Monitoring and Forecasting Species Extinction Risks

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Integrating Biodiversity Monitoring and Forecasting

- **Answer questions about effect of policy changes; make policy-relevant predictions**
- **Advance warning of major biodiversity changes (e.g., extinctions, regime shifts)**
- **Test/validate monitoring programs**

Estimating extinction risks

	Age0	Age1	Age2	Age3
Age0	m_1S_1	m_2S_2	m_3S_3	m_4S_4
Age1	S_1	0	0	0
Age2	0	S_2	0	0
Age3	0	0	S_3	0

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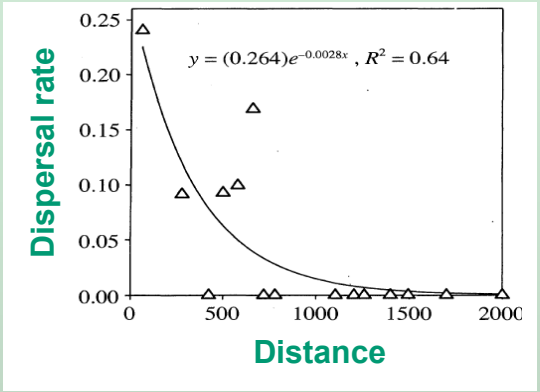

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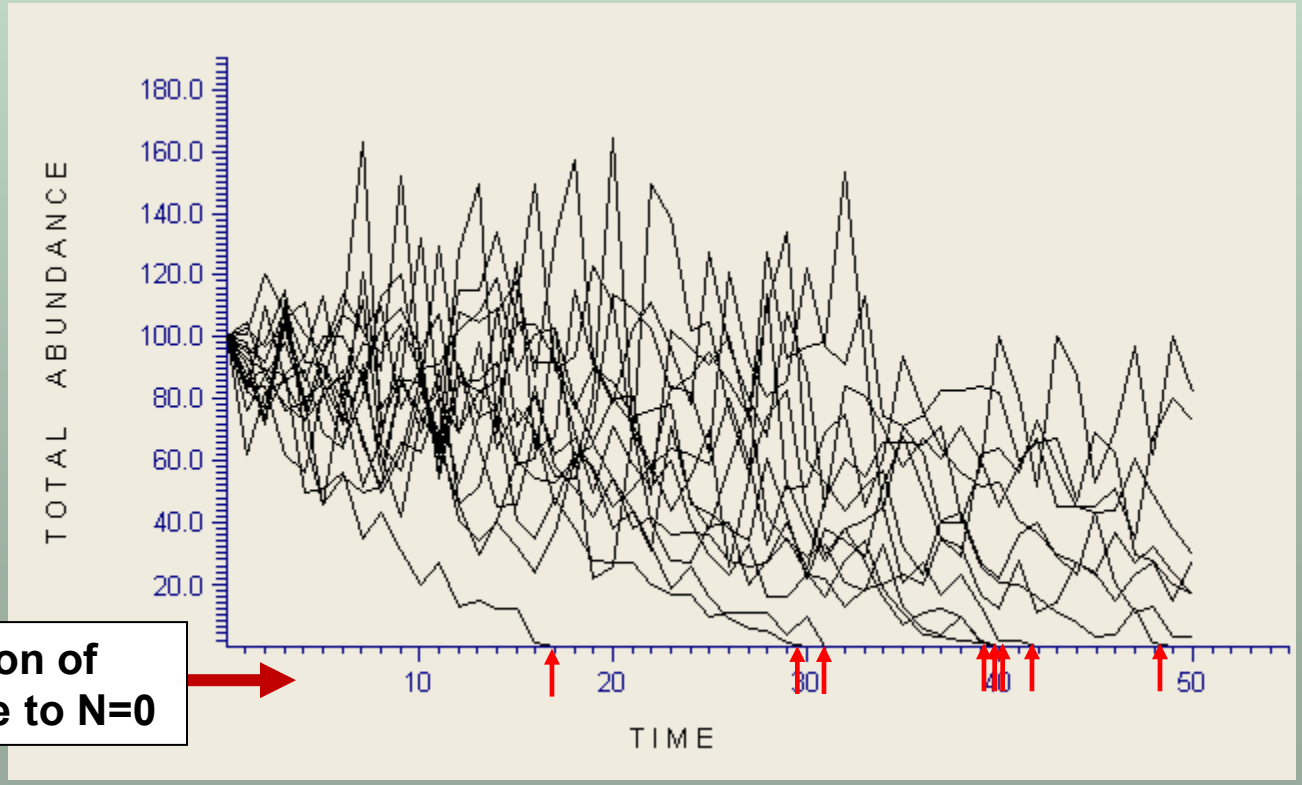
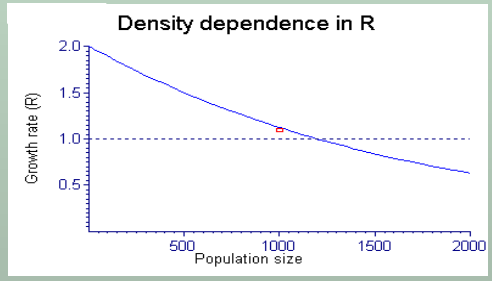


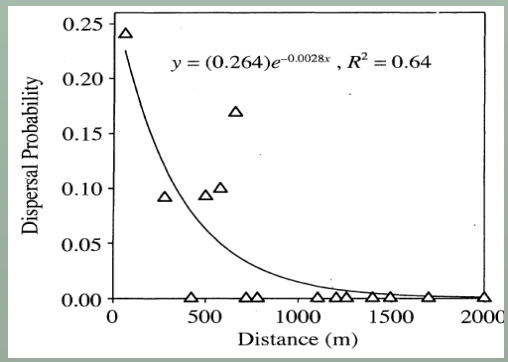
Extinction risk = proportion of replications that decrease to N=0

