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Tropicalization of temperate wetlands: projections of mangrove range expansion

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U.S. Geological Survey

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- **University of Florida:** Yiyang Kang, David A. Kaplan
- **U.S. National Park Service:** Laura C. Feher
- **U.S. Geological Survey:** Christopher J. Shipway

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Outline

- Background- tropicalization and mangrove range expansion
- Projections of mangrove expansion (Bardou et al. 2024 and Kang et al. 2023)
- Ecological implications of mangrove expansion

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Global Change Biology WILEY

RESEARCH REVIEW

Tropicalization of temperate ecosystems in North America: The northward range expansion of tropical organisms in response to warming winter temperatures

Michael J. Osland[1] | Philip W. Stevens[2] | Margaret M. Lamont[3] | Richard C. Brusca[4] | Kristen M. Hart[5] | J. Hardin Waddle[3] | Catherine A. Langtimm[3] | Caroline M. Williams[6] | Barry D. Keim[7] | Adam J. Terando[8] | Eric A. Reyier[9] | Katie E. Marshall[10] | Michael E. Loik[11] | Ross E. Boucek[12] | Amanda B. Lewis[7] | Jeffrey A. Seminoff[13]

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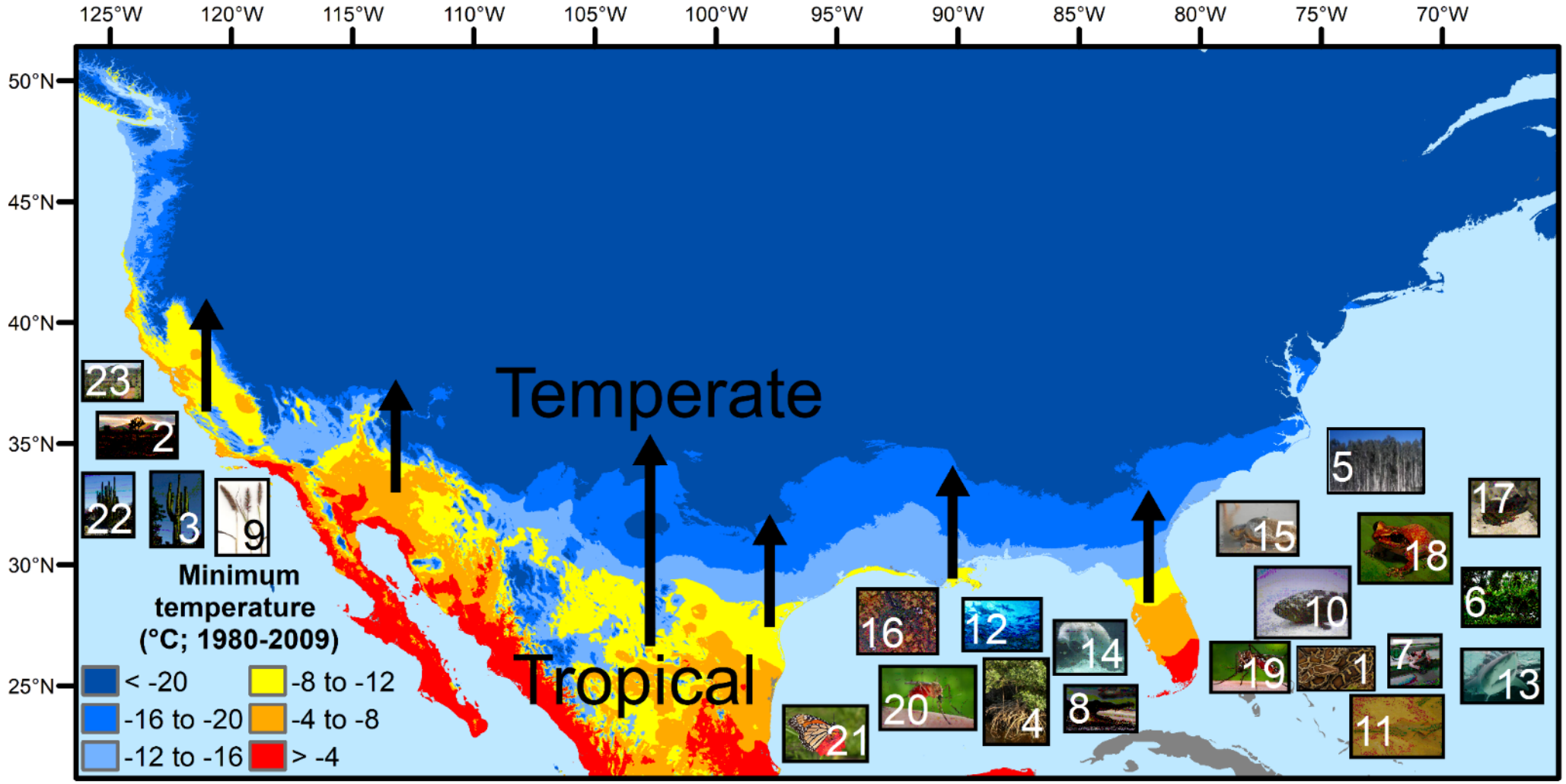
Tropicalization of temperate ecosystems due to warming winters



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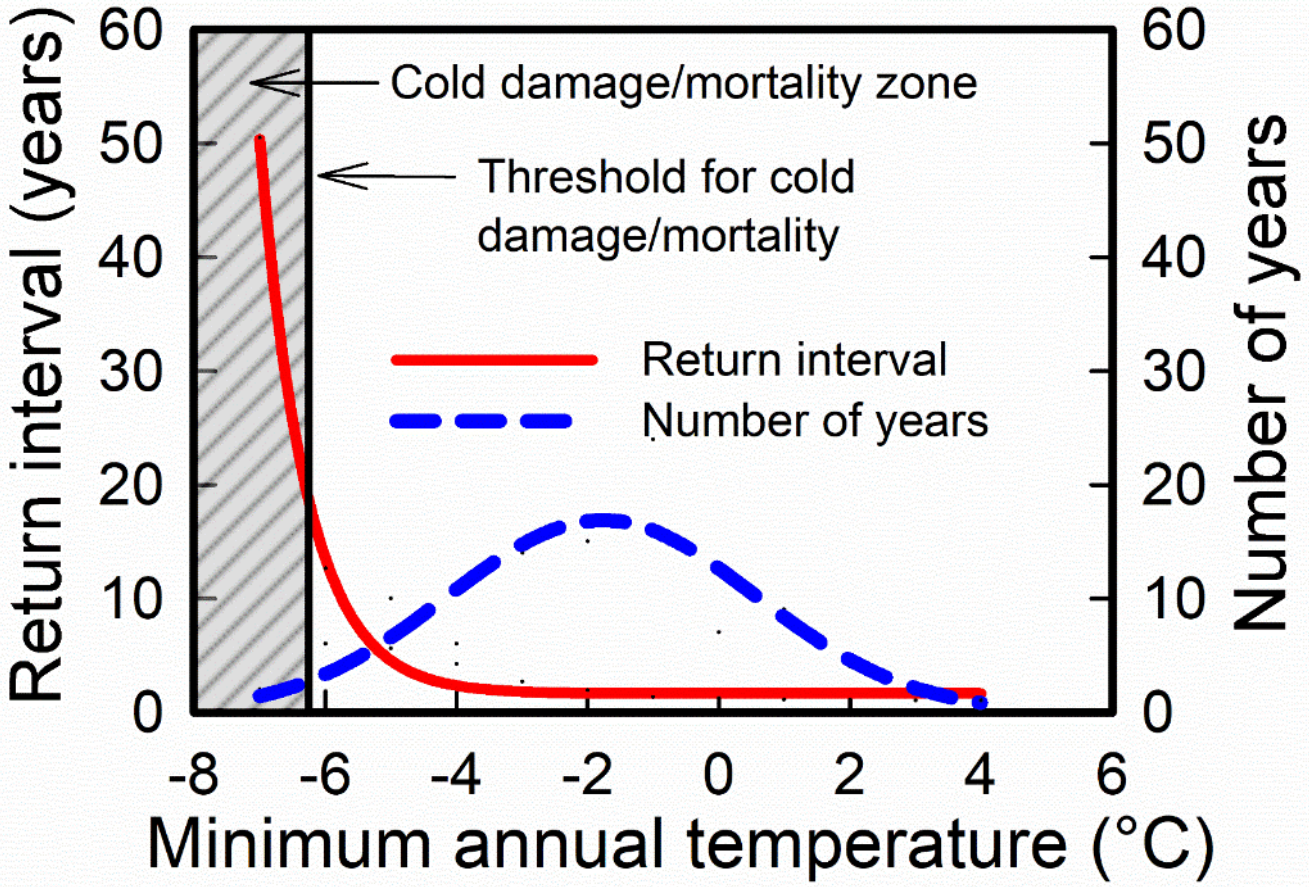
Osland et al. 2021, *Global Change Biology*

Cold damage/mortality events are infrequent in the tropical-temperate transition zone



Osland et al. 2021, *Global Change Biology*

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January 2025: Snow in south Louisiana!

