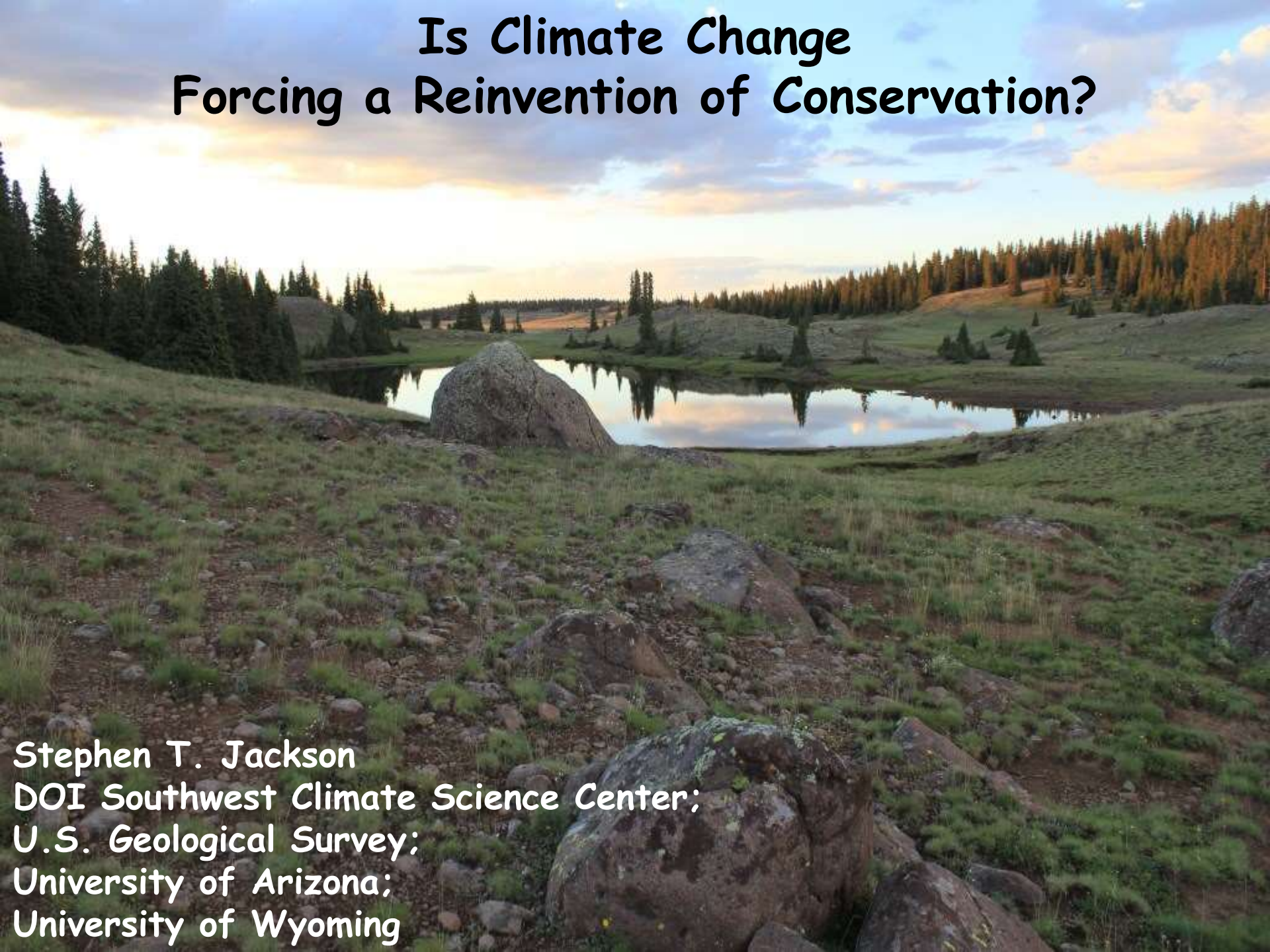
Is Climate Change Forcing a Reinvention of Conservation?



Stephen T. Jackson
DOI Southwest Climate Science Center;
U.S. Geological Survey;
University of Arizona;
University of Wyoming

Case study of a simple physical system: The Colorado River

- Highest vulnerability to warming-related discharge reduction in western North America
- Runoff low relative to precipitation (evaporative loss)

Temperature increase —> ET increase —> reduced runoff —> reduced discharge

How will global climate change affect the Colorado River?

Scientists to the rescue!

Mid-21st Century Flow Projections from GCMs

- At least 12 major studies as of 2014 (more since…)
- Divergent results:

  -6% (-40% to +18%)

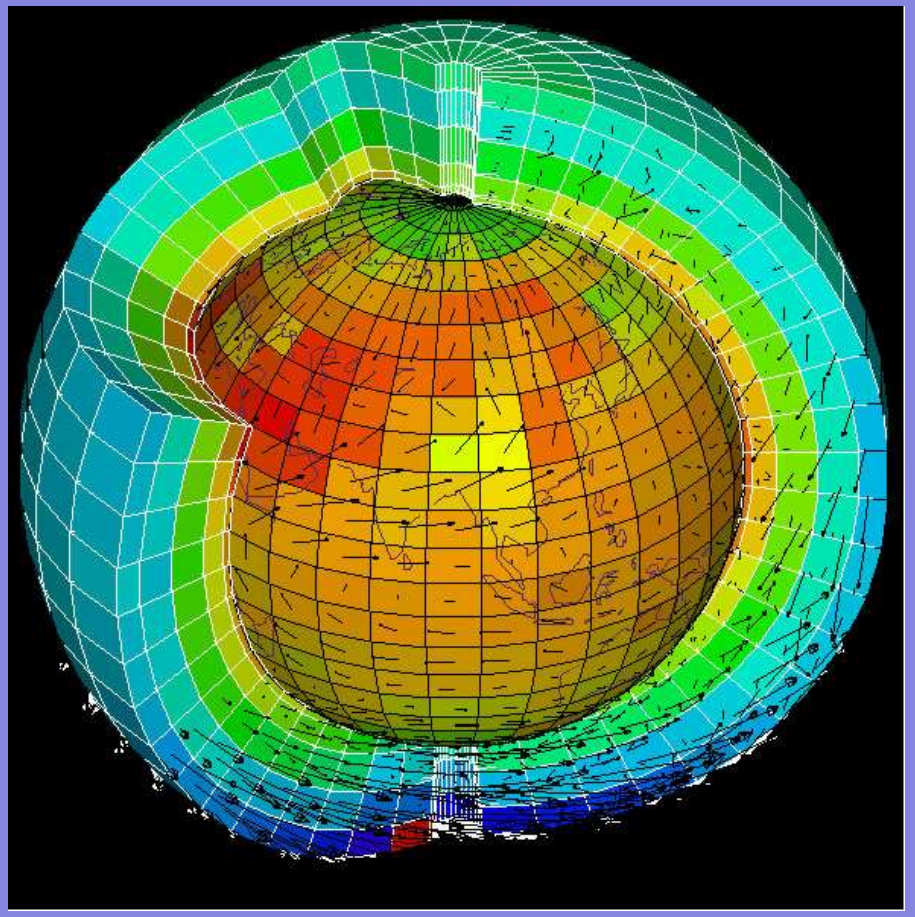
  -10% to -20%

  -16 % (-8% to -25%)

