and short on science. A much better introduction to these issues is provided by the recent book, Extinctions (2021) by Michael Hannah, who is a professor of Geography, Environment, and Earth Sciences, and who will be cited frequently hereafter.



The First Mass Extinction occurred 444 million years ago, and the Fifth 65 million years ago. A mass extinction is commonly defined as the loss of at least 75% of the world's species. Scientists have only a vague idea as to how many species there are presently in the world. The International Union for the Conservation of Nature and Natural Resources (the "IUCN") estimates a possible range of 5-30 million with 14-18 million being a "best guess." Hannah estimates 8.7 million +/- 1.3 million. Another scientist believes that at least 10 million species exist just in the world's tropical rain forests. Assuming 8.7 million species, then a Mass Extinction would require the extinction of at least 75% or 6.5 million species

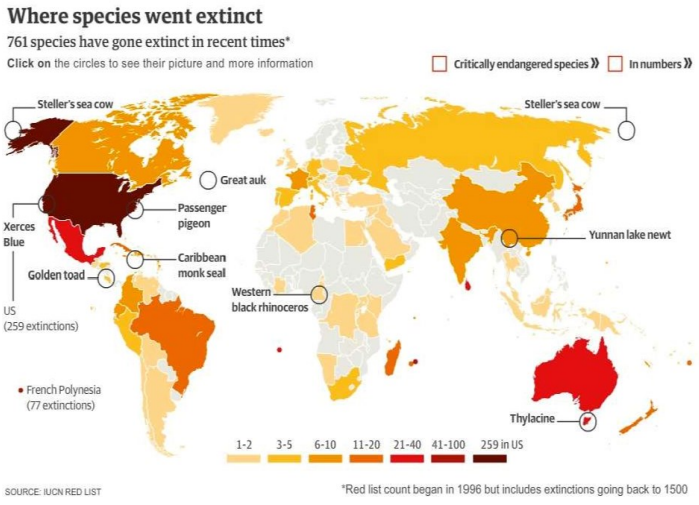
Extinction is normal and natural. Species have life cycles. They are born, mature, age, and die. An average mammal species lives 1-2 million years. In world history there have been at one time or another roughly 4 billion species, and Hannah estimates that over 99% of them are now extinct. A species commonly evolves and creates a new species that is better adapted to the environment than the old species. The new species may then drive the old one into extinction. For example, our species is homo sapiens. There have been at least 7 prior species in the "homo" genera, and perhaps 11 or more. All of them are now extinct. Some scientists believe that homo sapiens drove homo neanderthalensis into extinction.

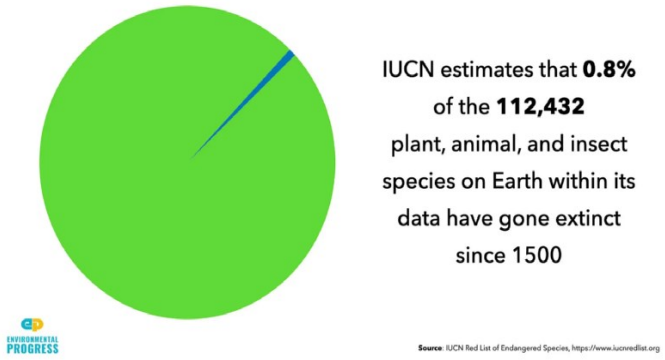




This image summarizes the case for a 6th Mass Extinction. It asserts that 865 species have gone extinct in the last 500 years (less than 2 per year), that 20,000 more species are threatened, and that within 5 centuries 75% of all species will be extinct. But, as discussed above, 75% of all species means about 6.5 million species going extinct in the next 500 years, or about 13,000 per year.

Counting extinctions is very difficult. According to this image the IUCN is able to count only 761 species gone extinct since 1500. The IUCN maintains what is considered the world's best dataset on threatened and endangered species.