Generic Life History models

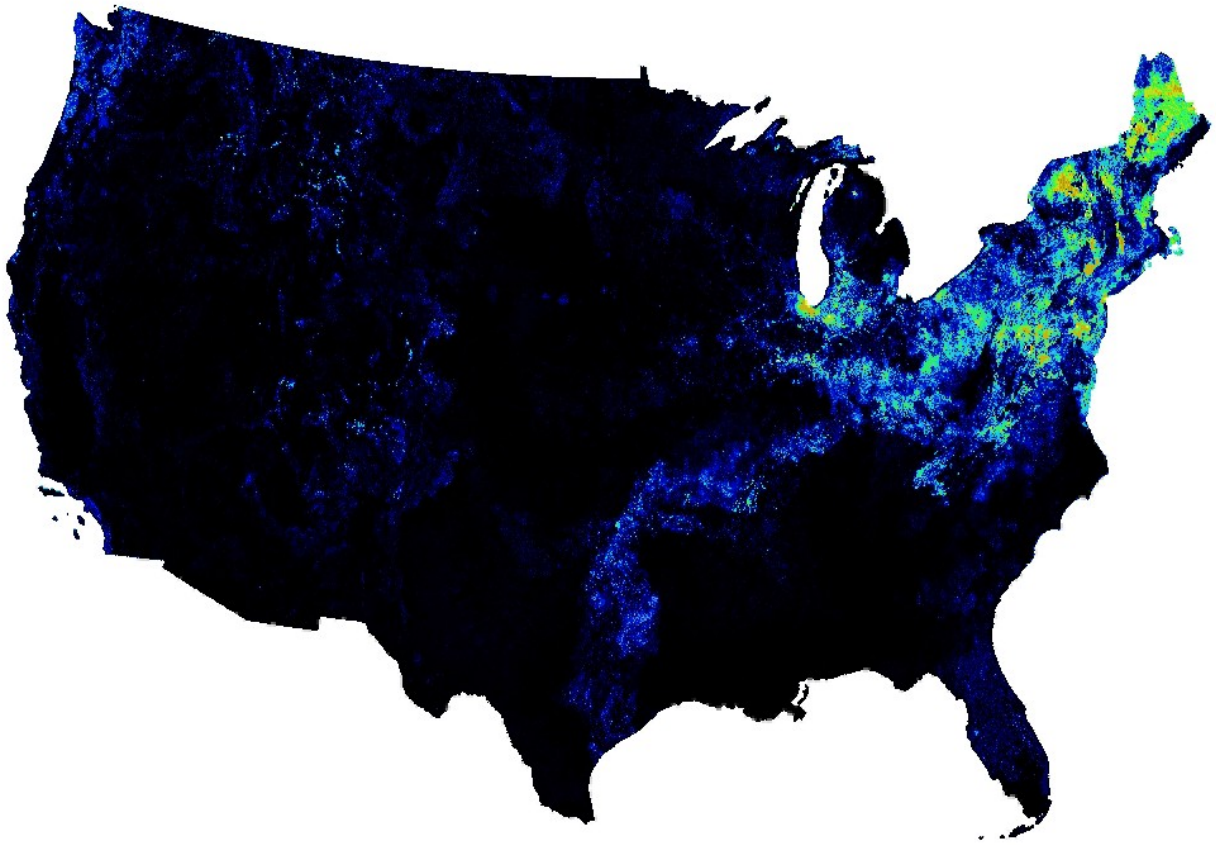
- "Generic model" with a standard set of 4 to 5 parameters:
  - Growth rate (R_{max} or λ)
  - Survival rates & Fecundities
  - Temporal variability in survival & fecundity
  - Dispersal
  - Spatial correlation
- Range (min & max) for each parameter
- Sampled random models with Latin hypercube (10 per dimension)
- Combine with habitat maps; run simulations; estimate viability

$$\begin{bmatrix} m_1S_1 & m_2S_2 & m_3S_3 & m_4S_4 \\ S_1 & 0 & 0 & 0 \\ 0 & S_2 & 0 & 0 \\ 0 & 0 & S_3 & 0 \end{bmatrix}$$





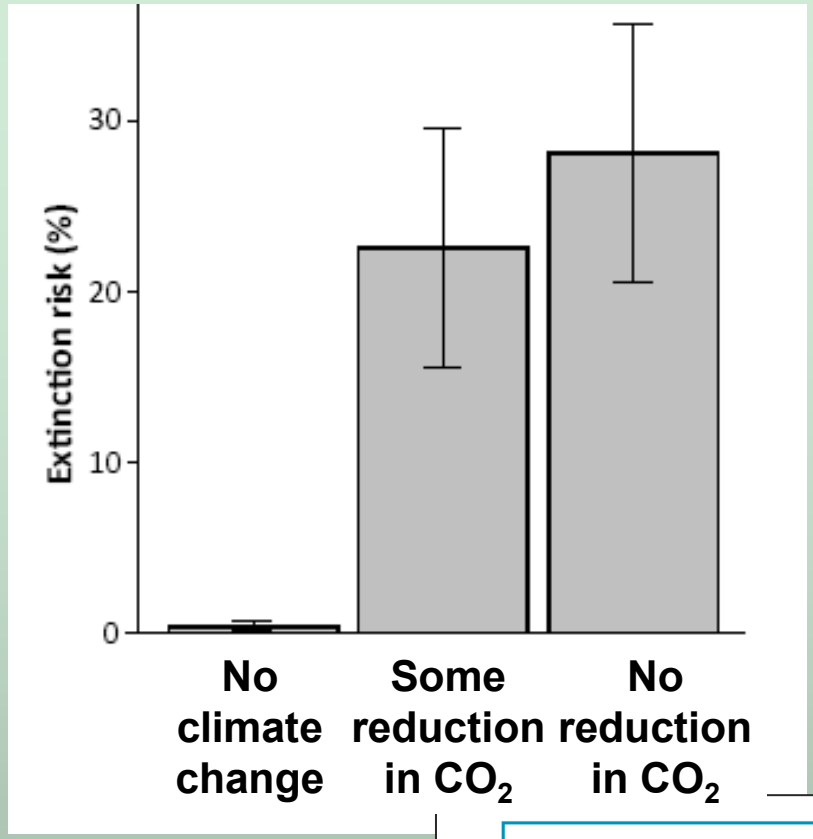
Kirtland's Snake



Habitat suitability

Population density

Extinction Risk Under Climate Change



nature climate change

LETTERS

PUBLISHED ONLINE: 26 FEBRUARY 2014 | DOI: 10.1038/NCLIMATE2113

Life history and spatial traits predict extinction risk due to climate change

Richard G. Pearson[1,2], Jessica C. Stanton[3], Kevin T. Shoemaker[3], Matthew E. Aiello-Lammens[3], Peter J. Ersts[2], Ned Horning[2], Damien A. Fordham[4], Christopher J. Raxworthy[2], Hae Yeong Ryu[3], Jason McNees[5] and H. Reşit Akçakaya[3]*

