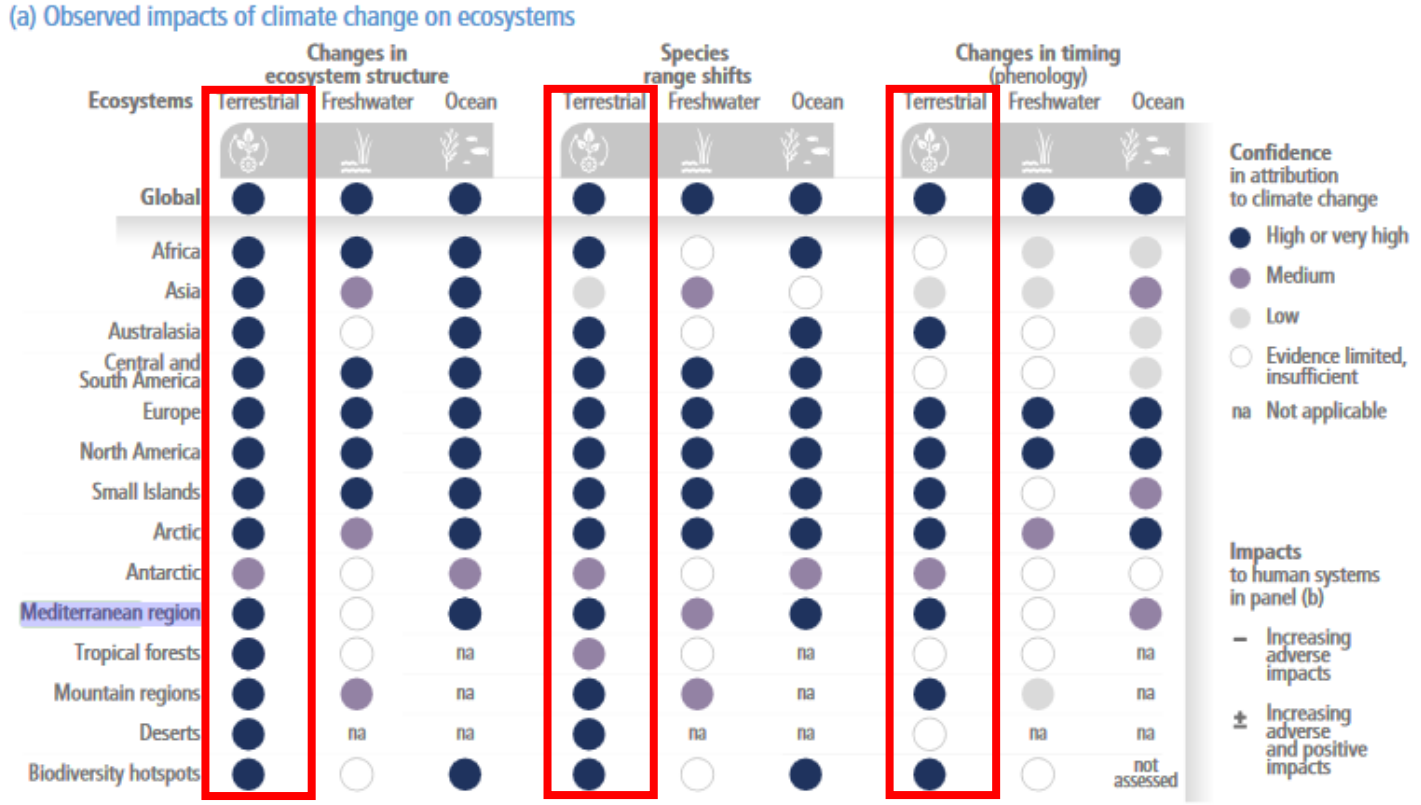
8TH ANNUAL MEETING OF THE EUROPEAN INTEGRATE NETWORK

Connecting knowledge to action

Adaptation and management for more resilient forests to drought

Andrés Bravo-Oviedo
Forest Researcher
Dept. Biogeography and Global Change
National Museum of Natural Sciences - CSIC

Adaptation and management for more resilient forests to drought



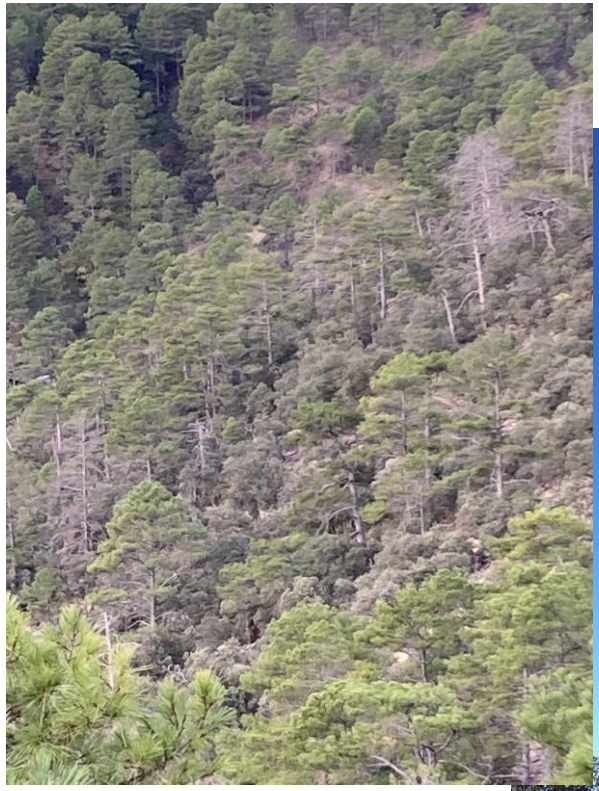
IPCC 2022

- *Warmer world*
- *Global precipitation increase*
- *Spatial variation*
- *Contrast between seasons*
- *Longer drought periods*
- *More frequent heat weaves*

Adaptation and management for more resilient forests to drought

Consequences

- More frequent drought-stress mortality
- Lower secondary growth
- Regeneration failure



Resilience of what to what????