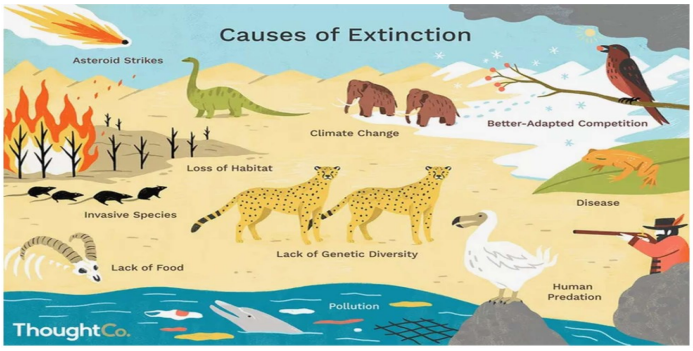




Tis IUCN data indicates that 0.8% of 112,432 = 899 species have gone extinct since 1500, which is still less than 2 per year. Obviously 0.8% is tremendously less than the 75% required for a mass extinction.

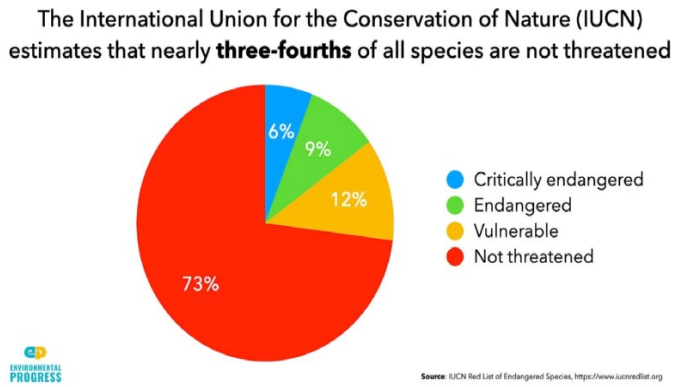
Also the IUCN estimates that 73% of species are not threatened. Hannah says that the term "Sixth Extinction" is not a term he likes using. He has coined the word "defaunation" to describe the growing threat of species extinction. There is definite evidence that the rate of extinction is increasing, but, as Hannah acknowledges, the current extinction data "doesn't look too dire," and it is "not even close" to a mass extinction. But Hannah contends that we are at the start of a crash in biodiversity, because the rate of extinctions is increasing so significantly as to constitute a crisis that will manifest itself in future centuries. Hannah does not indicate how many centuries.

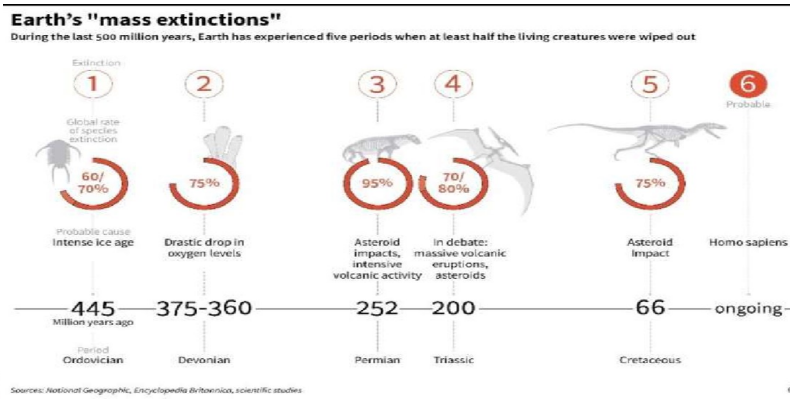
All of the Five Mass Extinctions were caused by climate change. They all occurred long before humans appeared on earth. The media today commonly suggests, if not states, that present extinctions are also caused by climate change.



