

AdaptWest –

A new spatial database to support landscape planning for climate resilience in North America

Carlos Carroll, Klamath Center for Conservation Research

May 28, 2015

See <http://adaptwest.databasin.org> for more information.

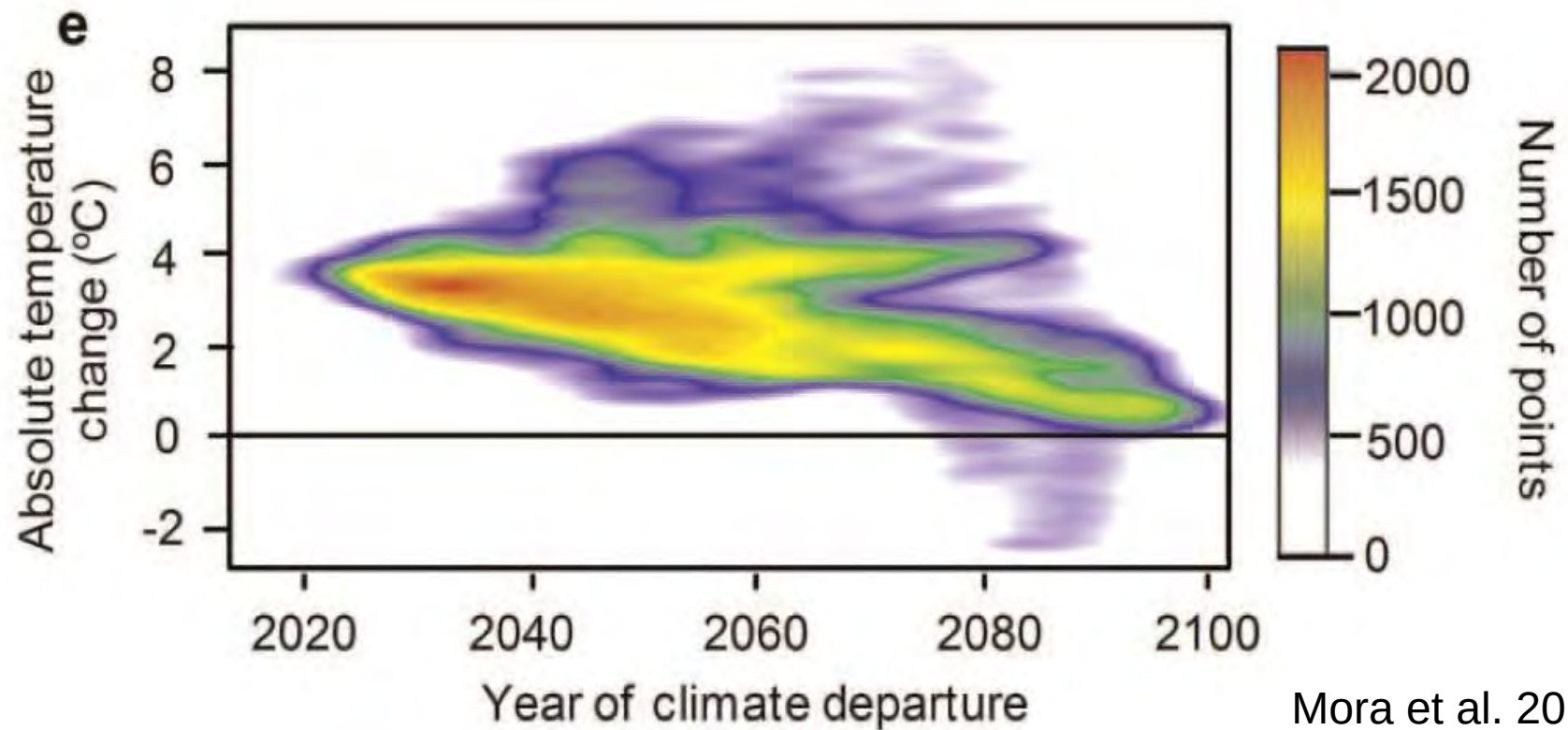


The AdaptWest project team

- Carlos Carroll, Klamath Center for Conservation Research
- Josh Lawler, University of Washington
- Julia Michalak, University of Washington
- Brad McRae, The Nature Conservancy
- Scott Nielsen, University of Alberta
- Andreas Hamann, University of Alberta
- Dave Roberts, University of Alberta
- Quinn Barber, University of Alberta

Why Adaptation Planning?

Most regions will depart from historical climate space by year 2050-2070.

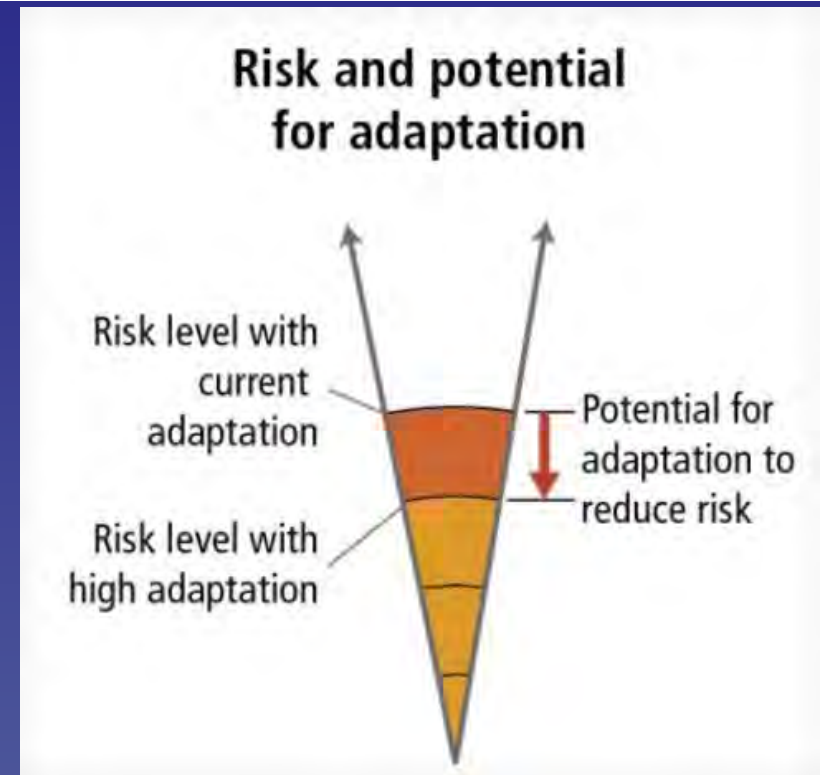


Executive order of Nov. 1, 2013:
Enhance the Role of Science in
Helping Manage Climate Impacts

- Develop Actionable Climate Science
- Launch a Climate Data Initiative
- Provide a Toolkit for Climate Resilience



Enhance the Role of Science in Helping Manage Climate Impacts



“Strengthen the **climate resilience** of our watersheds, natural resources, and ecosystems” (Executive order of November 1, 2013).

Enhance **adaptive capacity**, the ability of a system to adjust to climate change, to moderate potential damages, or to cope with the consequences.

To meet their adaptation planning goals,
organizations need spatial data on

The location of areas with high contribution to a
landscape's
adaptive capacity (refugia).



The relative intensity of climate-
related threats to ecosystem
services across the landscape.



AdaptWest is a new **spatial database**

designed to help land management agencies and other organizations implement strategies that **promote resilience, protect biodiversity, and conserve natural resources** in the face of a changing climate.

AdaptWest – A Climate Adaptation Conservation Planning Database for Western North America

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What is AdaptWest?

What is the purpose of AdaptWest?

What information is available?

How can I use AdaptWest?

AdaptWest is a spatial database and synthesis of methods for conservation planning aimed at enhancing resilience and adaptation potential of natural systems under climate change.

Get started quickly with the AdaptWest [Take a Tour](#)

Explore Guides and Case Studies

Connectivity Analysis Toolkit (CAT)

The Connectivity Analysis Toolkit (CAT) is a freely available software that provides new tools for both linkage mapping and landscape-level 'centrality' analysis. Conservation biologists have long recognized that natural areas that are linked into networks are often more effective than isolated areas at preserving certain components of biodiversity. Although in the past

[read more](#)

Ecoregion Climate Data Explorer

Explore and summarize current and projected future climate data for North American ecoregions. Available metrics include seasonal and annual means, extremes, growing and chilling degree days, snow fall, drought indices, and more.

Featured Datasets

AdaptWest News

Jan 22 - AdaptWest brochure available

Jan 22 - A new presentation describing AdaptWest is available

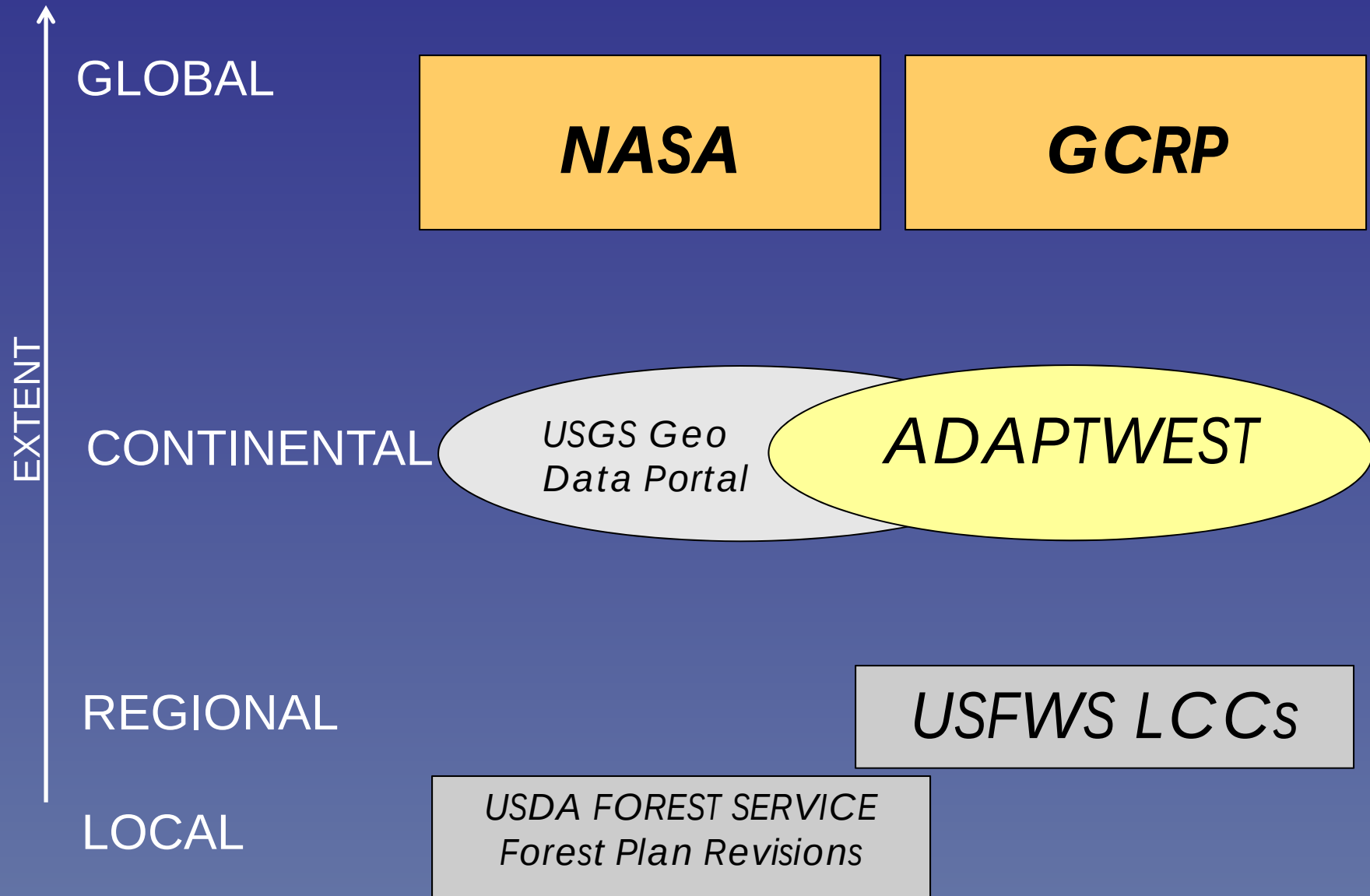
Dec 6 - Now online: Current and projected climate data for western North America (ClimateWNA)

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What makes AdaptWest a key resource for planners?