Link to paper: http://www.nature.com/nclimate/journal/v4/n3/full/nclimate2113.html

IUCN Red List

CRITERIA

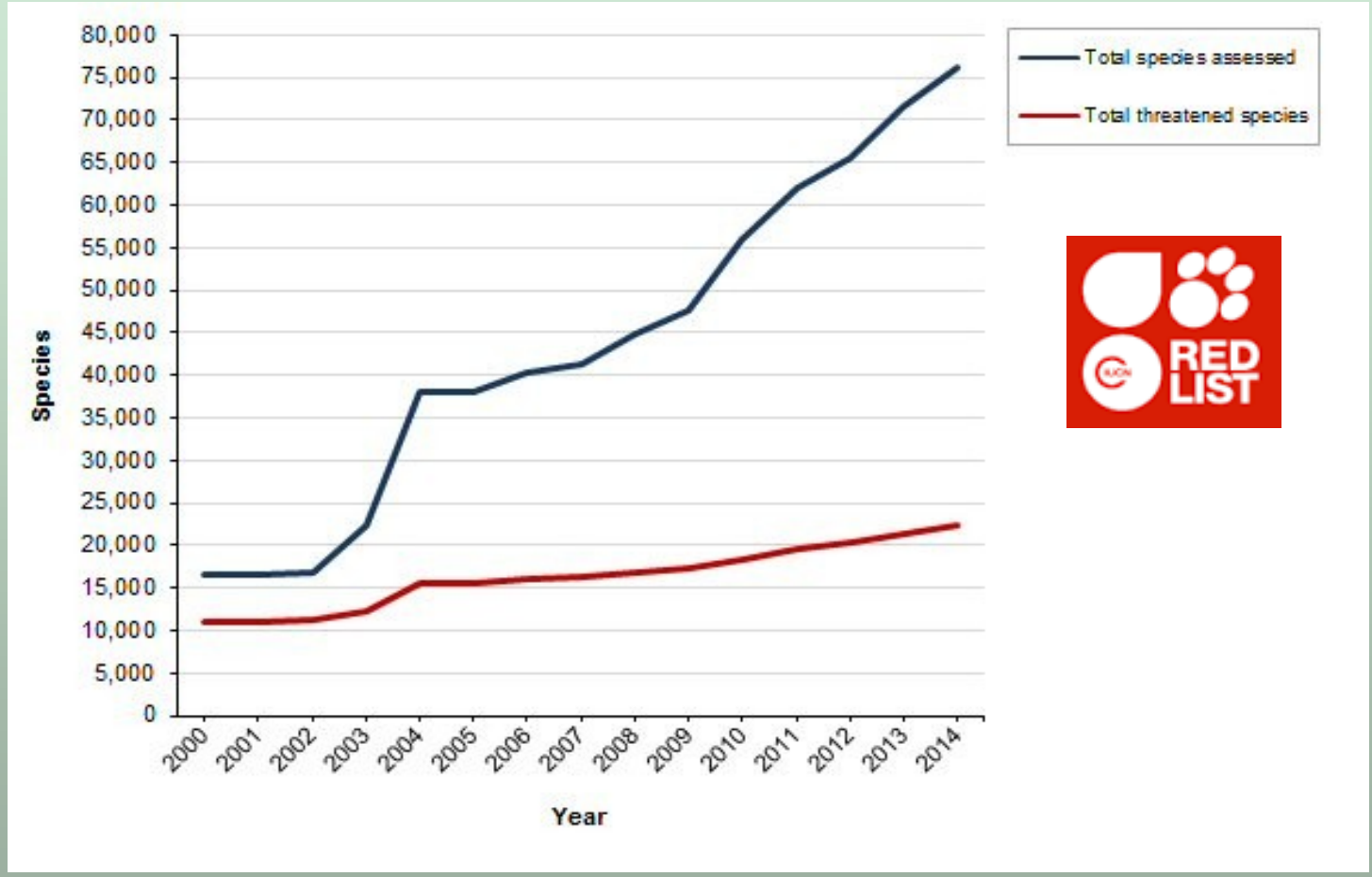
- **A** — Population reduction
- **B** — Restricted geographic range
- **C** — Small population size & decline
- **D** — Very small or restricted population
- **E** — Quantitative analysis

Quantitative thresholds

- Extinct
- Extinct in the Wild
- Critically endangered
- Endangered
- Vulnerable
- Near-threatened
- Least concern