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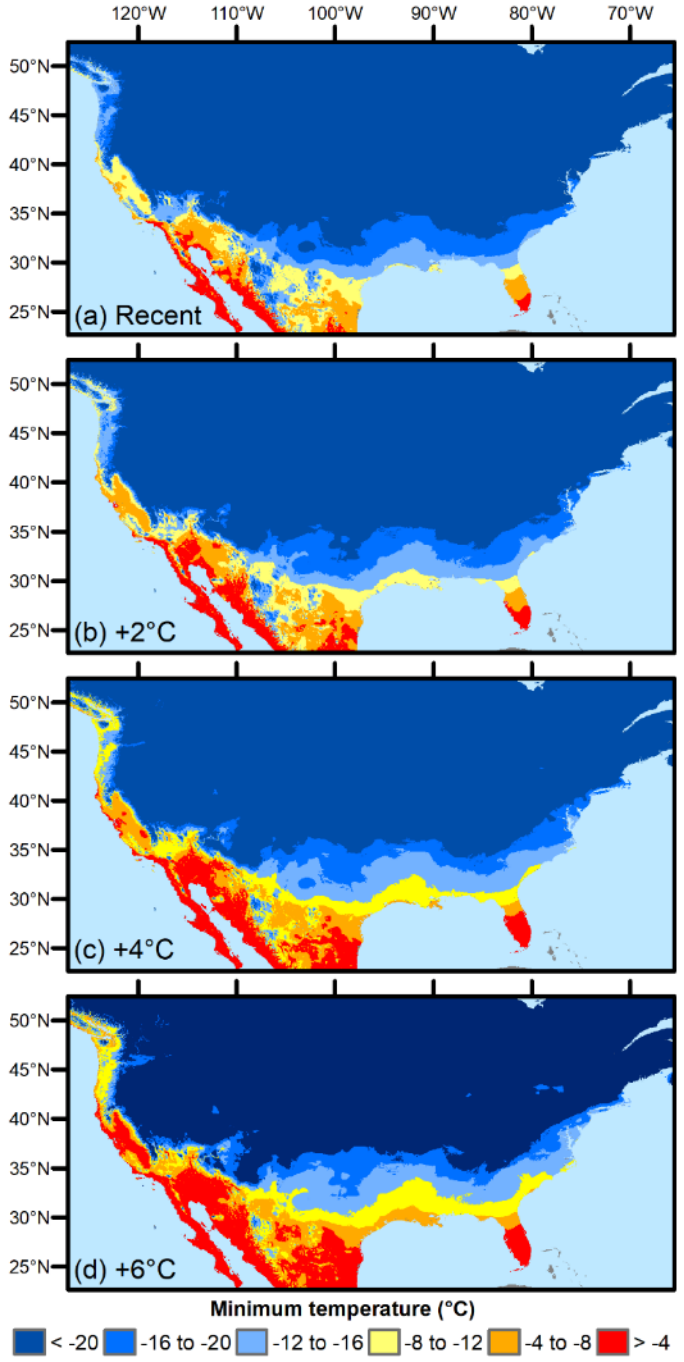
Northward position of climatic zones under alternative future scenarios - a 2°C, 4°C, and 6°C increase in winter temperature extremes



Recent (1980-2009)