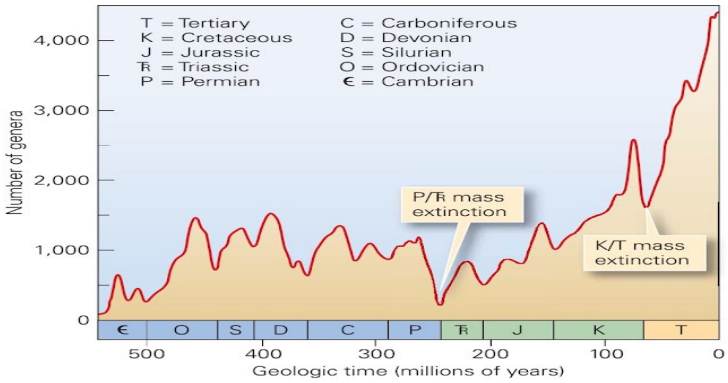
Since 1500 bird species whose habitat has been a single island or island group have been particularly vulnerable. For example, Hawaii has lost about 70 bird species over the last 200 years, mostly due to invasive species (cats, snakes, and rats). Since humans came to New Zealand, nearly half of the native bird species (some 400 out of 800) have gone extinct due to causes other than climate change.

Despite the 5 mass extinctions and about 20 "minor" extinctions (more than 40% species extinct but less than 75%) world biodiversity has always strongly rebounded. World biodiversity is probably greater today than it has ever been. Despite current extinctions, the number of overall species in the world is probably increasing although there is great uncertainty about by how much.





But extinctions during the human era have had a wide variety of causes. The principal cause has been direct human activity of various types - habitat destruction, invasive species (commonly transported by human activity), human predation (overhunting and fishing), and pollution. Scientists have had difficulty linking extinctions in the last 200 years to climate change.



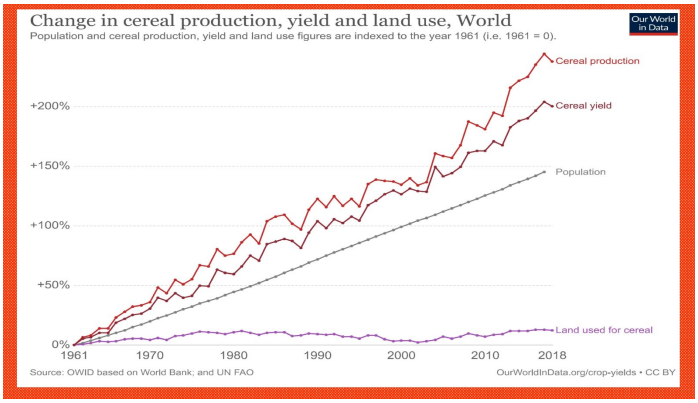
NASA Study by an international team of 32 authors from 24 institutions in 8 countries (2016) –

From a quarter to half of Earth's vegetated lands showed significant greening over the prior 35 years.

Leaves on plants and trees increased equivalent in area to two times the continental United States.

Attribution – 70% rising CO2, 30% rising temperatures.

With rising CO2 levels plants make more efficient use of water, and so they can grow in places that were previously too dry for plant growth. The entire Southern rim of the Sahara Desert is greening. The Sahara has shrunk by about 8% over the 30 years 1988-2018.



Producing the food needed to feed the world's population now requires less land, and so farmland can be reforested.

AR6 FINDINGS

Greenness has increased globally since the early 1980s. (WGI 366)

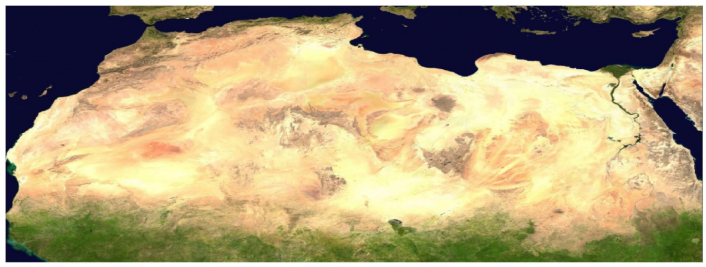
Climate zones have shifted poleward. The growing season has lengthened by up to two days per decade since the 1950s in some areas. (WGI 6)

Increasing atmospheric CO2 concentrations has increased plant growth and water-use efficiency. (WGI 8-6)

One study shows that there has been a 7% rise in global tree cover 1982-2016. (WGI 365)