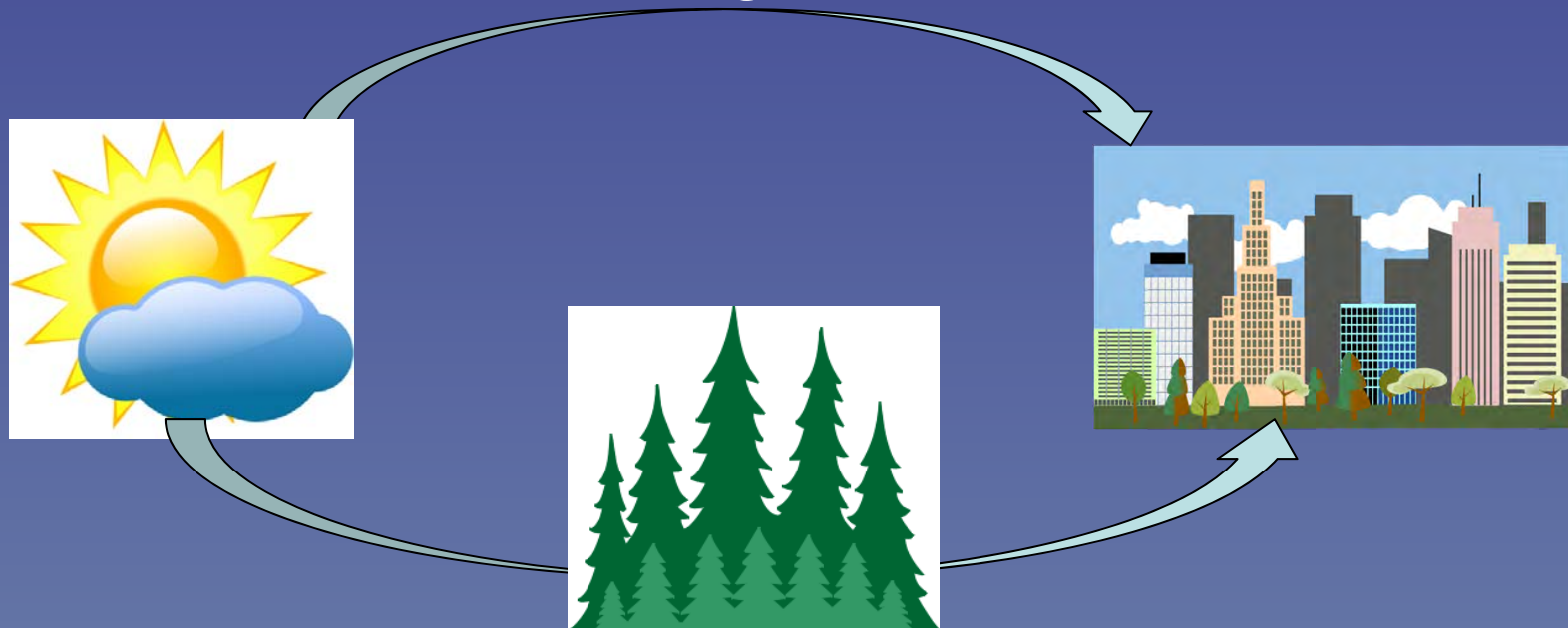
- Broad geographic **extent** (most of North America),
- Relatively high spatial **resolution** (1 km or less),
- Access to a **wide range** of spatial data relevant to resilience and adaptation potential of natural systems under climate change.
- Guides which help place this diverse information in **context**.

AdaptWest leverages global change products for use in regional analyses

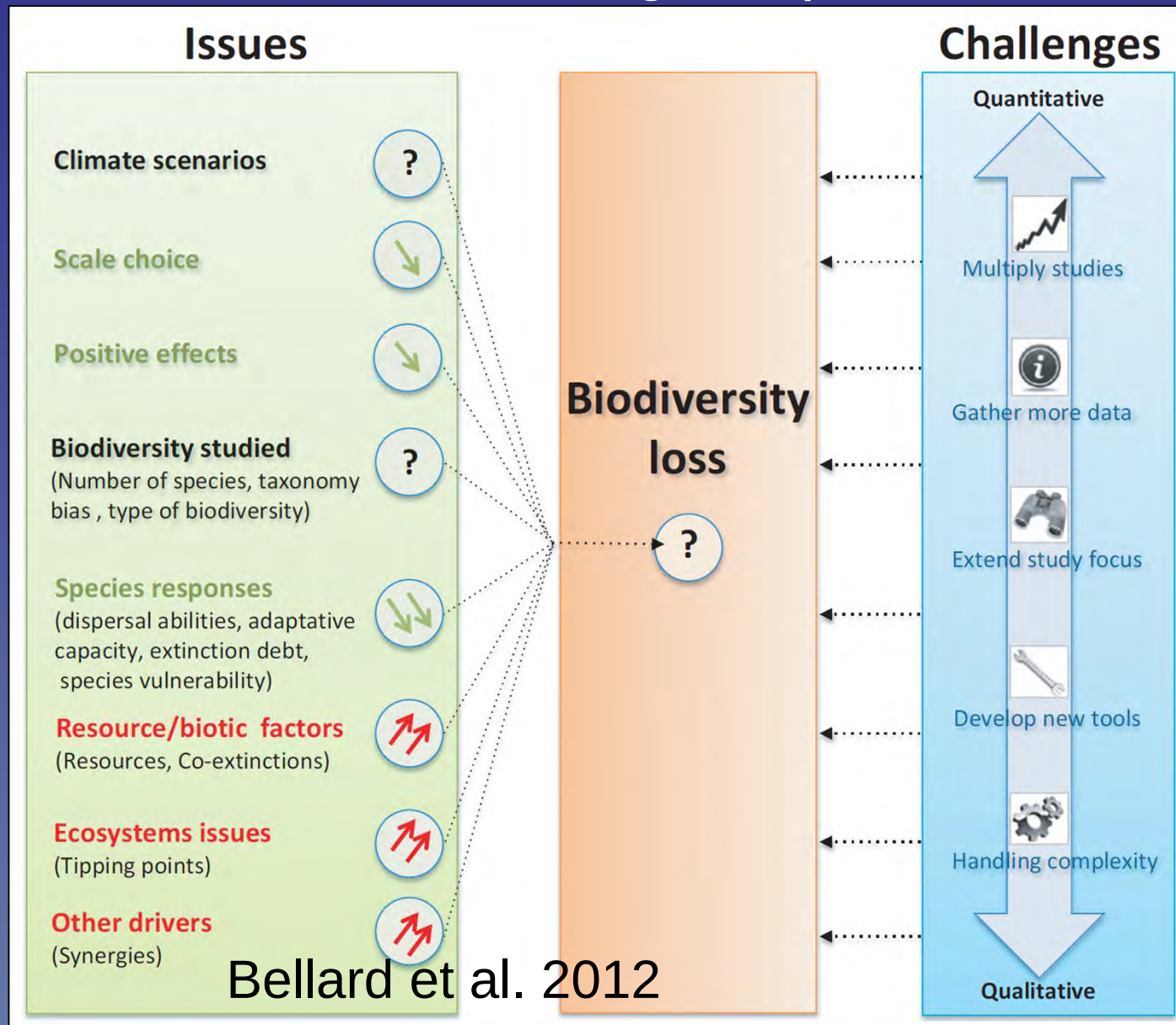


AdaptWest provides a bridge between climate and ecological data

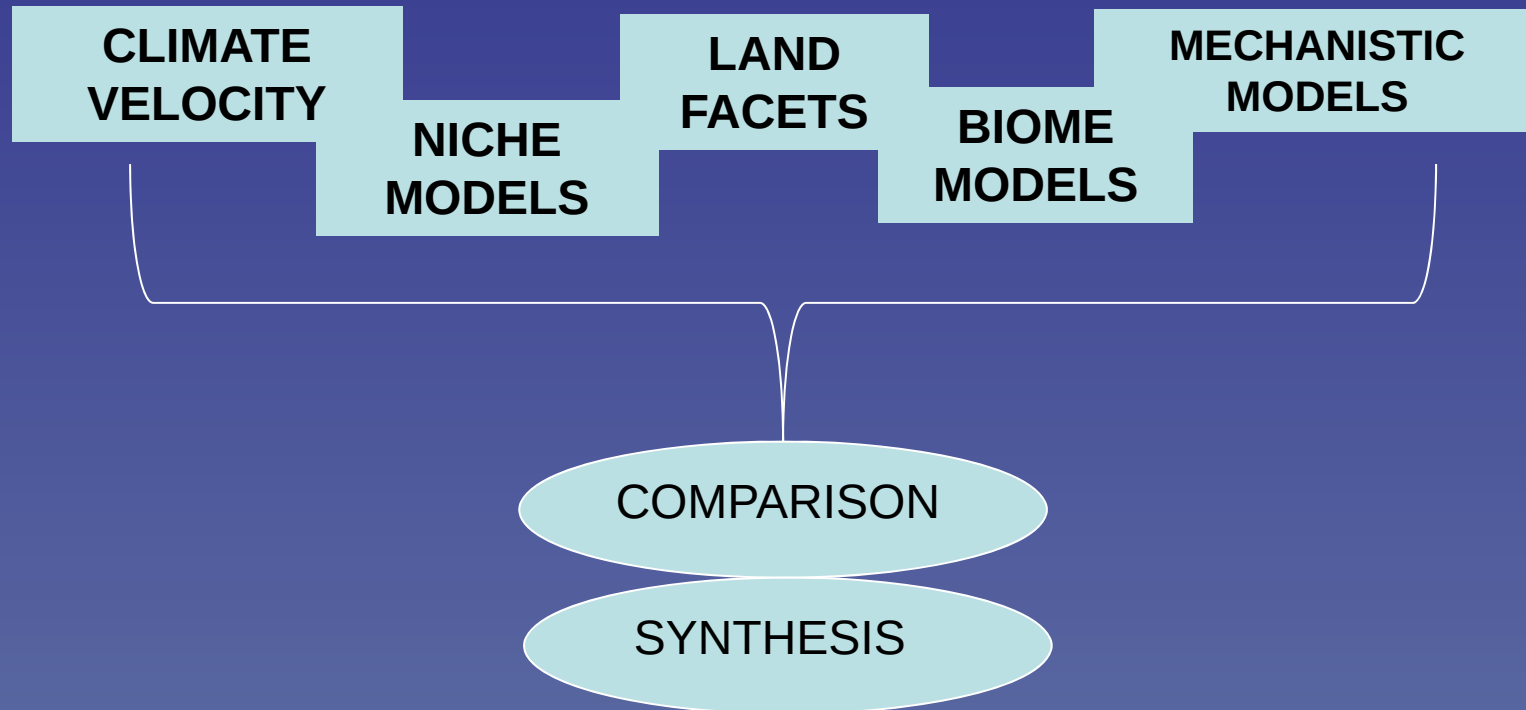
- Ecologically-based metrics that offer new ways of looking at climate resilience and adaptive capacity.
- A single data portal for communicating climate and ecological information.



How do we make sense of the variety of data and link it to ecological processes?



