AdaptWest –

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

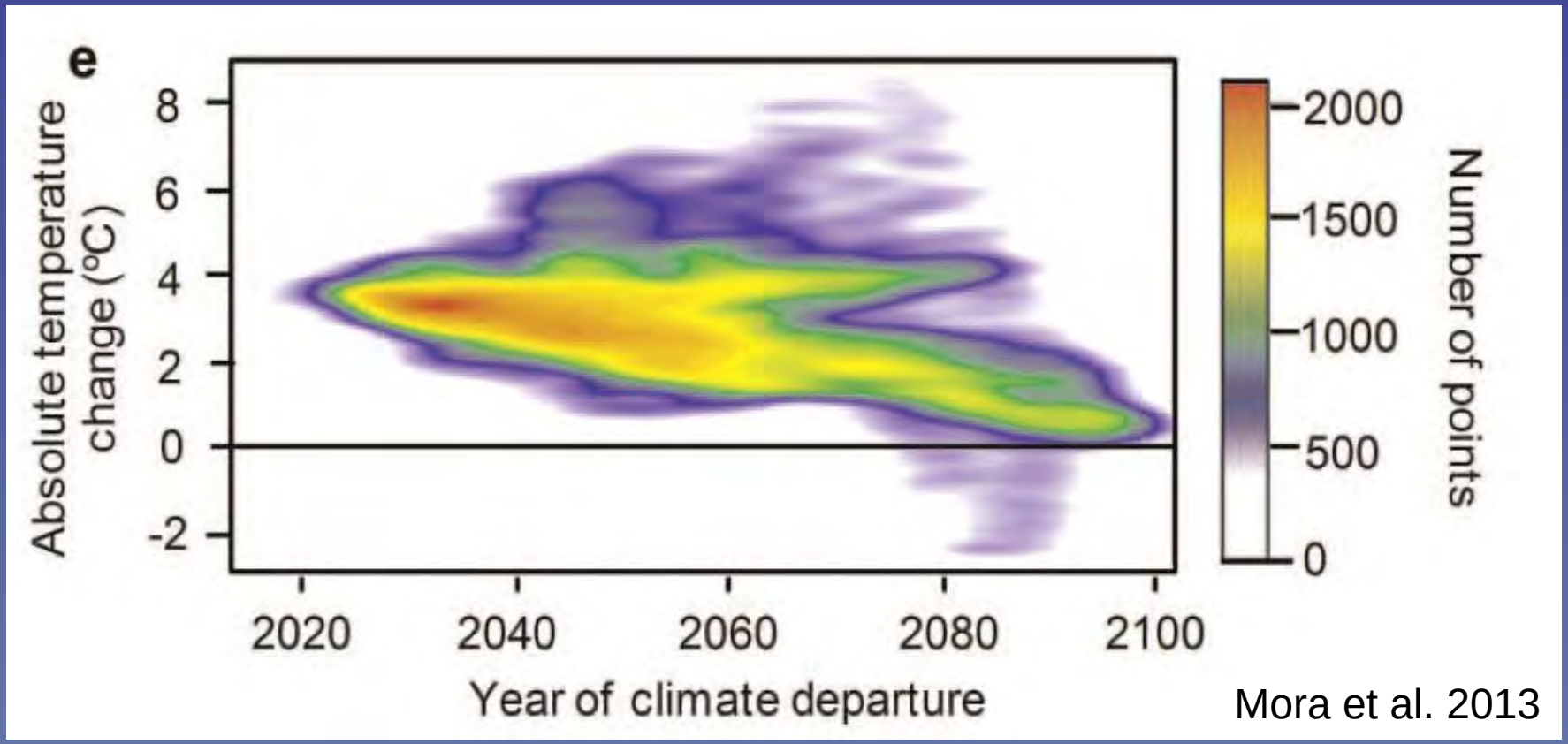
Carlos Carroll, Klamath Center for Conservation Research
May 28, 2015
See http://adaptwest.databasin.org for more information.

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.

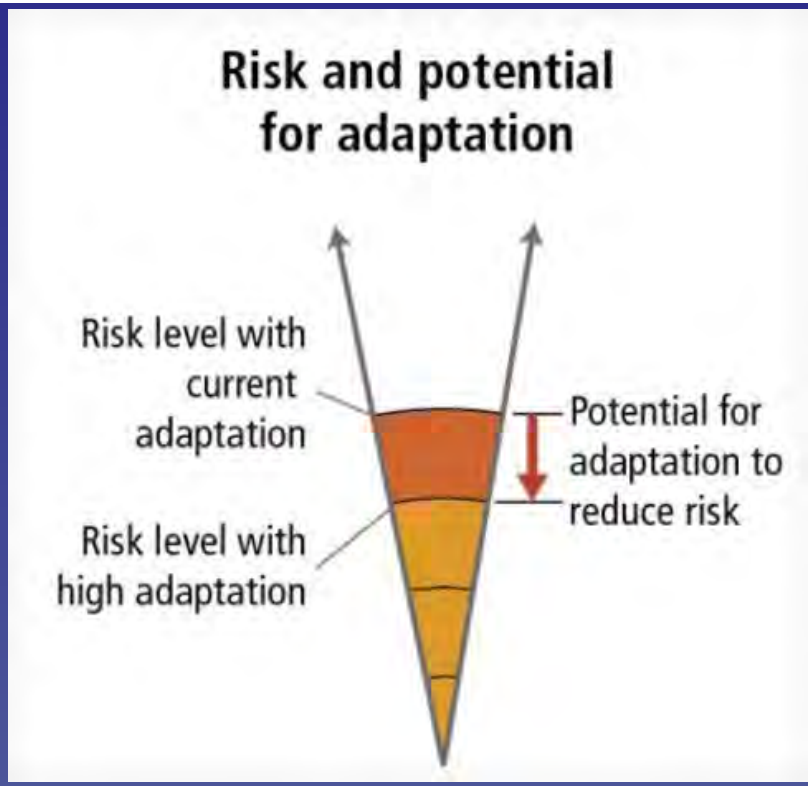


Mora et al. 2013

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.

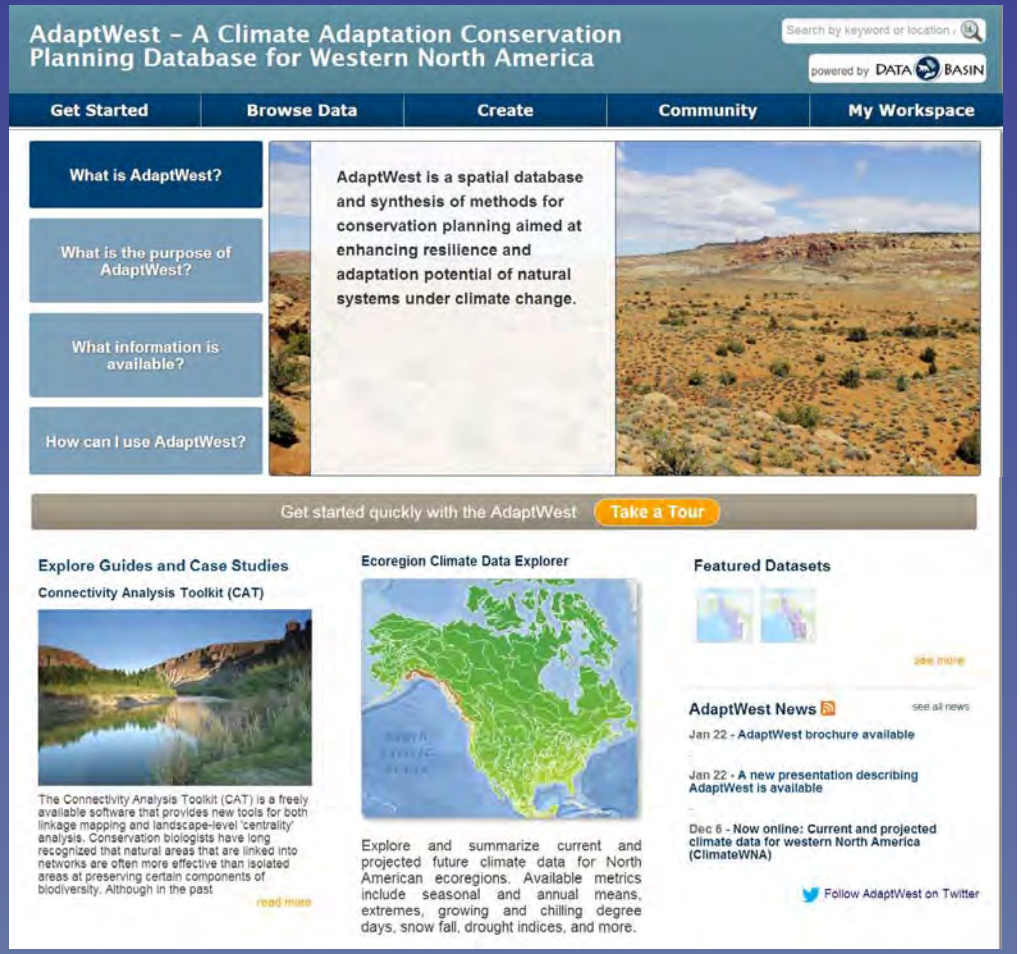
To meet their adaptation planning goals, organizations need spatial data on

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

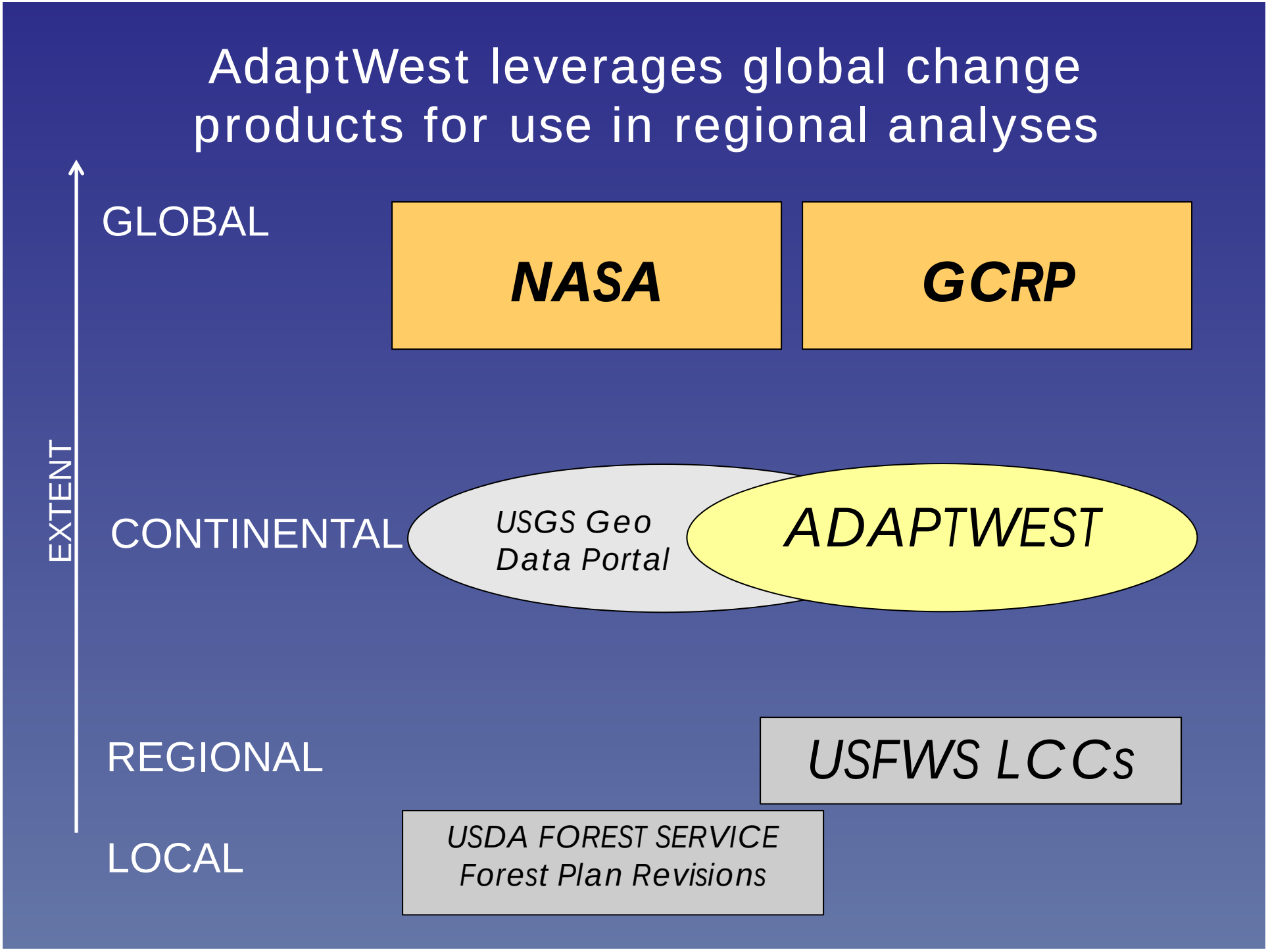
designed to help land management agencies and other organizations implement strategies that promote resilience, protect biodiversity, and conserve natural resources in the face of a changing climate.



