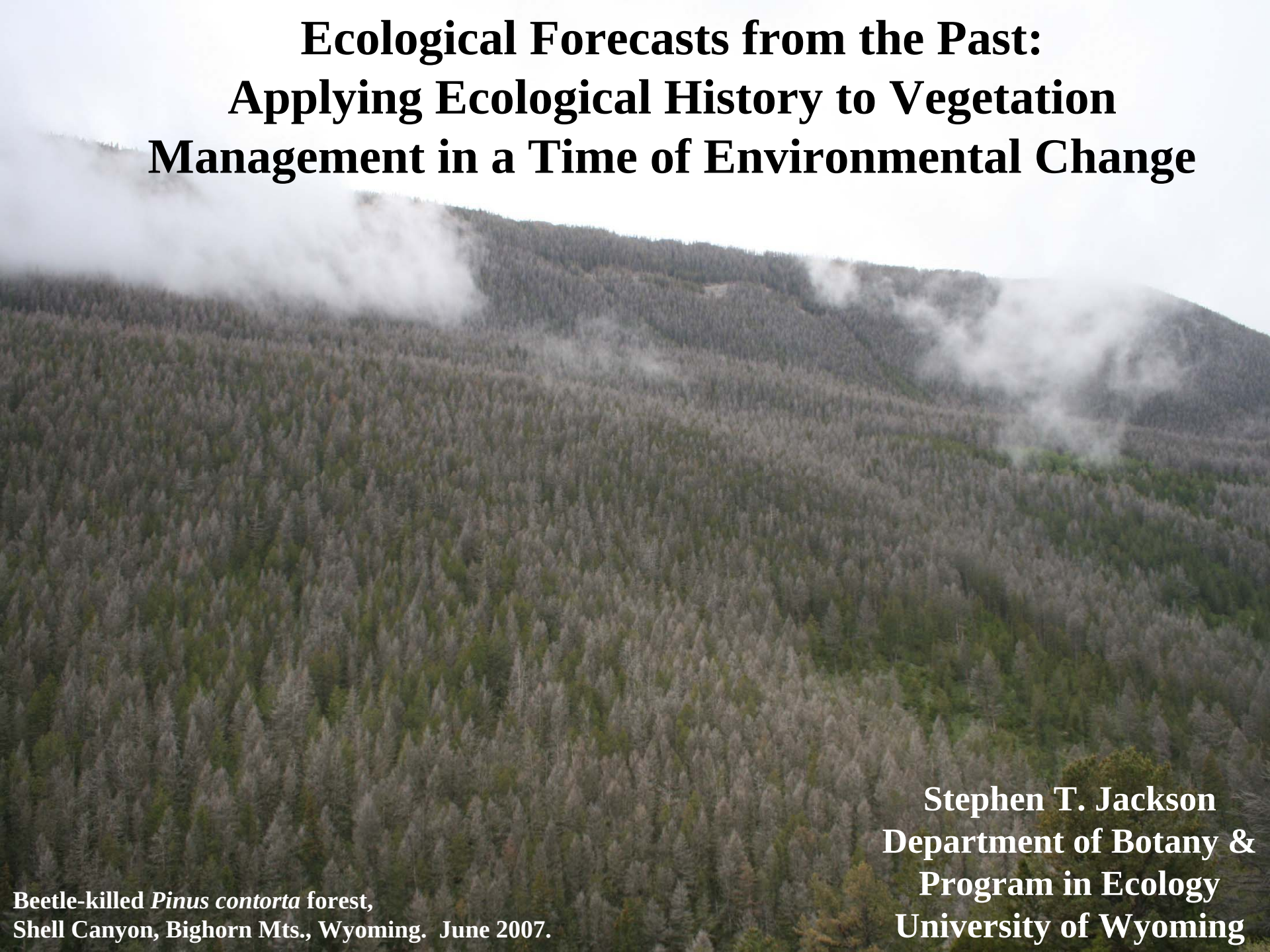
Ecological Forecasts from the Past: Applying Ecological History to Vegetation Management in a Time of Environmental Change



Beetle-killed *Pinus contorta* forest,
Shell Canyon, Bighorn Mts., Wyoming. June 2007.

Stephen T. Jackson
Department of Botany &
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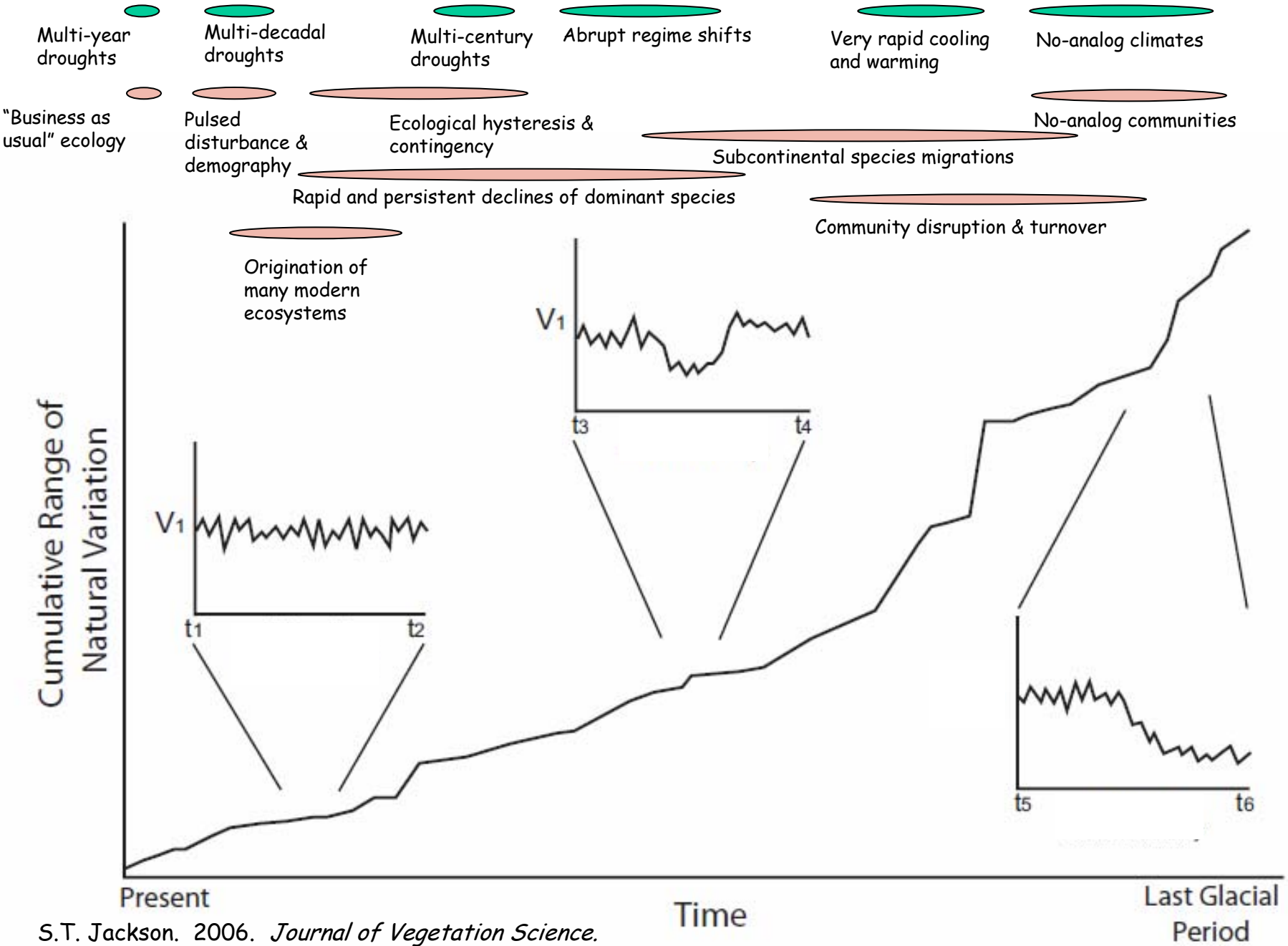
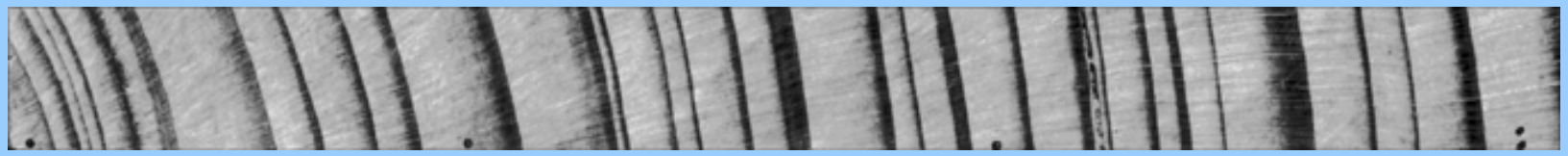
University of Wyoming