AdaptWest provides **access** to diverse types of data



But also helps place the data in **context**

AdaptWest help planners integrate diverse data by allowing them to

- Compare priority areas from different approaches
- Test assumptions (surrogacy value)
- Encompass a range of model complexity
- Use a multi-track approach to produce a comprehensive, unified analysis

Open access to well-documented datasets

AdaptWest – A Climate Adaptation Conservation Planning Database for Western North America

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AdaptWest Resources

- Climate Data
 - Climate Data - Western North America
 - Climate Data - North America
 - Ecoregion Climate Data Explorer
- Physical Habitat Data
- Species Data
- Integrated Prioritization Data
- Other documents and data

Resources on Data Basin

-  Guides & Case Studies
-  Galleries
-  Maps
-  Datasets

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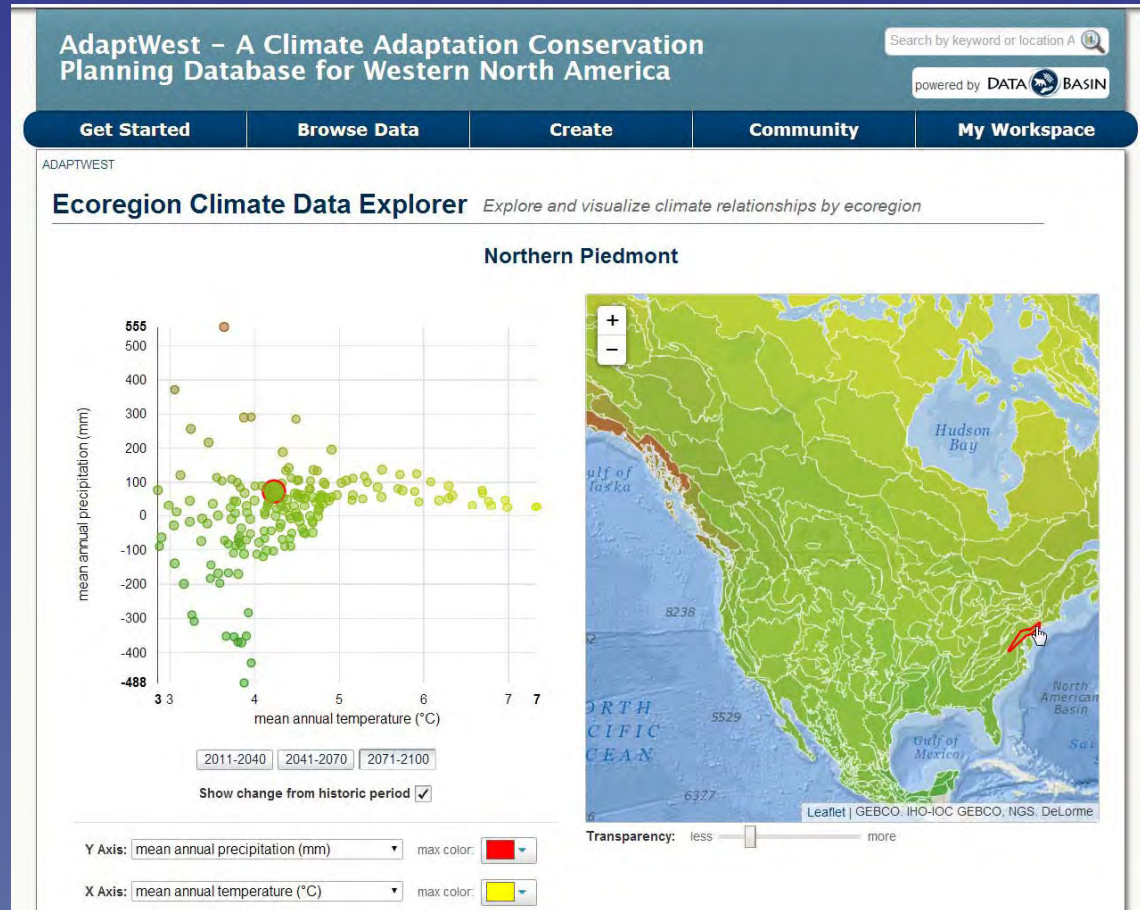
[see all news](#)

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Interactive data visualization: Communicating the big picture

Goal: Rapidly
explore,
summarize, and
visualize
relationships in the
data without
making a detailed
map.
Place information
for their area in a
wider context.



Data-Driven Documents

Builds on Databasin's capacity for online collaboration and learning

Translating data into knowledge

Online cartography – Create new maps

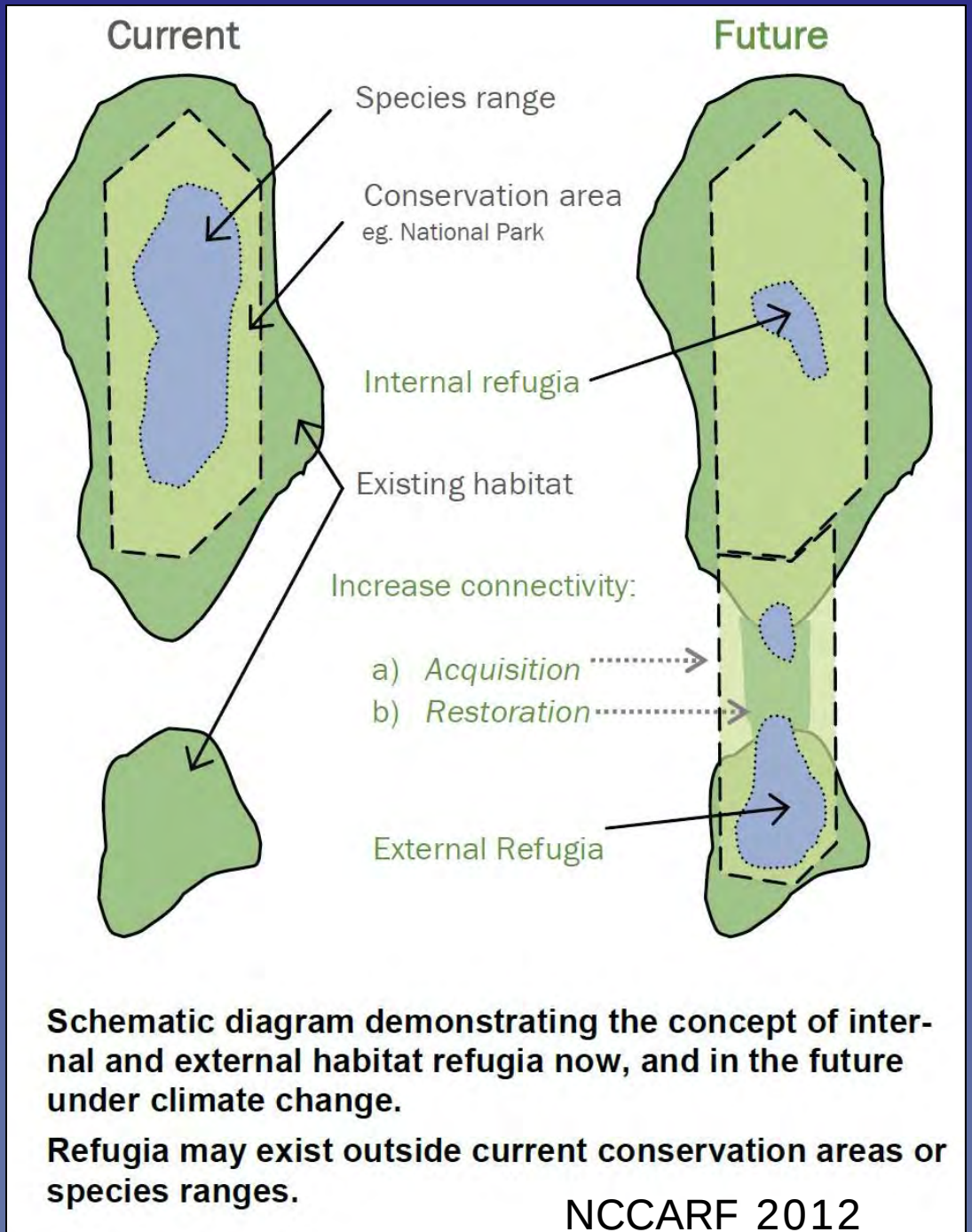
Discuss and annotate maps and data, either in small workgroup or public setting.

Leverages community of 12,000 Databasin users.



Refugia are key to promoting climate change resilience

But there is little agreement on what areas will function as refugia or how they can be identified.



Types of “refugia”:

Microrefugia: Allows population to persist indefinitely

Holdout: Allows population to persist temporarily

Stepping-stone: Facilitates range shifts

Opinion

CellPress

Fine-grain modeling of species' response to climate change: holdouts, stepping-stones, and microrefugia

Lee Hannah¹, Lorraine Flint², Alexandra D. Syphard³, Max A. Moritz⁴, Lauren B. Buckley⁵, and Ian M. McCullough⁶

¹Betty and Gordon Moore Center for Science and Oceans, Conservation International, Arlington, VA, USA

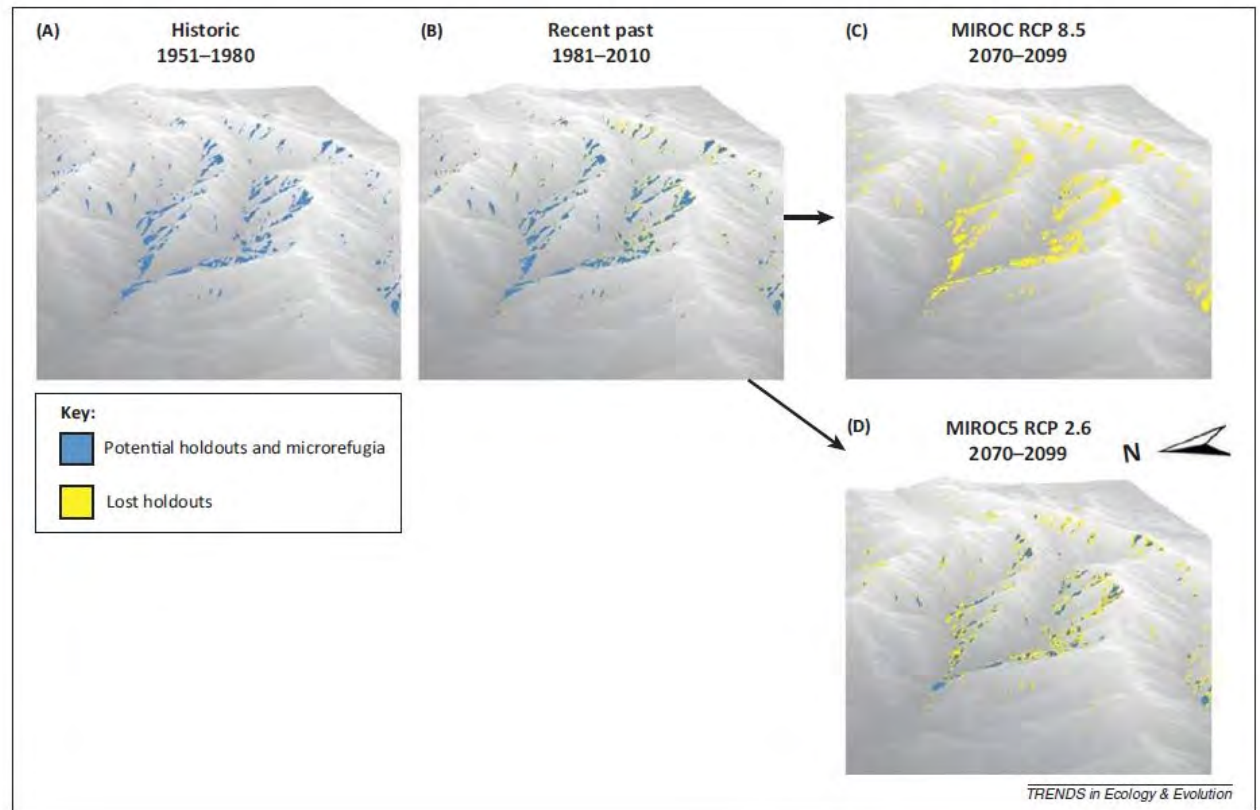
²United States Geological Survey, Sacramento, CA, USA