Threatened

Data deficient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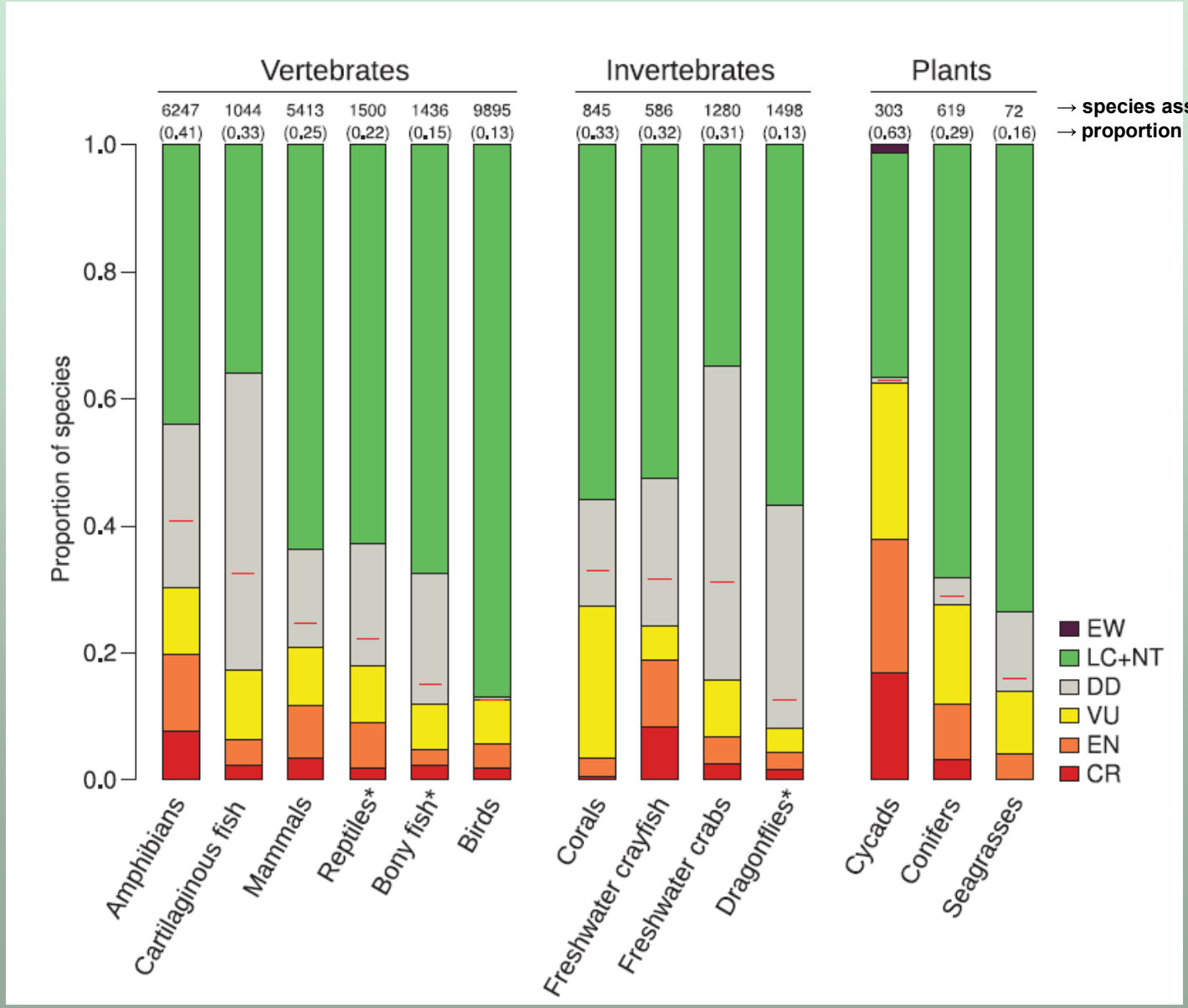
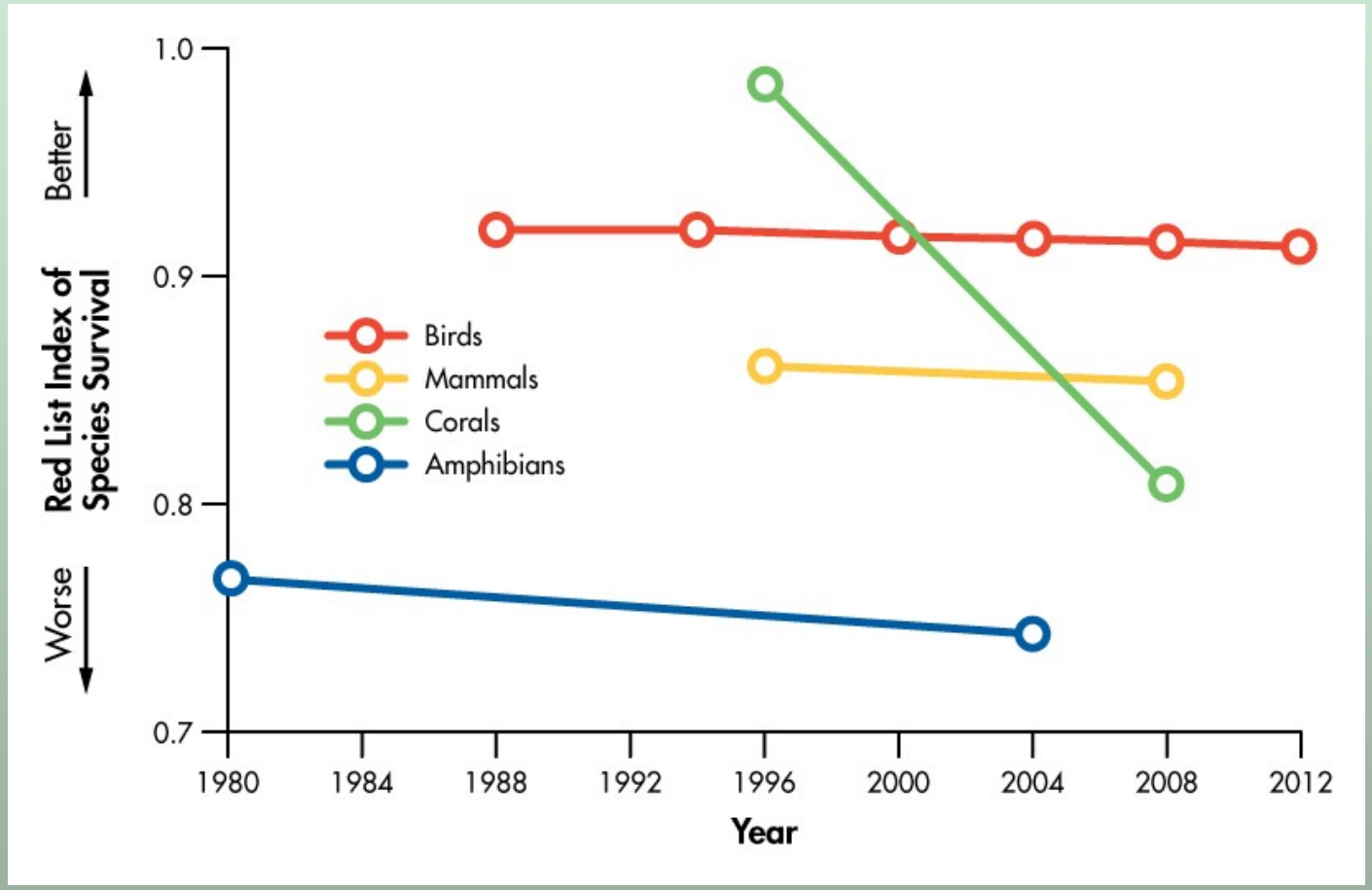
5,000
0
Species
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year
Total species assessed
Total threatened species
RED LIST

