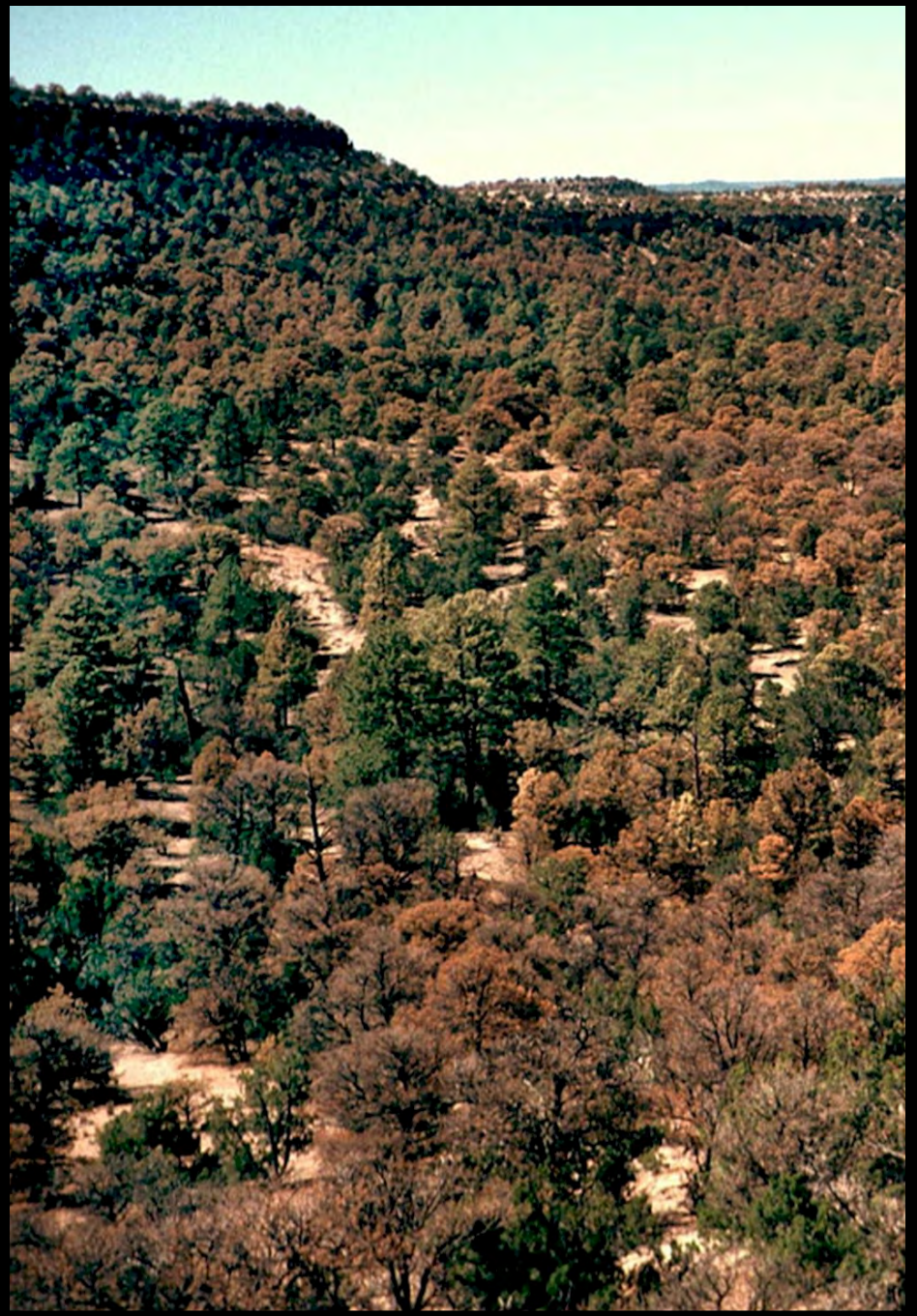
The potential masking of eastern US forest vulnerability during the Anthropocene due to 20th Century Climate


KITV

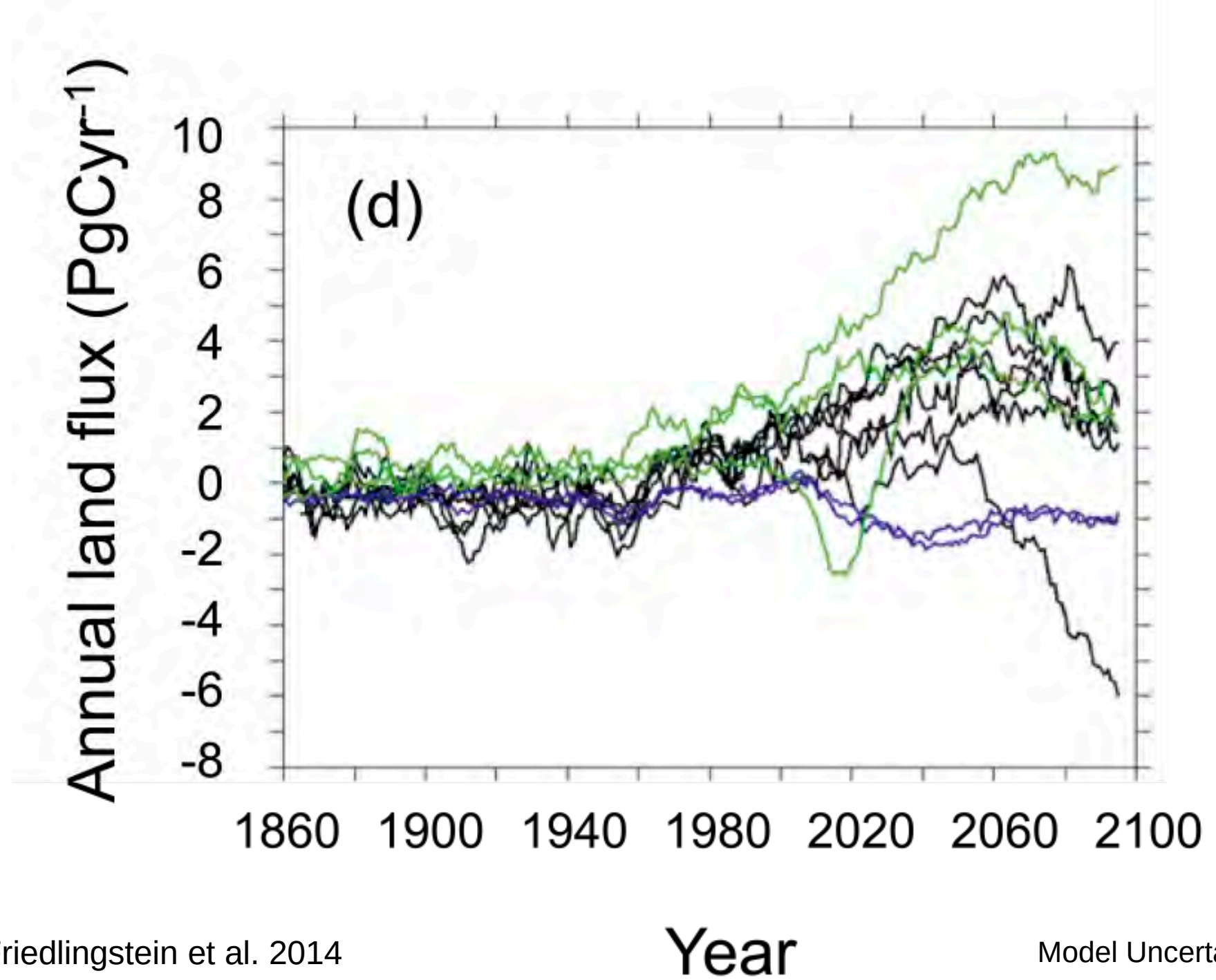
The potential masking of eastern US forest vulnerability during the Anthropocene due to 20th Century Climate