³Conservation Biology Institute, La Mesa, CA, USA

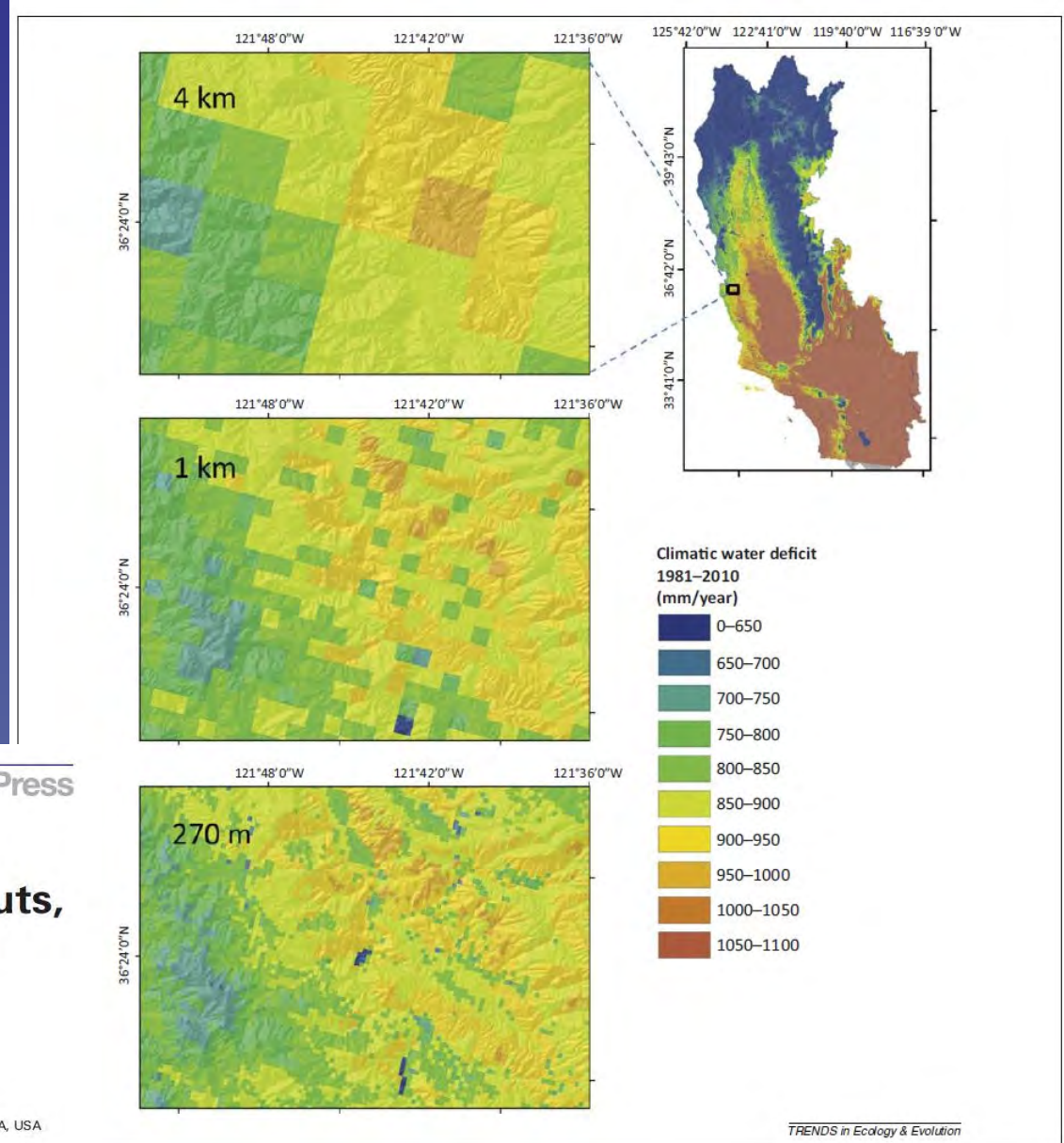
⁴Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA, USA

⁵Department of Biology, University of Washington, Seattle, WA, USA

⁶Bren School of Environmental Science and Management, University of California, Santa Barbara, Santa Barbara, CA, USA



Different areas
may be identified
as refugia
depending on the
resolution of the
data



Opinion

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Refugia may differ between coarse-filter and fine-filter targets

Coarse-filter (non-species-specific):

Climate-data-based refugia

Physical-habitat-based refugia (topodiversity, land facets)

Fine-filter (species-specific):

Species-niche-model-based refugia

Focal-species-habitat-based refugia



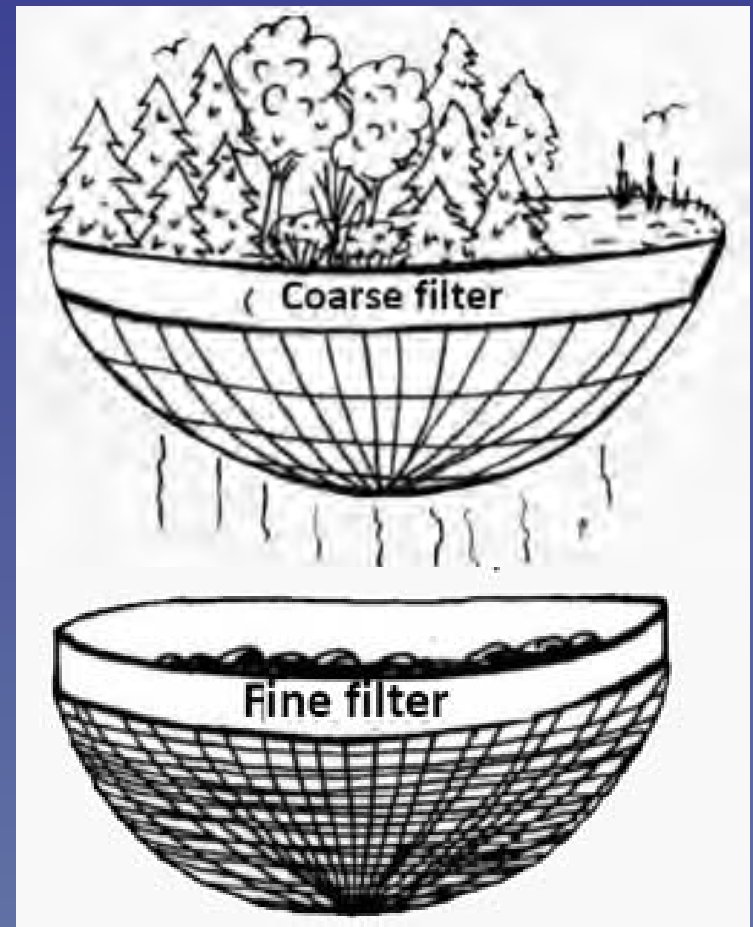
Multi-track coarse/fine-filter approach:

Why use coarse-filter targets?

Lack of information
about most species

Why use fine-filter targets?

Coarse-filter surrogate
imperfectly protects
individual species



Finding a balance: Conserving the actors and the stage

Land facets



Ann. N.Y. Acad. Sci. ISSN 0077-8923

Climate refugia



Restore key habitat



Stepping stones



ANNALS OF THE NEW YORK ACADEMY OF SCIENCES

Issue: *The Year in Ecology and Conservation Biology*

Fine- and coarse-filter conservation strategies in a time of climate change

Morgan W. Tingley,¹ Emily S. Darling,² and David S. Wilcove^{1,3}

¹Woodrow Wilson School, Princeton University, Princeton, New Jersey. ²Biology Department, University of North Carolina, Chapel Hill, North Carolina. ³Department of Ecology and Evolutionary Biology, Princeton University, Princeton, New Jersey

Address for correspondence: Morgan W. Tingley, Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, CT 06269. morgan.tingley@uconn.edu



What data are available?

In order of increasing complexity:

- Metrics based on **physical habitat types** (land facets and topodiversity).
- **Downscaled projections** of future climate,
- **Velocity of climate change**, including refugia areas of low climate velocity,
- **Biotic velocity**, and projected climate refugia for individual species.

