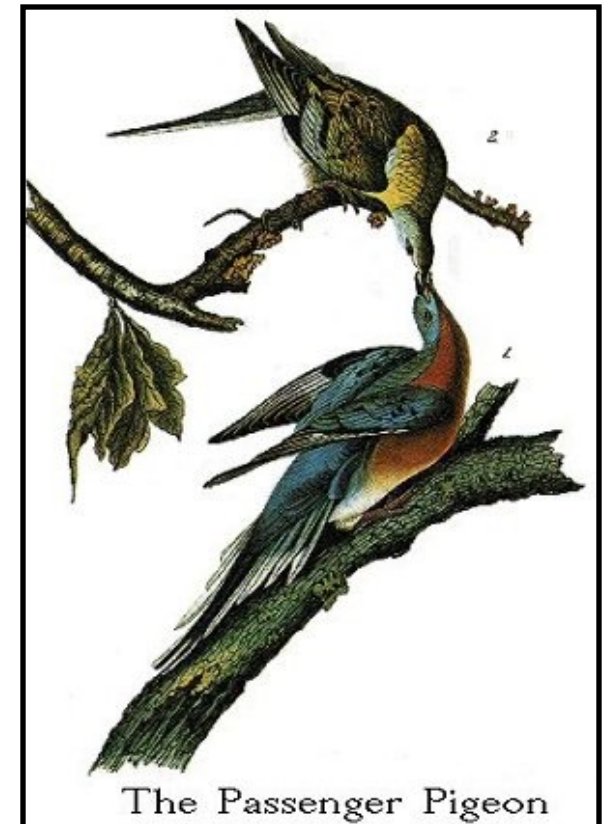



Knowing the Hazards: Extinction and Loss of Ecosystem Services

Class 16



Critical Ecosystem Services


1. Climate and Biogeochemical Cycles
2. Regulation of Hydrologic Cycle
3. Soils and Erosion
4. Biodiversity and Ecosystem Functions
5. Mobile Links
6. Balance of Diseases Transmission

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The first set of assessment reports consists of an overall synthesis and 5 others that interpret the MA findings for specific audiences. [Learn more](#)

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- [Desertification](#)
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- [Wetlands and Water](#)
- [Health](#)


Statement of the MA Board




The MA Board of Directors has developed an interpretation of the key messages to emerge from the assessment, entitled *Living Beyond Our Means: Natural Assets and Human Well-being*. [Learn more](#)

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A Framework for Assessment






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About the Millennium Assessment

The Millennium Ecosystem Assessment assessed the consequences of ecosystem change for human well-being. From 2001 to 2005, the MA involved the work of more than 1,360 experts worldwide. Their findings provide a state-of-the-art scientific appraisal of the condition and trends in the world's ecosystems and the services they provide, as well as the scientific basis for action to conserve and use them sustainably. [Read More](#)