Neil Pederson

J. McColgan, USFS firefighter

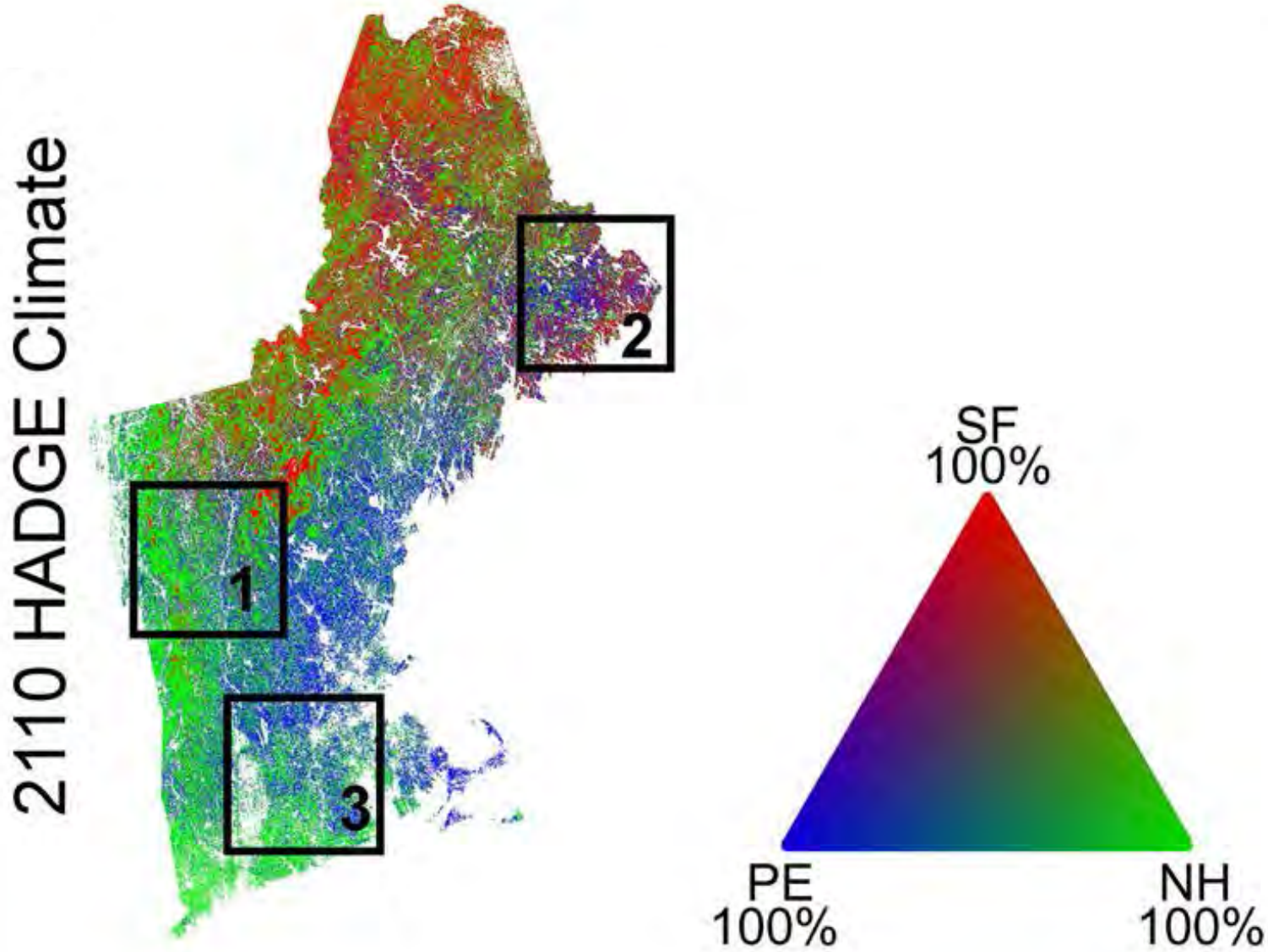


http://www.lanl.gov/news/index.php/fuseaction/nb.story/story_id/%207335

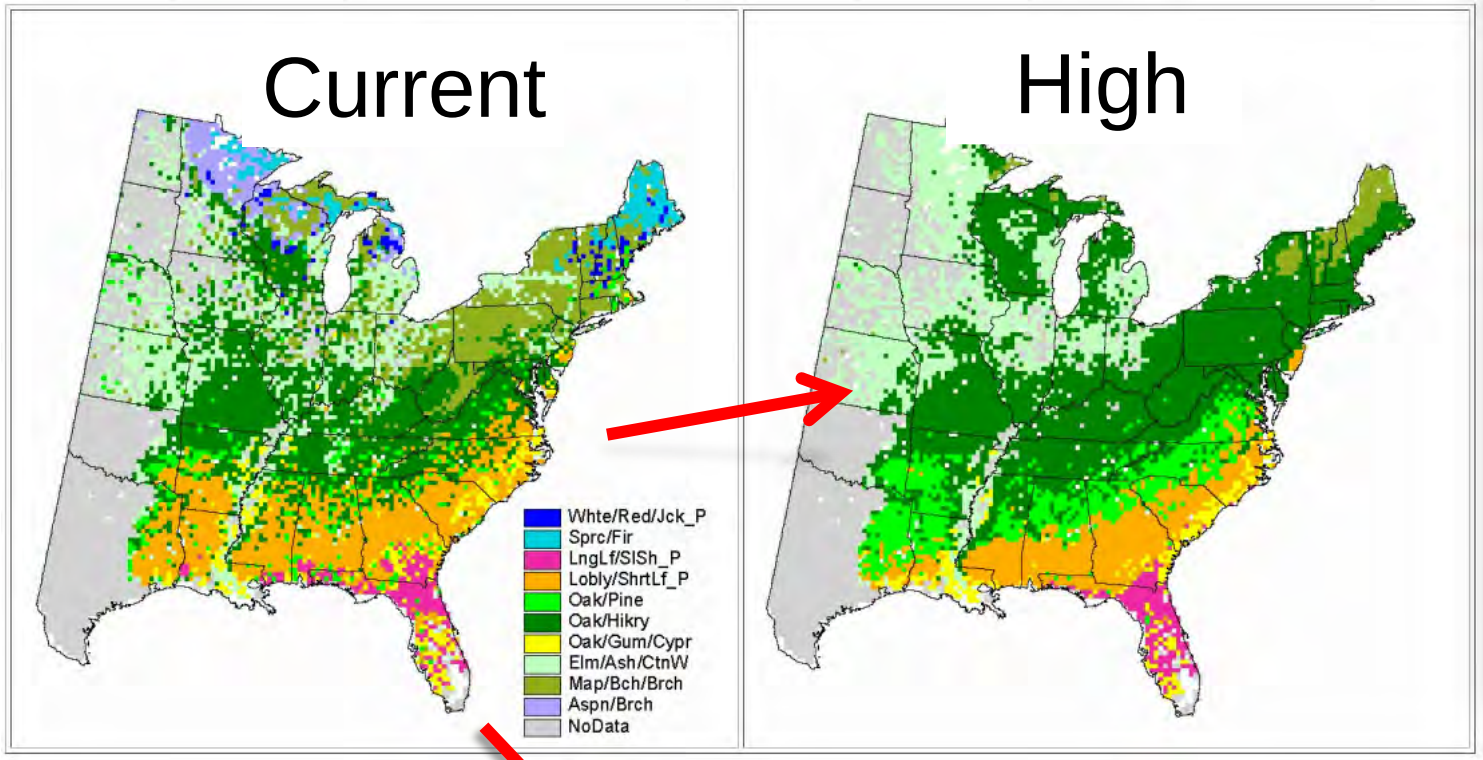


Friedlingstein et al. 2014

Model Uncertainty



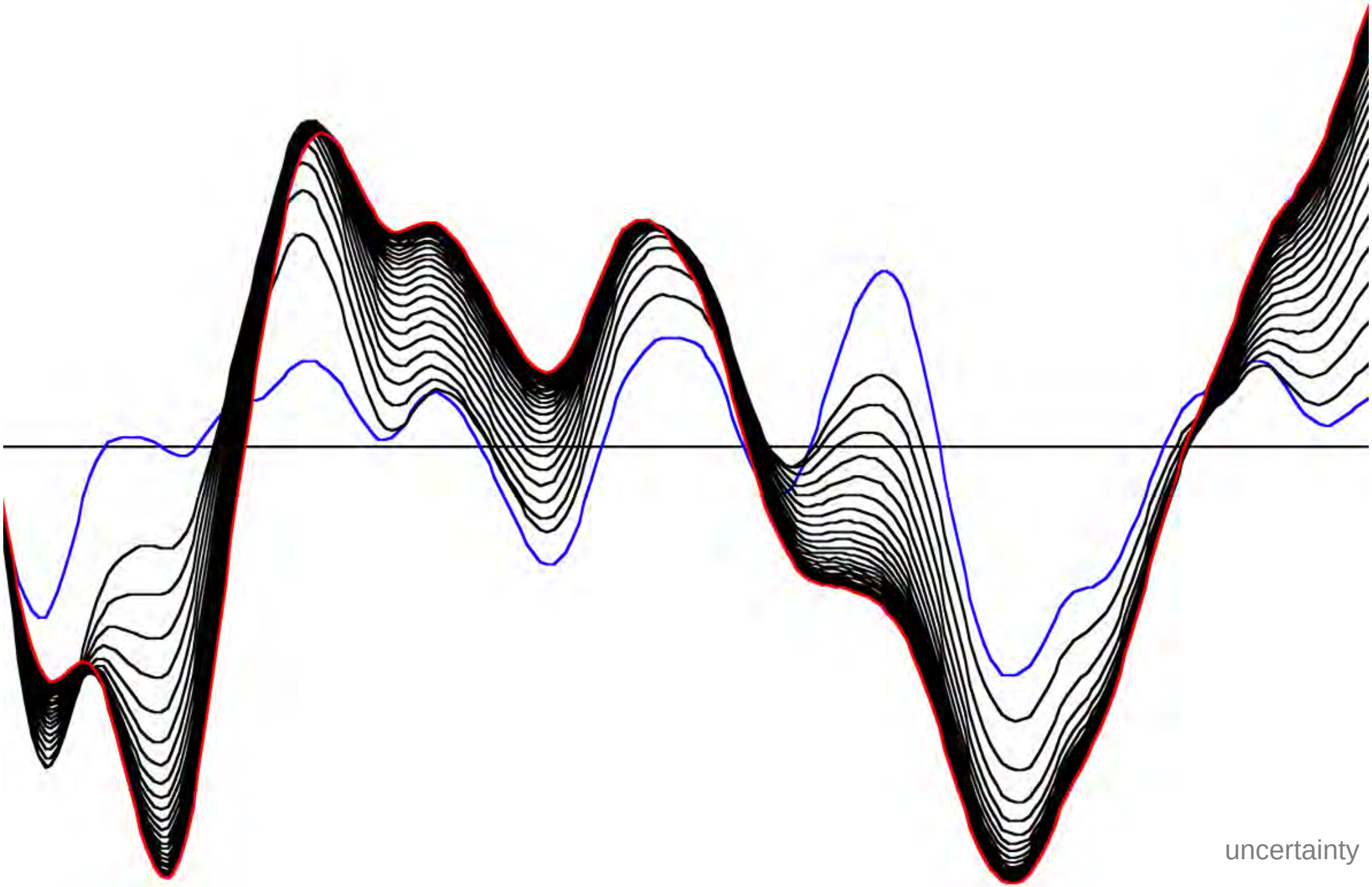
Duveneck et al., 2016



Potential Broadscale

Iverson et al., 2008


SPACELY & SPROCKETS


uncertainty

Eastern Deciduous Forest

Small-scale dynamics

Eastern Deciduous Forest

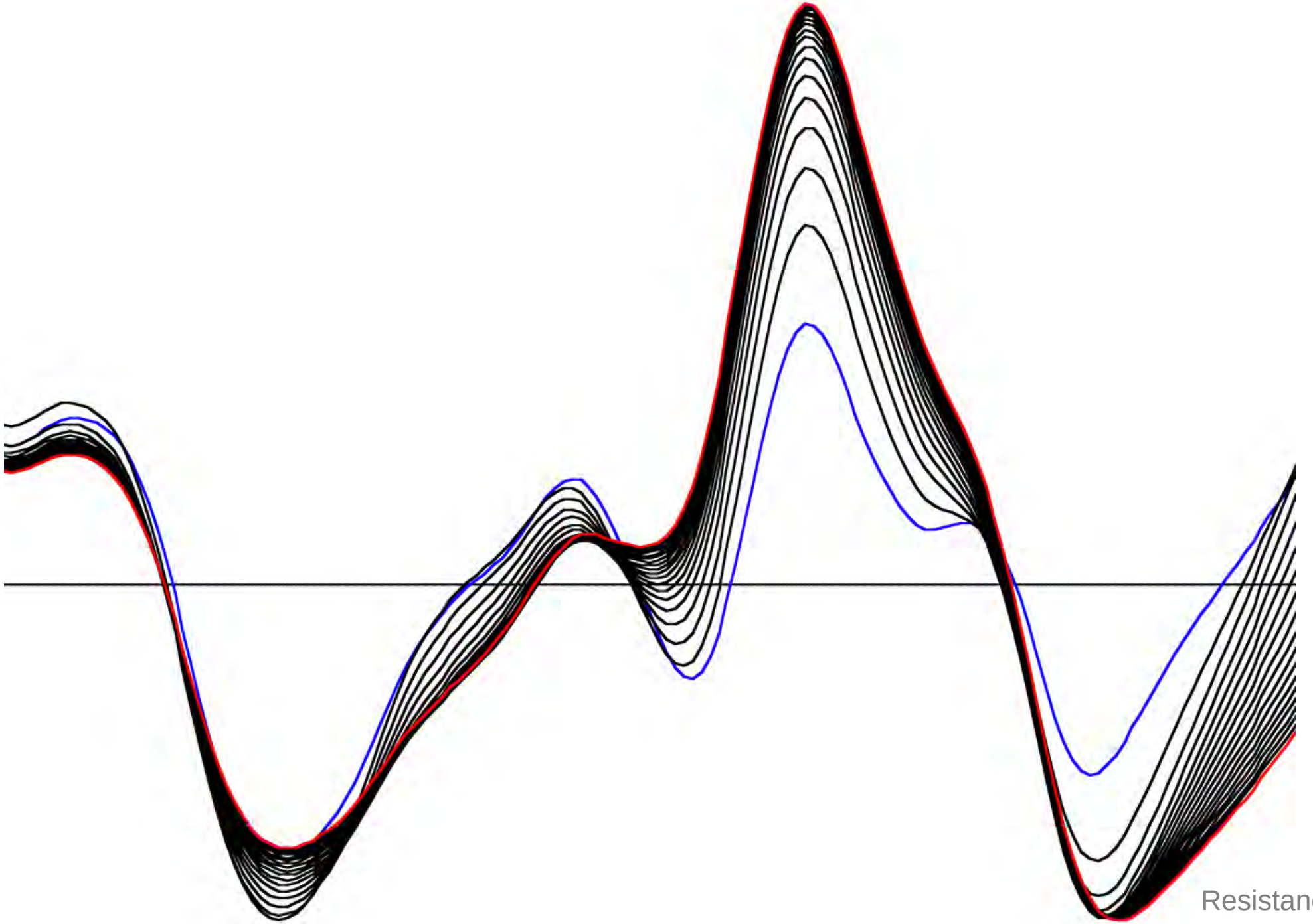
intermediate
dynamics

Temperate Broadleaf Forests

Republic of Georgia

China

Bhutan



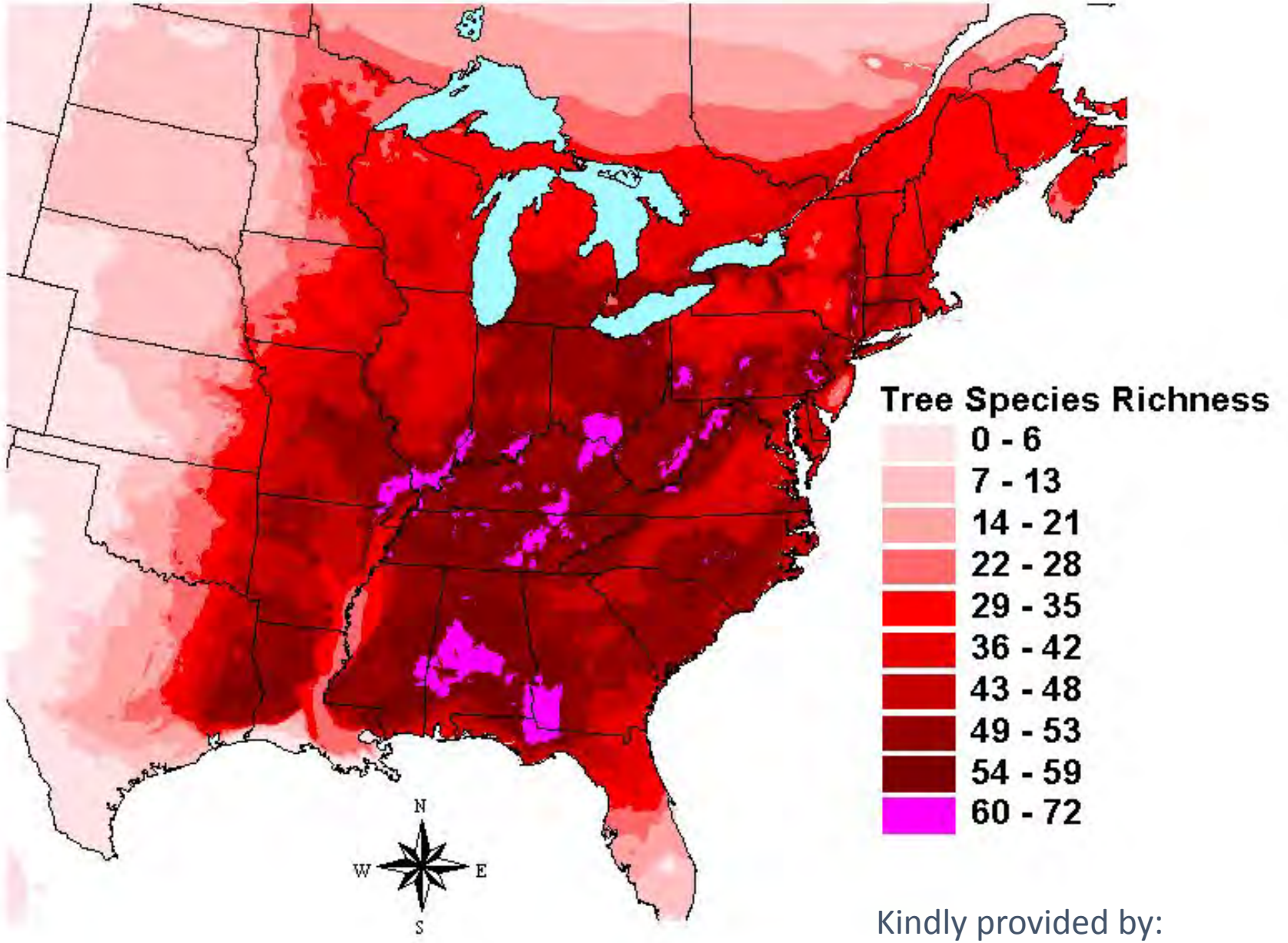
Resistance/resilience?

LETTER

doi:10.1038/nature1537

Biodiversity increases the resistance of ecosystem productivity to climate extremes

Forest Isbell[1], Dylan Craven[2,3], John Connolly[4], Michel Loreau[5], Bernhard Schmid[6], Carl Beierkuhnlein[7], T. Martijn Bezemer[8], Catherine Bonin[9], Helge Bruelheide[2,10], Enrica de Luca[6], Anne Ebeling[11], John N. Griffin[12], Qinfeng Guo[13], Yann Hautier[14], Andy Hector[15], Anke Jentsch[16], Jürgen Kreyling[17], Vojtěch Lanta[18], Pete Manning[19], Sebastian T. Meyer[20], Akira S. Mori[21], Shahid Naeem[22], Pascal A. Niklaus[6], H. Wayne Polley[23], Peter B. Reich[24,25], Christiane Roscher[2,26], Eric W. Seabloom[1], Melinda D. Smith[27], Madhav P. Thakur[2,3], David Tilman[1,28], Benjamin F. Tracy[29], Wim H. van der Putten[8,30], Jasper van Ruijven[31] Alexandra Weigelt[2,3], Wolfgang W. Weisser[20], Brian Wilsey[32] & Nico Eisenhauer[2,3]



