



Fire in pine-oak forests and woodlands of the northern Sierra Madre Occidental

**Patterns shaped by interactions between
nature and people**

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Landscape Ecology (IALE–North America) Annual Meeting.
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Research Team

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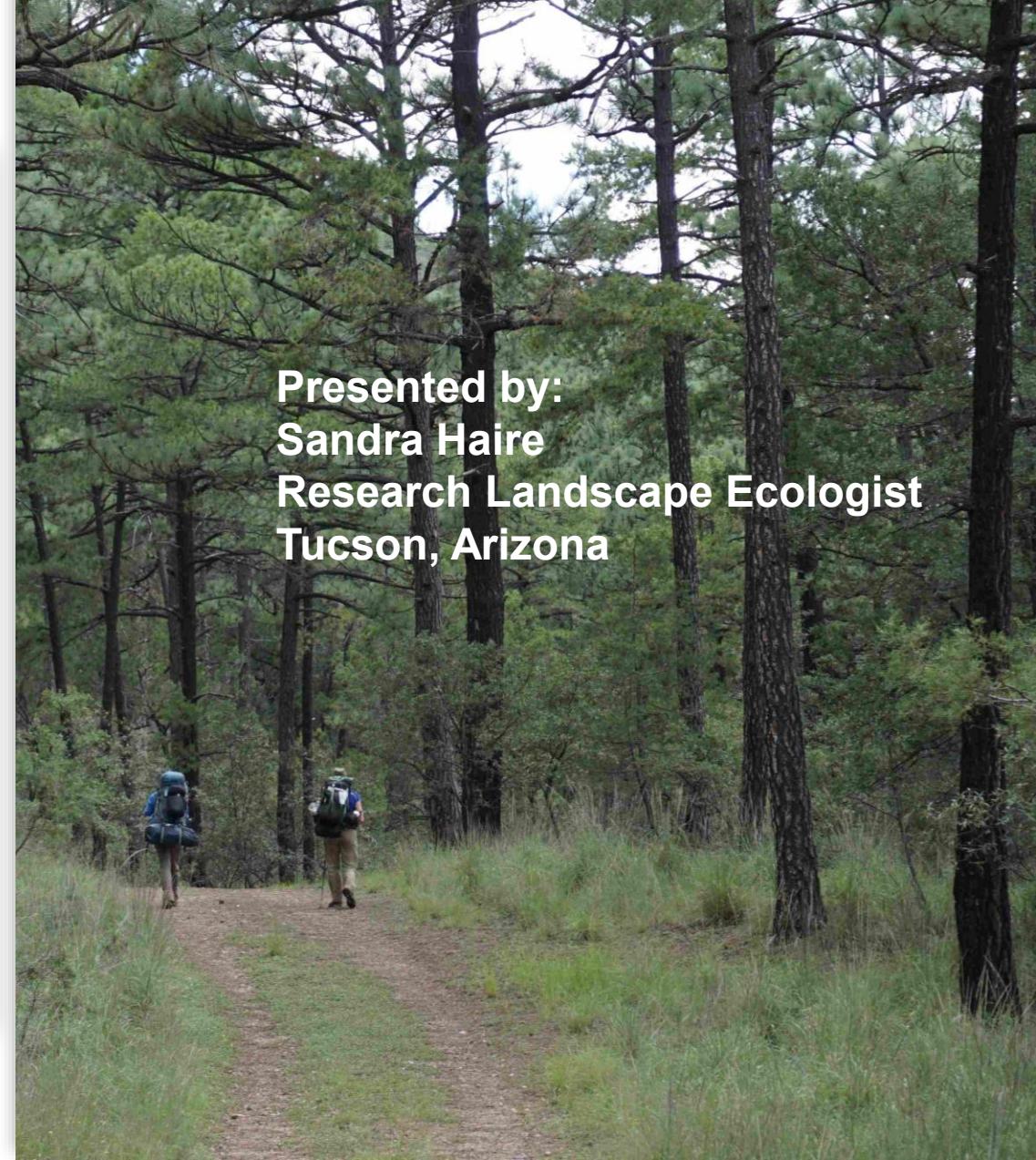
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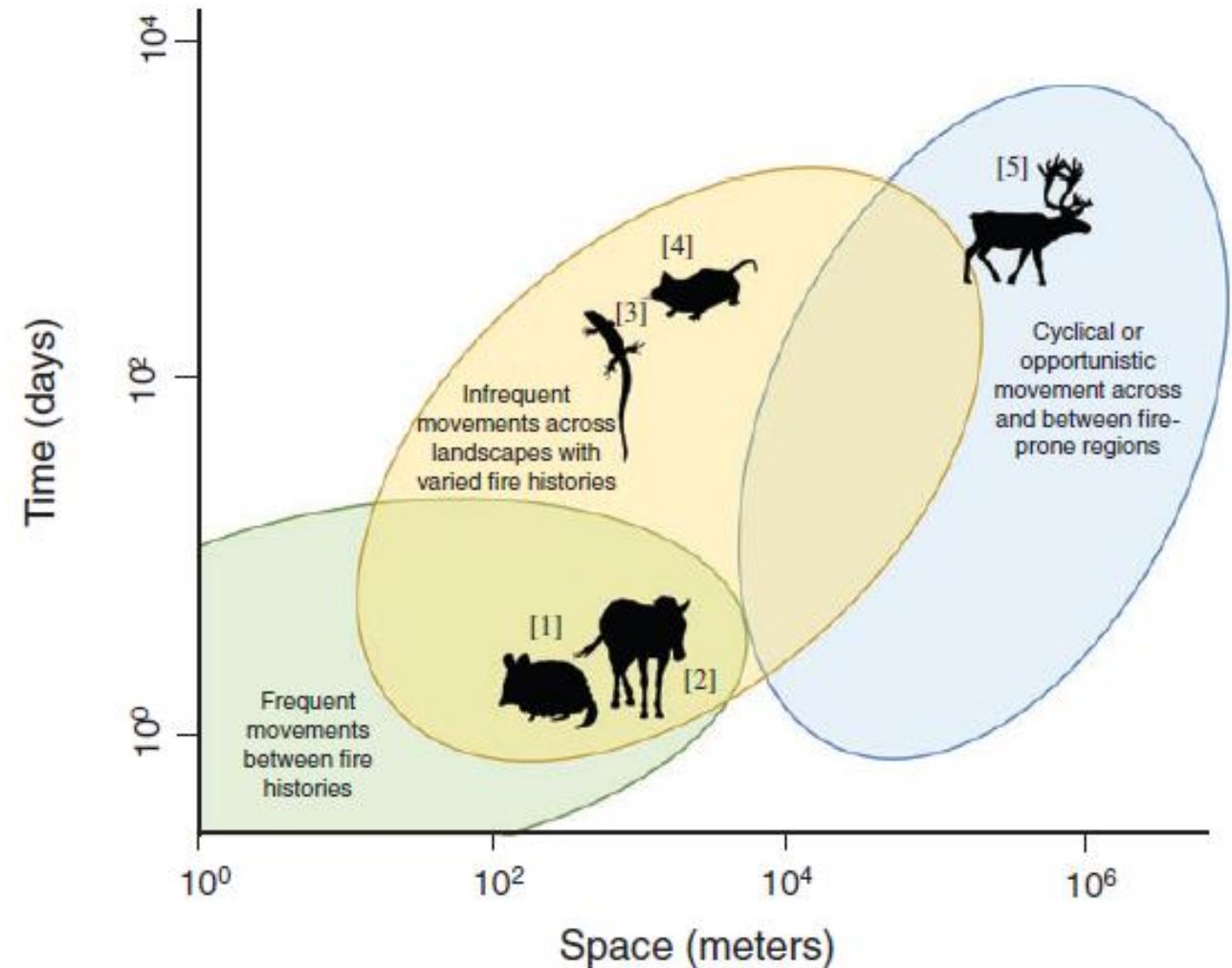
Presented by:
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Background: Fire History as a key landscape attribute

- Fire history provides a backdrop for ecological functions
- Capturing spatio-temporal dynamics of habitats

Nimmo, D.G. et al. Animal movements in fire-prone landscapes. Biological Reviews (2019)