What makes AdaptWest a key resource for planners?

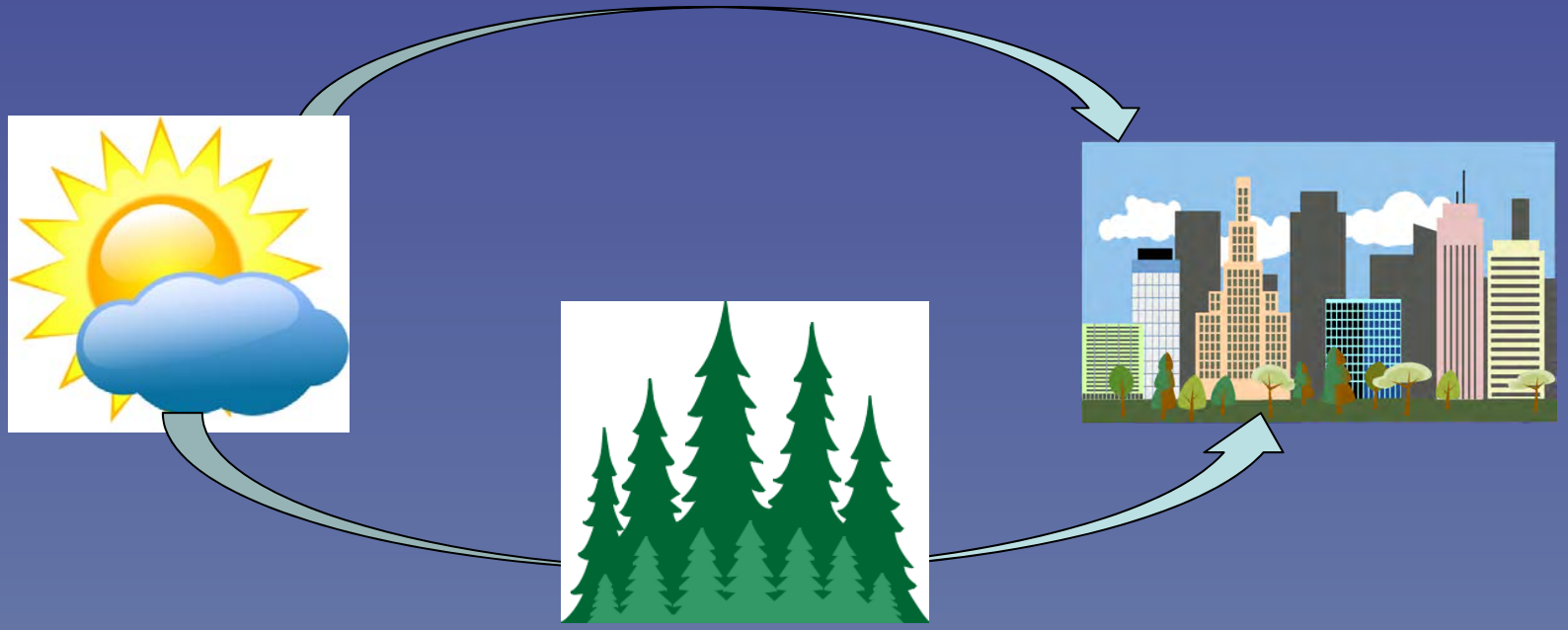
- Broad geographic extent (most of North America),
- Relatively high spatial resolution (1 km or less),
- Access to a wide range of spatial data relevant to resilience and adaptation potential of natural systems under climate change.
- Guides which help place this diverse information in context.

AdaptWest leverages global change products for use in regional analyses

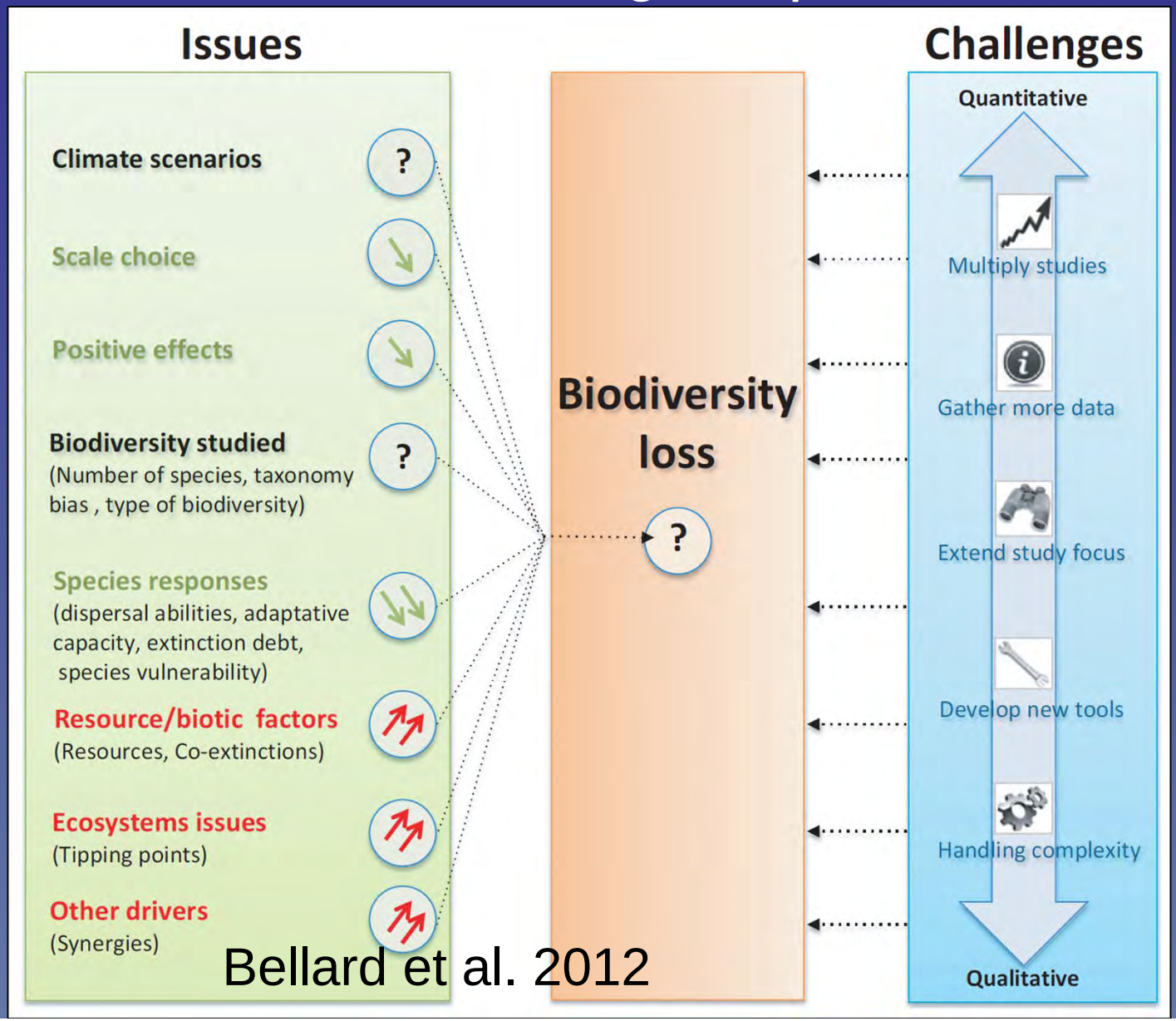


AdaptWest provides a bridge between climate and ecological data

- 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.

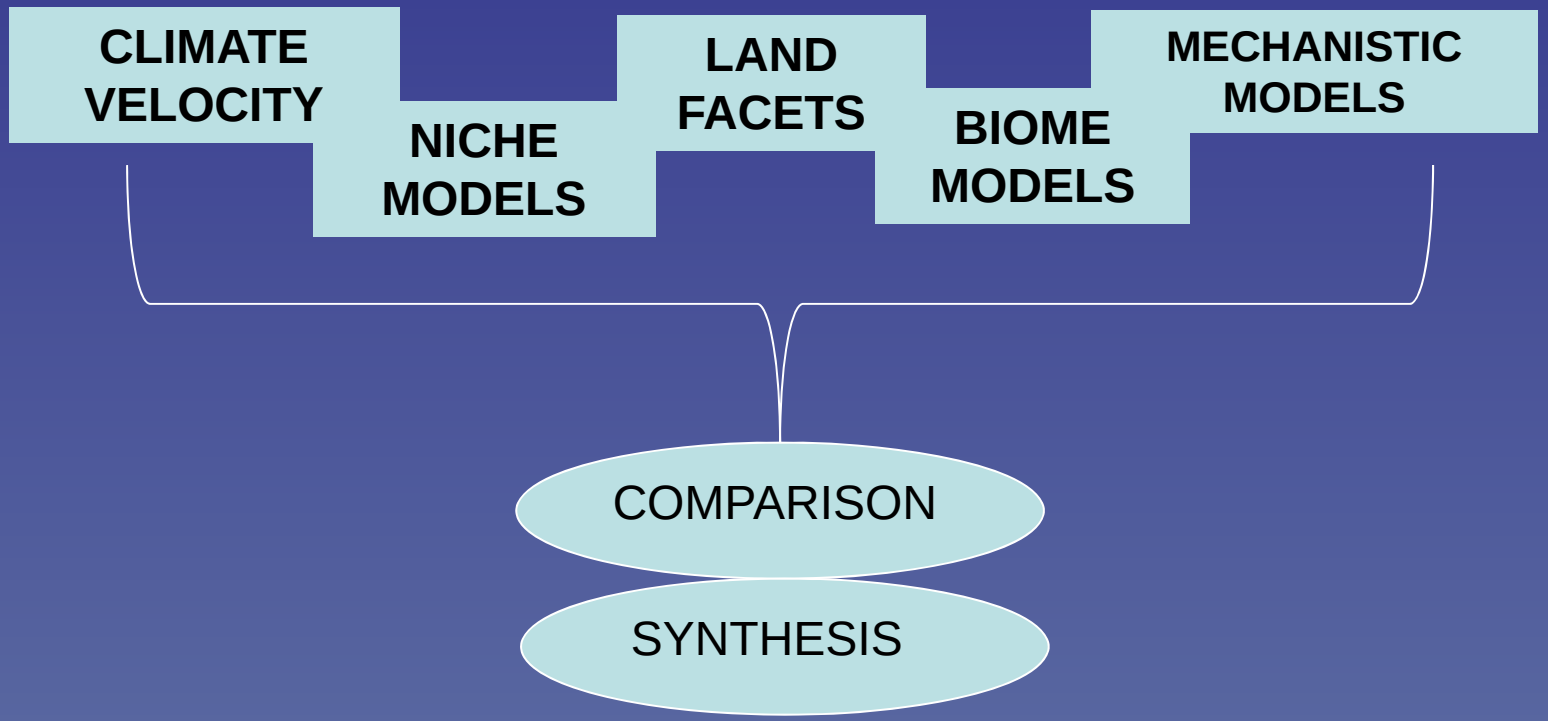


How do we make sense of the variety of data and link it to ecological processes?