Adaptation and management for more resilient forests to drought

Consequences

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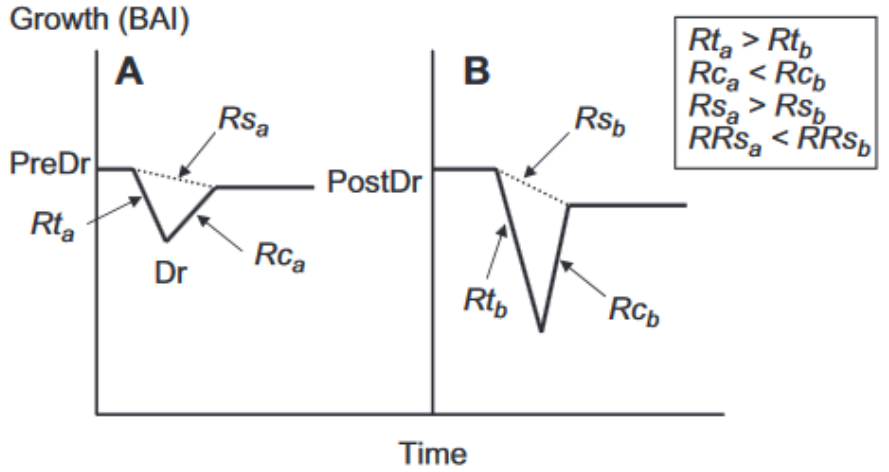


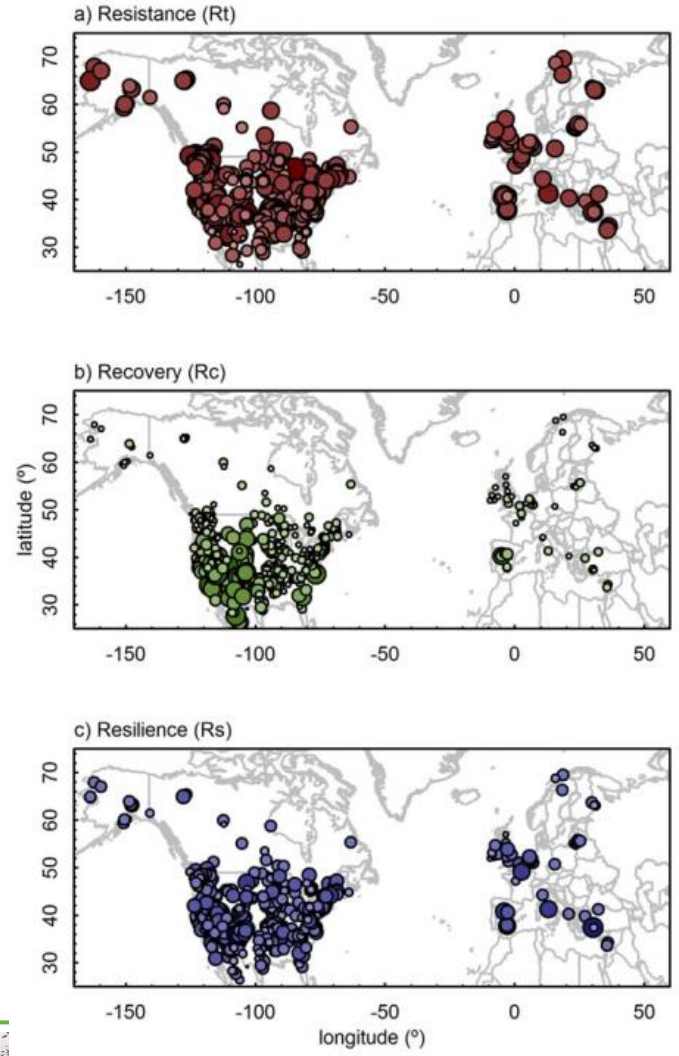
Resistance *Rt* = Dr/PreDr
Recovery *Rc* = PostDr/Dr
Resilience *Rs* = PostDr/PreDr
Relative resilience *RRs* = ((PostDr-Dr)/(PreDr-Dr)) (1-(Dr/PreDr))

OIKOS ADVANCING ECOLOGY

Components of tree resilience: effects of successive low-growth episodes in old ponderosa pine forests

Francisco Lloret, Eric G. Keeling, Anna Sala

Adaptation and management for more resilient forests to drought



Temperate broadleaf forests in wet regions ↑ resistance

Conifer forests in dry regions ↑ recovery

Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2016)

