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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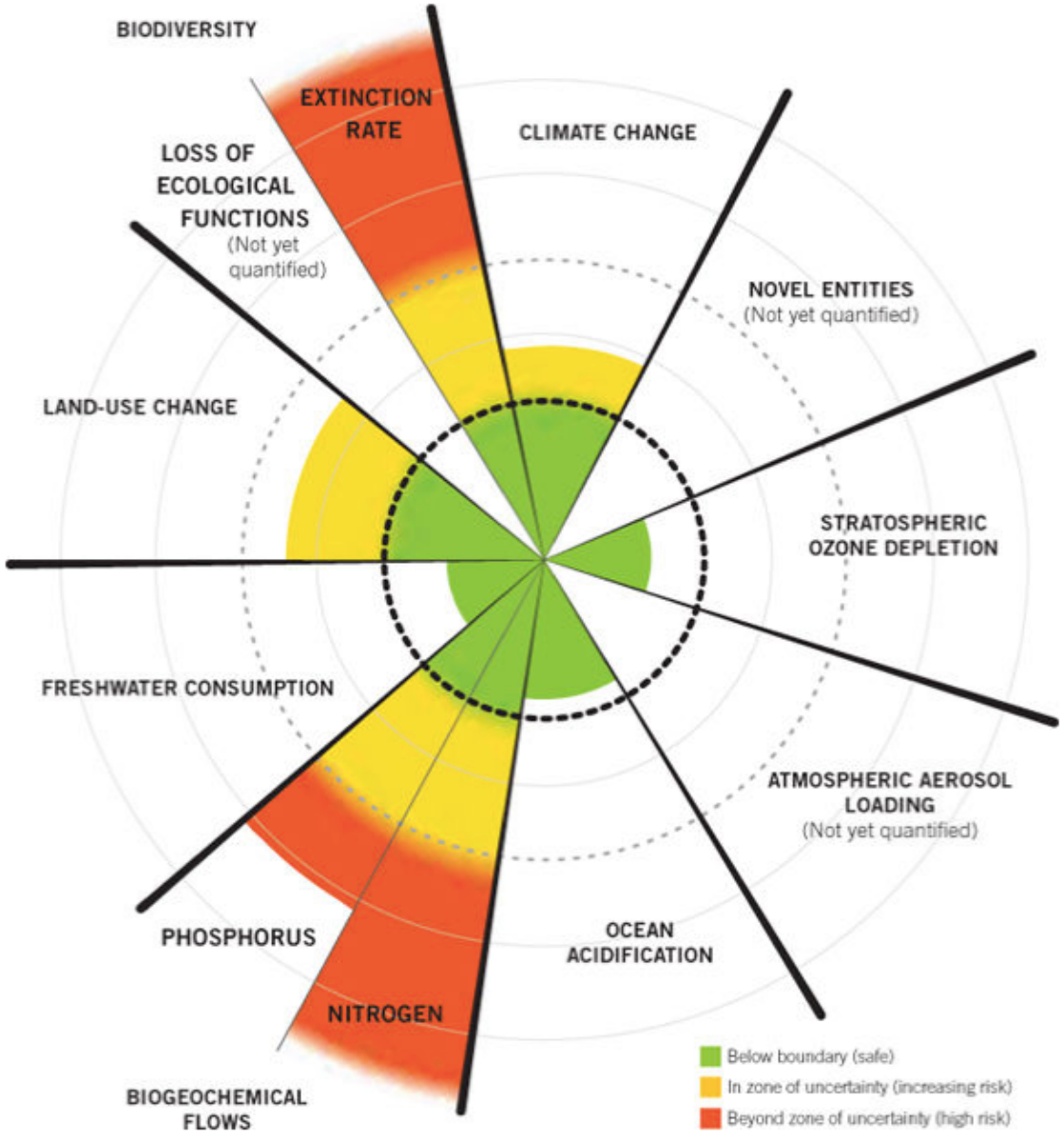
Leaving the “Safe Operating Space”