Environmental History Enlarges Our Experience



S.T. Jackson. 2006. *Journal of Vegetation Science.*



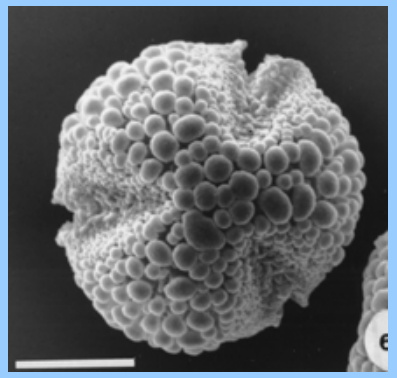
Four major challenges from ecological history:

1.Change won’t be smooth or gradual.

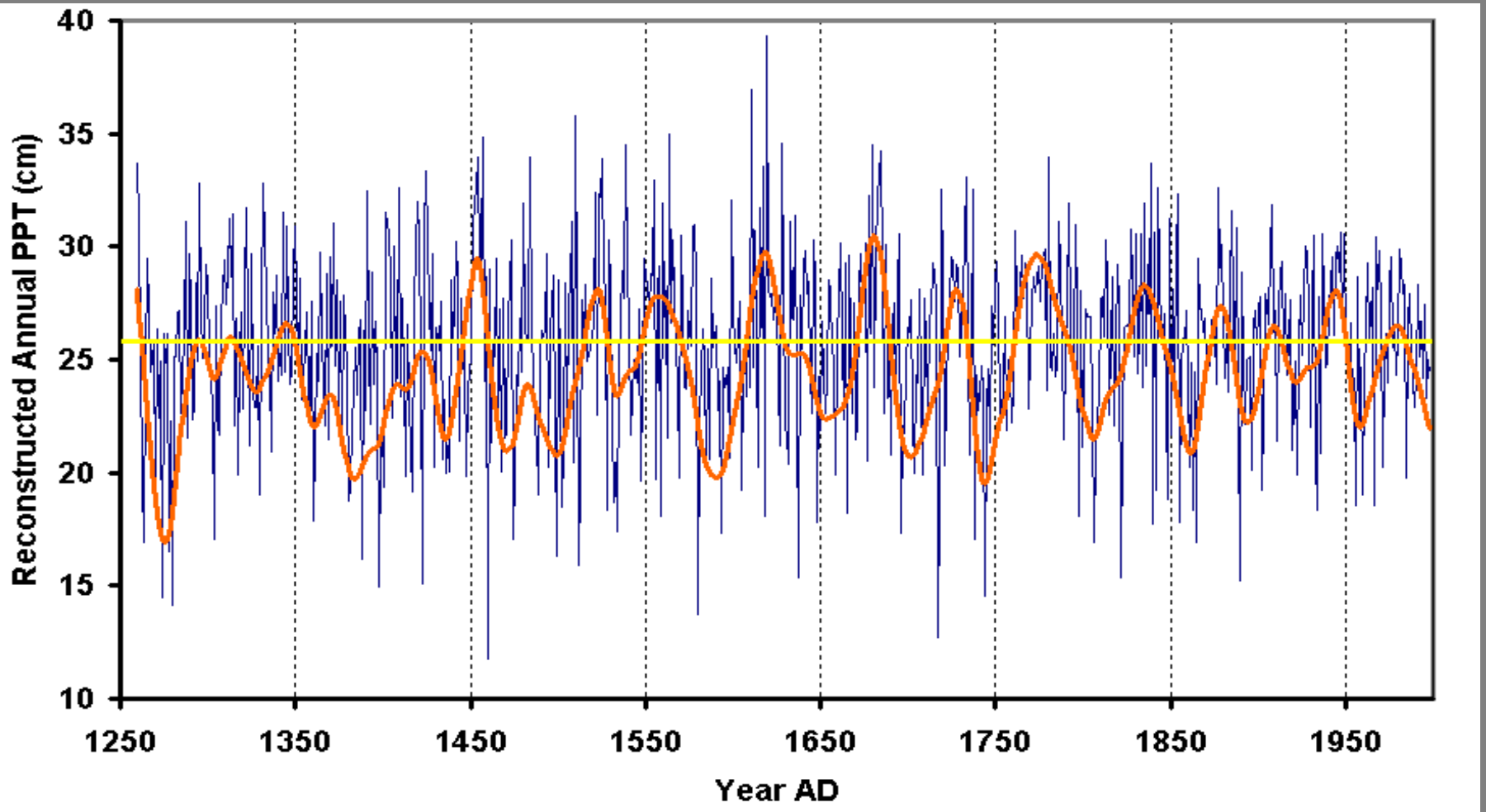
2.Climate realizations will disappear.

3.Novel climates will arise.

4.Surprises may be in store.



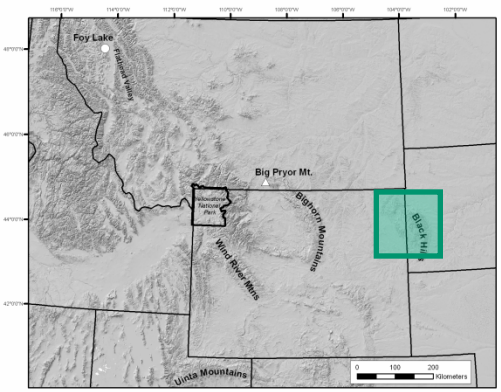
Annual Precipitation Variation in the Bighorn Basin in the Last 750 Years