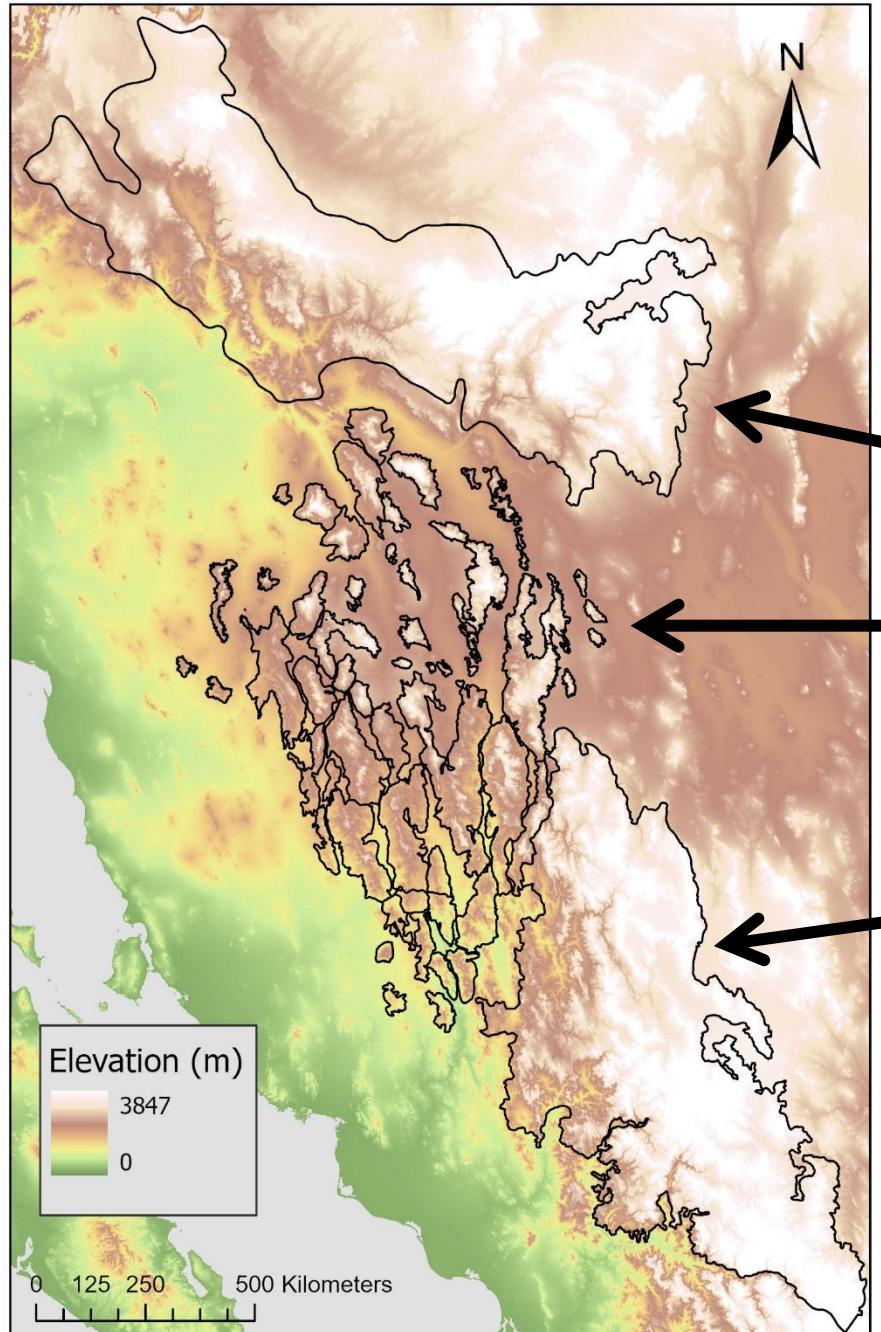
Heuristic framework

- Visualization (and modeling) fire history across watersheds
- Goal: to better understand the reciprocal relationship between fire history, people and nature



Pinus leiophylla var chihuahuana,
Reserva de la Biosfera de Janos

Study Region



Mogollon Rim & Plateau

Madrean Sky Islands

Northern Sierra Madre Occidental

Aburto-Oropeza et al.
Harnessing cross-border
resources to confront
climate change, Environ
Sci Pol (2018)

Northern Sierra Madre Occidental



- Rugged topography
- Pine-oak ecosystems
- Sparse population with close ties to land
- Frequent fire

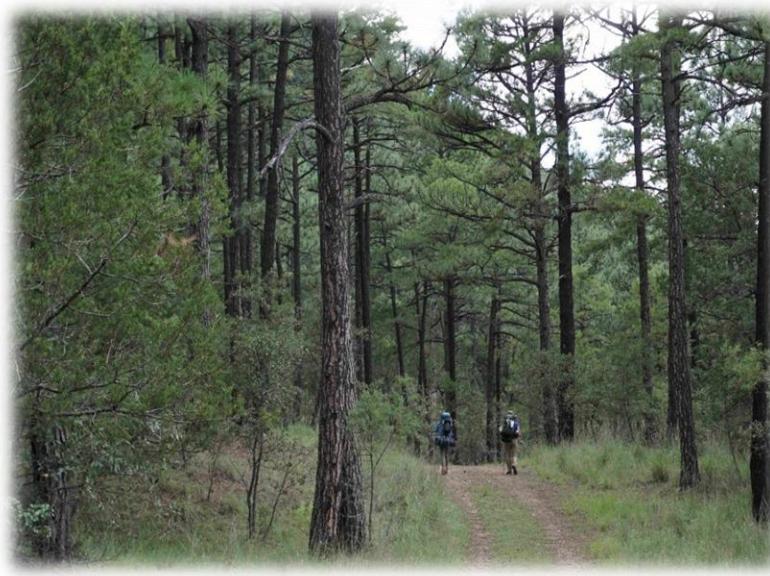
Cortés Montaño, C., et al.
Linking old-growth forest
composition, fire history, climate
Ecosphere 3(11).(2012)

Gonzalez-Elizondo, M.S. et al.
Ecosystems and diversity of
the Sierra Madre Occidental.
RMRS-P-67. (2013)

Madrean Sky Islands

- Steep topography, isolated forests in climatic transition
- Zone of conflict and collaboration
- Fires vary in frequency and severity

Villarreal, M. L., et al.
Distant neighbors, *Fire Ecology*, 15. (2019)
A mosaic of land tenure, *Case Studies in the Environ* 3.1 (2019)
Contemporary fire regimes, *Air, Soil Water Res* 13 (2020)