RESEARCH PAPER

Impacts of droughts on the growth resilience of Northern Hemisphere forests

A. Gazol[1], J. J. Camarero[1]*, W. R. L. Anderegg[2,3] and S. M. Vicente-Serrano[1]

Adaptation and management for more resilient forests to drought

Factors shaping resilience response

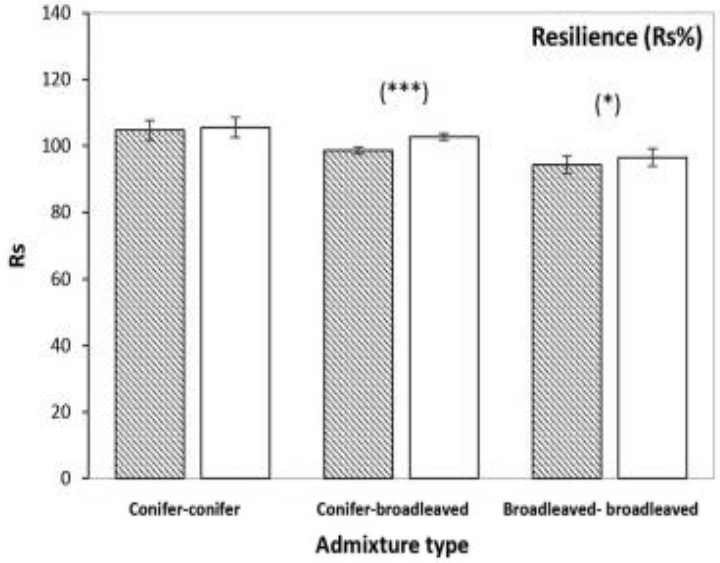
Species composition

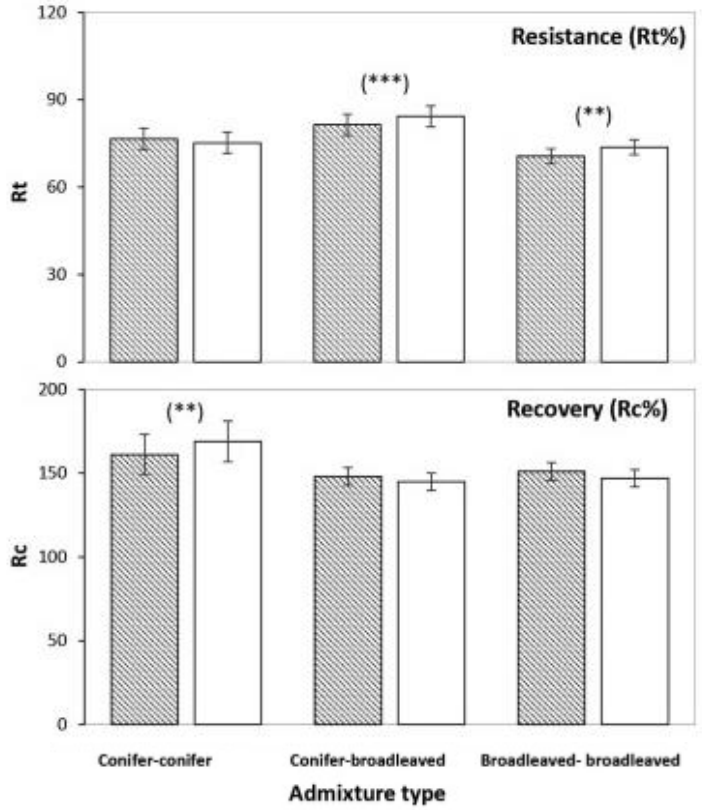
Density control

Ontogenic development

Adaptation and management for more resilient forests to drought

Observed patterns – Species composition





ELSEVIER

Forest Ecology and Management

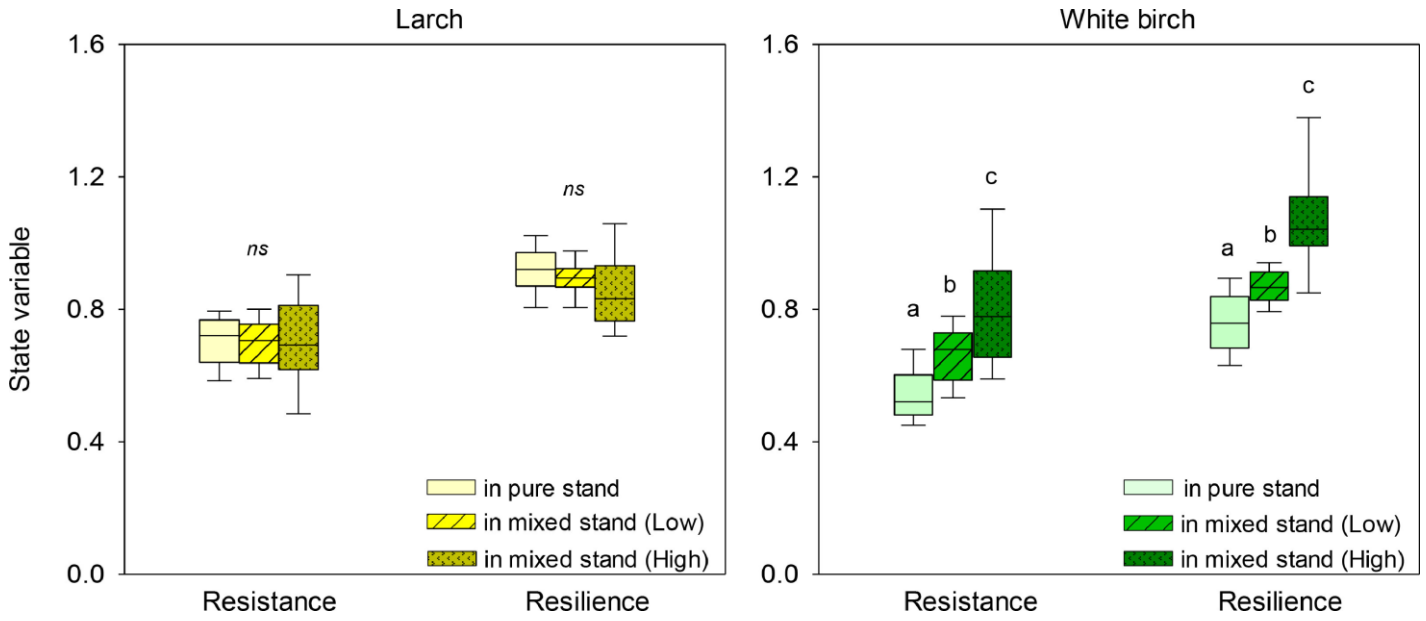
Volume 481, 1 February 2021, 118687

The greater resilience of mixed forests to drought mainly depends on their composition: Analysis along a climate gradient across Europe

M. Pardos [a, b], M. del Río [a, b], H. Pretzsch [c], H. Jactel [d], K. Bielak [e], F. Bravo [b, f], G. Brazaitis [g], E. Defossez [h], M. Engel [i], K. Godvod [g], K. Jacobs [j], L. Jansone [k], A. Jansons [k], X. Morin [l], A. Nothdurft [i], L. Oreti [m], Q. Ponette [j], M. Pach [n] ... R. Calama [a, b]

Adaptation and management for more resilient forests to drought

Observed patterns – Species composition



ELSEVIER

Agricultural and Forest Meteorology
Volume 325, 15 October 2022, 109137

Mixed forest suffered less drought stress than pure forest in southern Siberia

Jing Cao [a], Hongyan Liu [a], Bo Zhao [b], Ruonan Peng [a], Boyi Liang [c], Oleg A. Anenkhonov [d], Andrey Yu. Korolyuk [e], Denis V. Sandanov [d]

Adaptation and management for more resilient forests to drought

Observed patterns – Species composition

ELSEVIER

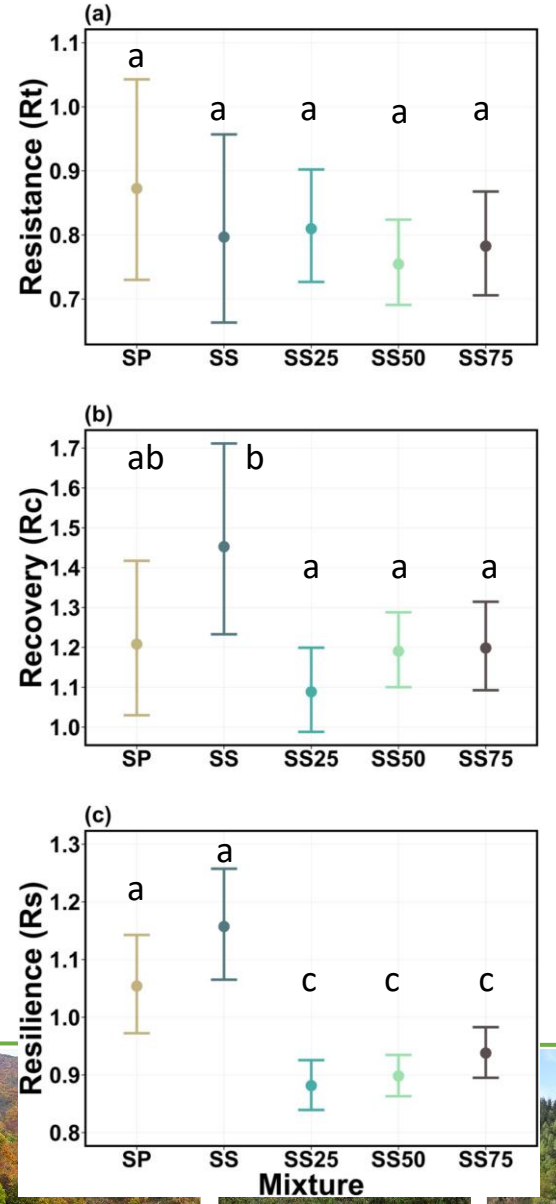
Forest Ecology and Management

Volume 521, 1 October 2022, 120448

Intimate mixtures of Scots pine and Sitka spruce do not increase resilience to spring drought