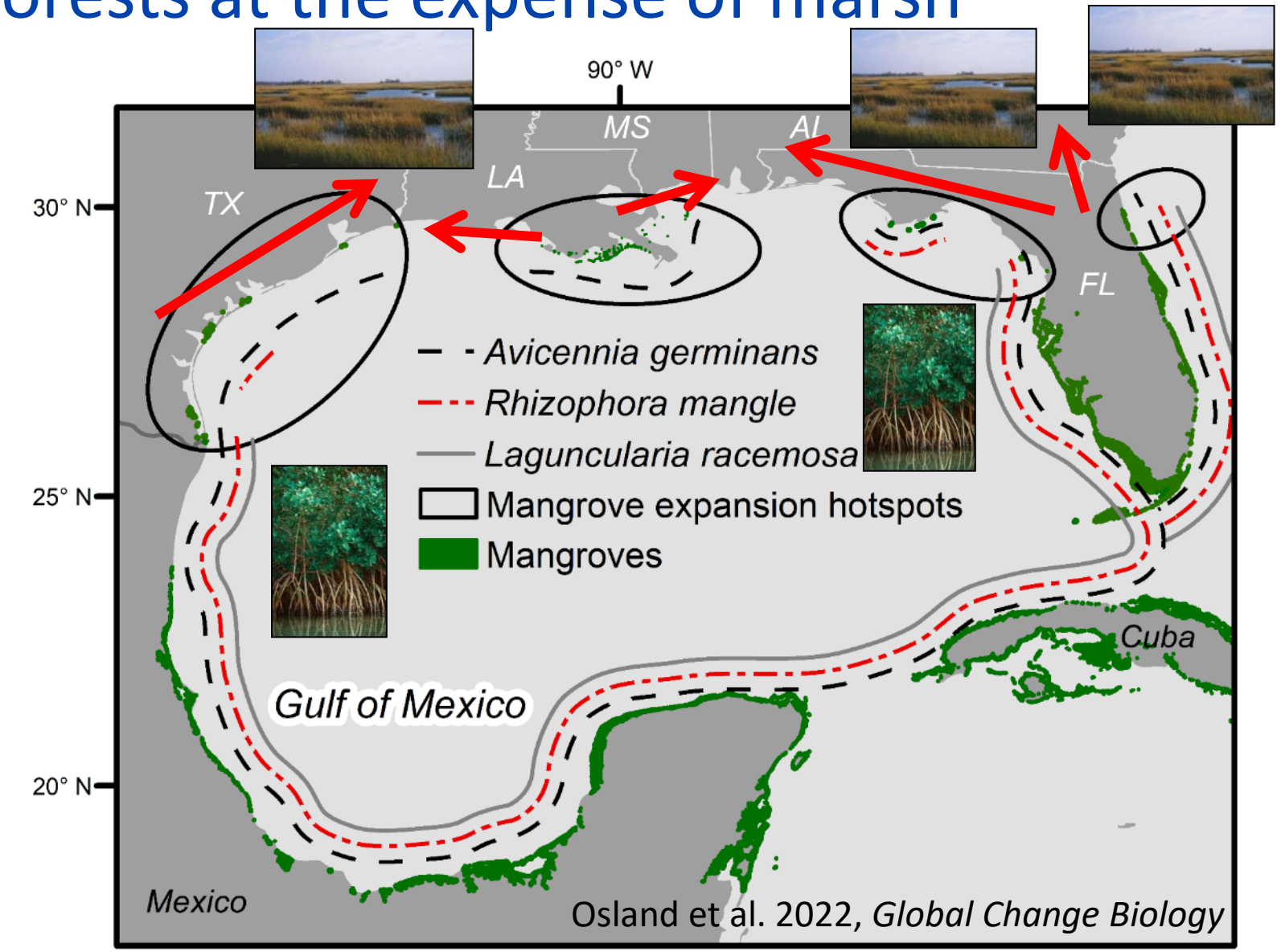
+2°C

+4°C

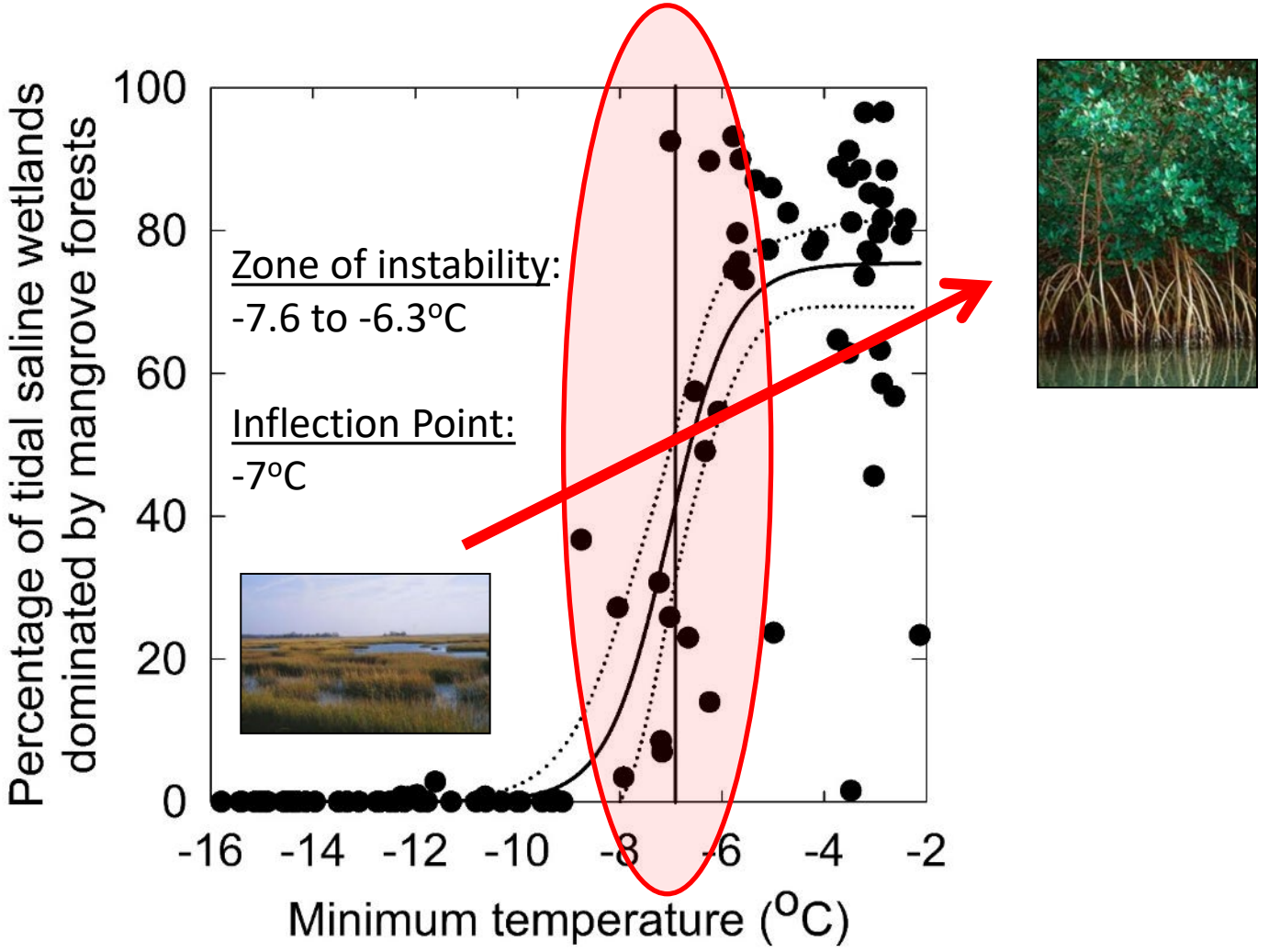
+6°C

Osland et al. 2021, *Global Change Biology*

Warming winters are expected to lead to range expansion of mangrove forests at the expense of marsh



The tipping point: where salt marshes are replaced by mangrove forests



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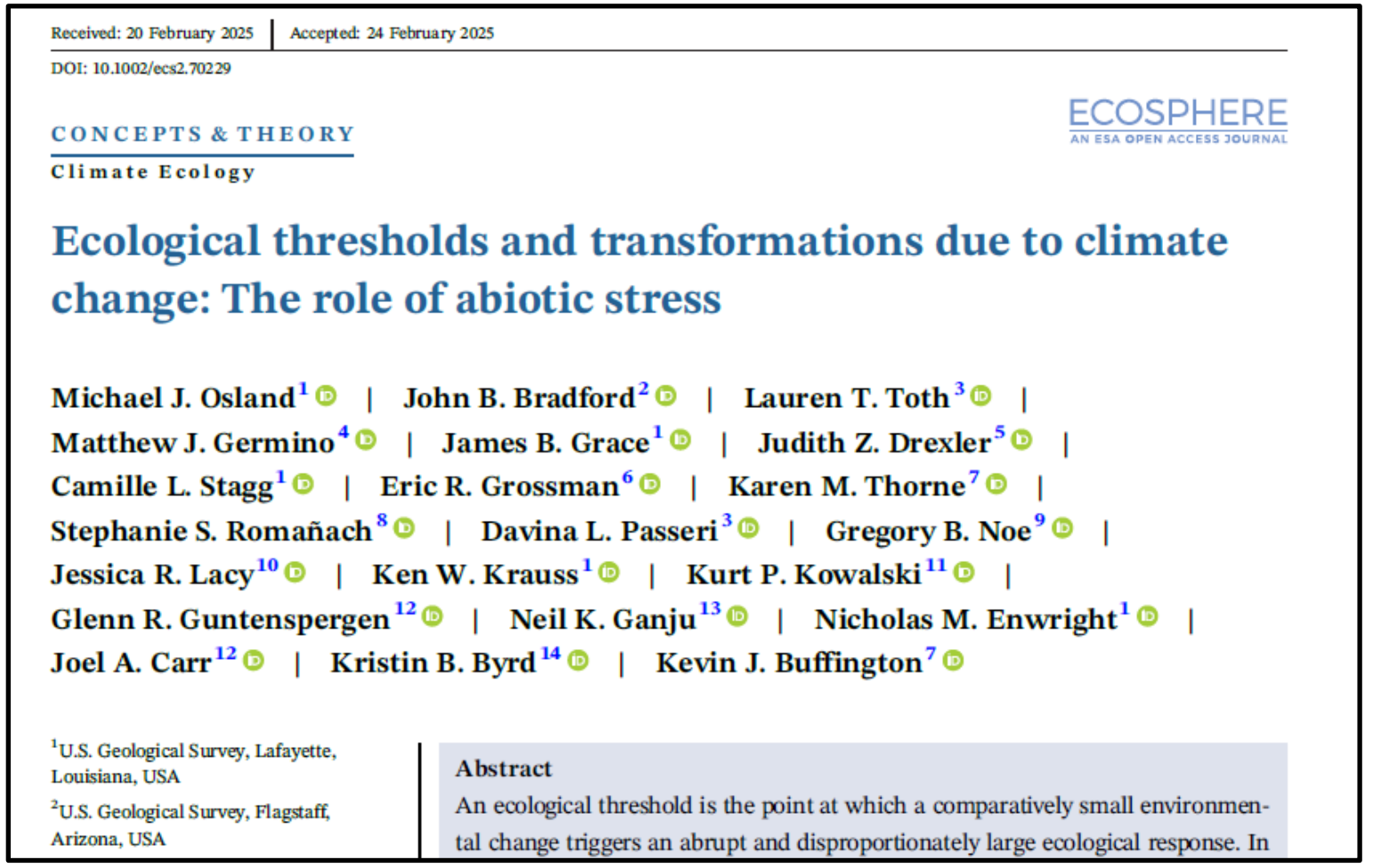
Osland et al. 2013, *Global Change Biology*

Cross-ecosystem concept paper on ecological thresholds and transformations (2025, *Ecosphere*)



Received: 20 February 2025 | Accepted: 24 February 2025

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CONCEPTS & THEORY

Climate Ecology

ECOSPHERE
AN ESA OPEN ACCESS JOURNAL

Ecological thresholds and transformations due to climate change: The role of abiotic stress

Michael J. Osland[1] | John B. Bradford[2] | Lauren T. Toth[3] | Matthew J. Germino[4] | James B. Grace[1] | Judith Z. Drexler[5] | Camille L. Stagg[1] | Eric R. Grossman[6] | Karen M. Thorne[7] | Stephanie S. Romañach[8] | Davina L. Passeri[3] | Gregory B. Noe[9] | Jessica R. Lacy[10] | Ken W. Krauss[1] | Kurt P. Kowalski[11] | Glenn R. Guntenspergen[12] | Neil K. Ganju[13] | Nicholas M. Enwright[1] | Joel A. Carr[12] | Kristin B. Byrd[14] | Kevin J. Buffington[7]

[1]U.S. Geological Survey, Lafayette, Louisiana, USA

[2]U.S. Geological Survey, Flagstaff, Arizona, USA

Abstract

An ecological threshold is the point at which a comparatively small environmental change triggers an abrupt and disproportionately large ecological response. In