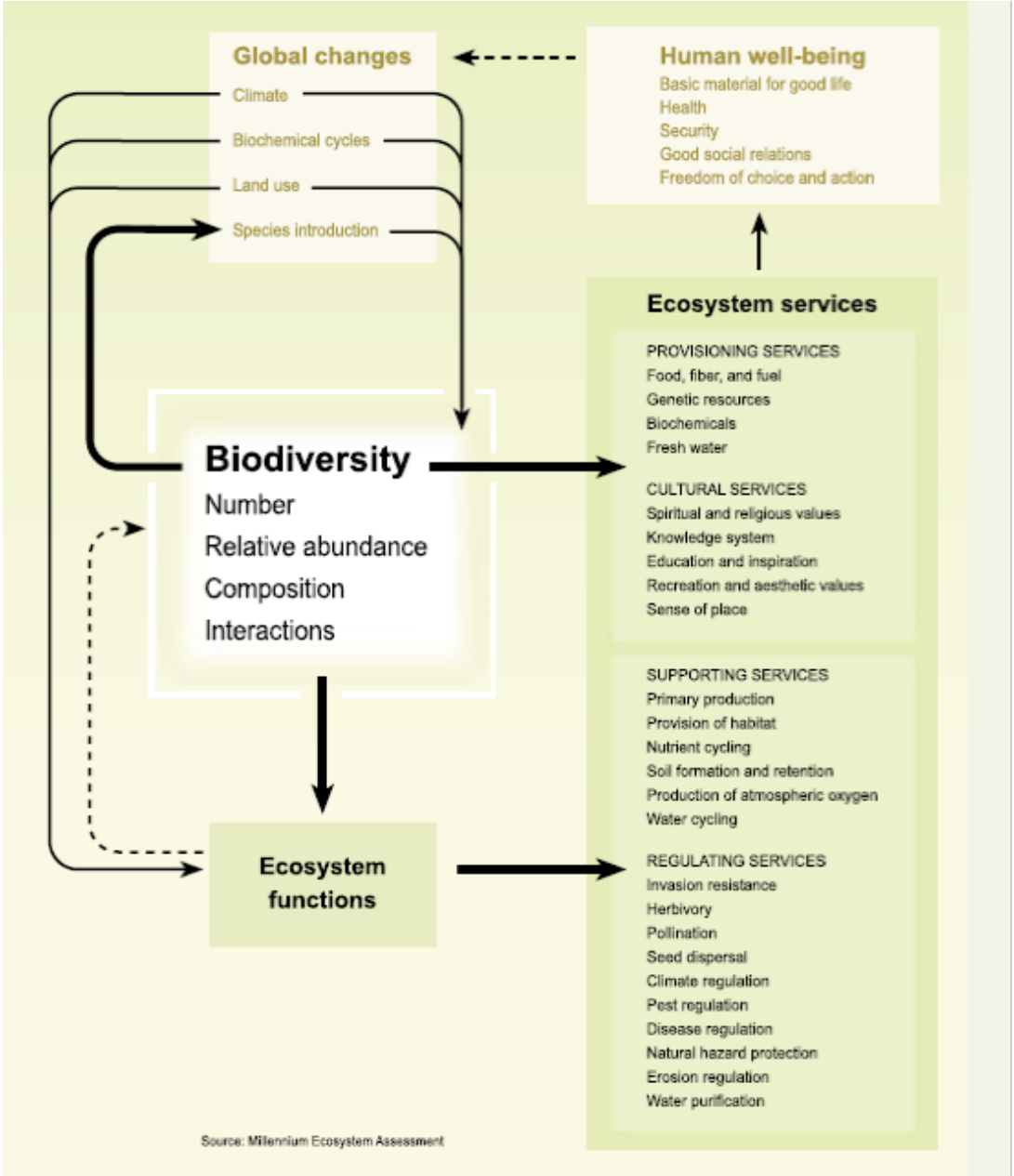


Biodiversity and Ecosystem Function

- 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

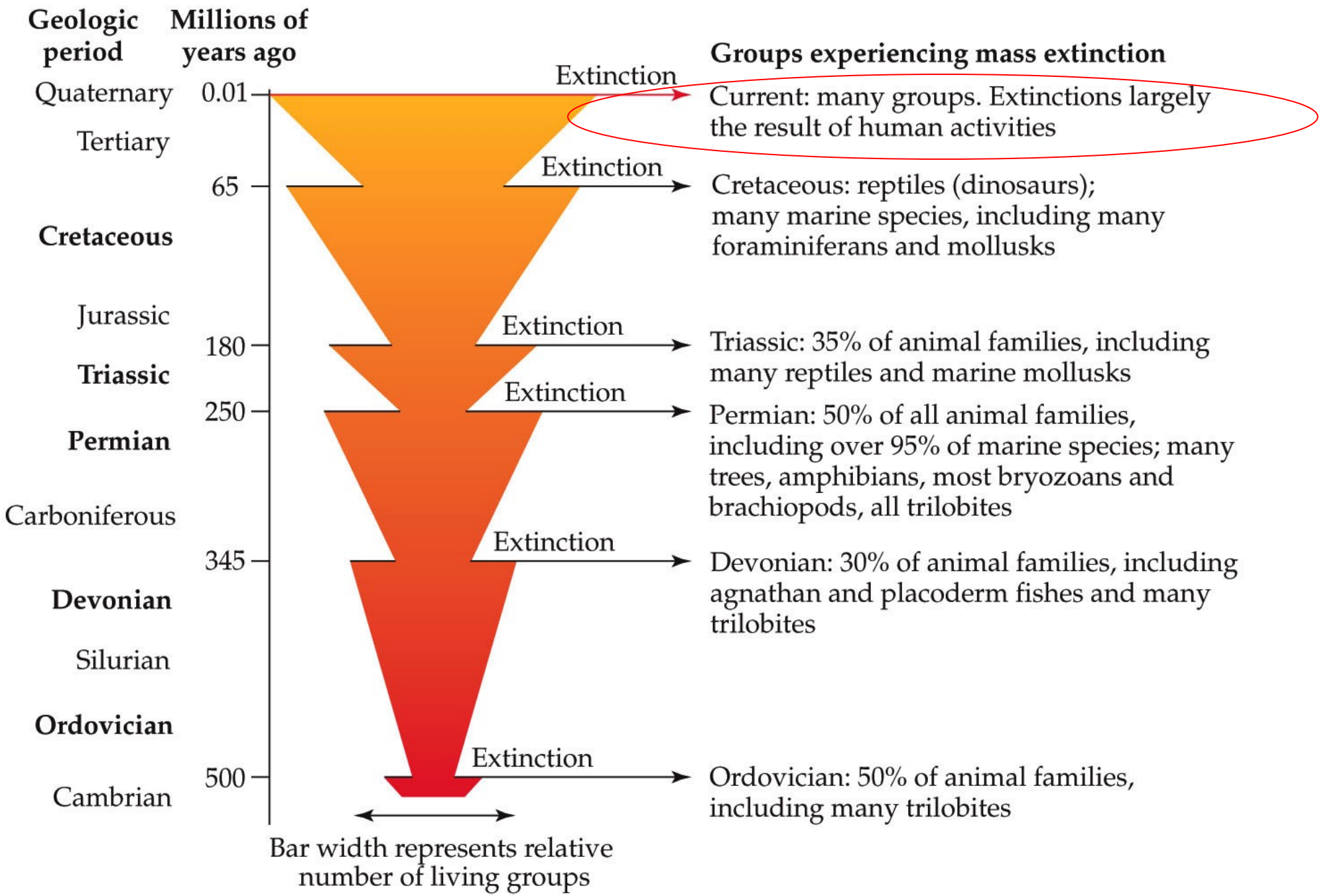
- *"Ecosystems and communities can be degraded, reduced, and damaged but as long as all the original species survive, communities retain its potential to recover"*

