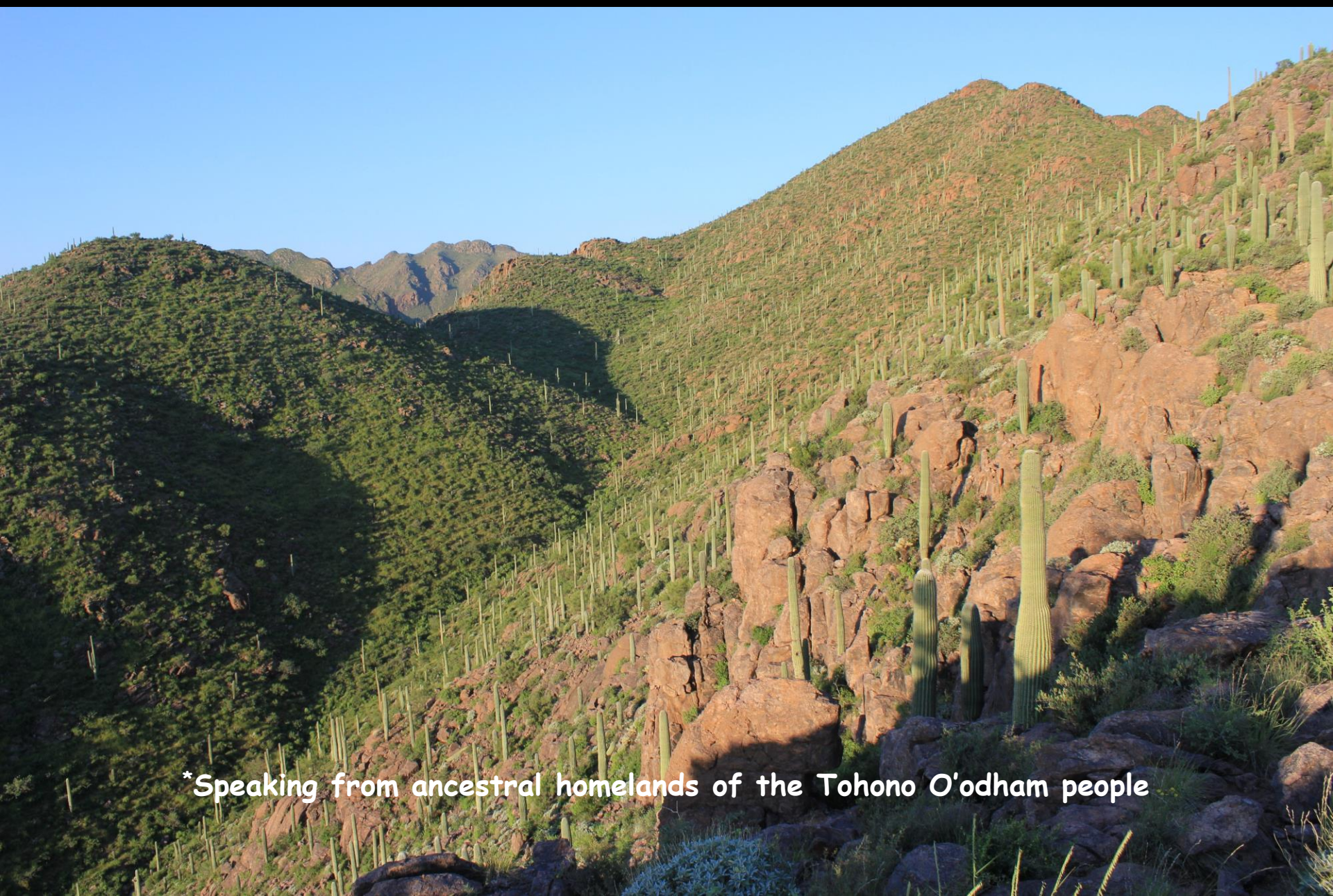


# If we direct change, to what ends do we direct it?

Steve Jackson\*, US Geological Survey and University of Arizona



\*Speaking from ancestral homelands of the Tohono O'odham people





Four tasks from the organizers:

1. Summarize a recent essay\*
2. Discuss processes of ecological transformation
3. Provide perspective from paleoecology
4. Expound on directed change

All in 20 minutes...

\*S.T. Jackson. 2021. Transformational ecology and climate change.  
Science 373:1085-1086.