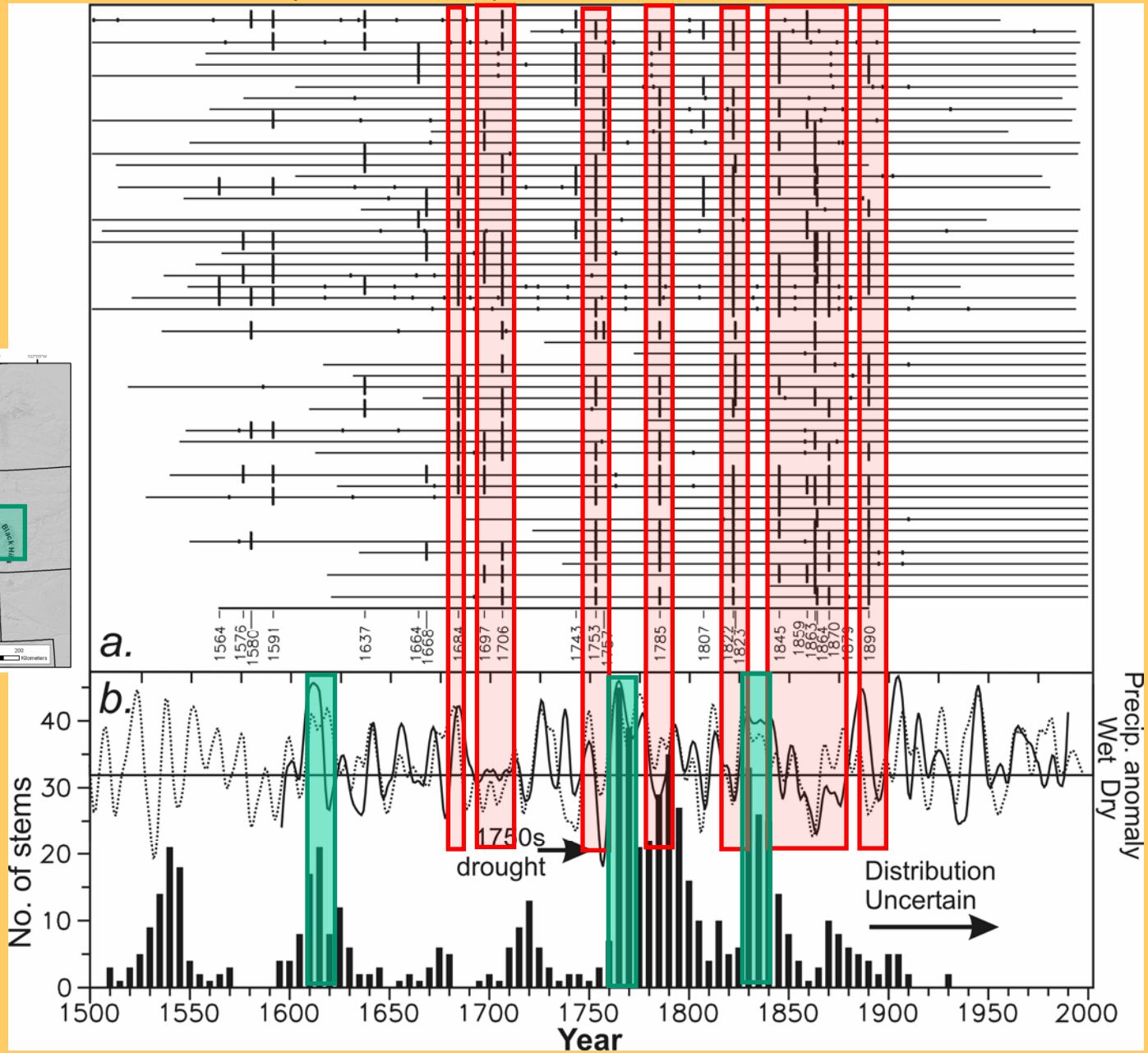


S.T. Gray, S.T. Jackson, J.L. Betancourt, C.L. Fastie. 2004. *Journal of Climate*.

21st Century:
Climate change will interact with interannual to multidecadal variability regimes

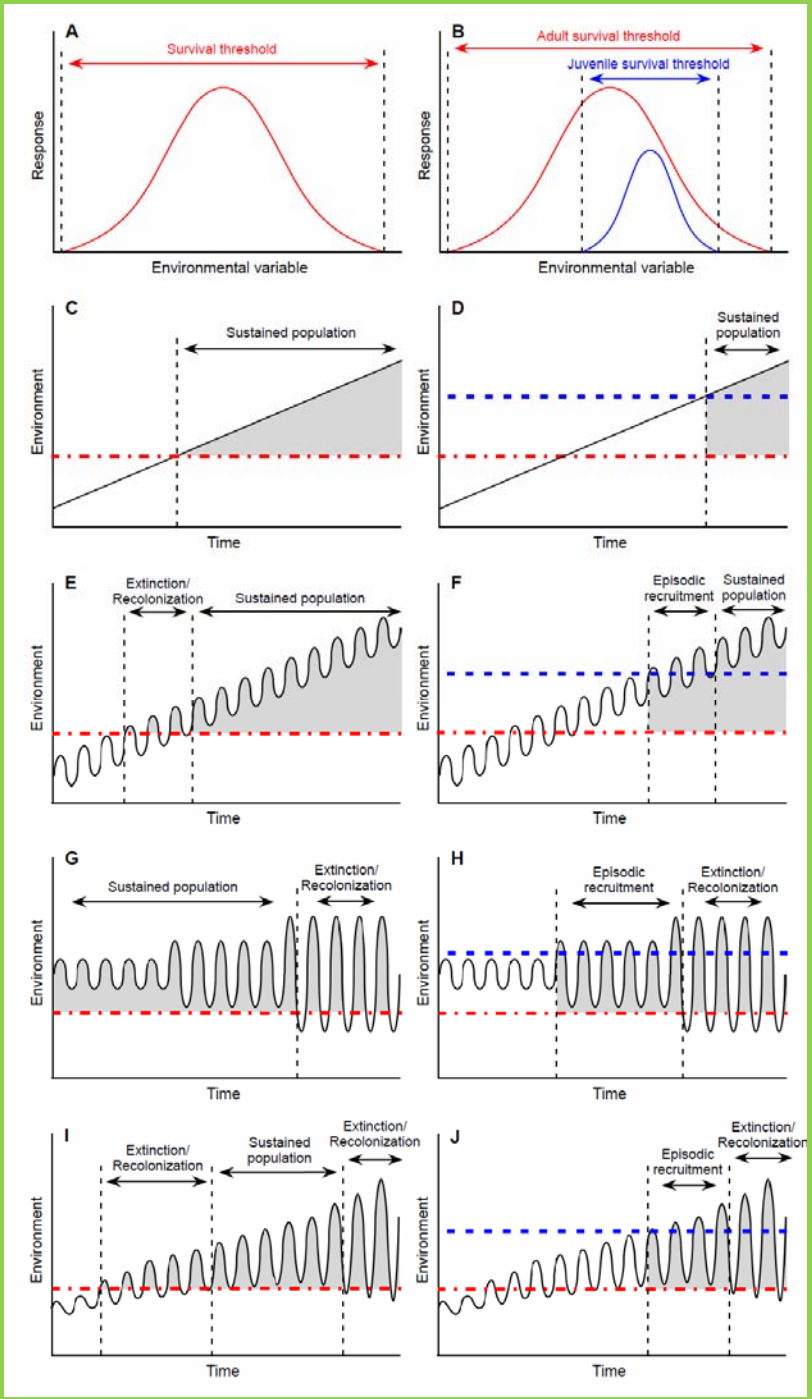
Historical legacies are imposed by influence of climate change and variability on disturbance & recruitment regimes.