- *"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



***PRIMER OF CONSERVATION BIOLOGY 4e*, Figure 5.1**

What have caused passed mass extinctions?

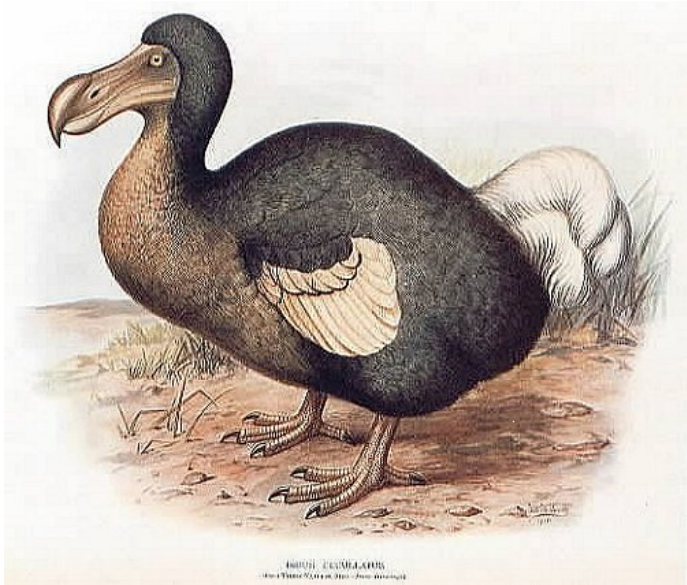
- Volcanogenic-atmospheric kill mechanisms included:
  - ocean acidification,
  - toxic metal poisoning,
  - acid rain,
  - ozone damage