Bellard et al. 2012

AdaptWest provides access to diverse types of data

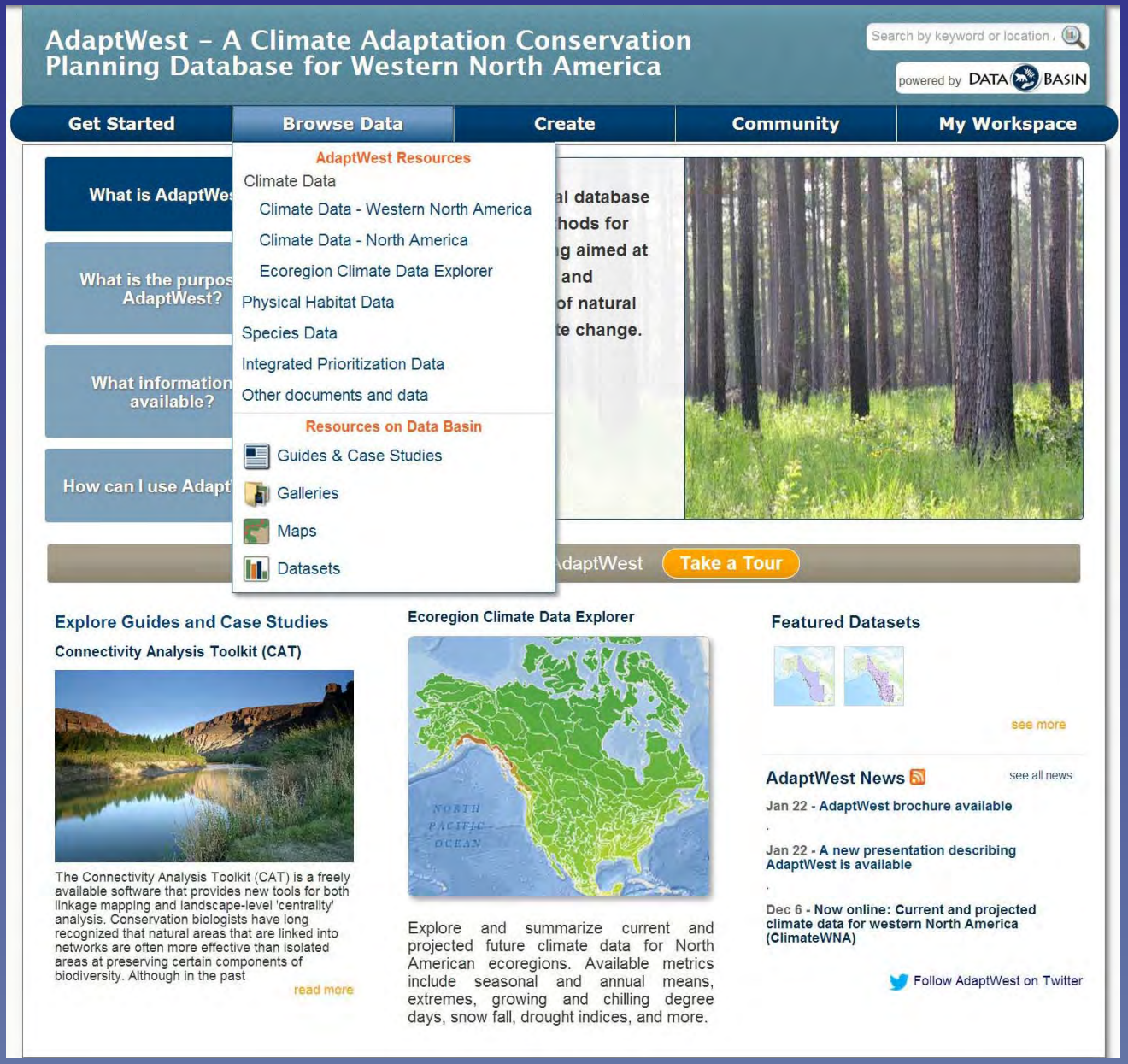


But also helps place the data in context

AdaptWest help planners integrate diverse data by allowing them to

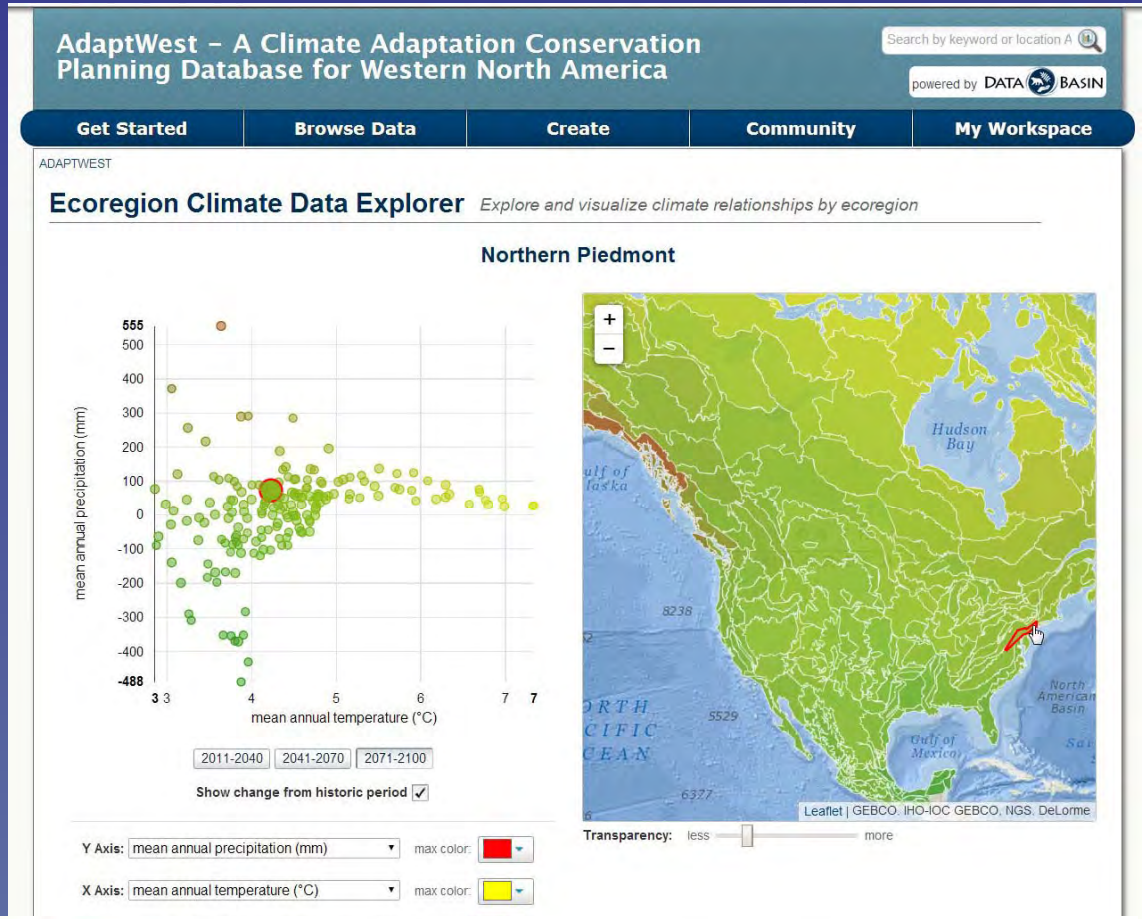
- Compare priority areas from different approaches
- Test assumptions (surrogacy value)
- Encompass a range of model complexity
- Use a multi-track approach to produce a comprehensive, unified analysis

Open access to well-documented datasets



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

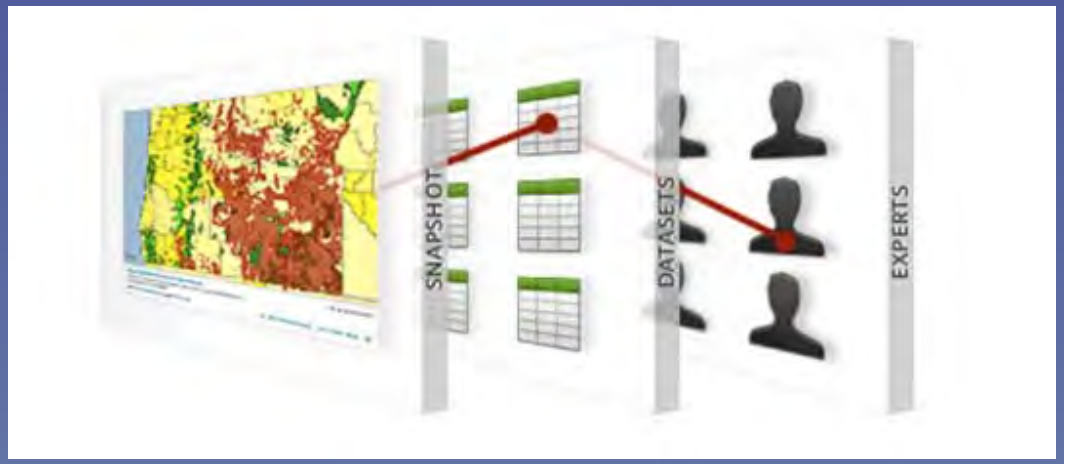
Builds on Databasin's capacity for online collaboration and learning

