Extinction rates: historic and recent trends

David Burslem

https://news.yahoo.com/animals-went-extinct-2018-161155478.html?guccounter=1

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These are the animals that went extinct in 2018

Mark Kaufman, Mashable • December 28, 2018

9

With the end of 2018 comes the near-certain reality that some critters, after millions of years of existence on Earth, are gone for good.

Spix's Macaw (in captivity)

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World's 'loneliest' frog gets a date

By Helen Briggs
BBC News

15 January 2019 Share

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Lecture Plan

- Definitions of ‘extinct’
- Extinction as a natural phenomenon
- Human-induced extinctions
  - Estimates of current and future extinction rates
  - Extinction centres
    - The significance of endemism
    - Extinction on islands
  - Prediction of extinction rates from island biogeography
  - A cautionary tale from Singapore

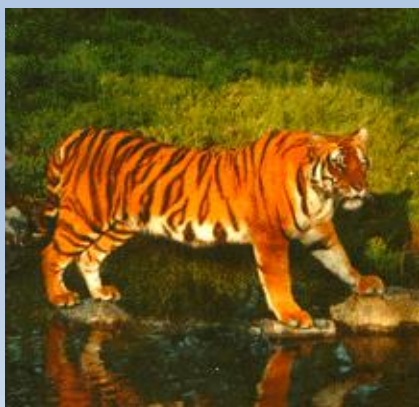
Definitions of 'Extinct'

- Extinct = no member of the species remains alive anywhere in the world, e.g. Dodo
- Extinct in the Wild = individuals remain alive only in captivity or other human-controlled situations, e.g. Northern White Rhino, *Ceratotherium simum cottoni:* two individuals remain in captivity in the Ol Pejeta Conservancy in Kenya

Definitions of 'Extinct' (cont.)

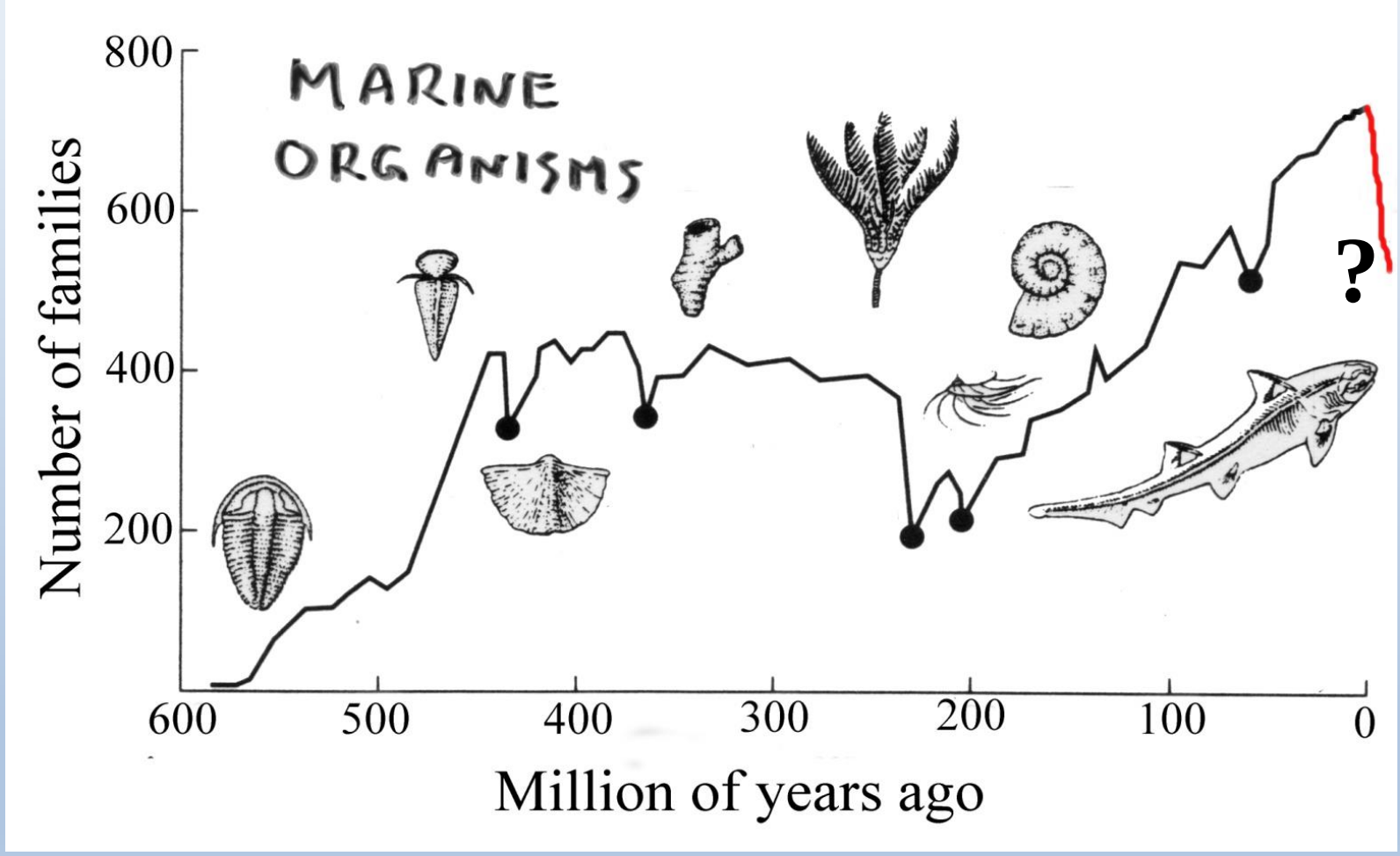
- Globally extinct = extinct in the wild across its entire range, e.g. the Franklin tree
- Locally extinct = no longer found in an area it once inhabited but is still found elsewhere in the wild, e.g. the Eurasian Lynx and Brown Bear in Scotland
- Ecologically or functionally extinct = persists at such reduced numbers that its effects on the other species in its community are neglible, e.g. tigers



Is extinction a natural phenomenon?