Monitoring Biodiversity Status:
IUCN Red List



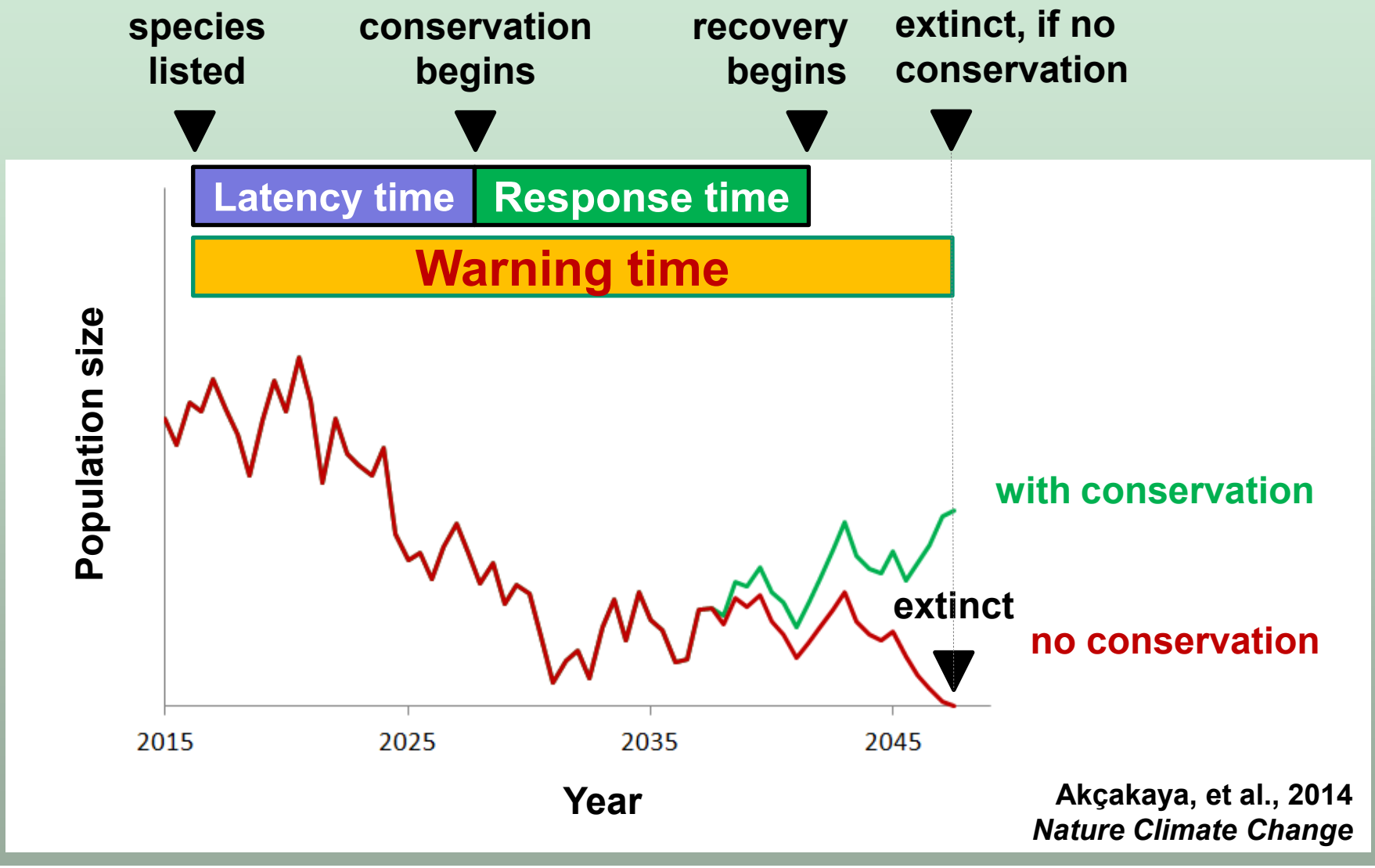
Hoffmann et al. 2010. *Science*

Monitoring Biodiversity Trends: The Red List Index



Red List Index for the world's mammals, birds, amphibians and corals.
http://www.bipindicators.net/rli/2010 Data source: IUCN & Birdlife International, 2013