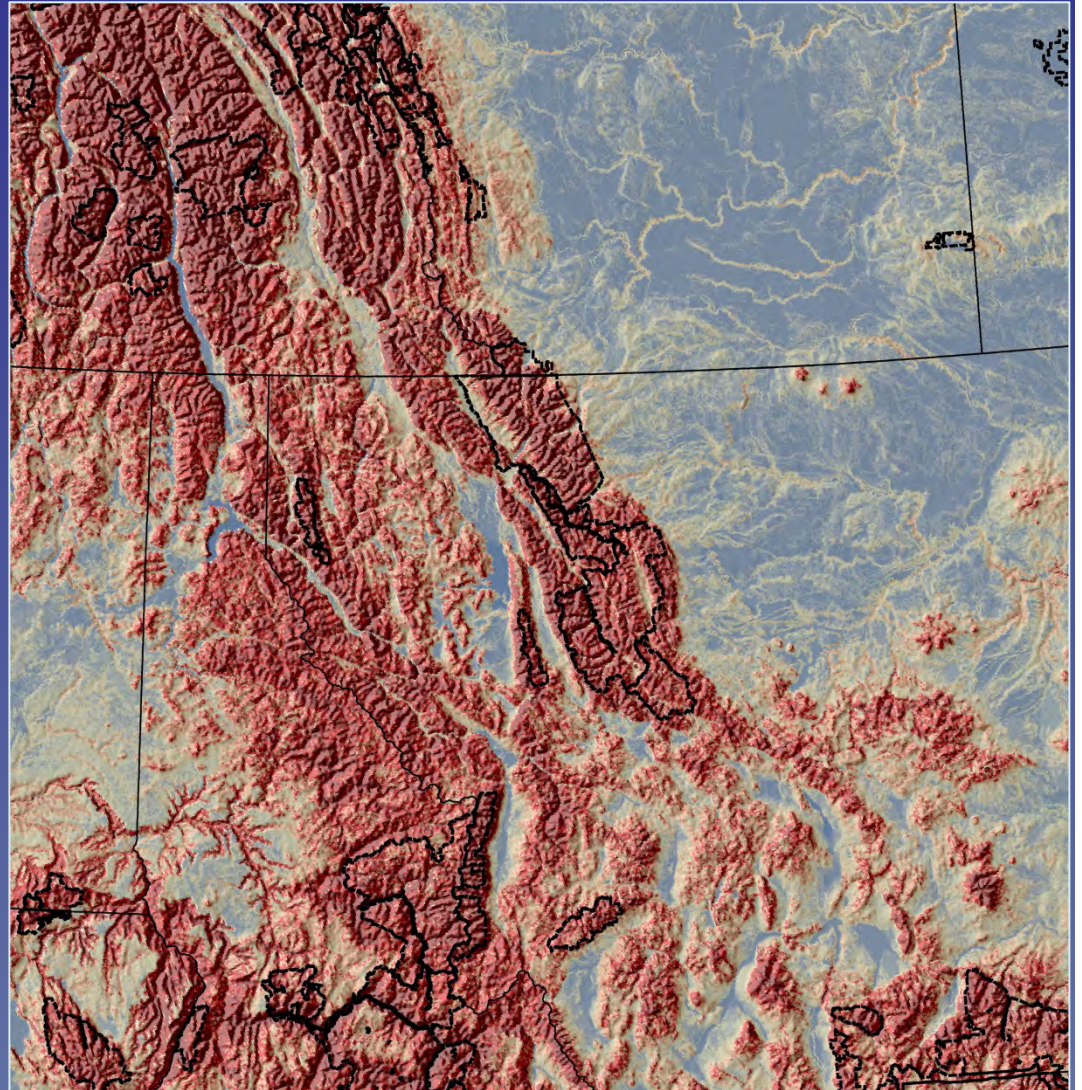
Physical habitat types and diversity

Land facets



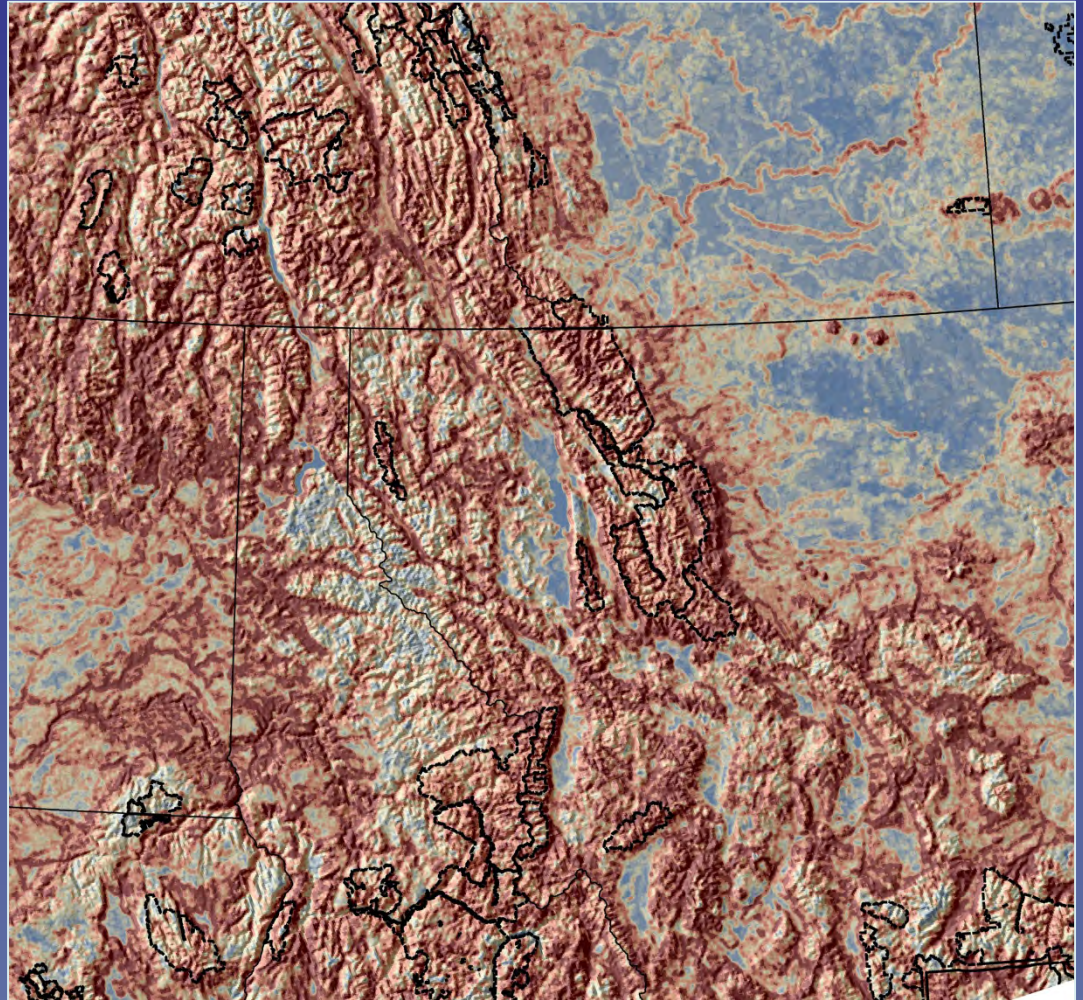
Topodiversity

- Resolution-dependent
- May be based on elevation or more complex metrics (heat load, etc.)
- May highlight montane areas that are already well-represented in protected areas.

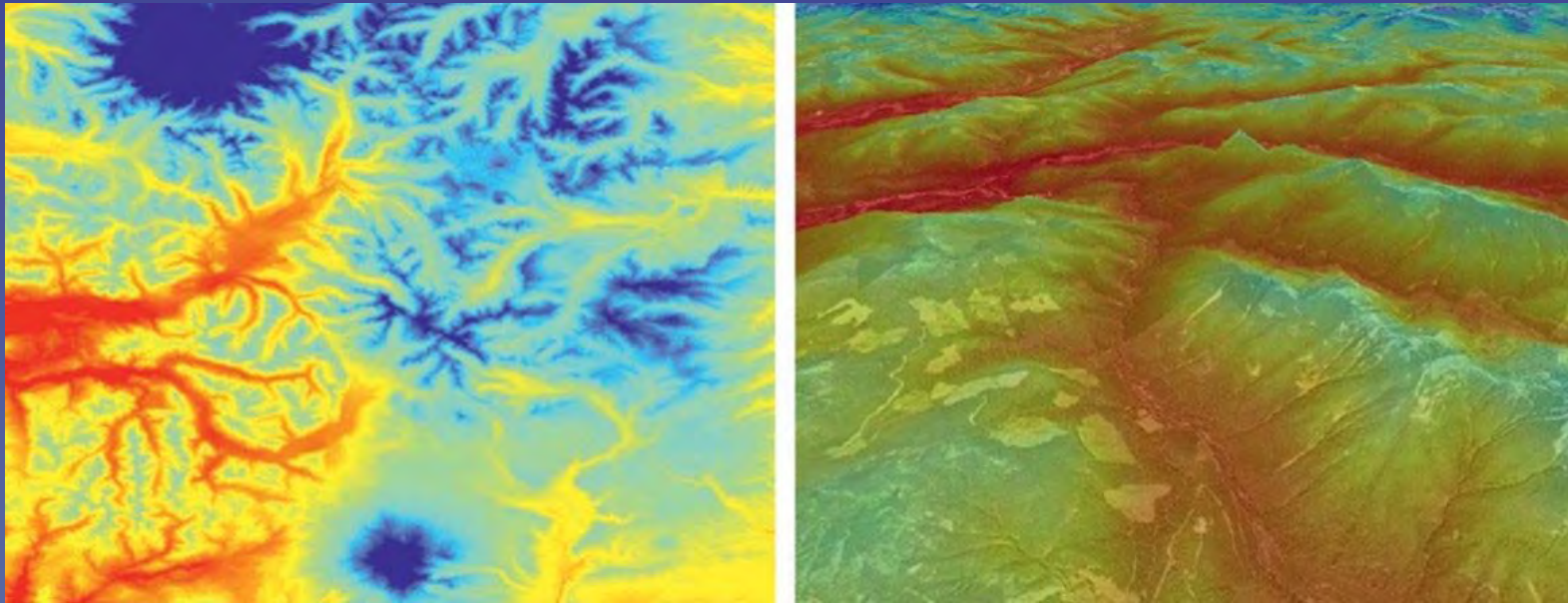


Land facet diversity

- This metric is based on USGS ecological land unit data created from climate, landform, lithology, and landcover.
- Tends to highlight lower elevation areas: e.g., forest/grassland ecotone.



Downscaled climate data and climate-based metrics



Downscaled projections of future climate *via ClimateNA software*

IPCC 5th Assessment:
Ensemble of GCMs for
RCP4.5 and RCP8.5
scenarios

Time periods: 2020s,
2050s, 2080s
T. Wang, A. Hamann
and D. Spittlehouse
UBC & Univ. of Alberta

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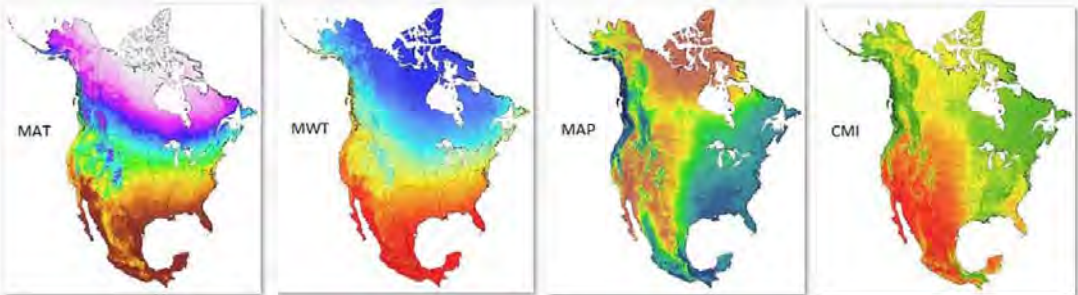
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ADAPTWEST | CURRENT AND PROJECTED CLIMATE DATA FOR NORTH AMERICA (CLIMATENA)

Current and projected climate data for North America (ClimateNA)

This dataset was created by Diana Stralberg, Xianli Wang, and Andreas Hamann. It is based on the Parameter Regression of Independent Slopes Model (PRISM) interpolation method for current climate, and the Coupled Model Intercomparison Project phase 3 (CMIP3) database corresponding to the 4th IPCC Assessment Report for future projections. The thumbnails below are images of mean annual temperature (MAT), mean winter temperature with inversions in northern mountain valleys (MWT), mean annual precipitation with leeward rainshadows (MAP), and Hogg's climate moisture index (CMI).



Data coverage and variables

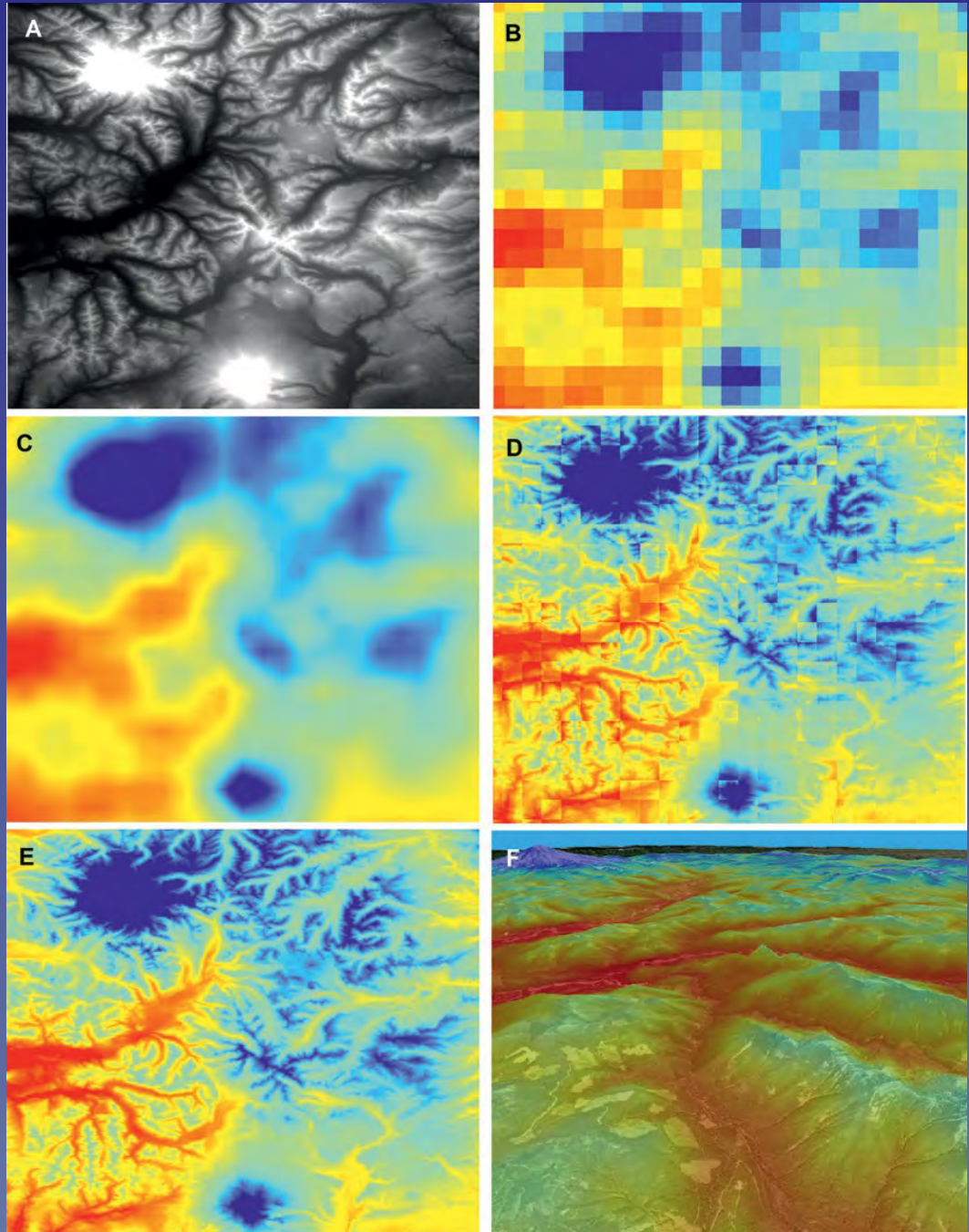
The gridded climate layers downloadable below are in Lambert Conformal Conic projection, covering all of North America. The database is based on a 1km digital elevation model, but sub-sampled at 4km vertical and horizontal intervals for a manageable database size. This preserves the full range of climate values (as opposed to a 4km average), and captures elevational gradients, temperature inversions, and rain shadows in the mountainous landscape of western North America.

Two sets of variables are available for download in standard ESRI ASCII format. One comprises 20 biologically relevant variables, including seasonal and annual means, extremes, growing and chilling degree days, snow fall, potential evapotranspiration, and a number of drought indices. The second dataset consists of 36 monthly temperature and precipitation variables.