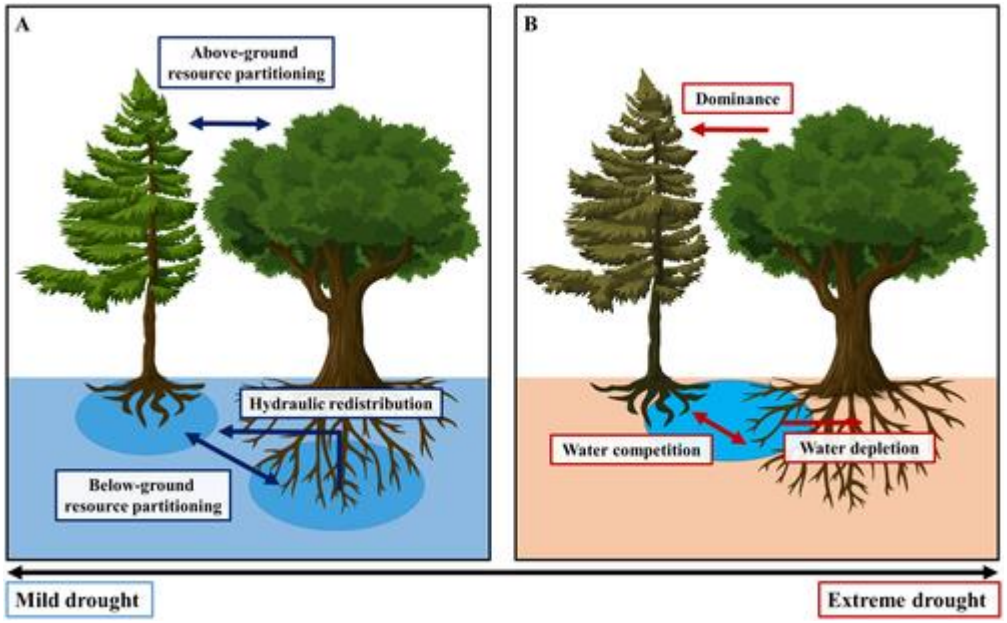
Thomas S. Ovenden [a, b], Mike P. Perks [b], David I. Forrester [c], Maurizio Mencuccini [d, e], Jazz Rhoades [a], Danielle L. Thompson [f], Victoria J. Stokes [b], Alistair S. Jump [a]

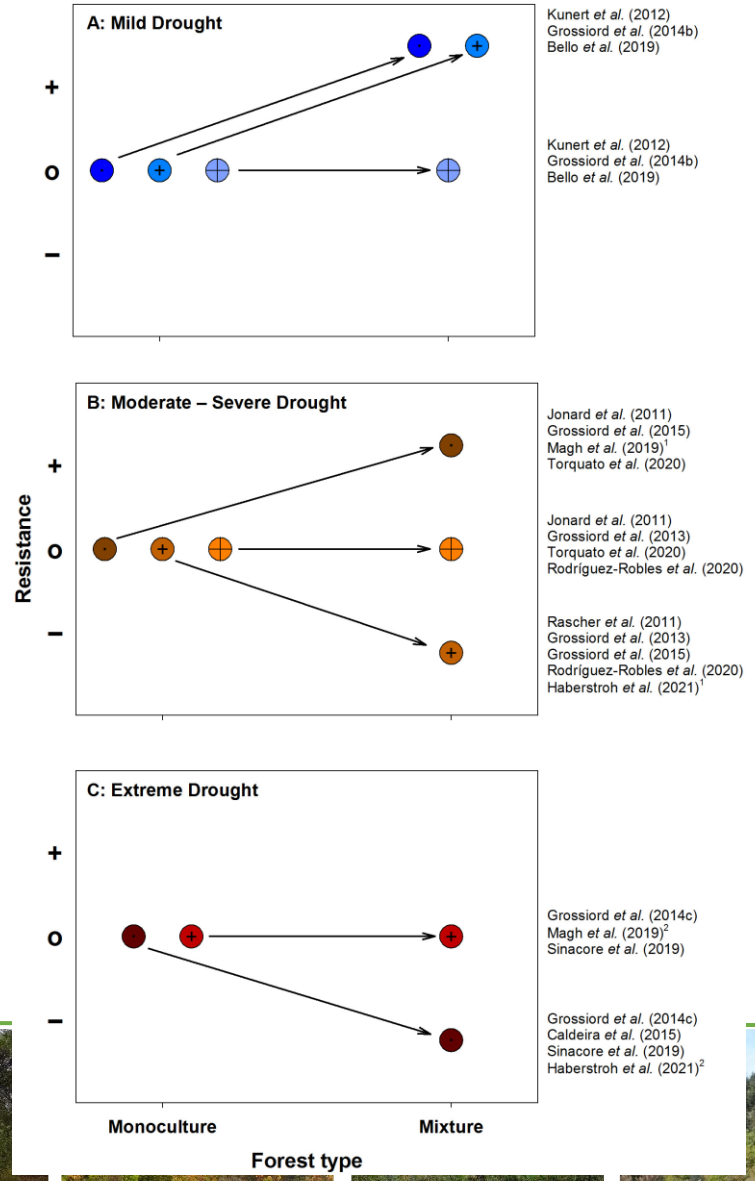
SP: Scots pine; SS: Sitka spruce

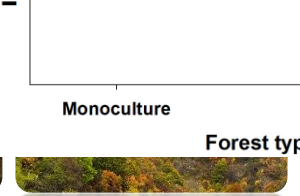


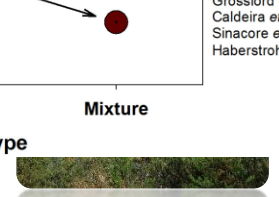
Adaptation and management for more resilient forests to drought

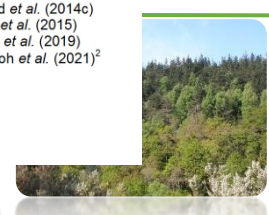
Observed patterns - Species composition





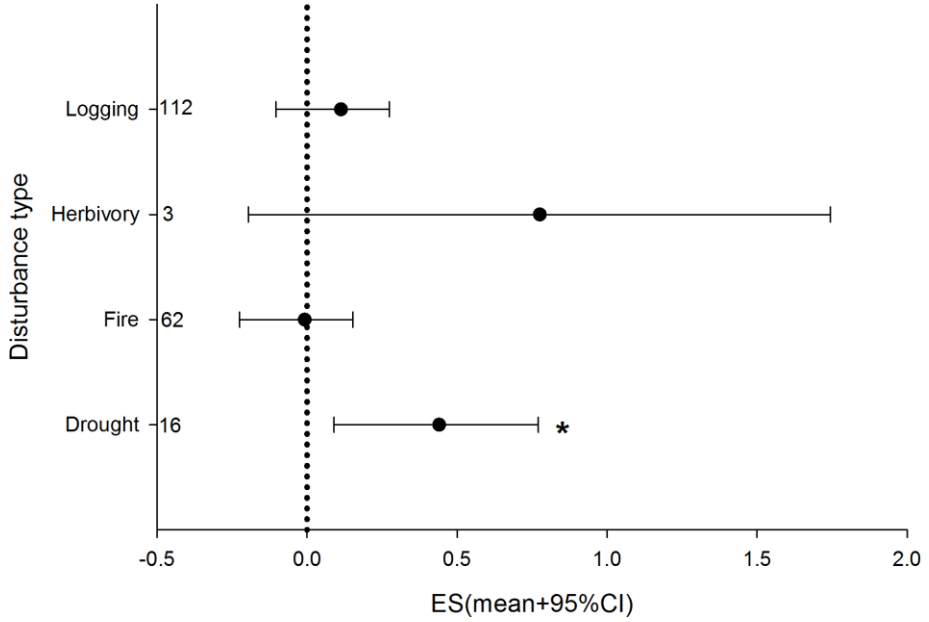






Adaptation and management for more resilient forests to drought

Observed patterns – Density control



Biomass reduction effect across disturbance type

Only resilience to drought is enhanced

PLOS ONE

OPEN ACCESS PEER-REVIEWED

RESEARCH ARTICLE

Forest resilience under global environmental change: Do we have the information we need? A systematic review