P.M. Brown. 2006. *Ecology.*

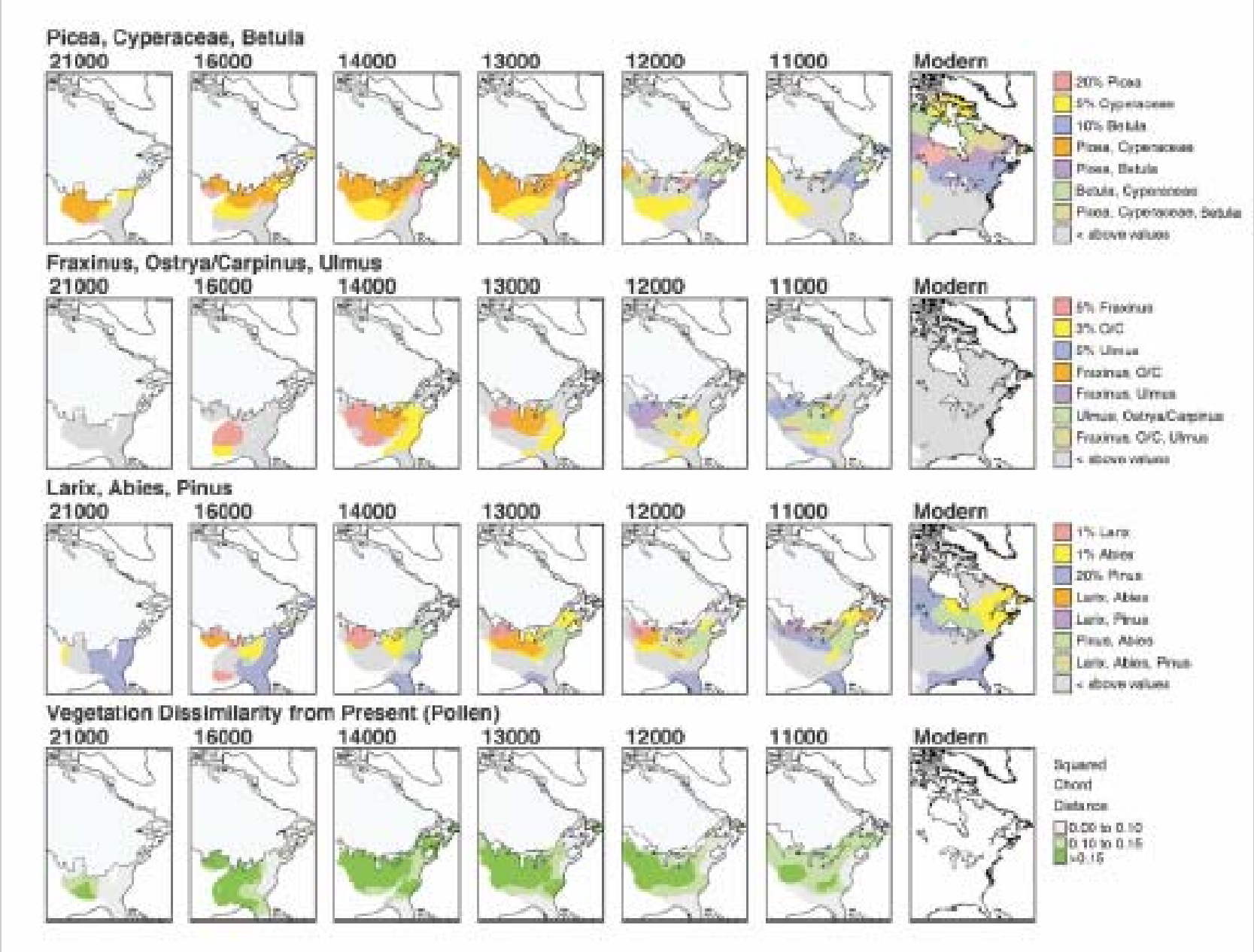
Variability regimes will interact with species attributes (esp. regeneration niche)



S.T. Jackson *et al.* 2009. *PNAS.*

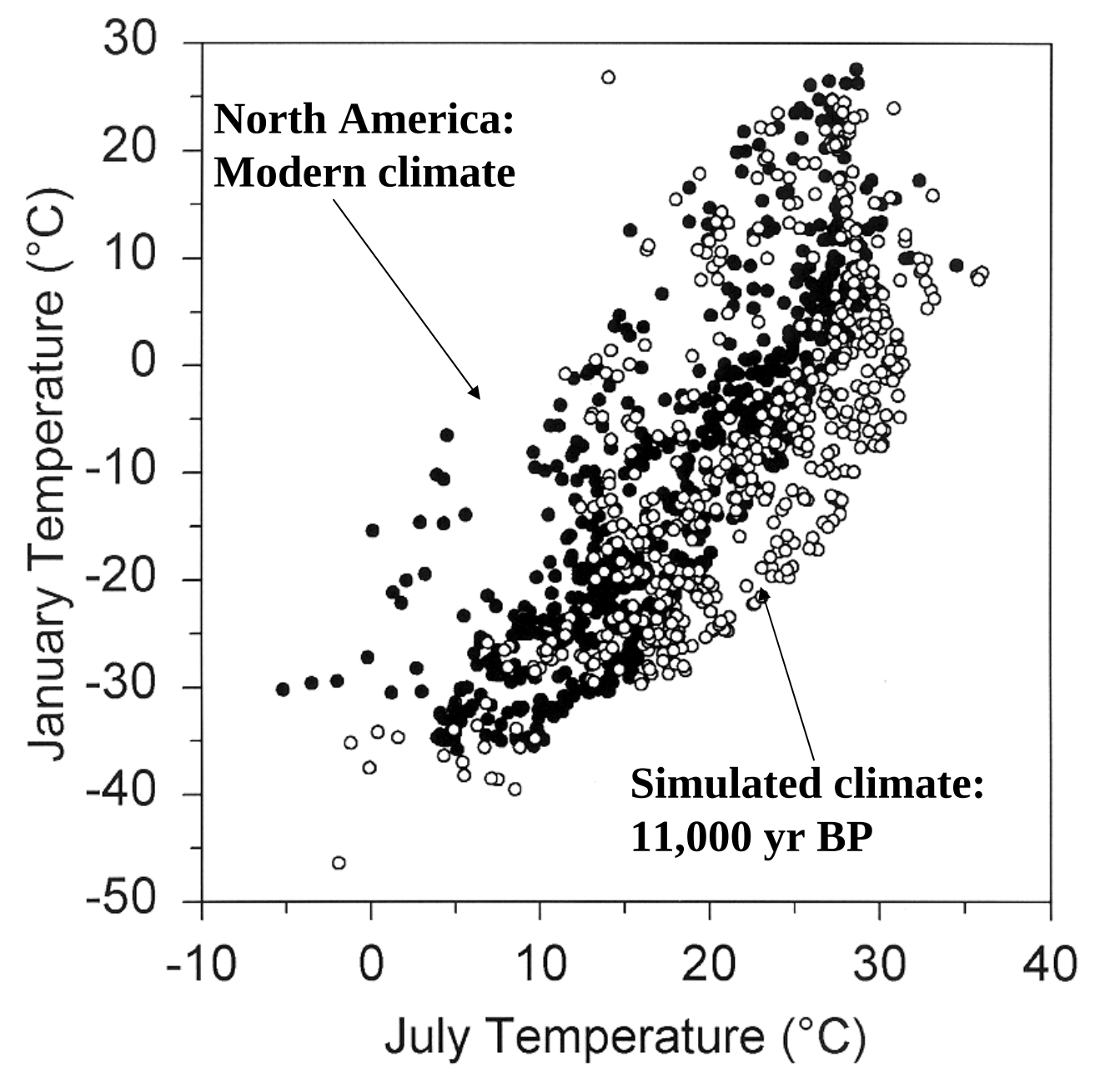
Future vegetation and ecosystem realizations will be contingent on particular sequences of climate-mediated disturbance and recruitment events

In the past, climate realizations and ecosystems have vanished.