For downloadable data for individual GCMs, see [this page](#).

ClimateNA

downscaling process
combines
DEM data &
PRISM data using
a combination of
bilinear interpolation
and elevation
adjustment.

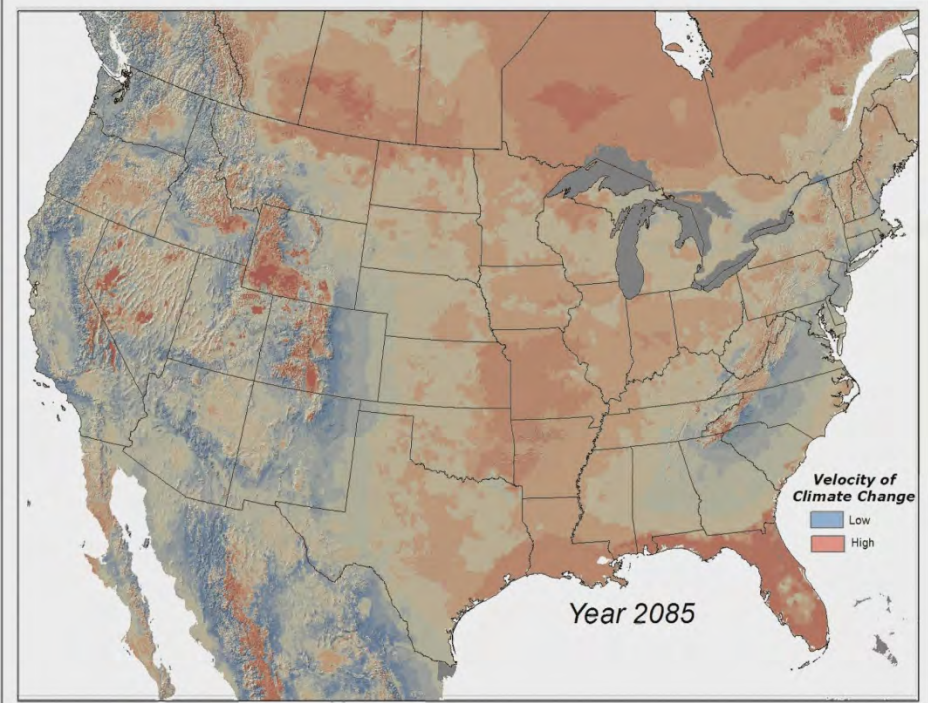
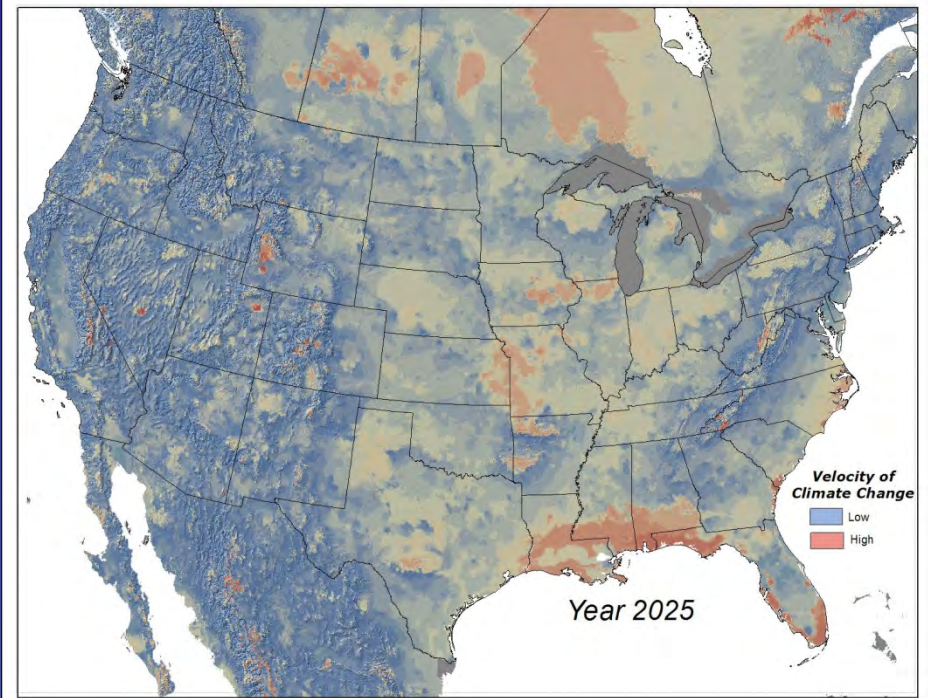


Velocity of Climate Change

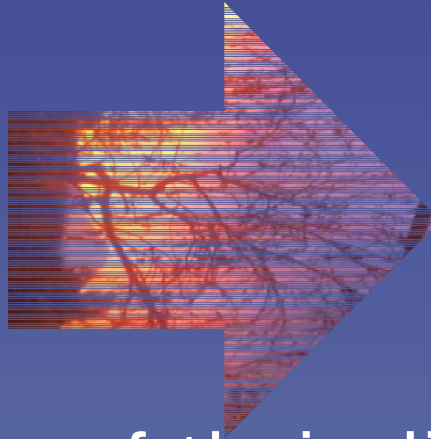
Velocity ~ rate at which species must move to track climate.

Highlights:

- Areas with high adaptive capacity that may serve as refugia.
- Areas with high levels of threat to ecosystem services.

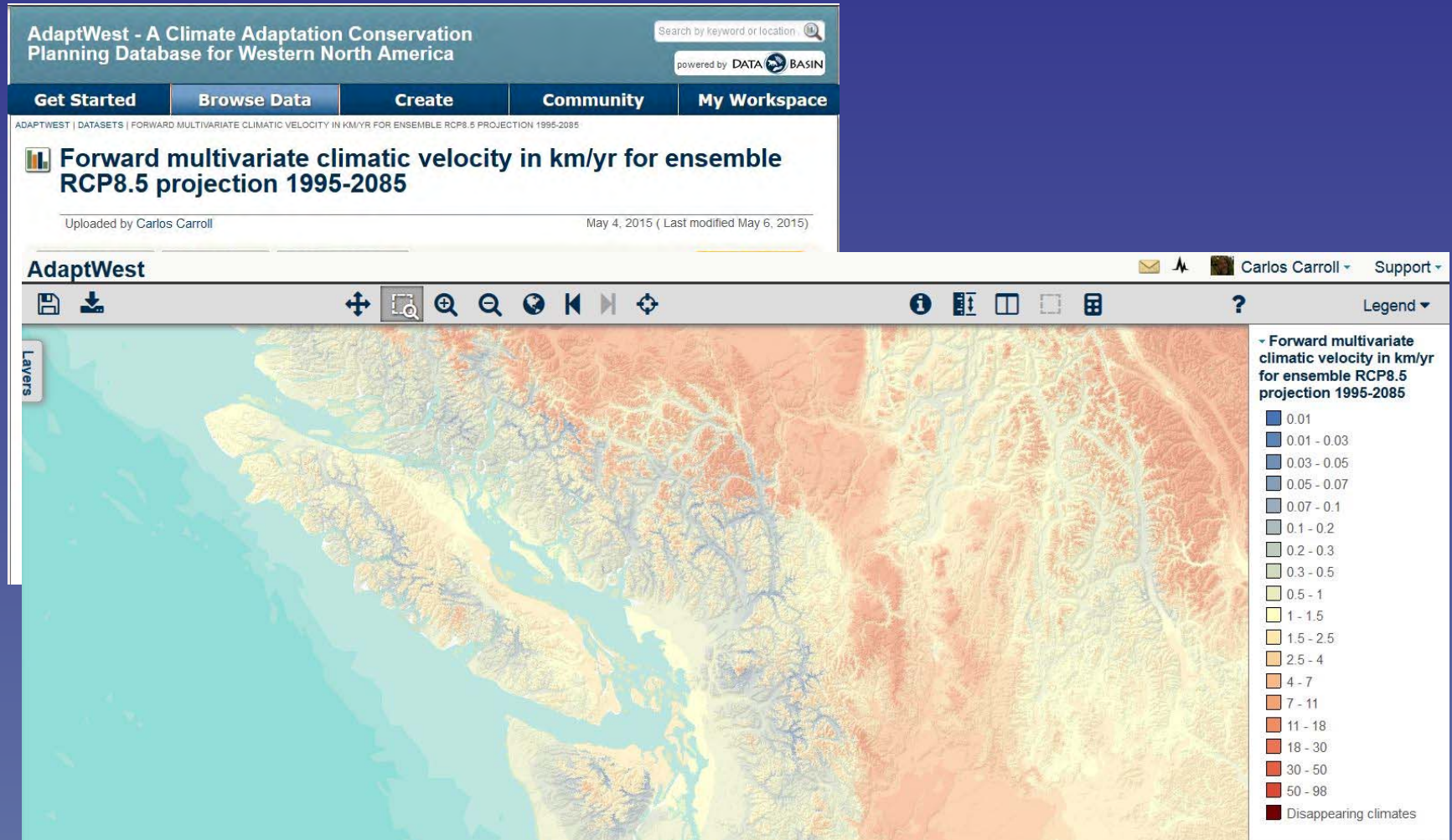


Areas of low “velocity of climate change”
Species can keep pace if...



the velocity of their dispersal is greater than
the velocity of climate change

Newly released data: Climate velocity for North America at 1km



adaptwest.databasin.org/pages/adaptwest-velocitywna

New methods provides direct estimate of velocity

Global Change Biology

celebrating 20 years

Global Change Biology (2014), doi: 10.1111/gcb.12736

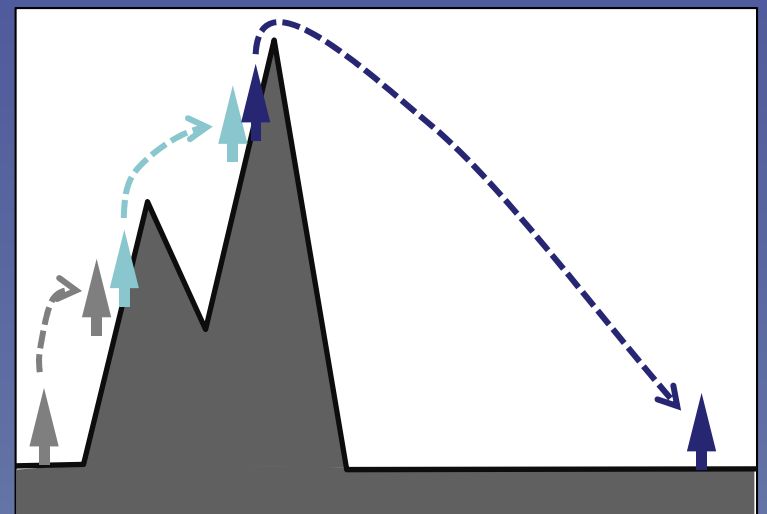
TECHNICAL ADVANCE

Velocity of climate change algorithms for guiding conservation and management

ANDREAS HAMANN¹, DAVID R. ROBERTS¹, QUINN E. BARBER¹, CARLOS CARROLL² and SCOTT E. NIELSEN¹

¹Department of Renewable Resources, Faculty of Agricultural, Life, and Environmental Sciences, University of Alberta, 751 General Services Building, Edmonton, AB, T6G 2H1, Canada, ²Klamath Center for Conservation Research, PO Box 104, Orleans, CA, 95556, USA

Improves on previous methods:
Identifies climatic *cul-de-sacs*
where climates are pushed off
mountaintops and continents.