Inés Ibáñez, Kirk Acharya, Edith Juno, Christopher Karounos, Benjamin R. Lee, Caleb McCollum, Samuel Schaffer-Morrison, Jordon Tourville

Adaptation and management for more resilient forests to drought

Observed patterns – Density control

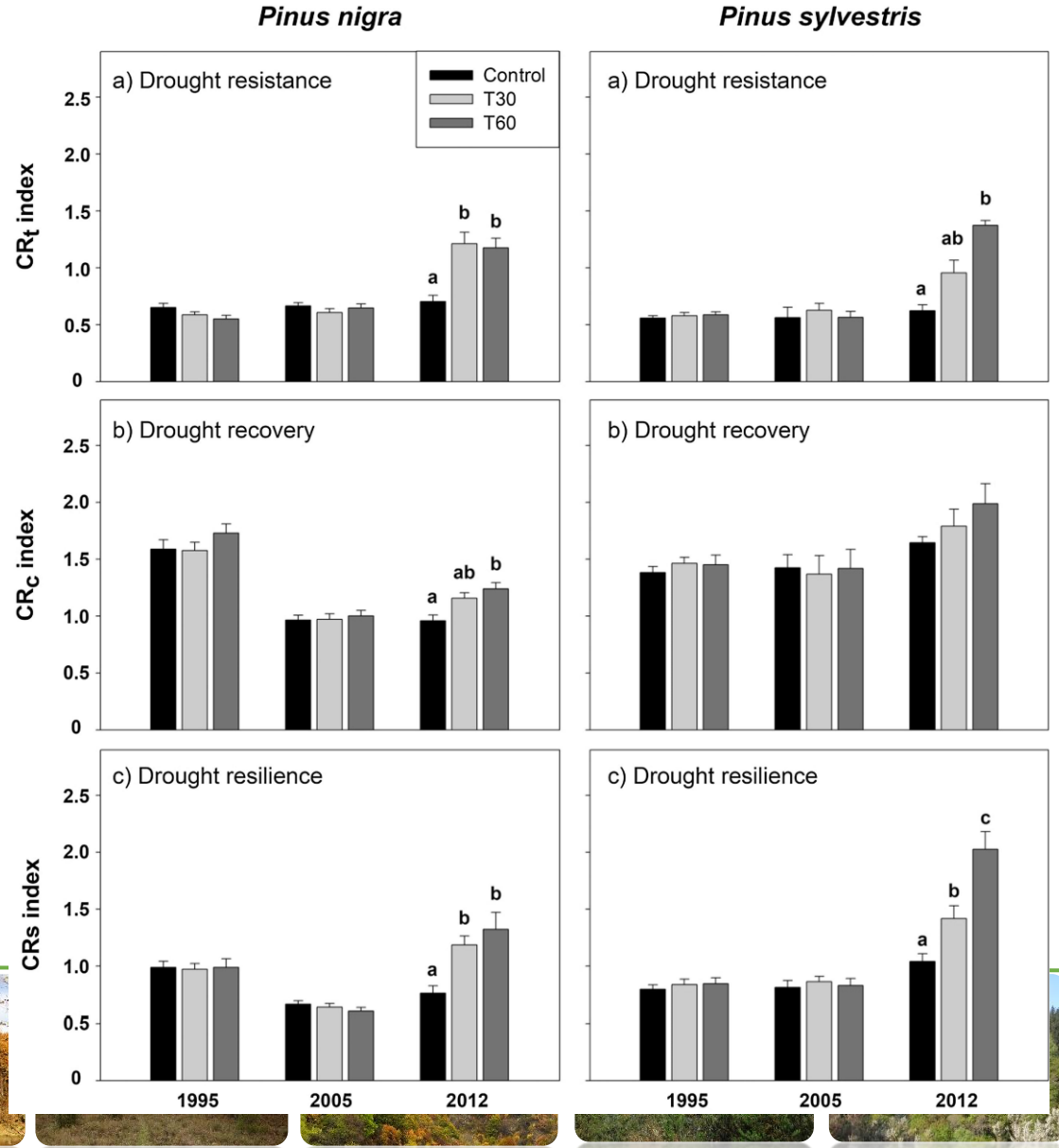
ELSEVIER

Forest Ecology and Management

Volume 433, 15 February 2019, Pages 313-324

Is thinning an alternative when trees could die in response to drought? The case of planted *Pinus nigra* and *P. Sylvestris* stands in southern Spain

Rafael M. Navarro-Cerrillo [a, 1], Raúl Sánchez-Salguero [b, 1], Carlos Rodriguez [a], Joaquín Duque Lazo [a], José M. Moreno-Rojas [c], Guillermo Palacios-Rodriguez [a], J. Julio Camarero [d]