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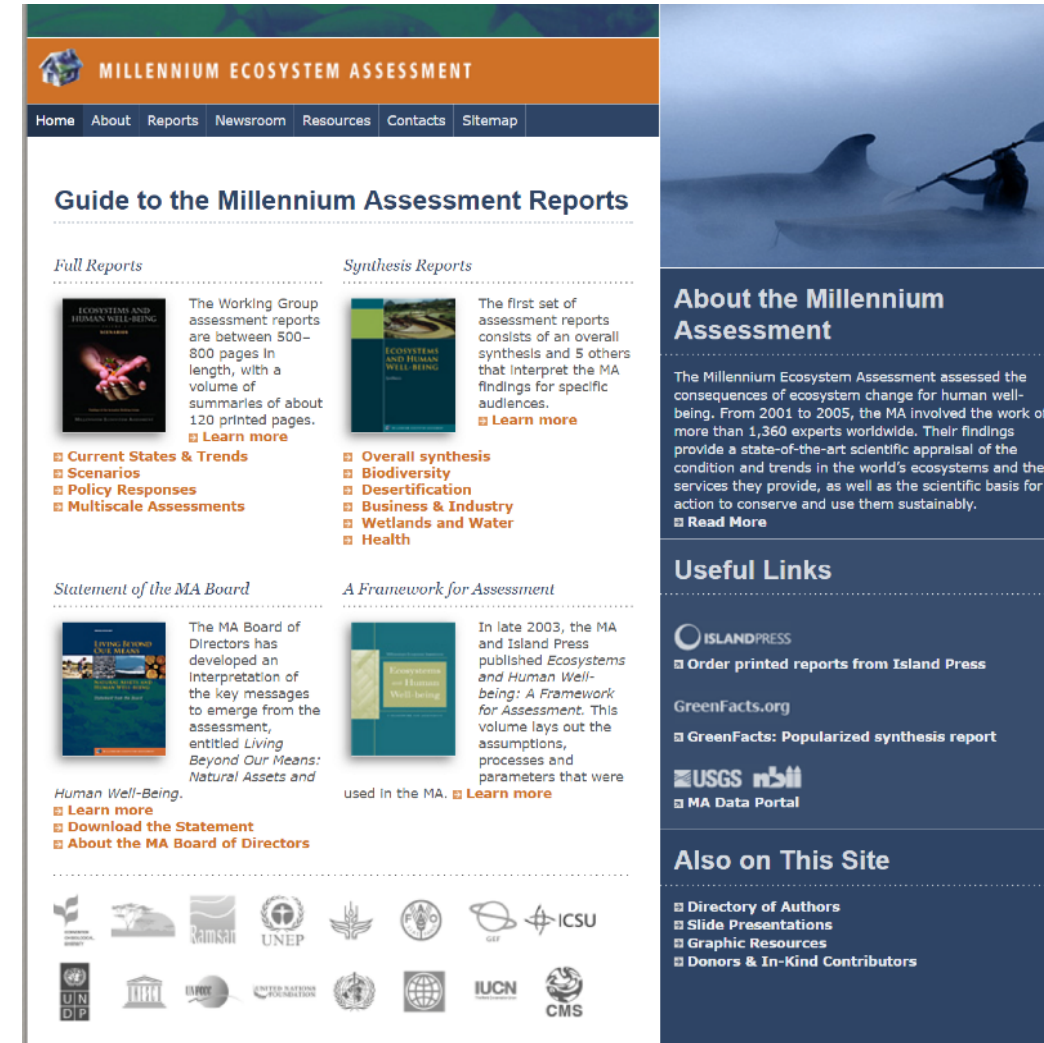
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