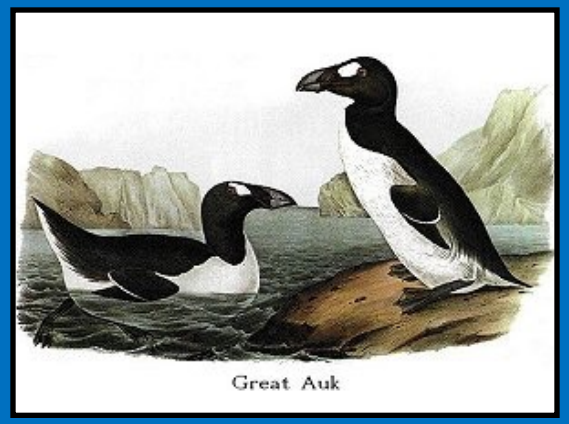
  - increased UV-B radiation,
  - volcanic darkness,
  - cooling and
  - photosynthetic shutdown

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



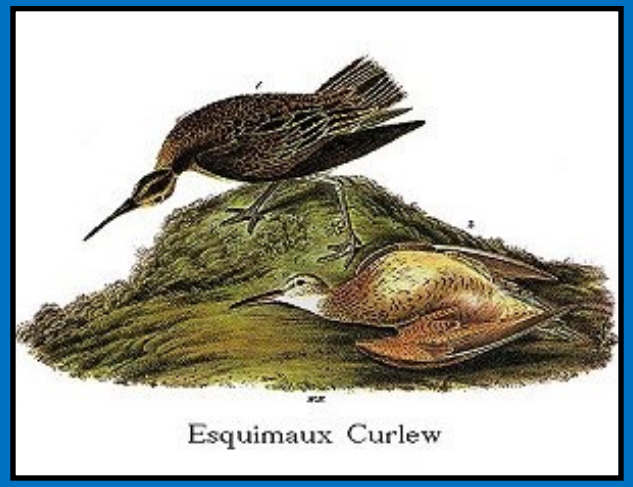

Great Auk

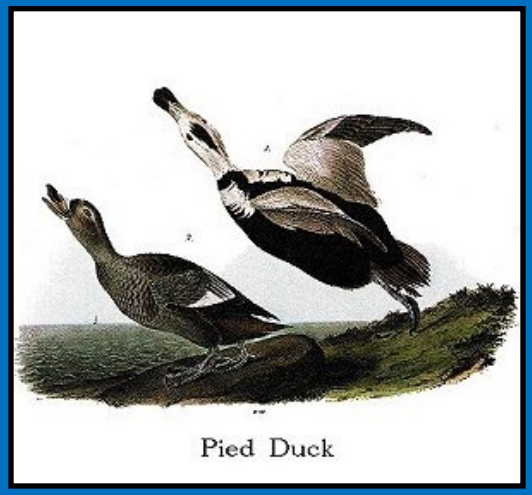

The Passenger Pigeon

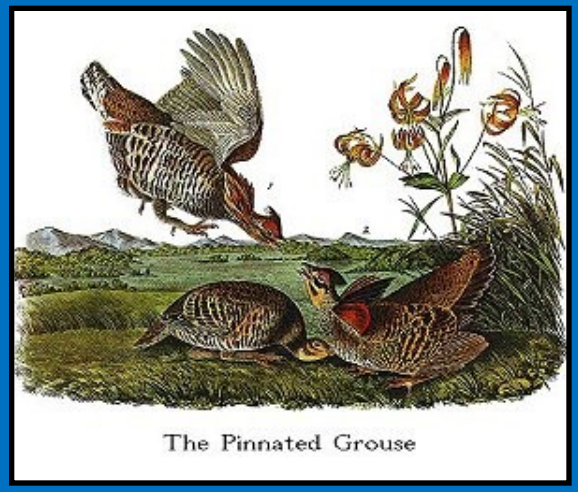

The Carolina Parrot


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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- 25.5 km^2 (~ 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
  - x1,000> than background rate of 0.1 E/MSY