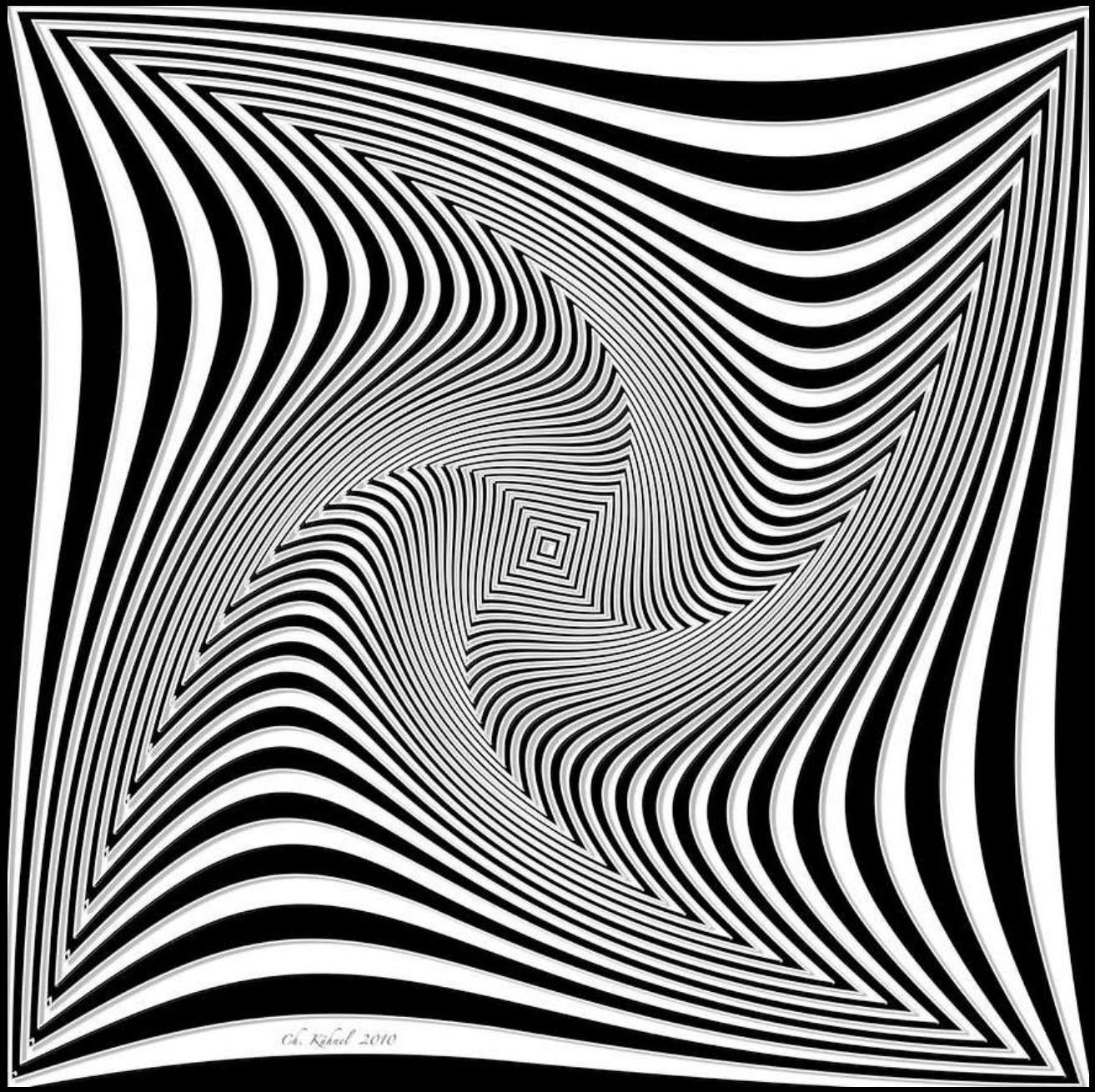
  -17%

  -18%

  -45%



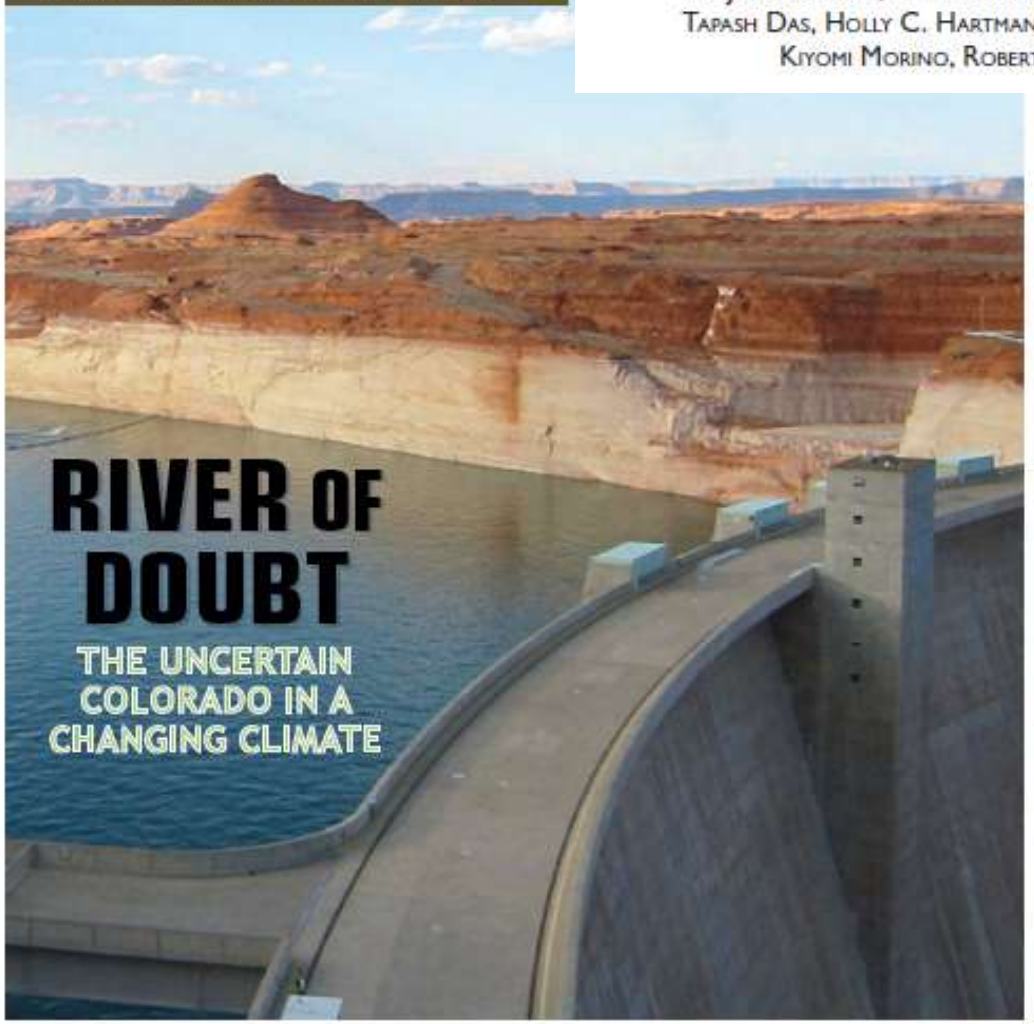
Stakeholder Confusion

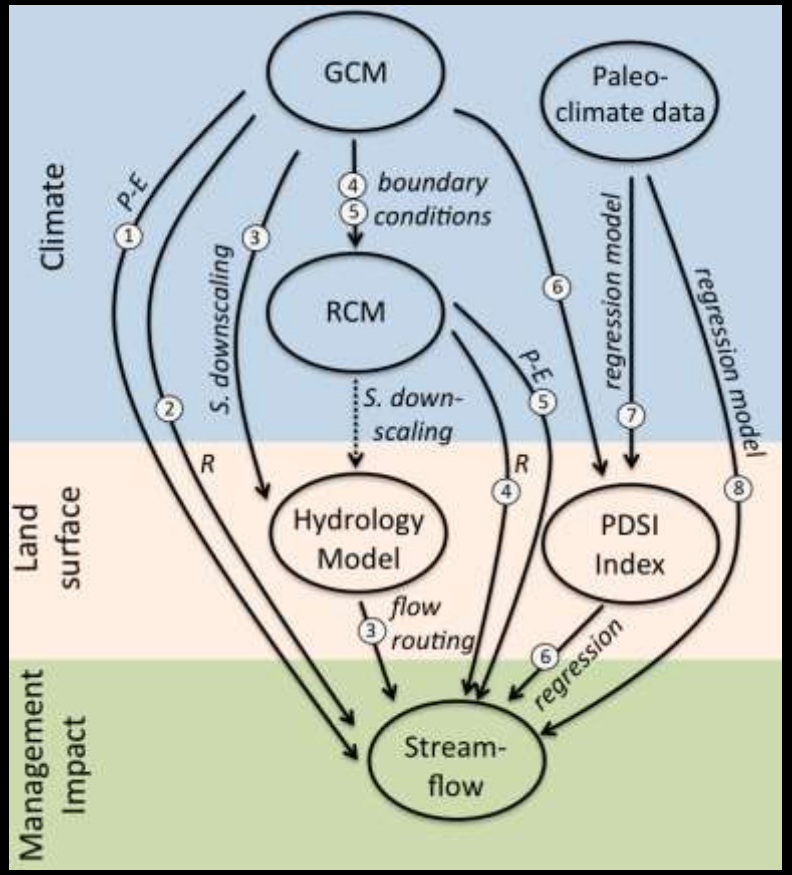


Volume 95 Number 1 January 2014
BAMS
Bulletin of the American Meteorological Society