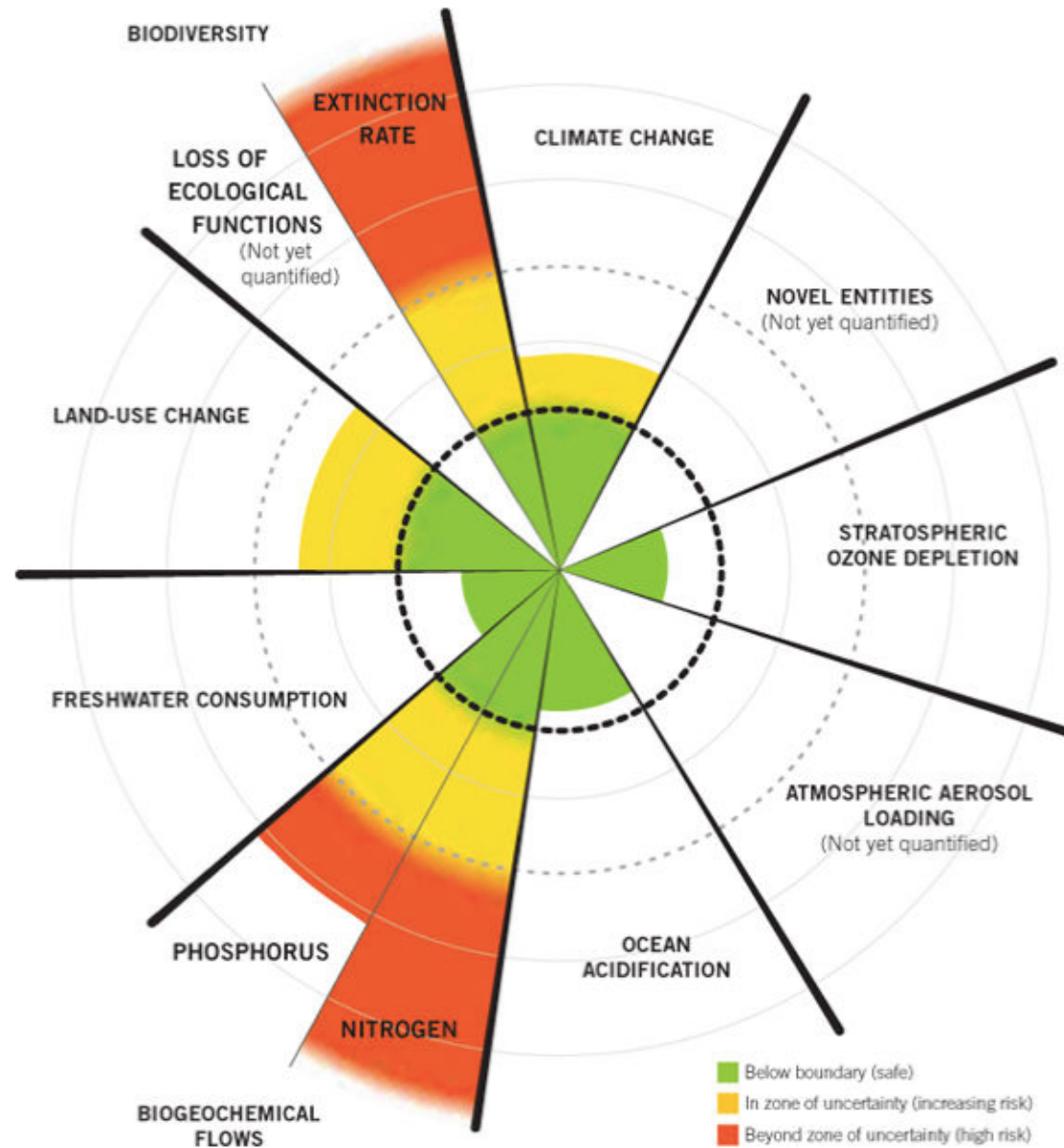
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Leaving the “Safe Operating Space”