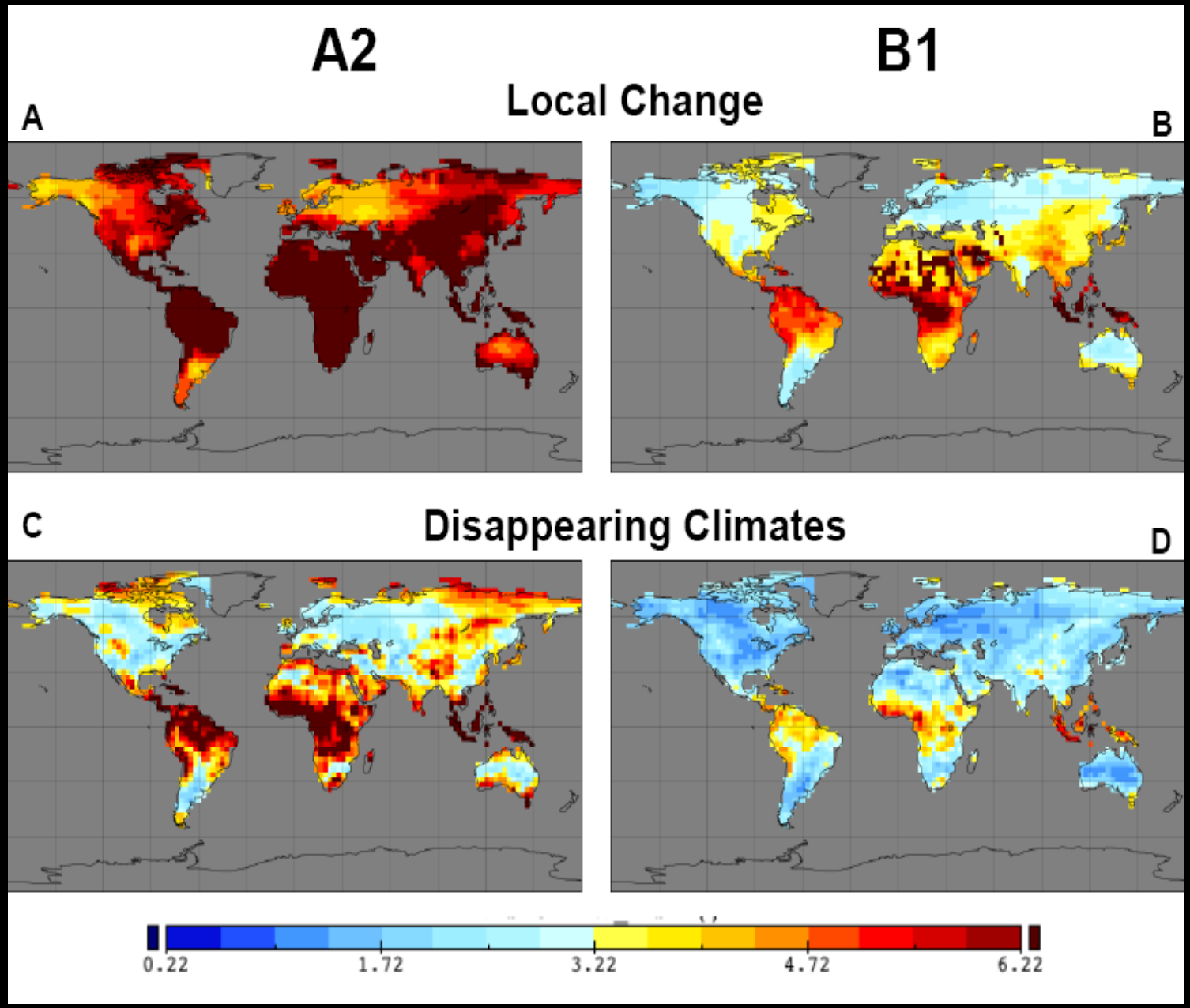


S.T. Jackson & J.W. Williams. 2004. *Ann. Rev. Earth & Planet. Sci.*

Consequences of a multivariate, shape-shifting environment



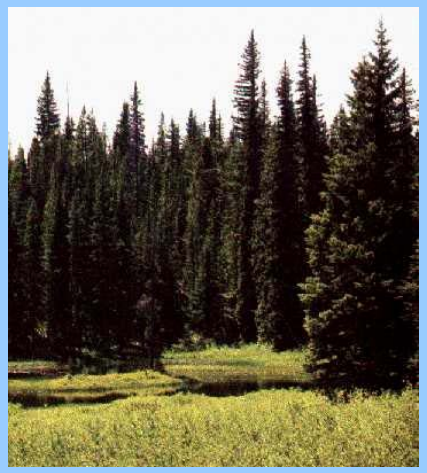
S.T. Jackson. 2000. *In* R.A. Gastaldo & W.A. DiMichele (eds.). *Phanerozoic Terrestrial Ecosystems*.



J.W. Williams, S.T. Jackson & J.E. Kutzbach. 2007. *PNAS.*

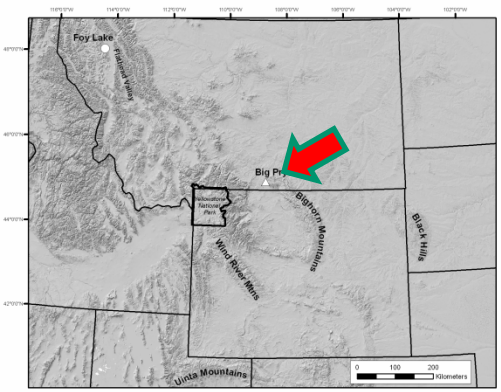
What challenges are posed by disappearance of existing environmental realizations?

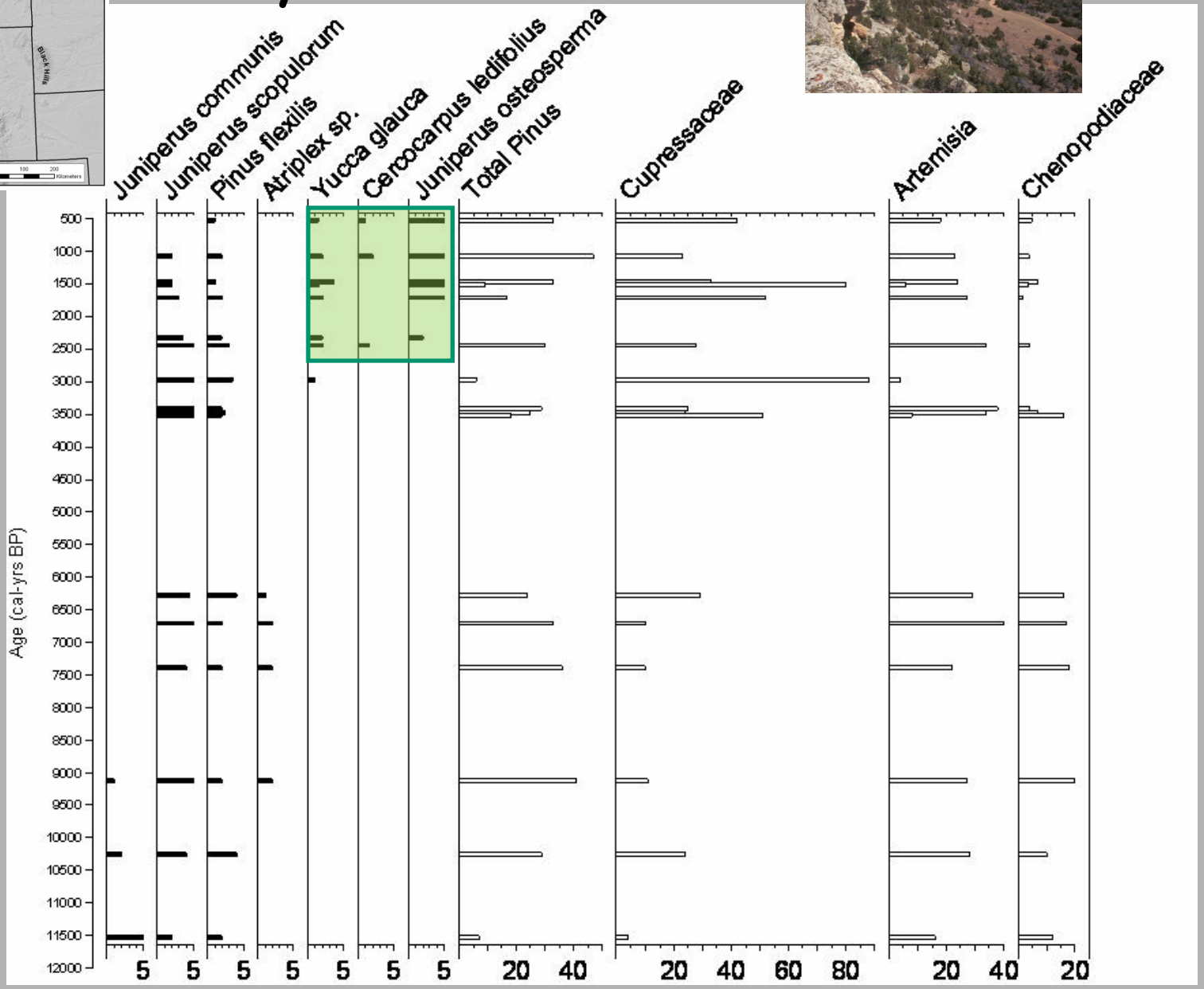
- Disruption (or disassembly) of existing communities