Mogollon Rim-Plateau

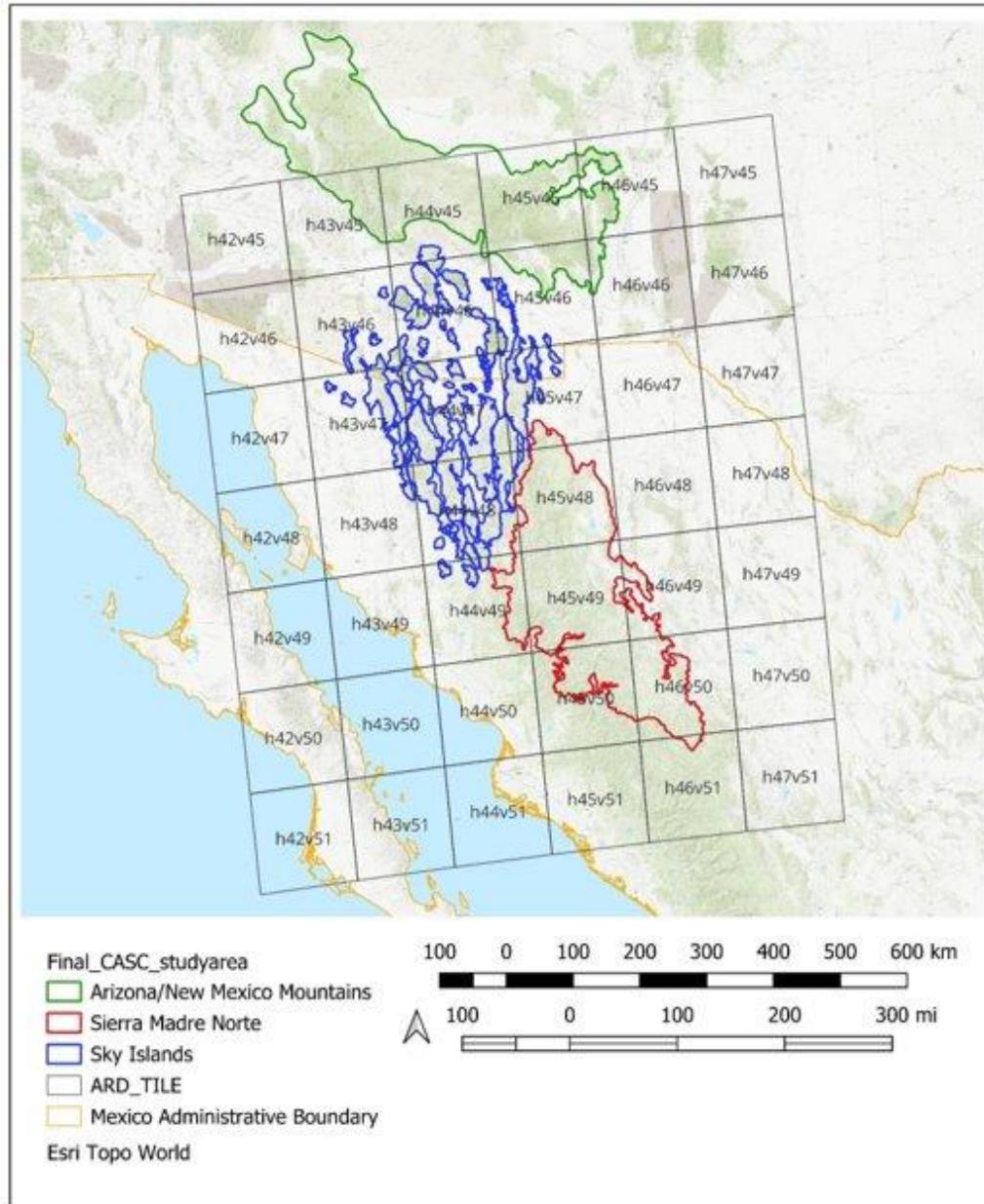


- High desert, scattered forest
- Iconic forests of *P. ponderosa*
- Large areas of public lands with active management
- Record-breaking fire size

Iniguez, Jose M. et al, Topography affected landscape fire history, *For Ecol Manage* 256.3 (2008)

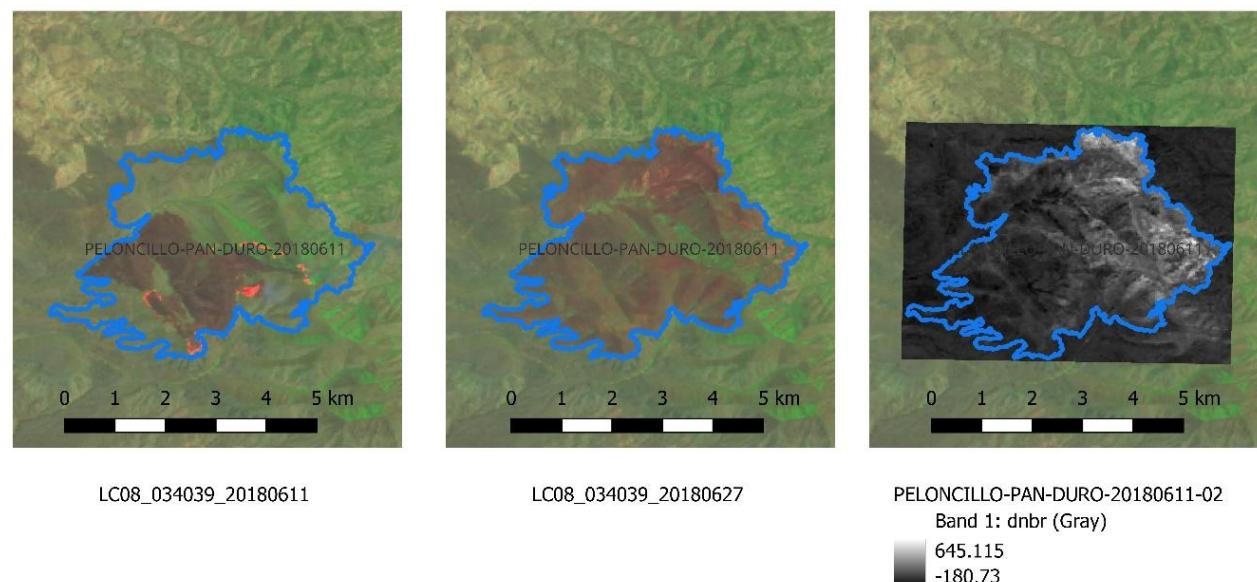
Hunter, Molly E. et al. Historical and current fire management practices, USFS Gen. Tech. Rep. (2014)

Data and analysis: Fire mapping 1990-2022



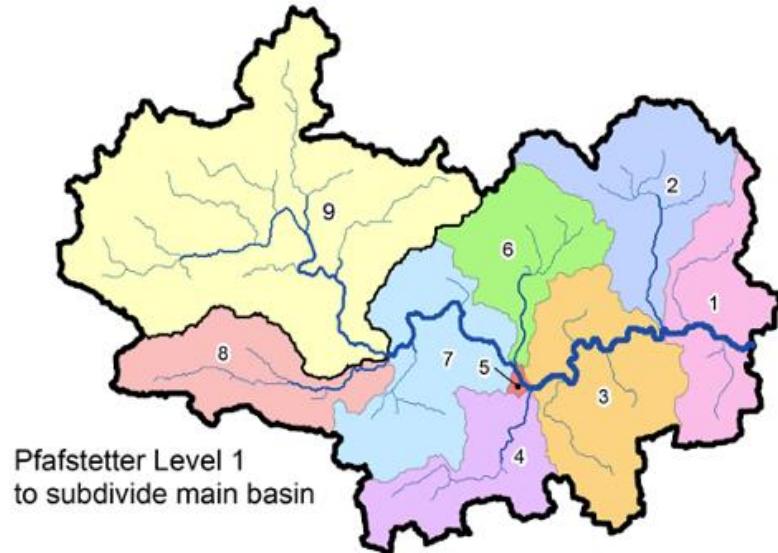
- Global application of Landsat Burned Area Algorithm

Mapped Burned Area and Burn Severity Example



Hawbaker, TJ et al. The Landsat burned area algorithm and products, *Rem Sens Environ* 244 (2020)

Data and analysis: Hydrography



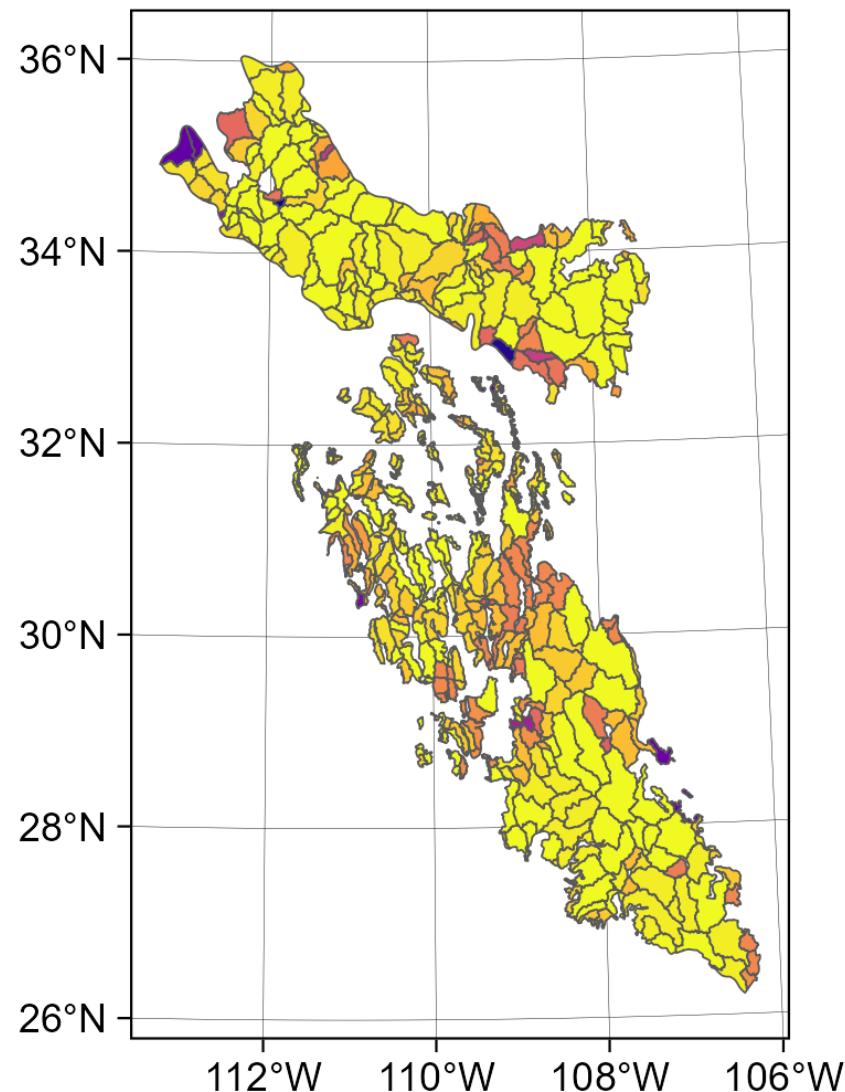
Lehner, B., Grill G. (2013): Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. *Hydrological Processes*, 27(15): 2171–2186.

