

Cons. Sci. Week 2: Biodiversity

Isla Myers-Smith
Crew Building, School of GeoSciences

Schedule for Today

9:30 - 10:15 - Lecture on Patterns of biodiversity

10:15 - 10:30 Break

10:30 - 11:30 Discussion of biodiversity monitoring, biodiversity hotspots and cold spots and the Living Planet Index

11:30 - 11:45 Debrief of discussions

11:45 - 12:20 Live coding activity – exploring the LPI database

12:20 - 12:30 Brainstorm of hot topics and discussion of the opinion piece assignment

How many species on planet Earth?



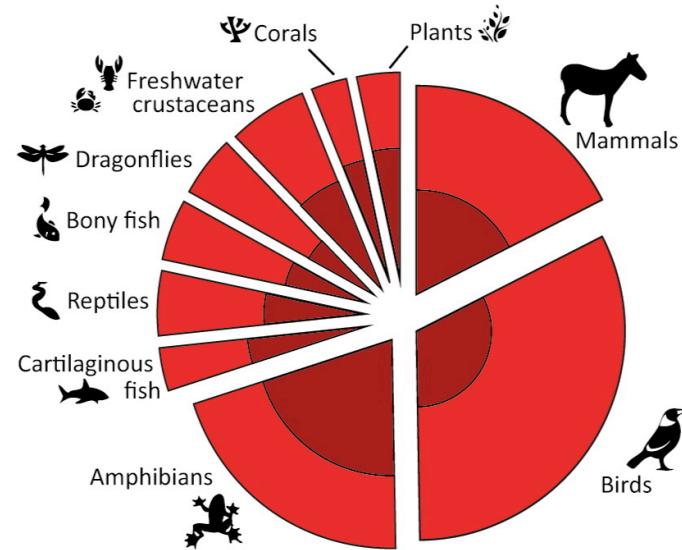
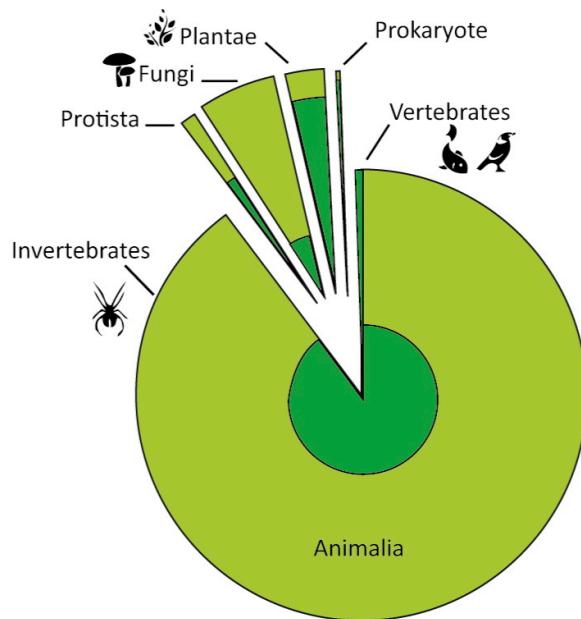
How many species are there on Earth?
(Not including the bacteria and viruses)

- a) 10,000
- b) 100,000
- c) 800,000
- d) 1.5 million
- e) 30 million

How many species are there on Earth?

~ 1.5 million species have been named

Estimates of total # range from 3-30 million



Pereira et al. Annu. Rev. Environ. Resour. 2012

How many species are there on Earth?



# beetle species in 19 <i>Luehea seemannii</i> trees, Panama	1200
# of those species specialized on <i>L. seemannii</i>	163 (14%)
% of arthropod species that are beetles	40%
# specialist arthropod spp in <i>L. seemannii</i> canopy	$163 \times 100 / 40 = 408$
% of arthropods in canopy	0.66
# arthropod species on <i>L. seemannii</i>	$408 \times 100 / 66 = 618$
# tropical tree species	50,000
# arthropod species in tropics	$618 \times 50,000 \approx 30,000,000$

Odegaard Biol. J. Linn. Soc. 2000

How many species are there on Earth?

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Species count put at 8.7 million

By Richard Black
Environment correspondent, BBC News

23 August 2011

f Share

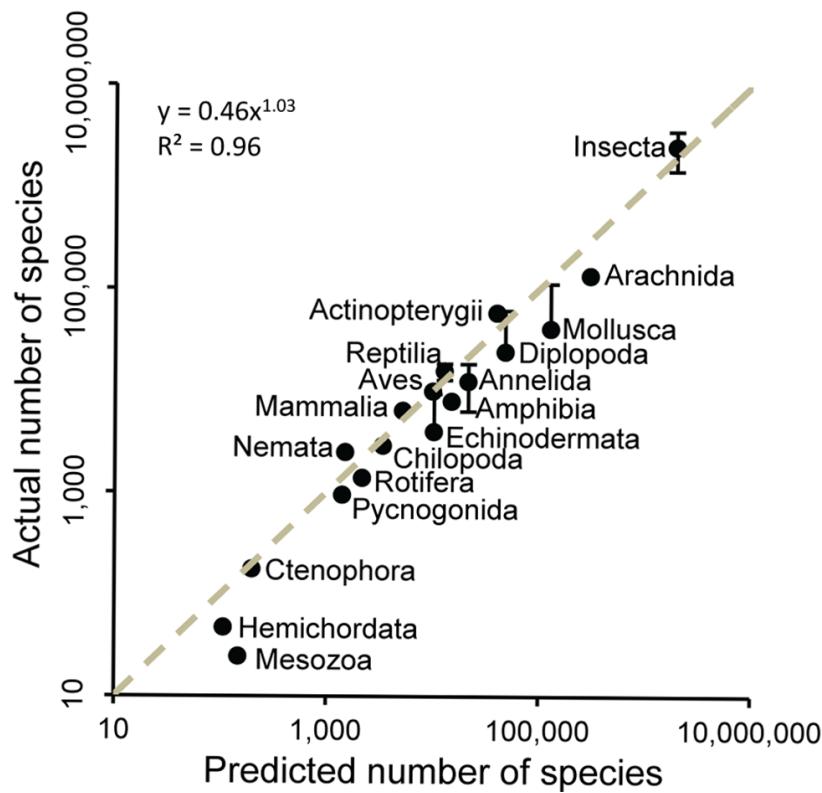
The natural world contains about 8.7 million species, according to a new estimate described by scientists as the most accurate ever.

But the vast majority have not been identified - and cataloguing them all could take more than 1,000 years.