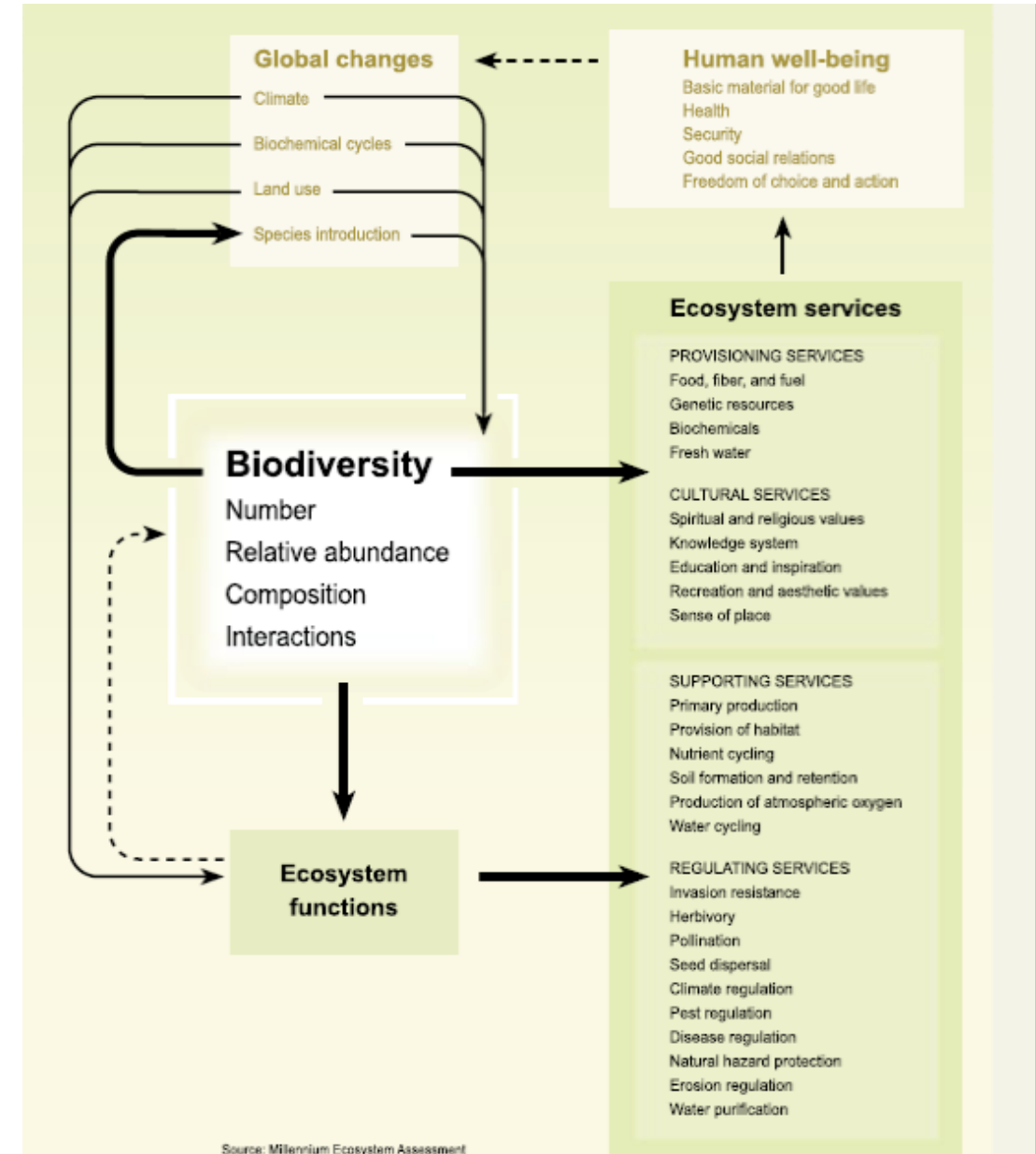
Biodiversity and Ecosystem Function

- Increased biodiversity improves ecosystem functioning in plant communities (Naeem and Li 1997; Tilman 1997) → different plant species capture different resources, leading to greater efficiency and higher productivity (Tilman et al. 1996).
- More biodiverse ecosystems are likely to be more stable and more efficient due to the presence of more pathways for energy flow and nutrient recycling.
- Diversity is thought to stabilize overall ecosystem functioning (Chapin et al. 2000; Tilman 1996) and make the ecosystem more resistant to perturbations (Pimm 1984).



Interactions between Biodiversity, Ecosystem Services and Human

Biodiversity is both, a *response* variable affected by global change drivers and a *factor* modifying ecosystem processes & services and human well-being



Extinction

- *“Ecosystems and communities can be degraded, reduced, and damaged but as long as all the original species survive, communities retain its potential to recover”*
- *“The most serious aspect of environmental damage is the extinction of species”*