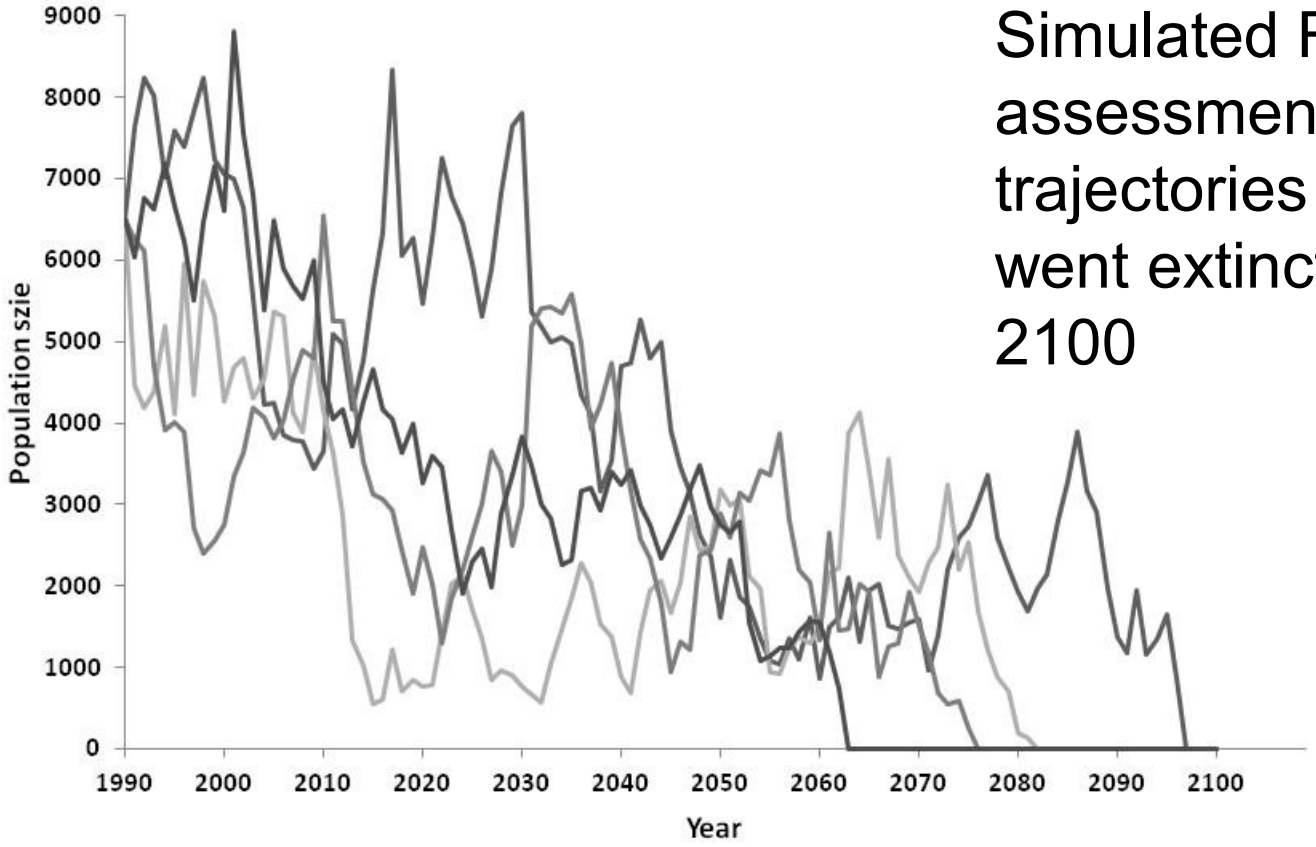
Testing Biodiversity Indicators



Akçakaya, et al., 2014
Nature Climate Change

Link to paper: http://www.nature.com/nclimate/journal/v4/n12/full/nclimate2455.html

Testing the Red List: Warning times for species going extinct because of climate change