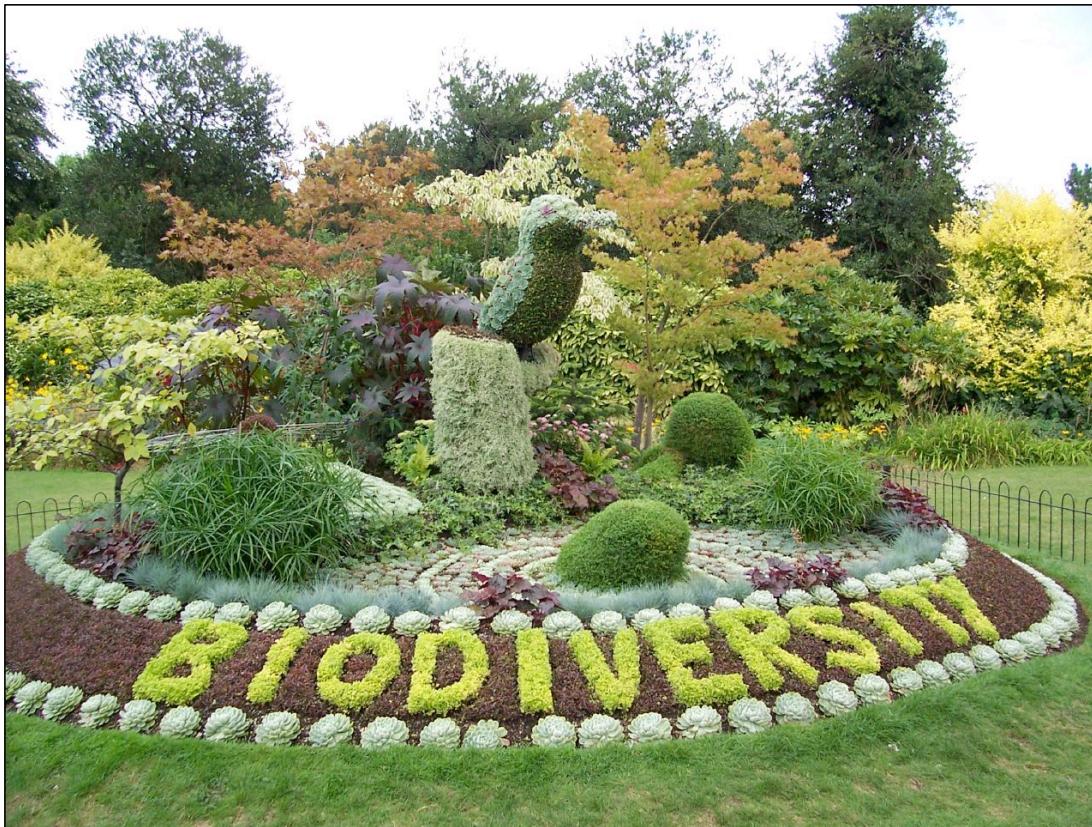
Mora et al. PLOS Biology 2011

How many species are there on Earth?



Mora et al. PLOS Biology 2011

What is biodiversity?



Biodiversity



Arctic Tundra



Coastal Rain Forest

Biodiversity

“The variety of life, including variation among genes, species and functional traits.” - Wikipedia

Biodiversity

“The variety of life, including variation among genes, species and functional traits.” - Wikipedia

Often measured as:

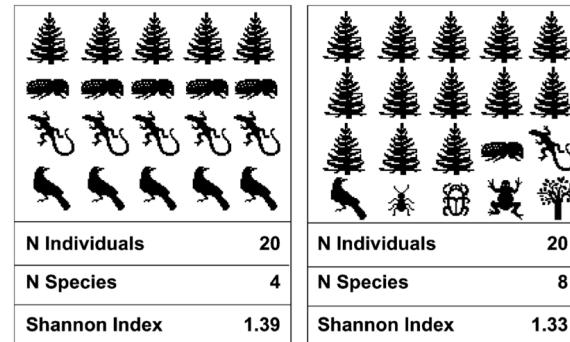
Richness - a measure of the number of unique life forms

Evenness - a measure of the equitability among life forms

Heterogeneity - the dissimilarity among life forms



Arctic Tundra



Coastal Rain Forest

Biodiversity

A narrower (and more scientifically useful) definition of biodiversity:

The numbers and relative equitability of different biological variants found in a given place and time.



Arctic Tundra

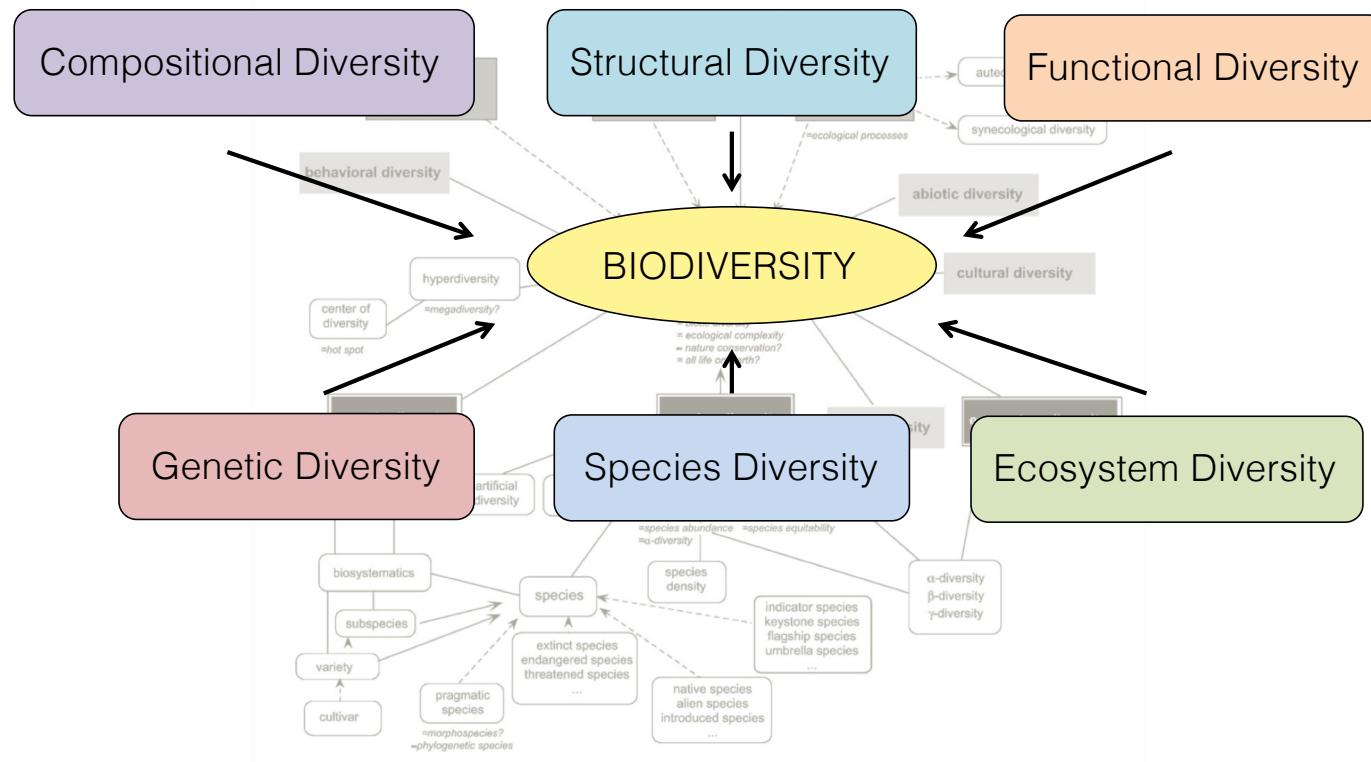


Coastal Rain Forest

What is biodiversity?

- Genetic diversity: amount of genetic variation within a species
- Species diversity: number of species within a region
- Ecosystem diversity:
 - variation among ecosystems, communities, landscapes
 - Variation within ecosystems

Biodiversity



Duelli and Obrist AE&E 2003

What is biodiversity?