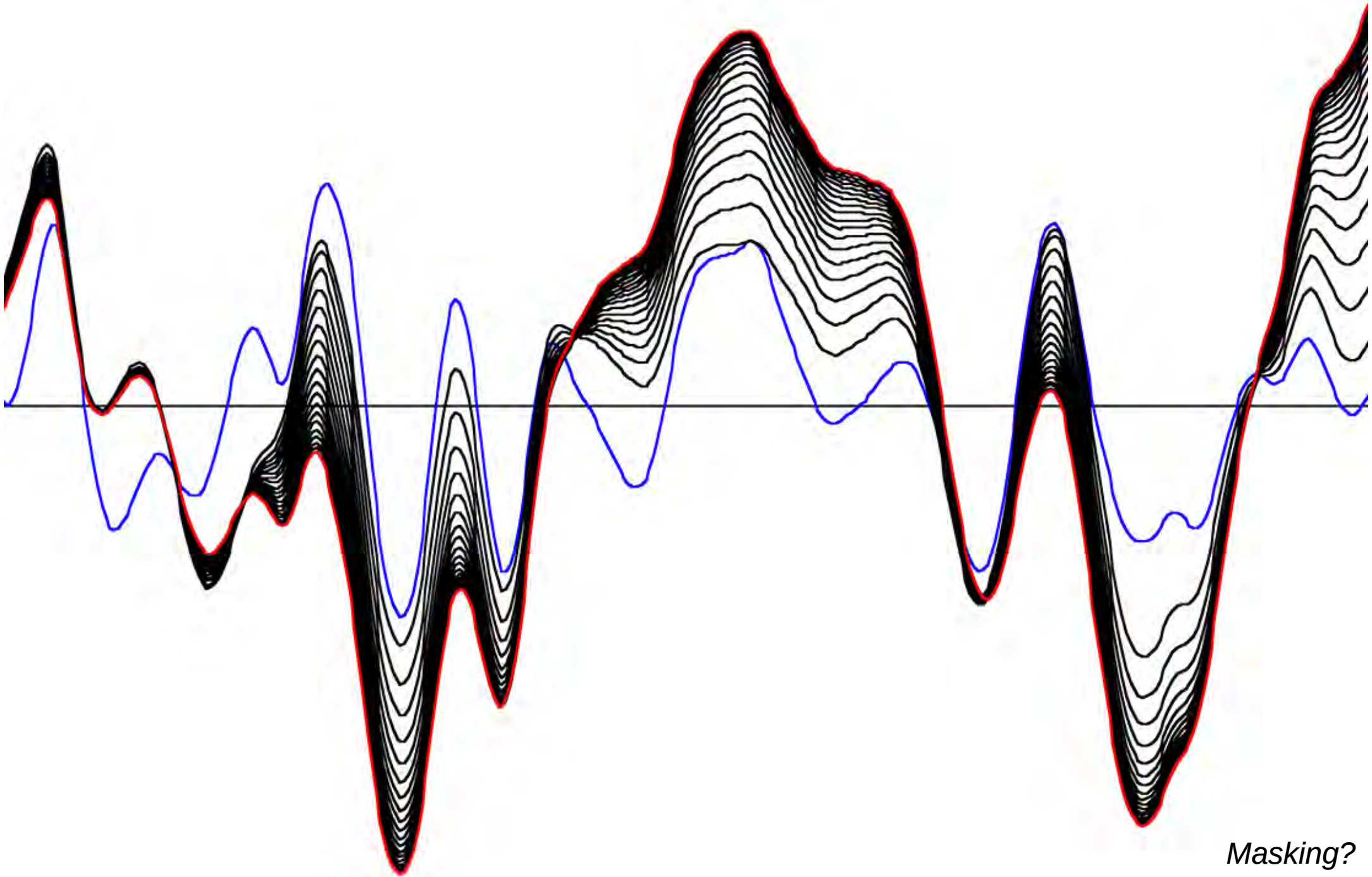
Kindly provided by:
Louis Iverson and Ananthda Prasada
Northeastern Research Station USDA Forest Service

LETTER

doi:10.1038/nature1537

Biodiversity increases the resistance of ecosystem productivity to climate extremes

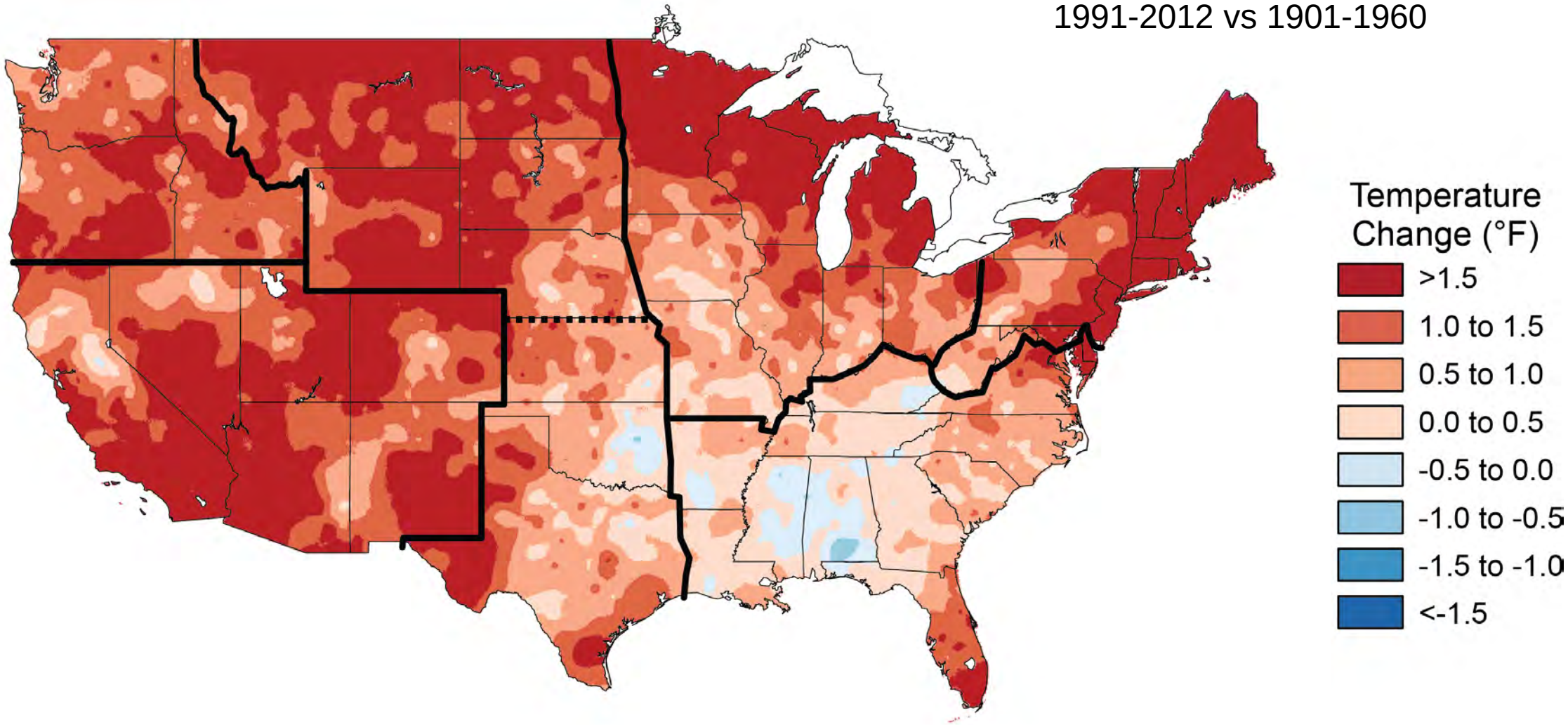
→*"If we had defined climate extremes based only on data from the early (or late) 1900s, then we would probably have identified more (or fewer) extreme climate events."*



Masking?

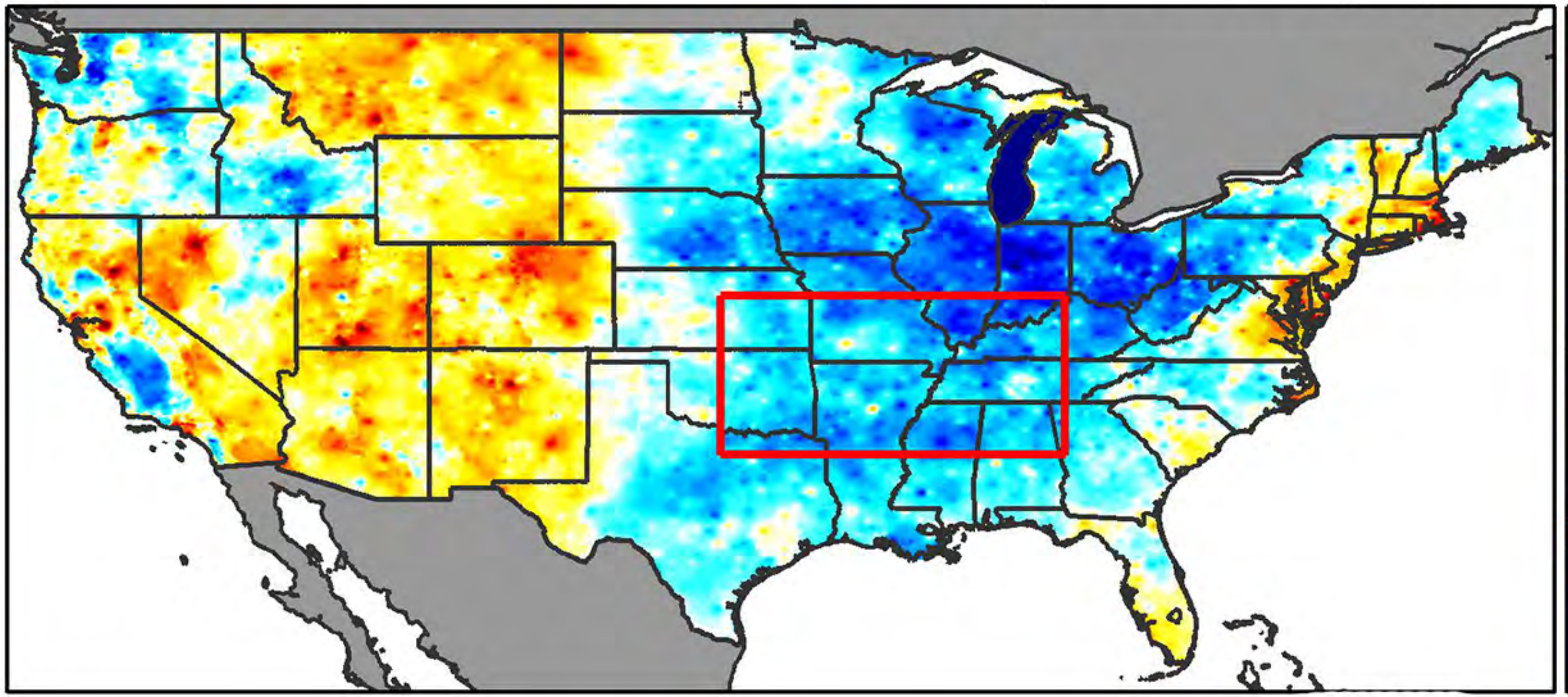
Observed U.S. Temperature Change

1991-2012 vs 1901-1960



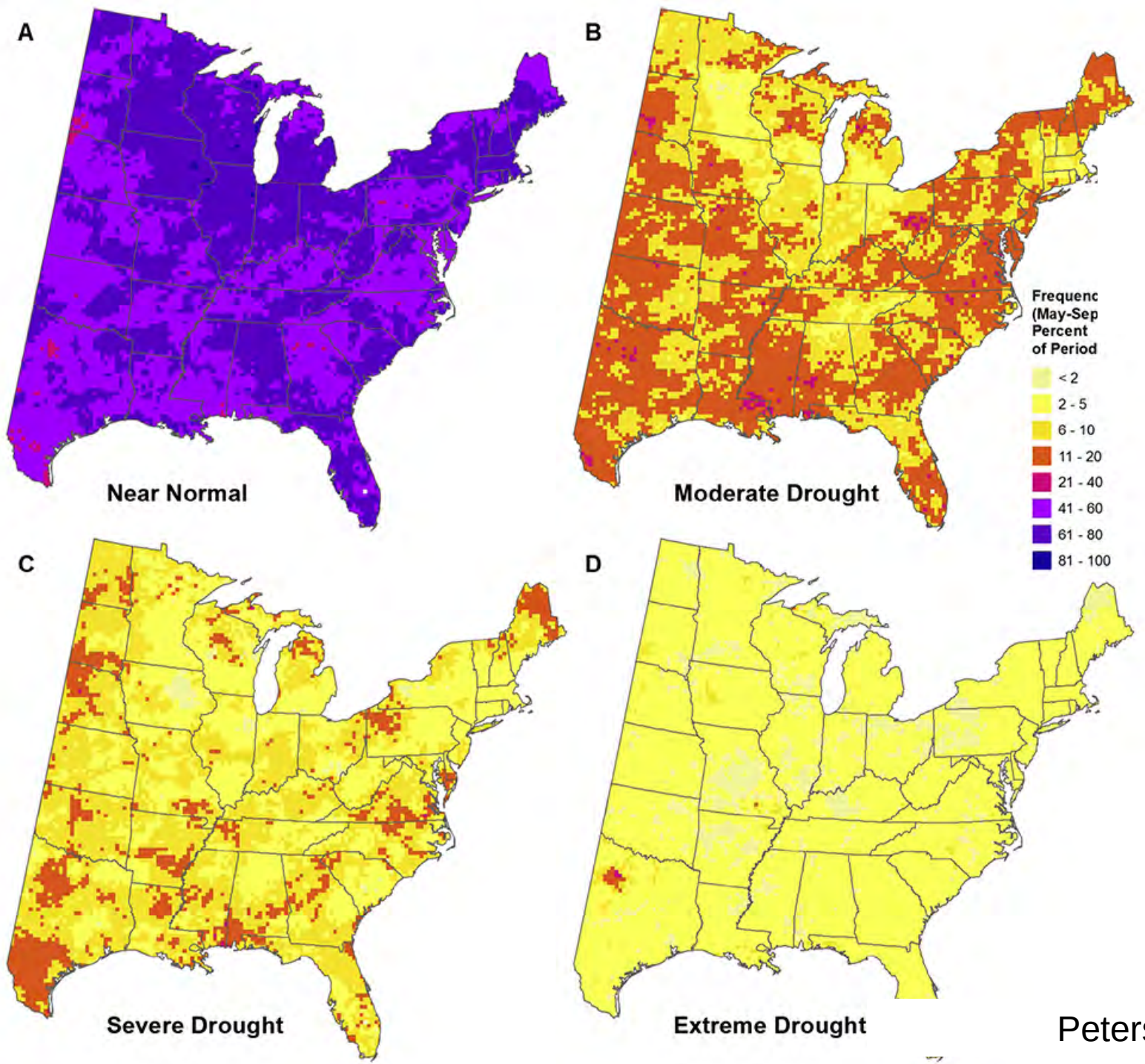
2014 US Climate Change Report

Observed Tmax Trend (°C/100 yr)