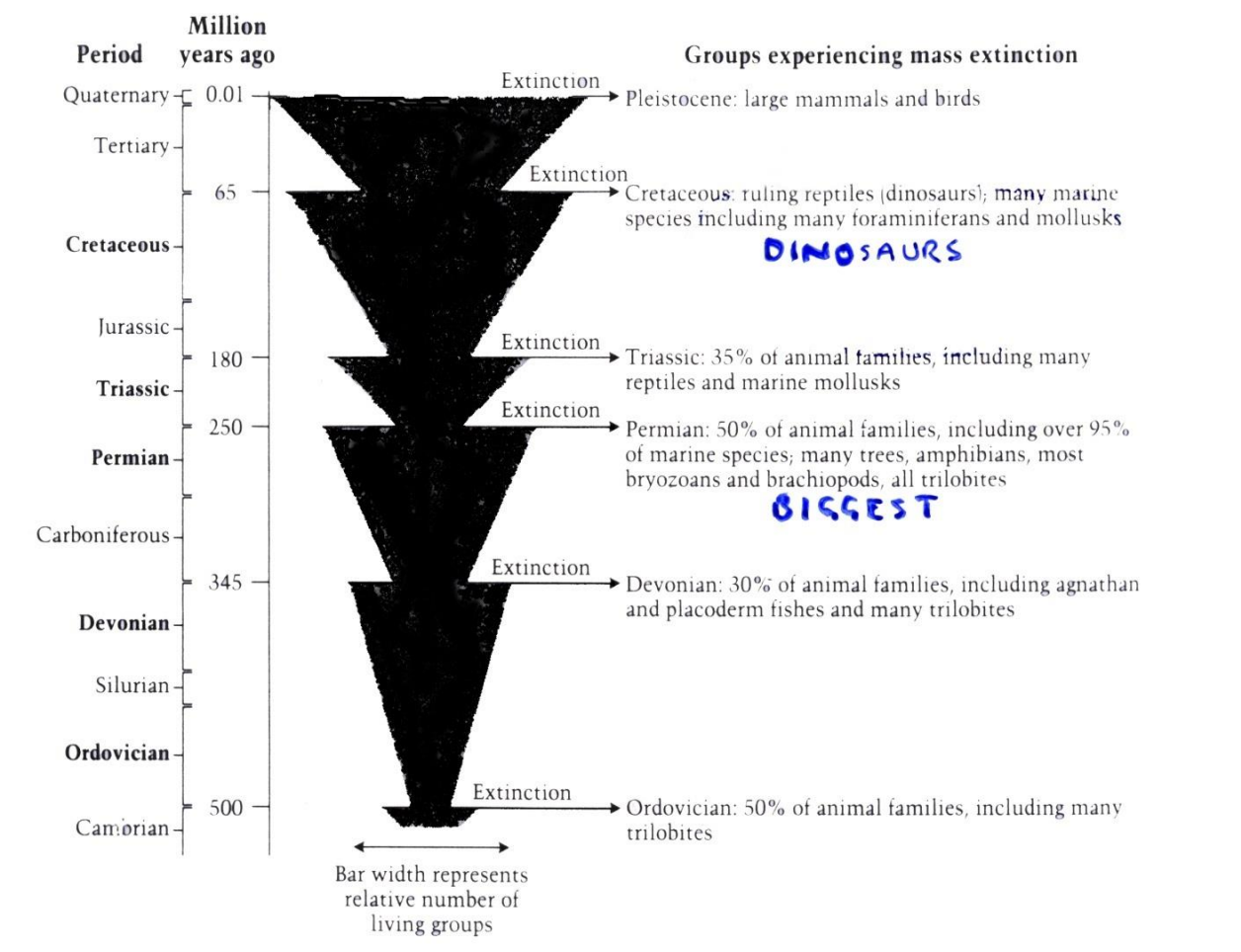
Extinction as a natural phenomenon



Source: Primack (2002)

Extinction as a natural phenomenon

? Anthropocene extinction



Source: Primack (2002)

The Anthropocene

The Anthropocene could be said to have started in the late eighteenth century, when analyses of air trapped in polar ice showed the beginning of growing global concentrations of carbon dioxide and methane.

Source: Crutzen (2002)

Background extinction rate

- Fossil record (11 studies of marine invertebrates) – individual species last between 1 and 10 million years before going extinct or evolving.
- So background extinction rates is 1 to 0.1 extinctions/million-species-year
- If we have 10 million species on the globe – we should expect – between 10 and 1 species going extinct per year.

Primack (2002)

Is extinction a natural phenomenon?

Yes!!

1-10 species/year background rate

5 periods of documented mass extinction

Human-induced extinctions

- ? Megafauna of Australia and North and South America
  - 74-86 % Extinction of Megafauna, probably due to hunting
- Pacific islands – colonised by Polynesians 4000-1000 yrs before present
  - > 2000 species of birds (mainly Rails) ~ 15 % of Global avifauna