Taxa:

Kingdoms



↓
Genera

↓
Species

Scale:

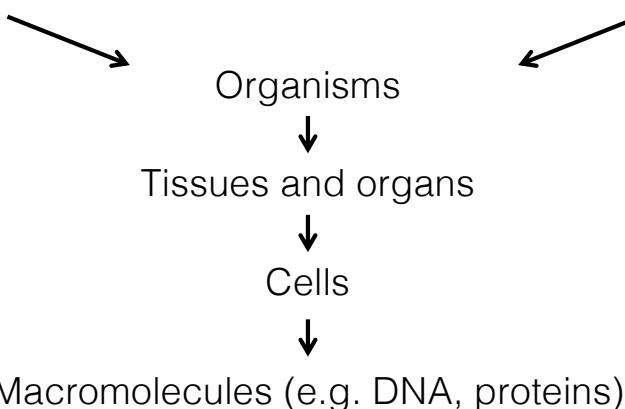
Ecosystem



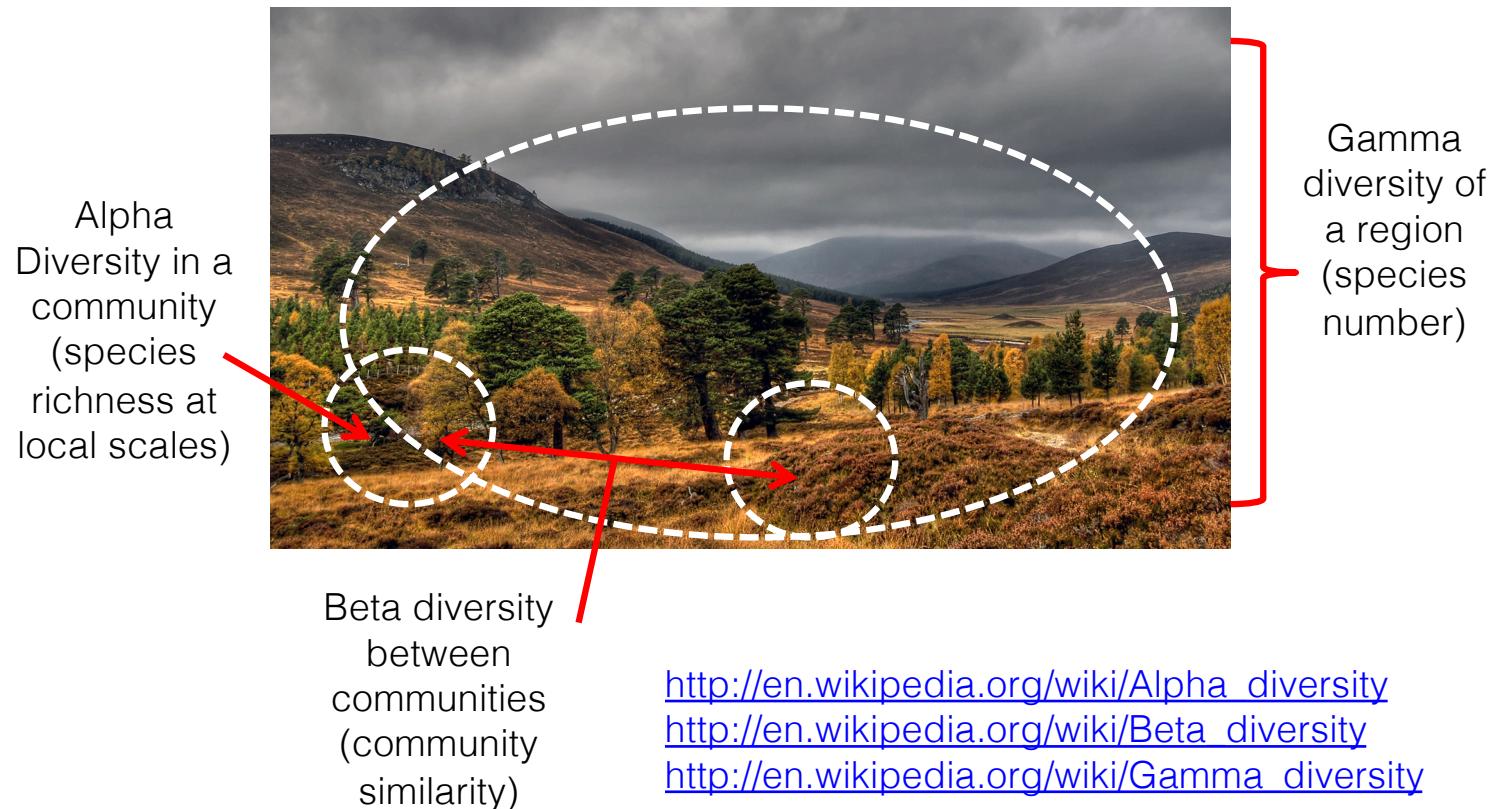
Communities



Populations



What are the biodiversity metrics across scales?

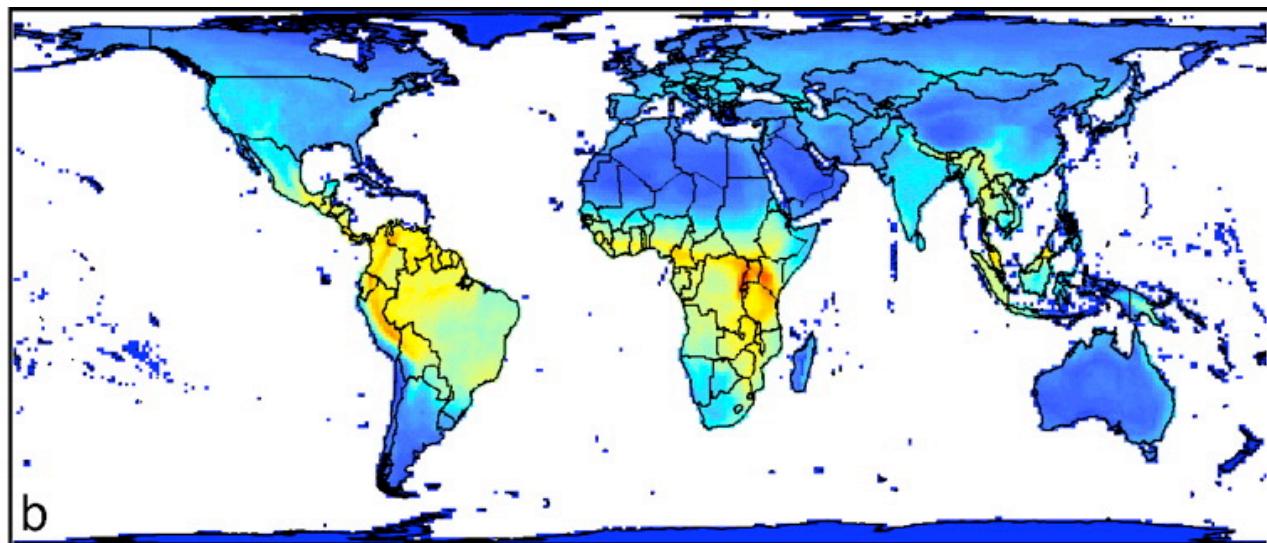
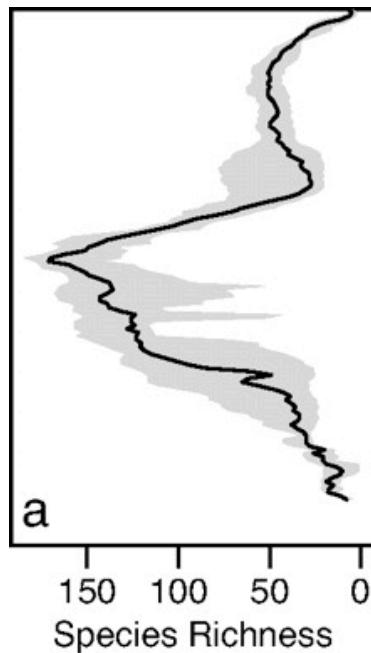


How does biodiversity change across geographic gradients?