Data available: www.hydrosheds.org.

- Catchment basin polygons and attributes
 - Levels 1-12
 - Level 8: good match for our study region & fire mapping boundaries

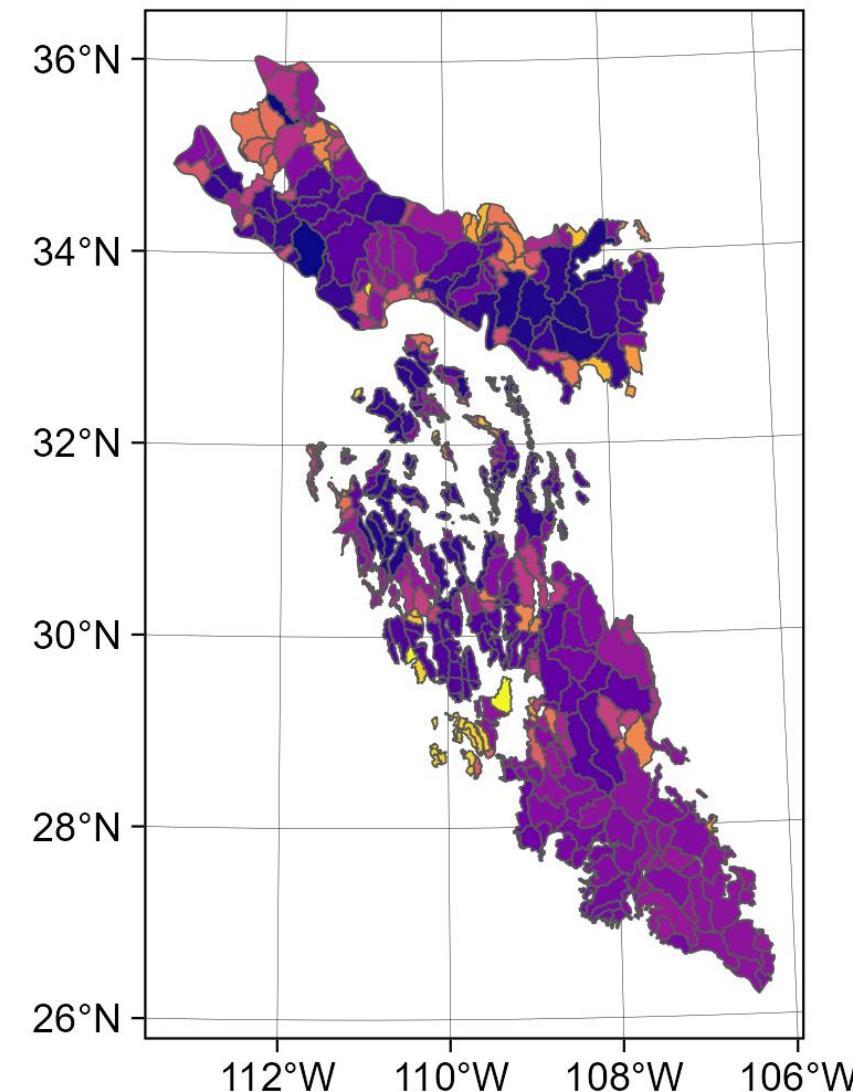


Fire history across the study region 1990-2022



Most Recent
Fire Year

2020
2010
2000
1990

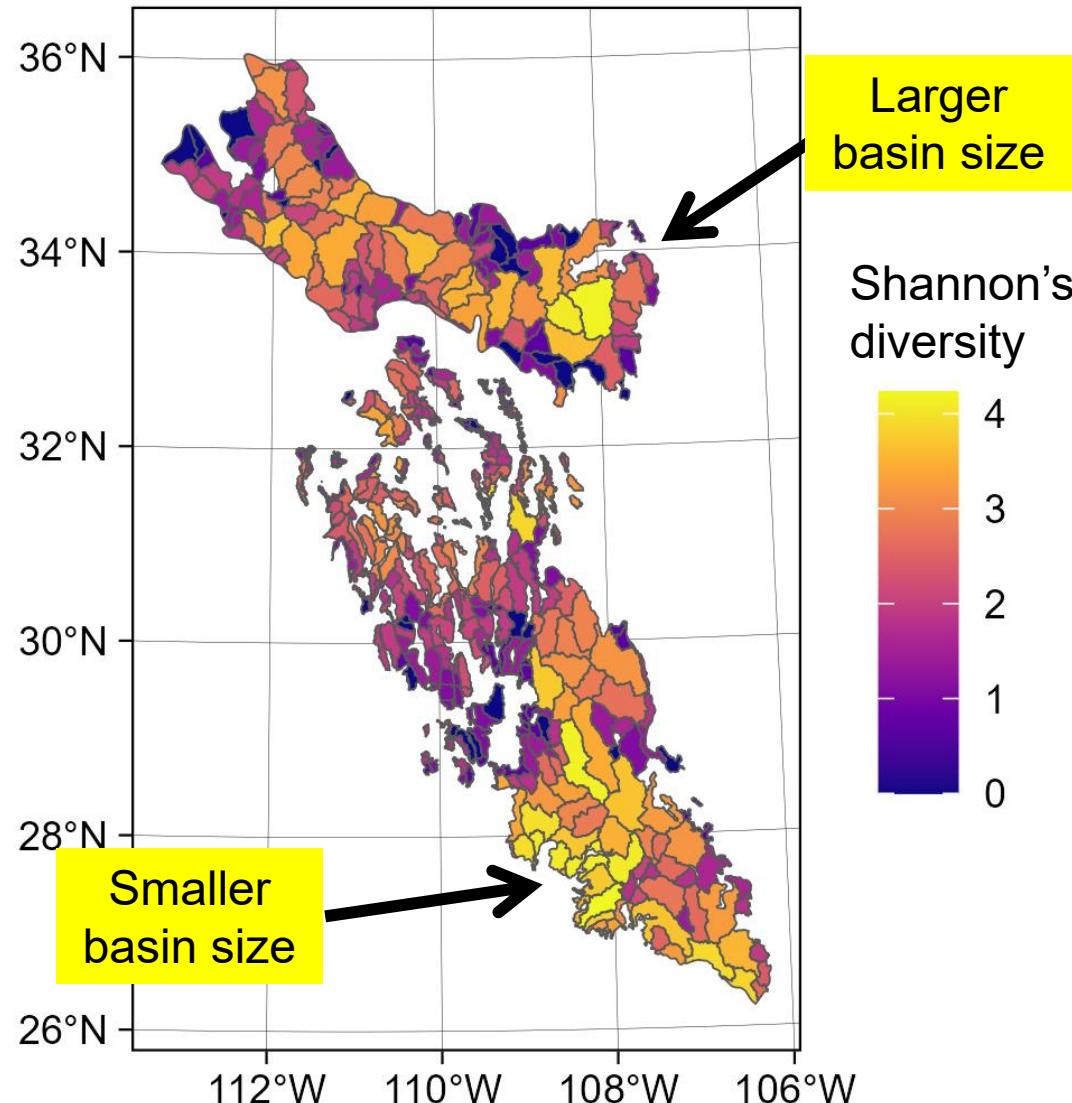


Earliest
Fire Year

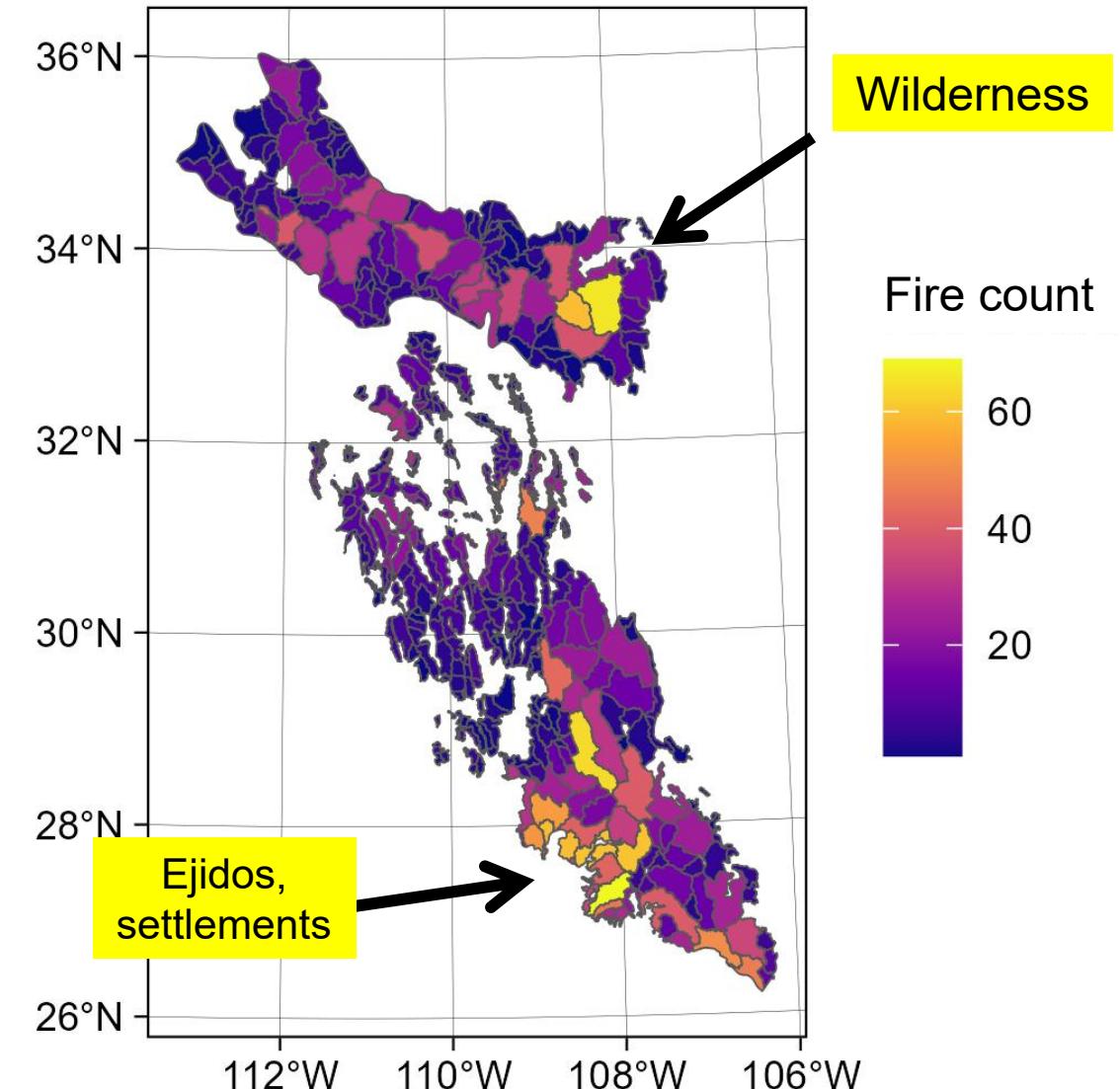
2020
2010
2000
1990

Fire history across the study region 1990-2022

Diversity (fire year)