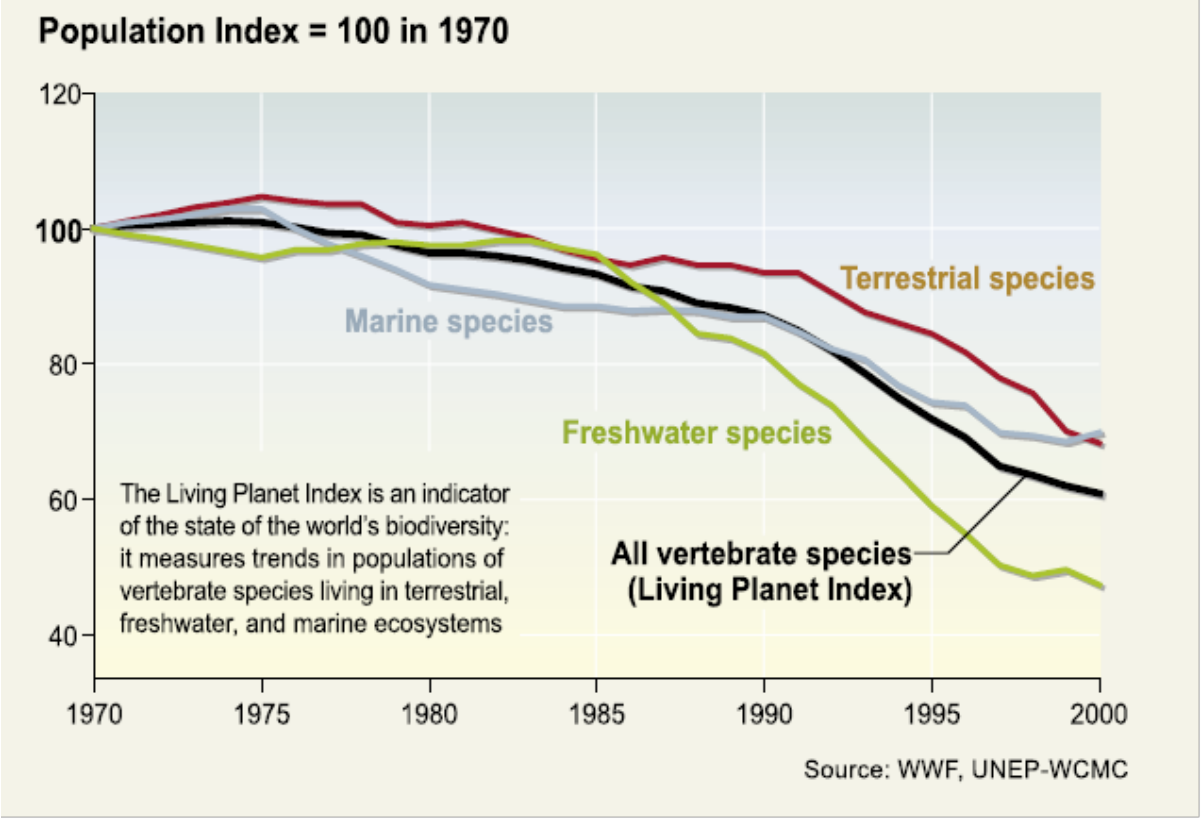
- Local rates from regions can be much higher:
  - 132 E/MSY for *all birds* after 1900
  - 305 E/MSY for *fish* in NA rivers and lakes
  - 954 E/MSY for the NA freshwater *gastropods*
  - likely >1,000 E/MSY for *cichlid fishes* in Africa's Lake Victoria