Adaptation and management for more resilient forests to drought

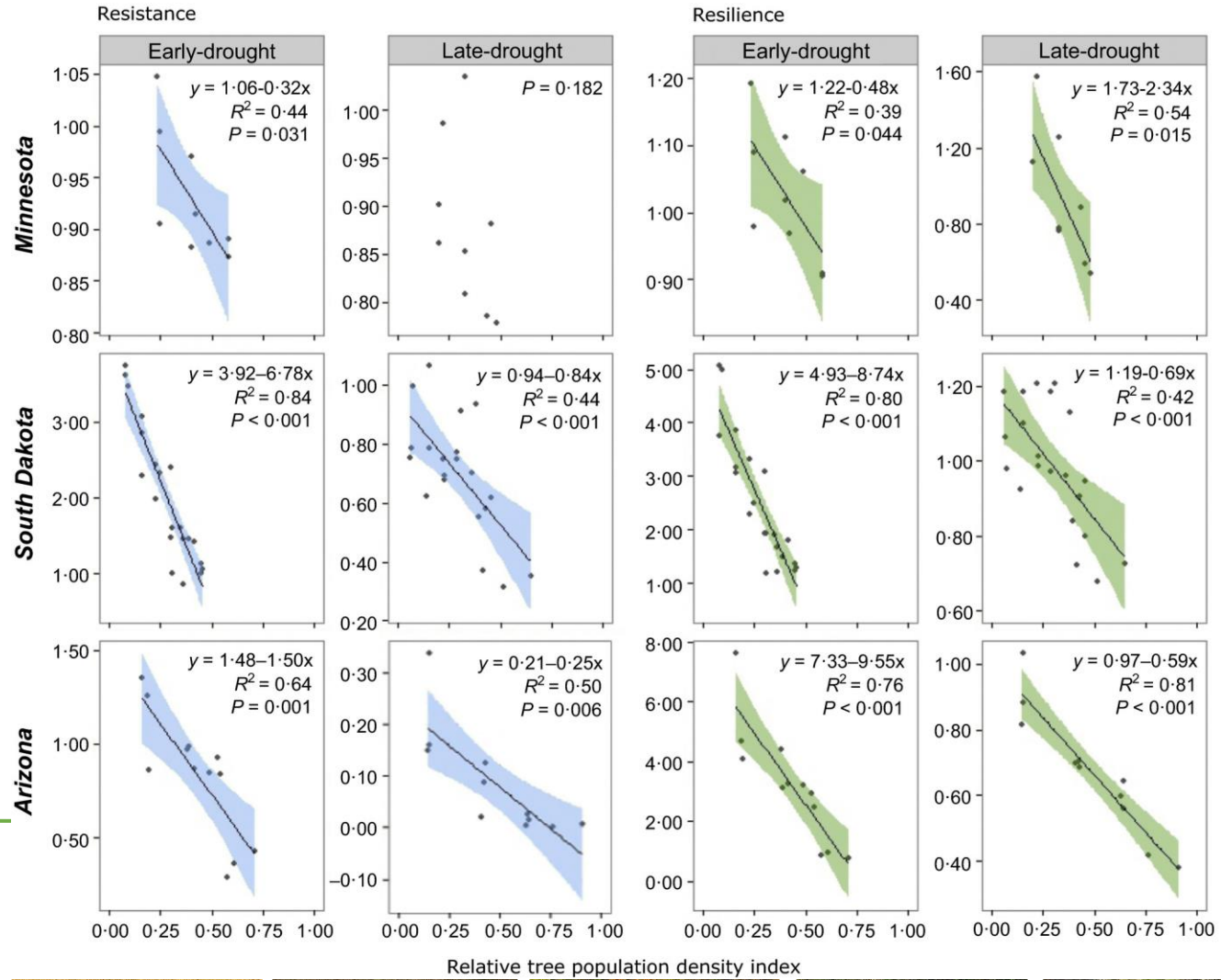
Observed patterns – Density control

Journal of Applied Ecology
BRITISH ECOLOGICAL SOCIETY

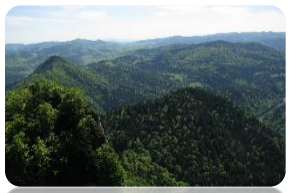
Standard Paper | Free Access

Density-dependent vulnerability of forest ecosystems to drought

Alessandra Bottero, Anthony W. D'Amato, Brian J. Palik, John B. Bradford, Shawn Fraver, Mike A. Battaglia, Lance A. Asherin

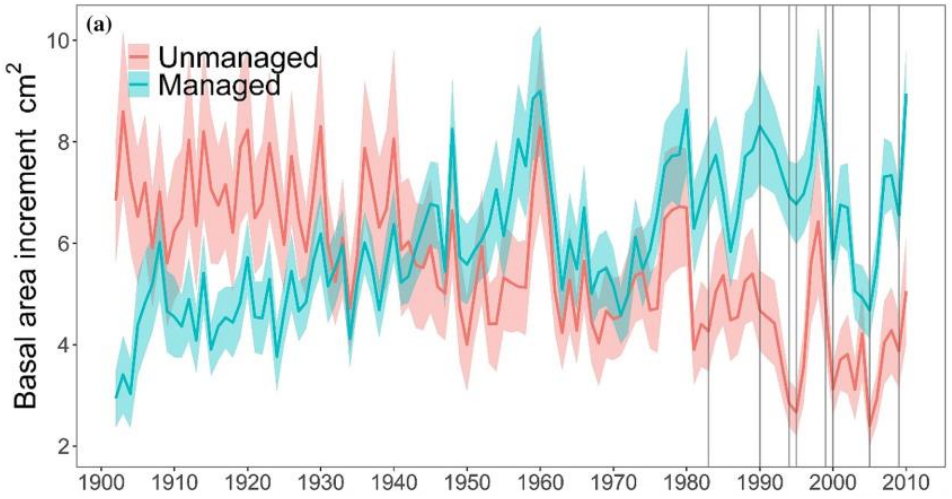


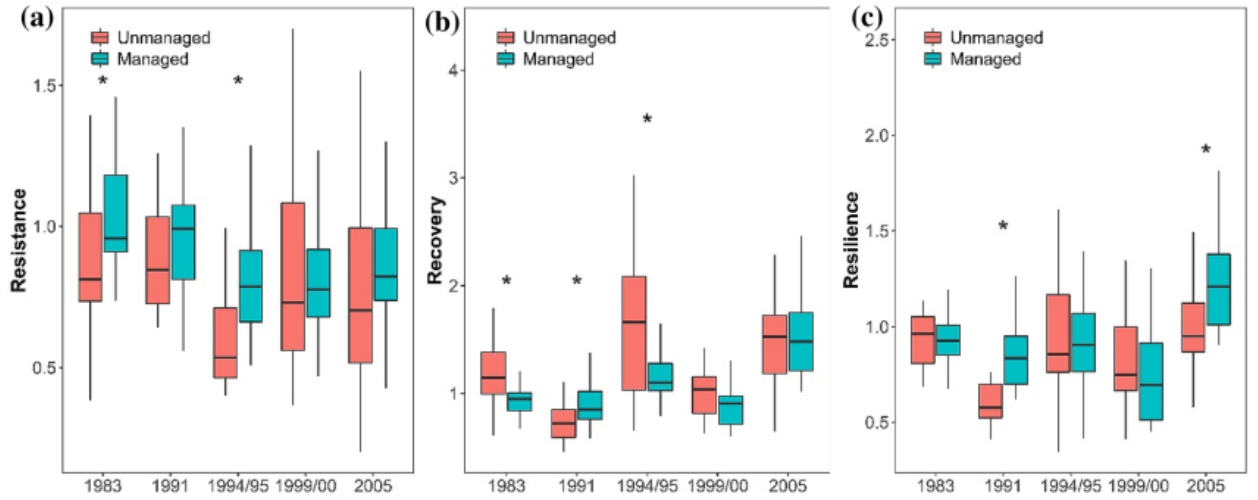


Adaptation and management for more resilient forests to drought

Observed patterns – Density control (long term)