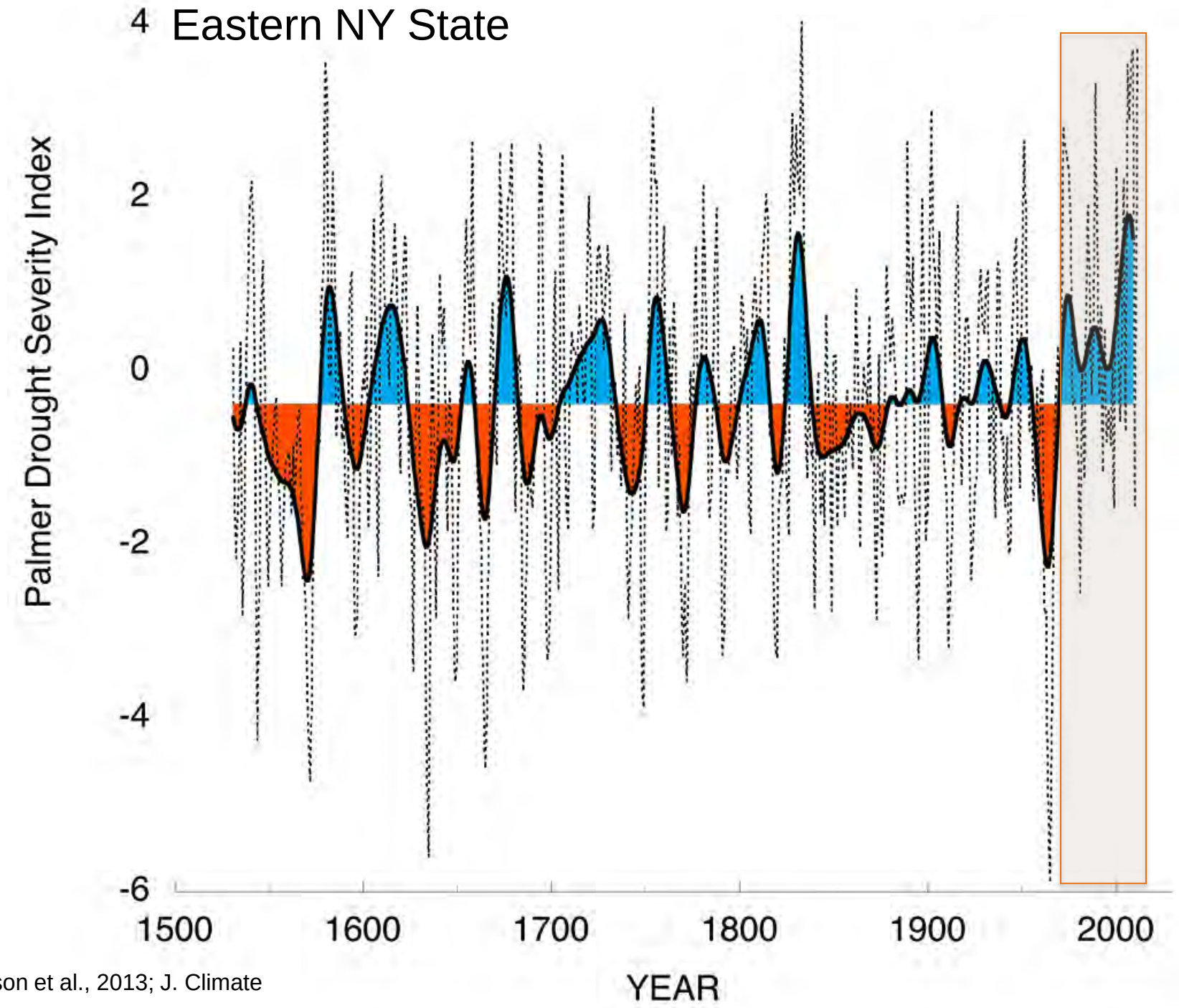
Courtesy of Park Williams, unpublished

Summer



Frequency of Drought 1961-2012

Peters & Iverson, 2015



Pederson et al., 2013; J. Climate

“trending towards garden…”

Memory of Trees

The legacy of episodic climatic events in shaping temperate, broadleaf forests

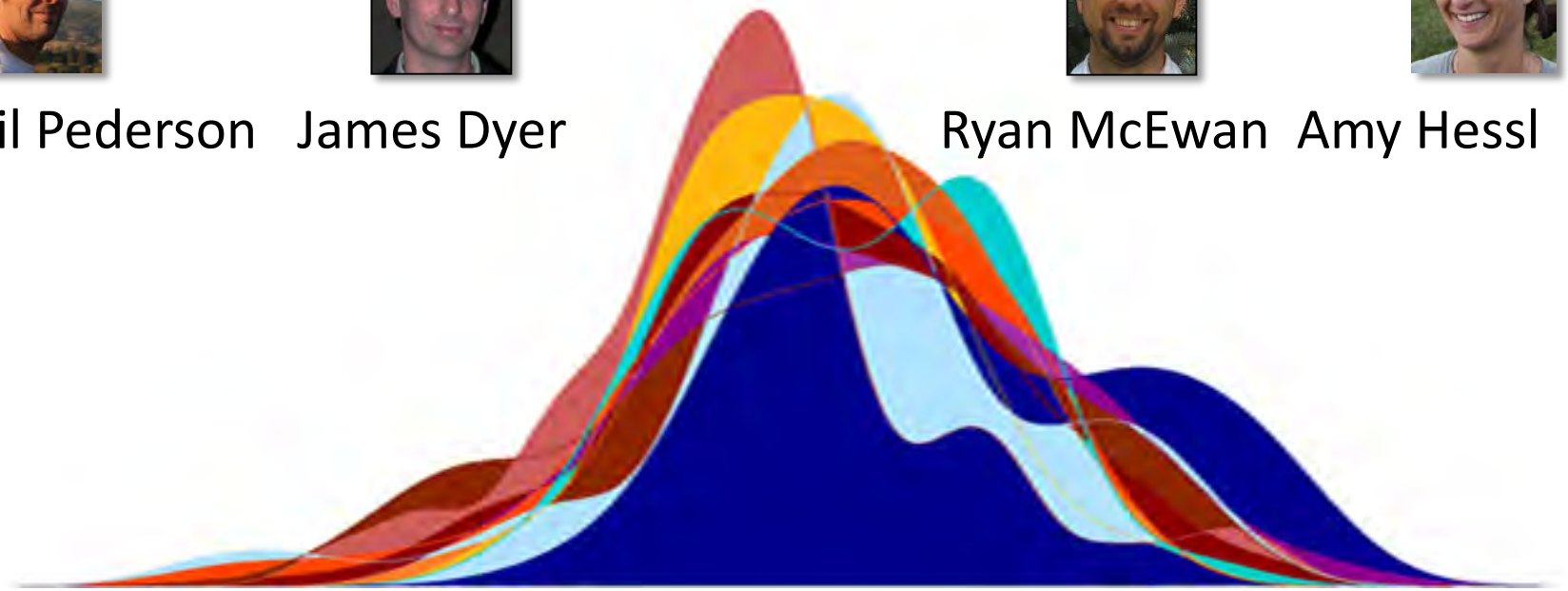
Ecological Monographs, 2014

Neil Pederson

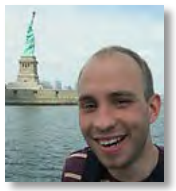
James Dyer

Ryan McEwan

Amy Hessl



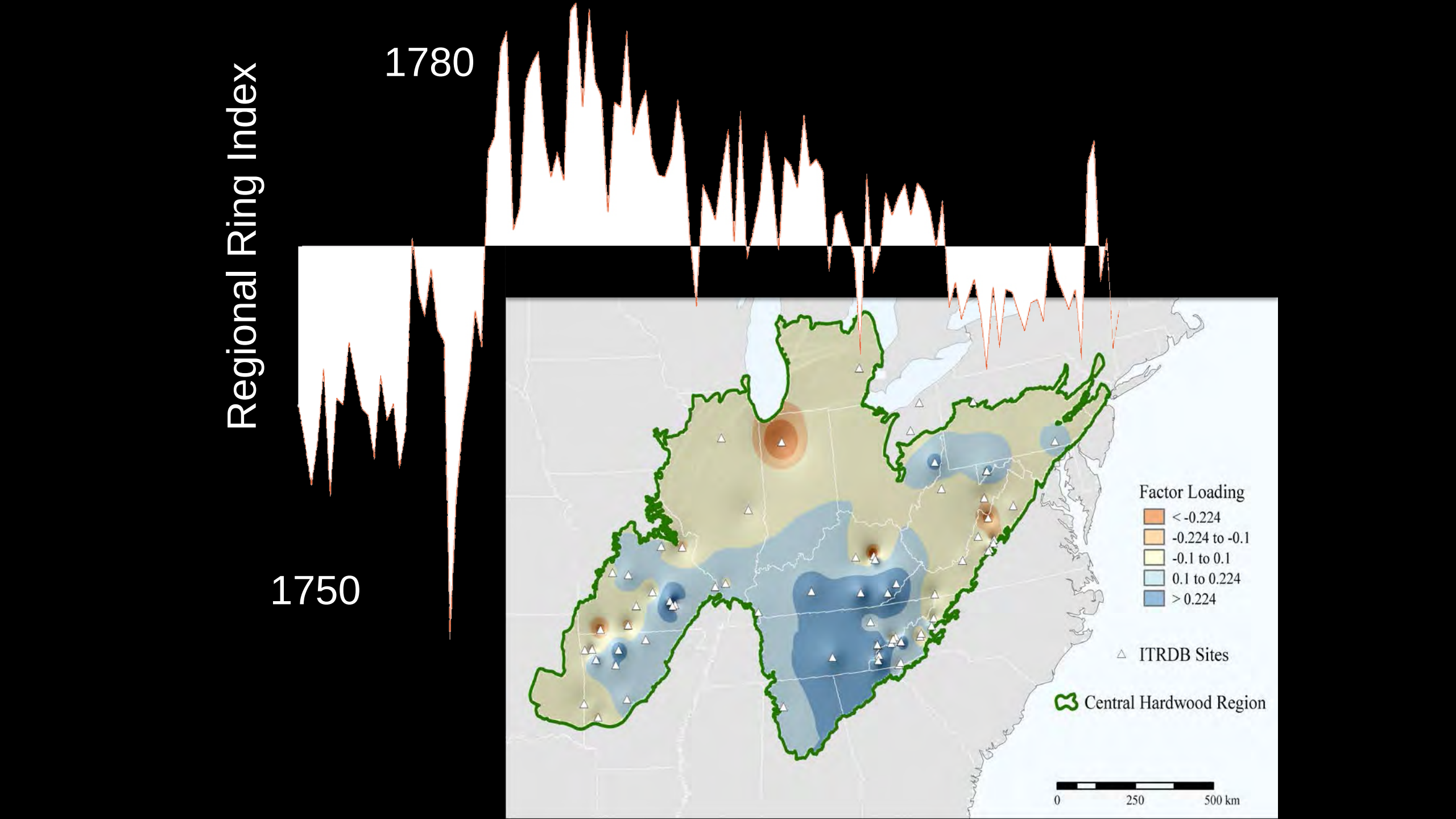
Cary Mock



Harald Rieder

David Orwig

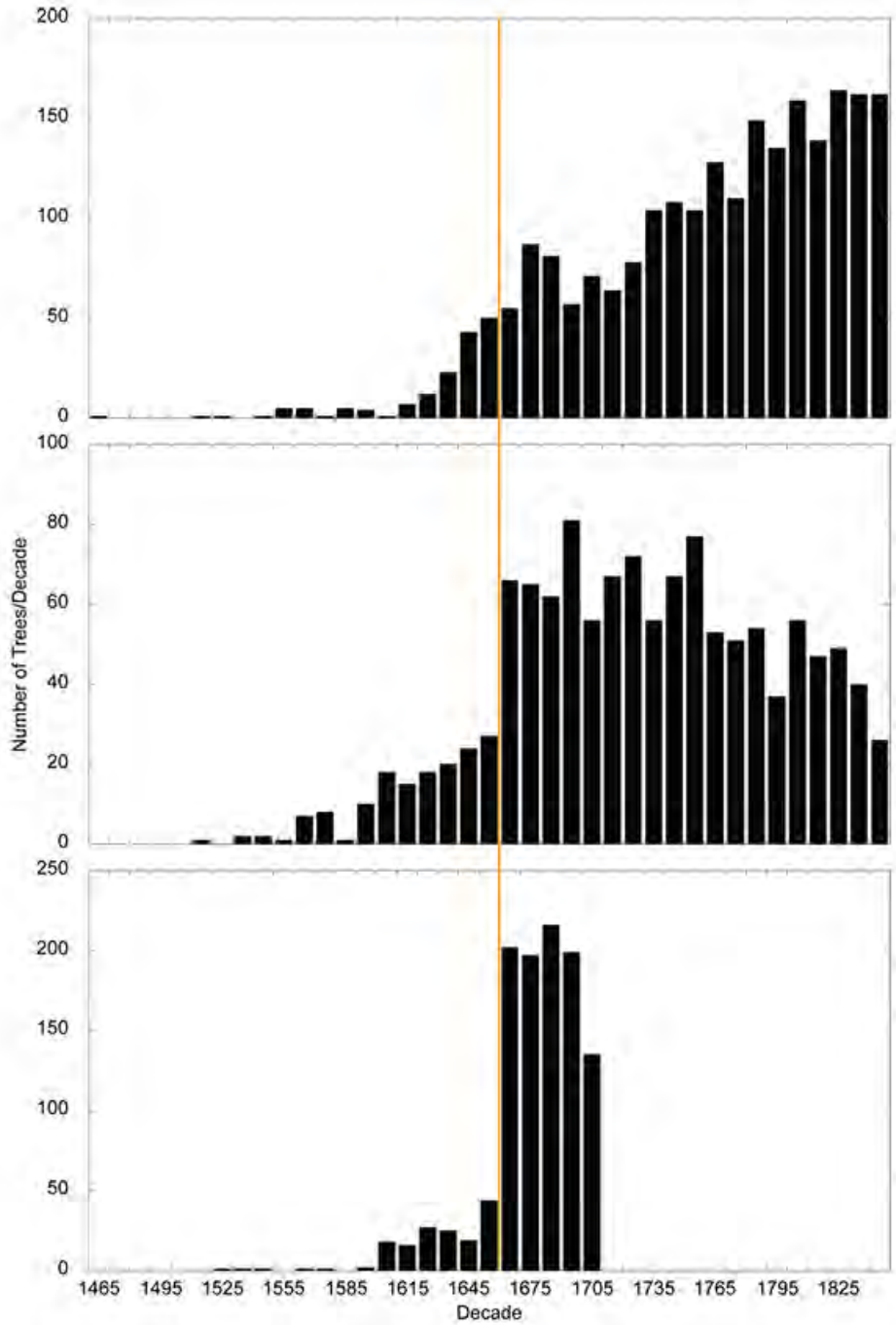
Ben Cook


Regional Ring Index
1780
1750
Factor Loading
< -0.224
-0.224 to -0.1
-0.1 to 0.1
0.1 to 0.224
> 0.224
ITRDB Sites
Central Hardwood Region
0
250
500 km