Biodiversity Gradients

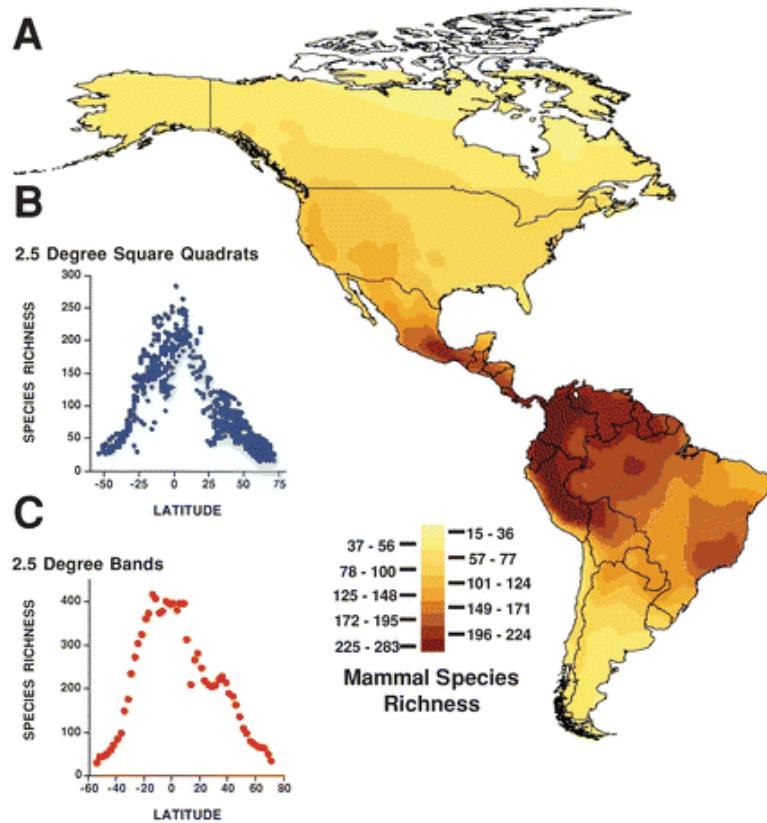
The Latitudinal geographic gradient in biodiversity for mammals



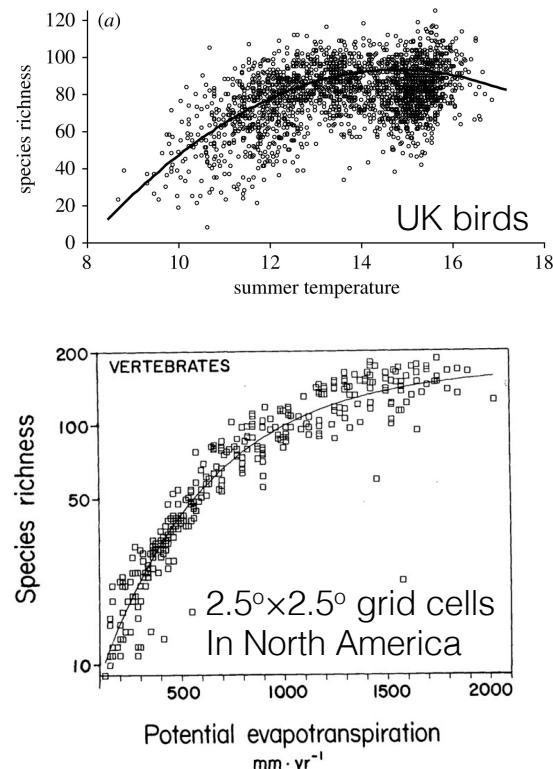
Davies et al. PNAS 2008

Biodiversity Patterns & Relationships

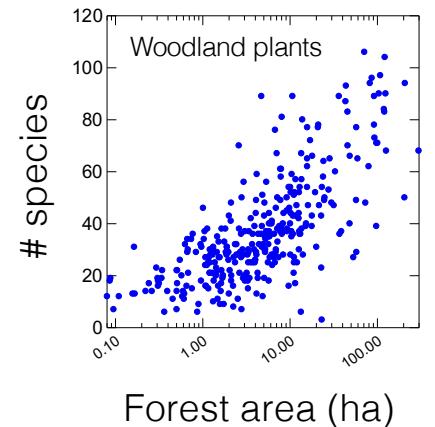
1. Latitudinal diversity gradients



2. Species-energy relationship/ Species-resource relationship



3. Species-area relationship



Why do we care about biodiversity?



How do you value biodiversity?

- a) Just because (inherent value)
- b) Because of the goods or services it provides
- c) Because it is beautiful/cool/fun (instrumental value)
- d) I don't especially value biodiversity

The value of biodiversity

- Goods (food, fiber, medicine)
- Services (water/air purification, flood control, pollination, etc.)
- Informational (scientific)
- Psychological (nature appreciation, cultural)
- Intrinsic (each species is inherently valuable)

What is biodiversity science?



The Biodiversity Research Centre at the University of British Columbia in Vancouver, Canada

Definitions of Conservation

- “The science of scarcity and **diversity**.” (Soulé 1986)
- “The applied science of **maintaining the Earth's biological diversity**” or more simply “biology as applied to conservation issues.” (Hunter 1996, 2002)
- “Conservation biology is the new, multidisciplinary science that has developed to deal with the crisis confronting **biological diversity**.” (Primack 2006)

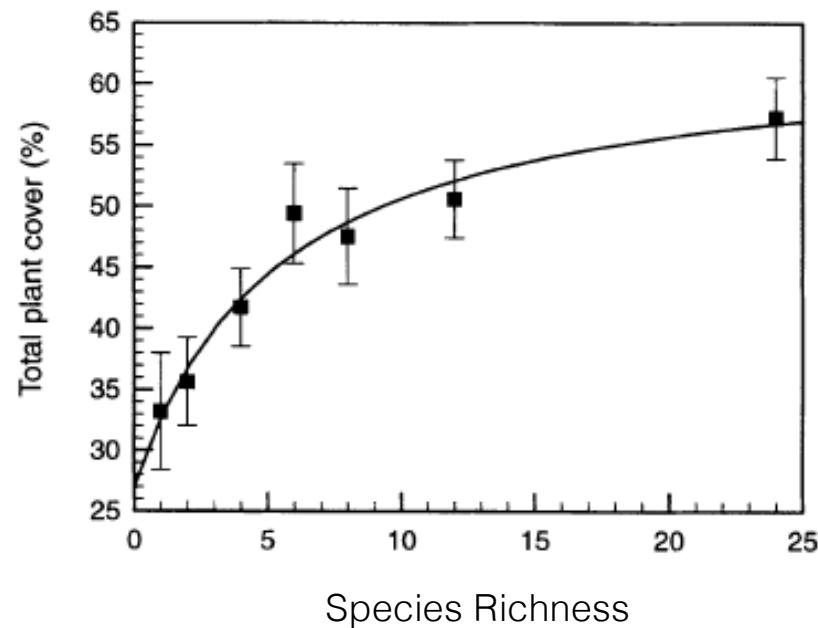
Goals of Conservation

- To document the full range of biological diversity on Earth – “taxonomy, natural history, ecology”
- To investigate human impact on species, genetic variation, and ecosystems – “ecology, genetics, biogeography, etc.”
- To develop practical approaches to prevent the extinction of species, maintain genetic diversity within species, and protect and restore biological communities and their associated ecosystem function – “conservation biology, communication, natural and social sciences, economics, politics, management, etc.”