Translating data into knowledge

Online cartography – Create new maps

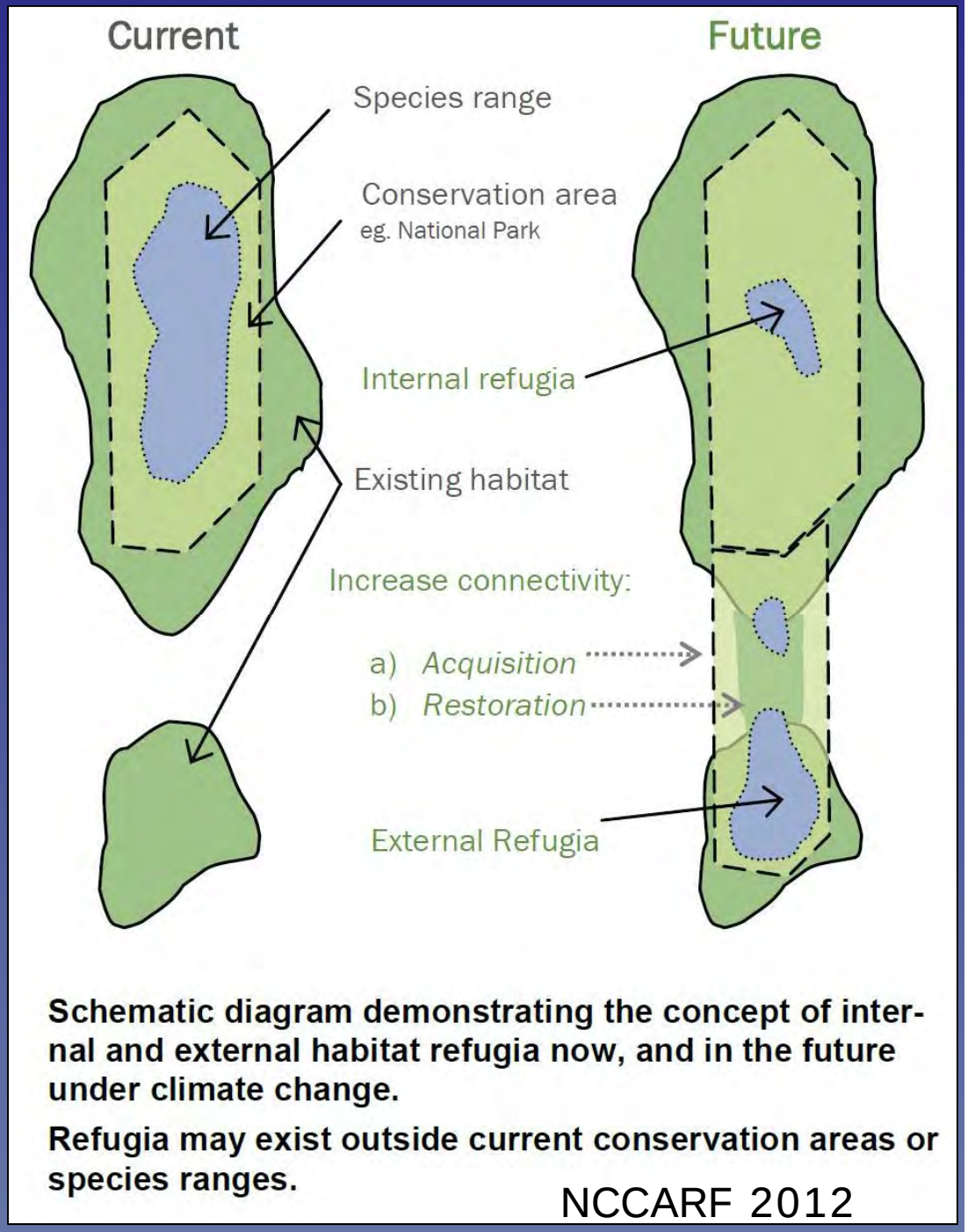
Discuss and annotate maps and data, either in small workgroup or public setting.

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.



Schematic diagram demonstrating the concept of internal and external habitat refugia now, and in the future under climate change.

Refugia may exist outside current conservation areas or species ranges.

NCCARF 2012

Types of "refugia":

Microrefugia: Allows population to persist indefinitely

Holdout: Allows population to persist temporarily

Stepping-stone: Facilitates range shifts

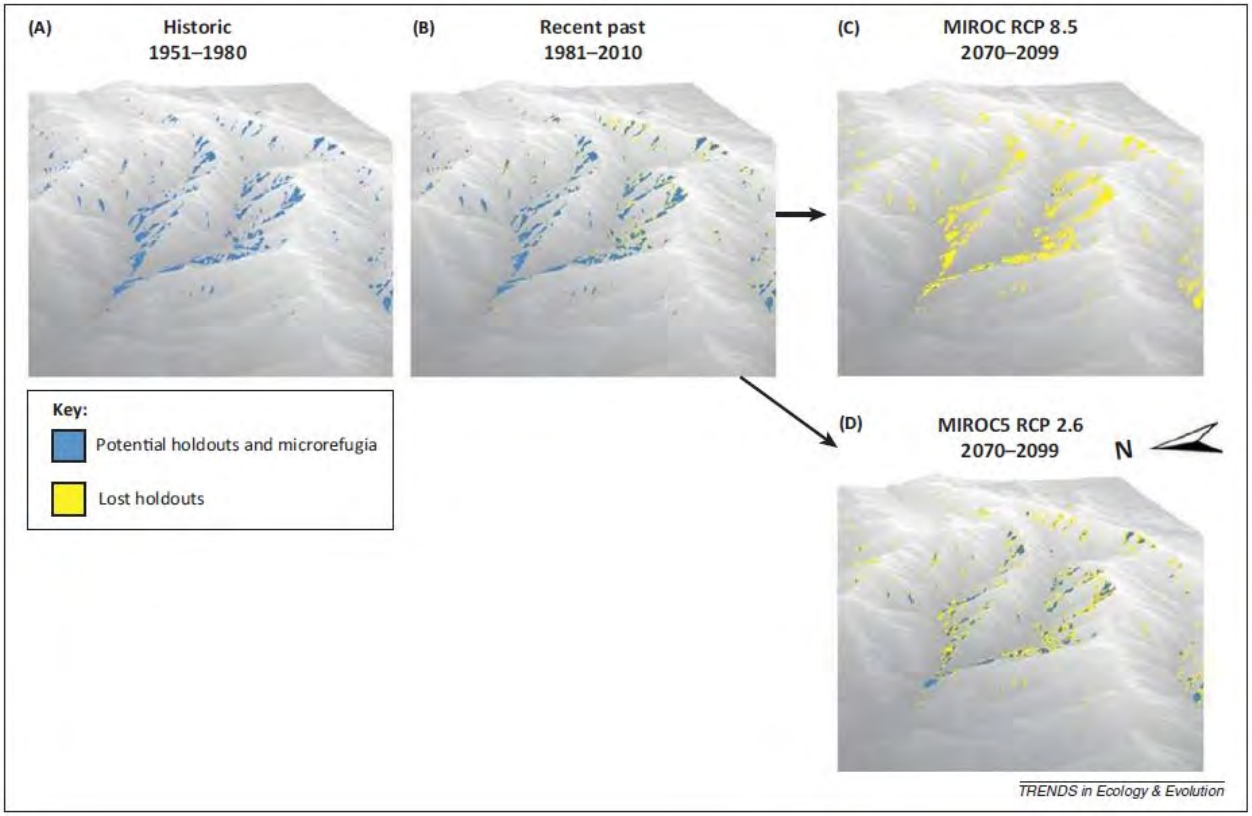
Opinion

CellPress

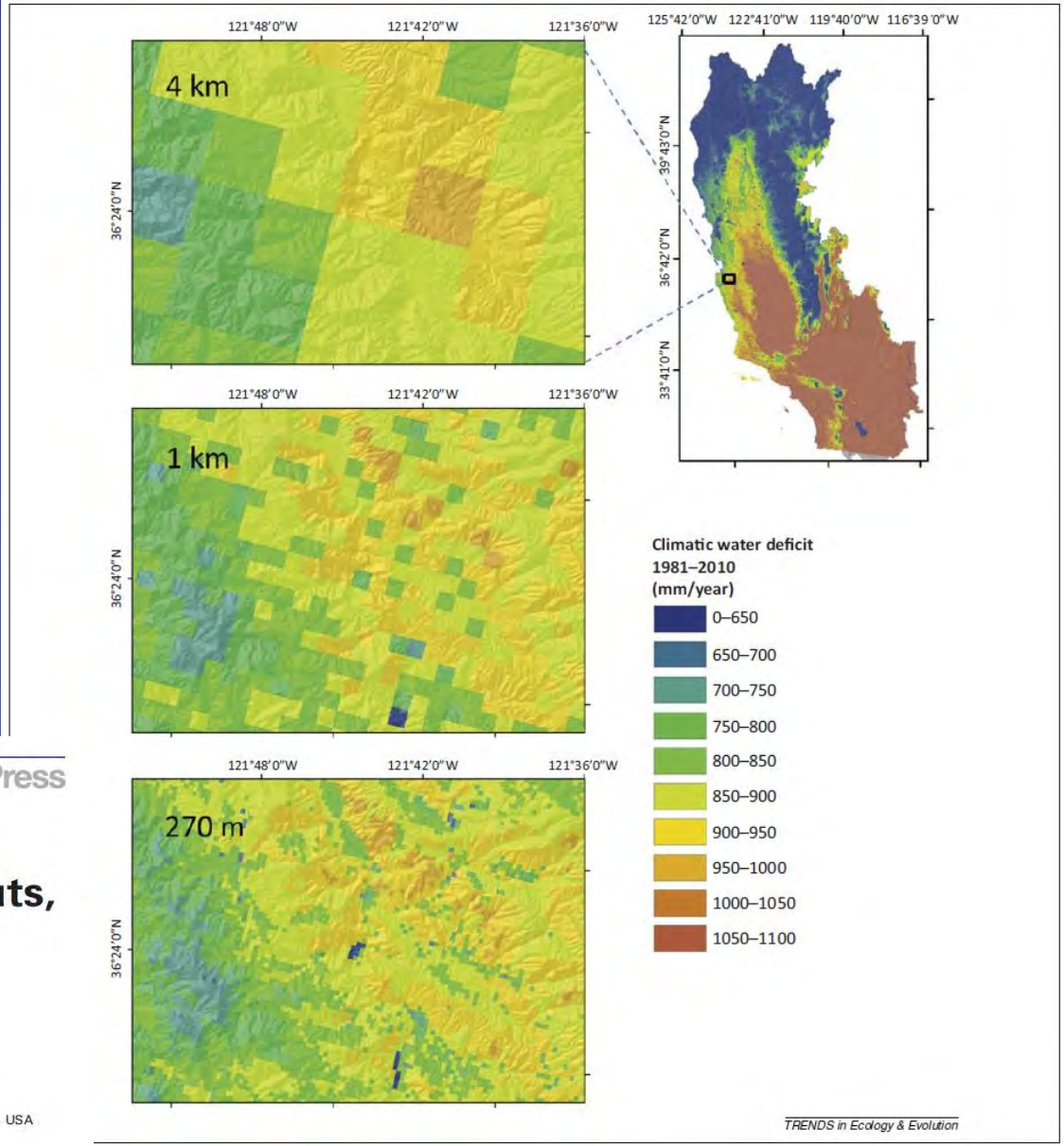
Fine-grain modeling of species' response to climate change: holdouts, stepping-stones, and microrefugia

Lee Hannah[1], Lorraine Flint[2], Alexandra D. Syphard[3], Max A. Moritz[4], Lauren B. Buckley[5], and Ian M. McCullough[6]

[1] Betty and Gordon Moore Center for Science and Oceans, Conservation International, Arlington, VA, USA
[2] United States Geological Survey, Sacramento, CA, USA
[3] Conservation Biology Institute, La Mesa, CA, USA
[4] Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA, USA
[5] Department of Biology, University of Washington, Seattle, WA, USA
[6] Bren 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