<https://www.science.org/doi/10.1126/science.abj6777>

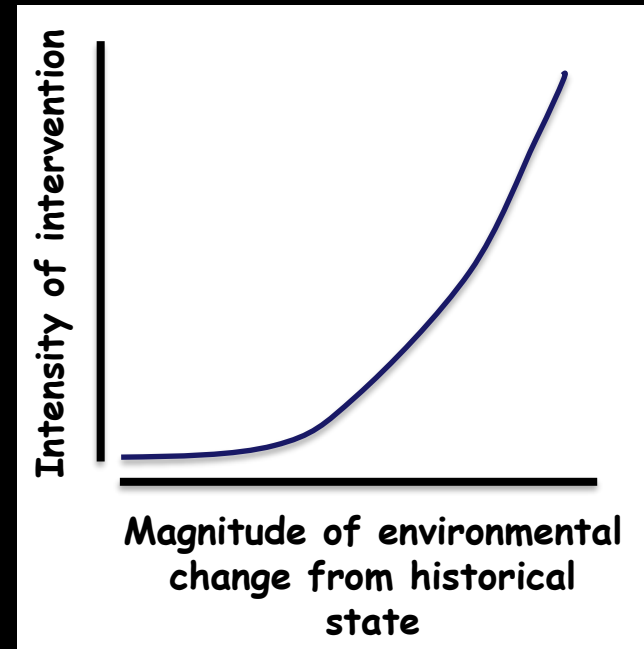
(or request a PDF from [stjackson@usgs.gov](mailto:stjackson@usgs.gov) )

## Resistance is easy because...

- It provides clear and discrete targets for management (e.g., historical states)
- It involves familiar species, communities, ecosystems

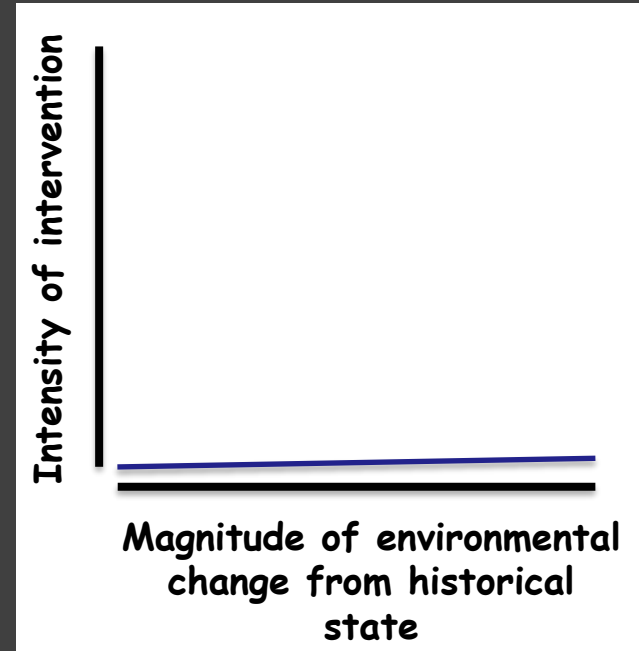
## Resistance is hard because...

- Success requires actions and interventions
- The more the environment changes, the more difficult it becomes
- Likelihood of eventual failure



## Acceptance is easy because...

- We don't have to do much
- We don't have to make hard decisions



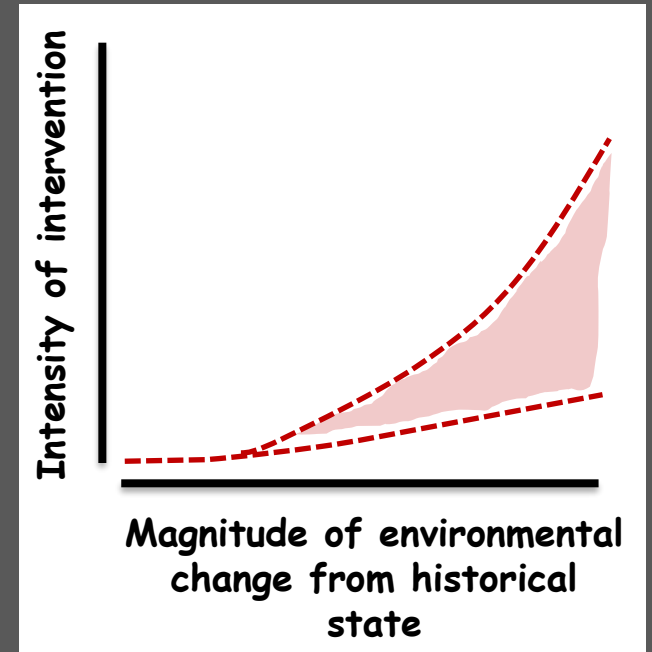
## Acceptance is hard because...

- We can't always be sure what we'll get
- What we get may not be what we like

# Direction is easy because...

- Ummh, well, uh,...

# Direction is hard because...



- It forces hard thinking about our objectives (and how to attain them)
- It deliberately deviates from historical states
- It takes us into unfamiliar ecological terrain
- It is full of uncertainties
- It may require adjudicating among conflicting values

# Barriers to RAD-based adaptation

## Resistance:

- Material resource limitations
- Ultimate failure (but maybe later...)