What are the research questions in biodiversity science?

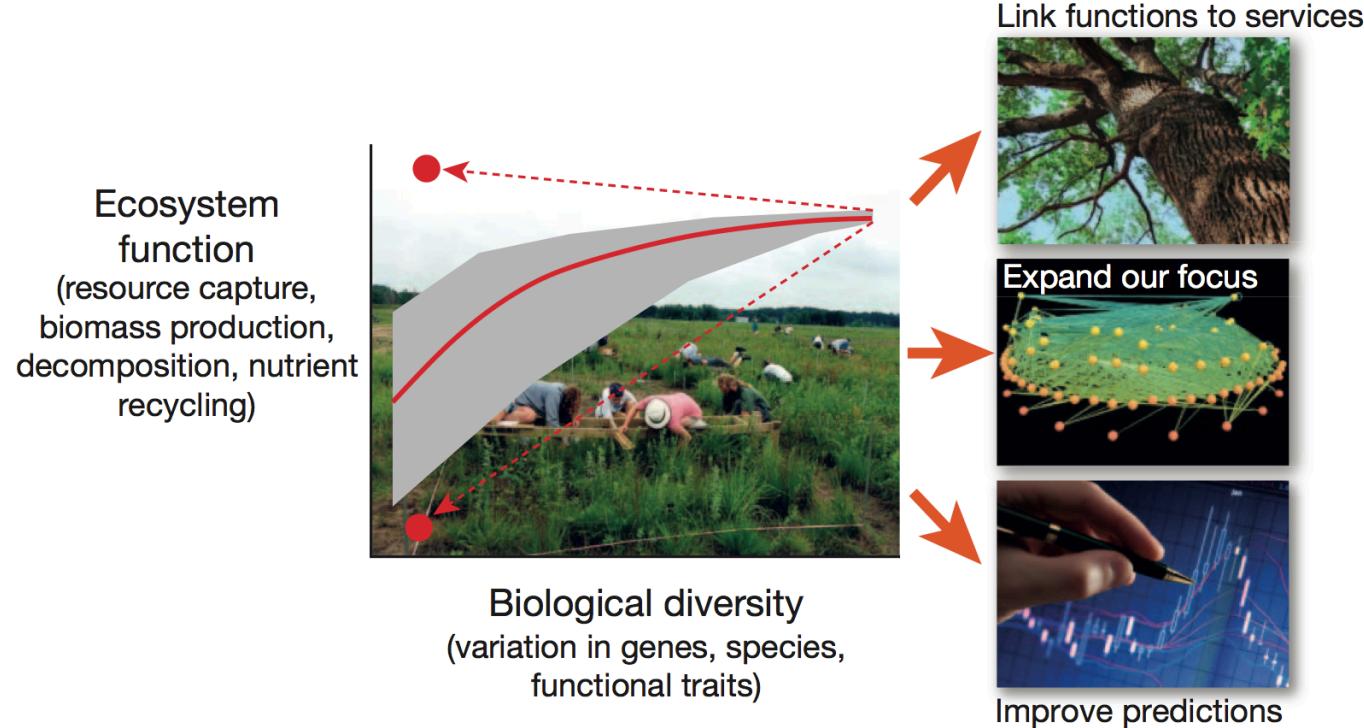
- Why does this place contain this many plant and animal species, and not more, or less?
- Why is species Y common and species X rare?
- How does biodiversity influence ecosystem functions?

Biodiversity ecosystem function research



Tilman et al. Nature 1995

Biodiversity ecosystem function research

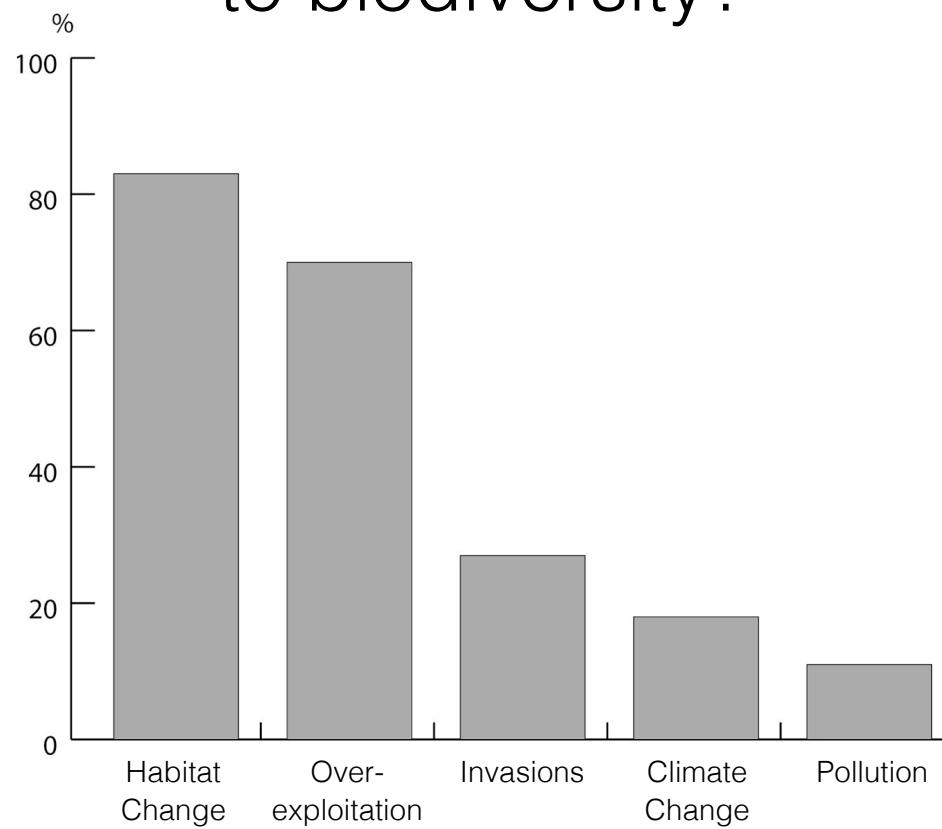


Cardinale et al. Nature 2012

What are the biggest threats
to biodiversity?