CellPress

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

Lee Hannah[1], Lorraine Flint[2], Alexandra D. Syphard[3], Max A. Moritz[4], Lauren B. Buckley[5], and Ian M. McCullough[6]

[1] Betty and Gordon Moore Center for Science and Oceans, Conservation International, Arlington, VA, USA
[2] United States Geological Survey, Sacramento, CA, USA
[3] Conservation Biology Institute, La Mesa, CA, USA
[4] Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA, USA
[5] Department of Biology, University of Washington, Seattle, WA, USA
[6] Bren School of Environmental Science and Management, University of California, Santa Barbara, Santa Barbara, CA, USA

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):

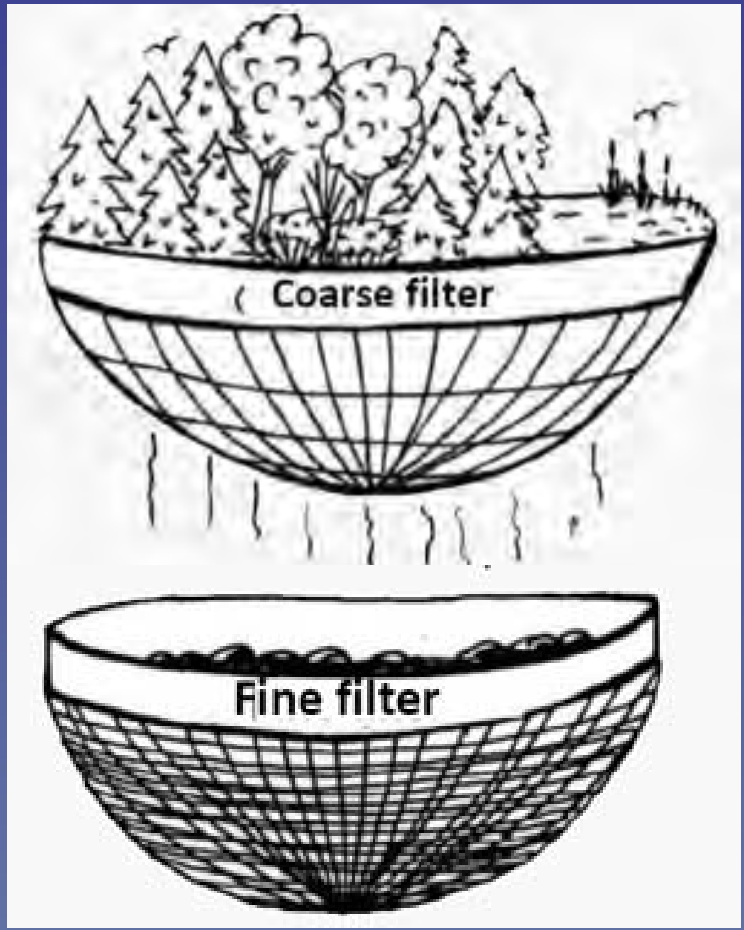
Species-niche-model-based refugia

Focal-species-habitat-based refugia

Multi-track coarse/fine-filter approach:

Why use coarse-filter targets?
Lack of information
about most species

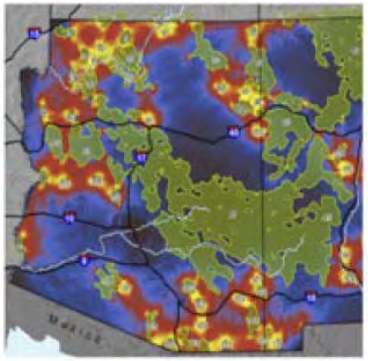
Why use fine-filter targets?
Coarse-filter surrogate
imperfectly protects
individual species



Finding a balance: Conserving the actors and the stage

Land facets

Climate refugia



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

Restore key habitat

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]

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

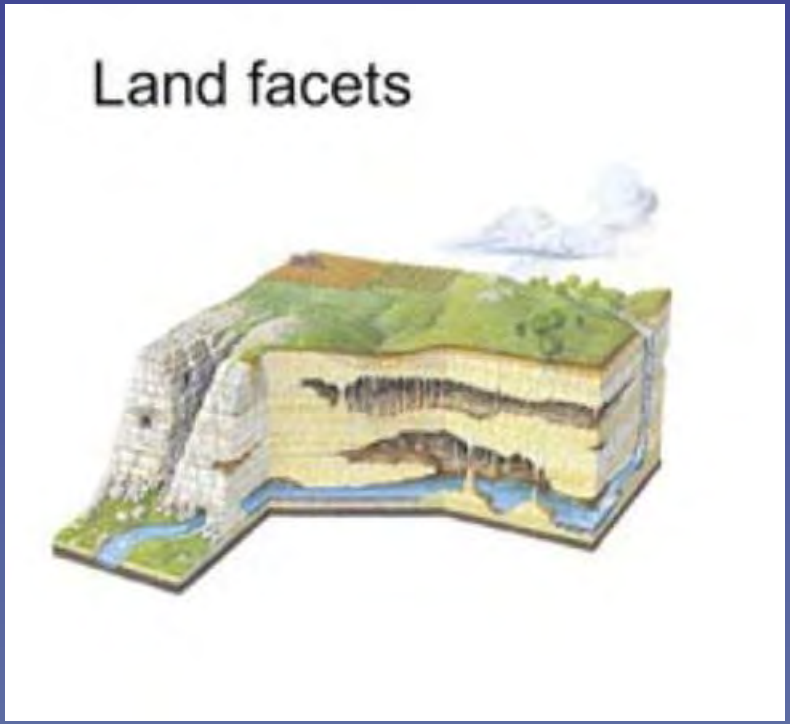
Address for correspondence: Morgan W. Tingley, Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, CT 06269. morgan.tingley@uconn.edu

Stepping stones

What data are available?
In order of increasing complexity:

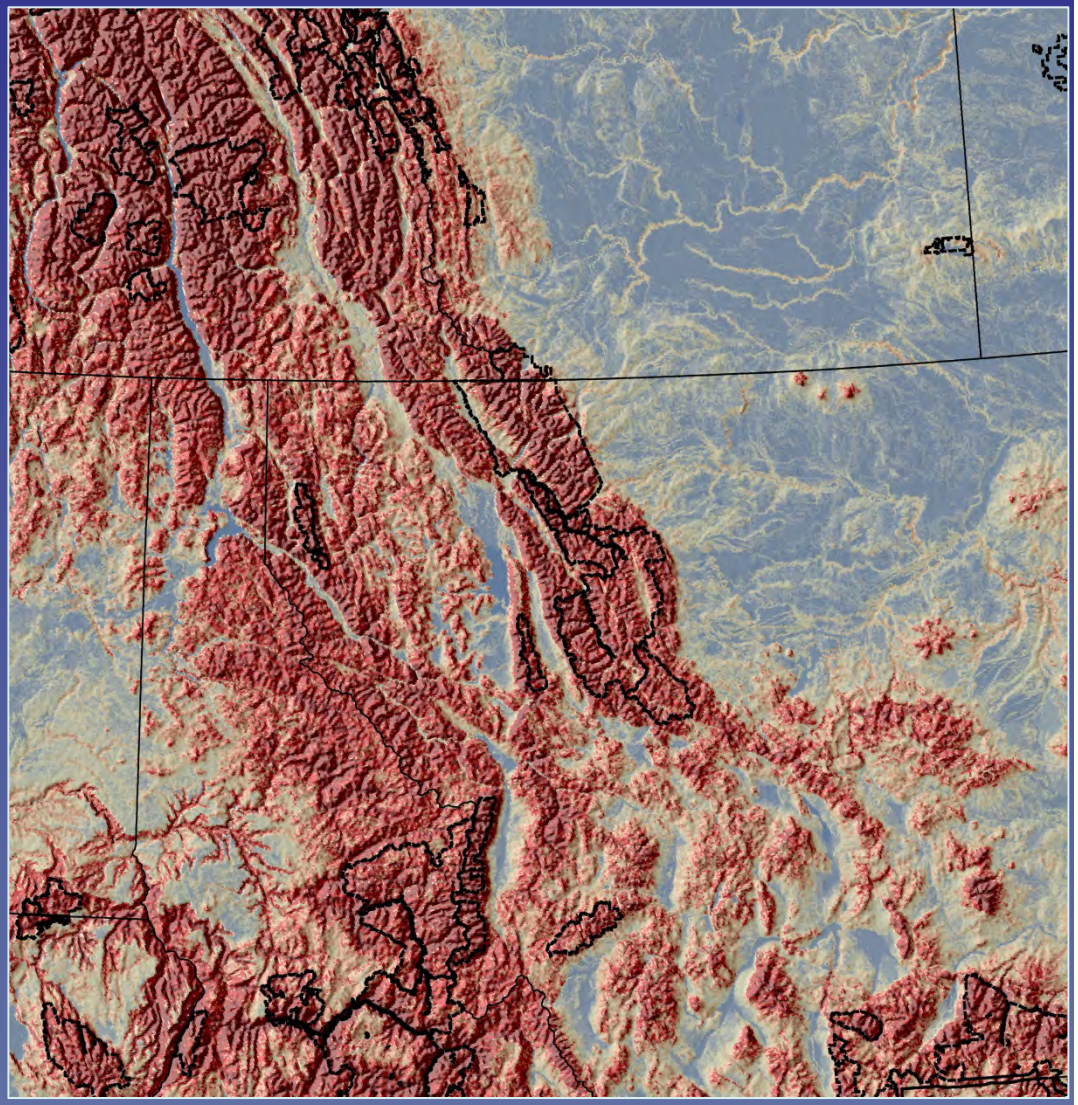
- Metrics based on **physical habitat types** (land facets and topodiversity).
- **Downscaled projections** of future climate,
- **Velocity of climate change**, including refugia areas of low climate velocity,
- **Biotic velocity**, and projected climate refugia for individual species.