Procoptodon
A 300 kg kangaroo

Guam Rail

Moa

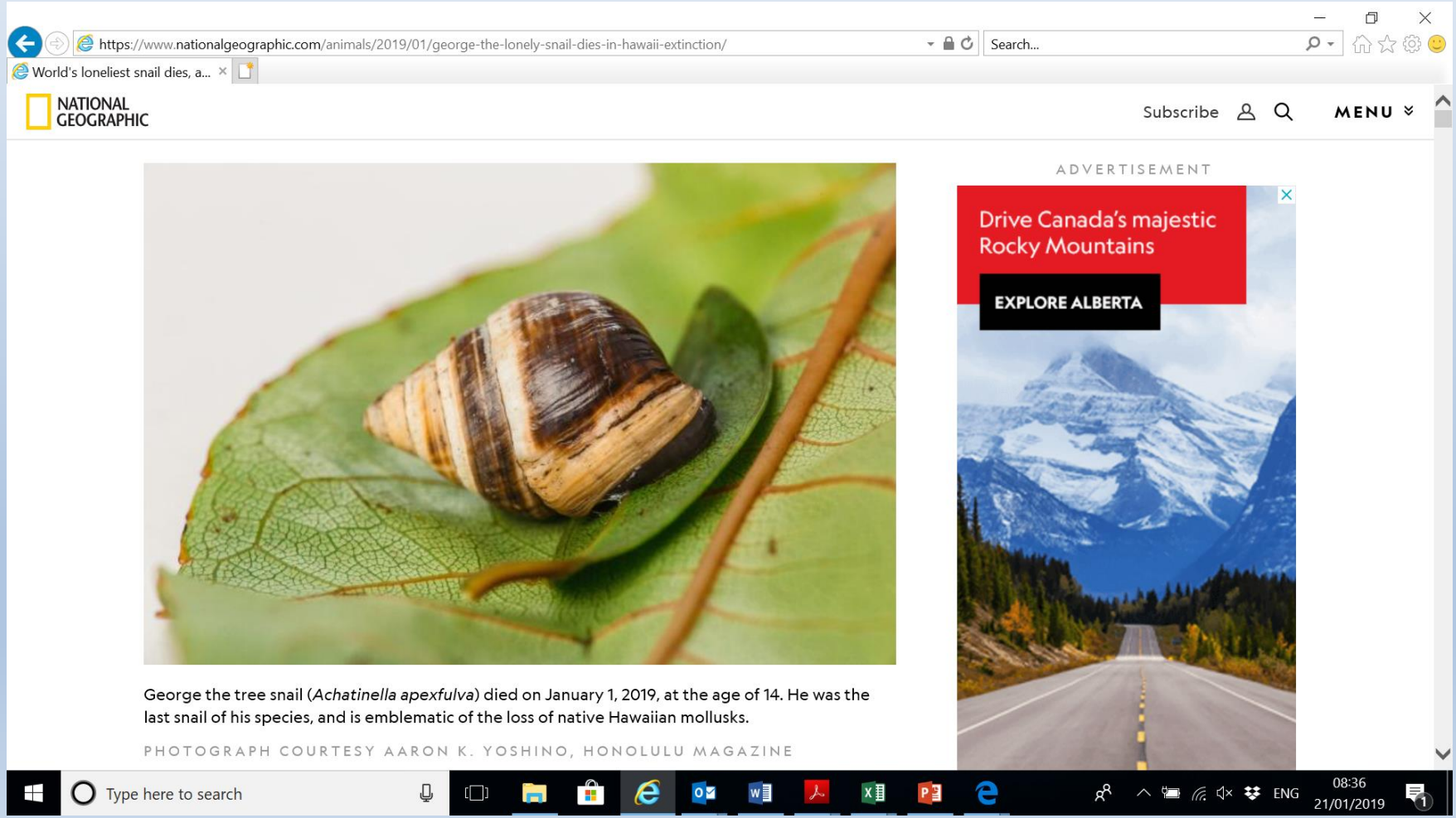
Are we seeing a human-induced increase in extinction rates ?

Human-induced extinctions

- European colonization of the Pacific – Since 1778
  - Hawaii: 18 species of birds + 12 more uncertain
  - Hawaii: 84/980 native plants and another 113 with < 100 individuals
- Other Islands
  - 60 mammal extinctions – 19 from Caribbean Islands
  - Mauritius, Rodrigues and Reunion – 30 spp birds, 30 spp land snails and 11 spp reptiles
- Continents also
  - Australia

Human-induced extinctions

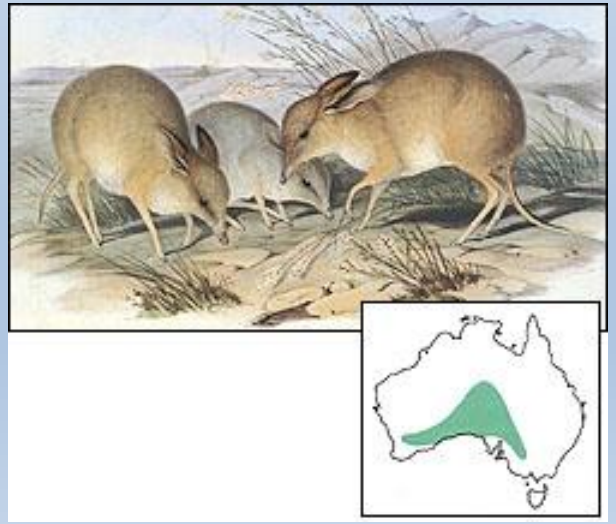
- European colonization of the Pacific – Since 1778