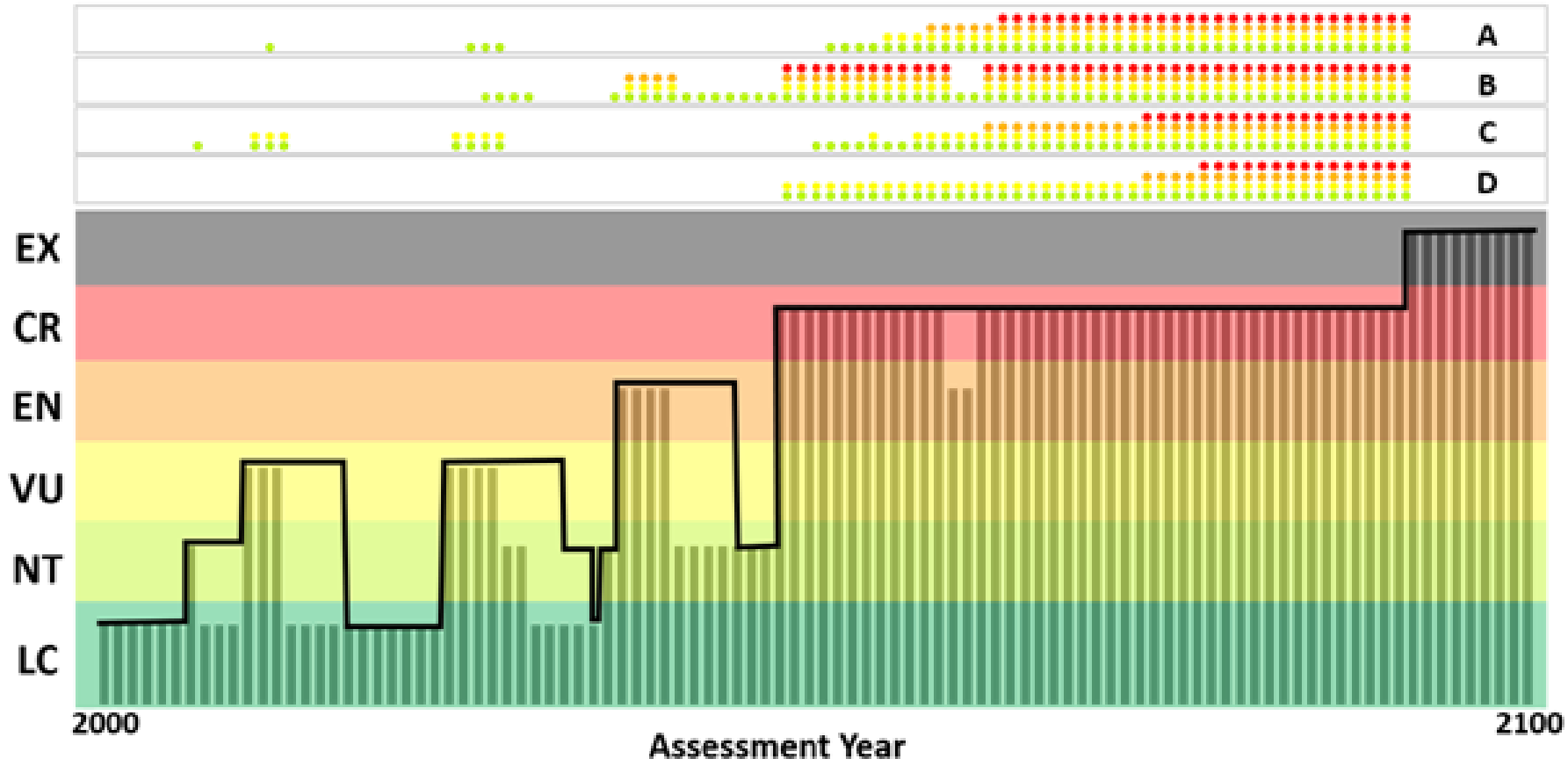


Simulated Red List assessments of all trajectories that went extinct by 2100

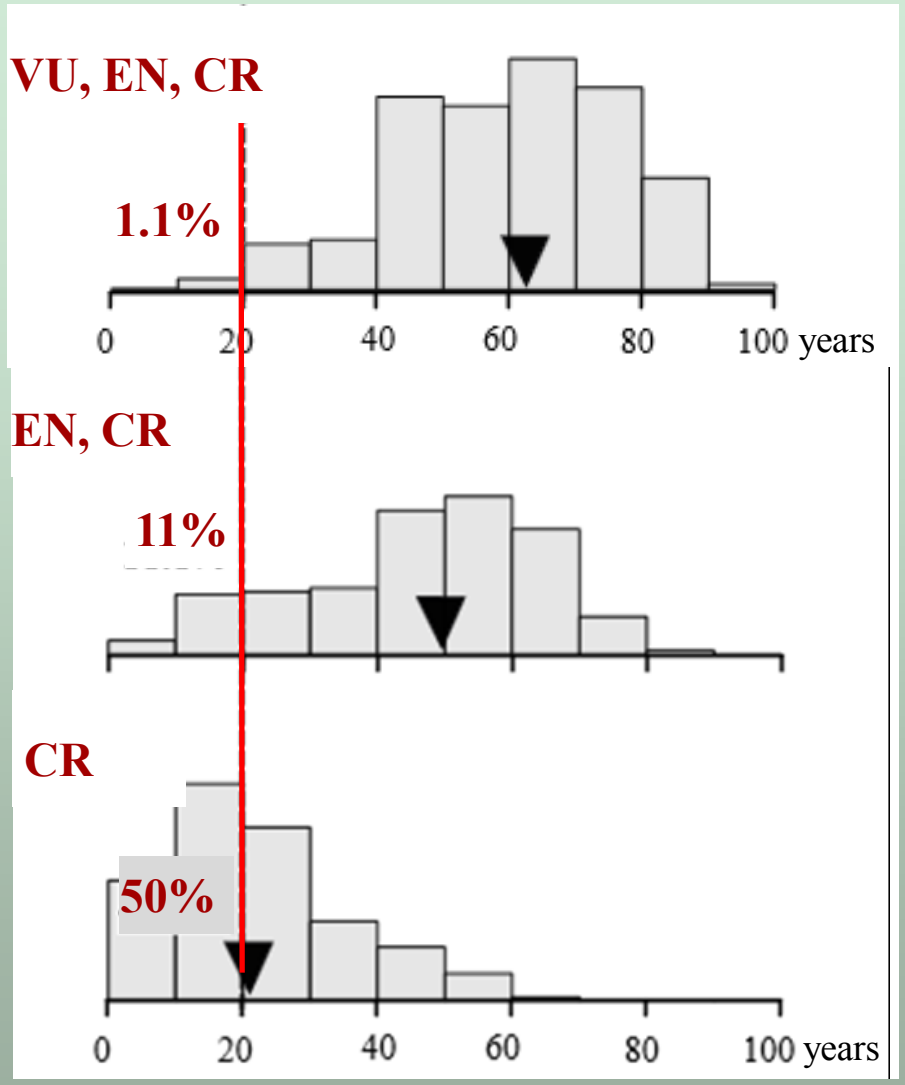
Stanton, Shoemaker, Pearson & Akçakaya. 2015. *Global Change Biology*