Trees (2021) 35:1651–1662
https://doi.org/10.1007/s00468-021-02143-6

ORIGINAL ARTICLE

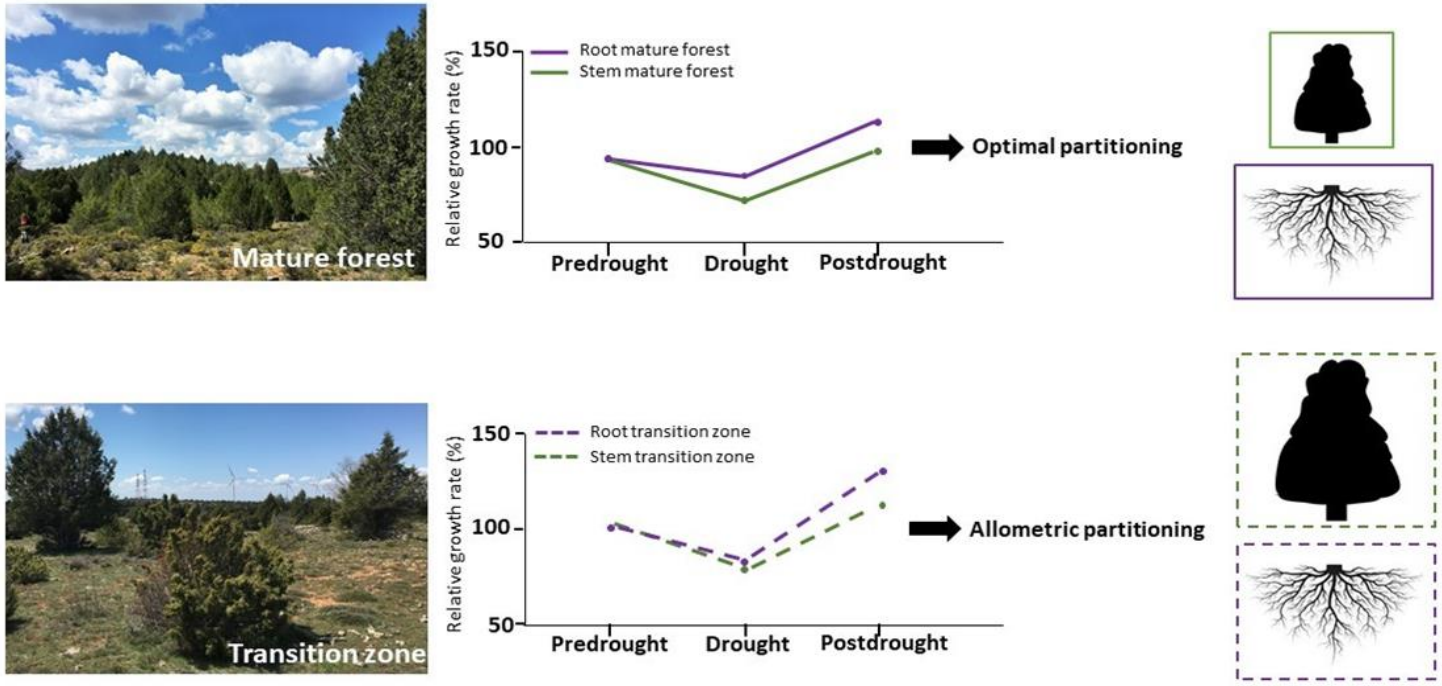
Check for updates

Long term forest management drives drought resilience in Mediterranean black pine forest

M. E. Lucas-Borja[1] · E. Andivia[2] · D. Candel-Pérez[3] · J. C. Linares[4] · J. J. Camarero[5]

Adaptation and management for more resilient forests to drought

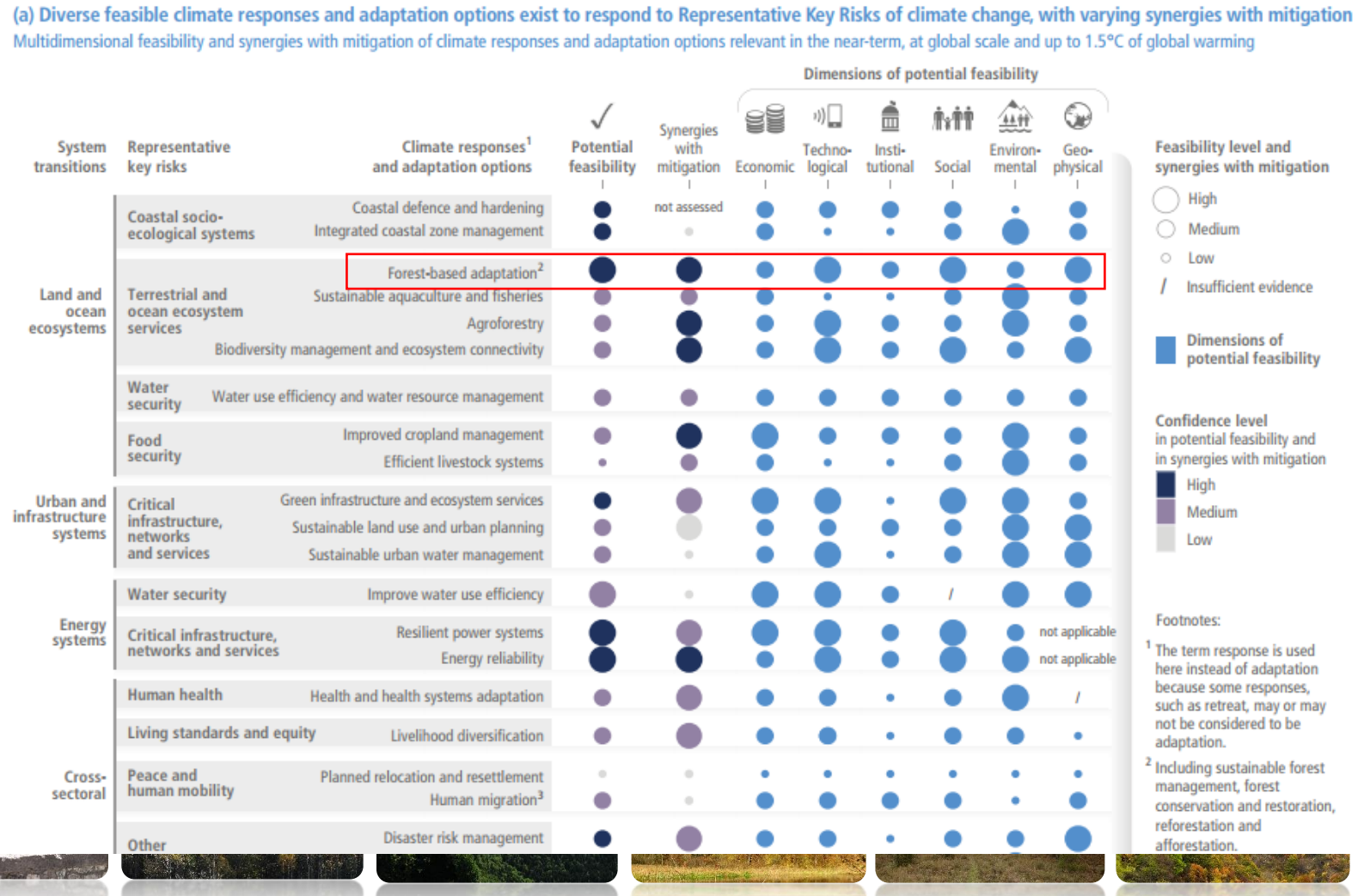
Observed patterns – Ontogenic development control