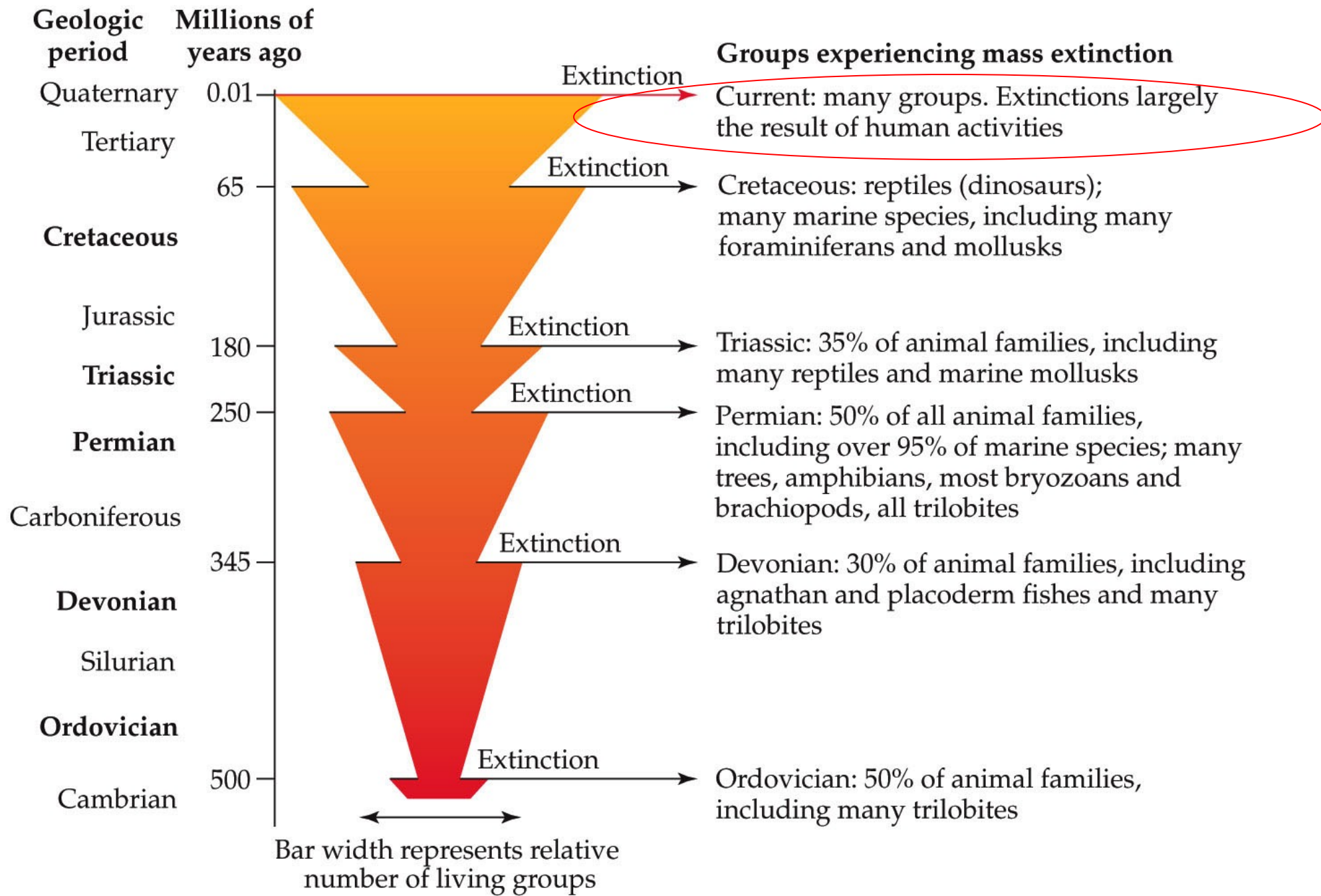


E.O. Wilson

Extinction

- **Extinction** = the disappearance of a species from Earth
 - Species last 1-10 million years
- **Extirpation (local extinction)** = the disappearance of a population from a given area, but **not** the entire species globally
 - Can lead to extinction

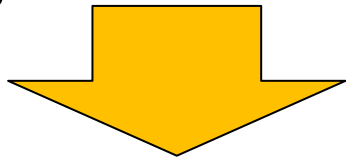




What have caused passed mass extinctions?

- Volcanogenic-atmospheric kill mechanisms included:

- ocean acidification,
- toxic metal poisoning,
- acid rain,
- ozone damage



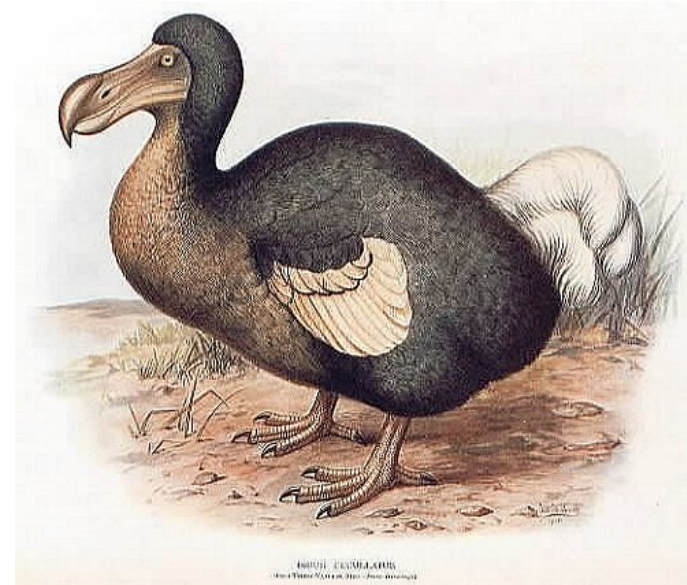
- increased UV-B radiation,
- volcanic darkness,
- cooling and
- photosynthetic shutdown



Bond and Grasby, 2016 <https://www.sciencedirect.com/journal/palaeogeography-palaeoclimatology-palaeoecology/vol/478/suppl/C>

Biodiversity loss and species extinction

- **Extinction is a natural process**
 - 99% of all species that ever lived are now extinct
 - *It's a matter of the rate!*
- **Background rate of extinction**
 - 0.1 extinction per million species-years (E/MSY) (Pimm et al., 2014)
 - (revised from 1E/MSY, Pimm et al., 1995)
 - each year 1 species out of every 10 million goes extinct
 - 1 bird species extinction per 1,000 years