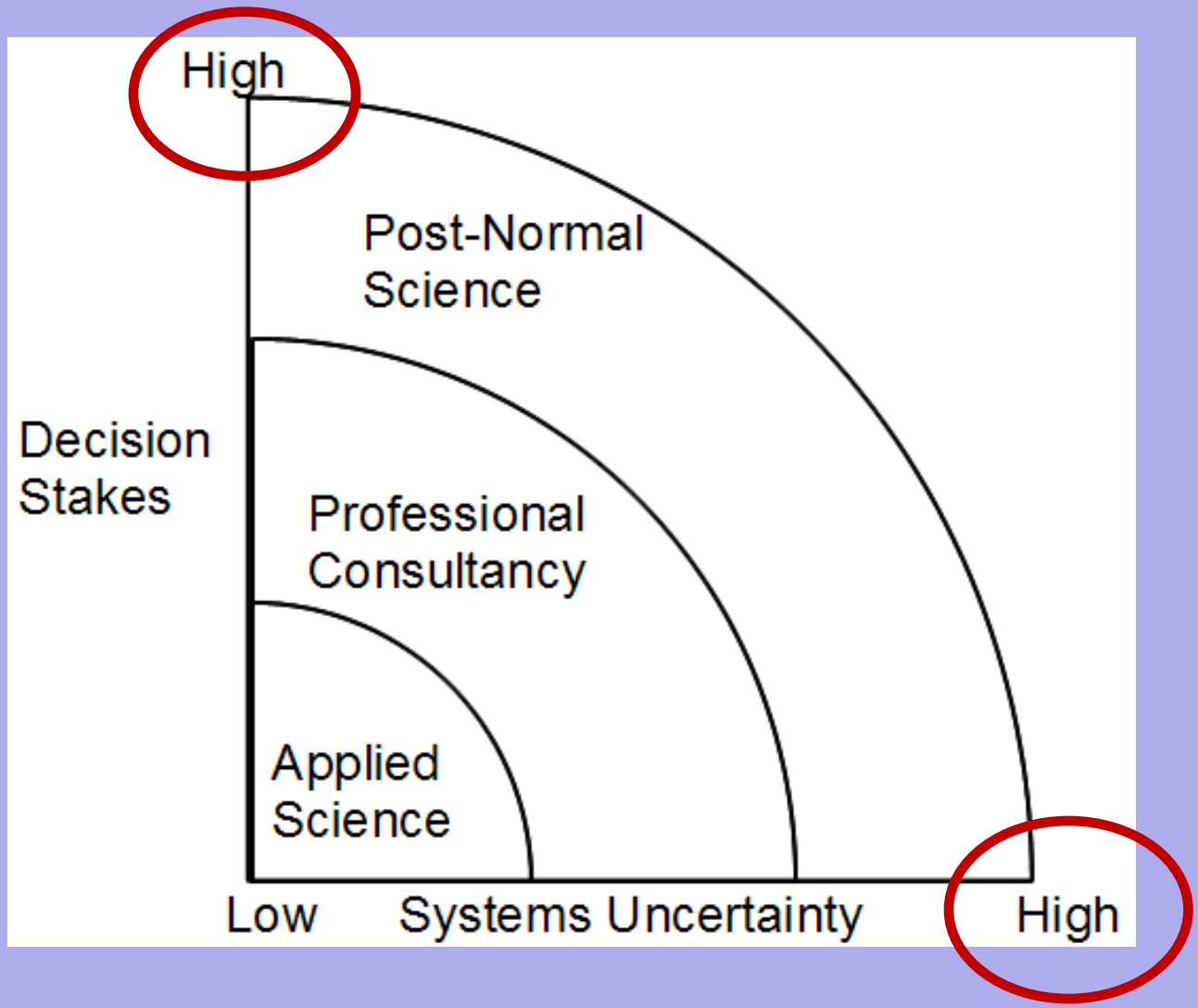
UNDERSTANDING UNCERTAINTIES IN FUTURE COLORADO RIVER STREAMFLOW

BY JULIE A. VANO, BRADLEY UDALL, DANIEL R. CAYAN, JONATHAN T. OVERPECK, LEVI D. BREKKE, TAPASH DAS, HOLLY C. HARTMANN, HUGO G. HIDALGO, MARTIN HOERLING, GREGORY J. MCCABE, KIYOMI MORINO, ROBERT S. WEBB, KEVIN WERNER, AND DENNIS P. LETTENMAIER