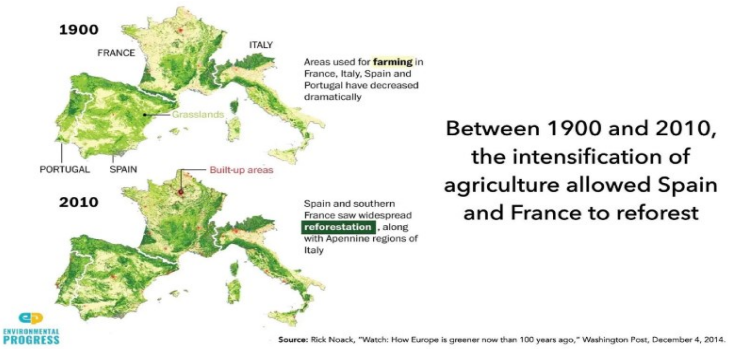
According to the 2021 IPCC Assessment Report 6 (AR6), the world has warmed about 1 C over the last century, and atmospheric CO2 levels have been rising significantly. This is climate change that is beneficial to plant growth. According to a massive NASA study the world is greening as a result of temperature and CO2 rise.

Using satellite images, Venter et al. 2018 found an eight percent increase in woody vegetation in sub-Saharan Africa over the last three decades, underscoring the global "greening trend".



Recent study by Venter et al finds that the Sahara has shrunk by 8% over the past three decades. NASA image, public domain.

Rising CO2 levels cause crops to produce more food per acre. World food production has been increasing greatly - at a rate of growth greater that the soaring world population.



Between 1900 and 2010, the intensification of agriculture allowed Spain and France to reforest

IPCC AR6 agrees with these conclusions as to greening. Increased greening means more healthy plant species and more food available for all types of organisms up the food chain. Thus the present rate of climate change, in general, is beneficial for plant, animal, and insect species. It does not threaten extinctions. And AR6 makes no claim that the rate of temperature rise or CO2 emissions is accelerating.

Some claim that rising temperatures pose a threat to particular species, such as polar bears and coral. Arctic summer (September) sea ice declined significantly from around 1995 to 2007. Since then, it has leveled off. But it has been theorized that this decline would so interfere with polar bears hunting seals (the bears' favorite food) that it would cause a collapse of the polar bear population. In 2008 environmentalists succeeded in having polar bears listed as "threatened" based on theoretical models calculating polar bear population collapse as a result of global warming causing reduced summer sea ice.

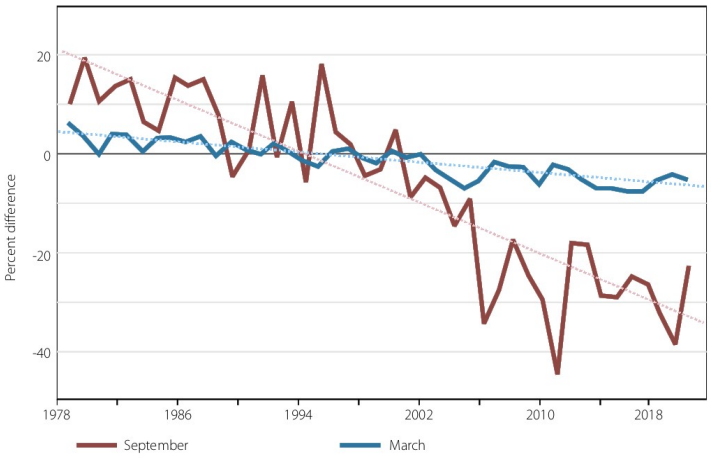


Figure 3: Sea ice extents, 1979–2021.

"OFFICIAL" ESTIMATES

ADDING ANECDOTAL ("PROXY") EVIDENCE

Susan Crockford

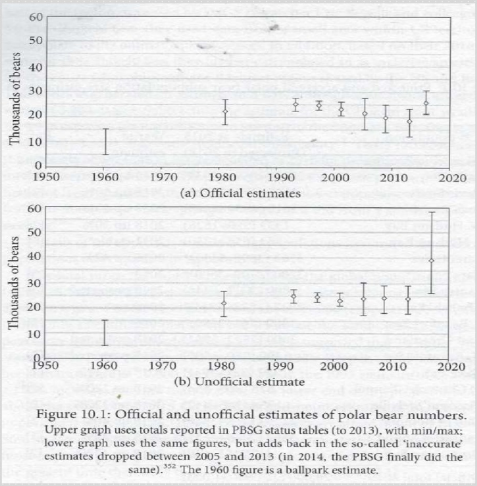


Figure 10.1: Official and unofficial estimates of polar bear numbers. Upper graph uses totals reported in PBSG status tables (to 2013), with min/max; lower graph uses the same figures, but adds back in the so-called 'inaccurate' estimates dropped between 2005 and 2013 (in 2014, the PBSG finally did the same).[552] The 1960 figure is a ballpark estimate.