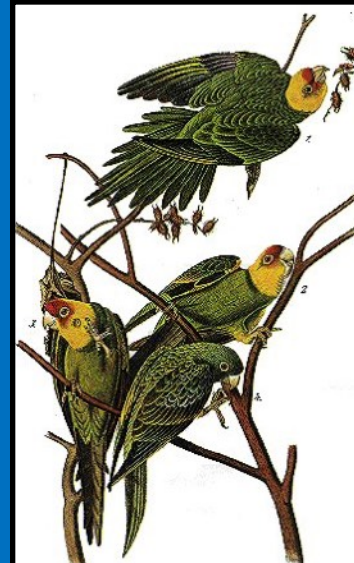




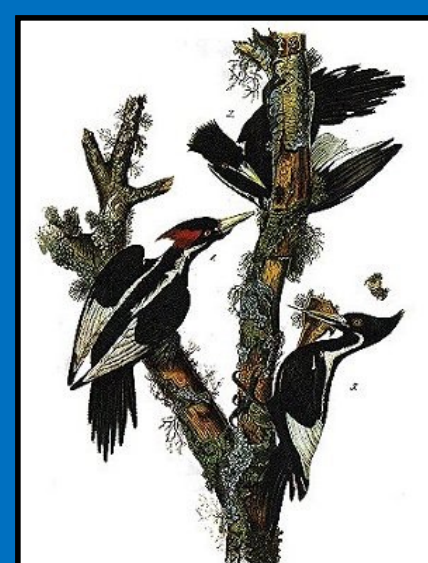
Great Auk



The Passenger Pigeon

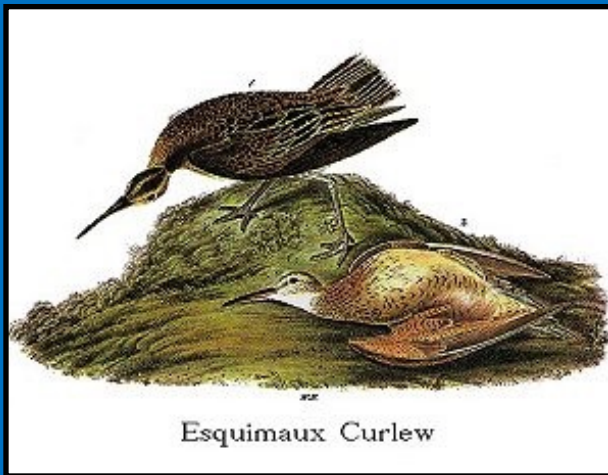


The Carolina Parrot

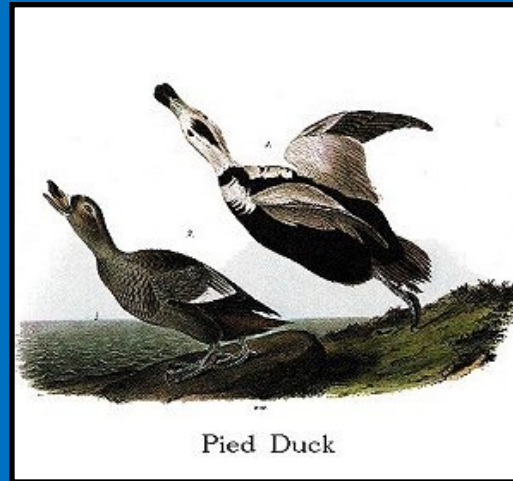


The Ivory-billed Woodpecker

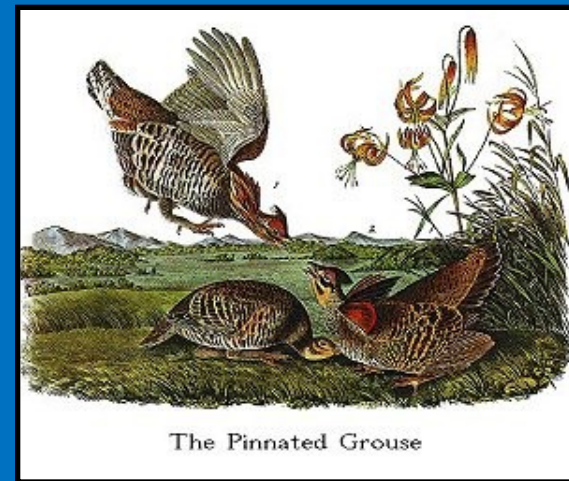
North American birds that have become extinct
since being painted by John James Audubon, 1827-1839



Esquimaux Curlew



Pied Duck



The Pinnated Grouse

During the time of this class...



During the time of this class...

- 3-5 species will go extinct



During the time of this class...

- 3-5 species will go extinct
- 25.5 km² (~ 5 football fields) of the tropical rainforests will be cut

During the time of this class...

- 3-5 species will go extinct
- 25.5 km² (~ 5 football fields) of the tropical rainforests will be cut
- 17,500 people will be added to the world population