The Eastern Deciduous Forest Wall

5,327 trees

~ 1.4 mill. km^2



Plot-level/representative sampling

Targeted sampling: old trees & historic timbers

Representative; no data post-1700

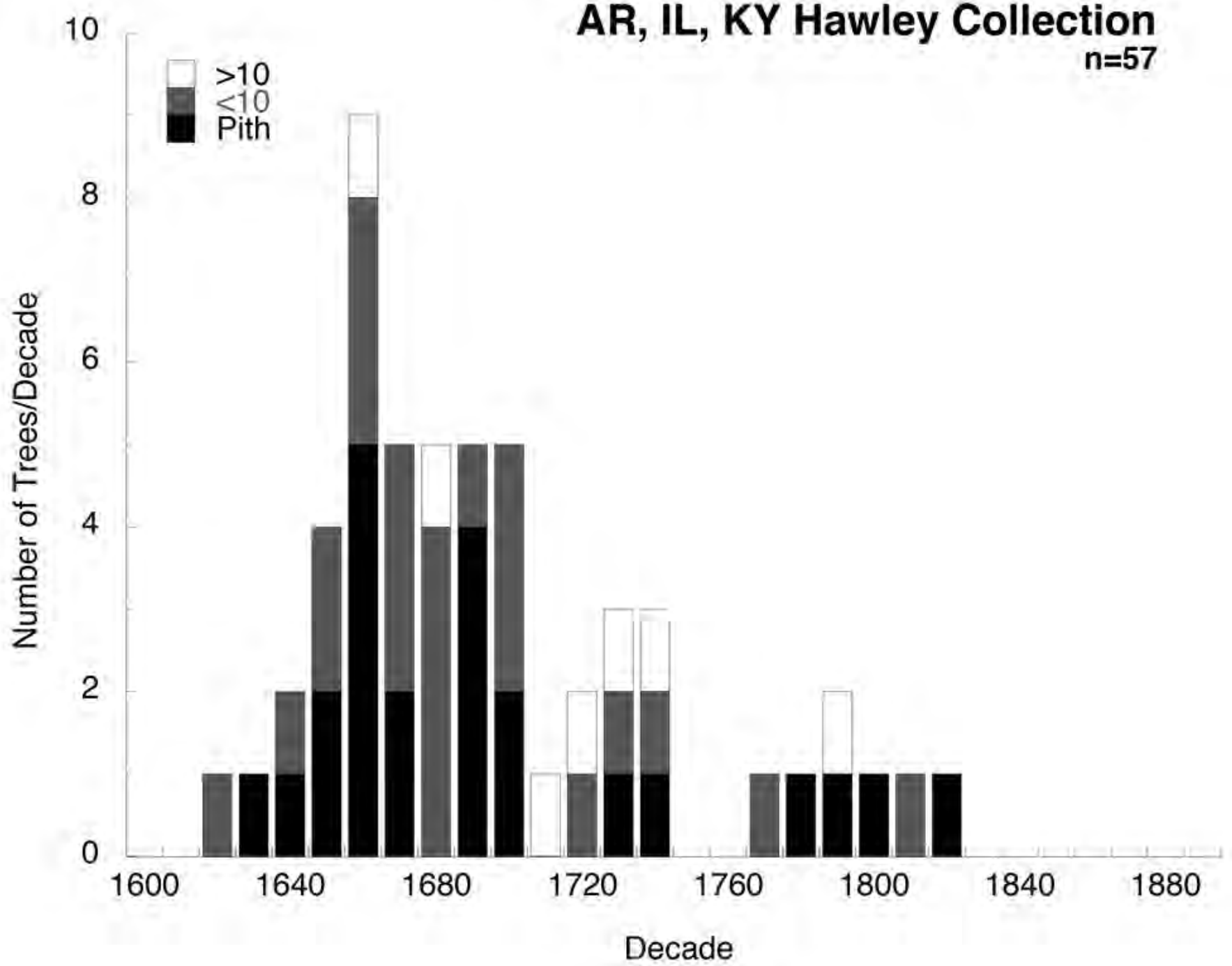
Pederson et al., 2014, EcoMono

Received the above in good order (date) Mar 30, 1941

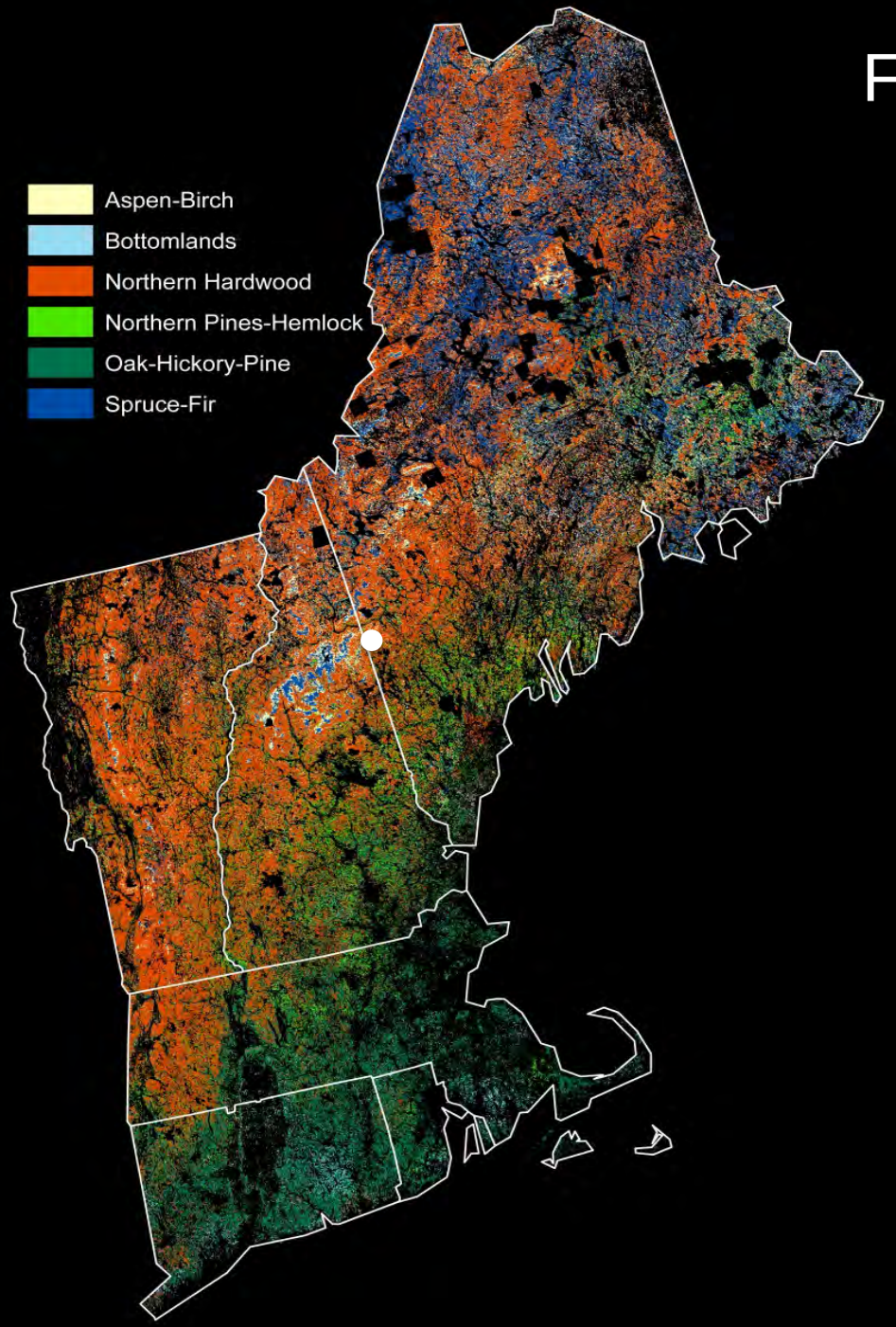
F. Hawley

RETAIN THIS COPY FOR YOUR RECORDS.

Florence Hawley


AR, IL, KY Hawley Collection
n=57
>10
≤10
Pith
Number of Trees/Decade
0
2
4
6
8
10
1600
1640
1680
1720
1760
1800
1840
1880
Decade