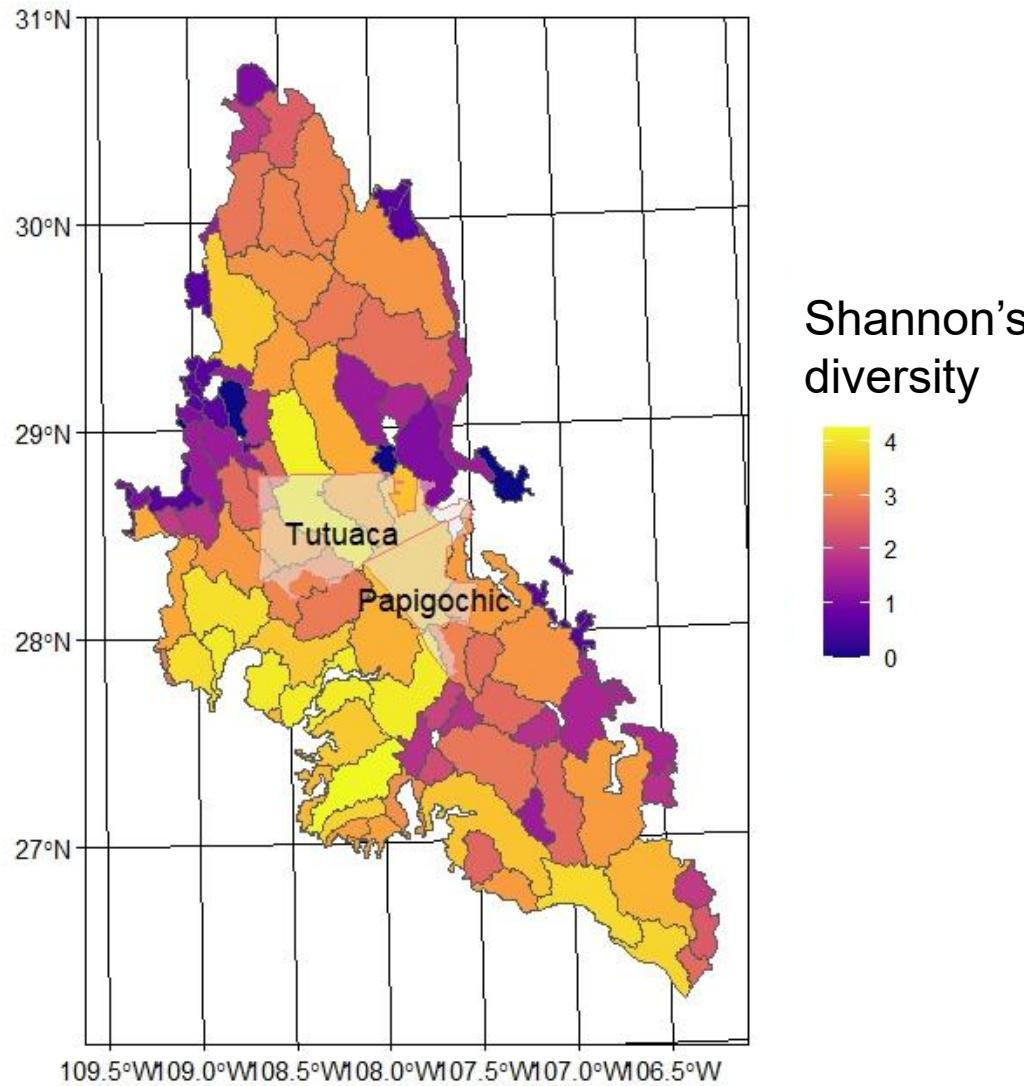


Fire count

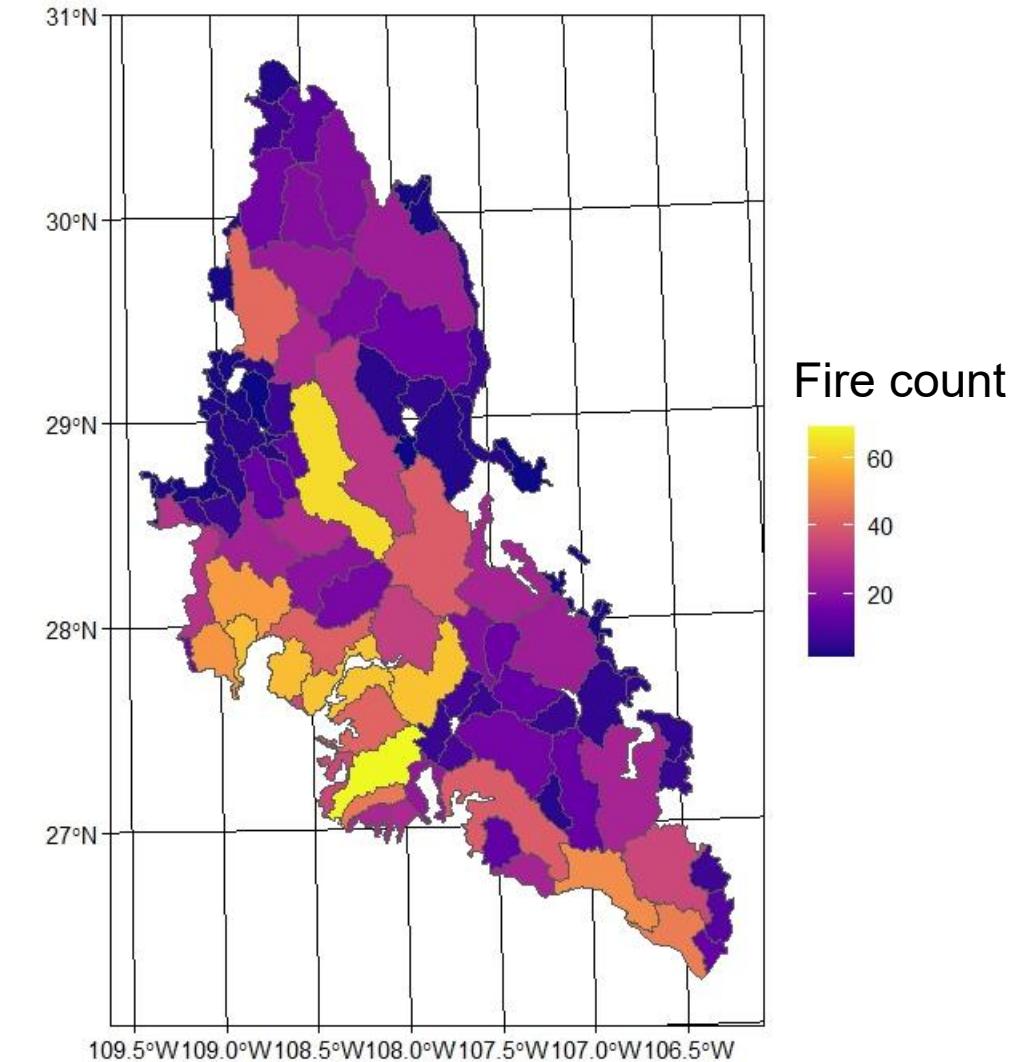


Fire history in the northern Sierra Madre Occidental 1990-2022

Diversity (fire year)