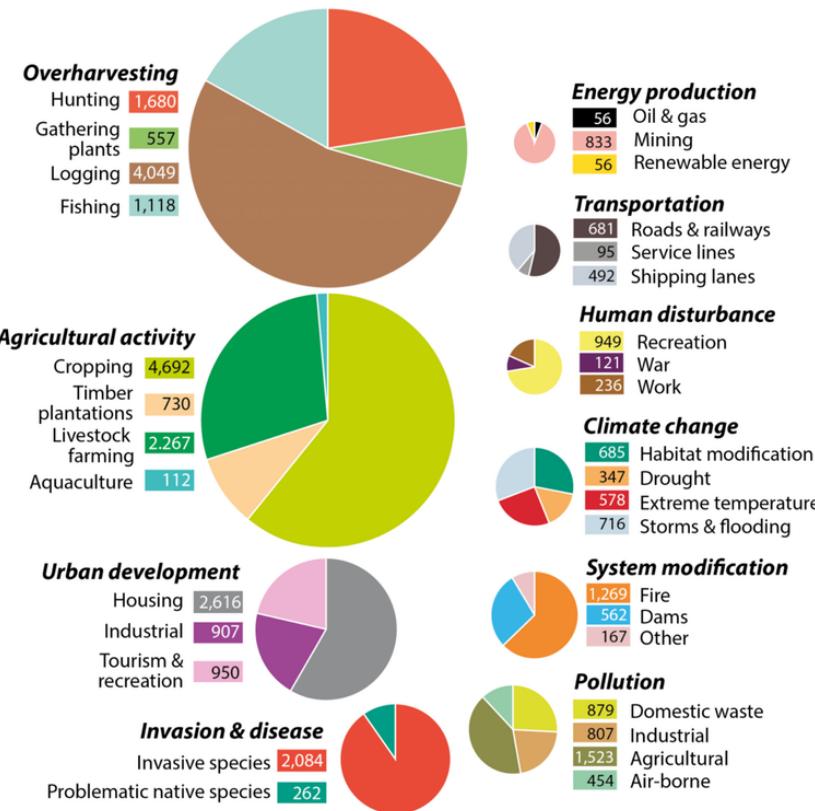


What are the biggest threats to biodiversity?



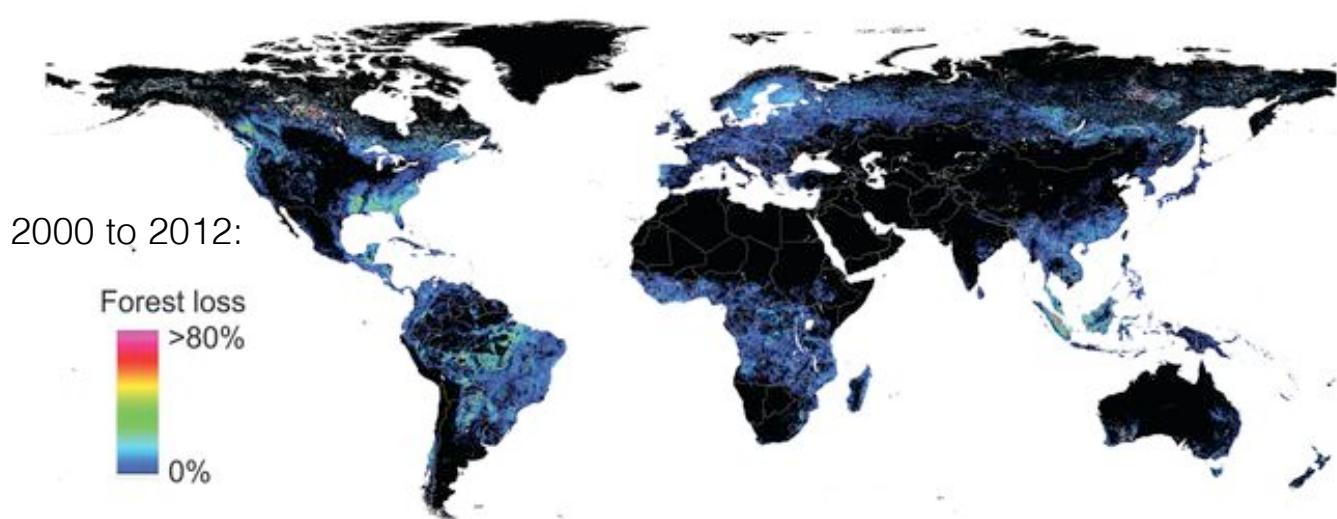
Pereira et al. Annu. Rev. Environ. Resour. 2012

What are the biggest threats to biodiversity?



Maxwell et al. Nature 2016

Habitat Conversion



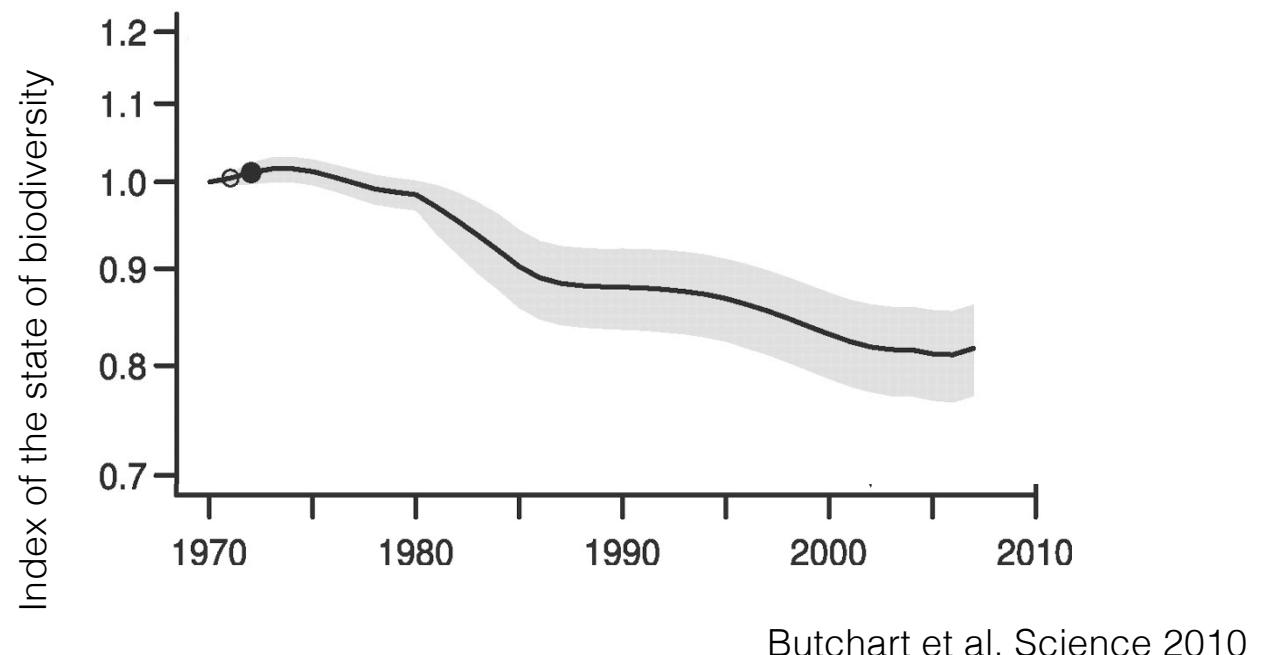
Hansen et al. Science 2013

Exploitation

“The state of biodiversity based on nine indicators of species’ population trends, habitat extent and condition, and community composition”



Black rhino



Butchart et al. Science 2010

Is biodiversity declining?