Extinct Australian mammals

Broad-faced Potoroo
1875

Pig-footed Bandicoot
1950s

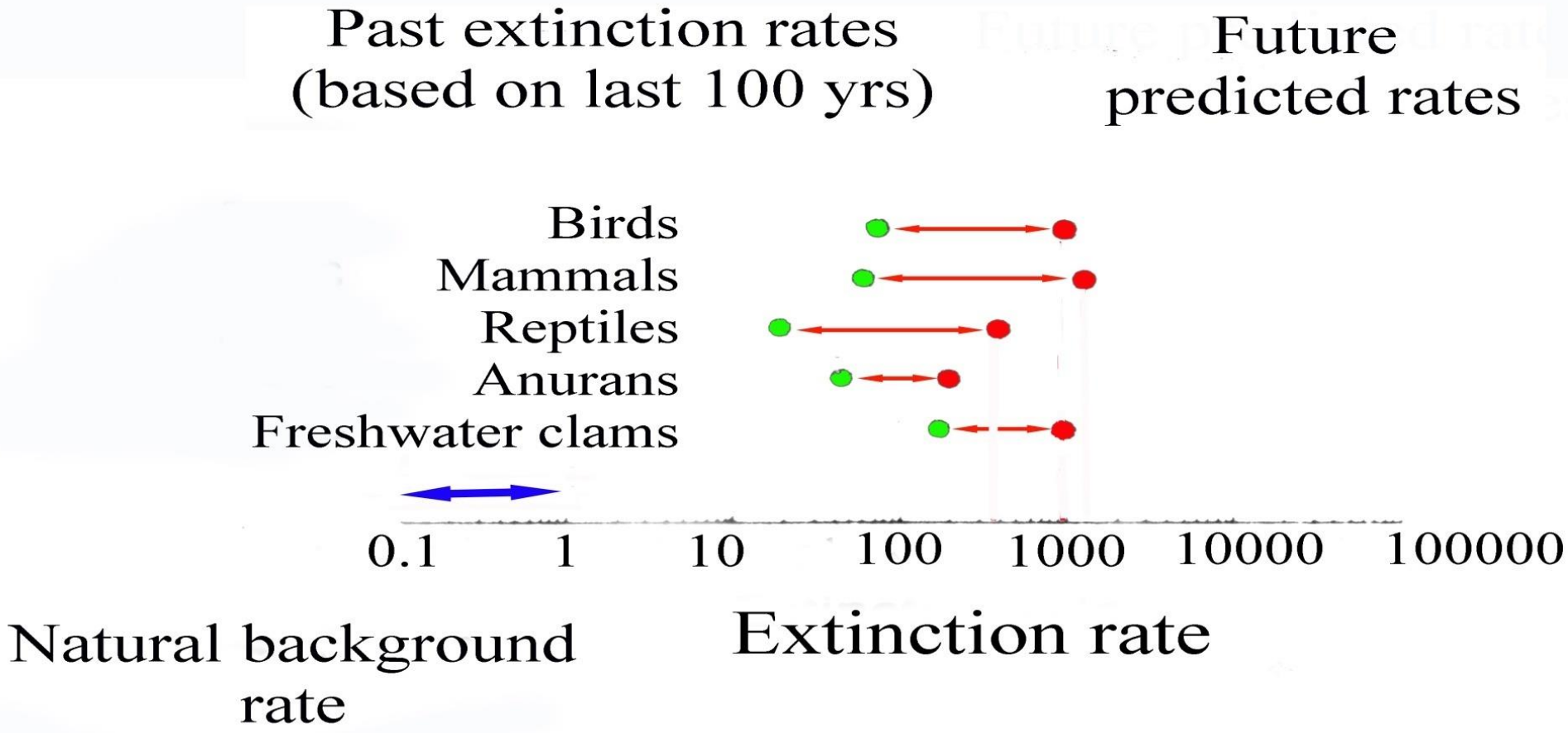


Thylacine
1936

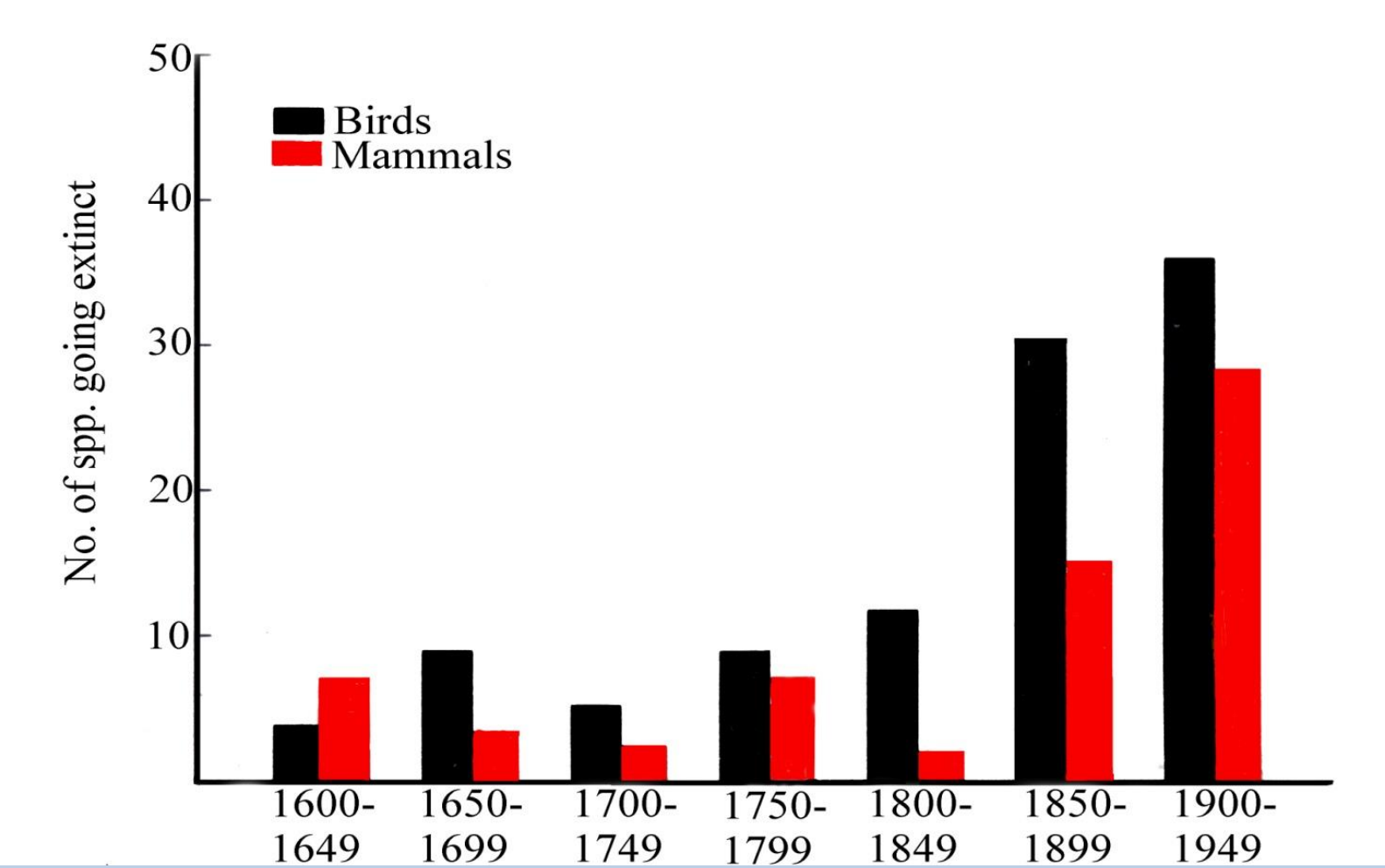
Source: ABC (2002)

Extinction rates

Modified from Pimm *et al.* (1995)



Extinction rates of birds and mammals



Are we seeing a human-induced increase in extinction rates ?

Yes !!!

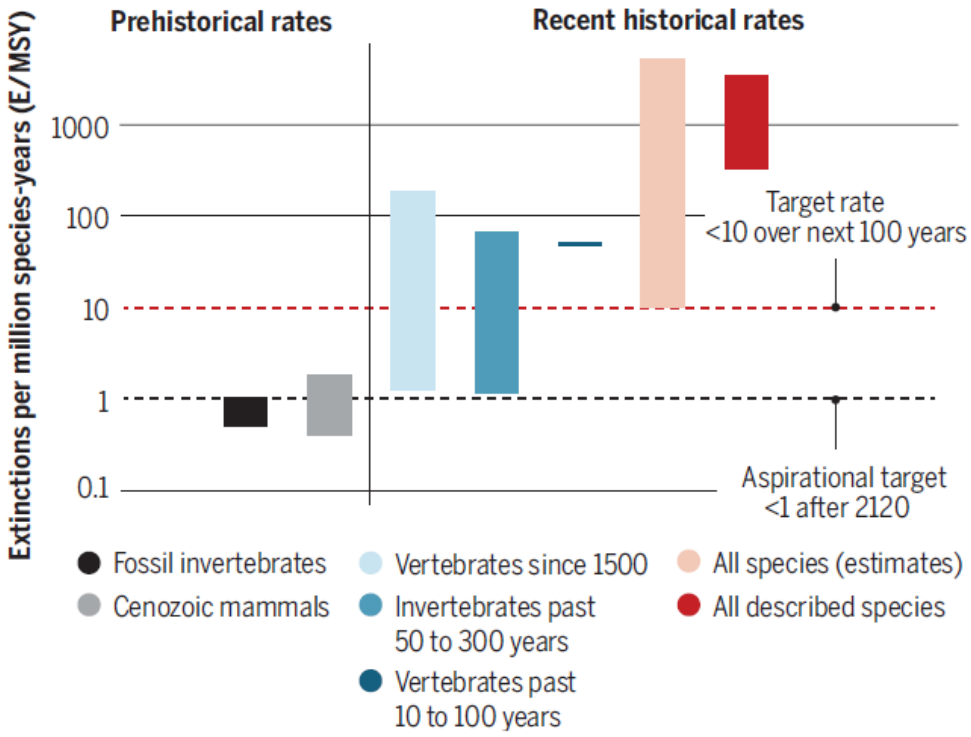
Current rates are: 100-1000 times greater than background rates