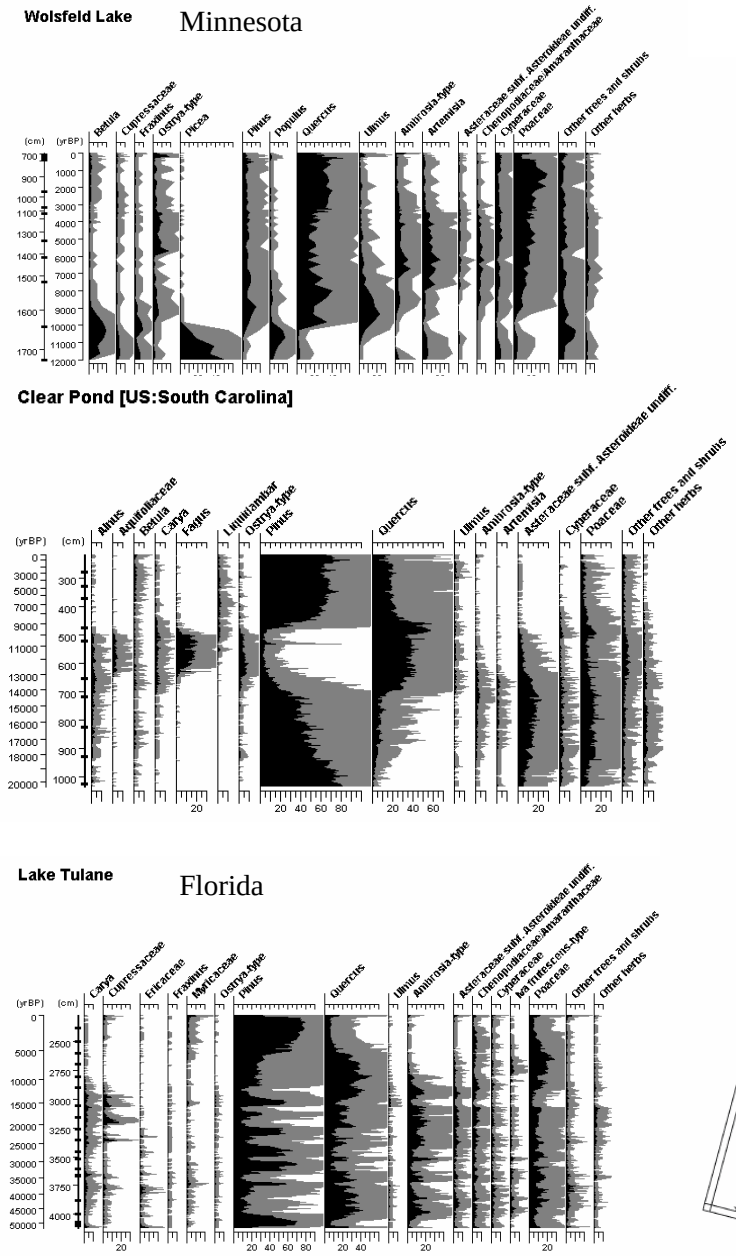
- Risk of disappearance of species' potential niche (= extirpation or extinction)

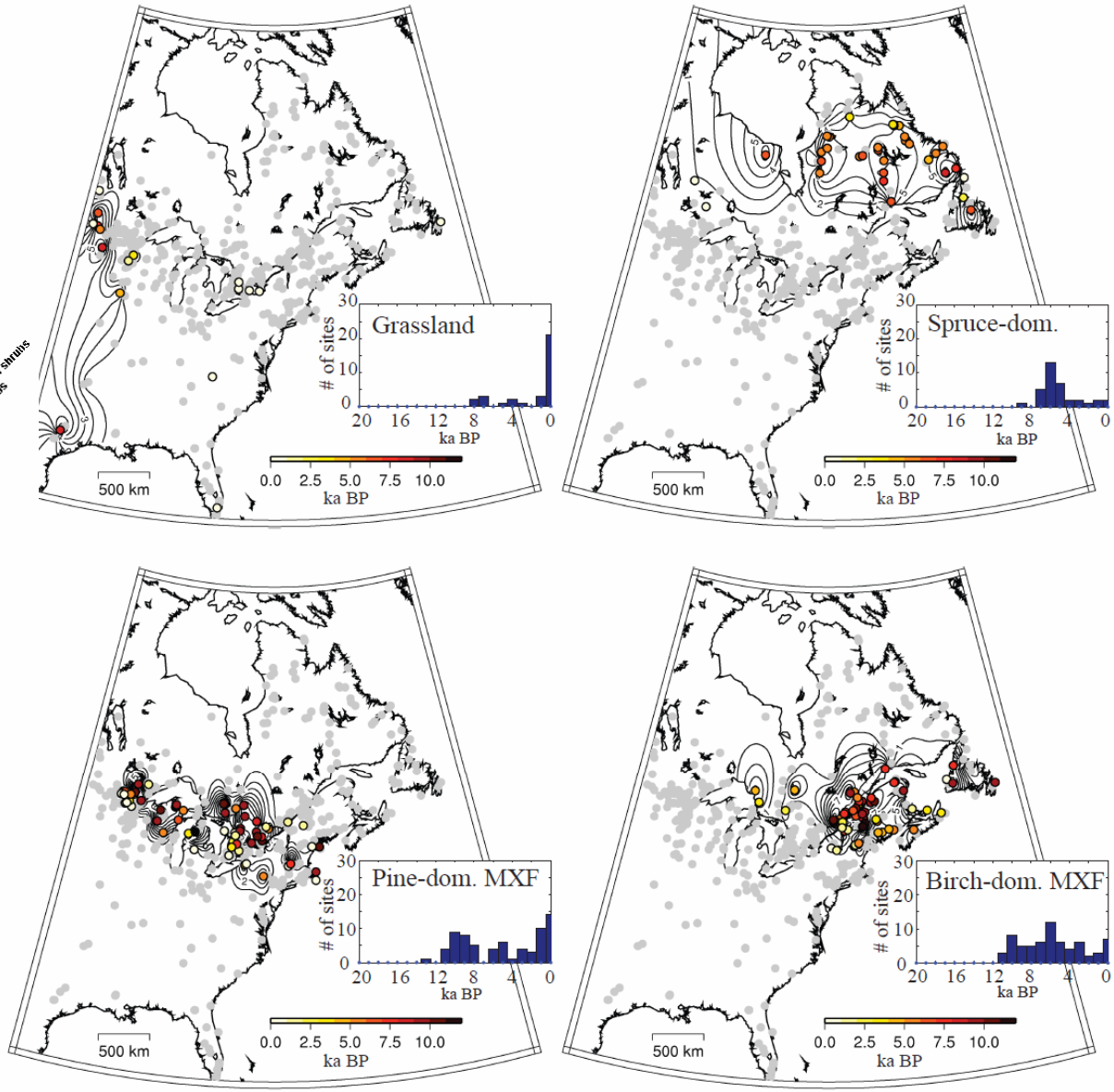
In the past, novel ecosystems have arisen.