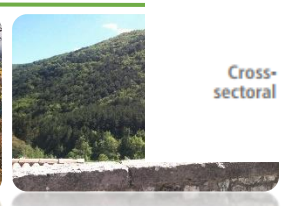


Acuña-Miguez et al. Increased recovery in coarse-root secondary growth improves resilience to drought in transition forests. *Accepted Journal of Ecology*

Adaptation and management for more resilient forests to drought

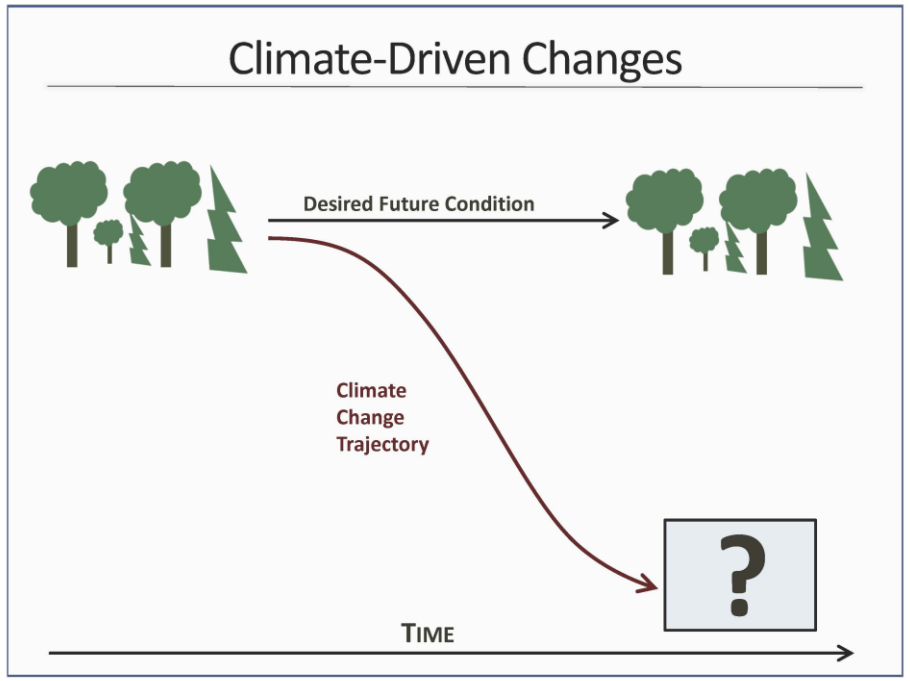
Management strategies



Adaptation and management for more resilient forests to drought

Management strategies



ECOSPHERE
AN ESA OPEN ACCESS JOURNAL
SYNTHESIS & INTEGRATION | Open Access

Operationalizing forest-assisted migration in the context of climate change adaptation: Examples from the eastern USA

Brian J. Palik, Peter W. Clark, Anthony W. D'Amato, Chris Swanston, Linda Nagel

Adaptation and management for more resilient forests to drought

Factors shaping resilience response
Silvicultural tactics

Species composition

Density control

Ontogenic development

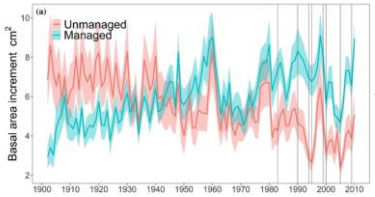
Adaptation and management for more resilient forests to drought

Options	Justification	Main strategy	Main tactics
Continuous cover	Less temperature stress for seedlings		
Thinning	Less interception & more available water		
Mixtures	Better use of resources, reduced competition, facilitation		
Shorten rotation	Reduce tree vulnerability due to aging		
Selection methods	Adapted crop trees		

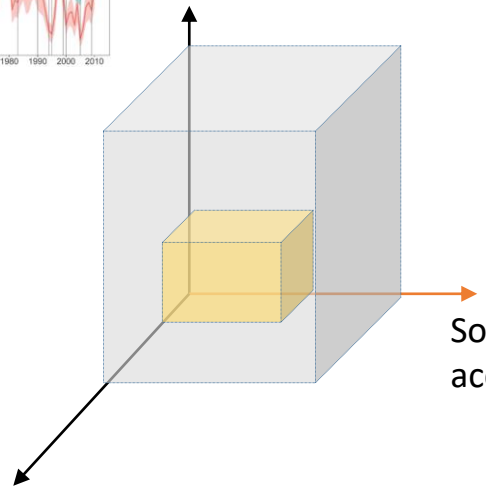
Adaptation and management for more resilient forests

Options	Justification	Strategy	Tactics
Transformation methods	Increase structural complexity		
Genetic improvement /Breeding	Adapted provenances/species		
Assisted migration	Changes in species distribution range		
Promote forest expansion	Colonization of abandoned crops		

Testing adaptation measures

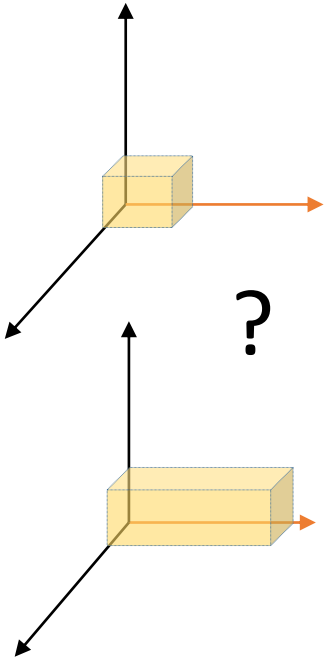


+ Resilient



Socially acceptable/adoptable

+ Ecosystem services



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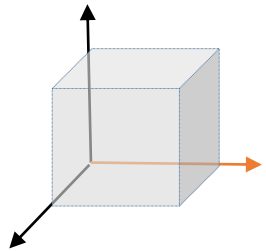

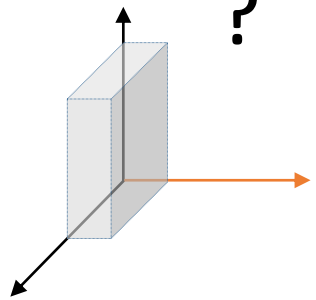

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Annals of Forest Science (2020) 77:48
https://doi.org/10.1007/s13595-020-00947-z

RESEARCH PAPER

Check for updates

Adoption of new silvicultural methods in Mediterranean forests: the influence of educational background and sociodemographic factors on marker decisions

Andrés Bravo-Oviedo[1] · Maurizio Marchi[2] · Davide Travaglini[3] · Francesco Pelleri[3] · Maria Chiara Manetti[3] · Piermaria Corona[3] · Fátima Cruz[5] · Felipe Bravo[6] · Susanna Nocentini[4]






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Connecting knowledge to action

Adaptation and management for more resilient forests to drought

bravo@mncn.csic.es

Thanks for your attention

Gracias