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Merida
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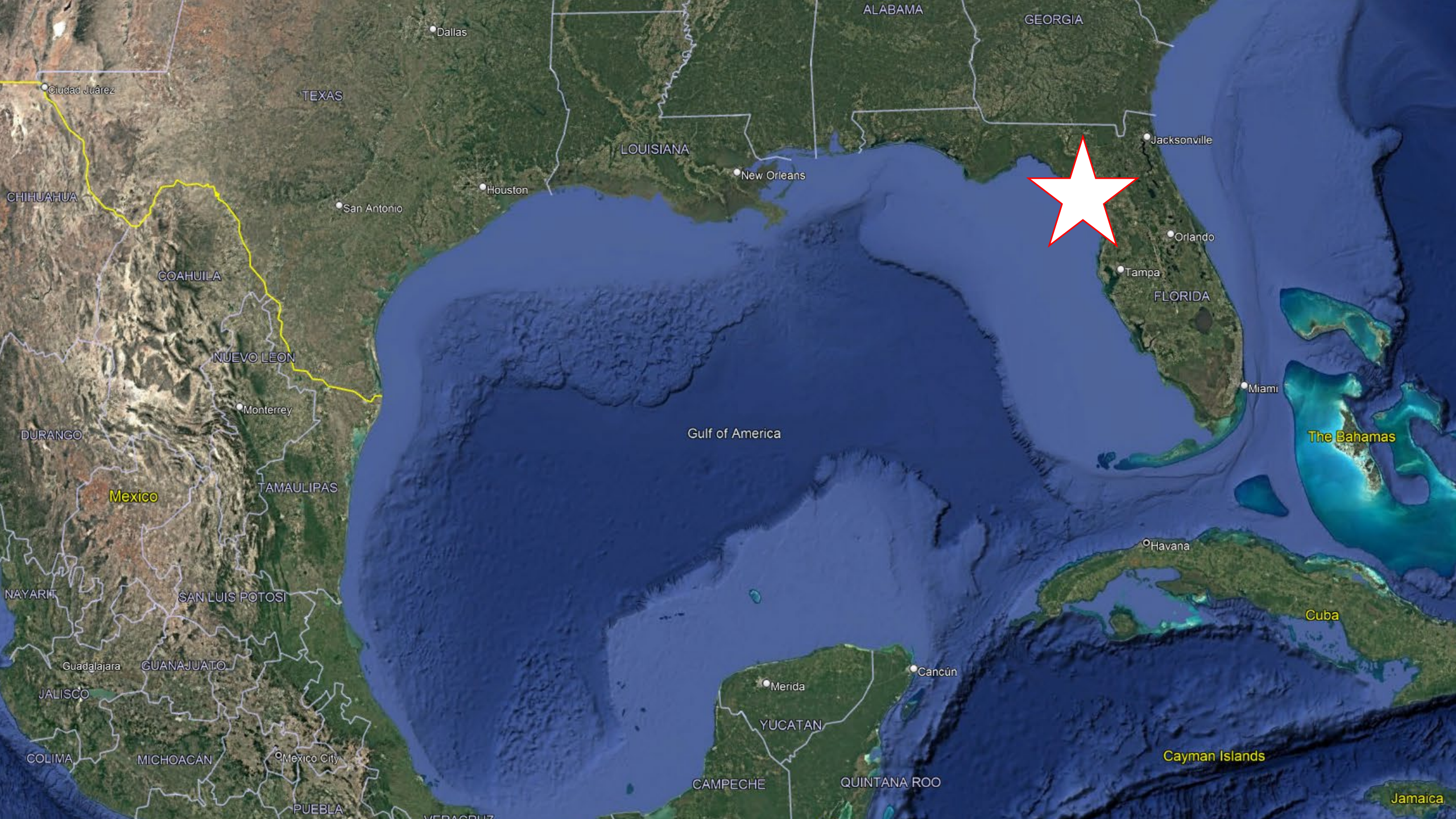
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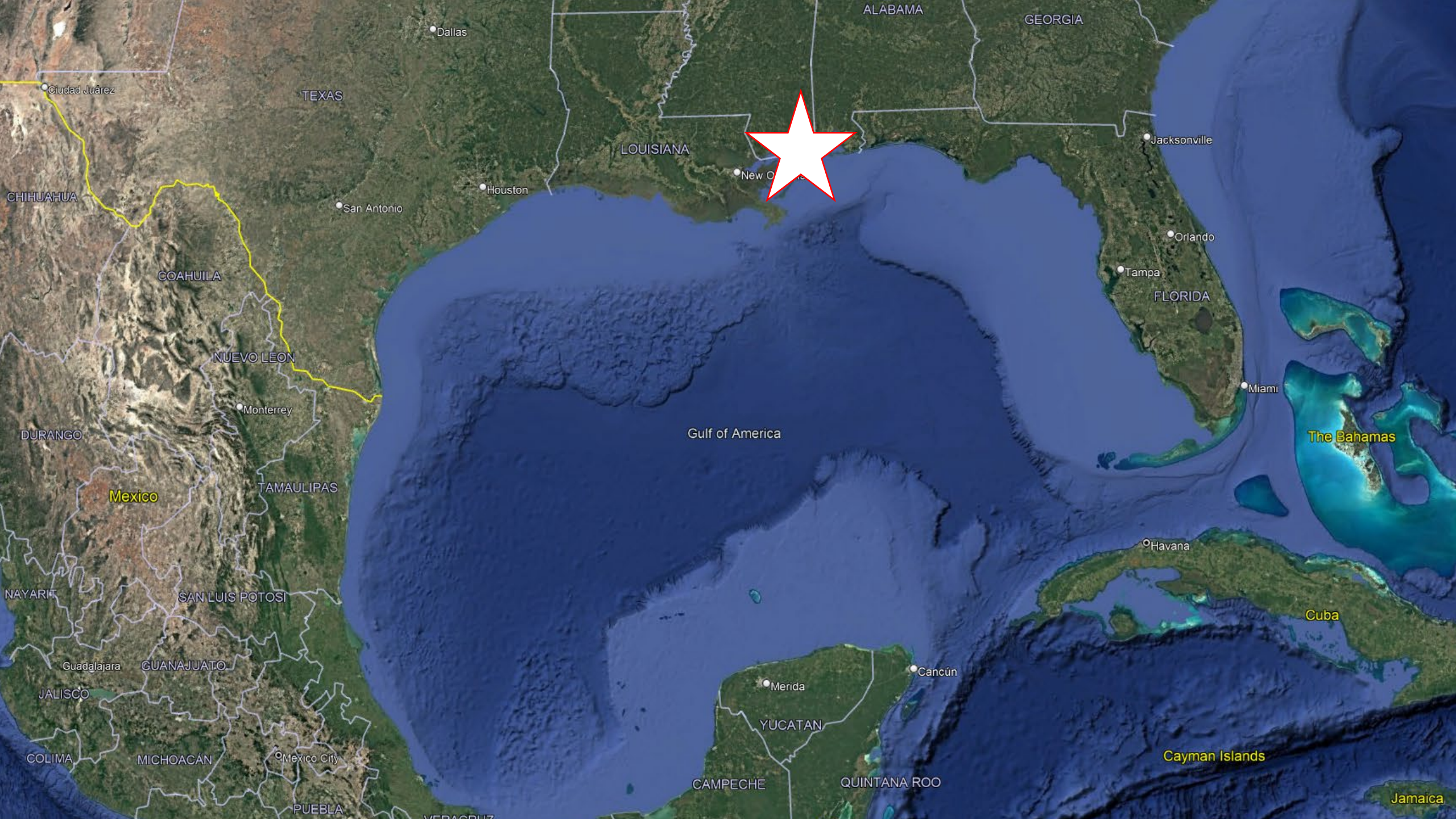
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Cayman Islands
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PUEBLA
Jamaica

Outline

- ~~Background- tropicalization and mangrove range expansion~~

- Projections of mangrove expansion (Bardou et al. 2024 and Kang et al. 2023)

- Ecological implications of mangrove expansion

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Journal of Biogeography | WILEY

RESEARCH ARTICLE

Projected changes in mangrove distribution and vegetation structure under climate change in the southeastern United States

Rémi Bardou[1] | Michael J. Osland[2] | Jahson B. Alemu I[1,3] | Laura C. Feher[2] | David P. Harlan[4] | Steven B. Scyphers[5,6] | Christine C. Shepard[7] | Savannah H. Swinea[5,6] | Kalaina Thorne[1] | Jill E. Andrew[8] | A. Randall Hughes[1]