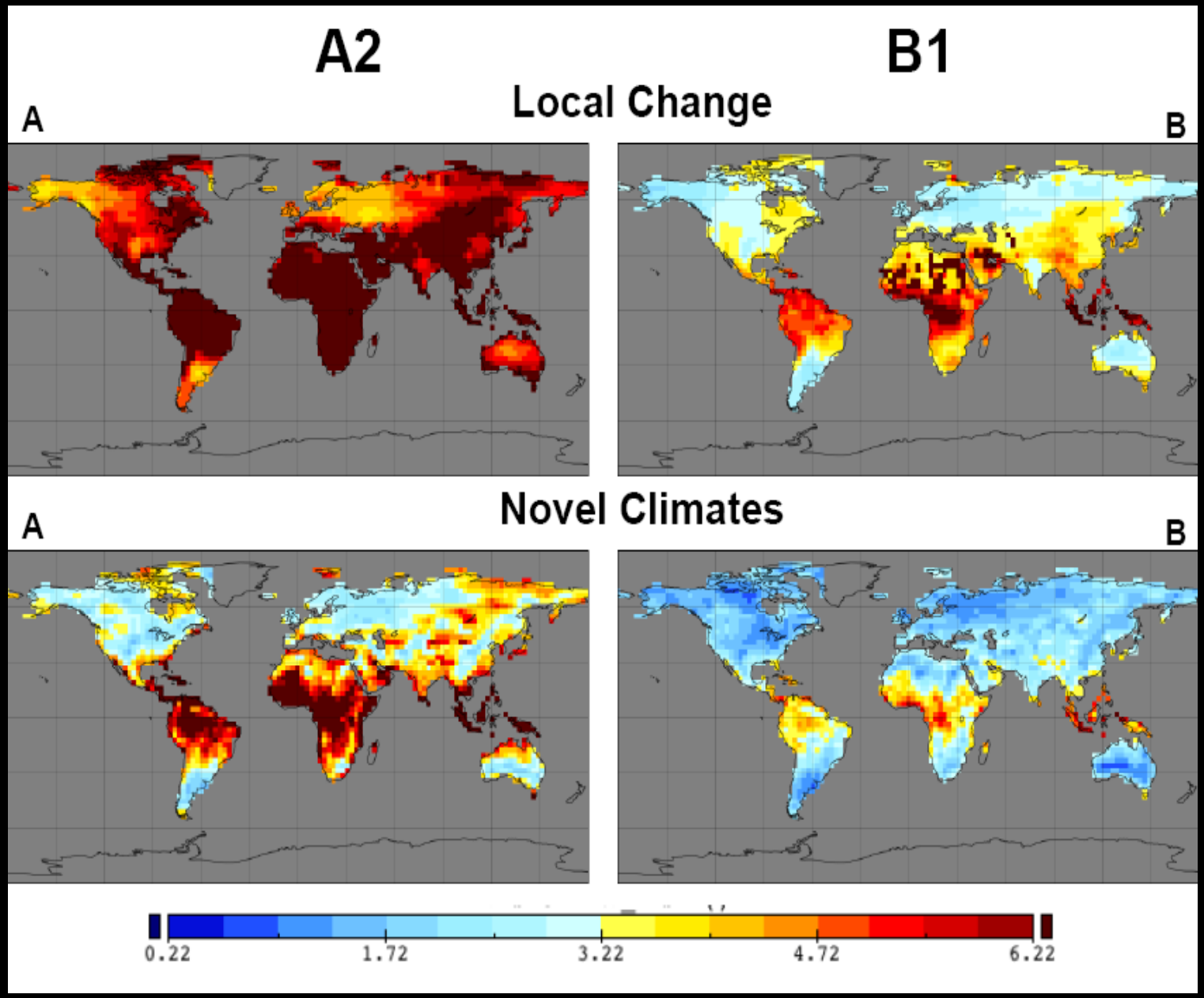


M.E. Lyford *et al.* 2002. *Quaternary Research.*





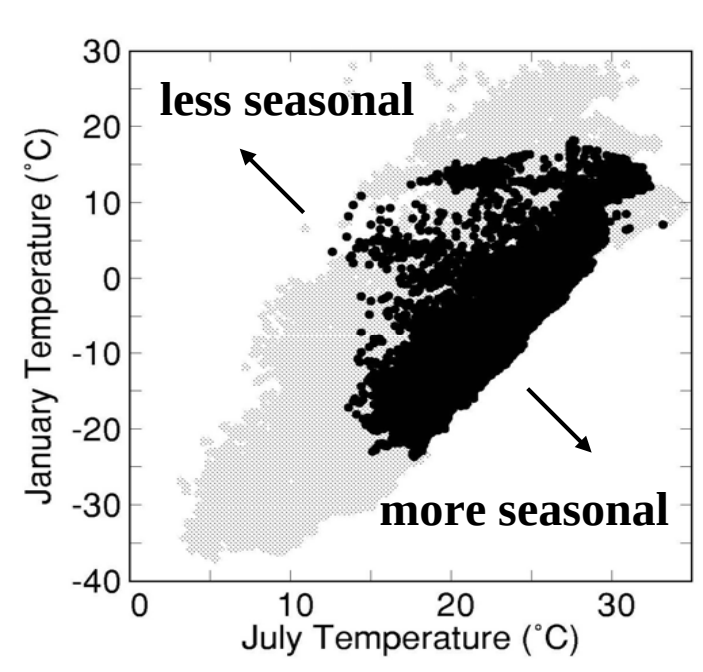
Y. Liu, S.T. Jackson, S. Brewer, J.W. Williams (in press)



J.W. Williams, S.T. Jackson & J.E. Kutzbach. 2007. *PNAS.*

What challenges are posed by development of novel environments?

- Uncertainties in prediction "outside the experiential box"



  - The environmental box itself
  - Species interactions
  - Interactions with:
    - Species invasions
    - Disturbances (fire, pest, pathogen, etc.)
    - Climate variability (and contingencies)
    - Human land-use and other activities

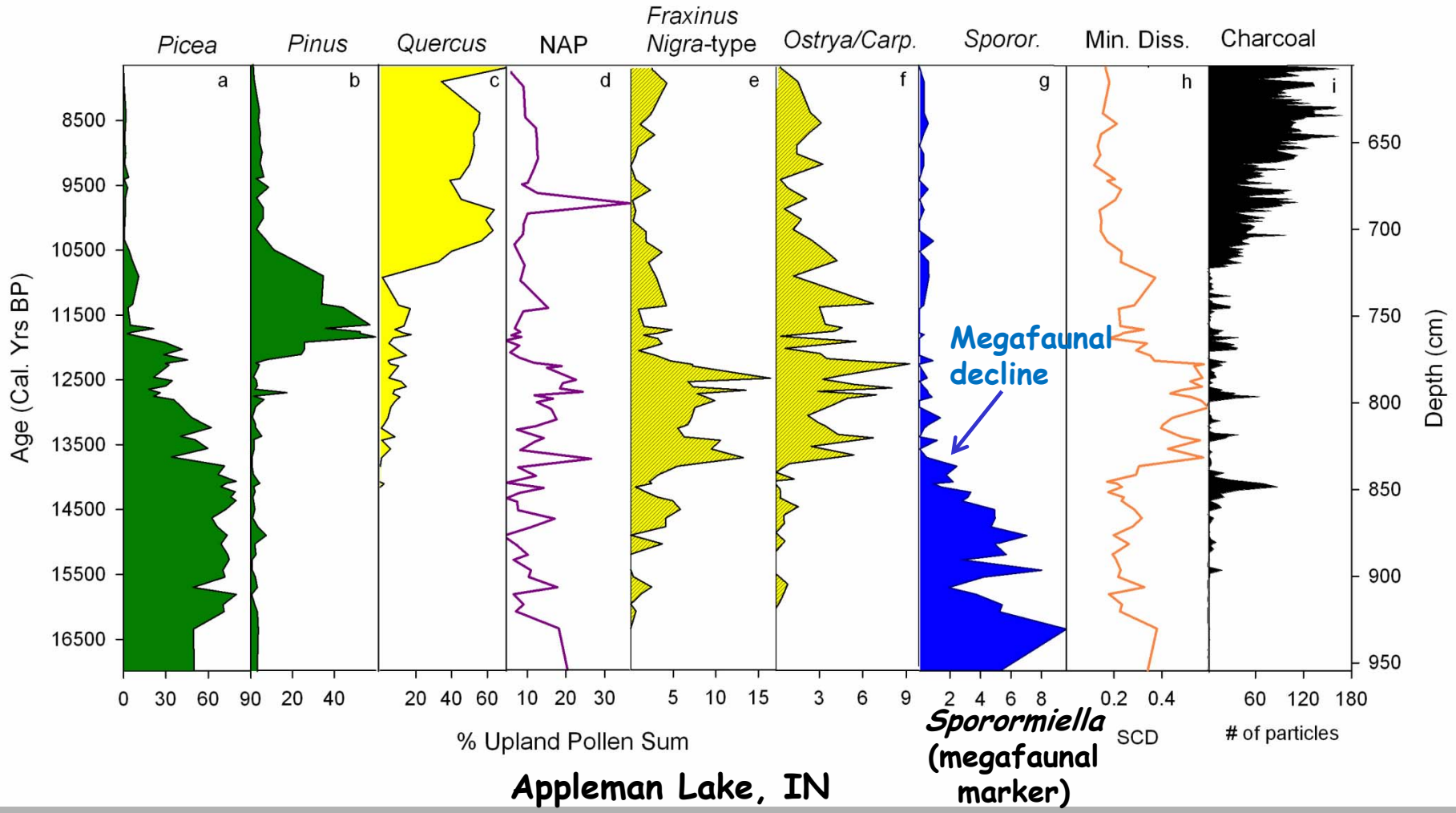
- Large potential for ecological and other "surprises"