Physical habitat types and diversity



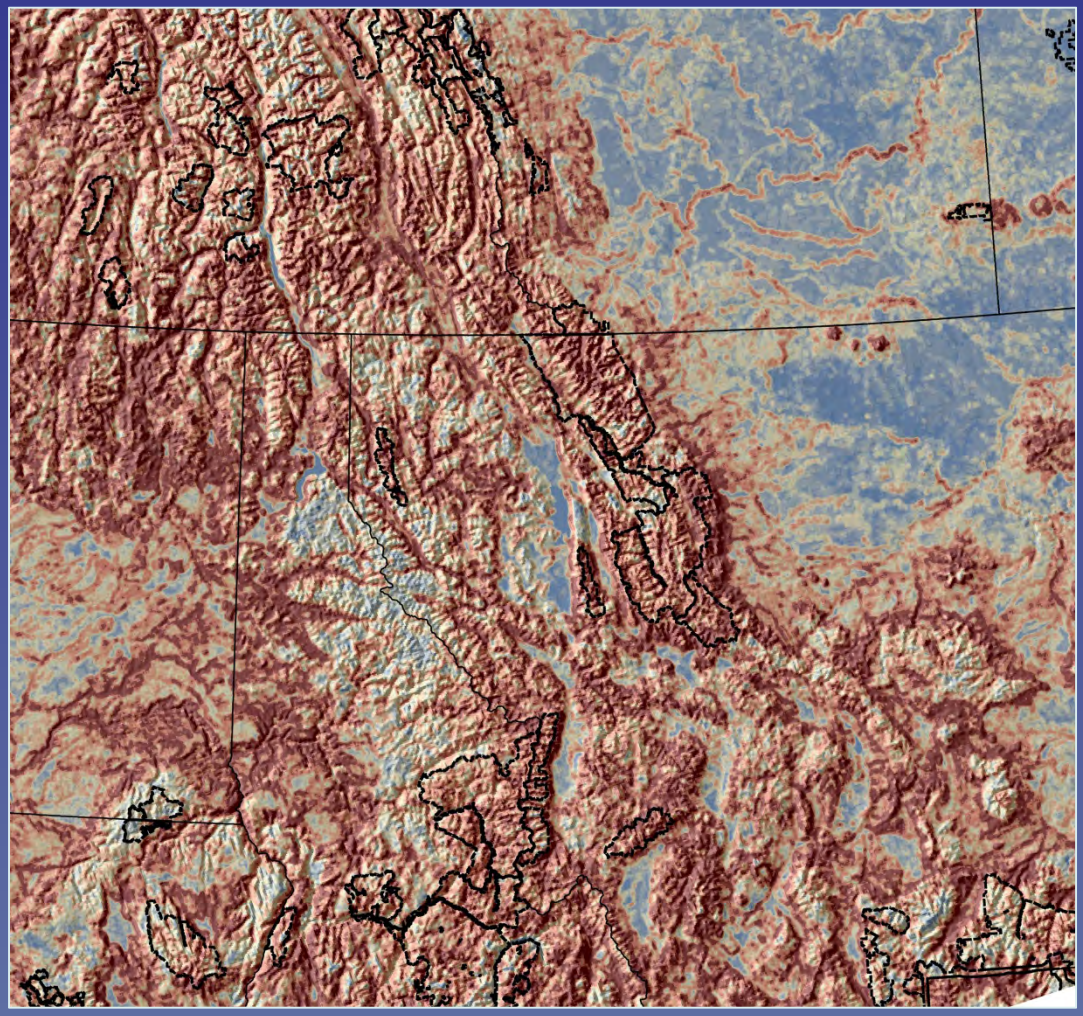
Topodiversity

- 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.

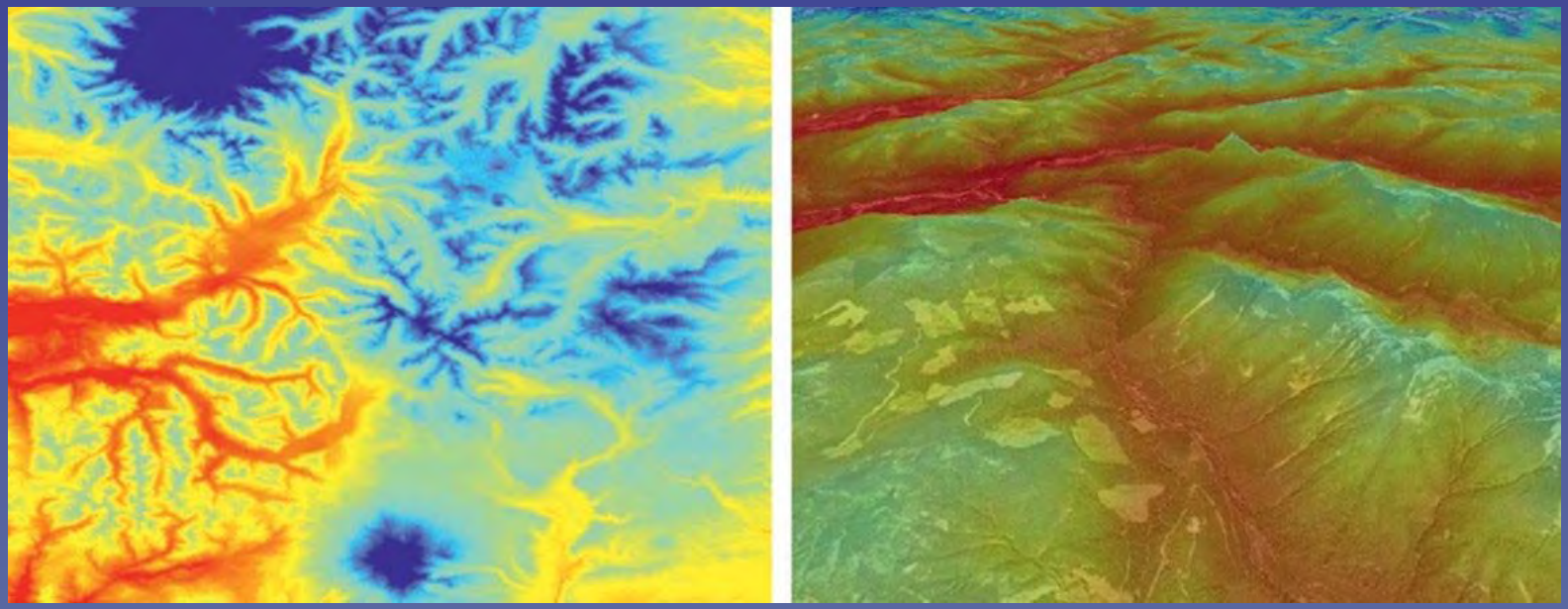


Land facet diversity

- 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

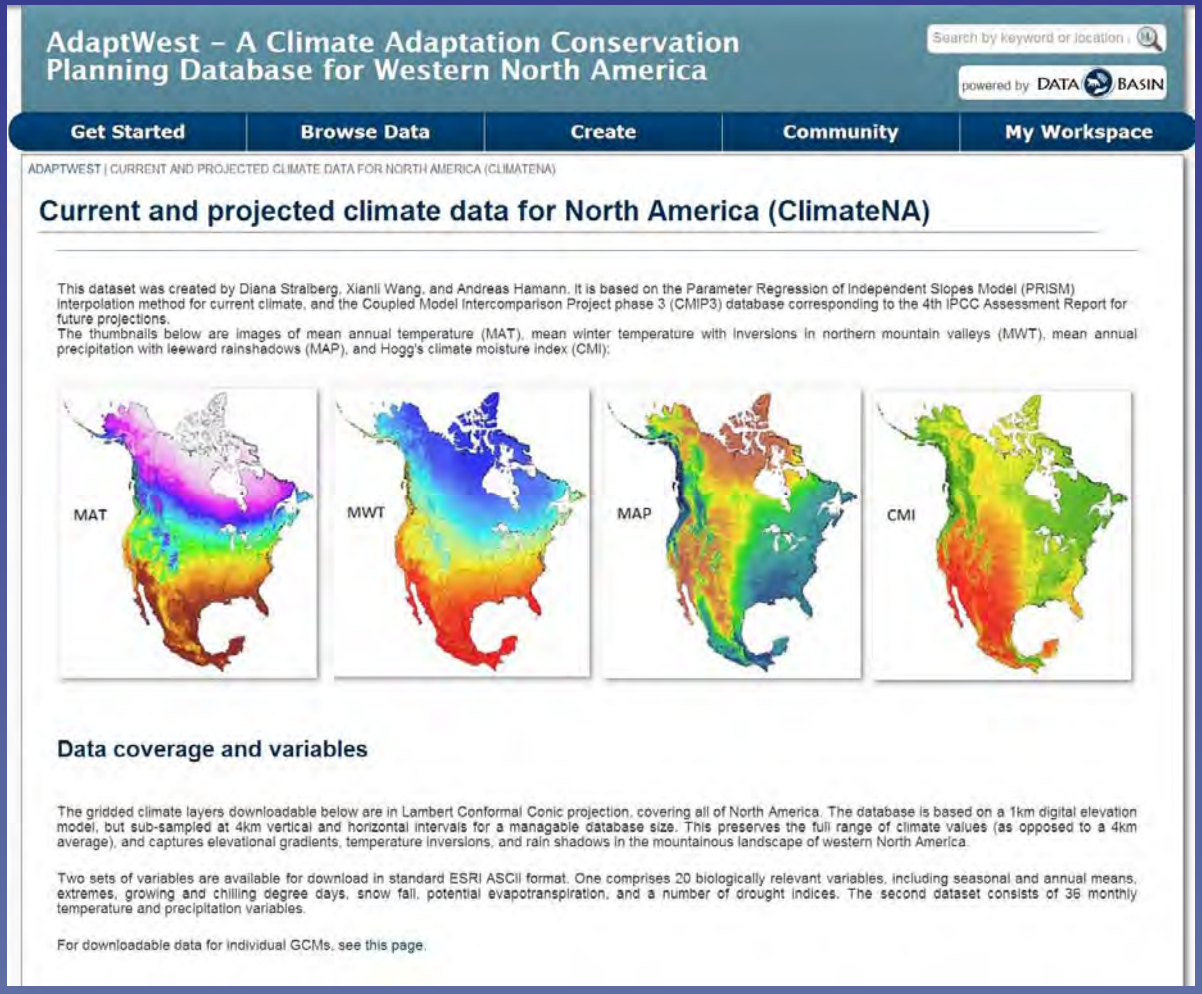


Downscaled projections of future climate *via ClimateNA software*

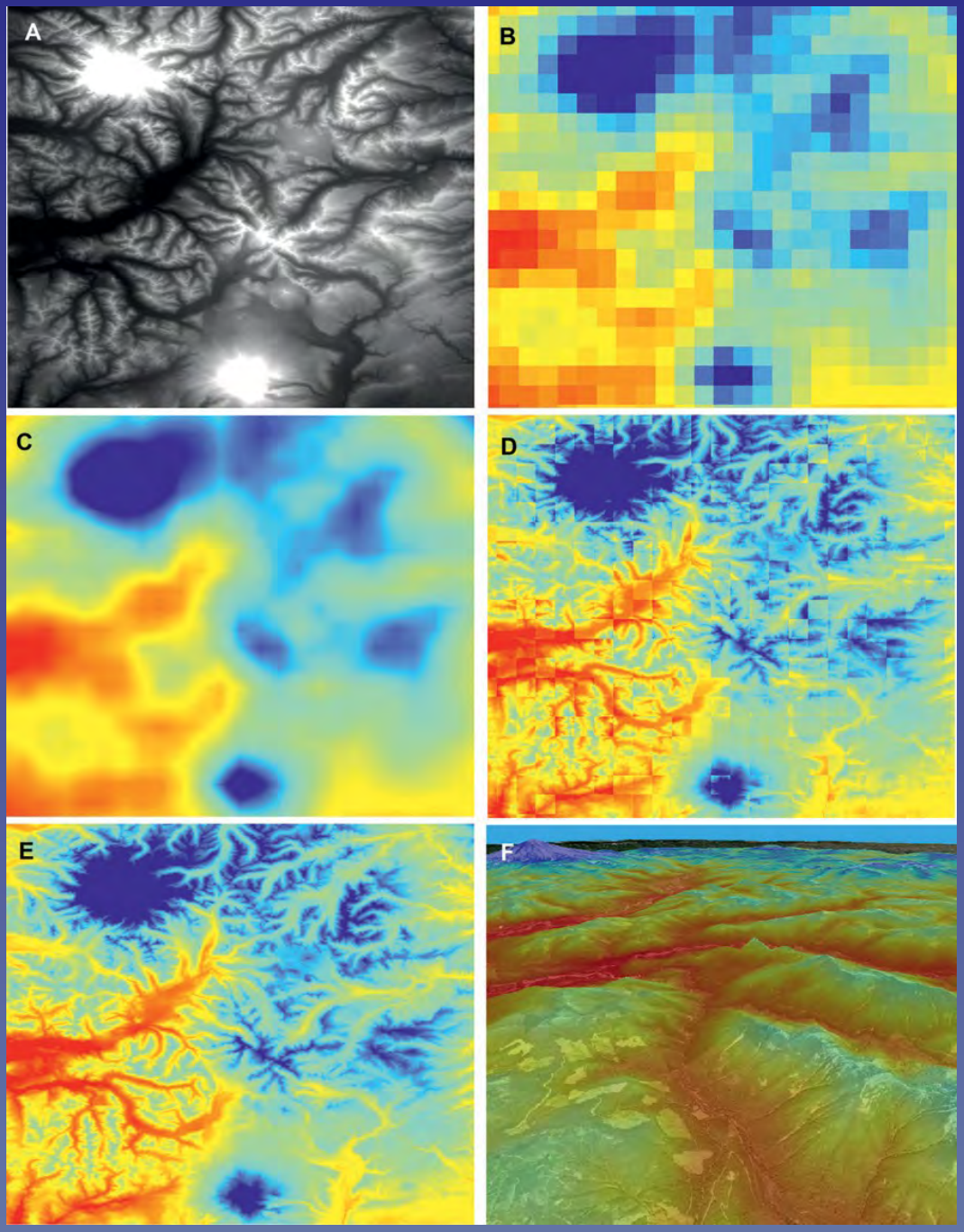
IPCC 5th Assessment:
Ensemble of GCMs for RCP4.5 and RCP8.5 scenarios