Biodiversity loss and its impact on humanity

Bradley J. Cardinale, J. Emmett Duffy, Andrew Gonzalez, David U. Hooper, Charles

Improving estimates of biodiversity loss

Chase D. Mendenhall*, Gretchen C. Daily, Paul R. Ehrlich

Center for Conservation Biology, Department of Biology, Stanford University, Stanford, CA 94305-5020, USA

A global synthesis reveals biodiversity loss as a major driver of ecosystem change

David U. Hooper, E. Carol Adair, Bradley J. Cardinale, Jarrett E. K. Byrnes, Bruce A.

Despite Progress, Biodiversity Declines

Erik Stokstad

Global Biodiversity: Indicators of Recent Declines

Stuart H. M. Butchart^{1,2,*}, Matt Walpole¹, Ben Collen³, Arco van Strien⁴, Jörn P. W. Scharlemann¹,

Species Coextinctions and the Biodiversity Crisis

Lian Pin Koh^{1,*†}, Robert R. Dunn^{2,*‡}, Navjot S. Sodhi^{1,§}, Robert K. Colwell³, Heather C. Proctor⁴, Vincent S. Smith^{5,¶}

Biodiversity: Species loss revisited

Carsten Rahbek & Robert K. Colwell

Impacts of Biodiversity Loss Escalate Through Time as Redundancy Fades

Peter B. Reich^{1,2}, David Tilman^{3,4}, Forest Isbell³, Kevin Mueller³, Sarah E. Hobbie³, Dan F. B. Flynn⁵,

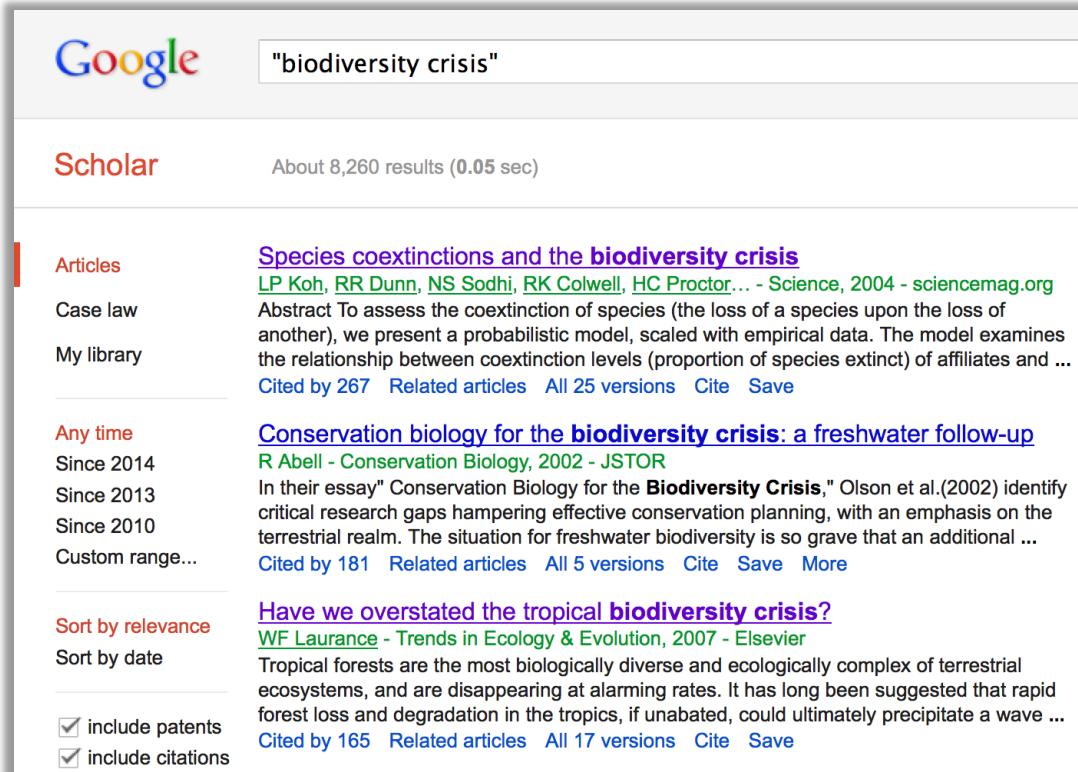
Climate Change, Keystone Predation, and Biodiversity Loss

Christopher D. G. Harley

Consequences of biodiversity loss for litter decomposition across biomes

I. Tanya Handa, Rien Aerts, Frank Berendse, Matty P. Berg, Andreas Bruder, Olaf

Is there a biodiversity crisis?



Google Scholar search results for "biodiversity crisis".

Scholar

About 8,260 results (0.05 sec)

Articles Species coextinctions and the **biodiversity crisis**
LP Koh, RR Dunn, NS Sodhi, RK Colwell, HC Proctor... - Science, 2004 - sciencemag.org
Abstract To assess the coextinction of species (the loss of a species upon the loss of another), we present a probabilistic model, scaled with empirical data. The model examines the relationship between coextinction levels (proportion of species extinct) of affiliates and ...
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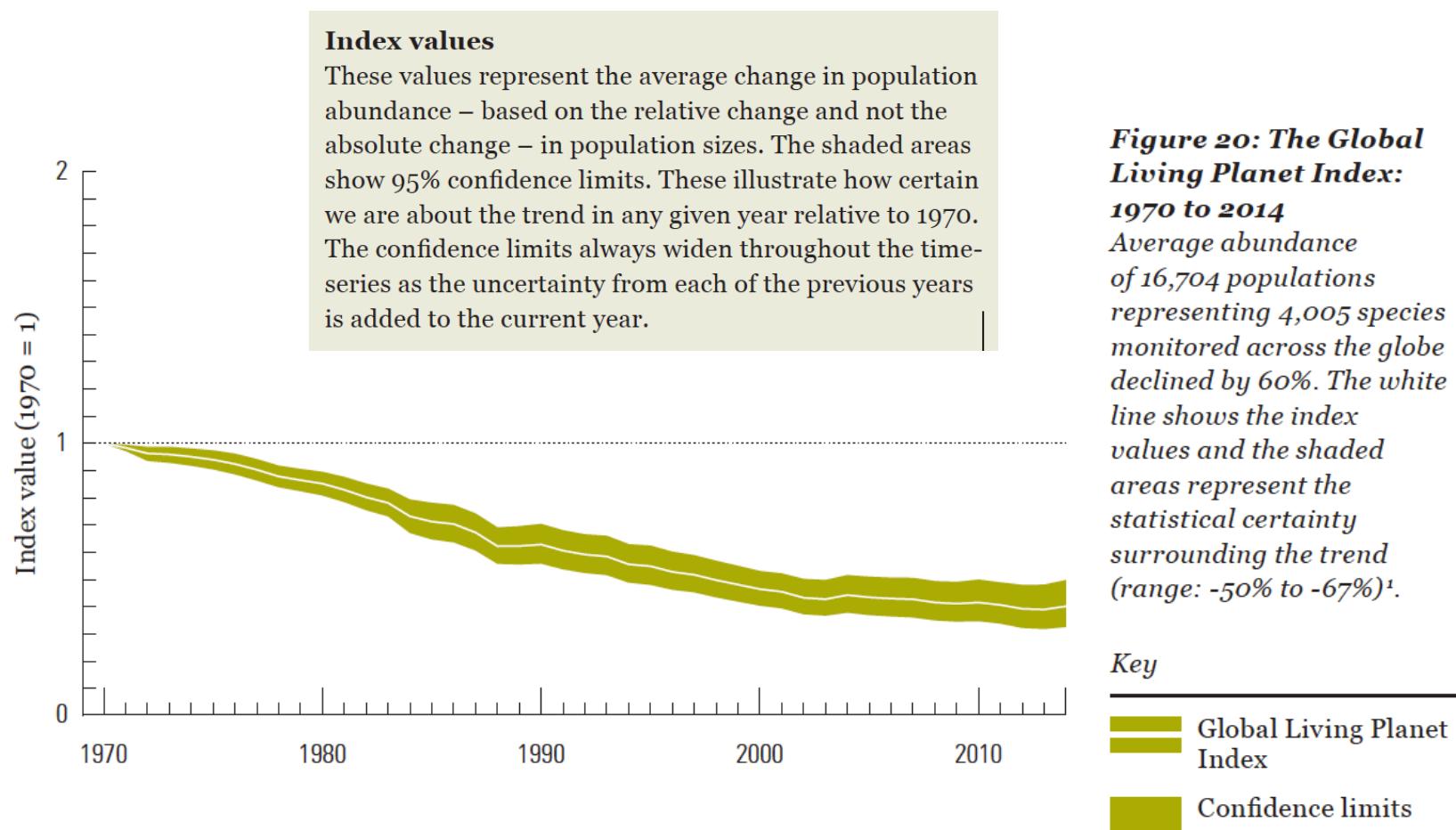
include patents