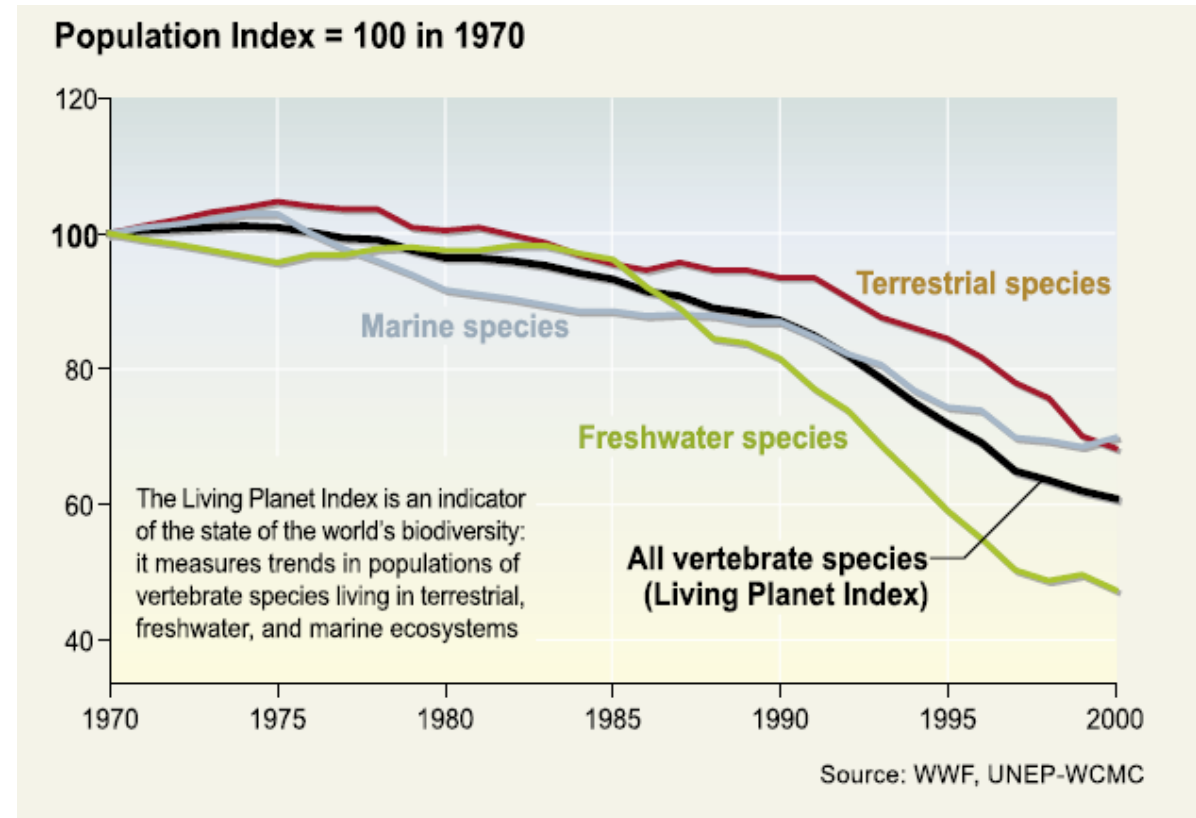
Extinction is a natural process, but ...

- Humans profoundly affect *rates* of extinction
- Present extinction rate ~ 100 E/MSY
 - $\times 1,000 >$ than background rate of 0.1 E/MSY
- Local rates from regions can be much higher:
 - 132 E/MSY for *all birds* after 1900
 - 305 E/MSY for *fish* in NA rivers and lakes
 - 954 E/MSY for the NA freshwater *gastropods*
 - likely $>1,000$ E/MSY for *cichlid fishes* in Africa's Lake Victoria