A biodiversity target based on species extinctions

A single target comparable to the 2°C climate target may help galvanize biodiversity policy

Targeting an extinction rate

Extinction rates (E/MSY) across a variety of taxonomic groups for different historical periods are related to the proposed extinction rate target for the next 100 years and the aspirational target (background extinction rates) from 2120. Bars show the full range of possible values for E/MSY when E, S, and Y are represented by ranges of possible values (see Table S4 for the data sources). Data encompass all plants, animals, and fungi unless indicated otherwise.



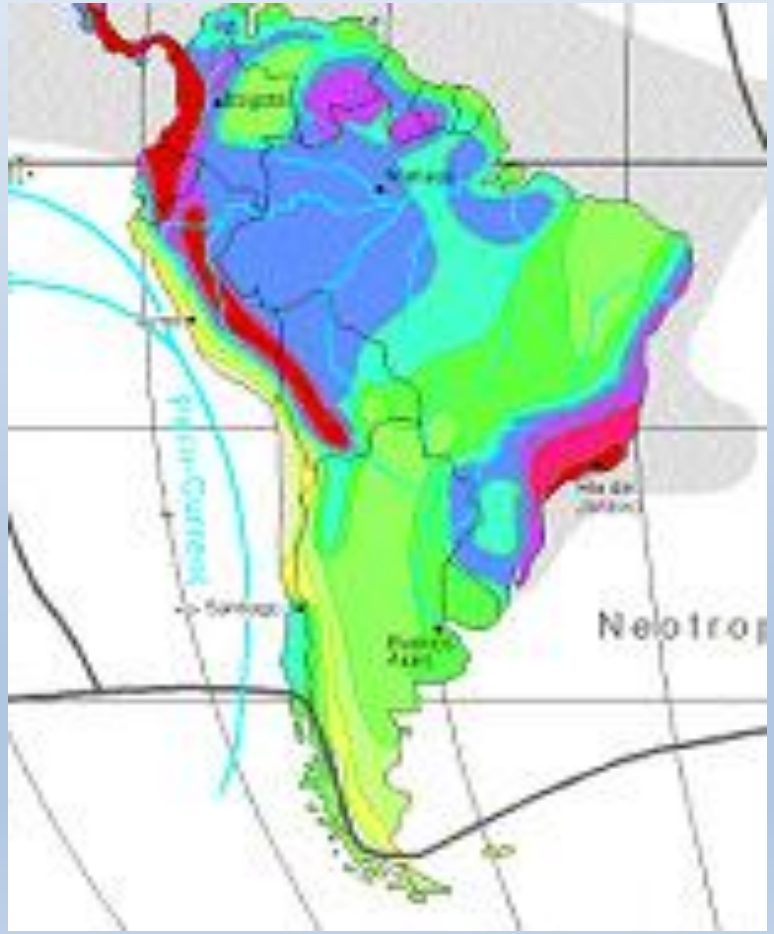
< 20 extinctions of described species per year

Rounsevell et al. 2020. Science.

Are there hotspots for extinction ?

Cookie-cutter model

The "cookie-cutter model of extinction" on mountain ridges in Ecuador



Tropical Andes

Plant species: 45000

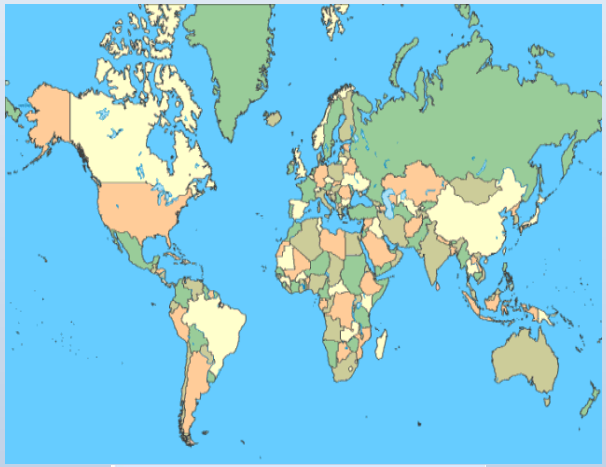
Endemics: 20000

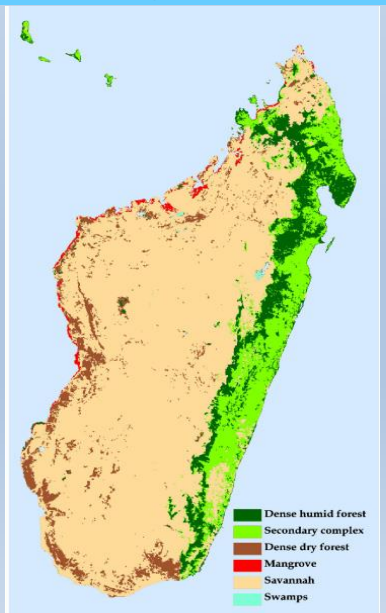
Centinella ridge:

"Cookie-cutter" = oil palm plantation

90 plant species possibly extinct

The "cookie-cutter model of extinction" on Madagascar





Original area: 594,150 km^2

Remaining: 59,038 km^2

Total terrestrial vertebrates: 987

Endemic terrestrial vertebrates: 771

Threatened: 123

Critically endangered: 23

Extinct: 46 (~20 % of global extinctions)

Number of plant species and their status on tropical islands

	Native Spp.	Endemic Spp.	% Endemic	% Endemics Threatened
Galapagos	543	229	42	59
Hawaii	970	883	91	40 $+10_{extinct}$
New Caledonia	3250	2474	76	6