Future Hot MegaDrought



Models

Landis-II with PnET Succession
ForClim with VS-lite

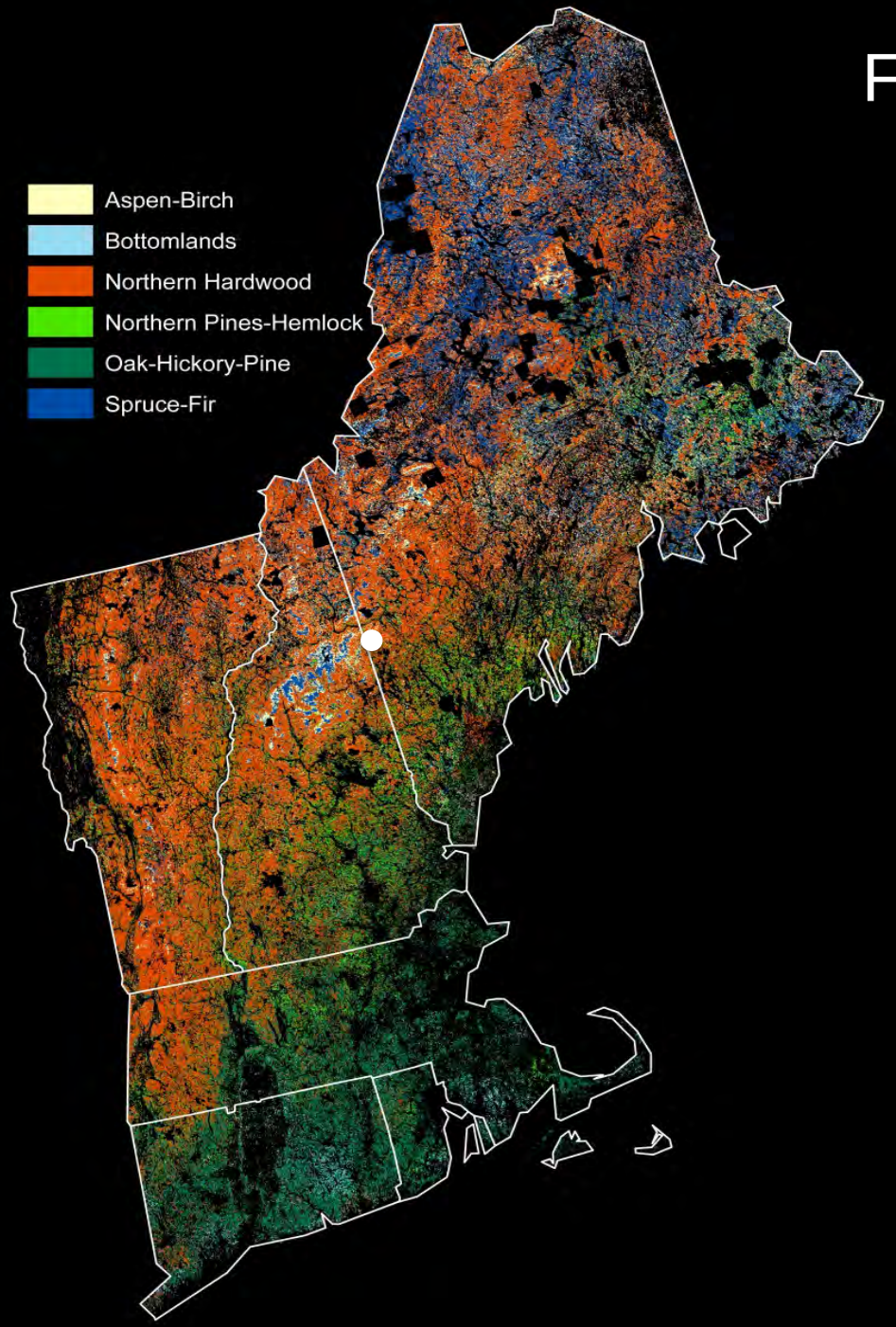
Vegetation

Hemlock-red maple

Climate

RCP 8.5 Temp, CO_2

Future Hot MegaDrought



Models

Landis-II with PnET Succession
ForClim with VS-lite

Vegetation

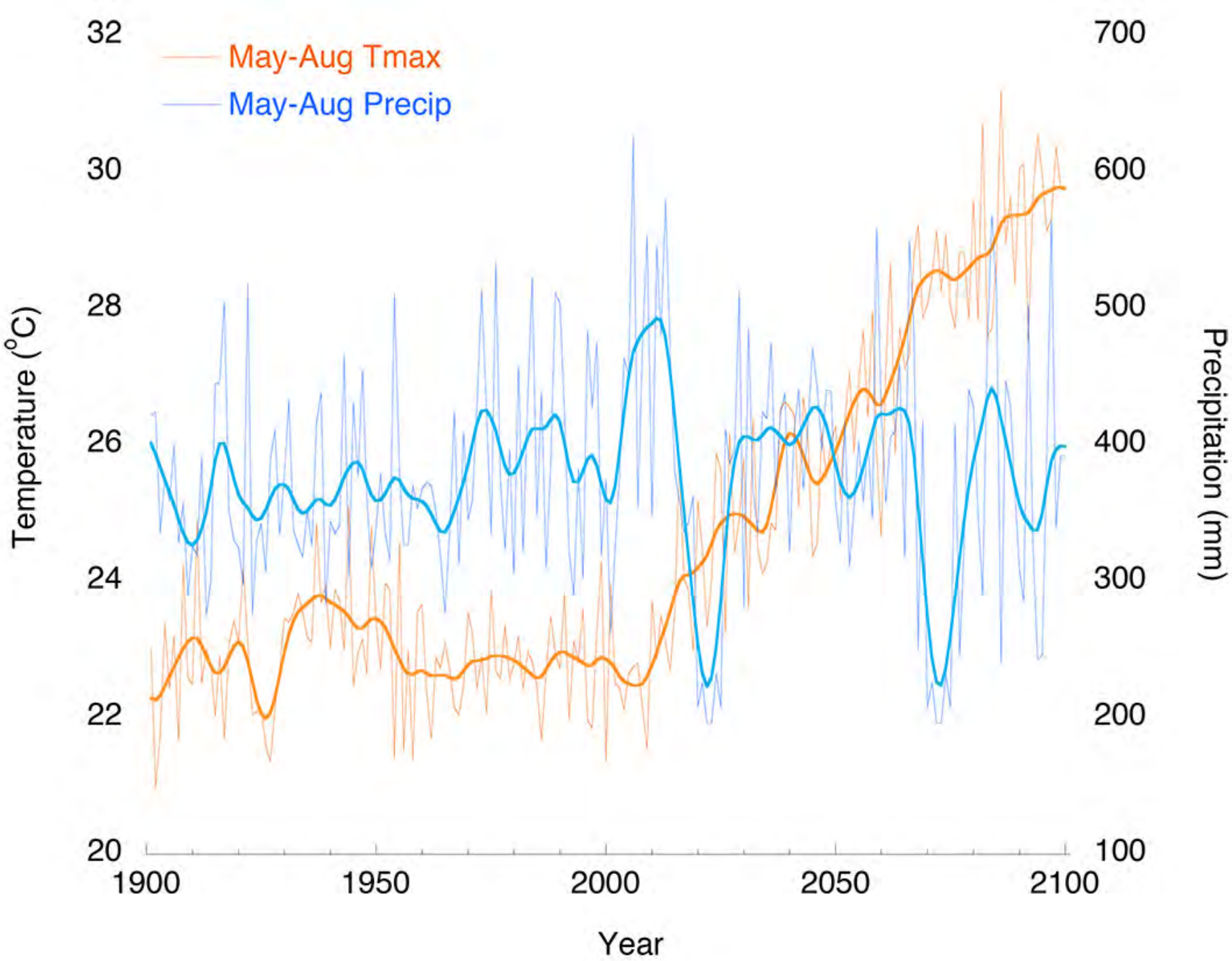
Hemlock-red maple

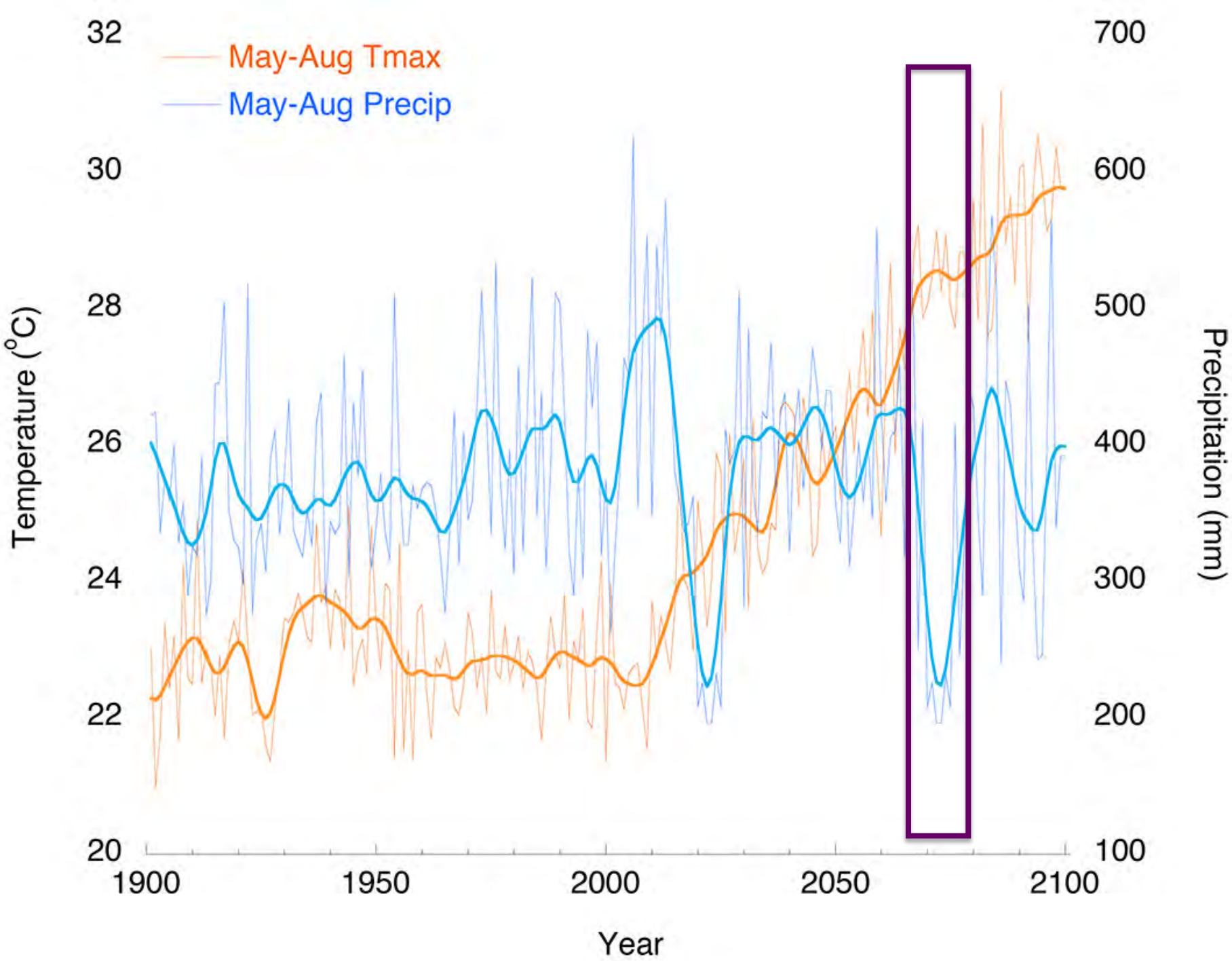
Climate

RCP 8.5 Temp, CO_2

Synthetic MegaDroughts

6 yrs long, 2017, 2070


May-Aug Tmax
May-Aug Precip
Temperature (°C)
Precipitation (mm)
Year
32
30
28
26
24
22
20
700
600
500
400
300
200
100
1900
1950
2000
2050
2100


May-Aug Tmax
May-Aug Precip
Temperature (°C)
Precipitation (mm)
Year
32
30
28
26
24
22
20
700
600
500
400
300
200
100
1900
1950
2000
2050
2100


Jarek Tuszynski photo

Why?

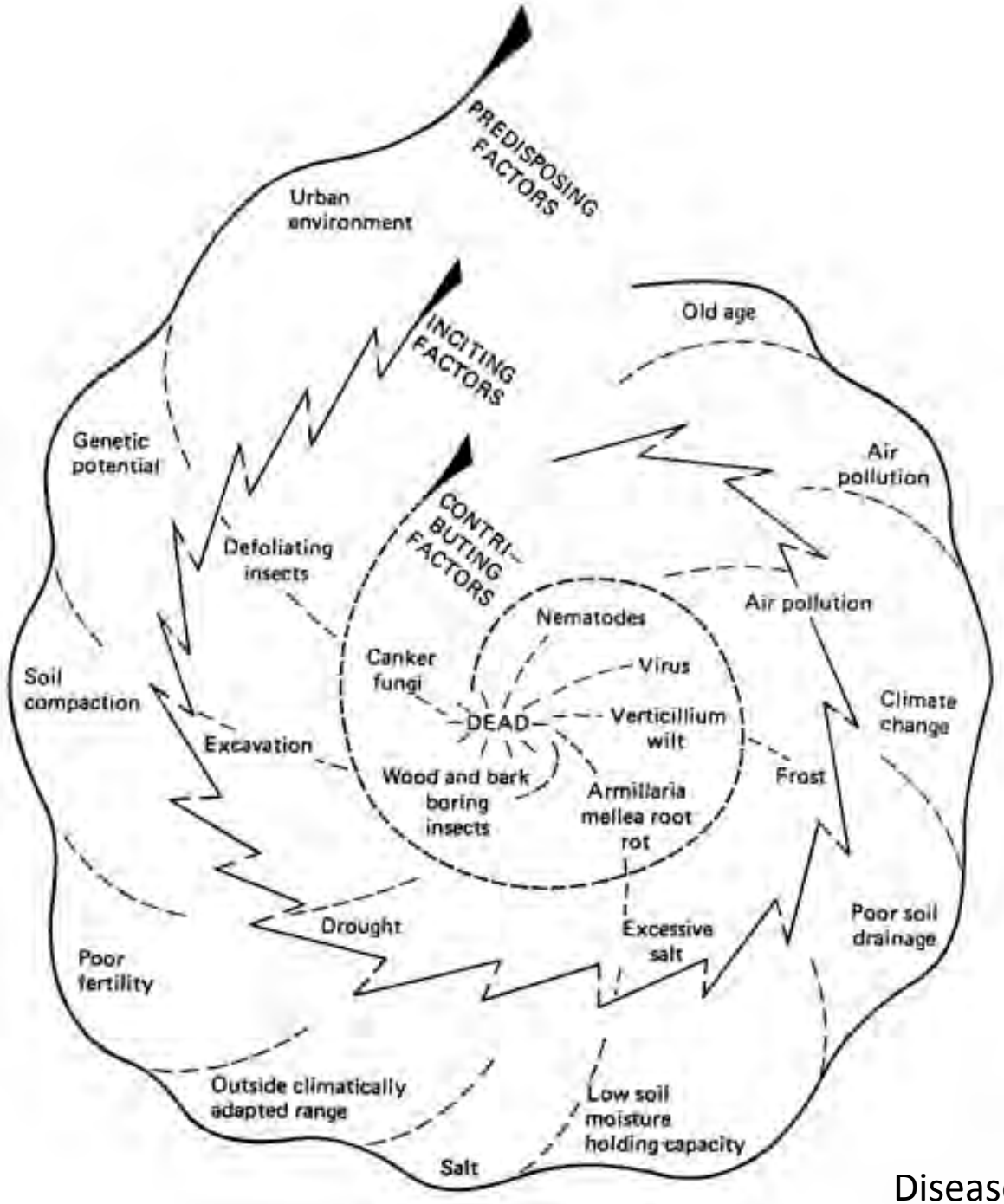

Aug 2, 2016
Resistant?

Levesque et al., in review

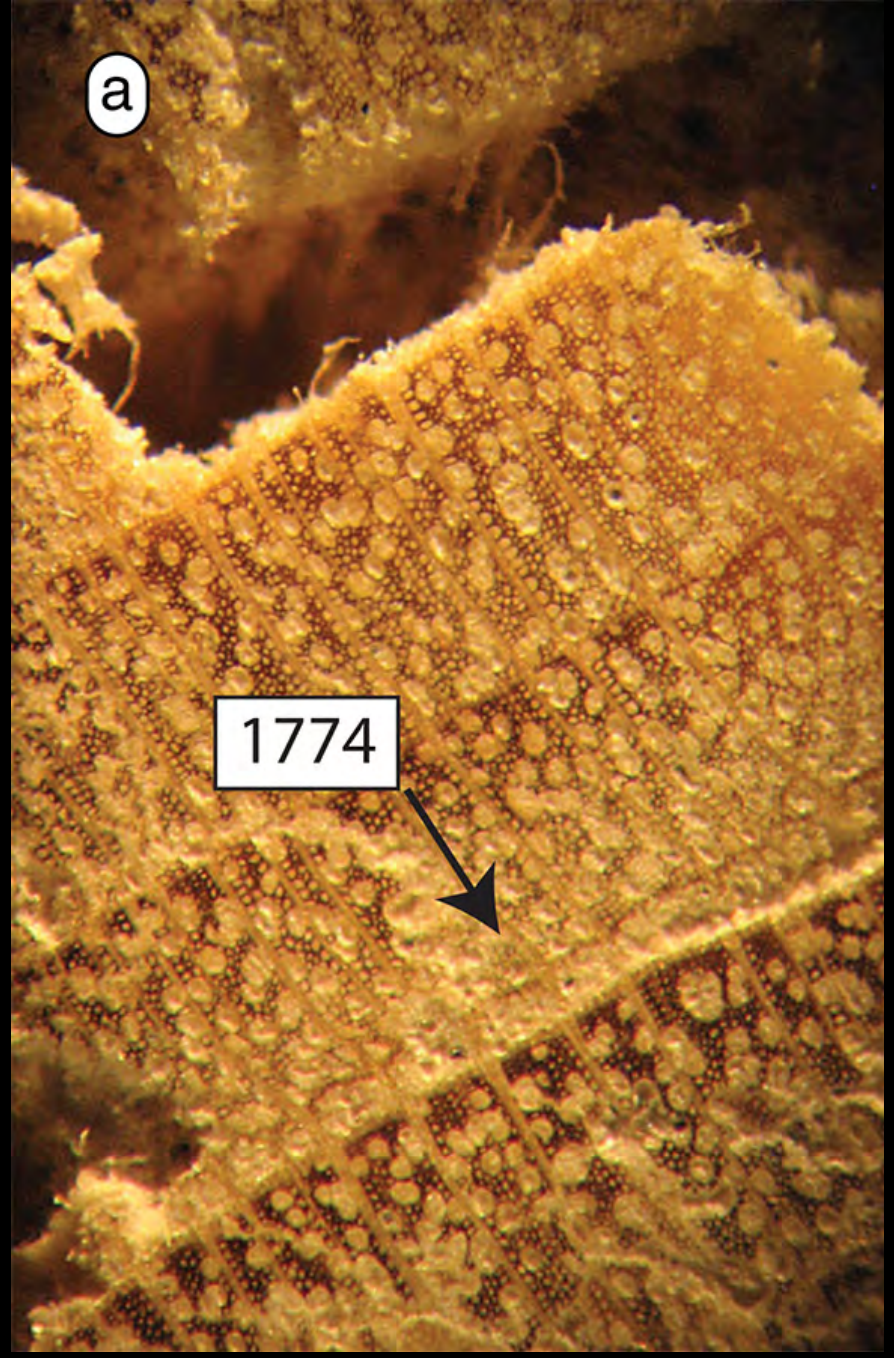
CO_2?

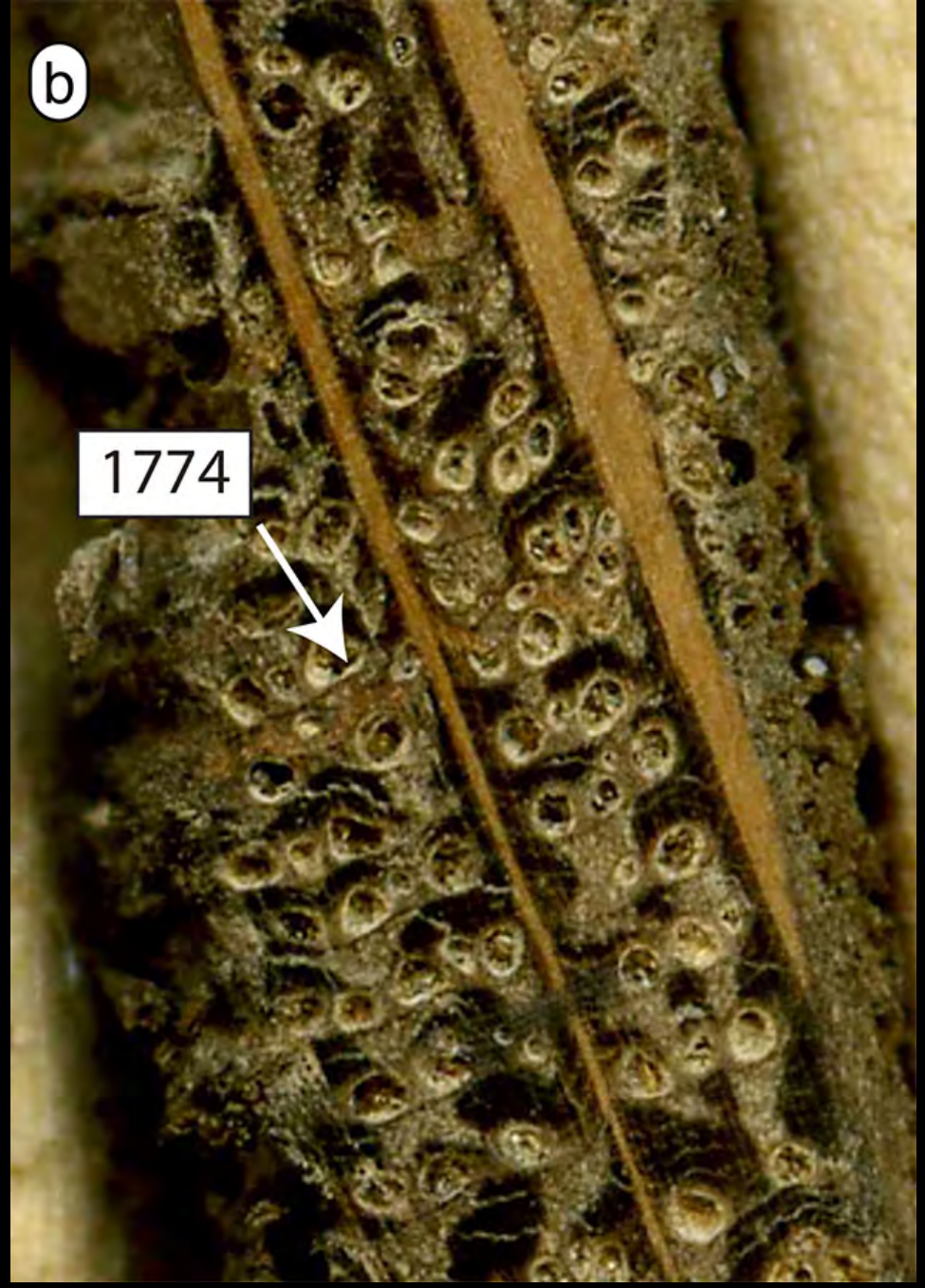
Image: A.Barker-Plotkin

Soil Water Holding Capacity?