## Acceptance:

- Deviation from historical norms
- Uncertain management of novel systems



# Barriers to RAD-based adaptation

## Direction:

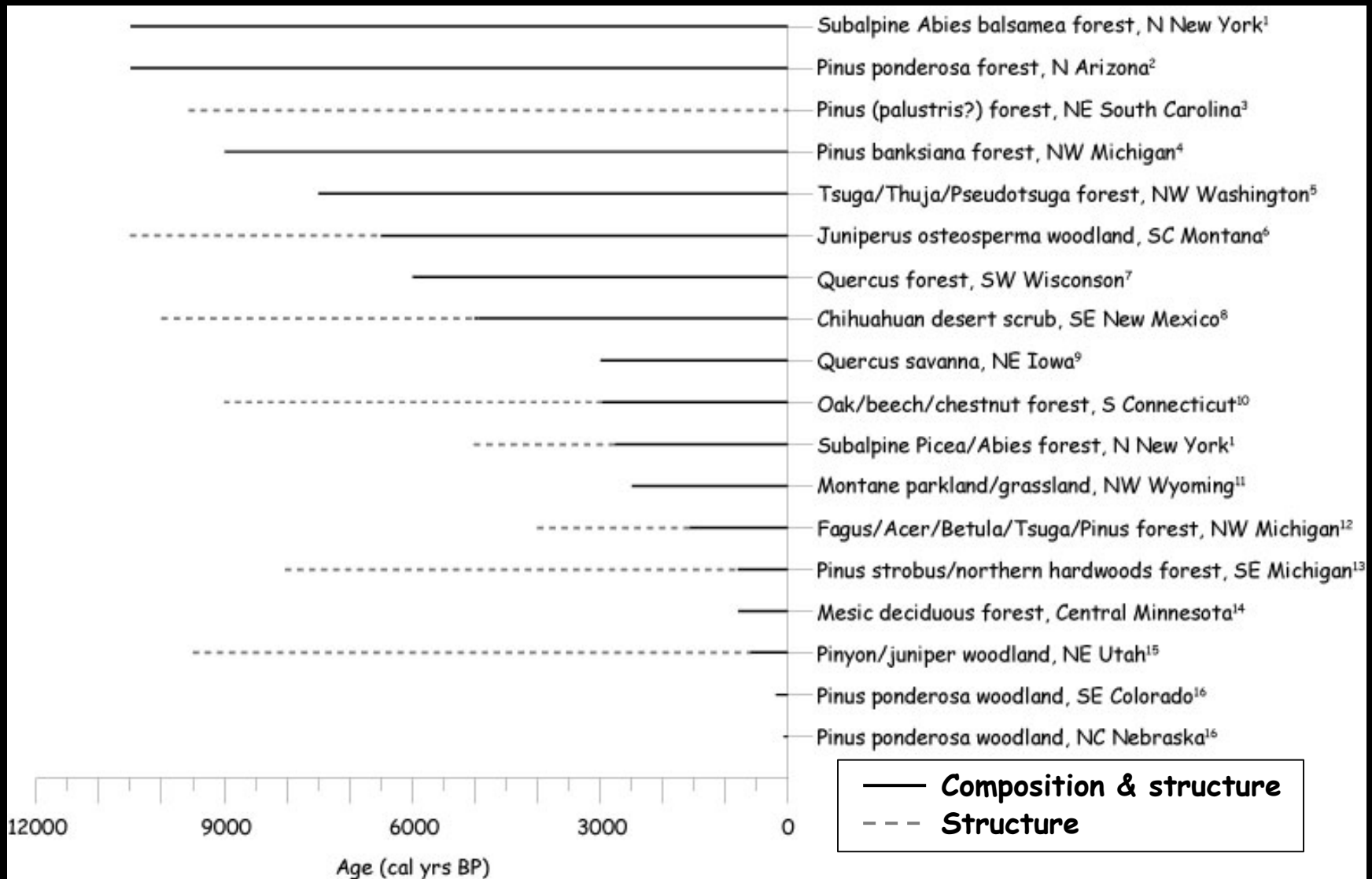
- Deviation from historical norms
- Uncertain management of novel systems
- Intentionality and accountability
- Choosing targets and pathways under uncertainty
  - Desirability
  - Attainability
  - Sustainability
- Endpoints? Or waypoints?
- Once we know where we want to go, do we know how to get there?







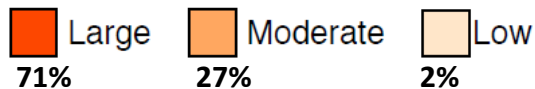
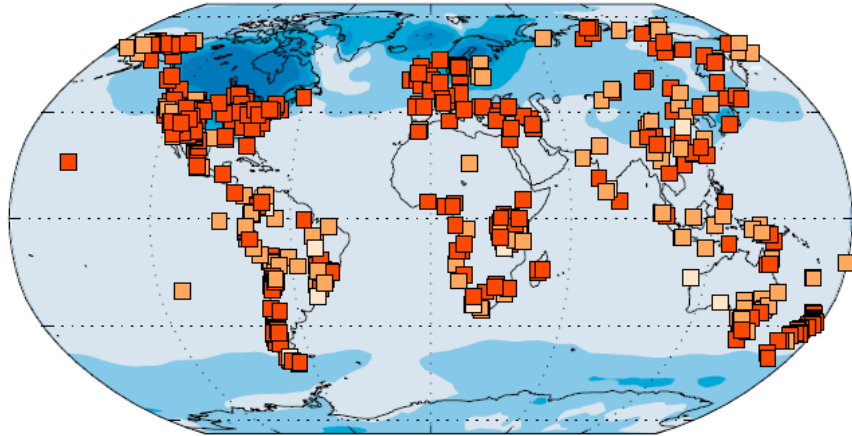
# Most ecosystems aren't very old