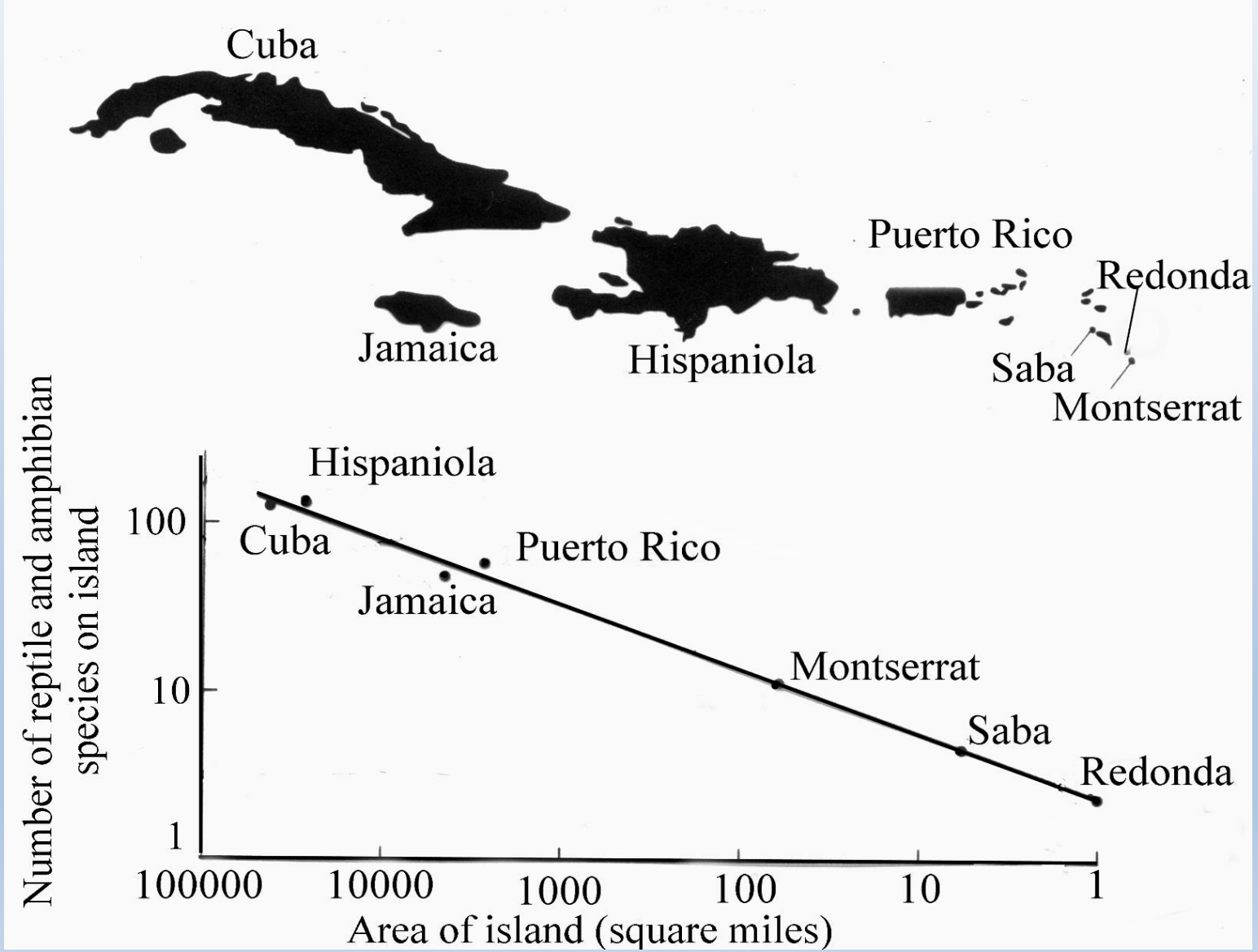
Source: Primack (2002)

Are there hotspots for extinction ?

Yes !!
Endemic rich areas
Islands

Can we estimate extinction rates from rates of habitat loss ?

Species – area relationship



Species - area curves

$$S = c A^z$$

Where:

S is the number of species present, A is the area and c and z are constants.