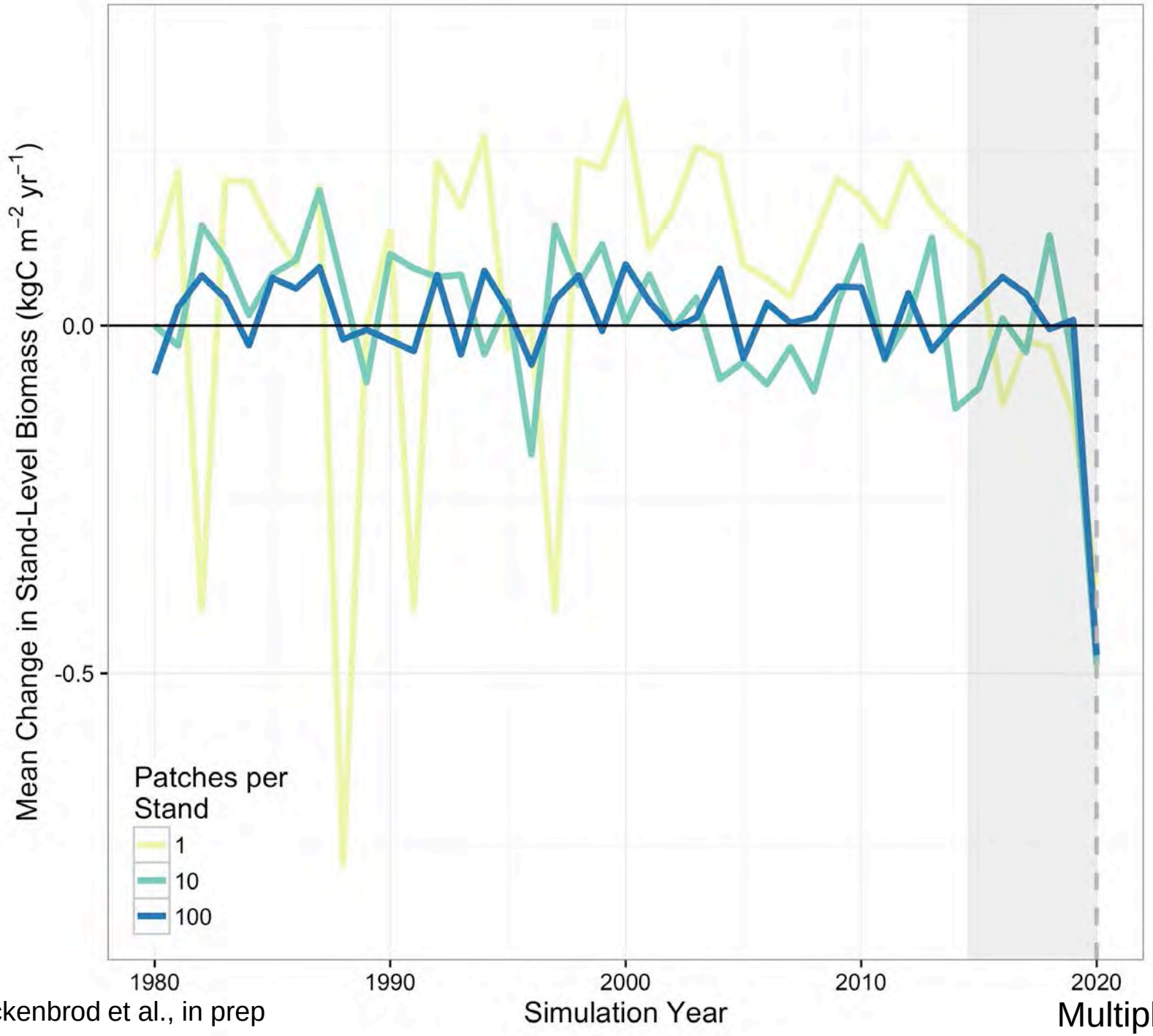
Disease-decline spiral - Manion (1981)





Pederson et al., 2014

Multiple Factors?

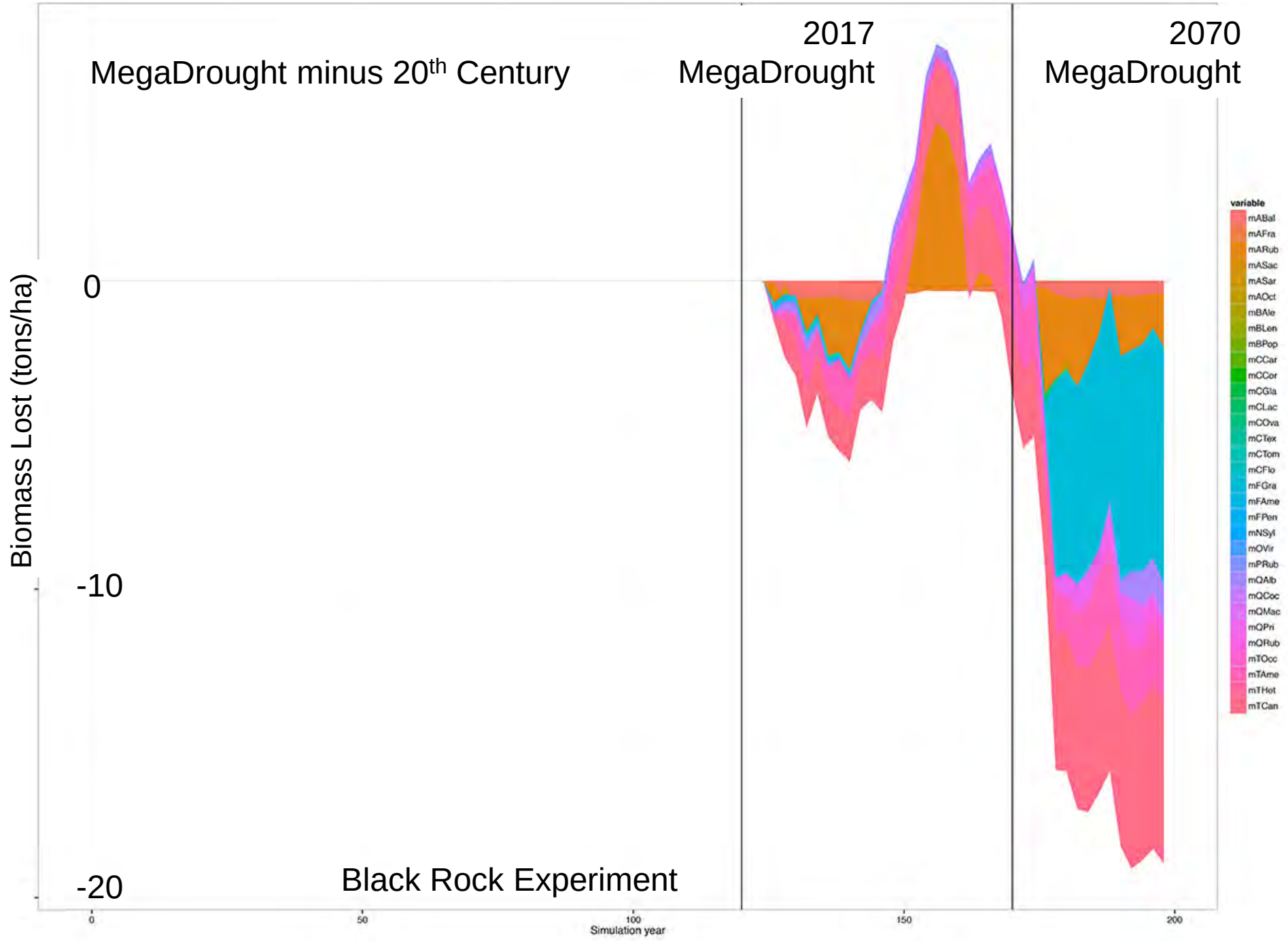


Druckenbrod et al., in prep

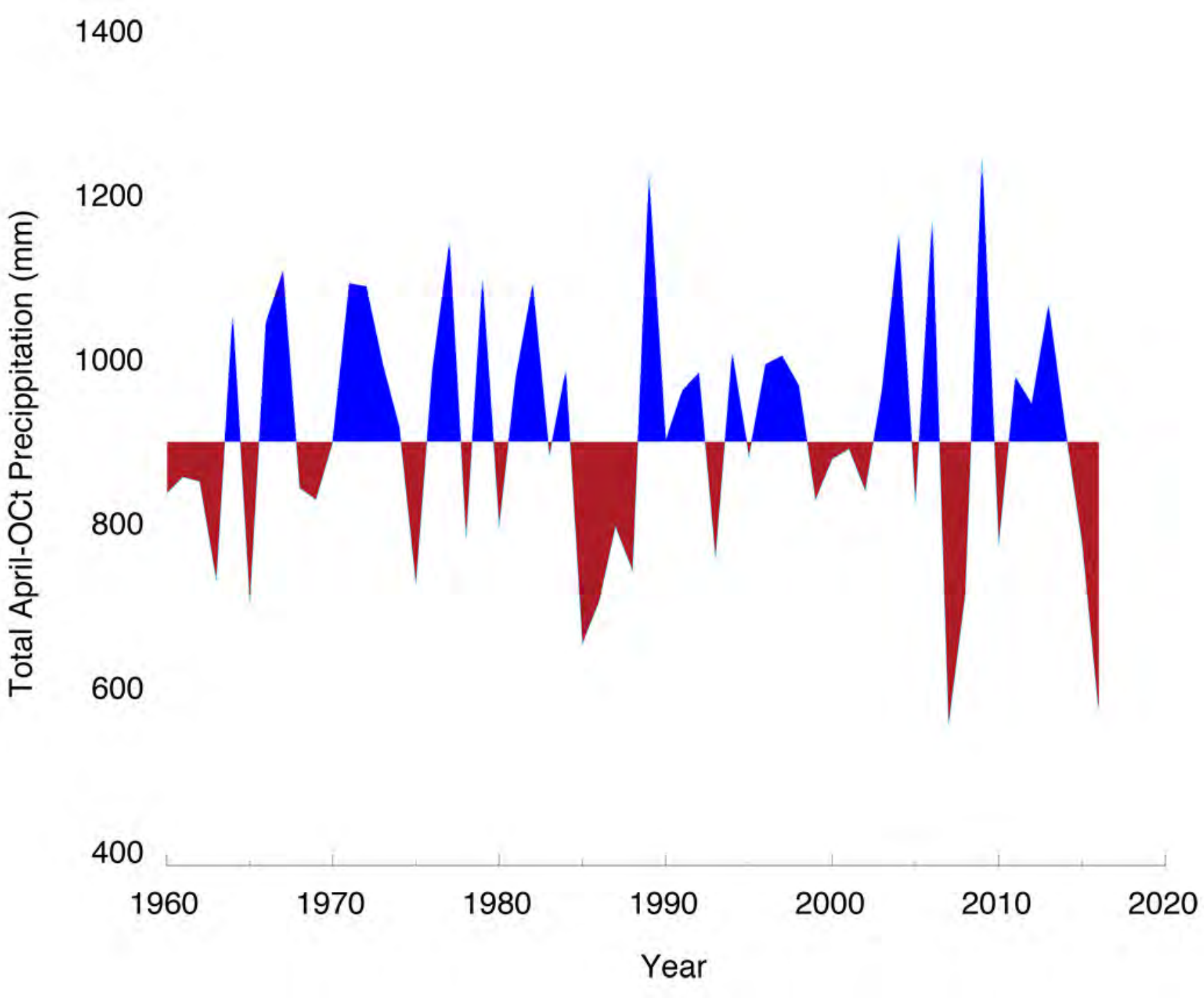
Multiple Factors?

http://easy.coffeecravingsdaily.com/

Iced Coffee?

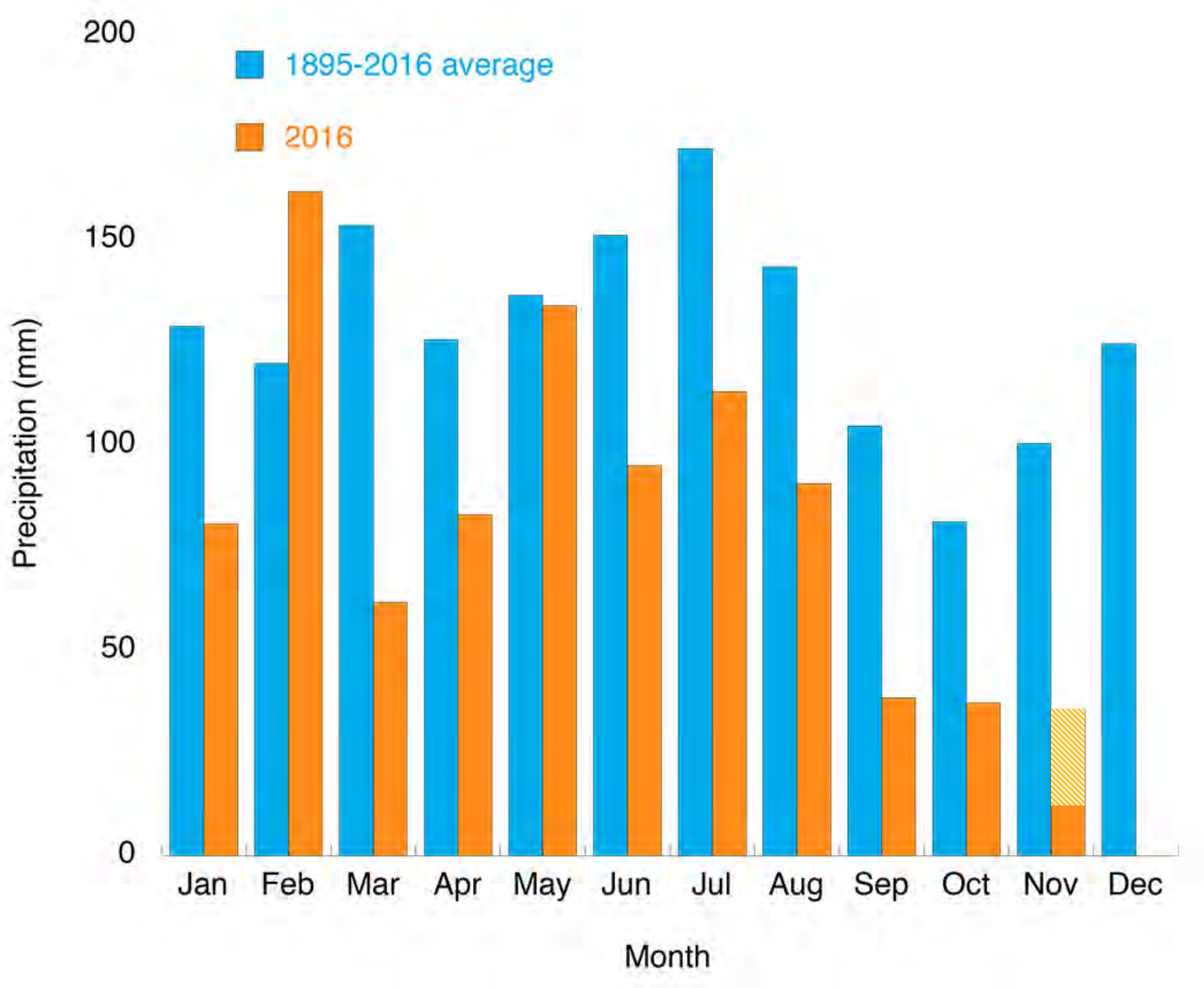

MegaDrought minus 20th Century
2017
MegaDrought
2070
MegaDrought
Biomass Lost (tons/ha)
0
-10
-20
Black Rock Experiment
0
50
100
150
200
Simulation year
variable
mABal
mAFra
mARub
mASac
mASar
mAOct
mBAle
mBLen
mBPop
mCCar
mCCor
mCGla
mCLac
mCOva
mCTex
mCTom
mCFlo
mFGra
mFAme
mFPen
mNSyl
mOVir
mPRub
mQAlb
mQCoc
mQMac
mQPri
mQRub
mTOcc
mTAme
mTHot
mTCan