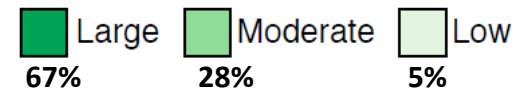
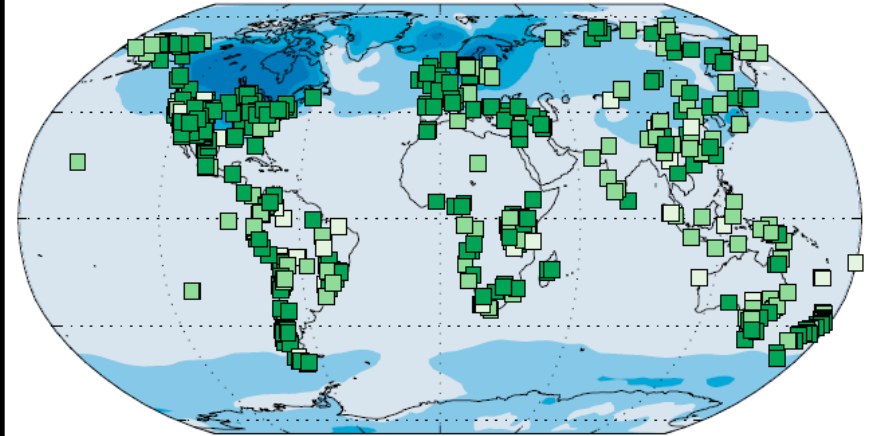
S.T Jackson. 2012. in J. Wiens *et al.* (eds.) *Historical Environmental Variation in Conservation and Natural Resource Management*.

# Few ecosystems have persisted since the last glacial maximum 20,000 yrs ago

## A. Composition



## B. Structure



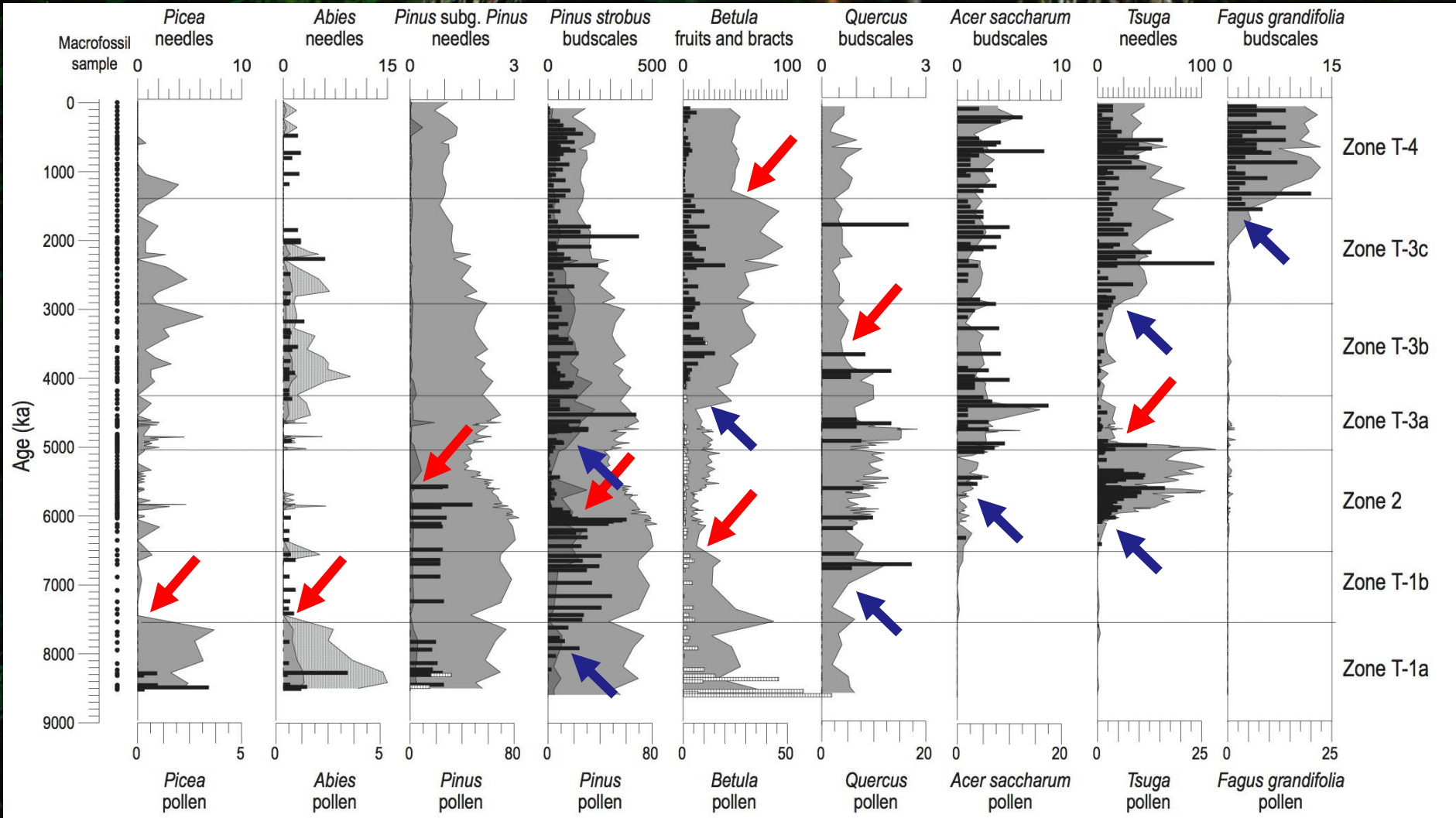
Estimated difference in vegetation between the last glacial maximum and the present (594 sites)