New methods highlight the two directions of velocity

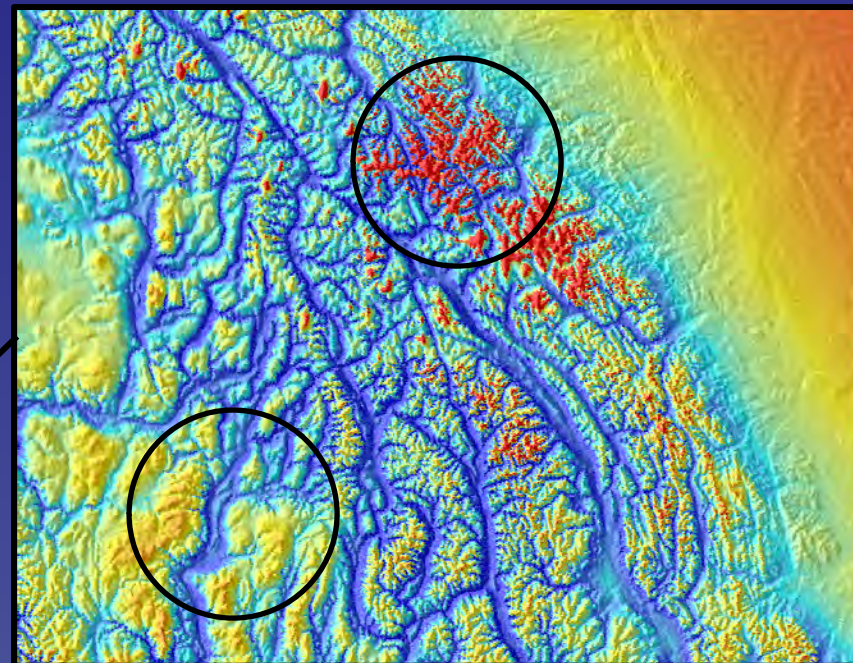
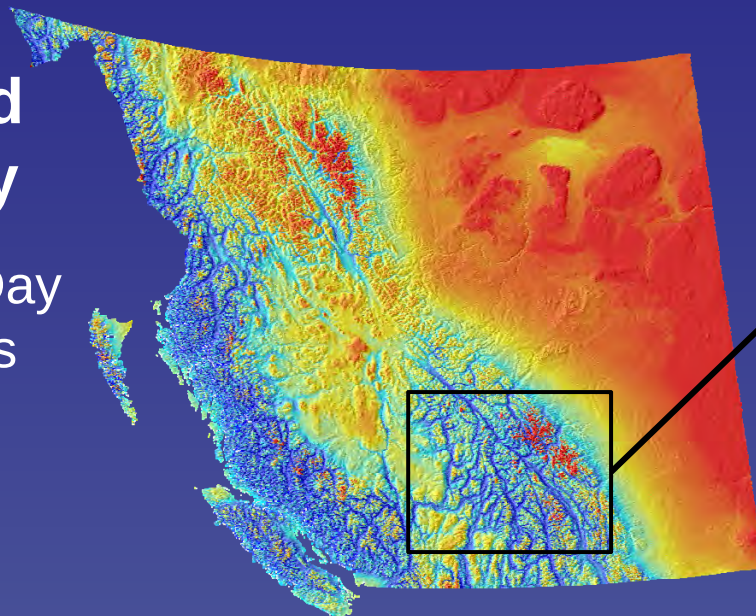


FORWARD (present to future): *Where will species go to?* How fast will populations need to move to maintain similar climate?

BACKWARD (future to present): *Where will species come from?* How distant is a source of colonizers adapted to a site's future climate?

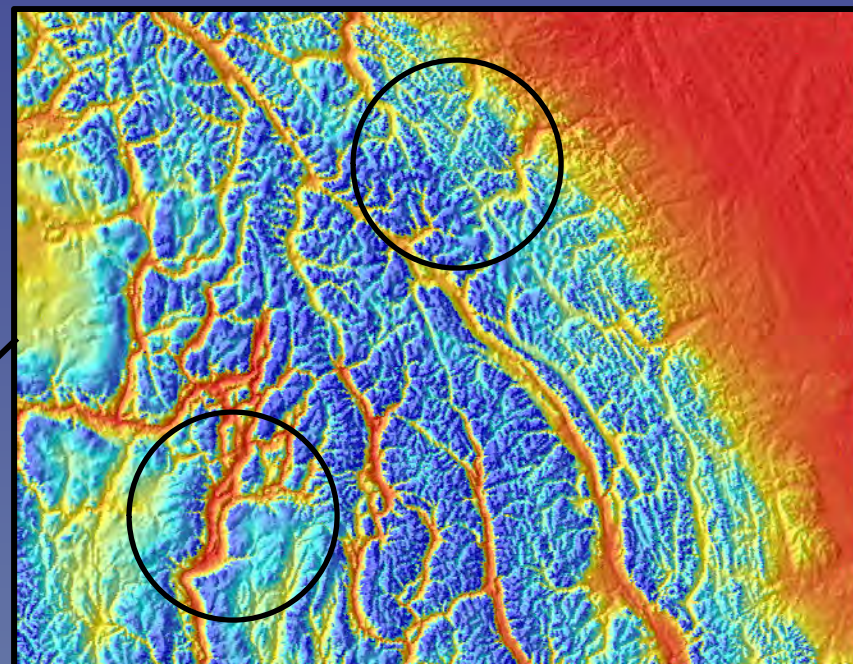
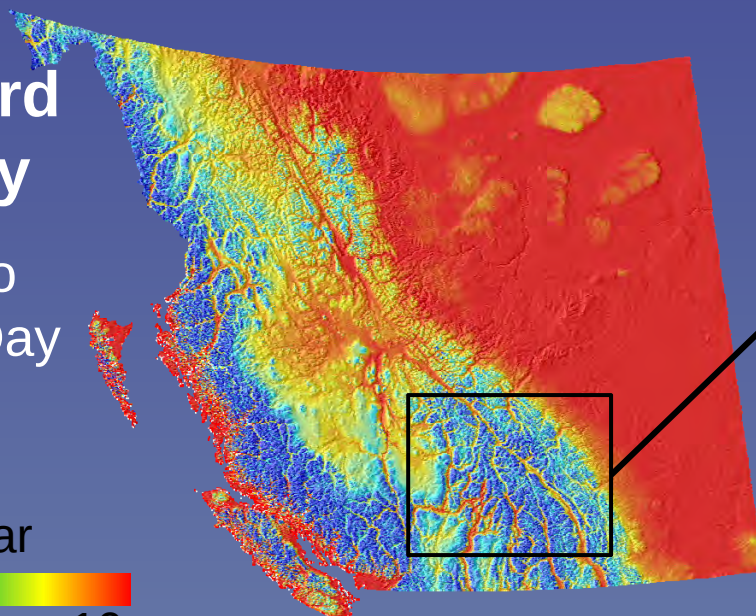
Forward Velocity

Present Day
to 2050s



Backward Velocity

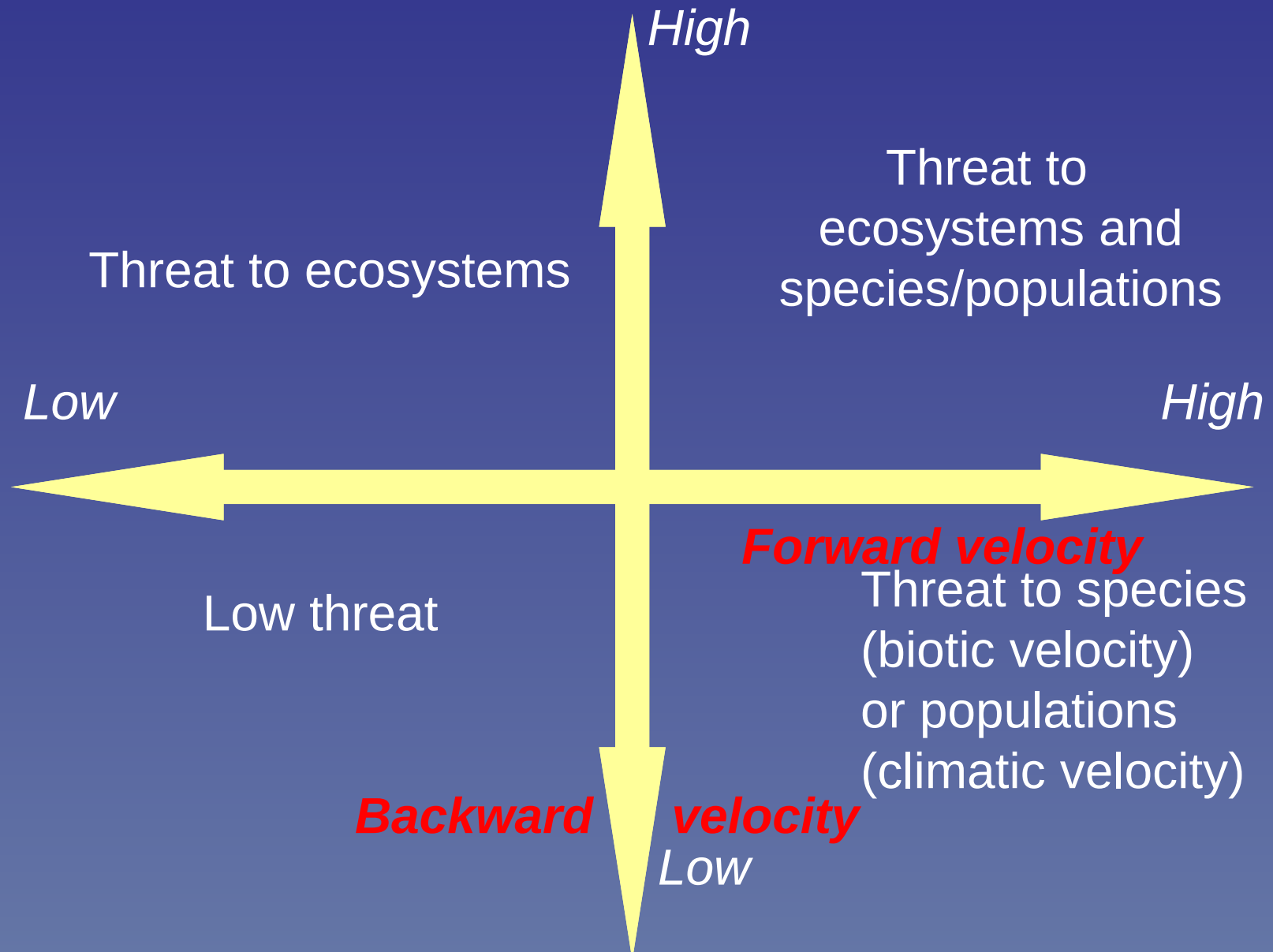
2050s to
Present Day



km/year



A suite of velocity metrics allows comprehensive threat assessment



What conservation questions can climate velocity address?

Can inform questions about

- Ability of resident species to persist locally or regionally
- Which areas can best facilitate such persistence
- Likely degree of community turnover