But, contrary to this theory, the polar bear population has been growing as a result of the international treaty of 1973 that restricted polar bear hunting. Human predation, not climate change, had threatened polar bear extinction. The melting sea ice allows more sunlight to penetrate the ocean, and this has resulted in ocean greening, the growth of more algae and phytoplankton, which are at the base of the ocean food chain. Moving up the food chain this results in more seals and hence more food for polar bears. The availability of more food is proving to be a larger plus for the polar bear population than reduced summer sea is a minus.

Some claim that rising sea temperatures threaten coral populations. But the coral on the Great Barrier Reef (by far the largest and the most studied coral reef in the world) is thriving.

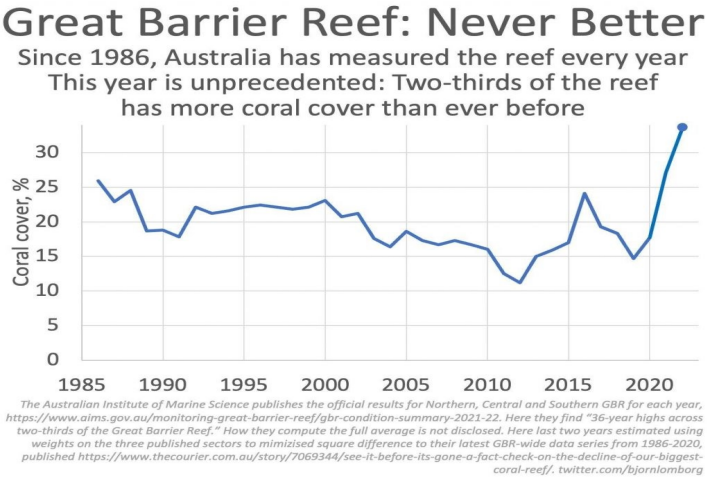
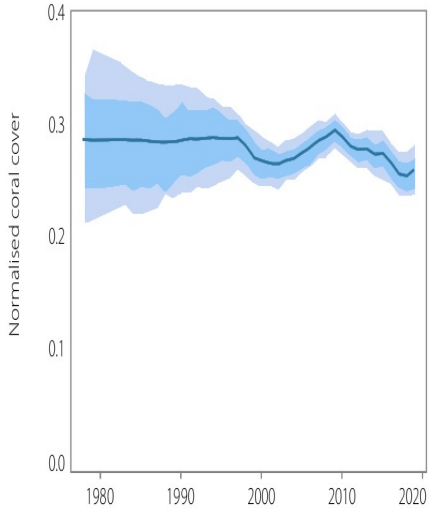