C. Nolan *et al.* 2018. Past and future global transformation of terrestrial ecosystems under climate change. *Science* 361:920-923.

# Locales across the globe have undergone repeated ecosystem transformations as climate has changed

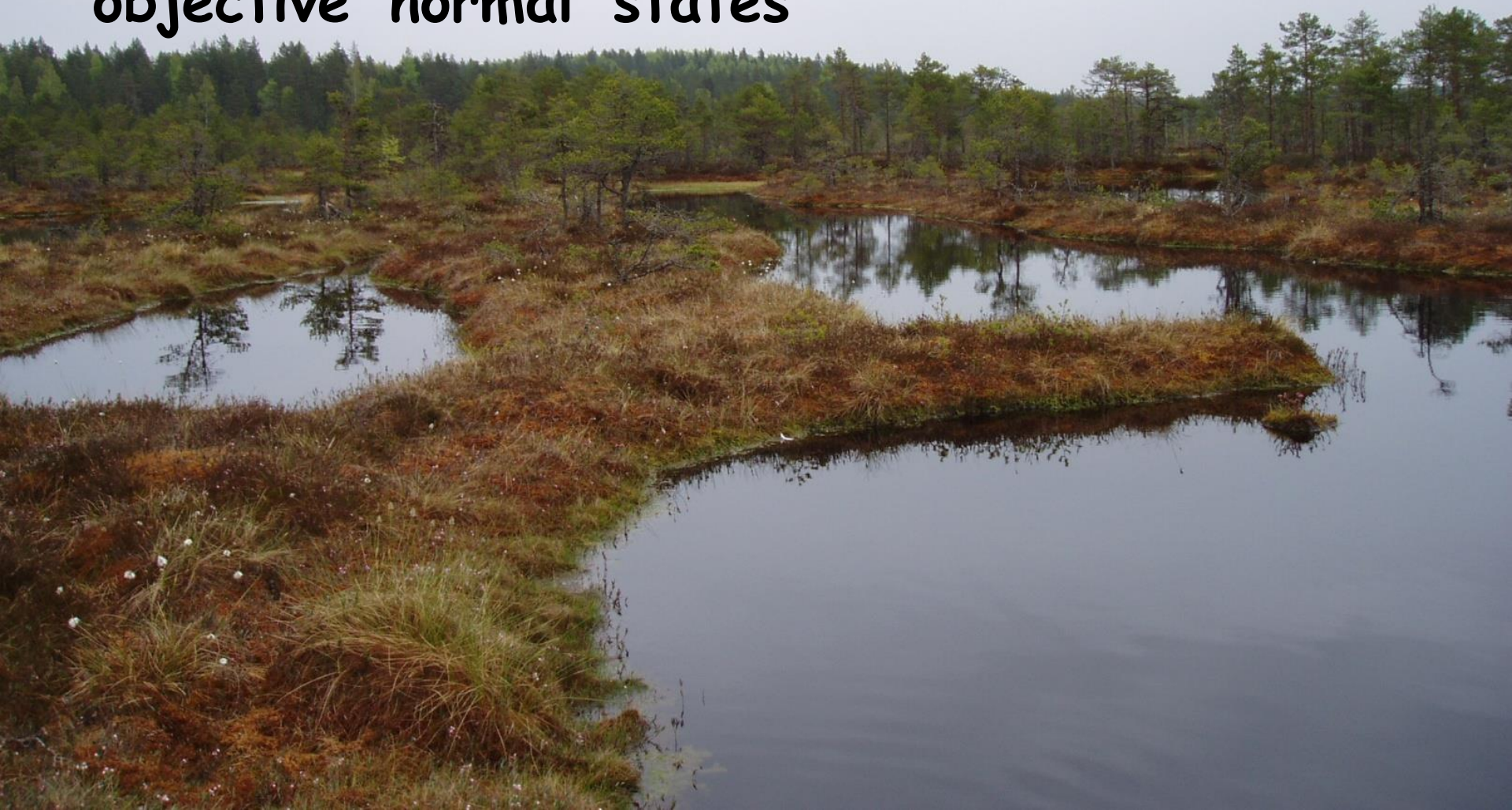
## Tower Lake, Upper Michigan

S.T. Jackson *et al.* 2014. *Quaternary Science Reviews*

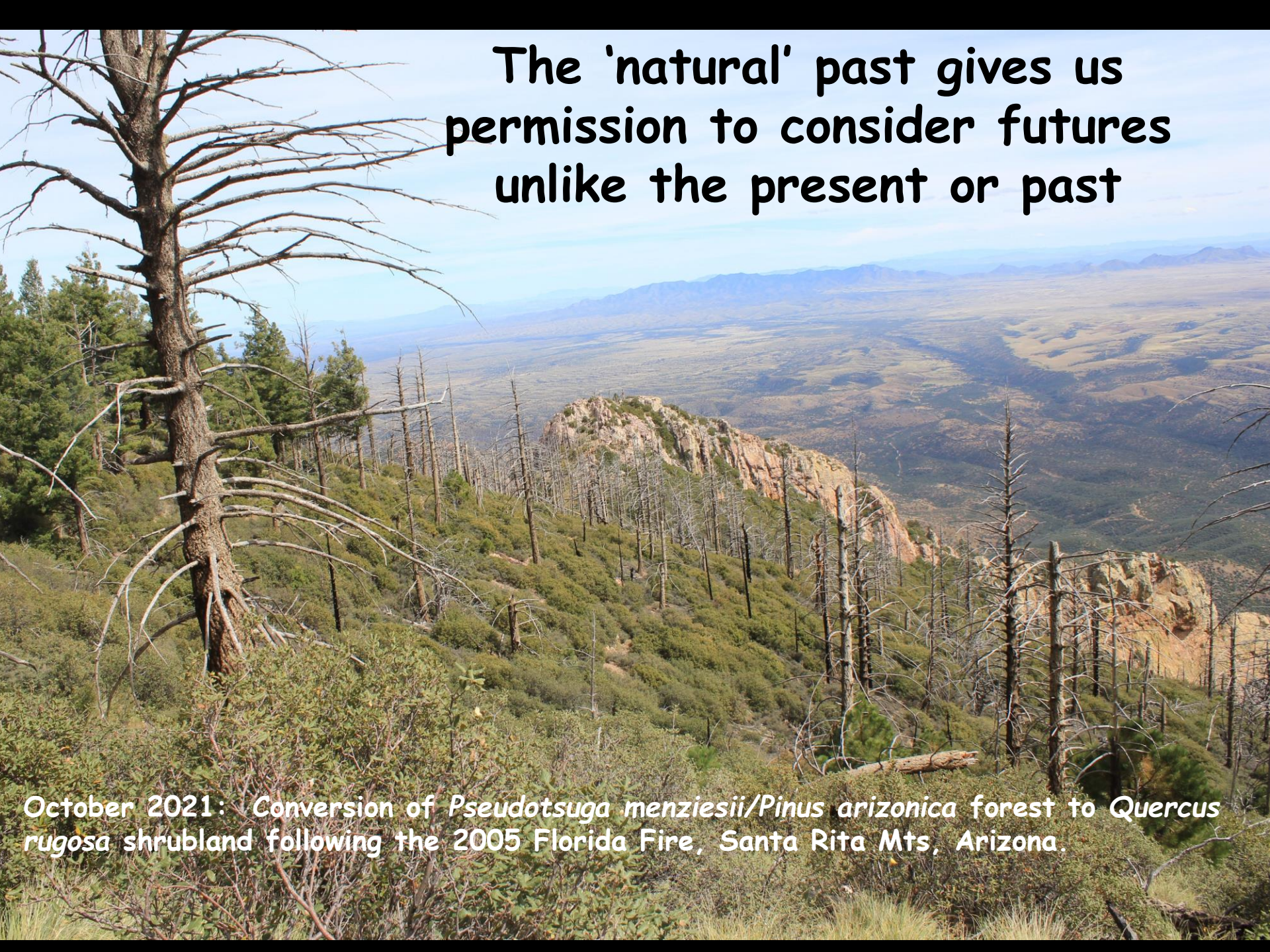




- Historical baselines are elusive in the long run
- Past ecosystem states were contingent on climate and events
- History isn't always reliable as a source of objective 'normal' states





A landscape photograph of the Santa Rita Mountains in Arizona. The foreground and middle ground show a hillside with a mix of living green shrubs and many dead, skeletal trees. A prominent, large, dead tree stands on the left. In the background, a valley stretches out, with a range of mountains visible under a clear blue sky. The text is overlaid in the upper right quadrant.

The 'natural' past gives us  
permission to consider futures  
unlike the present or past

October 2021: Conversion of *Pseudotsuga menziesii*/*Pinus arizonica* forest to *Quercus rugosa* shrubland following the 2005 Florida Fire, Santa Rita Mts, Arizona.