Taking logs,

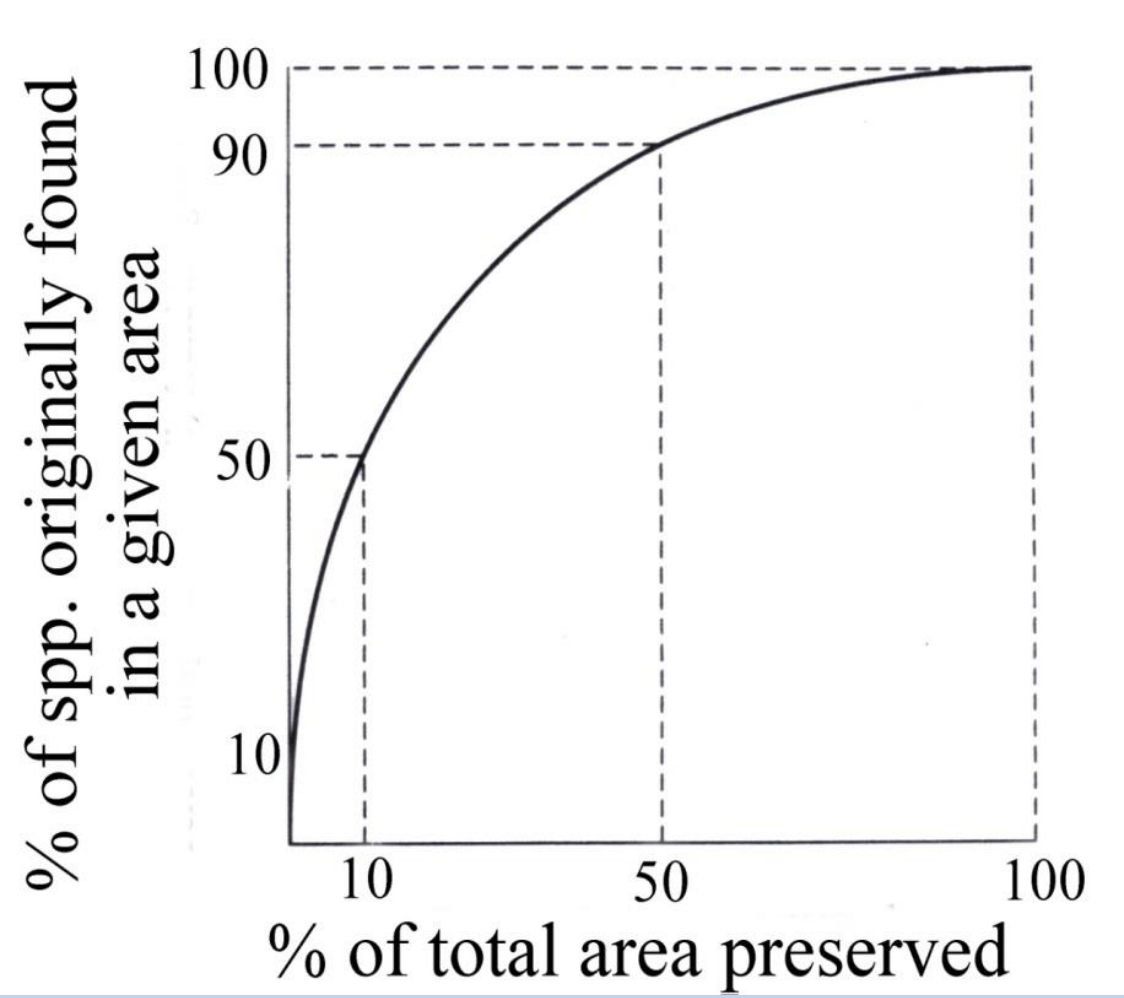
$$\text{Log } S = \log c + Z \log A$$

Which is a straight line of slope z

Z is usually about 0.25 (0.15-0.35)

Species - area

Using c = 1 and z = 0.25



Is it valid ?

- Is a fragmented forest the same as an island ?
- Are the typical value used for C and Z - suitable for all habitats and all organisms ?

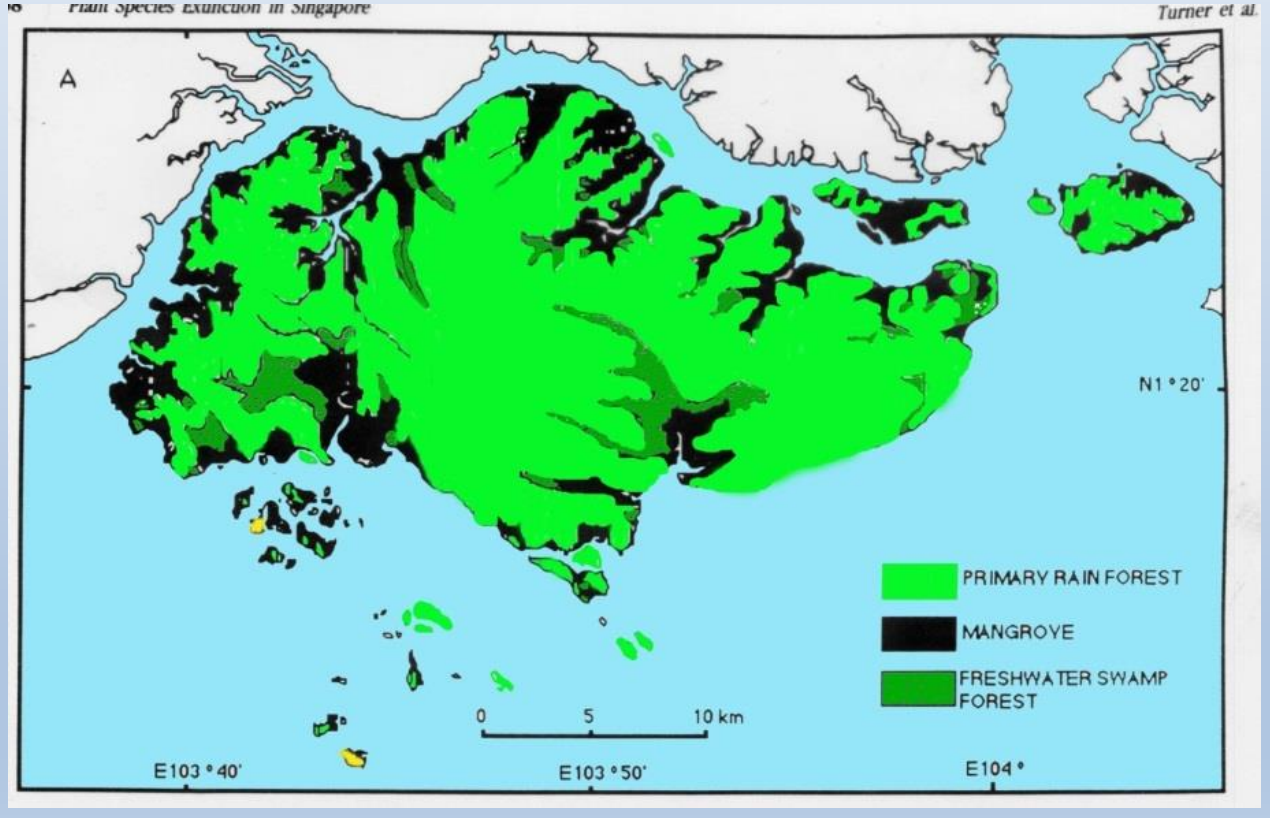
What sort of prediction have been made ?

Neotropics:
15% of all plants
12% of Amazonian birds
have gone extinct between 1986 and 2000