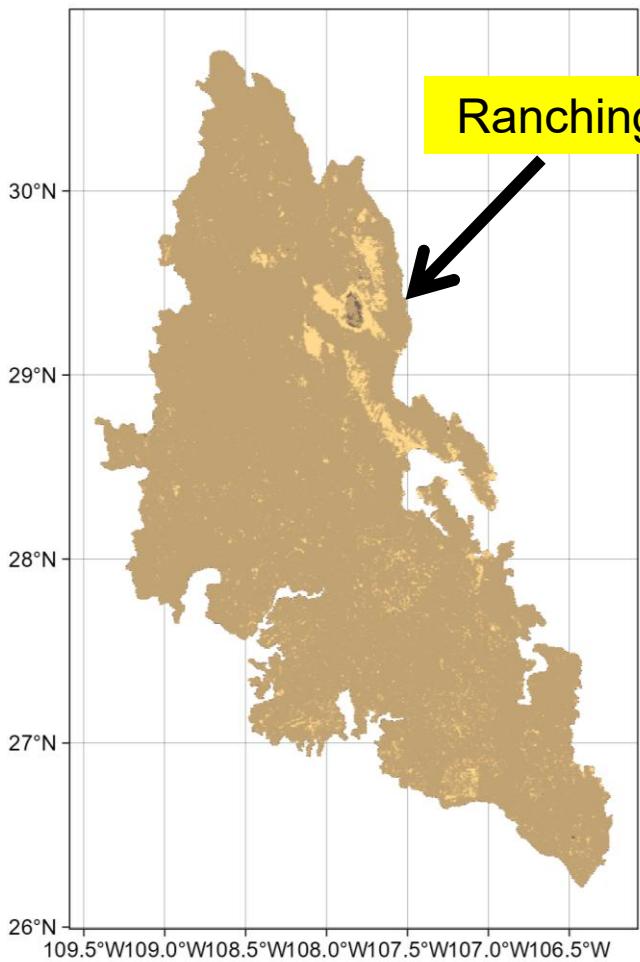


Fire count

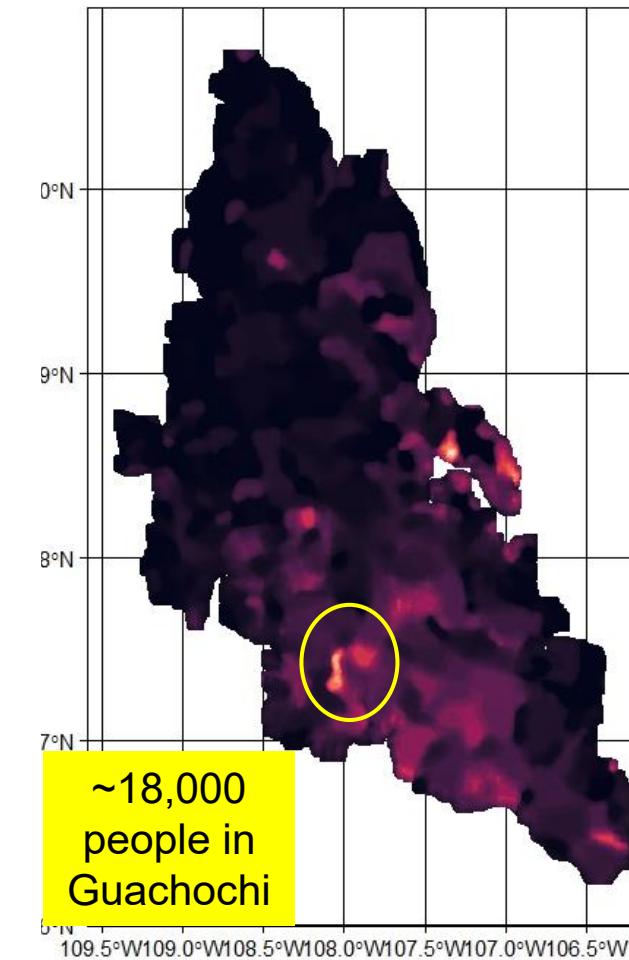


People and nature in the northern Sierra Madre Occidental

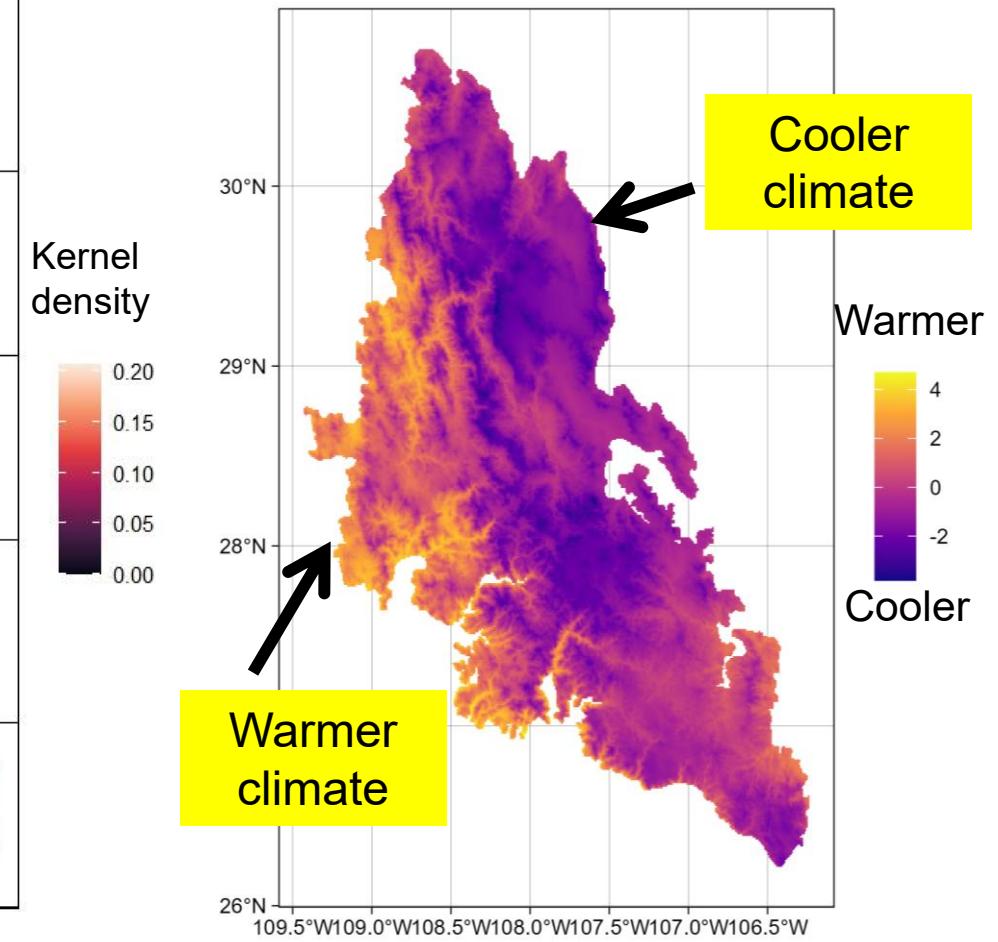
Agriculture



Population density

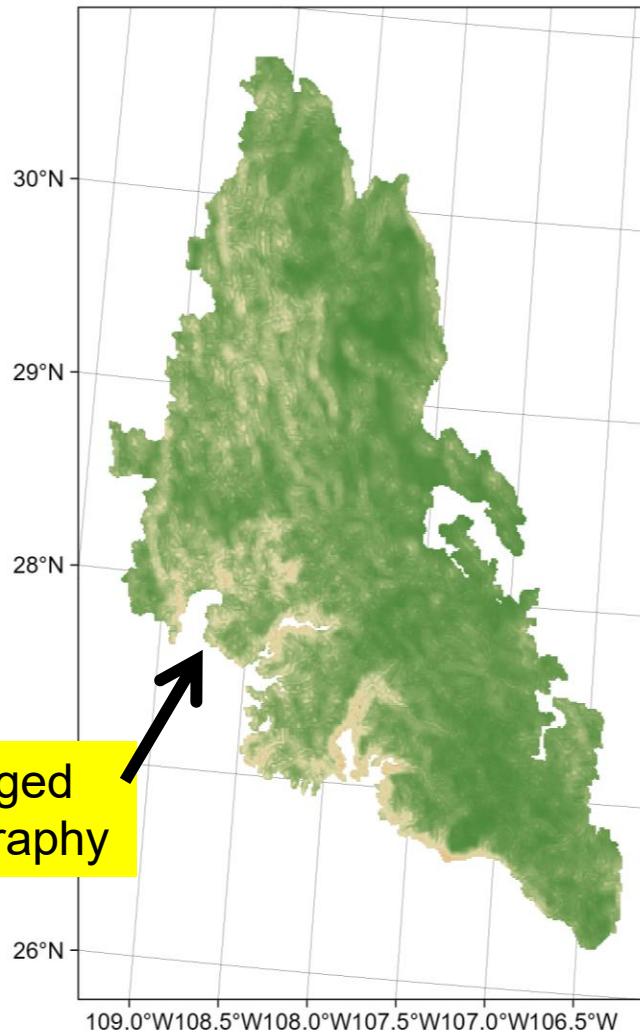


Climate gradient



People and nature in the northern Sierra Madre Occidental

Topographic ruggedness

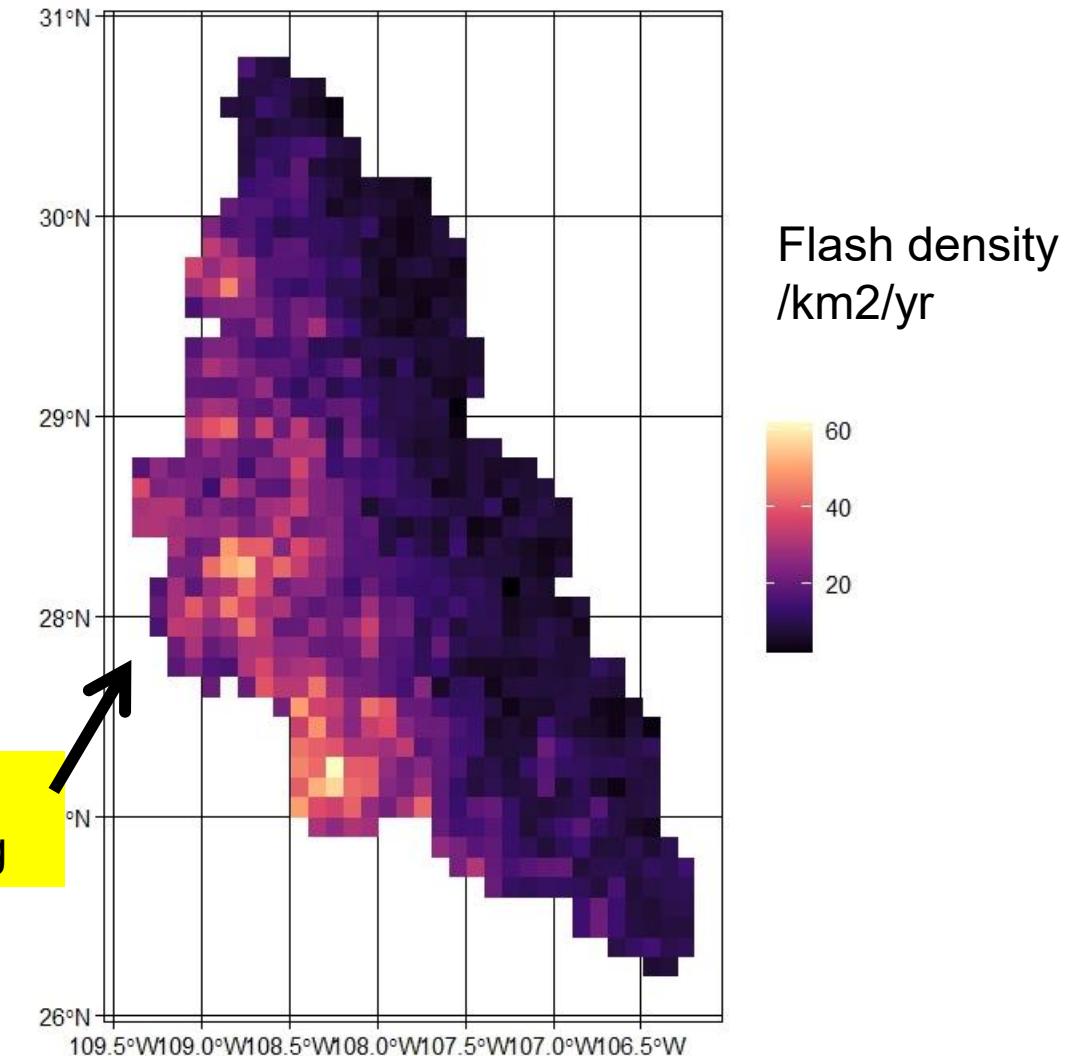


Rugged topography

Index value

5000
4000
3000
2000
1000
0

Lightning strikes



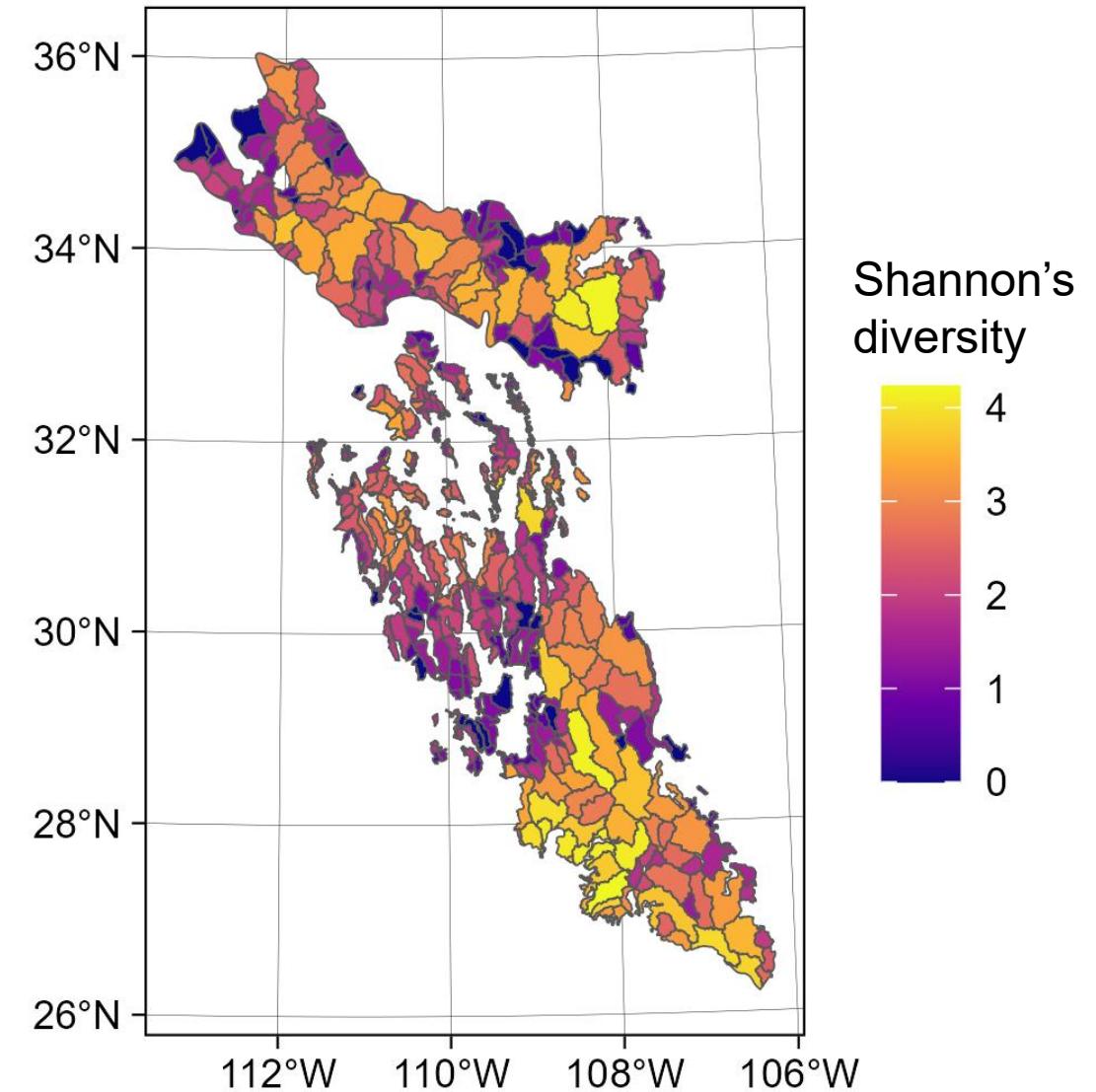