Time periods: 2020s, 2050s, 2080s

T. Wang, A. Hamann and D. Spittlehouse
UBC & Univ. of Alberta



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

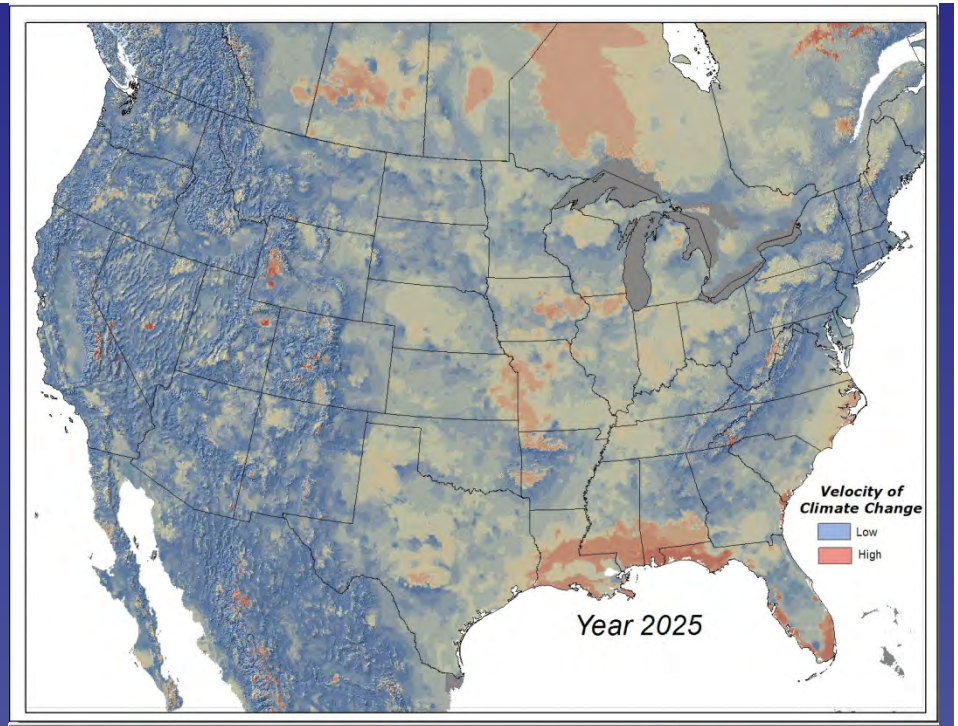


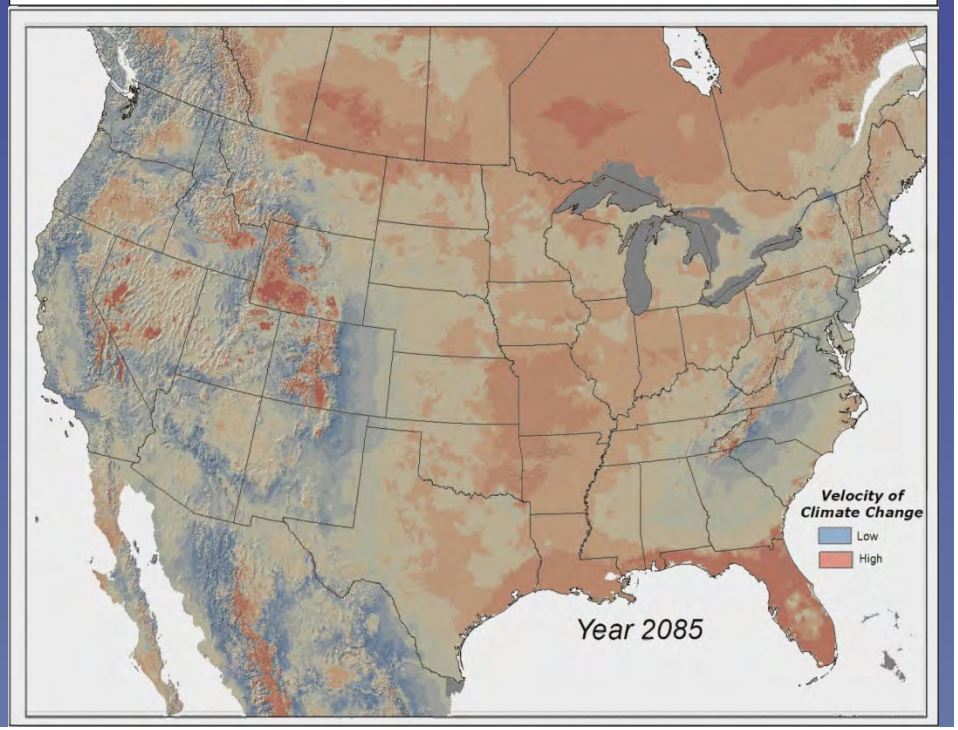
Velocity of Climate Change

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.

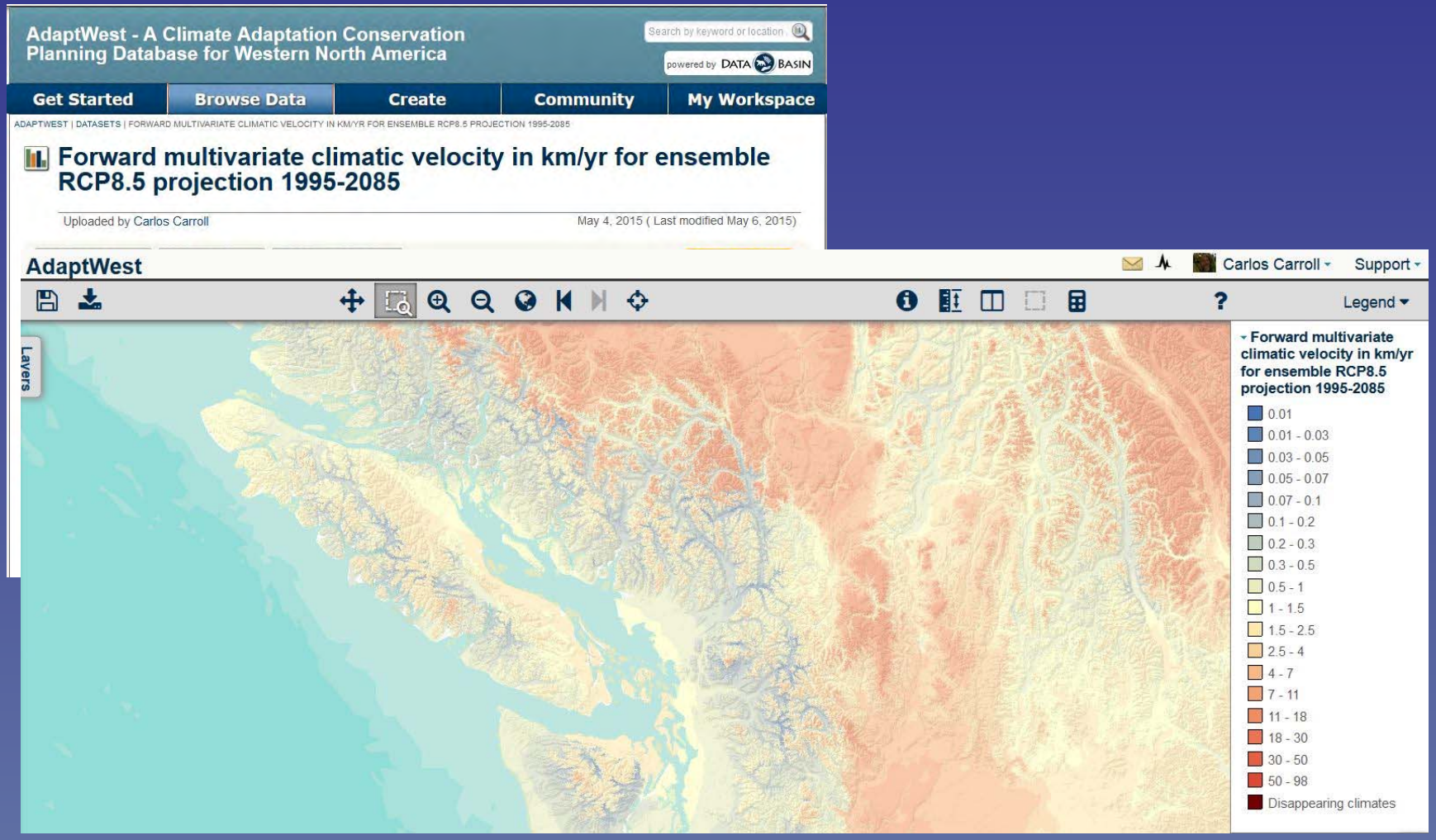




Areas of low “velocity of climate change” Species can keep pace if...