Post-normal science

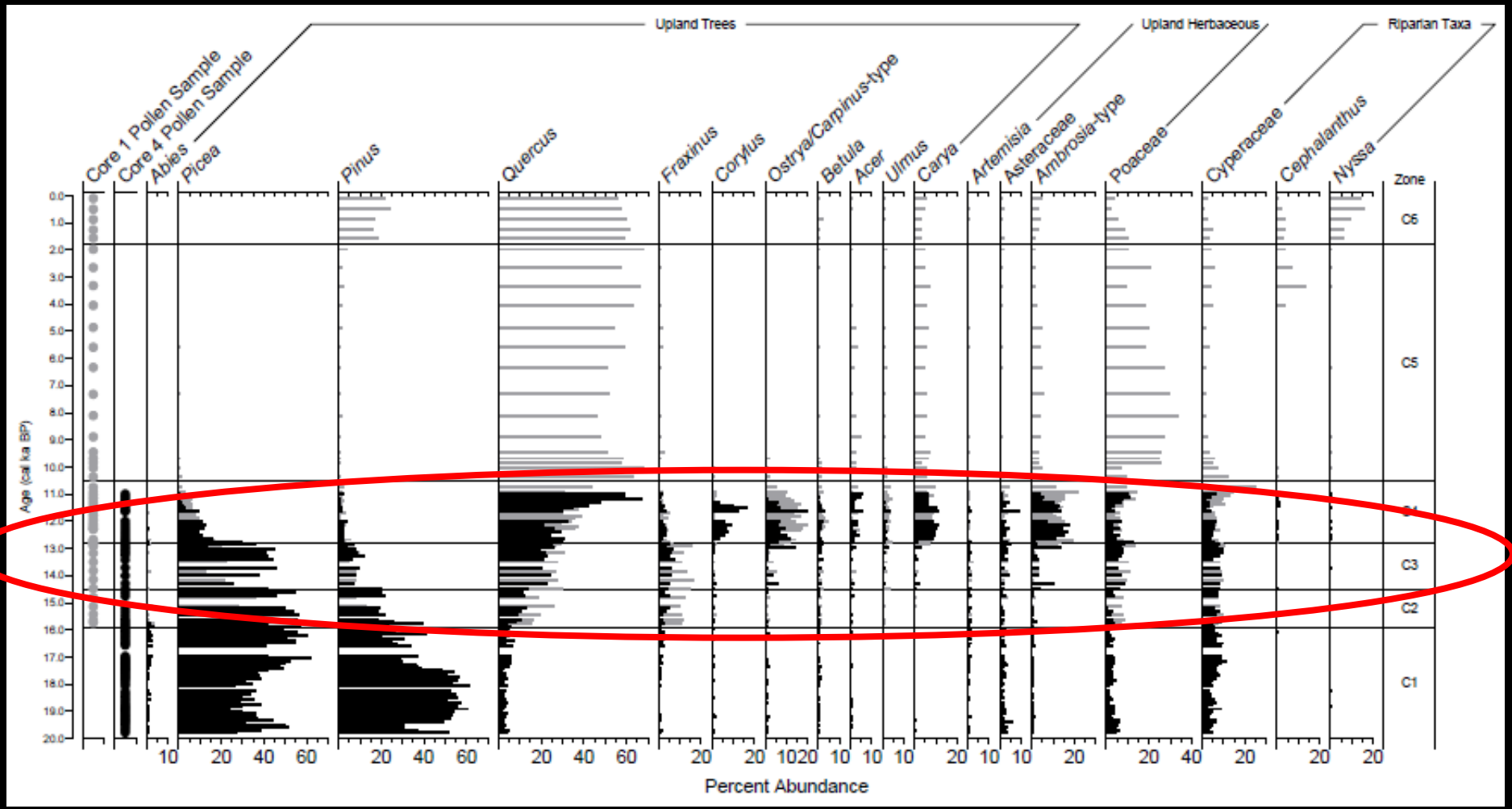


S. Funtowicz & J. Ravetz. 1993. Science for the post-normal age. *Futures* 25:739-755.

Post-Normal Conservation: Ecosystems under change

Novel communities on late-glacial landscapes in the central USA

Cupola Pond, Ozark Mts., Missouri

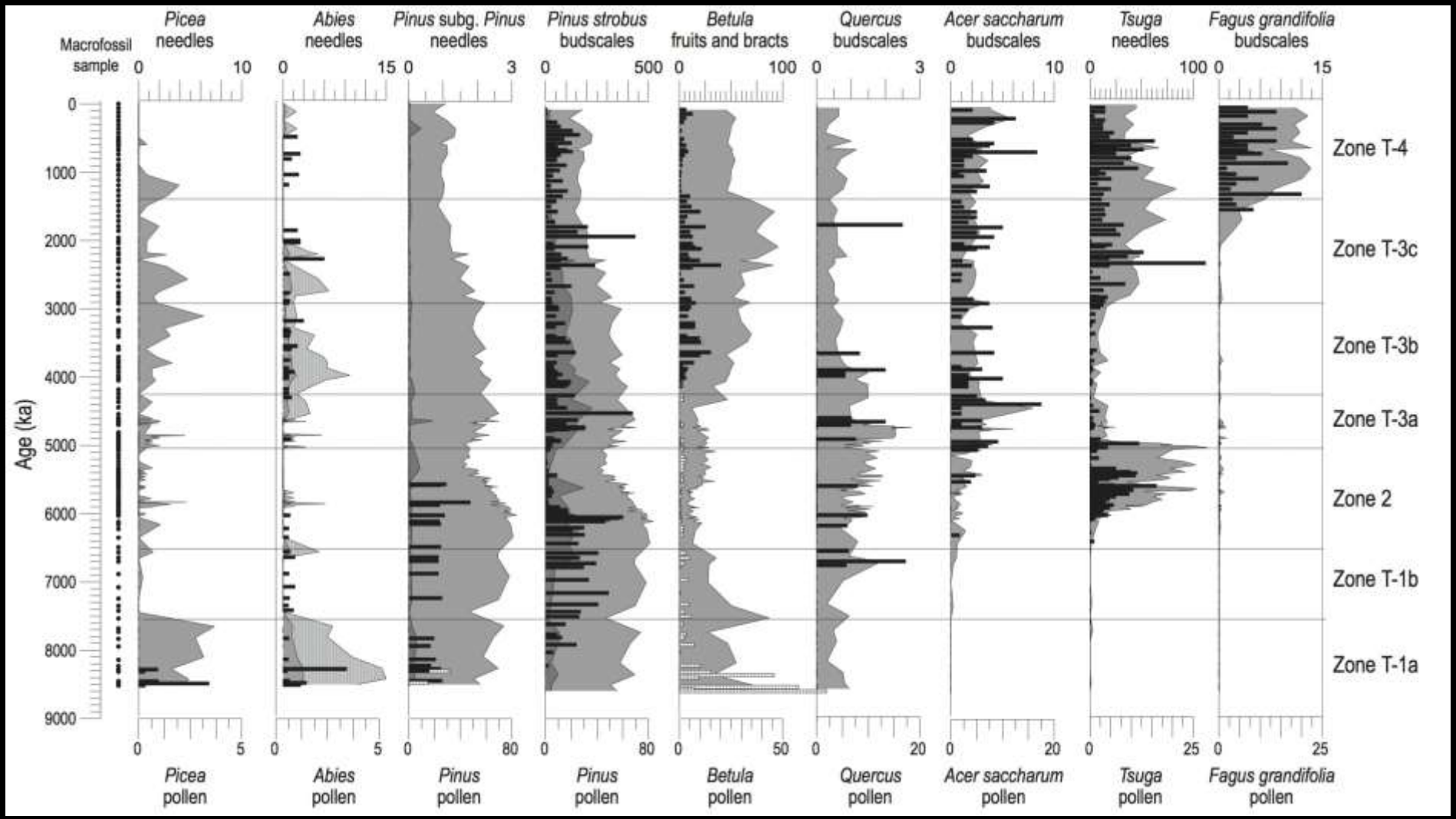


R.A.Jones, J.W. Williams, S.T. Jackson (*Quaternary Science Reviews*, accepted)

Looking forward from the past, nearly everything is novel

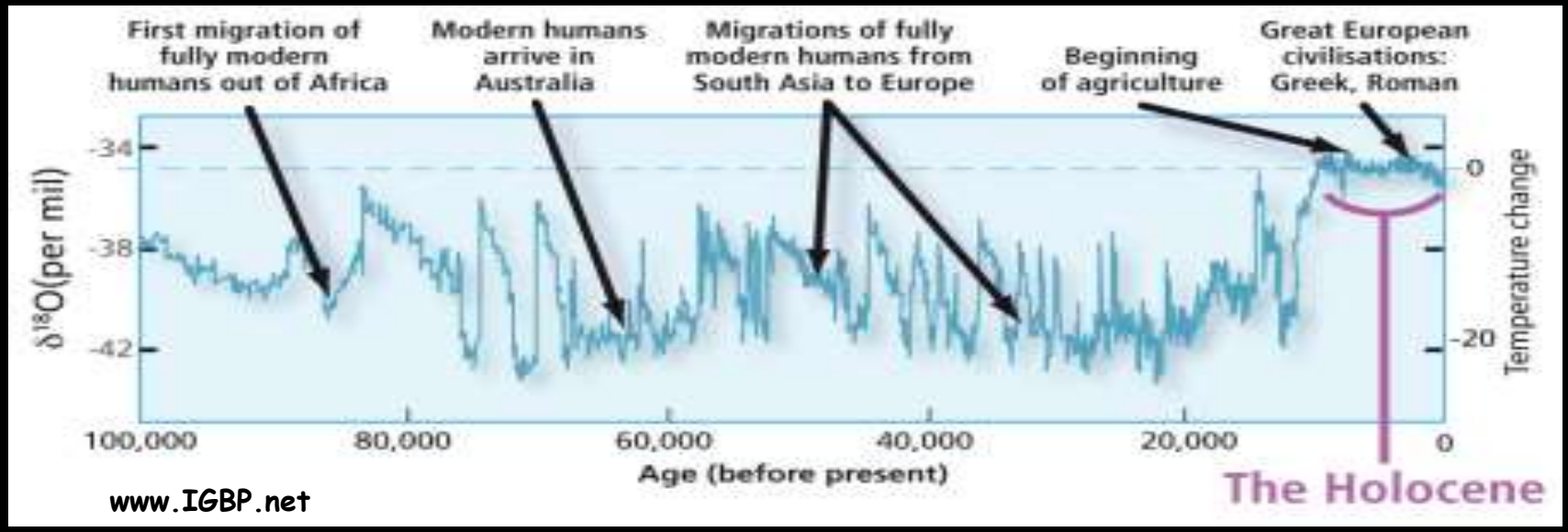
Environmental and Ecological Turnover: Hemlock/beech/sugar maple/yellow birch forest

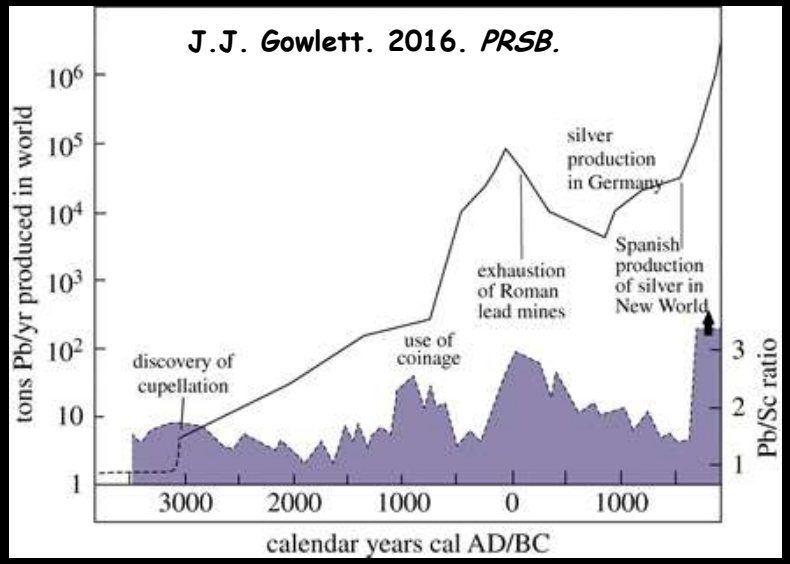
Tower Lake, Upper Michigan

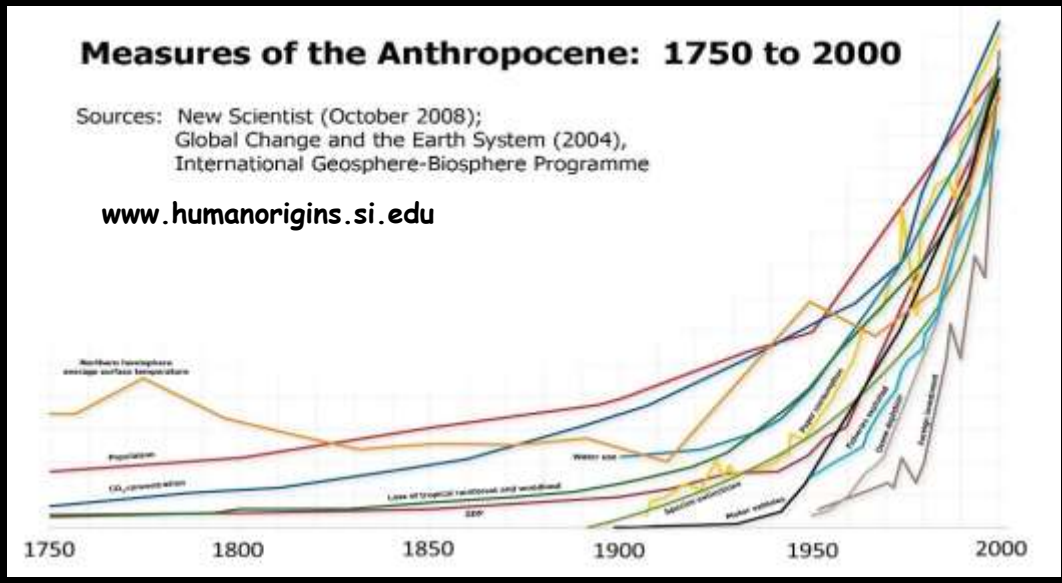


S.T. Jackson, R.K. Booth, .J. Andersen, K. Reeves, T.A. Minckley & R.A. Jones. 2014. *Quaternary Science Reviews* (see discussion in S.T. Jackson & J.L. Blois. 2015. *PNAS).*