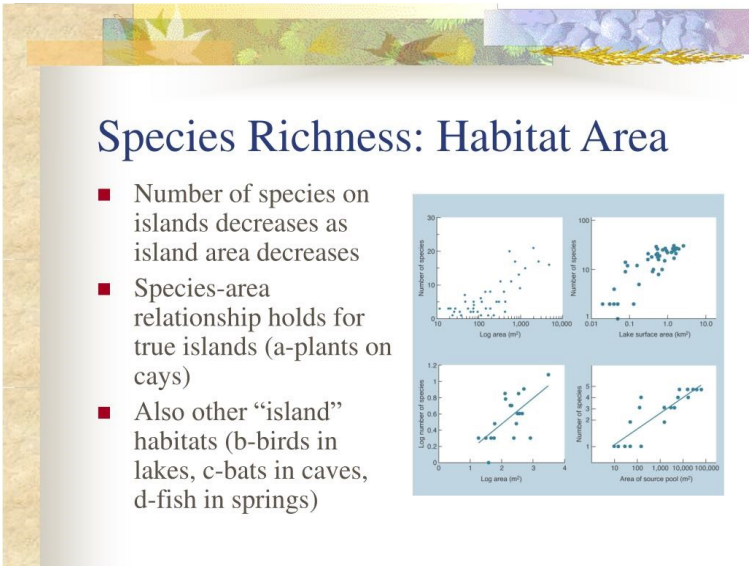
Figure 8: Global cover of hard coral

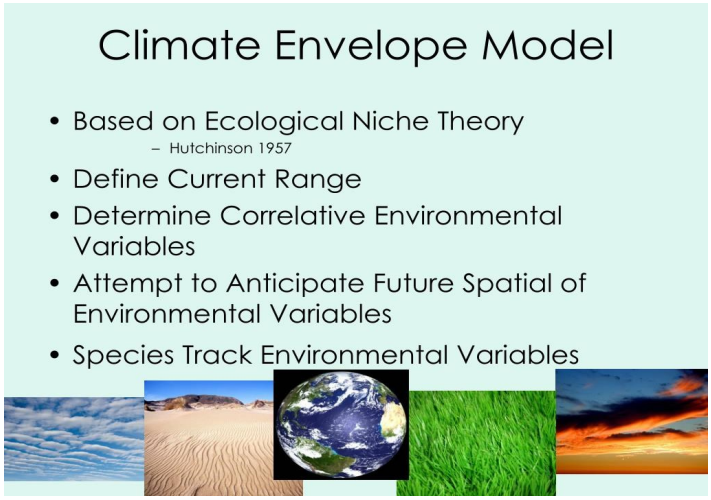
Estimated global average cover of hard coral (solid line) and associated 80% (darker shade) and 95% (lighter shade) credible intervals, which represent levels of uncertainty. Graph redrawn from GCRMN data report. Note, data before 1998 has very high uncertainty due to low number of measurements and problems with randomisation of sampling sites.



Such limited data as exists on coral world wide shows coral populations holding reasonably steady, not collapsing, despite ongoing global warming.

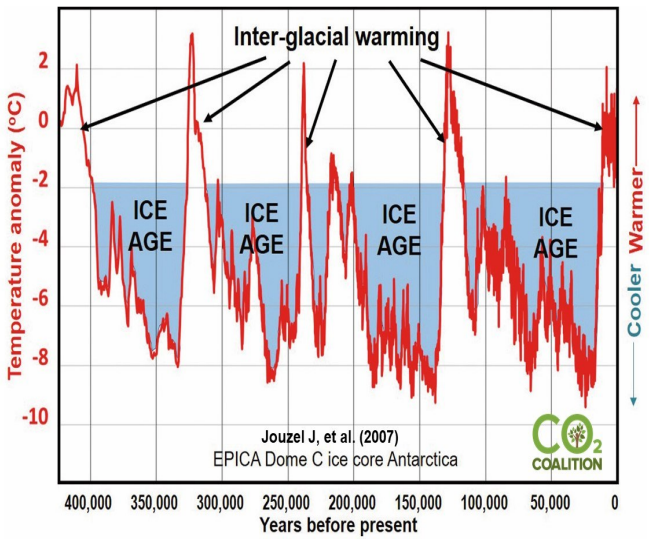
In addition to counting extinctions, scientists have constructed models to estimate extinctions. One type of such models is based on a theorized Species-Area Relationship. Assume a habitat has an area of 100,000 square miles, and assume 30% of the habitat is destroyed. One possible result is that the population of each species in the habitat is reduced by 30%. But the SAR models theorize that a significant percentage, say 30% of the species in the area, go extinct. This percentage extinction number is, at best, a guestimate.