Link to paper: http://onlinelibrary.wiley.com/doi/10.1111/gcb.12721/abstract

Progression through Red List Categories



Stanton, Shoemaker, Pearson & Akçakaya. 2015. *Global Change Biology*

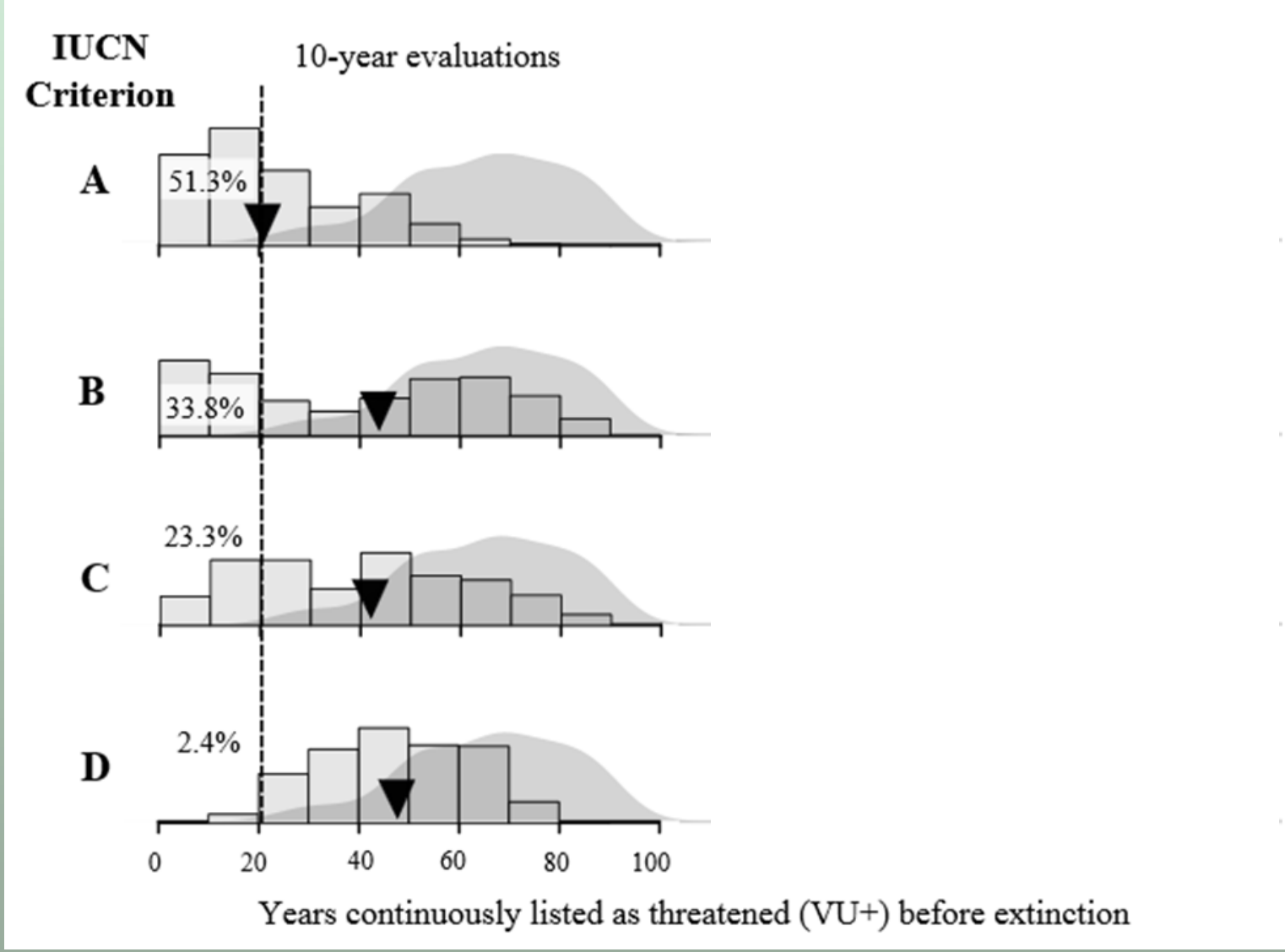


Warning Time for Species Extinctions due to Climate Change

Number of years continuously listed as threatened before extinction

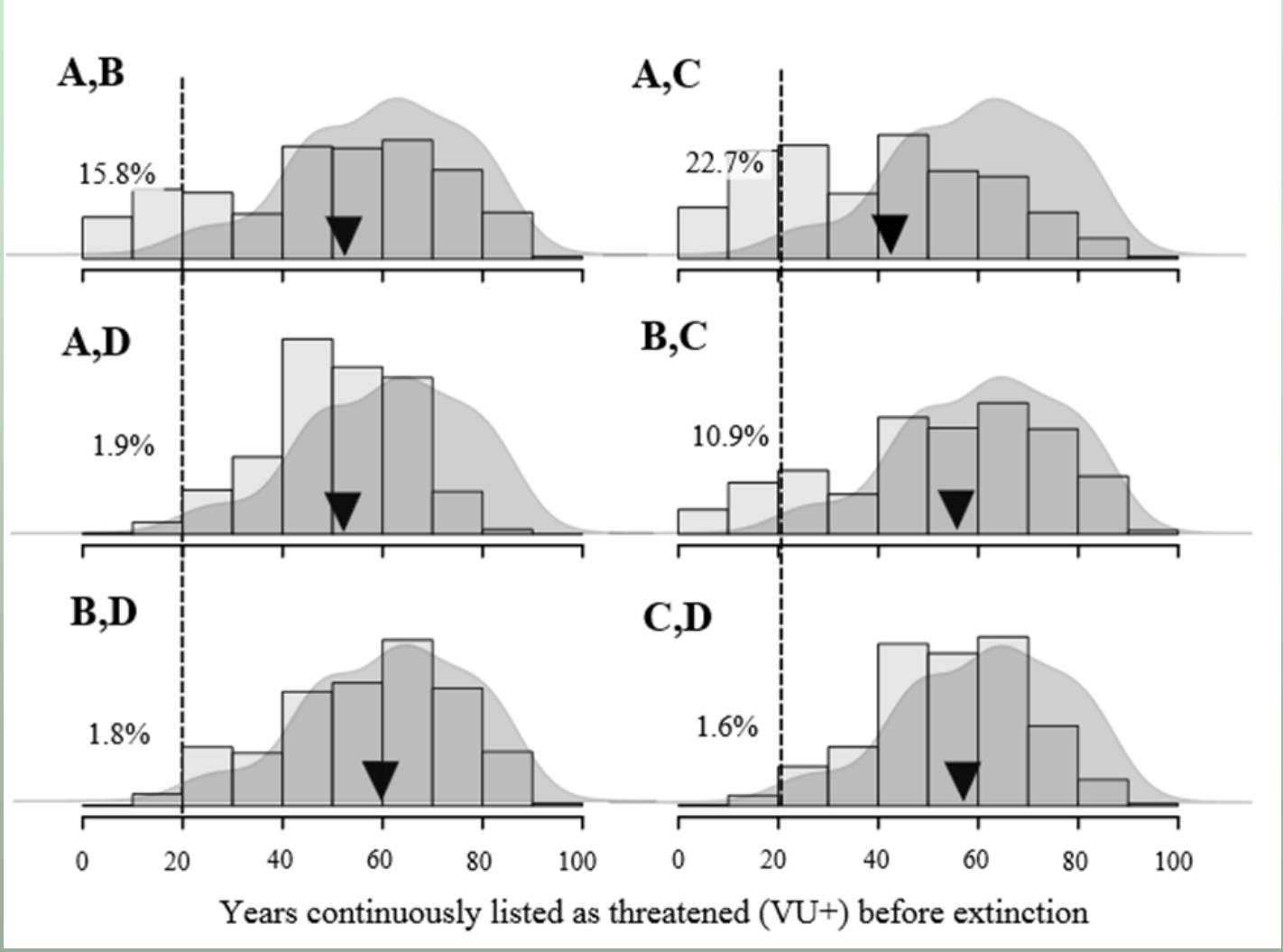
Stanton, Shoemaker, Pearson & Akçakaya. 2015. *Global Change Biology*

Effect of Uncertainty



Stanton, Shoemaker, Pearson & Akçakaya. 2015. *Global Change Biology*

Effect of Uncertainty



Stanton, Shoemaker, Pearson & Akçakaya. 2015. *Global Change Biology*

Conclusions

- High extinction risk due to climate change
- Extinction risk due to climate change can be predicted with present-day data
- Several decades of warning time for species extinctions due to climate change
- Multiple criteria or more frequent assessments
- Current assessment methods appear sufficient

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- **Advance warning of major biodiversity changes (e.g., extinctions, regime shifts)**
- **Test/validate monitoring programs**

Acknowledgements

Akçakaya Lab
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Jessica Stanton
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