Human influences…



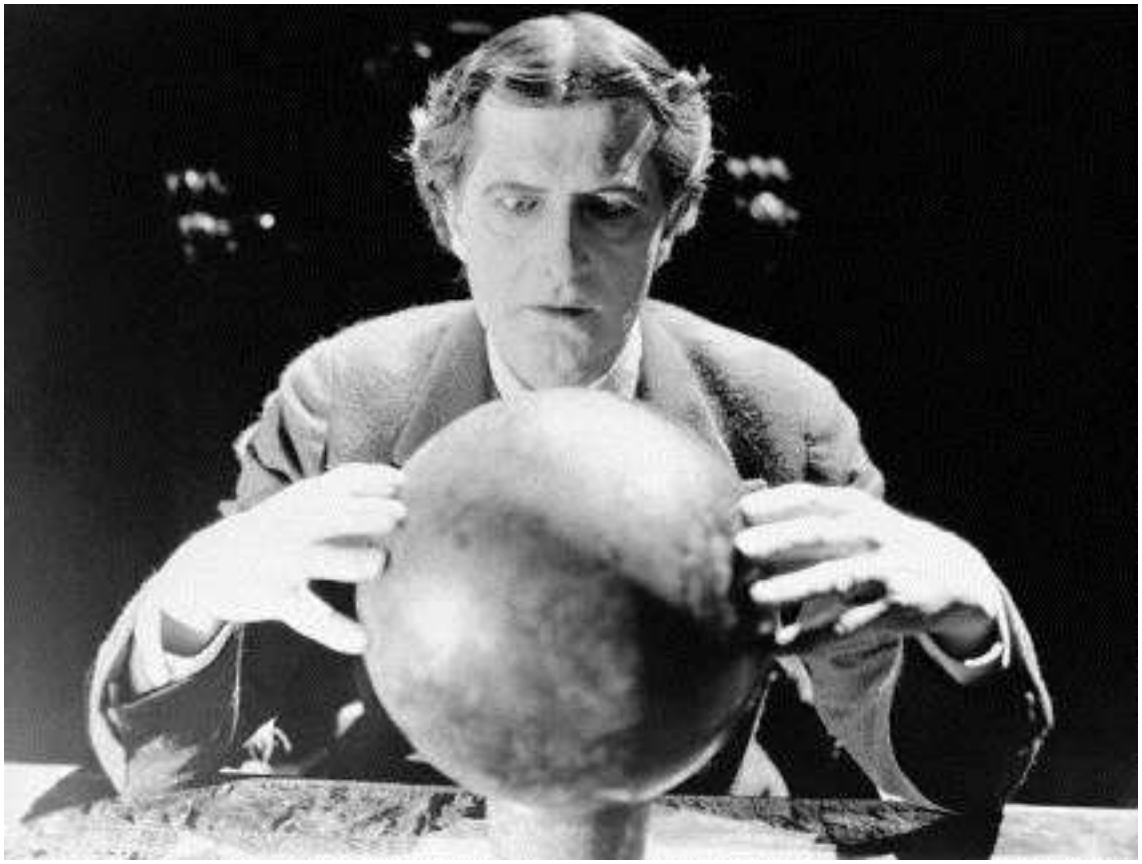




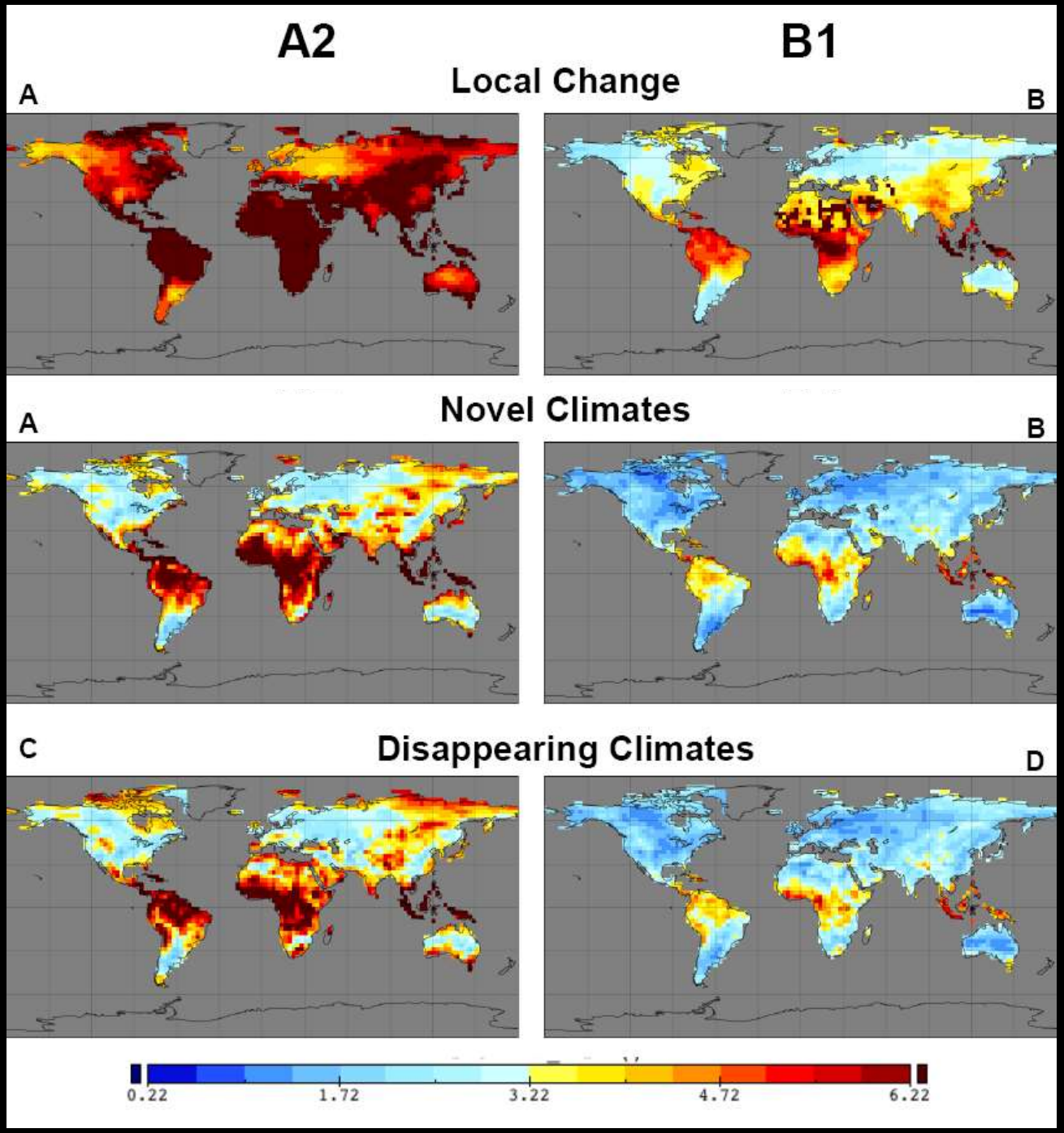

WELCOME
TO THE Fabulous
ANTHROPOCENE
ERA


If the goal of conservation is to prevent change, failure is inevitable

What Can We Say About The Future?