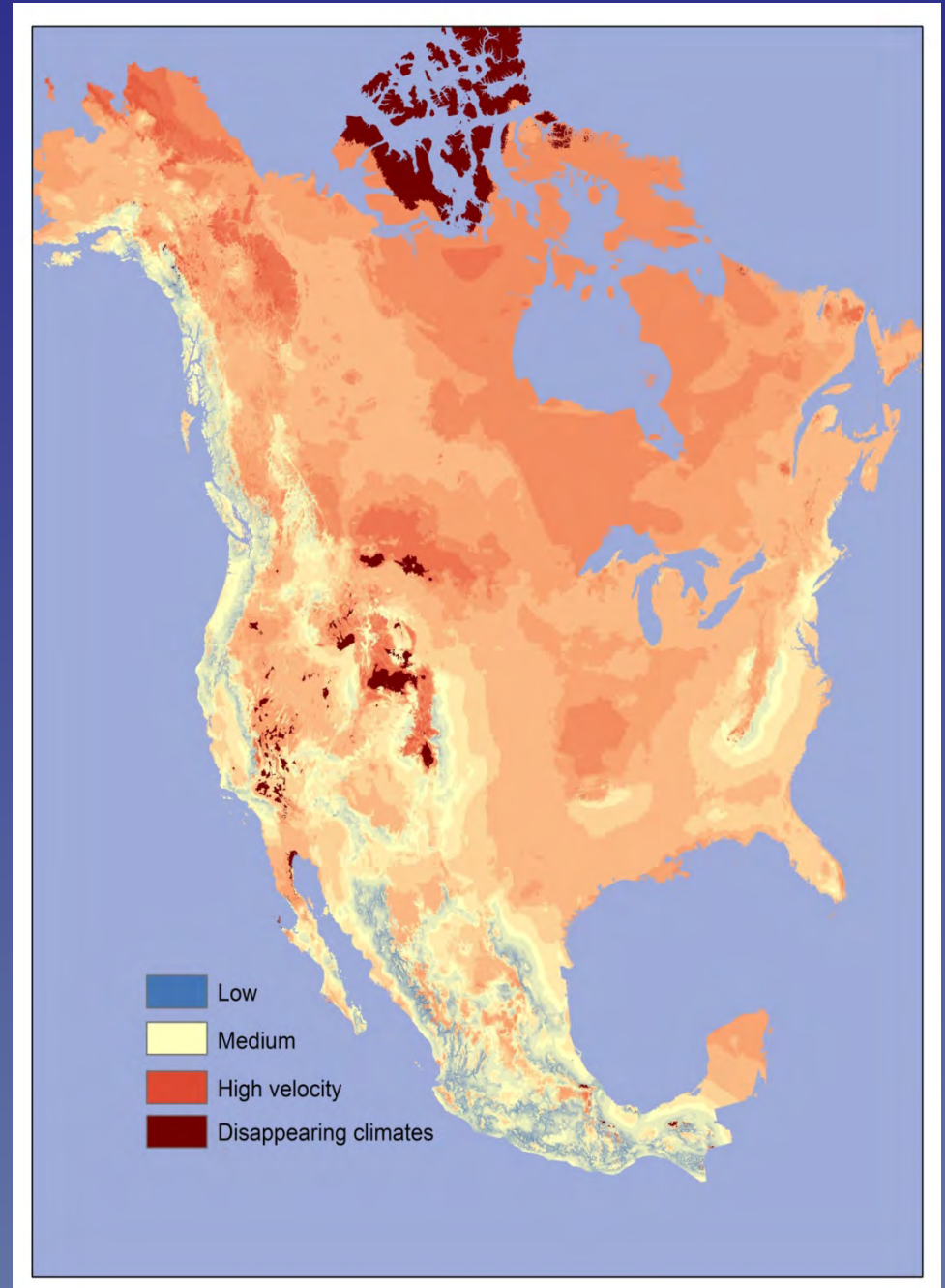
Does not indicate

- Absolute magnitude of climate change

Why do certain areas show high climate velocity?

Complex patterns driven by

- Local topography
- Regional topographic position
- Location on continent
- Location in relationship to global climate circulation patterns



Northern continental margins

Ellesmere Island

Areas in the High Arctic generally show high velocity as the edge of the continent prevents species from moving further northward to track shifting climate. Polar bear populations are declining in this area.



Interior plateaus

British Columbia's Central Interior

Interior plateaus such as this one often show high climate velocity.

Mountain pine beetle outbreaks have increased due to the lower frequency of killing frosts, triggering widespread mortality in the area's forests, as shown by the extent of red beetle-killed pines in the photo.



Interior basins

Green River Basin, Wyoming

Many valleys of the Great Basin region show high climate velocity or even more extreme threat due to “disappearing” climate.

Cheatgrass and other exotic invasive species have helped drive a shift to a more frequent fire regime in some areas.



High peaks at southern end of mountain range

Southern Appalachians

Characterized by High endemism.
Balsam wooly adelgid has killed
large proportion of Fraser fir.



Sierra Madre Occidental

The pine-oak forest of this region
of northern Mexico is noted for its
high biodiversity and large
number of endemic species.

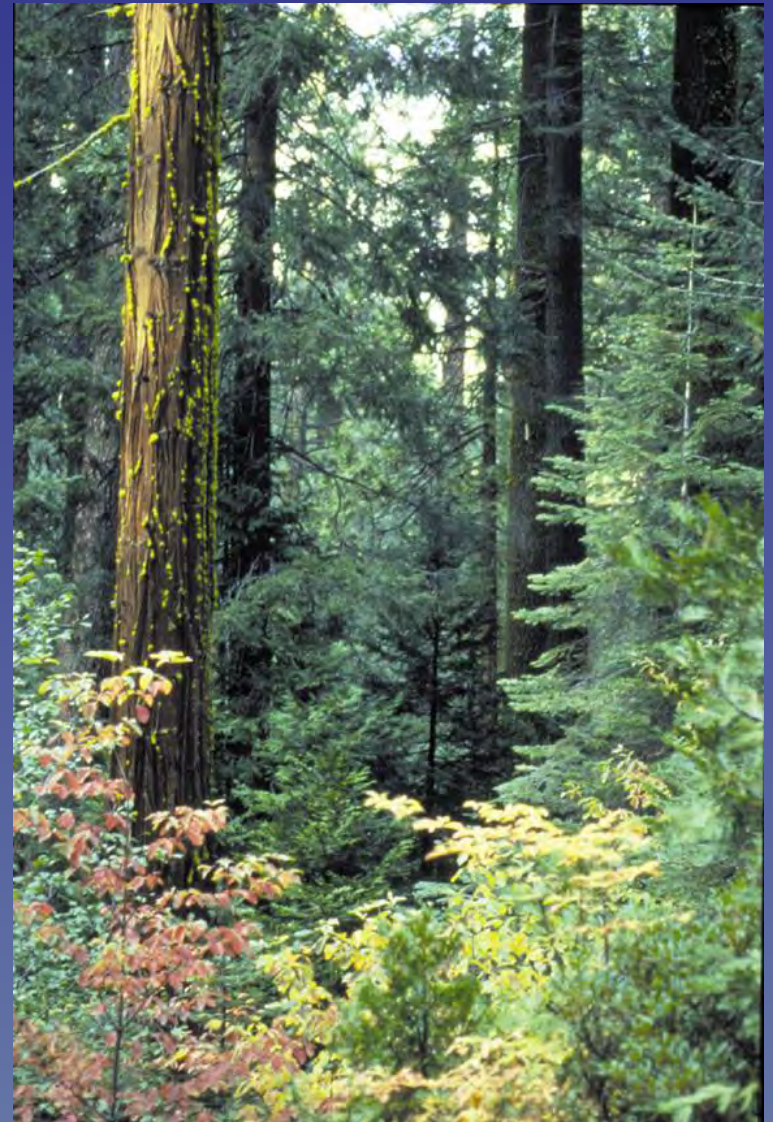


What areas are potential refugia?

Why do certain areas show low climate velocity, as potential refugia?

Many refugia are mid-slope montane areas, especially on north-south trending ranges.

But different processes drive patterns at local, regional, and continental scales.

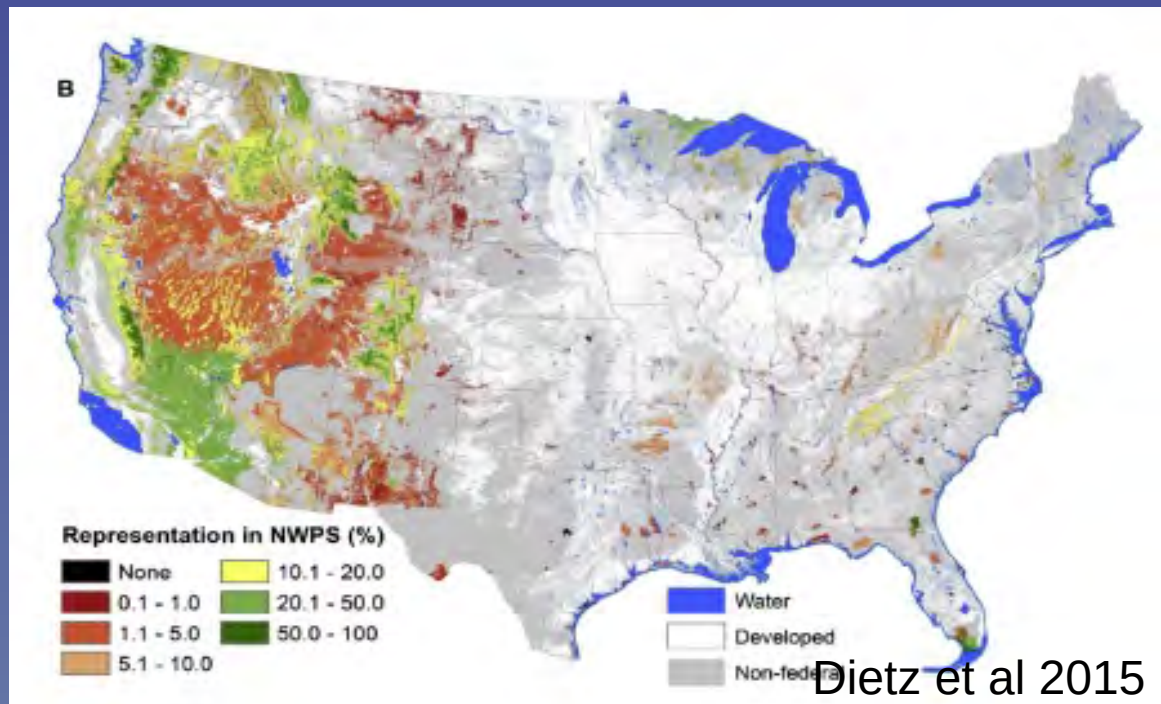


How can the data be used?



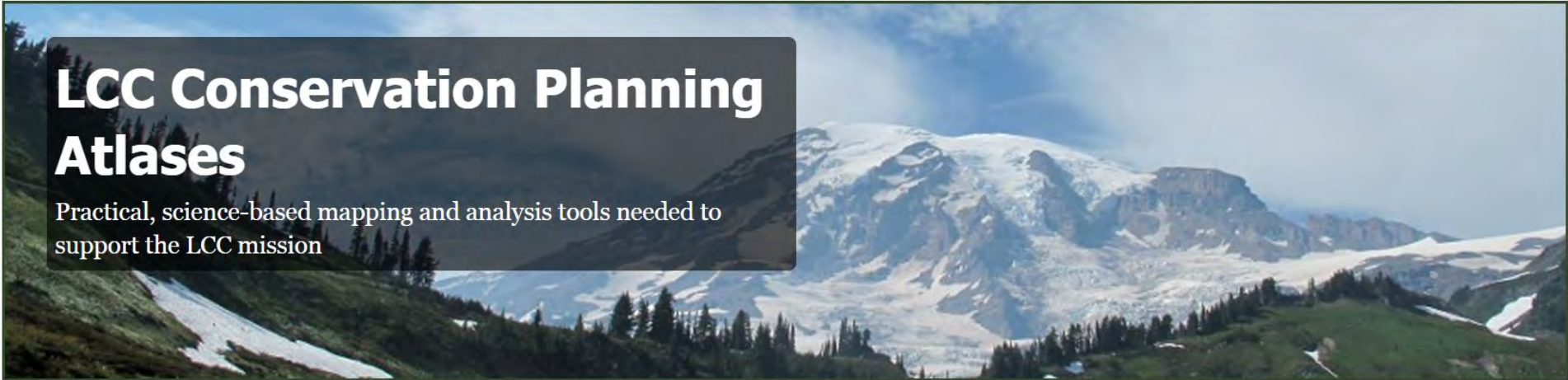
National case study: The Wilderness Society

Travis Belote of The Wilderness Society is using AdaptWest downscaled climate and climate velocity data to assess climate change related threats to the National Wilderness System.



Regional case study: Landscape Conservation Cooperatives

Shared location on Databasin allows use of
AdaptWest data in LCC conservation planning atlases.



LCC Conservation Planning Atlases

Practical, science-based mapping and analysis tools needed to
support the LCC mission

Regional case study: Heart of The Rockies Initiative

Bray Beltran of the Heart of The Rockies Initiative is using AdaptWest downscaled climate data to work with regional land trusts to assess the role their private land conservation efforts can play in maintaining the region's climate resilience.



Local case study: NGO or Land Trust

- Databasin collaborative mapping tools
- Opportunity for networking with other users

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Projecting dispersal corridors for climate-change-driven range shifts



In spite of considerable human development, the southeastern United States region could provide some of the Western Hemisphere's more heavily used thoroughfares for mammals, birds and amphibians on their way to cooler environments in a warming world, according to new research published in the journal Ecology Letters [read more](#)

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Featured Datasets



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Other uses?

We are looking for feedback on how AdaptWest can be made more useful to your project.

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- Follow [@adaptwest](#) on Twitter for updates on newly available data and webinars
- Contact via email:
[carlos \(at\) klamathconservation.org](mailto:carlos@klamathconservation.org)