Interactions and surprises

Climate change X
Drought episodes X
Disturbances X
Invasive species =
Ecological Surprises

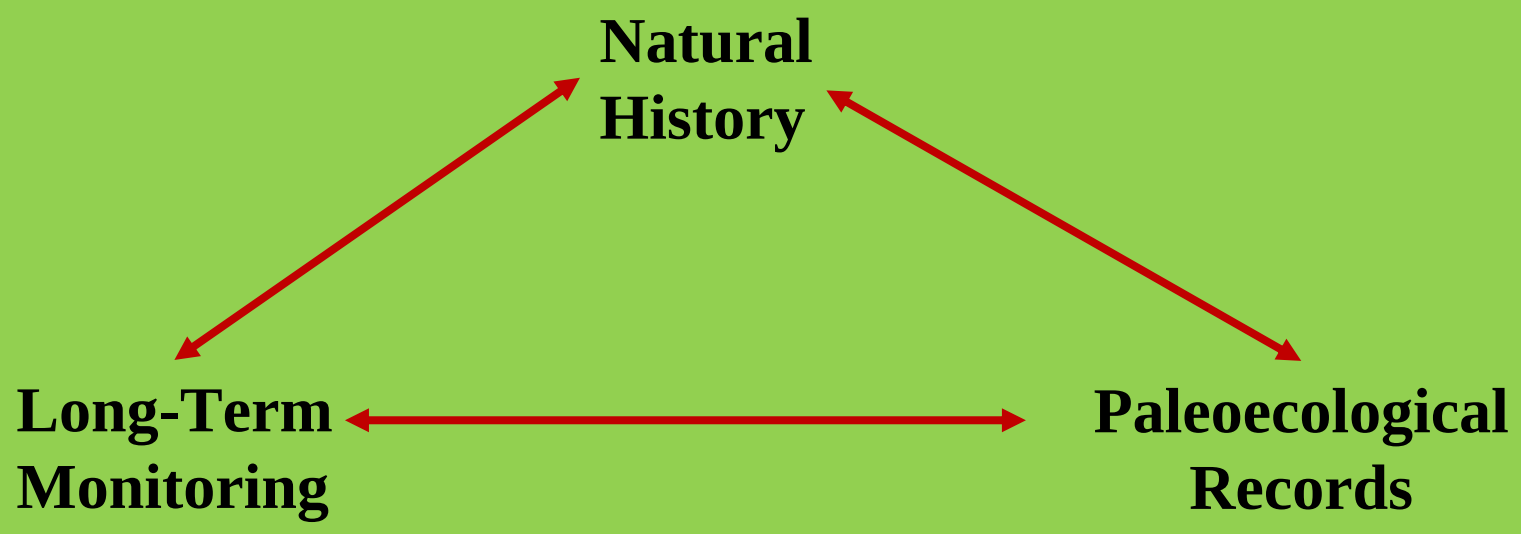
2008 *Bromus tectorum* in former *Juniperus osteosperma* woodland after 1999 wildfire (Goose Egg, Wyoming)

A Surprise from the Past: Trophic Interactions as a Mediator of Vegetation Response to Climate Change?

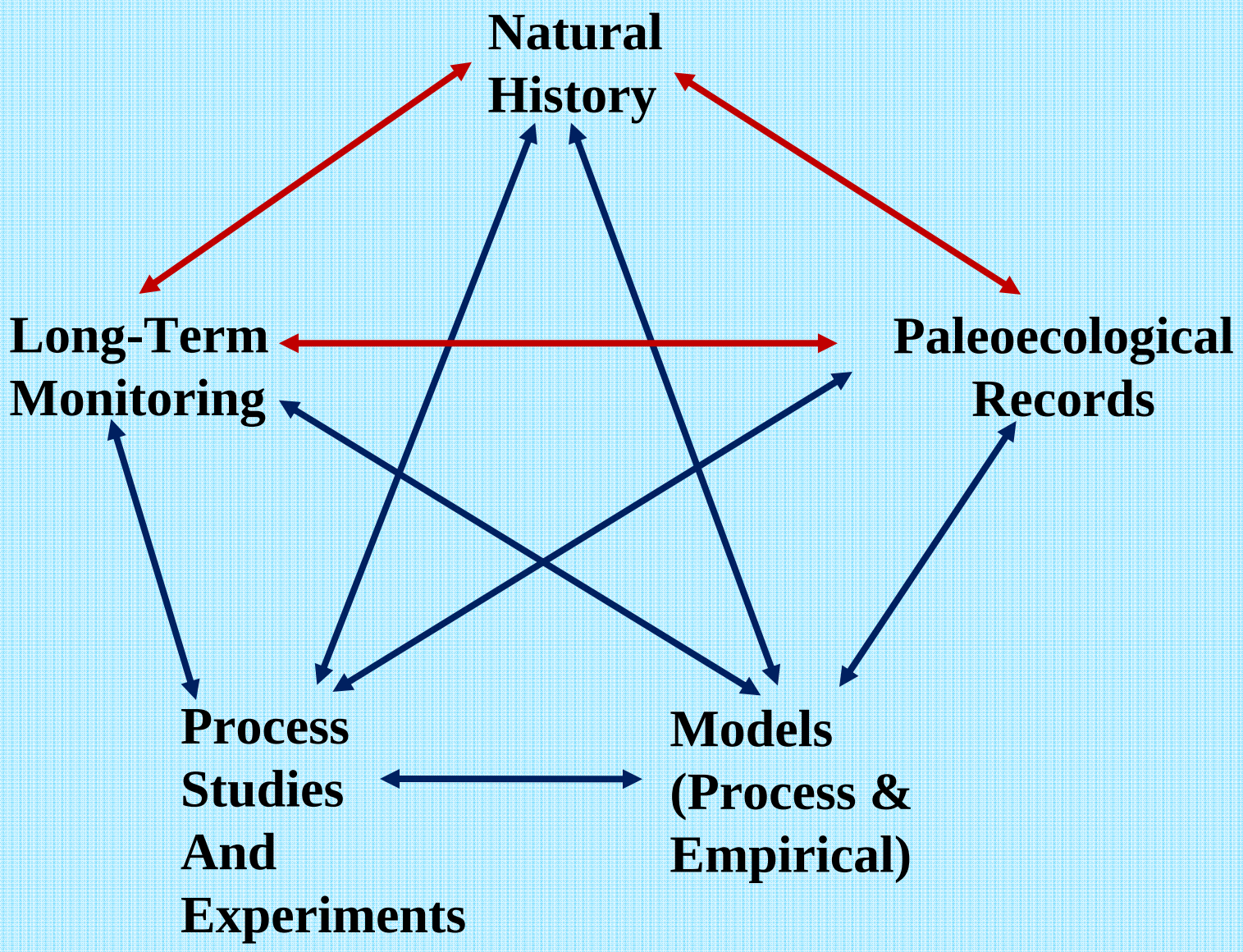


J.L. Gill *et al.* 2009. *Science.*

What can ecologists do to meet these challenges?



Observational Platform



Integrated Climate-Change Ecology