[1]Northeastern University Marine Science Center, Nahant, Massachusetts, USA

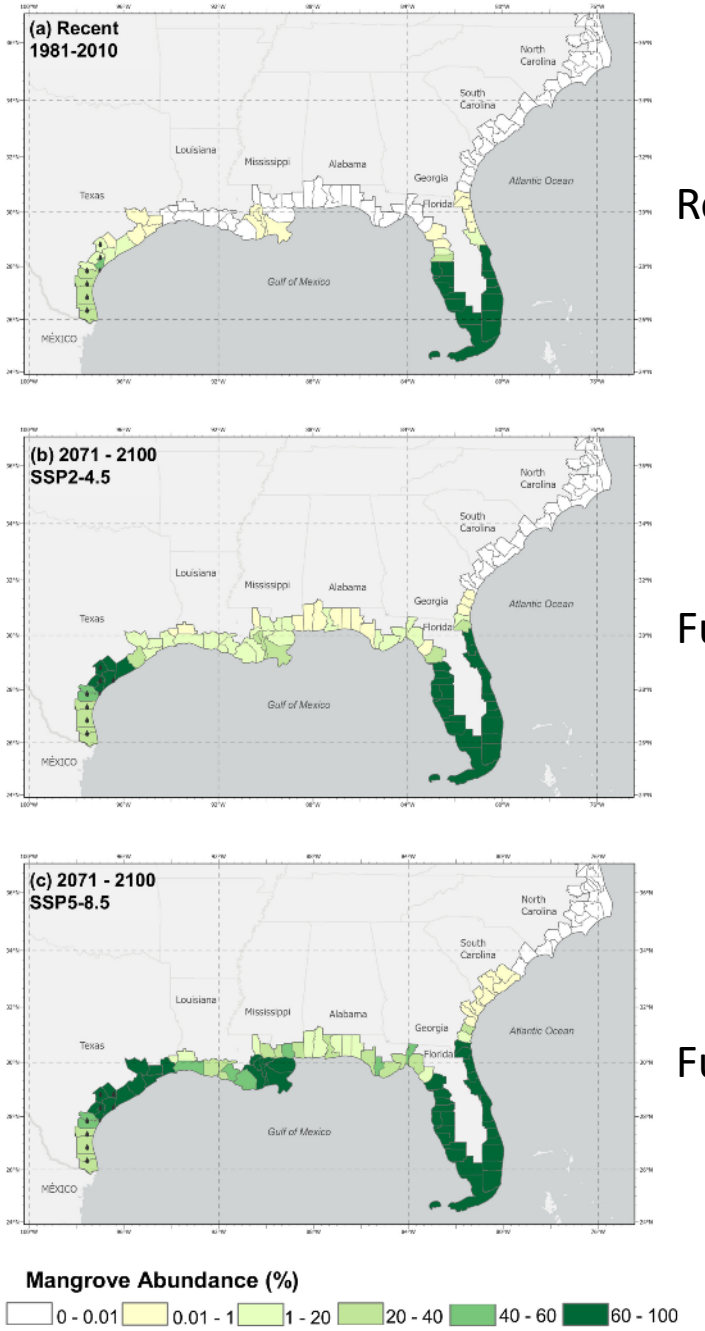
[2]U.S. Geological Survey, Lafayette, Louisiana, USA

[3]The Nature Conservancy, Massachusetts

Abstract

Aim: The climate change-induced transition from grass-dominated marshes to woody-plant-dominated mangrove forests has the potential to impact the ecosystem goods

Projections of future mangrove abundance under alternative scenarios (2071-2100)



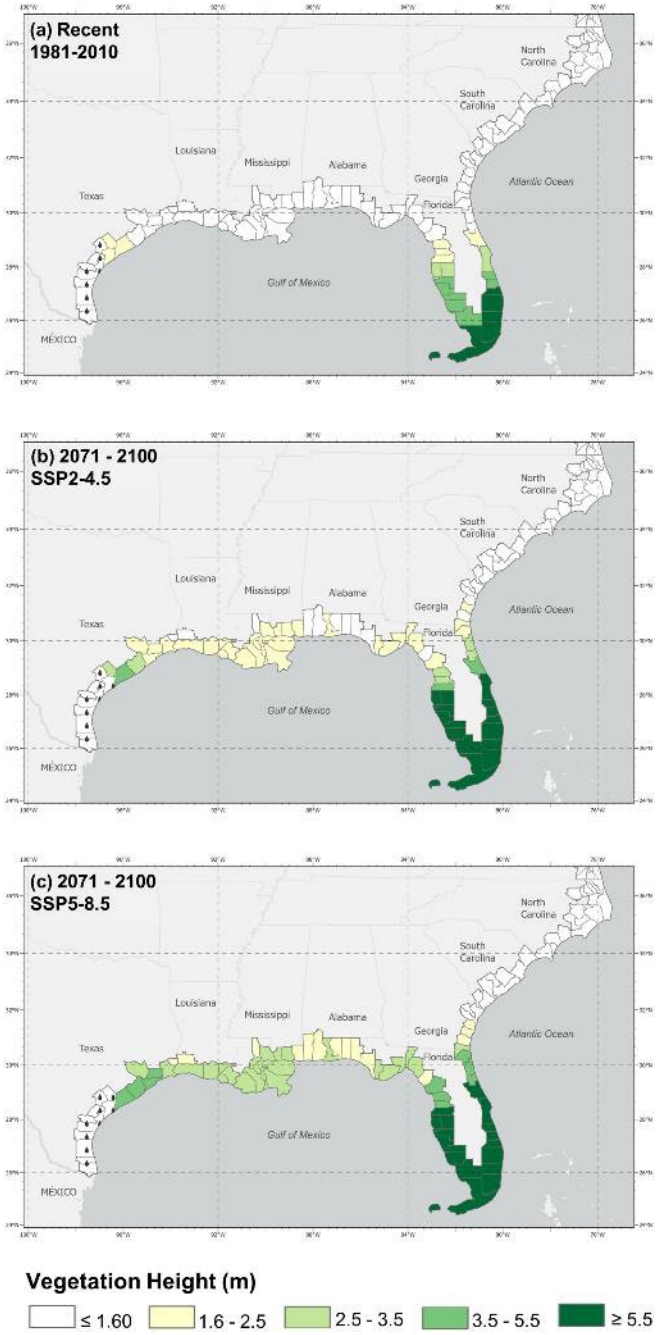
Recent (1981-2010)

Future (2071-2100); intermediate

Future (2071-2100); high

Bardou et al. 2024
Journal of Biogeography

Projections of coastal wetland vegetation height under alternative scenarios (2071-2100)



Recent (1981-2010)

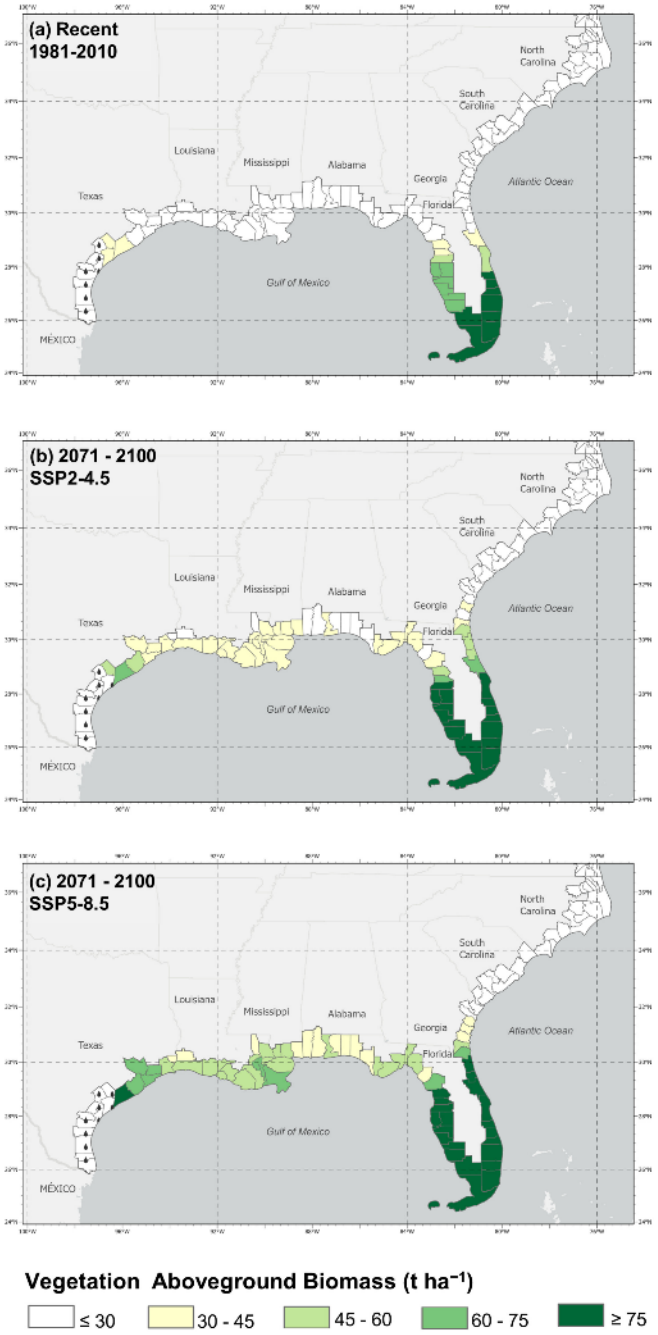
Future (2071-2100); intermediate

Future (2071-2100); high

Bardou et al. 2024
Journal of Biogeography

Projections of future coastal wetland aboveground biomass under alternative scenarios (2071-2100)

Bardou et al. 2024
Journal of Biogeography



Recent (1981-2010)

Future (2071-2100); intermediate

Future (2071-2100); high

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DOI: 10.1111/1365-2745.14296

Journal of Ecology | BRITISH ECOLOGICAL SOCIETY

RESEARCH ARTICLE

Linking temperature sensitivity of mangrove communities, populations and individuals across a tropical-temperate transitional zone