Another such type of model is the Climate Envelope Model. Hannah references (without citation and without indicating which type of model is being used) studies that we are losing between 11,000 and 58,000 species annually, primarily due to habitat reduction, land use changes, and invasive species. The extinction numbers that these models calculate are much, much larger than have ever been actually counted (less than 2 per year since 1500). These models are the basis for the claims that we are facing a Sixth Mass Extinction. But none of these models has ever been verified

All these extinction models assume that species are fragile, i.e. that species have limited ability to adapt to climate and environmental change. But in the last million years the climate has gone through ten massive glaciation cycles with temperatures swinging as much as 10 C or 18 F. The four most recent cycles are shown in this image. Most of the species on earth today have lived through more than these four cycles. For example, the average mammalian species exists for 1-2 million years. Scientists are increasingly documenting that species have great ability to adapt to changing climate conditions, which makes it unlikely that any reasonably foreseeable climate change over the next centuries will result in significant numbers of extinctions.



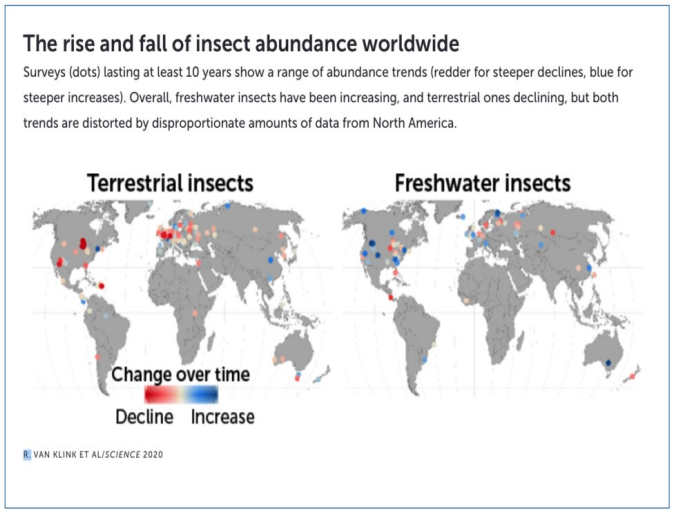
Conclusion

Extinction is a serious concern. As Hannah points out, there is evidence that the rate of extinction is significantly increasing, but we are, as yet, no where near another mass extinction. Further, it is clear that most of the modern extincttions are being driven by habitat reduction, land use changes, invasive species, human predation, and pollution, which are drivers that have little, if anything, to do with climate change. To reduce the rate of extinction we need to address these drivers directly.

A serious extinction problem that has not yet been discussed is overfishing, another example of human predation. But, as with the threat to polar bears and whales, this needs to be addressed directly by treaty involving the nations causing the problem. This is not a climate change problem that can be solved by reducing CO2 emissions.

UPDATE 04-13-24

Not addressed in the original post on extinctions was the issue of insect extinction, which has received significant attention in the media ("Insect Apocalypse" or "Insect Armageddon") . For example, in the early 2000s there were reports of large scale die offs of honeybees. These reports have proved to be unfounded. There is now abundant evidence of rising or stable populations of honey bees.

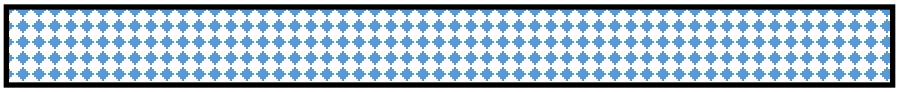


There was published in 2020 a massive survey paper in which 30 scientists assessed almost a century's worth of data from 166 long-term insect surveys in various parts of the world. Major findings of the paper include:

1. Terrestrial insects are declining much less rapidly than suggested in the media, and freshwater insect populations are increasing.
2. Increases in crop cover is associated with increases in insect populations, which rebuts the theory that pesticides are causing insect declines.
3. Global warming does not correlate with declining insect populations.
4. Urbanization does causes insect population declines., most likely as a result of habitat destruction

The data makes it difficult to generalize about the status of insects worldwide, because the studies mostly cover only North America or Europe, and because most of the studies cover only one specific order or family of insect. There is no consensus even on the number of insect species that exist, estimates ranging from 2 to 30 million, only a fraction of which have been named

Nevertheless, it does seem clear that terrestrial insect populations are declining (perhaps at a rate between 5% and 10% per decade), and that this is an issue of concern.



Works Cited

Extinctions by Michael Hannah (2021)

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