But wait! There's more...





# People have a long history of directing ecological change!

- Two centuries of scientific management
- Many millennia of indigenous management

## Learning opportunities!

- Outcomes and impacts
- Successes and failures
- Practices: what works in which situations

A step back: What's our long-term goal?

"Are we being good ancestors?"


Jonas Salk  
(1967, 1992)



# How do we become good ancestors?

- 'save all the parts' - minimize biodiversity loss
- Maximize decision space for the future (don't box in our successors)
- Learn, learn, learn
  - Advance relevant scientific understanding
  - Advance practical understanding
  - Adaptive learning involving researchers and practitioners
- Talk, talk, talk





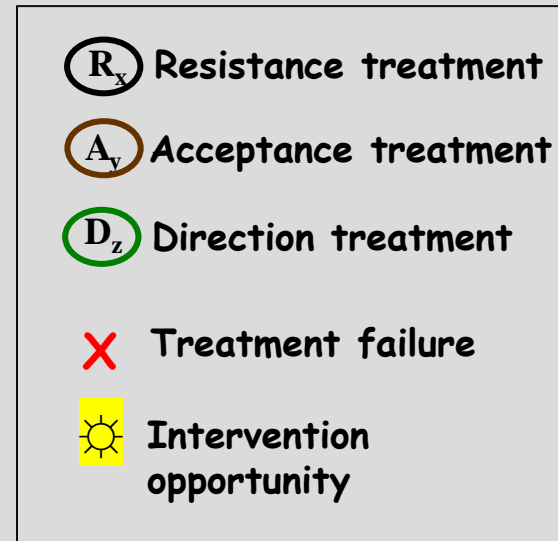
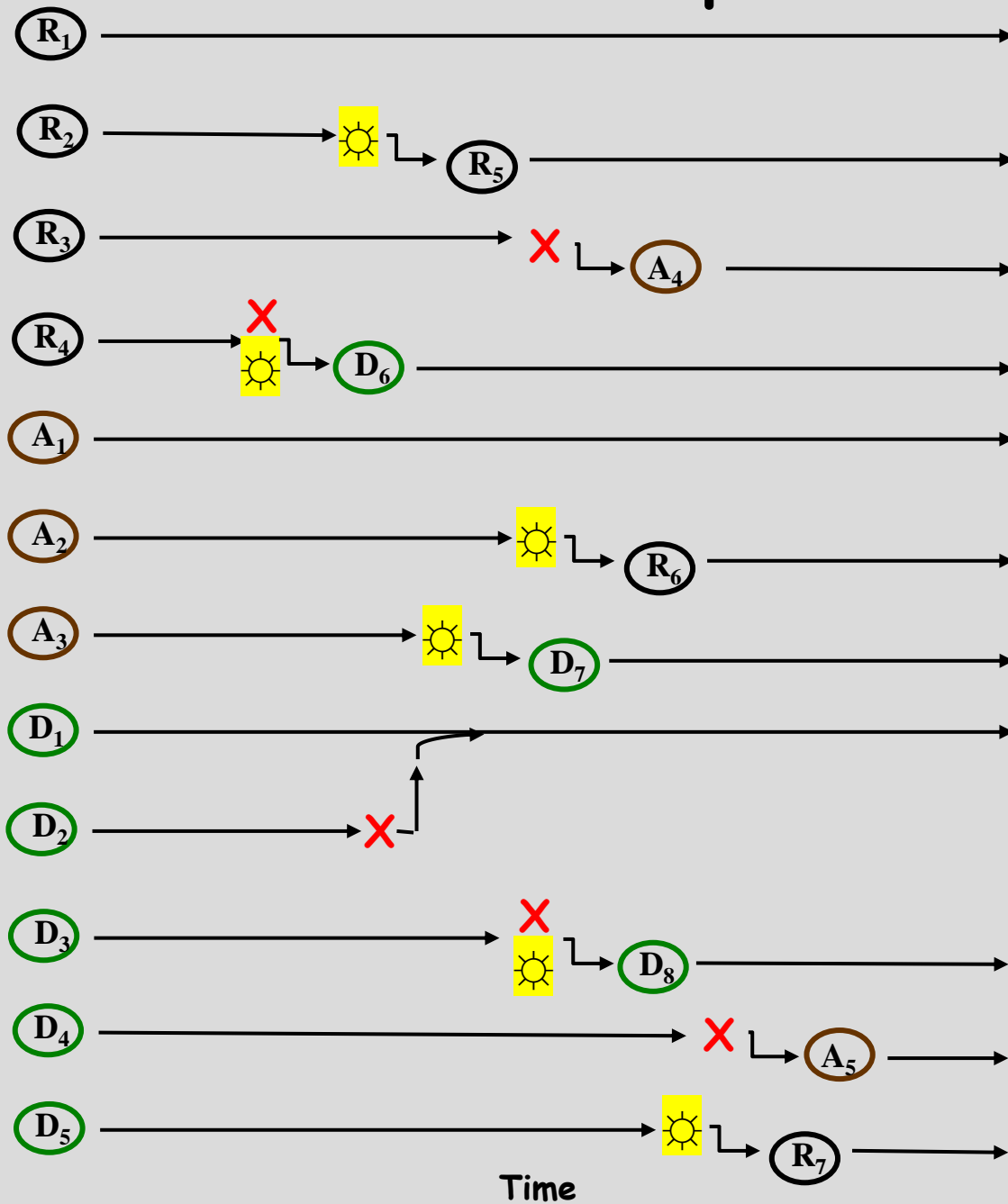
We don't, and won't,  
always know what's  
going to work and  
what's not