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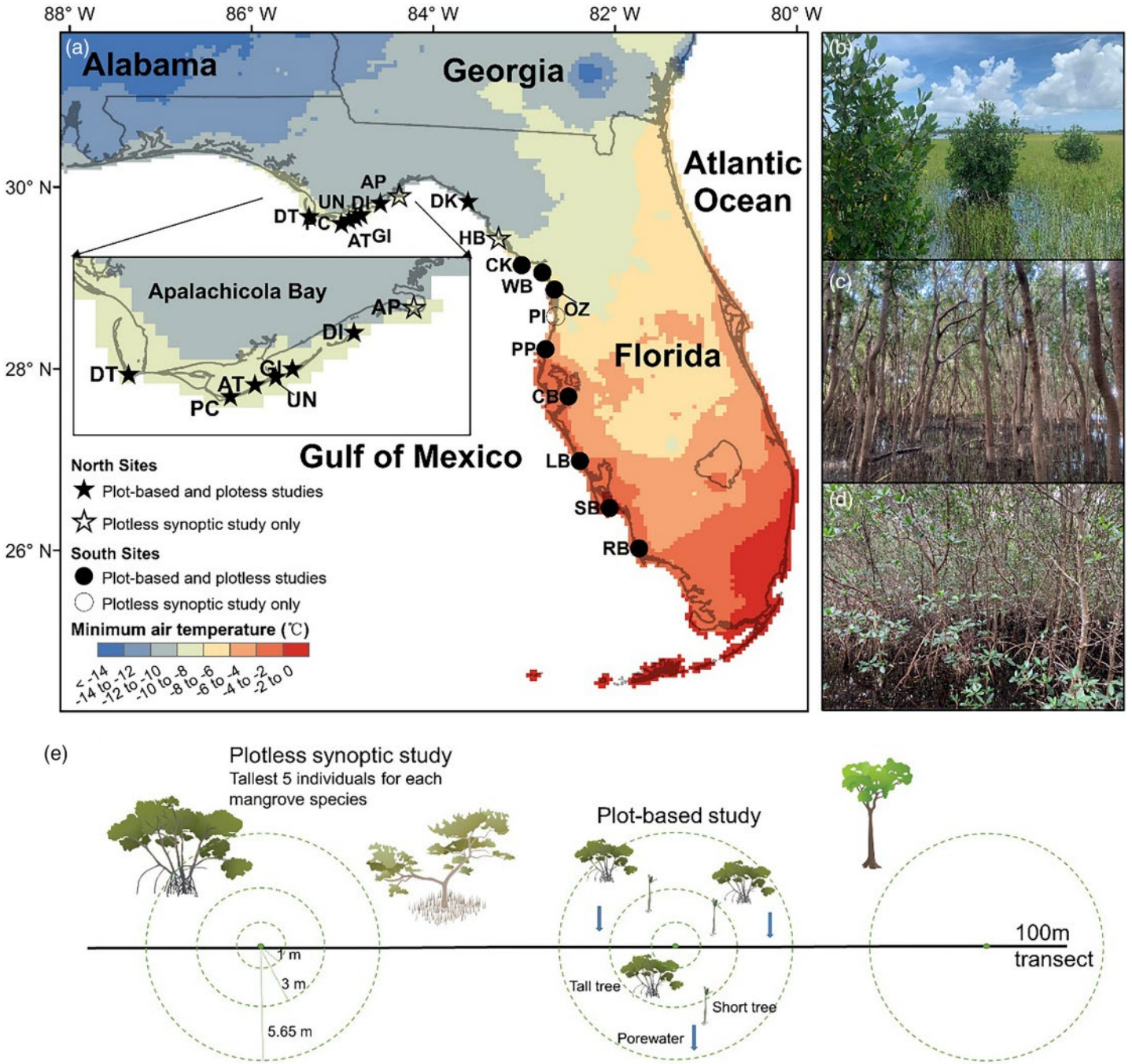
[1]School of Natural Resources and Environment, University of Florida, Gainesville, Florida, USA

Abstract

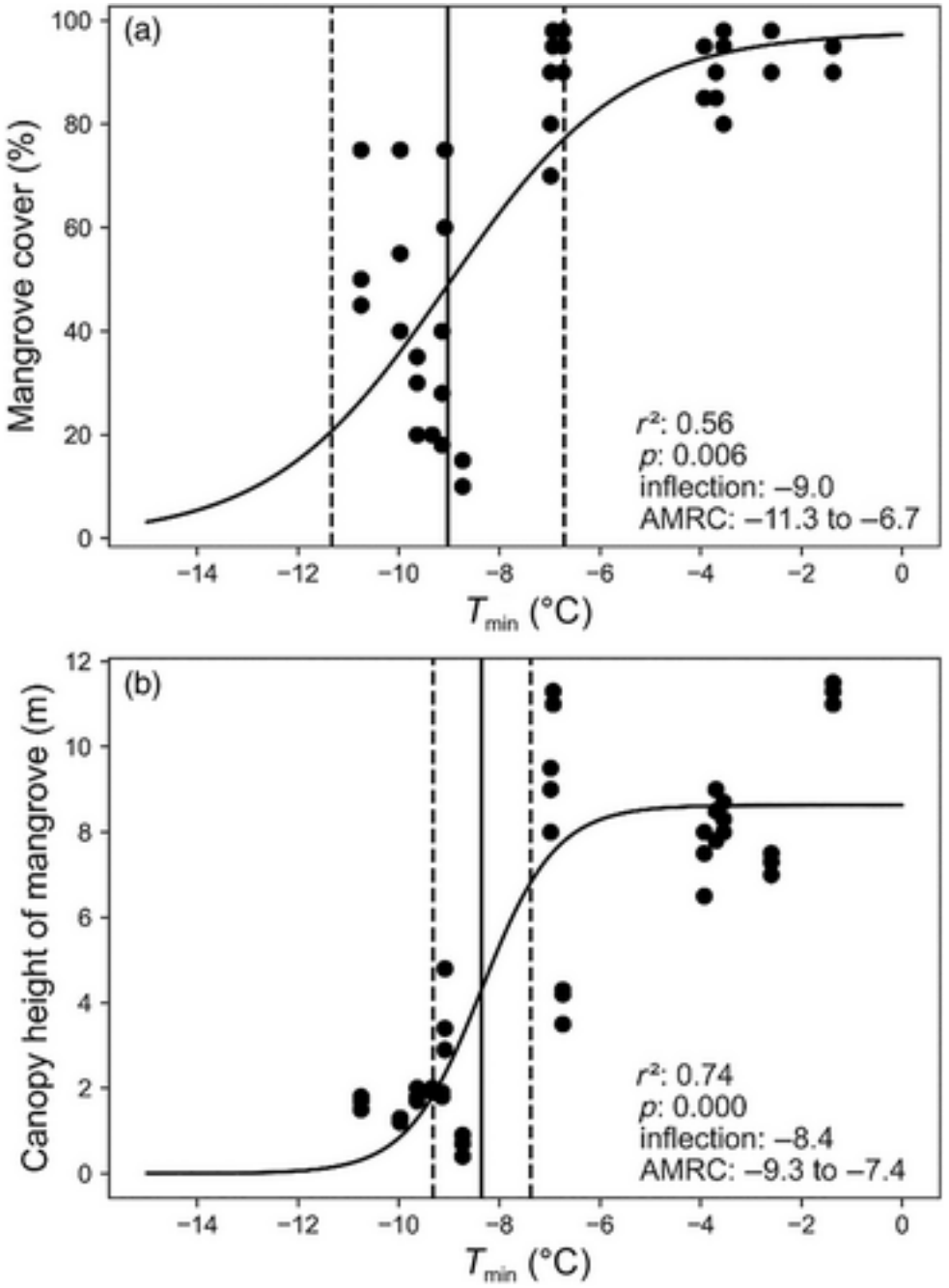
1. Climate change is reshaping coastal wetlands worldwide, driving ecosystem