Plentiful lightning

Flash density /km²/yr

60
40
20

Observations from our heuristic framework

- Diversity in fire histories can result from:
 - unique natural environments
 - diverse anthropogenic processes
 - & different spatial scales



Coming soon!

Fire history and biodiversity—how to better understand and use this relationship for conservation and management

Kelly, L.T. et al. Optimal fire histories for biodiversity conservation. *Conservation Biology*, 29 (2015)

Jones, G.M. et al. Pyrodiversity in a Warming World: Research Challenges and Opportunities. *Curr Landsc Ecol Rep* 7 (2022).

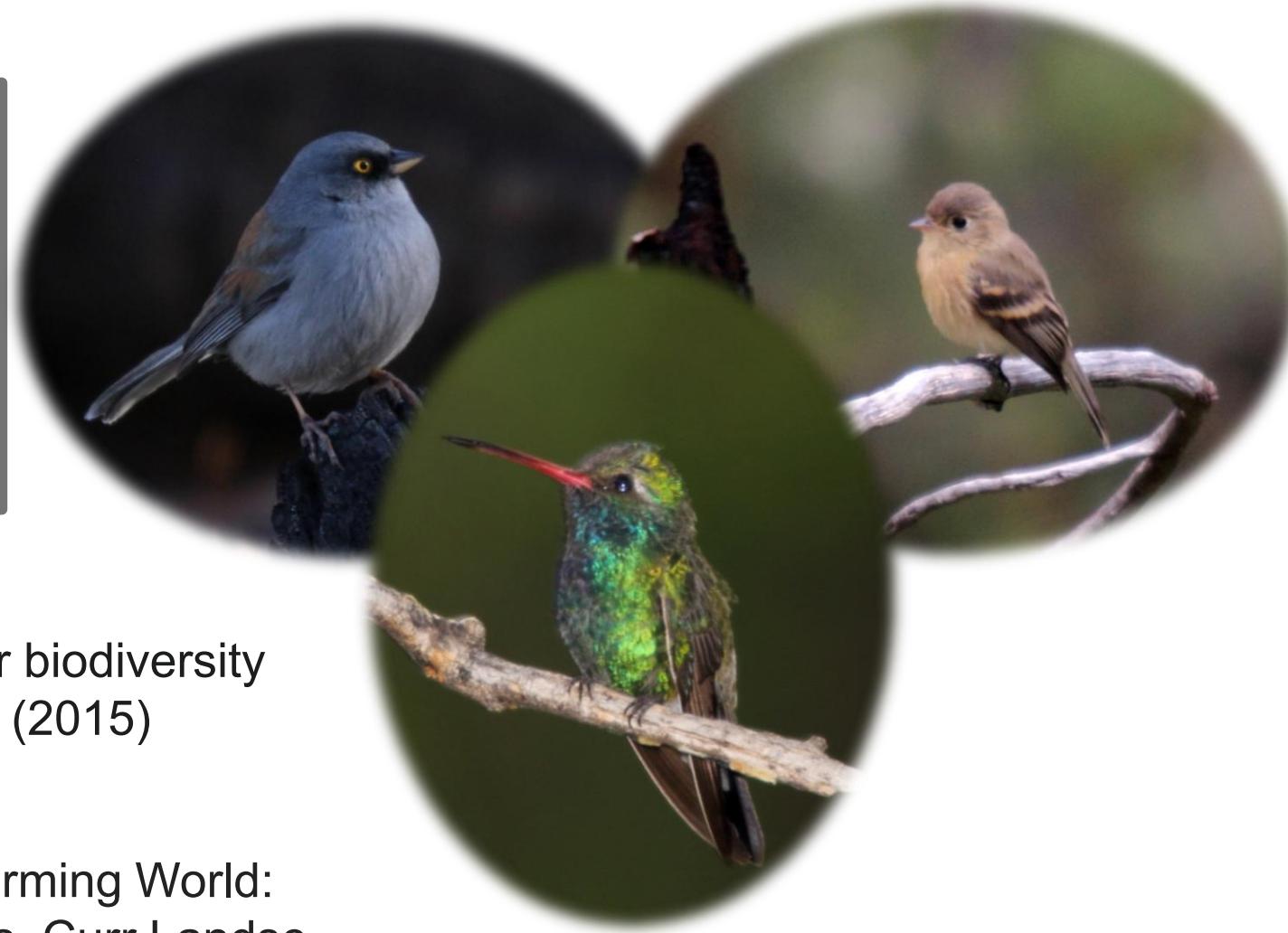


Photo credit: W Jaremko-Wright

Acknowledgements



- US Geological Survey National Land Imaging Program
- Southwest Climate Adaptation Science Center
- Universidad de Sonora, Hermosillo
- USDA Forest Service Rocky Mountain Research Station

- Data sources:
- Lightning and Population: NASA EARTHDATA
 - Climate: AdaptWest-ClimateWNA
 - Elevation: OpenTopography
 - ANP DataBasin

Thank you!

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