Uncertainty will  
remain deep and  
persistent

- Climate futures
- Climate variability
- Ecological outcomes

Success only in  
hindsight, and  
sometimes transient

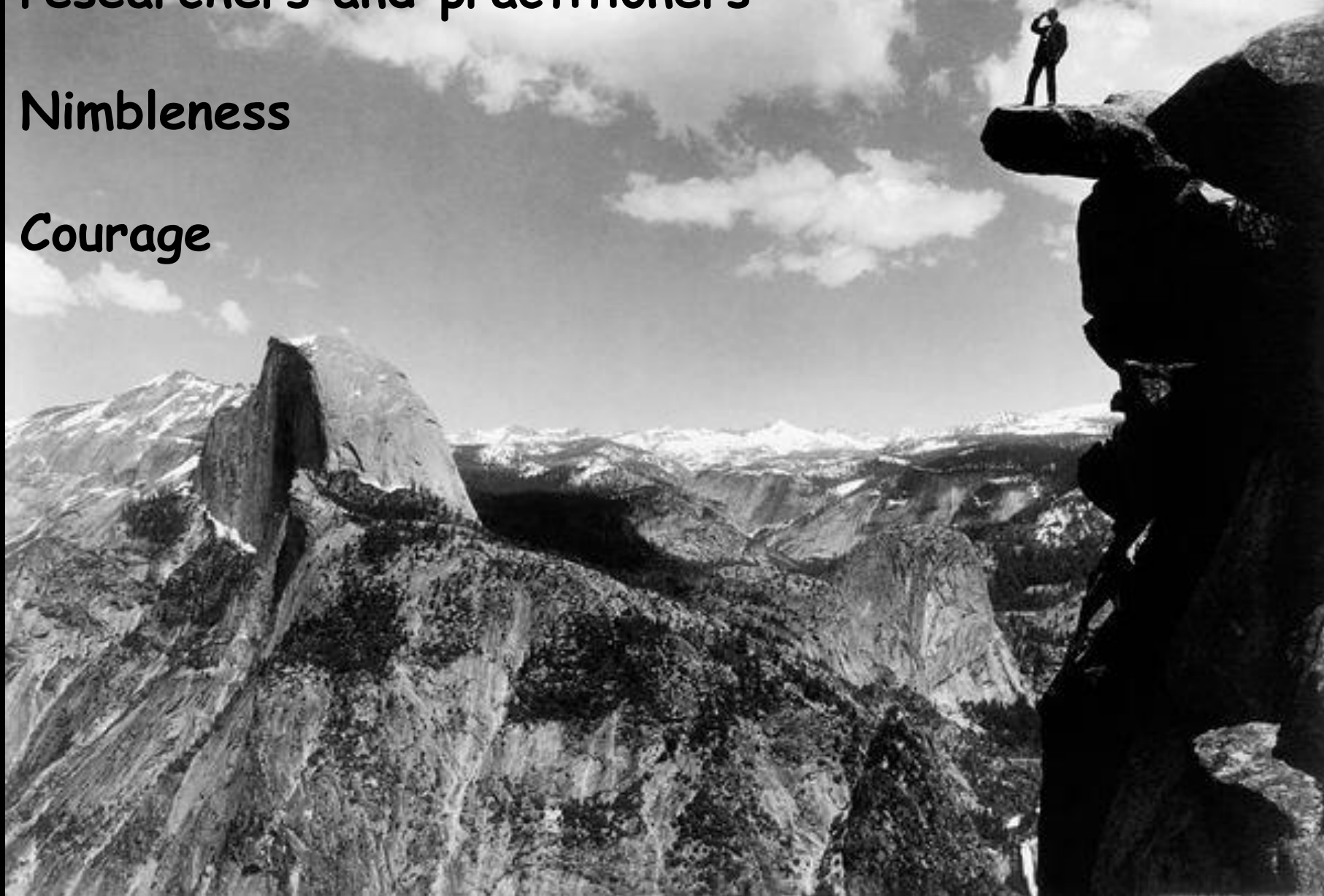
# Relentless experimentation



**Translational science: sustained dialogue between  
researchers and practitioners**

**Nimbleness**

**Courage**





**"He who predicts the future lies, even if he tells the truth."  
-Arabic proverb**



**Vincent van Gogh. *Wheat Field With Crows*. 1890**