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

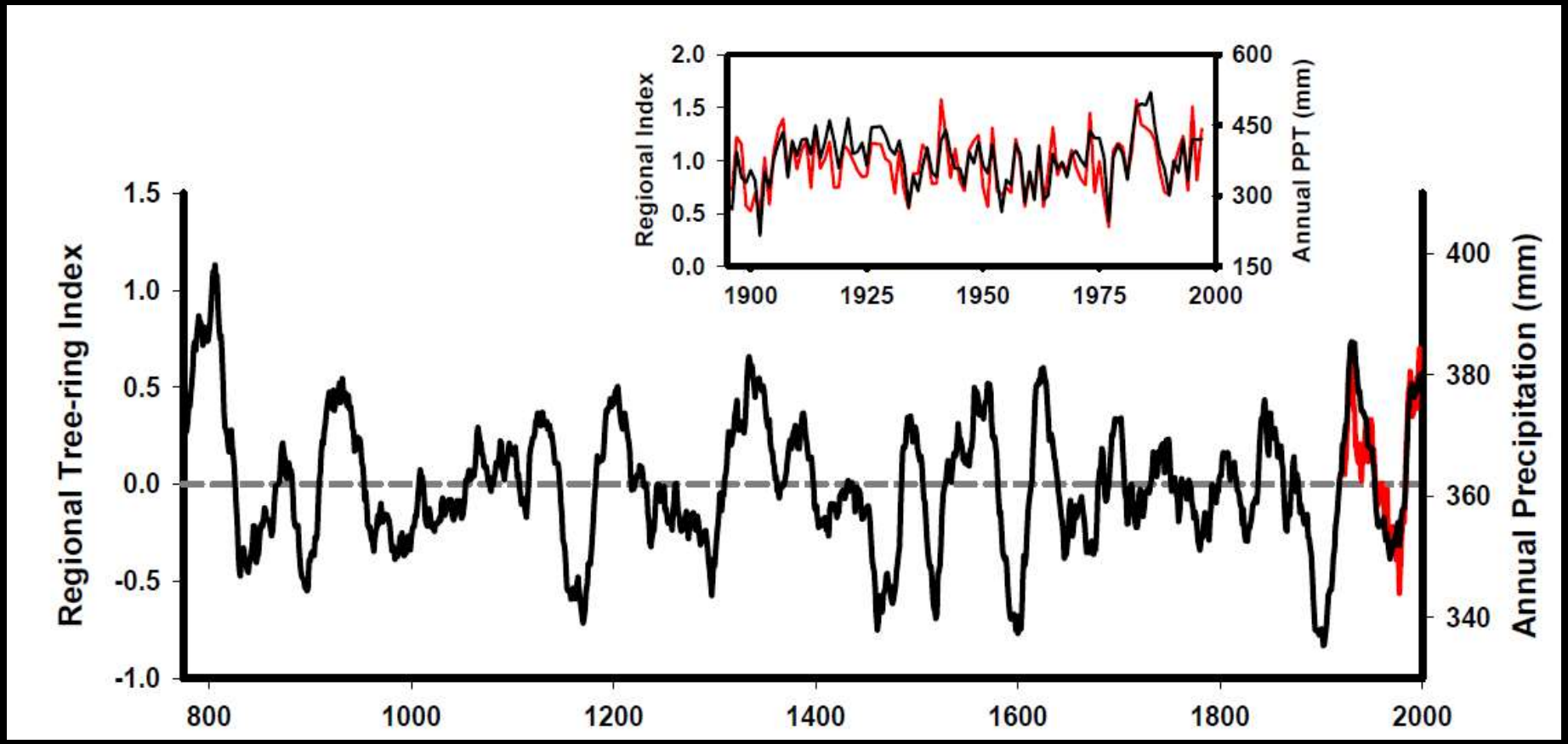


J.W. Williams, S.T. Jackson & J.E. Kutzbach. 2007. *PNAS.*

Novel climates will arise; some existing climates will vanish

Novel ecosystems will arise; some existing ecosystems will vanish

The path to the future: Interaction between natural variability and anthropogenic forcings



Past 1200 years: Upper Colorado River Basin (after Meko *et al.* 2007)

Contingent (path-dependent) outcomes: Climate variability, disturbance, ecology

2002 Mustang Ridge Fire, Daggett Co., Utah (800-yr old-growth pinyon-pine woodland).
Photo courtesy of Sherrill Goodrich, USFS

Historically contingent ecological outcomes (legacies and anachronisms)

For details, see S.T Jackson, R.K. Booth, J.L. Betancourt & S.T. Gray. 2009. *PNAS.*

Most species have (some) capacity for adapting to climate change:

- Phenotypic adjustment
- Habitat shift
- Migration
- Evolutionary adaptation

We must learn how to leverage these effectively


Species adapt to changing environments.
Shouldn't conservation adapt too?


Conservation is an intersection
of science and values

Scientific knowledge and understanding change…

PLUS ULTRA:
OR, THE
Progress and Advancement
OF
KNOWLEDGE
Since the Days of
ARISTOTLE.
In an ACCOUNT of some of the most Remarkable
LATE IMPROVEMENTS
OF
Practical, Useful Learning:
To Encourage
PHILOSOPHICAL ENDEAVOURS.
OCCASIONED
By a Conference with one of the *NOTIONAL* Way.

By JOS. GLANVILL.

LONDON,
Printed for *James Collins* at the *Kings-Head* in *Westminster-Hall*. 1668.

THE
Wisdom of God
Manifested in the
WORKS
OF THE
CREATION,
In Two PARTS.
VIZ.
The Heavenly Bodies, Elements, Meteors, Fossils, Vegetables, Animals, (Beasts, Birds, Fishes, and Insects) more particularly in the Body of the Earth, its Figure, Motion, and Consistency, and in the admirable Structure of the Bodies of Man, and other Animals, as also in their Generation, *&c.*

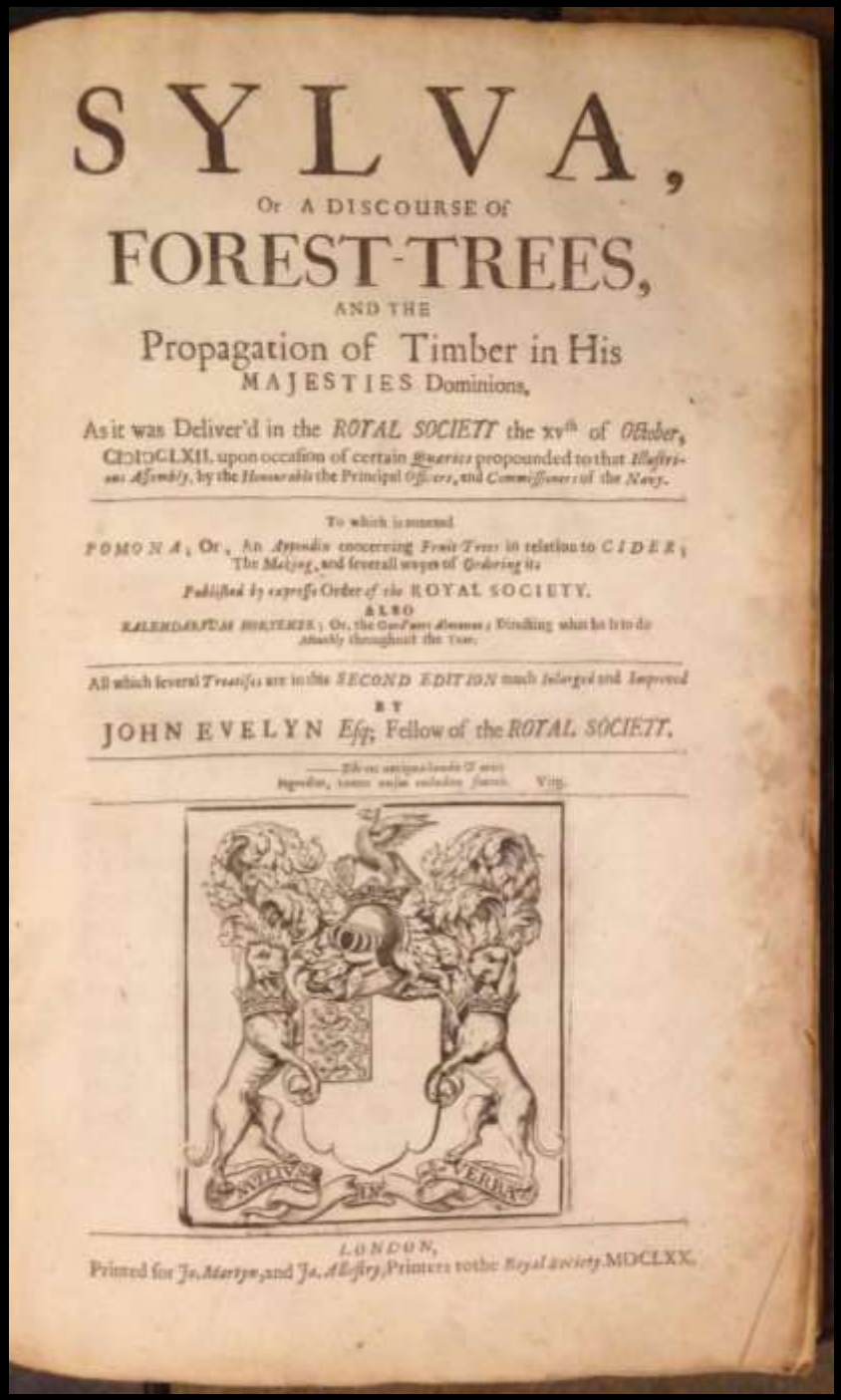
By JOHN RAY,
Fellow of the *Royal Society.*

The Second Edition, very much enlarged.

LONDON:
Printed for *Samuel Smith*, at the *Princes Arms* in St. *Paul's* Church-yard. 1692.