Globally:
20000-30000 species/year = 1 every 20 minutes

A cautionary tale from Singapore

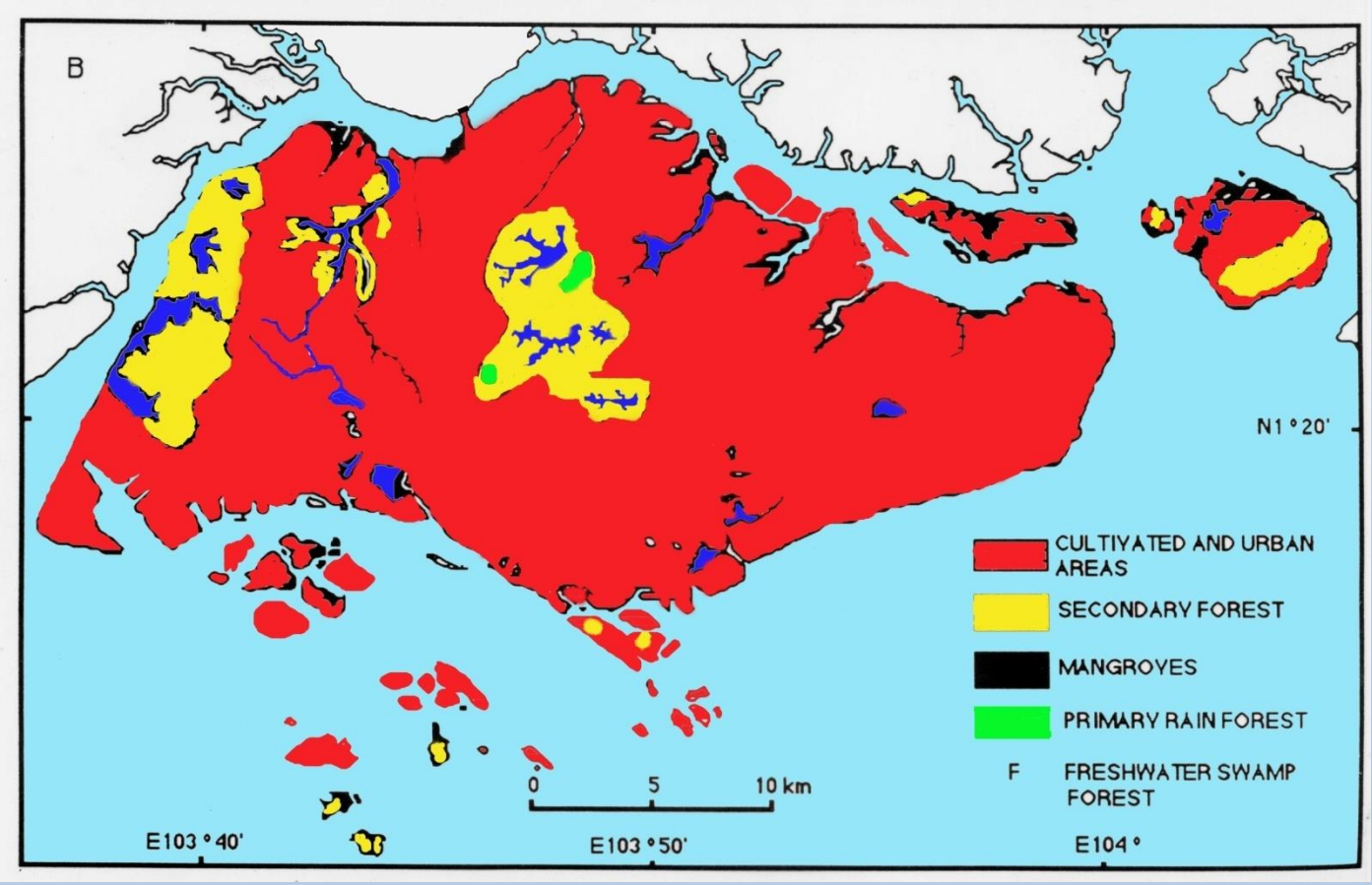
Forest cover in 1819



Source: Turner *et al*. (1994)

A cautionary tale from Singapore

Current forest cover



Source: Turner *et al*. (1994)

A cautionary tale from Singapore

594 spp lost out of 2277 ~ 26 %

Coastal forest = 39 %, inland forest = 29 % and epiphytes 62 %.

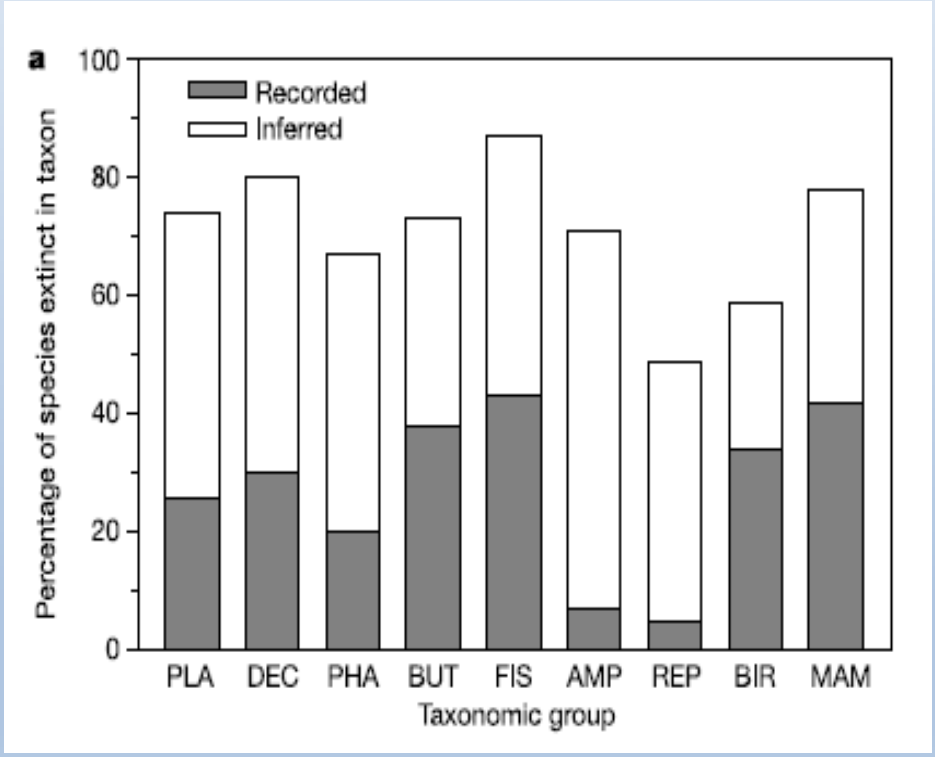
$$S_{new}/S_{original} = (A_{new}/A_{original})^{0.26}$$

$$S_{new}/1674 = (200/49600)^{0.26}$$

$$S_{new} = 399$$

~ 76 % extinct

Or not ?



Extinctions

- Observed = 28 %
- Inferred = 73 %

- Extrapolation to SE Asia
  - 13-42 % by end of 2100

Source: Brook *et al.* (2003)

Can we estimate extinction rates from rates of habitat loss ?

Maybe !!!

Summary

- *Extinction of species is a natural phenomenon* – YES!!
- *Are we seeing a human-induced increase in extinction rates ?* – YES !!! (100-1000 fold increase)
- *Are there extinction hotspots ?* YES (Islands and endemic rich areas)
- *Can we estimate extinction rates from rates of habitat loss ?* MAYBE!!

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