KITV

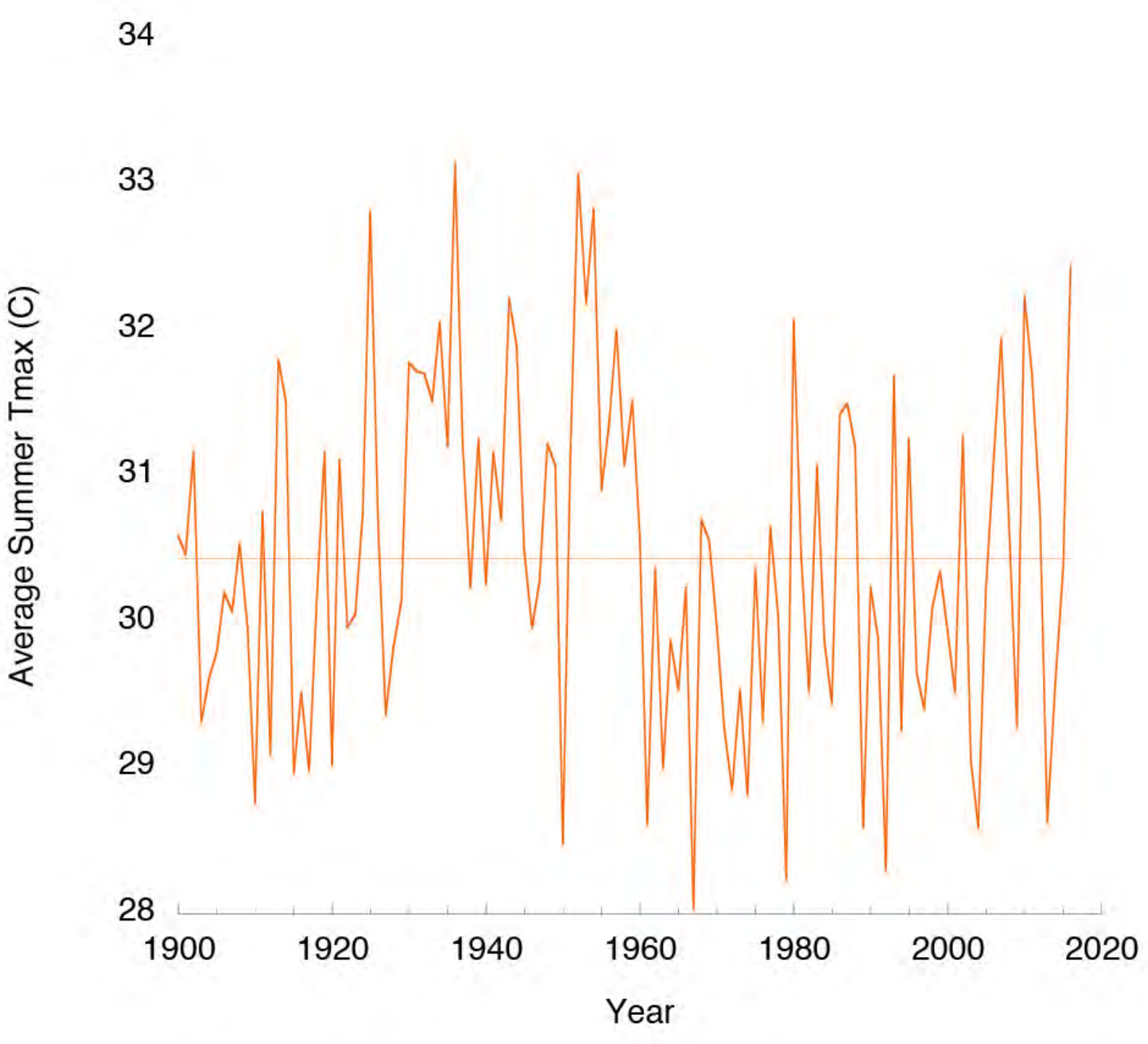


Gatlinburg Growing Season Precipitation

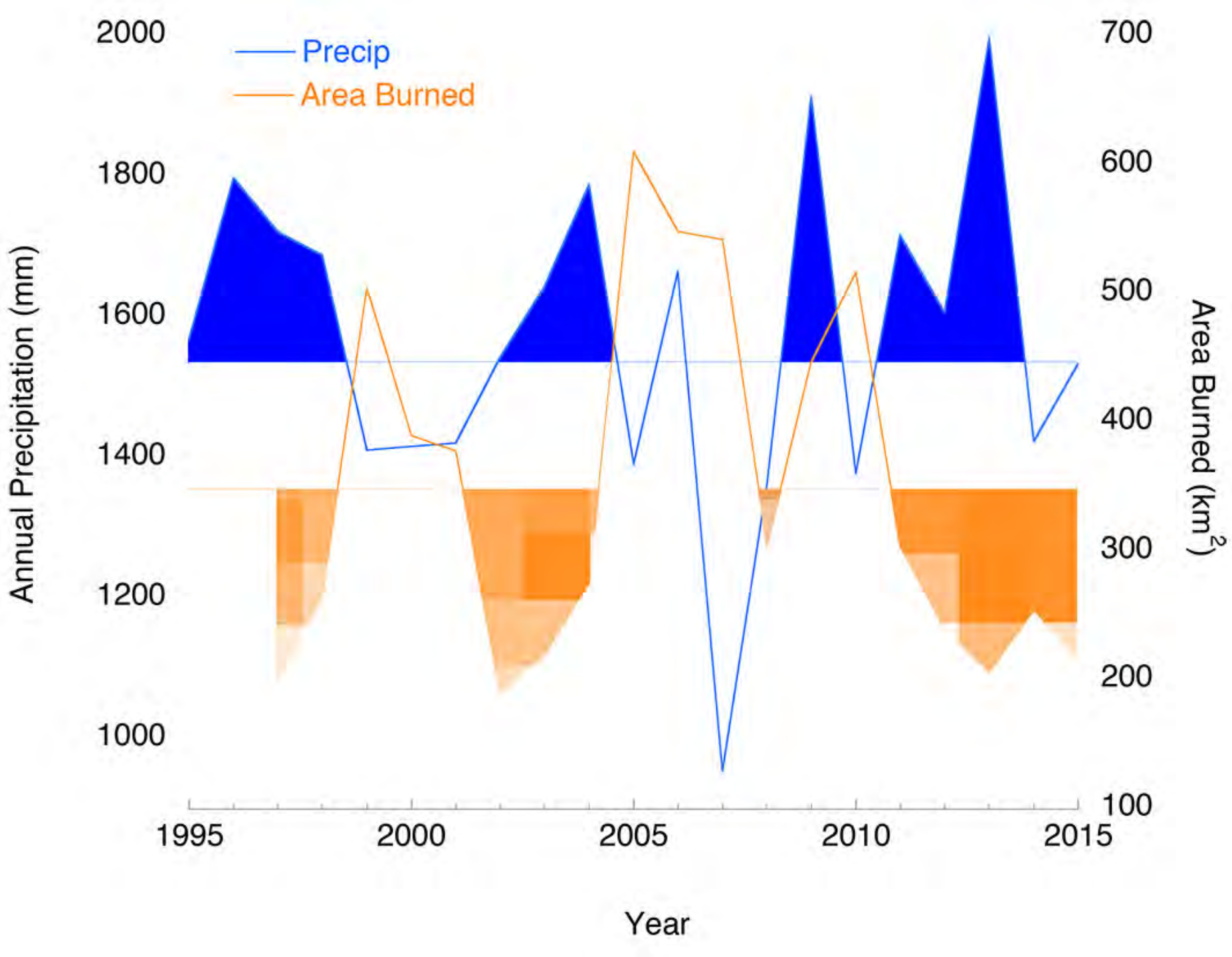
Gatlinburg



Provisional November Data Courtesy of Derek Ardnt

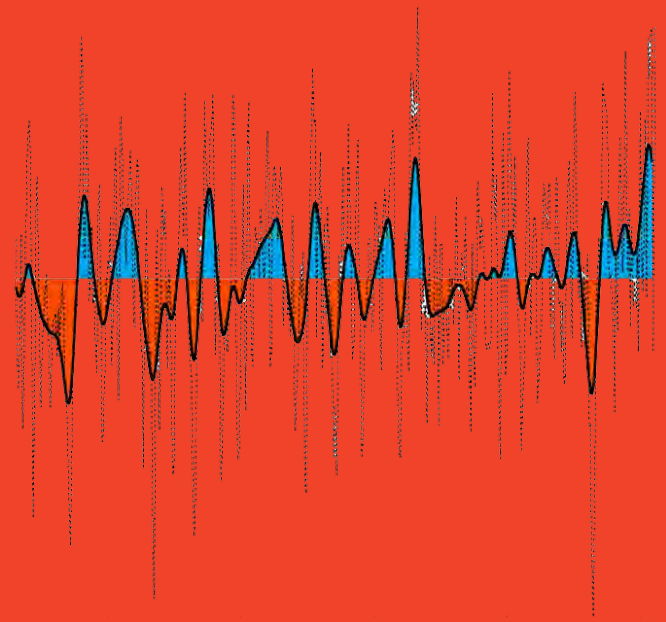


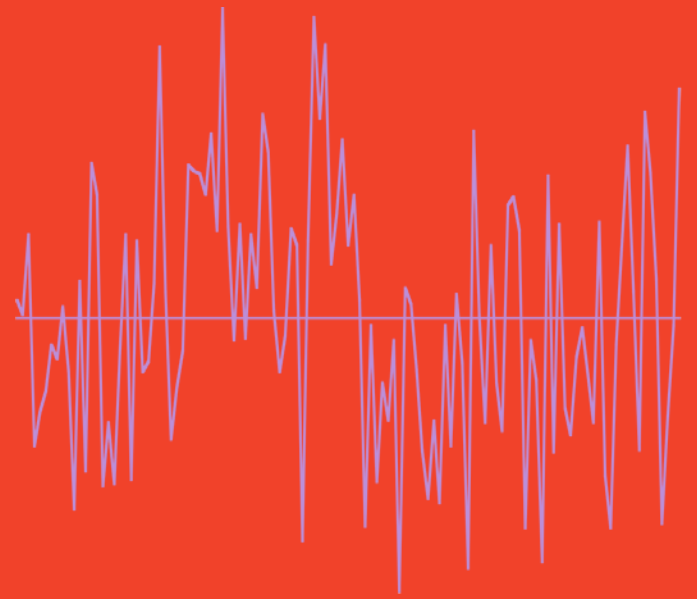
Southern Appalachian Summer Max Temperatures


Precip
Area Burned
2000
1800
1600
1400
1200
1000
700
600
500
400
300
200
100
Annual Precipitation (mm)
Area Burned (km^2)
1995
2000
2005
2010
2015
Year

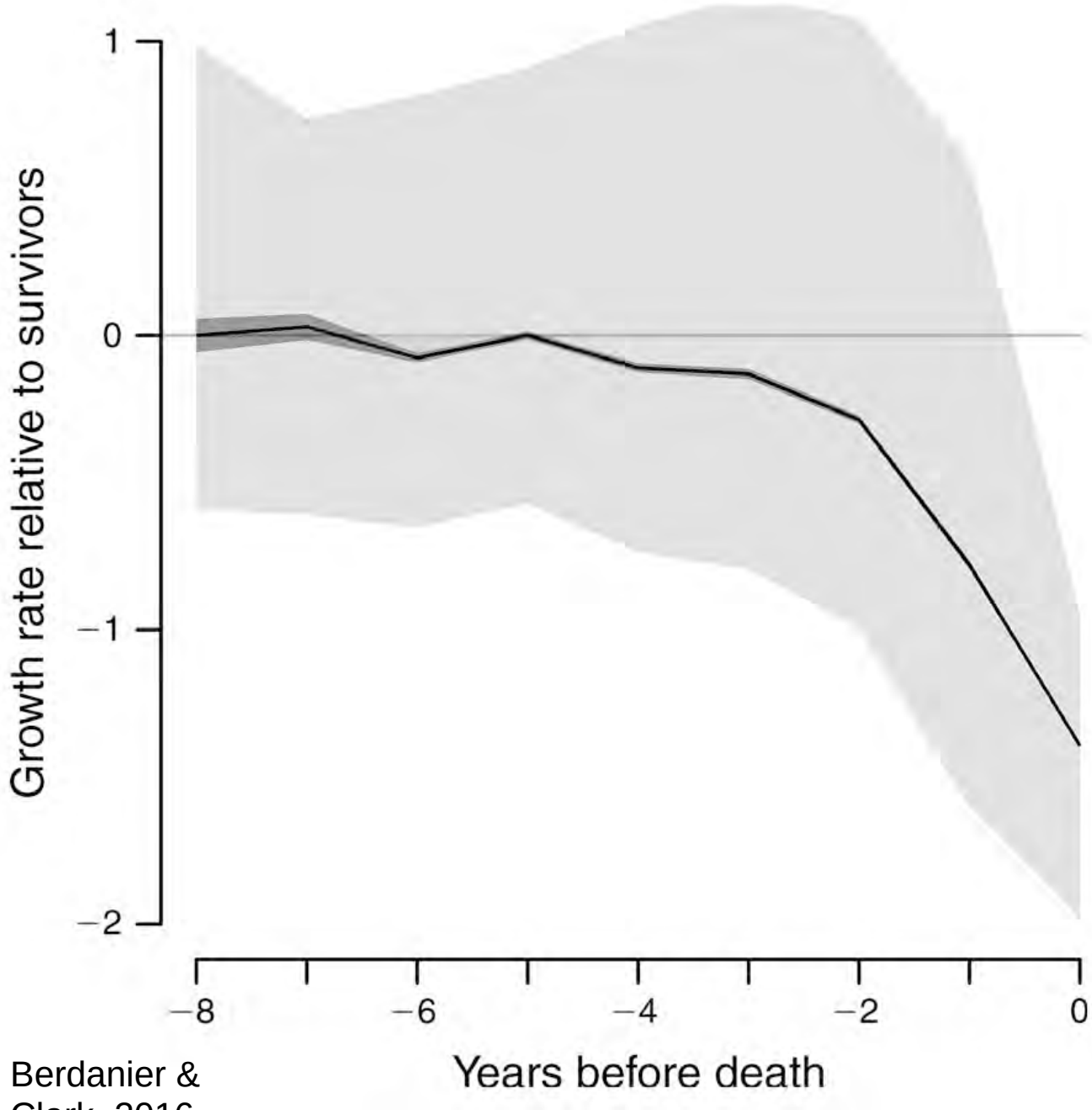
Regional scale mortality,
- recruitment, too?

Climatic Optimum?
- not hot [yet]





Vulnerability?



Berdanier &
Clark, 2016

Legacy?