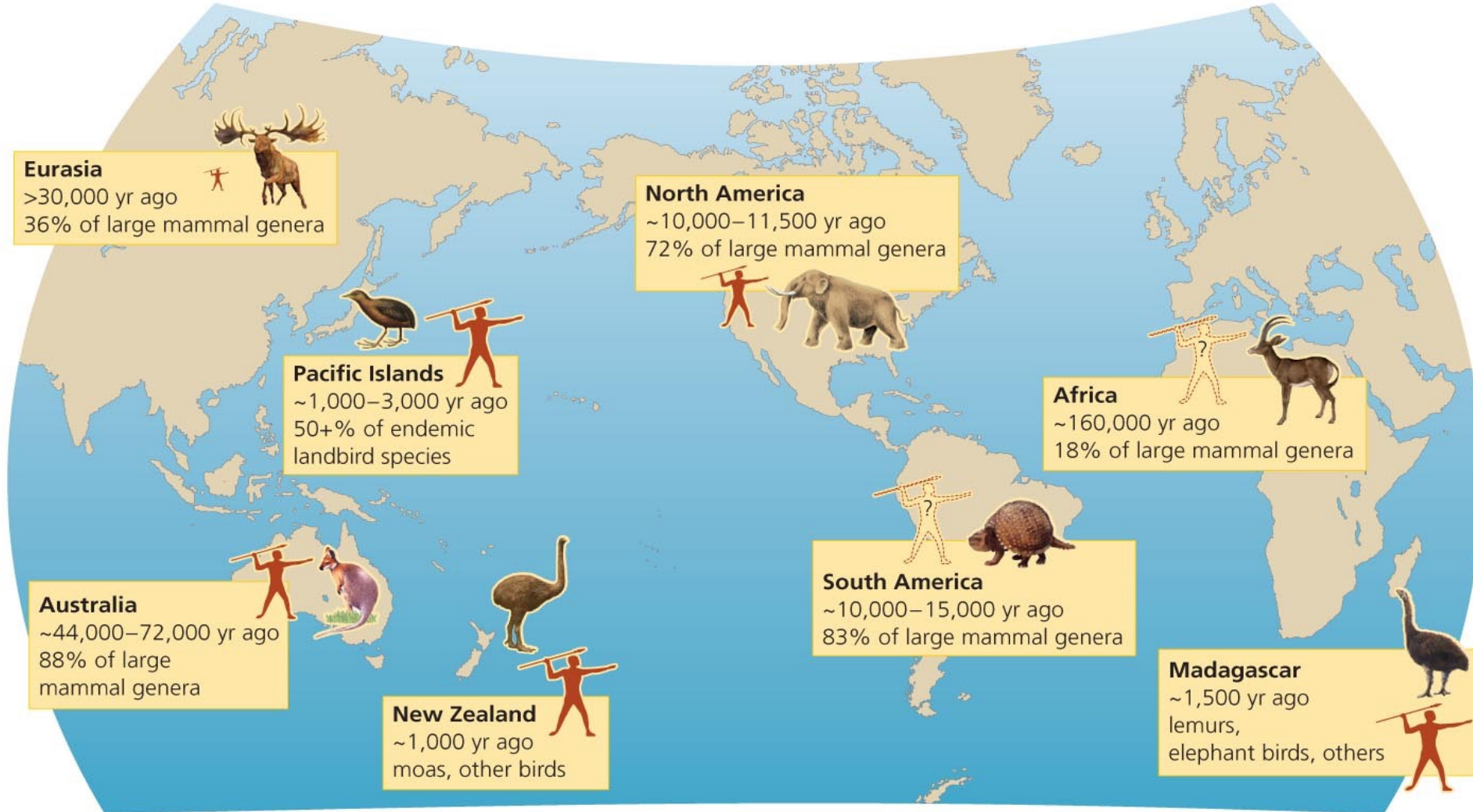


Current Impact on Biodiversity

- Changes in biodiversity and in ecosystems are almost always caused by multiple, interacting drivers.
- *The Living Planet Index* currently incorporates data on the **abundance of vertebrate** 555 terrestrial spp, 323 freshwater spp, and 267 marine spp around the world.
- While the index fell by some 40% between 1970 and 2000, the terrestrial index fell by about 30%, the freshwater index by about 50%, and the marine index by around 30% over the same period.



Humans are causing this mass extinction

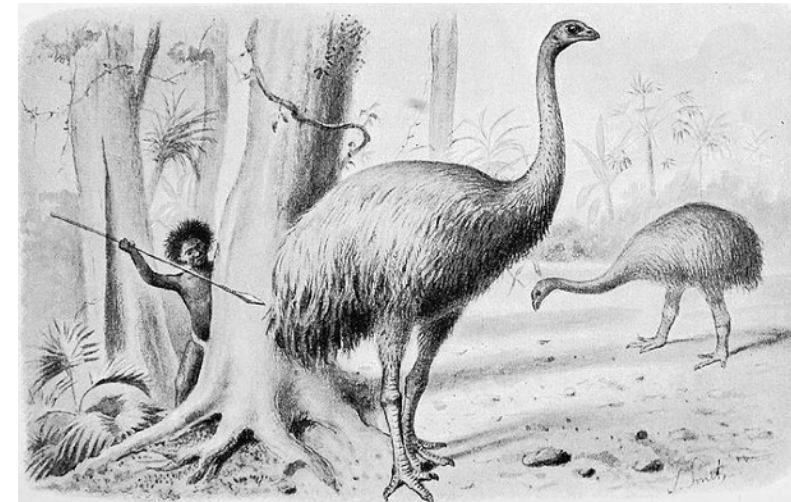


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Extinctions followed human arrival on islands and continents

Extinction on Islands

- Highest extinction rates during historic times have occurred on **islands**.
 - 90% of bird extinction
 - Madagascar: 40% of large mammals
 - Hawaii: 70-90 bird spp extinct
 - - 57 spp. = 42% of birds in New Zealand went extinct, including 11 spp. of moas
 - Pacific Islands: ~1,000 bird spp = 1 extinction every few years = 100 E/MSY



Extinction on Islands

- Highest extinction rates during historic times have occurred on **islands**. *Why?*



Extinction on Islands

- Highest extinction rates during historic times have occurred on **islands**. *Why?*
 - Small land area
 - Small populations
 - Small number of populations
 - Many endemic spp.
 - Limited (if any) natural predators → nobody evolved defenses



Extinction on Islands

- Highest extinction rates during historic times have occurred on **islands**.



Extinction on Islands

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Can we simply solve the problem by protecting all islands?

NO!



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Currently it has shifted to rapid increase in extinction on continents



Extinction on Islands

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NO!

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- Extinction occurs when the environment changes rapidly →
Natural selection can not keep up