18 field sites that span the marsh-mangrove transition zone



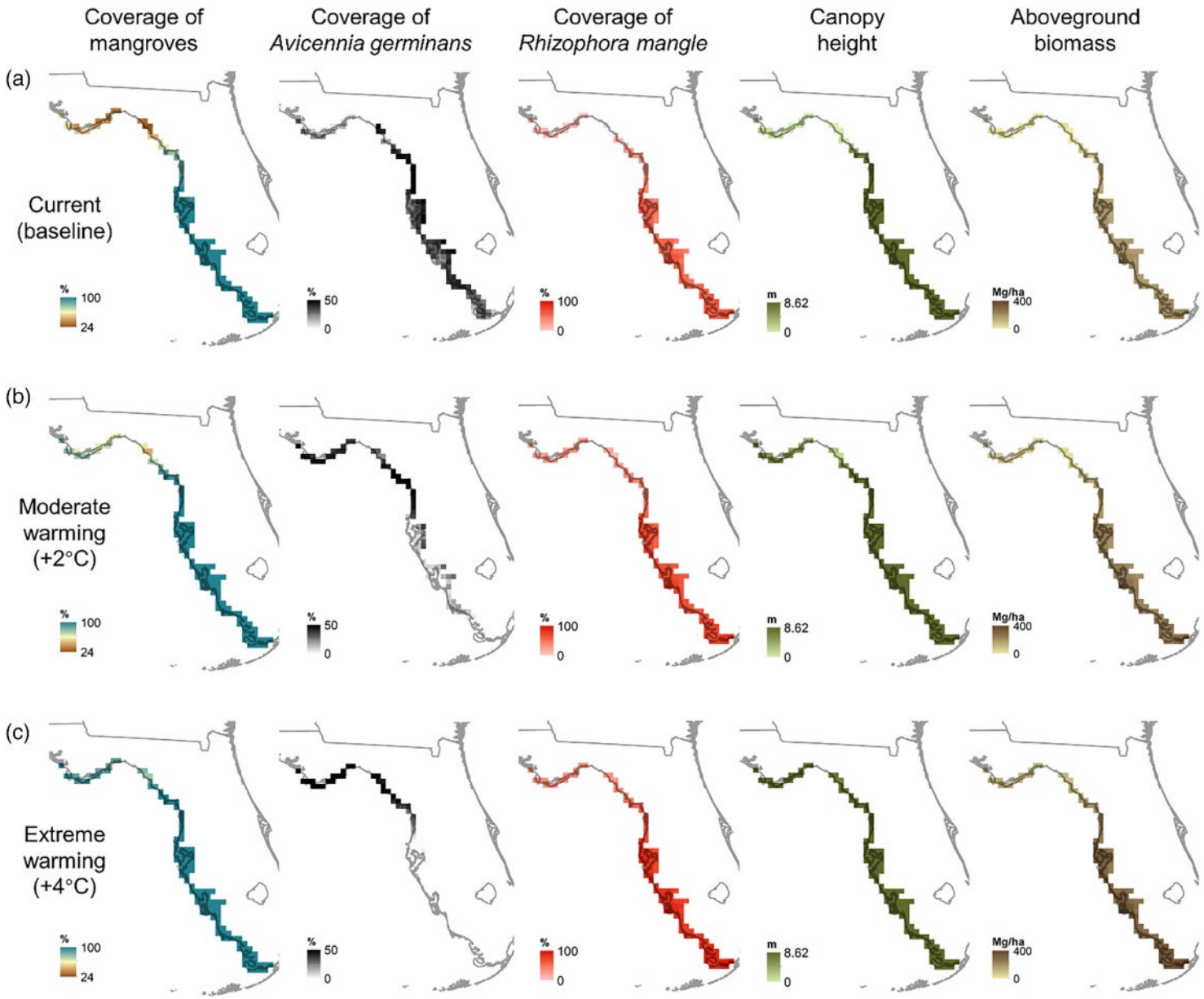
Kang et al. 2024,
Journal of Ecology

Quantified relationships between temperature and many ecological attributes



Kang et al. 2024,
Journal of Ecology

Projections of mangrove expansion under alternative warming scenarios



Kang et al. 2024,
Journal of Ecology

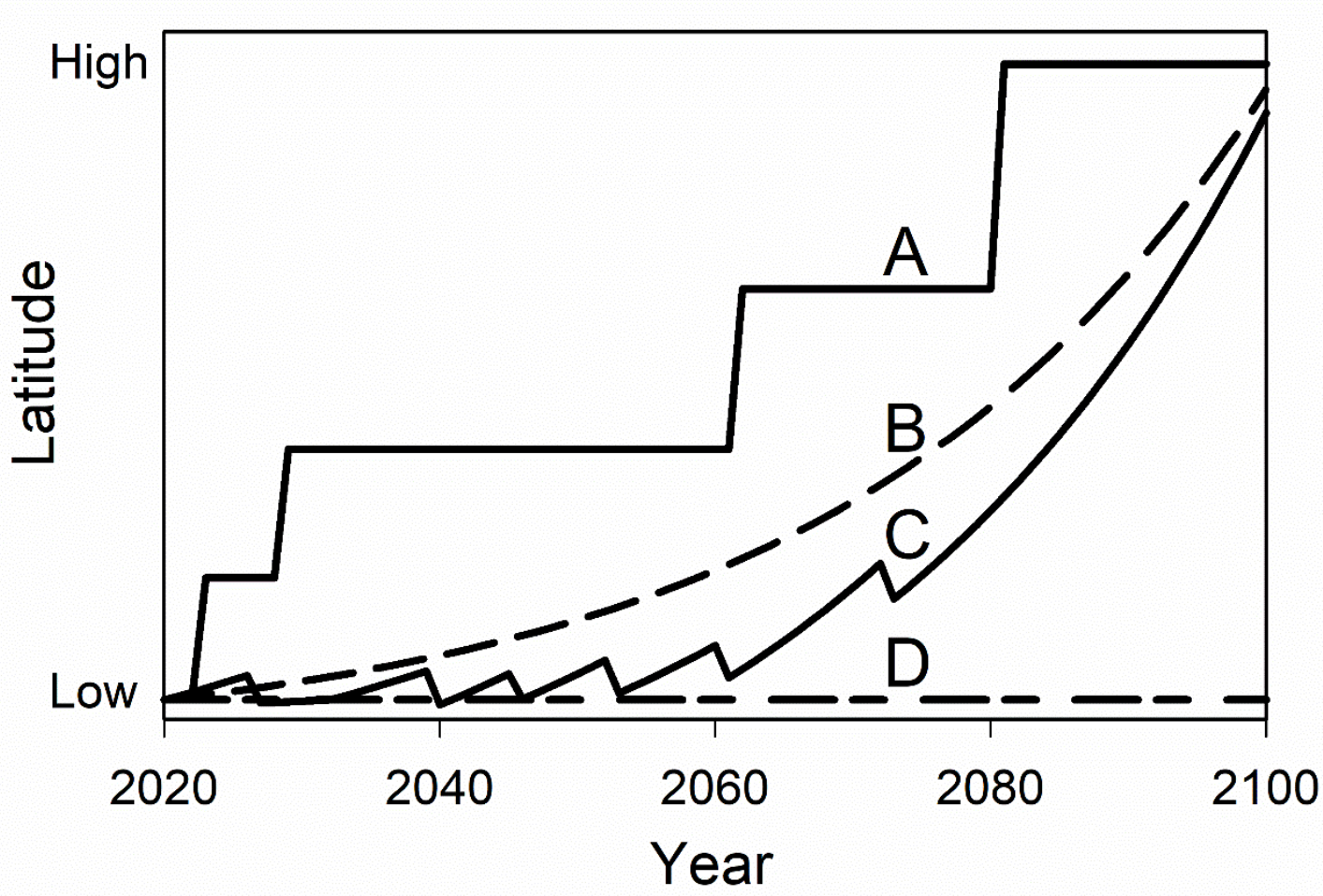
Alternative range expansion pathways

A: steps

B: continuous

C: expansion/contraction

D: no expansion



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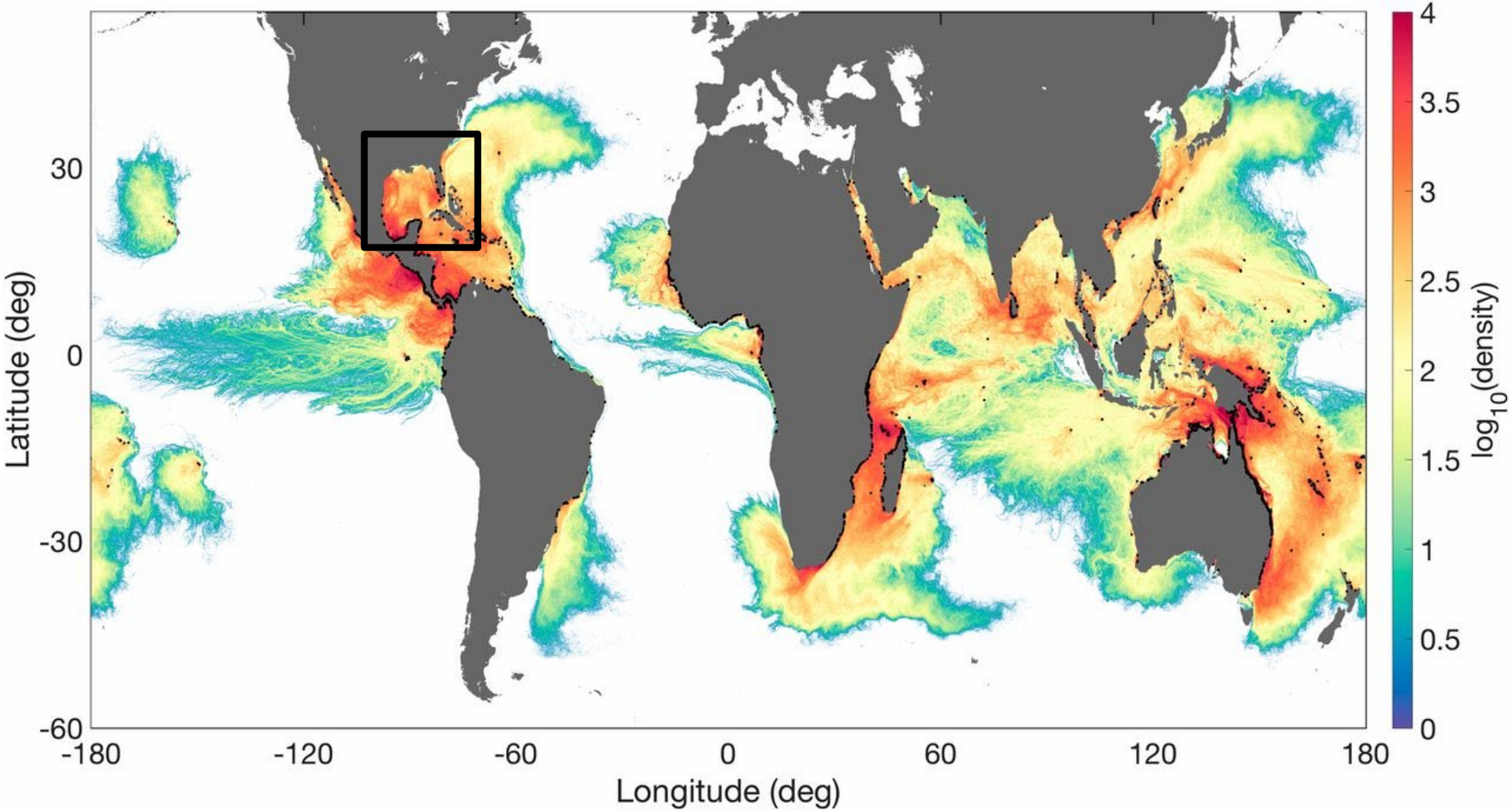
Osland et al. 2021, *Global Change Biology*

Red mangrove propagules in Alabama (2015)

Mangrove propagule density (Van der Stocken et al. 2018, *PNAS*)



Long-distance dispersal

+

Warming winters

Sea-level rise

=

Mangroves on the move

Outline

- ~~Background- tropicalization and mangrove range expansion~~
- ~~Projections of mangrove expansion (Bardou et al. 2024 and Kang et al. 2023)~~
- Ecological implications of mangrove expansion

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Global Change Biology WILEY

REVIEW

The impacts of mangrove range expansion on wetland ecosystem services in the southeastern United States: Current understanding, knowledge gaps, and emerging research needs

Michael J. Osland[1] | A. Randall Hughes[2] | Anna R. Armitage[3] | Steven B. Scyphers[2] | Just Cebrian[4] | Savannah H. Swinea[2] | Christine C. Shepard[5] | Micheal S. Allen[6] | Laura C. Feher[1] | James A. Nelson[7] | Cherie L. O'Brien[8] | Colt R. Sanspree[9] | Delbert L. Smee[10] | Caitlin M. Snyder[11] | Andrew P. Stetter[9] | Philip W. Stevens[12] | Kathleen M. Swanson[13] | Lauren H. Williams[14] | Janell M. Brush[15] | Joseph Marchionno[15] | Rémi Bardou[2]