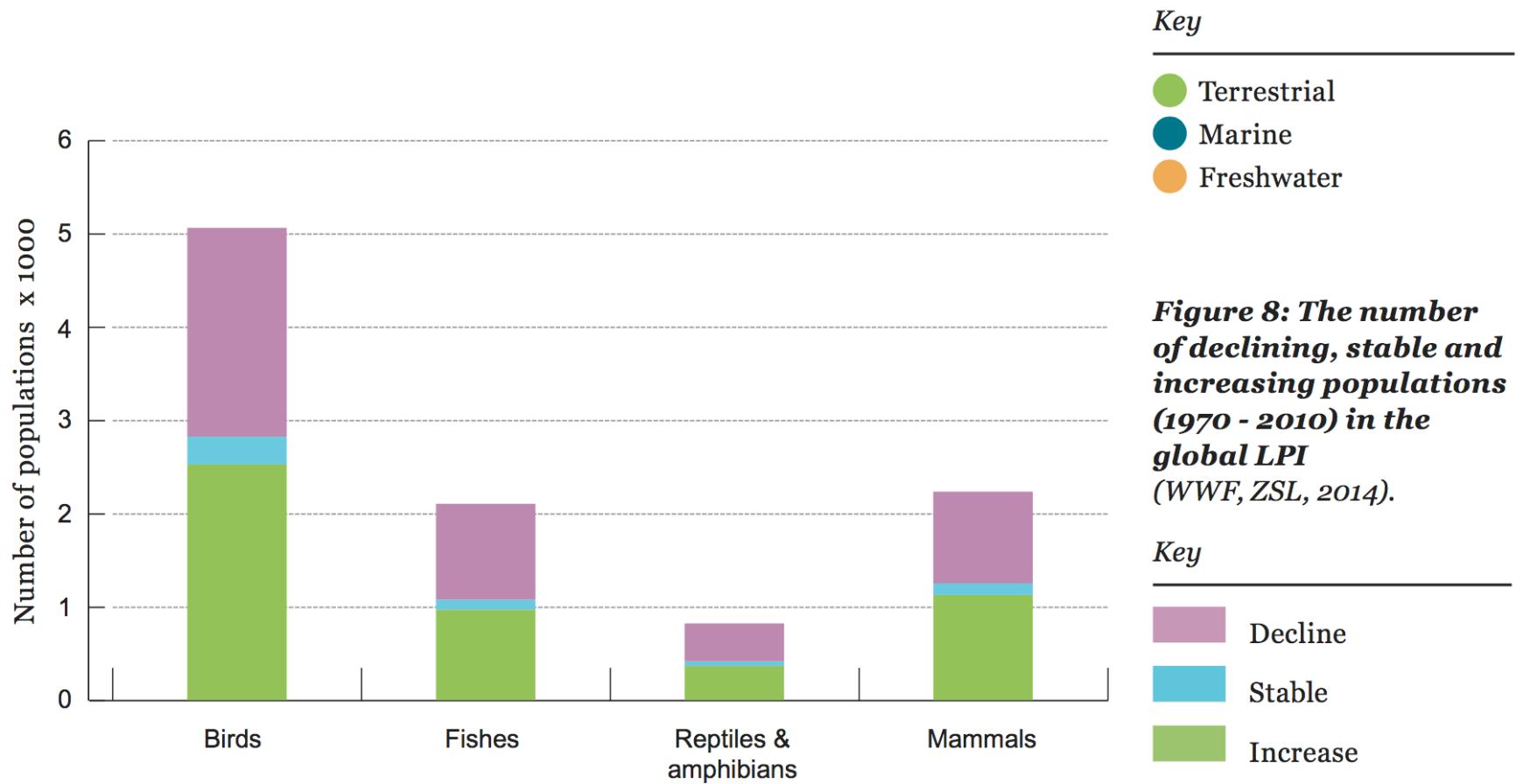
include citations

Conservation biology for the **biodiversity crisis**: a freshwater follow-up
R Abell - Conservation Biology, 2002 - JSTOR
In their essay "Conservation Biology for the **Biodiversity Crisis**," Olson et al.(2002) identify critical research gaps hampering effective conservation planning, with an emphasis on the terrestrial realm. The situation for freshwater biodiversity is so grave that an additional ...
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Have we overstated the tropical **biodiversity crisis**?
WF Laurance - Trends in Ecology & Evolution, 2007 - Elsevier
Tropical forests are the most biologically diverse and ecologically complex of terrestrial ecosystems, and are disappearing at alarming rates. It has long been suggested that rapid forest loss and degradation in the tropics, if unabated, could ultimately precipitate a wave ...
Cited by 165 Related articles All 17 versions Cite Save







Living Planet Report WWF 2014

Is there a biodiversity crisis?



Homework

Next Week: Background population ecology for conservation – Isla

Discussion: Population ecology and conservation management in practice
We will discuss how population ecology and ecological theory is used in conservation science and management today.

- What were the major findings of this study?
- How have changes in large mammal populations been associated with warfare and wildlife conflict in this study?
- What key population ecology metrics are used in the study? And how are they calculated?
- How was population change linked statistically to wildlife conflict? What type of statistical model was used?

Dornelas, M., Gotelli, N.J., Shimadzu, H., Moyes, F., Magurran, A.E. and McGill, B.J., 2019. A balance of winners and losers in the Anthropocene. *Ecology letters*, 22(5), pp.847-854. <https://onlinelibrary.wiley.com/doi/full/10.1111/ele.13242>

Daskin, J.H. and Pringle, R.M., 2018. Warfare and wildlife declines in Africa's protected areas. *Nature*, 553(7688), p.328. <http://www.nature.com/articles/nature25194>

Activities:

- Getting hands on with the theory of island biogeography
- Mark recapture to estimate population sizes
- Intro to programming and mathematical ecology