Societal values change

Conservation knowledge, values, and practice change…



SYLVA,

Or A DISCOURSE of

FOREST-TREES,

AND THE

Propagation of Timber in His MAJESTIES Dominions,

As it was Deliver'd in the *ROYAL SOCIETY* the xvth of *October*, CIↃIↃCLXII. upon occasion of certain *Queries* propounded to that *Illustrious Assembly*, by the *Honourable* the Principal *Officers*, and *Commissioners* of the *Navy*.

To which is annexed

POMONA, Or, An *Appendix* concerning *Fruit-Trees* in relation to *CIDER*; The *Making*, and several sorts of *Ordering* it.

Published by expresse Order of the ROYAL SOCIETY.

ALSO

KALENDARIUM HORTENSE; Or, the *Gardners Almanac*; Directing what he is to do *Monthly* throughout the Year.

All which several *Treatises* are in this *SECOND EDITION* much *Inlarged* and *Improved*

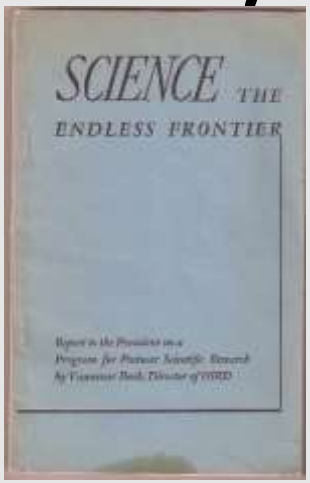
BY

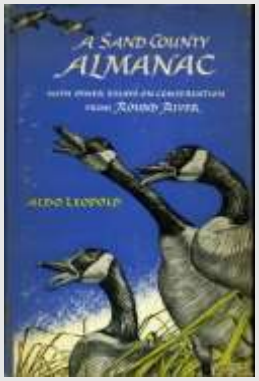
JOHN EVELYN *Esq*; Fellow of the *ROYAL SOCIETY*.

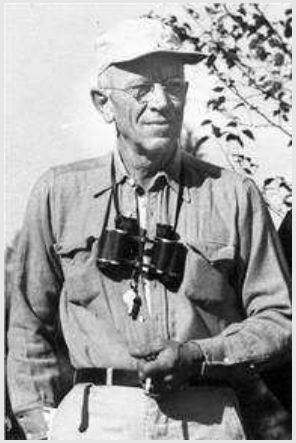
—*Tibi res antiquæ laudis & artis*
Ingredior, sanctos ausus recludere fontes. Virg.

LONDON,
Printed for *Jo. Martyn*, and *Ja. Allestry*, Printers to the *Royal Society*. MDCLXX.

Today's conservation derives from mid-20th Century science and values…







Science

Decisions

Value-laden controversies underway in conservation science

A critique of the 'novel ecosystem' concept

Carolina Murcia[1,2*], James Aronson[3,4*], Gustavo H. Kattan[5], David Moreno-Mateos[3], Kingsley Dixon[6,7], and Daniel Simberloff[8]

The Rise of Invasive Species Denialism

James C. Russell[1,2,*] and Tim M. Blackburn[3,4,*]

Novel ecosystems: concept or inconvenient reality? A response to Murcia *et al.*

Richard J. Hobbs[1], Eric S. Higgs[2], and James A. Harris[3]

The evidence and values underlying 'new conservation'

Michelle Marvier[1] and Peter Kareiva[2]

Non-natives: 141 scientists object

Have Ecosystem Services Been Oversold?

Jonathan Silvertown[1,*]

Assisted colonization is not a viable conservation strategy

Anthony Ricciardi[1] and Daniel Simberloff[2]

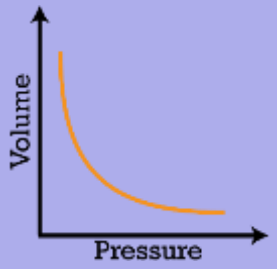
'New conservation' or surrender to development?

B. Miller[1], M. E. Soulé[2] & J. Terborgh[3]


Progress is not a zero-sum game!

Progress is subsumptive. We still use:

17th Century physics



$$\vec{F} = m\vec{a}$$

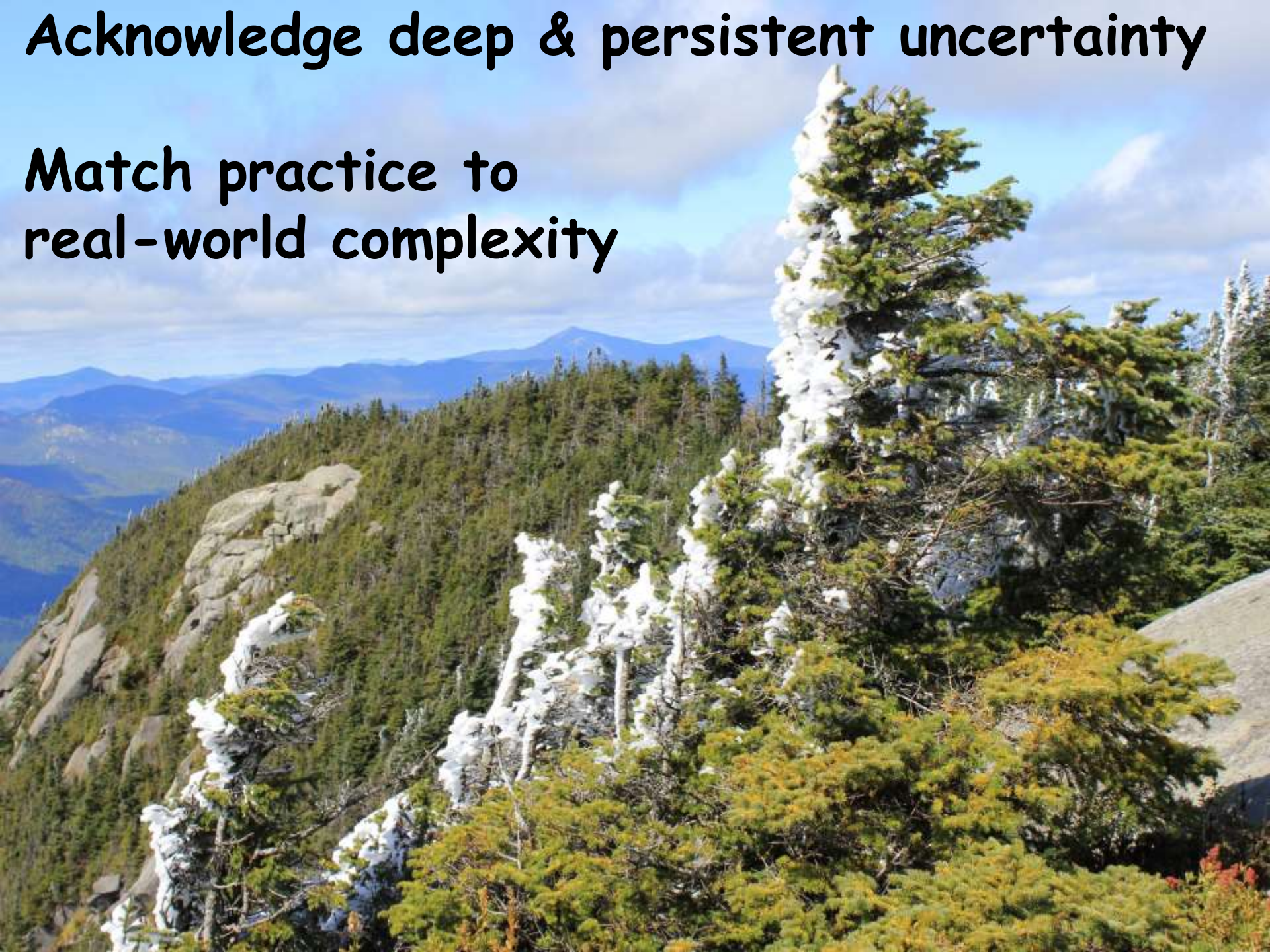
18th Century political systems

20th Century conservation policy

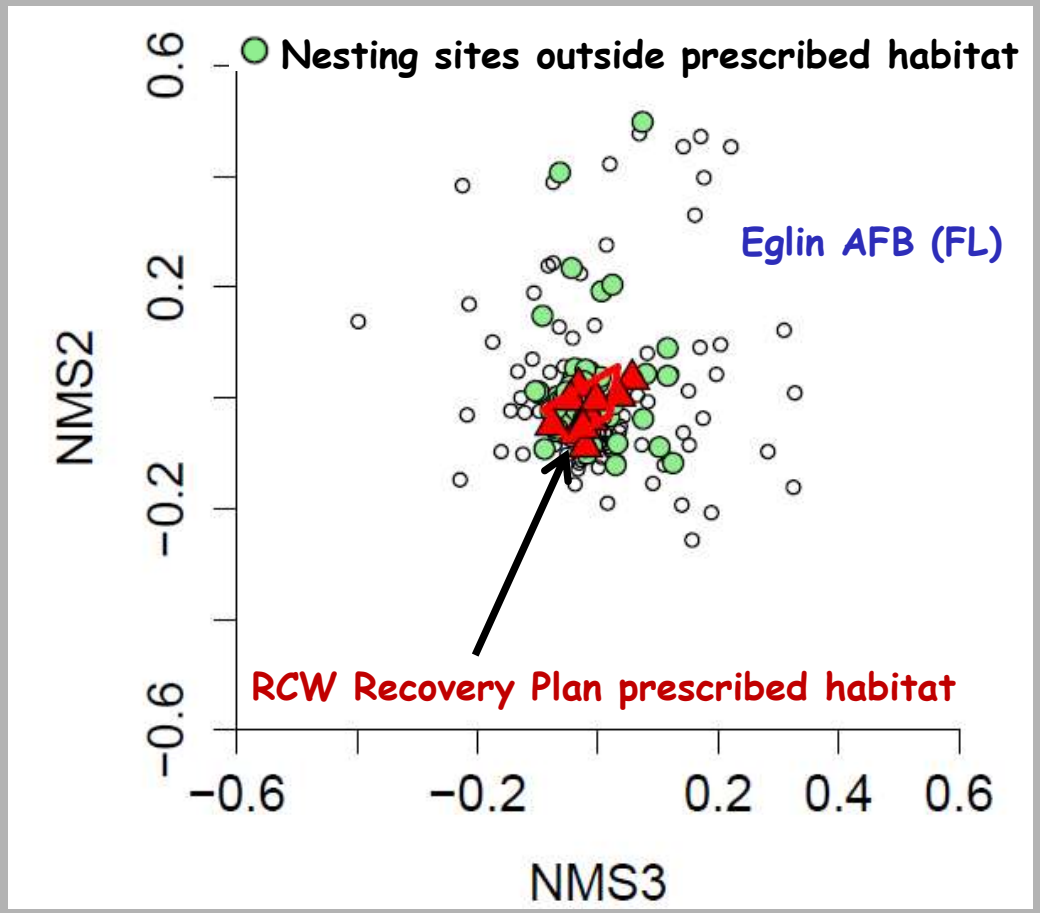

We can adapt conservation to evolving science and values without abandoning the progress of past decades

Reinventing conservation for the Anthropocene

Anthropocene rewilding: marshes reclaim industrial ground in Gary, Indiana. July 2011.


Acknowledge deep & persistent uncertainty
Match practice to
real-world complexity

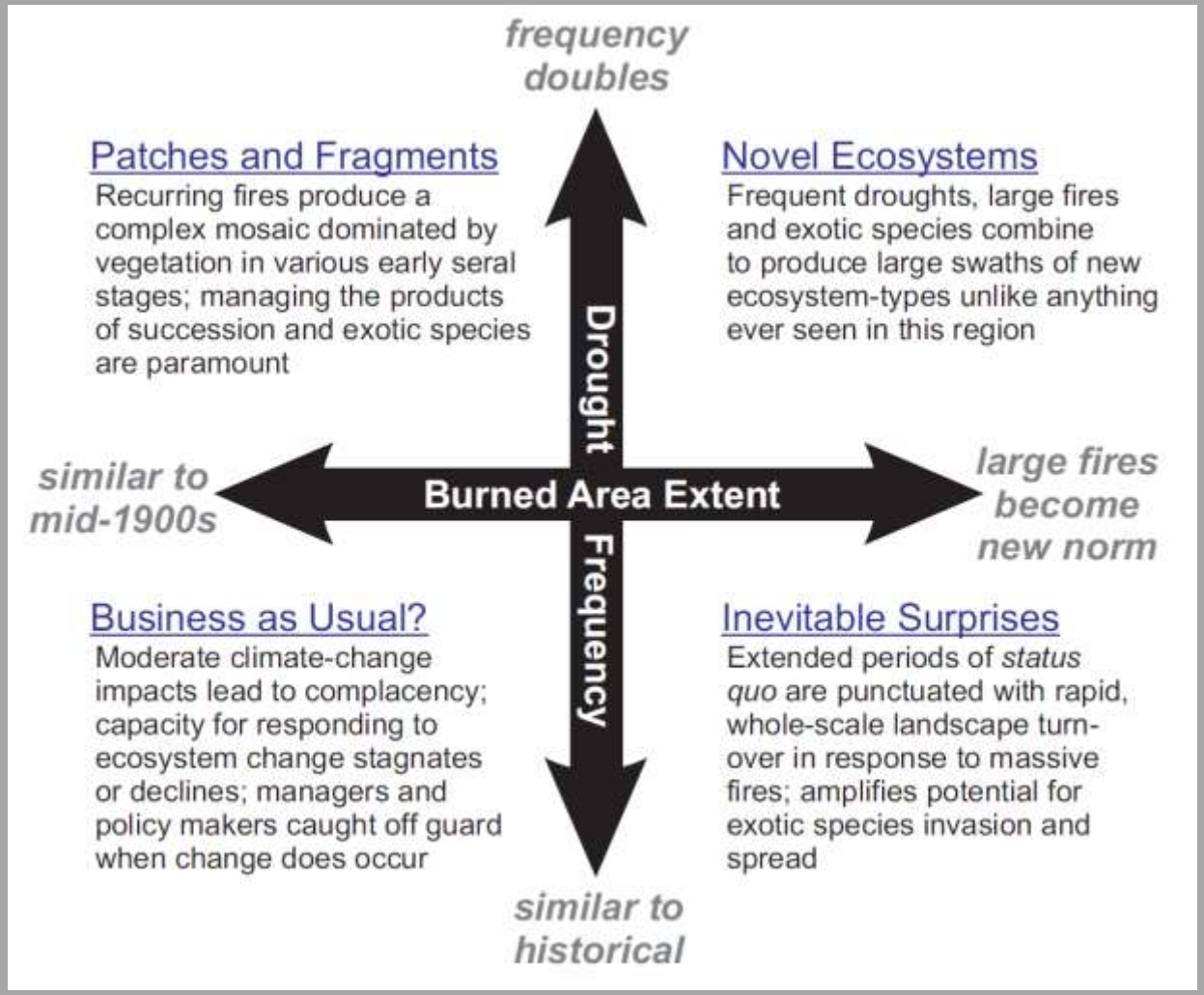
Broaden and diversify management targets



John James Audubon
Red-cockaded woodpecker

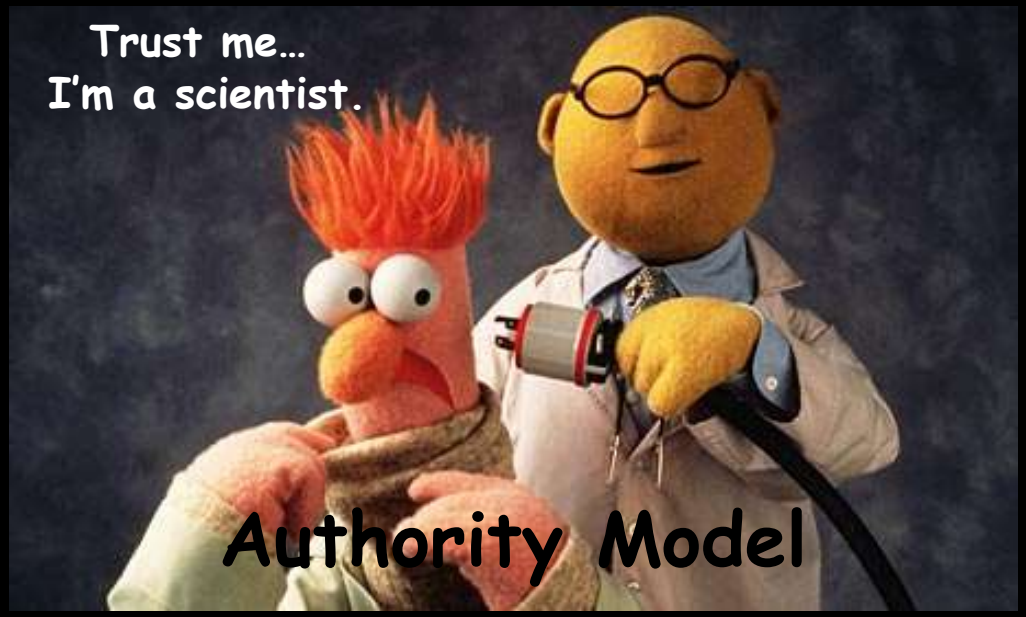
J.K. Hiers, S.T. Jackson, R.J. Hobbs, E.S. Bernhardt, L. Valentine. 2016.
Trends in Ecology and Evolution.

Replace 'predict-then-take-action' with more robust, adaptive management strategies (Example: scenario planning)



S.T. Jackson, S.T. Gray, B. Shuman. 2009. *Conservation Paleobiology.*

Look beyond traditional scientific 'outreach'…



…to develop effective translational sciences for conservation

NCEAS Translational Ecology Working Group, November 2015

C. Enquist *et al.* 2017. *Frontiers in Ecology and the Environment* (in press).