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Mangrove forests and salt marshes are both frequently ranked among the most valuable ecosystems on the planet (Costanza et al. 2014; Barbier et al. 2011)

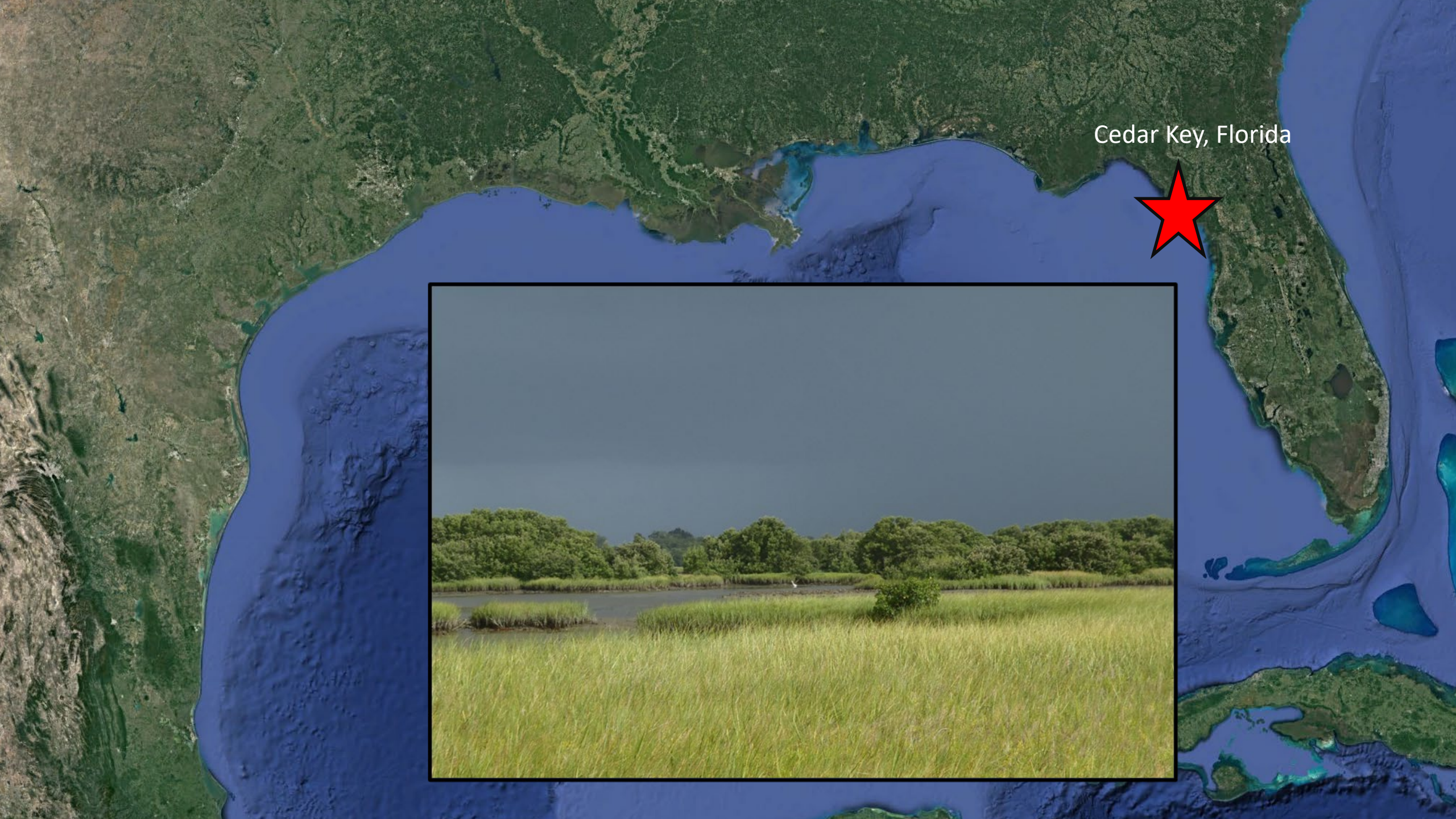
Ecosystem services provided by mangrove forests and salt marshes	Examples
Carbon sequestration	Plant carbon storage, soil carbon storage
Land loss avoidance	Elevation gains to offset relative sea-level rise
Erosion control	Shoreline erosion reduction
Water purification	Nutrient and sediment removal
Coastal protection	Wave and wind attenuation
Maintenance of fisheries	Fish, shrimp, and crabs
Maintenance of avifauna	Wading birds, shorebirds, marsh birds, and passerines
Recreation and tourism	Fishing, birdwatching, kayaking
Raw materials and food	Mangrove honey

Osland et al. 2022, *Global Change Biology*

Local Impacts & Trade-offs


Photo credit: Travis Glidden


Photo credit: Louisiana Department of Wildlife & Fisheries


Cedar Key, Florida

Port Aransas, Texas

Photo credit: Travis Glidden

Port Fourchon, Louisiana

Photo credit: Louisiana Department of Wildlife & Fisheries

Apalachicola, Florida

Take home messages

- Tropicalization: tropical species moving northward with warming winters & impacting “temperate ecosystems”
- Mangrove range expansion: Local impacts & trade-offs
  - local-scale differences in perceptions of the impacts of mangrove expansion into salt marshes
  - some individuals see mangrove expansion as a positive change to be embraced
  - others see mangrove expansion as a negative change to be constrained

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Thanks!

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