Current Impact on Biodiversity

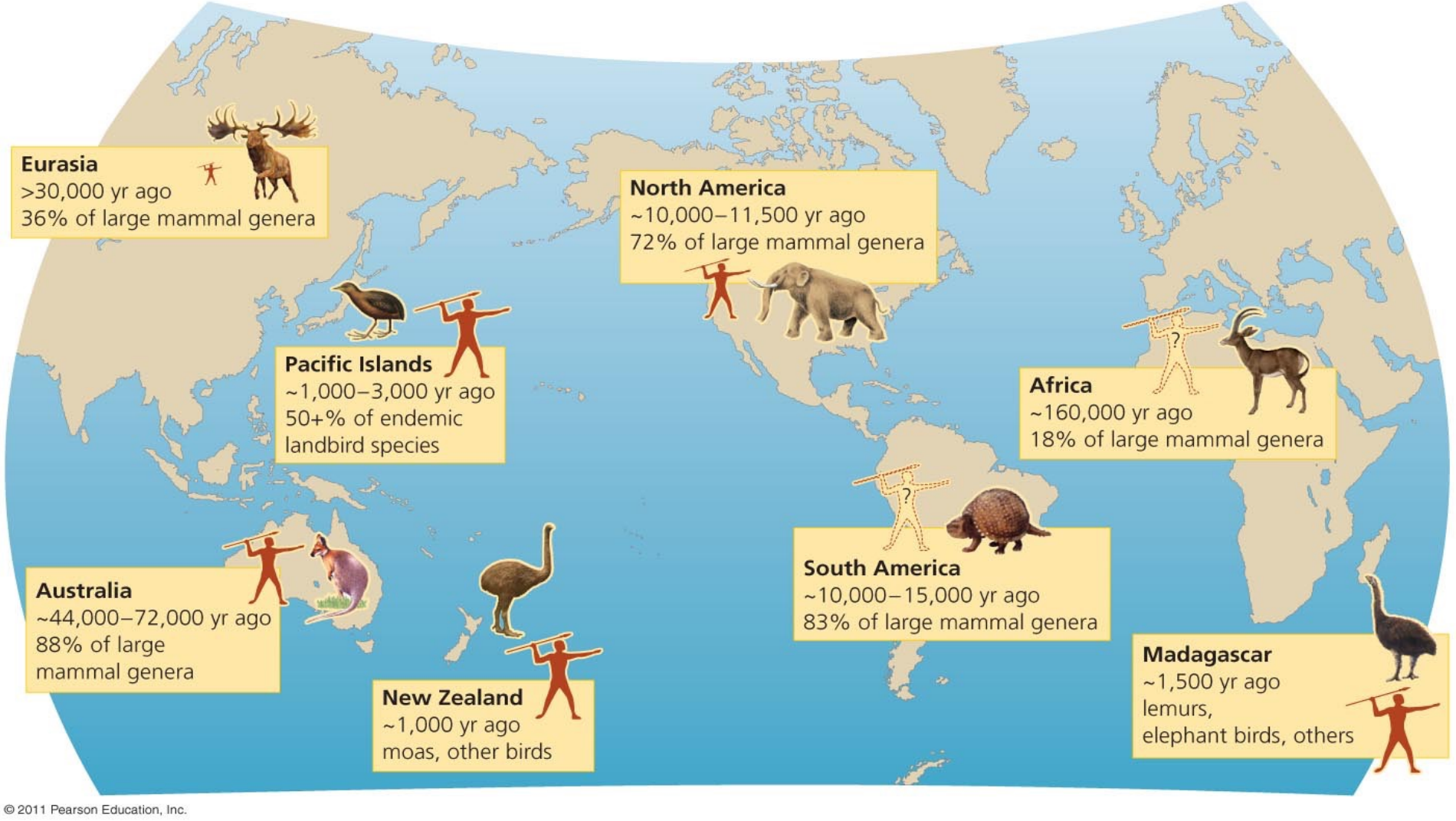
- **Changes in biodiversity and in ecosystems are almost always caused by multiple, interacting drivers.**

- *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.



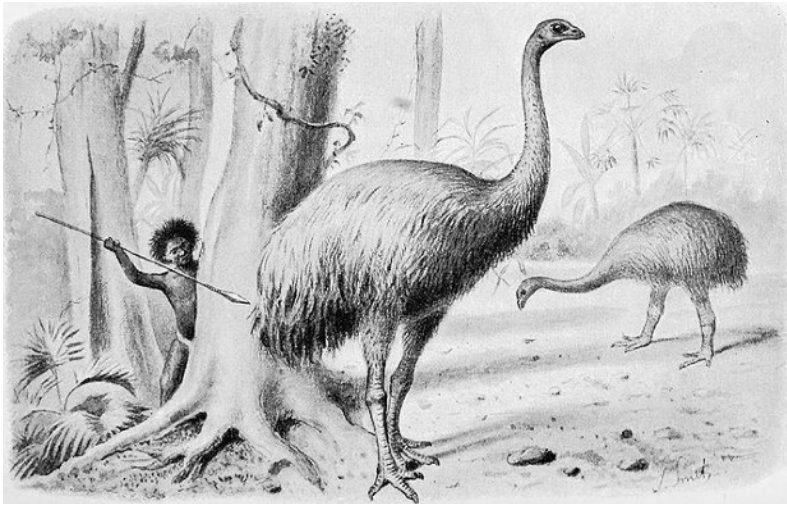
Humans are causing this mass extinction



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
  - Pasific Islands: ~1,000 bird spp = 1 extinction every few years = 100 E/MSY



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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

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- Extinction occurs when the environment changes <u>rapidly →</u>
  Natural selection can not keep up