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

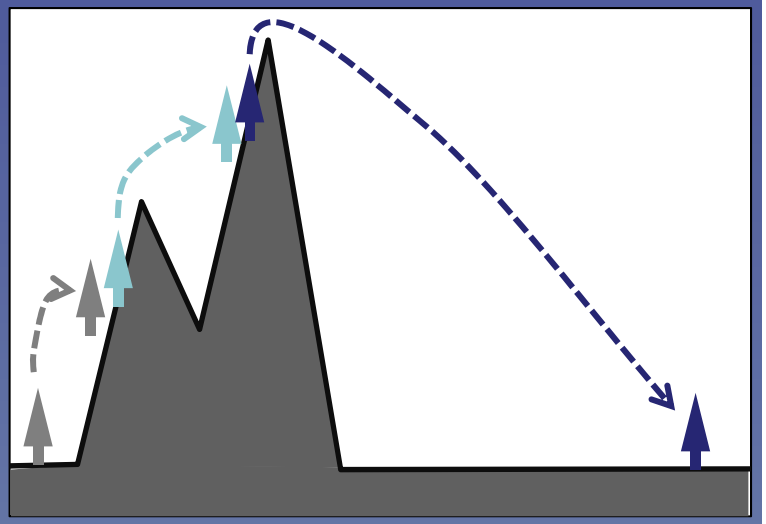
TECHNICAL ADVANCE

Velocity of climate change algorithms for guiding conservation and management

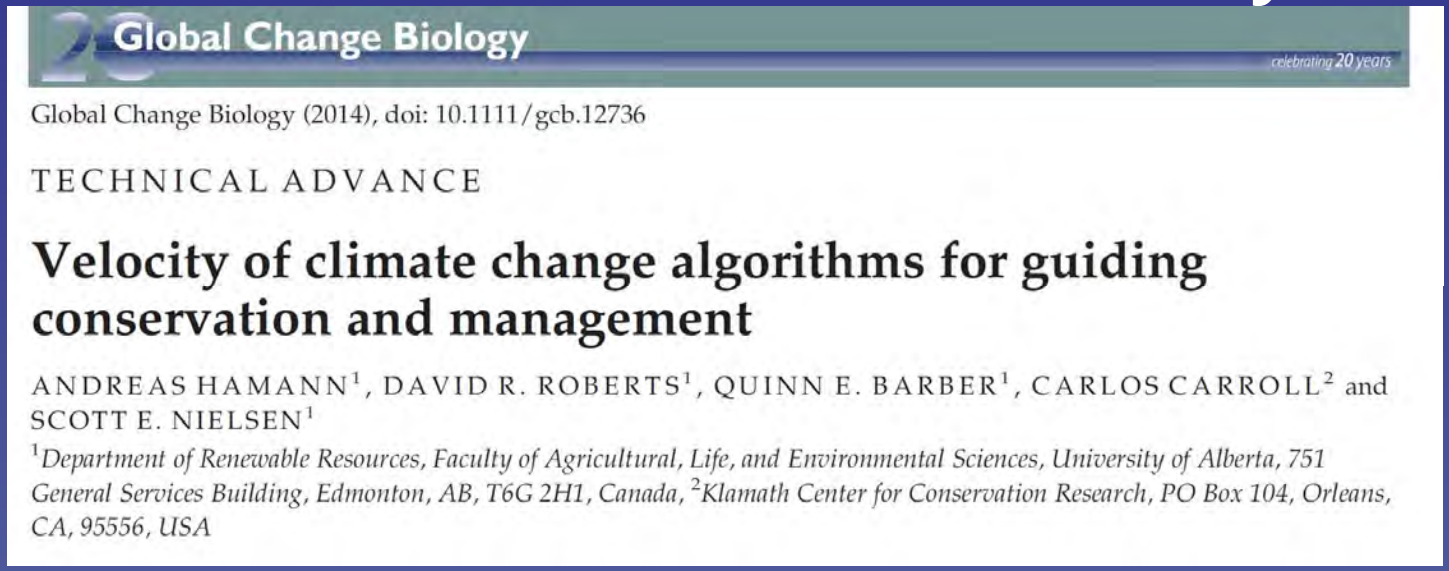
ANDREAS HAMANN[1], DAVID R. ROBERTS[1], QUINN E. BARBER[1], CARLOS CARROLL[2] and SCOTT E. NIELSEN[1]

[1]*Department of Renewable Resources, Faculty of Agricultural, Life, and Environmental Sciences, University of Alberta, 751 General Services Building, Edmonton, AB, T6G 2H1, Canada,* [2]*Klamath 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



Global Change Biology

celebrating 20 years

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

TECHNICAL ADVANCE

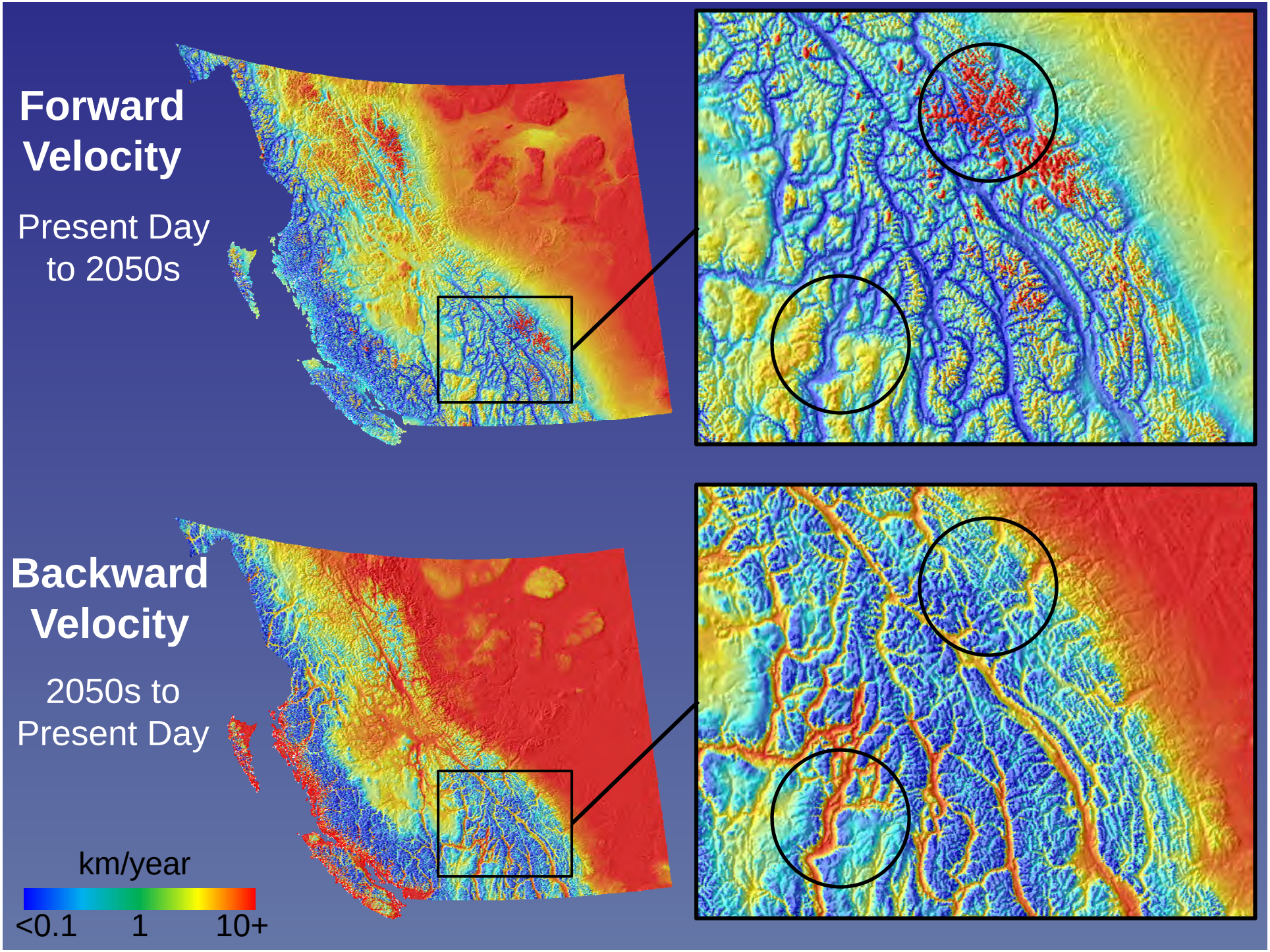
Velocity of climate change algorithms for guiding conservation and management

ANDREAS HAMANN[1], DAVID R. ROBERTS[1], QUINN E. BARBER[1], CARLOS CARROLL[2] and SCOTT E. NIELSEN[1]

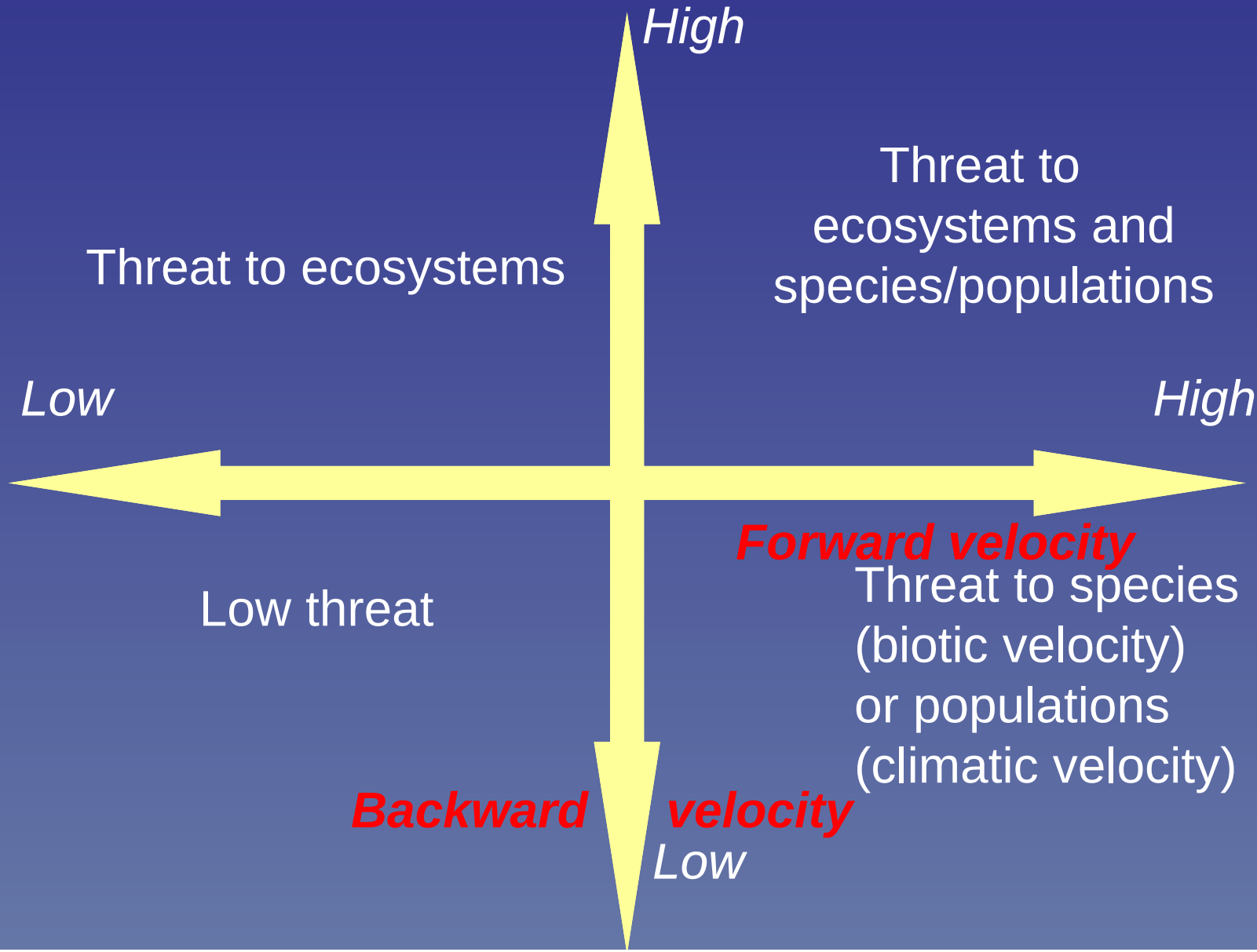
[1]*Department of Renewable Resources, Faculty of Agricultural, Life, and Environmental Sciences, University of Alberta, 751 General Services Building, Edmonton, AB, T6G 2H1, Canada,* [2]*Klamath Center for Conservation Research, PO Box 104, Orleans, CA, 95556, USA*

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
<0.1
1
10+

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

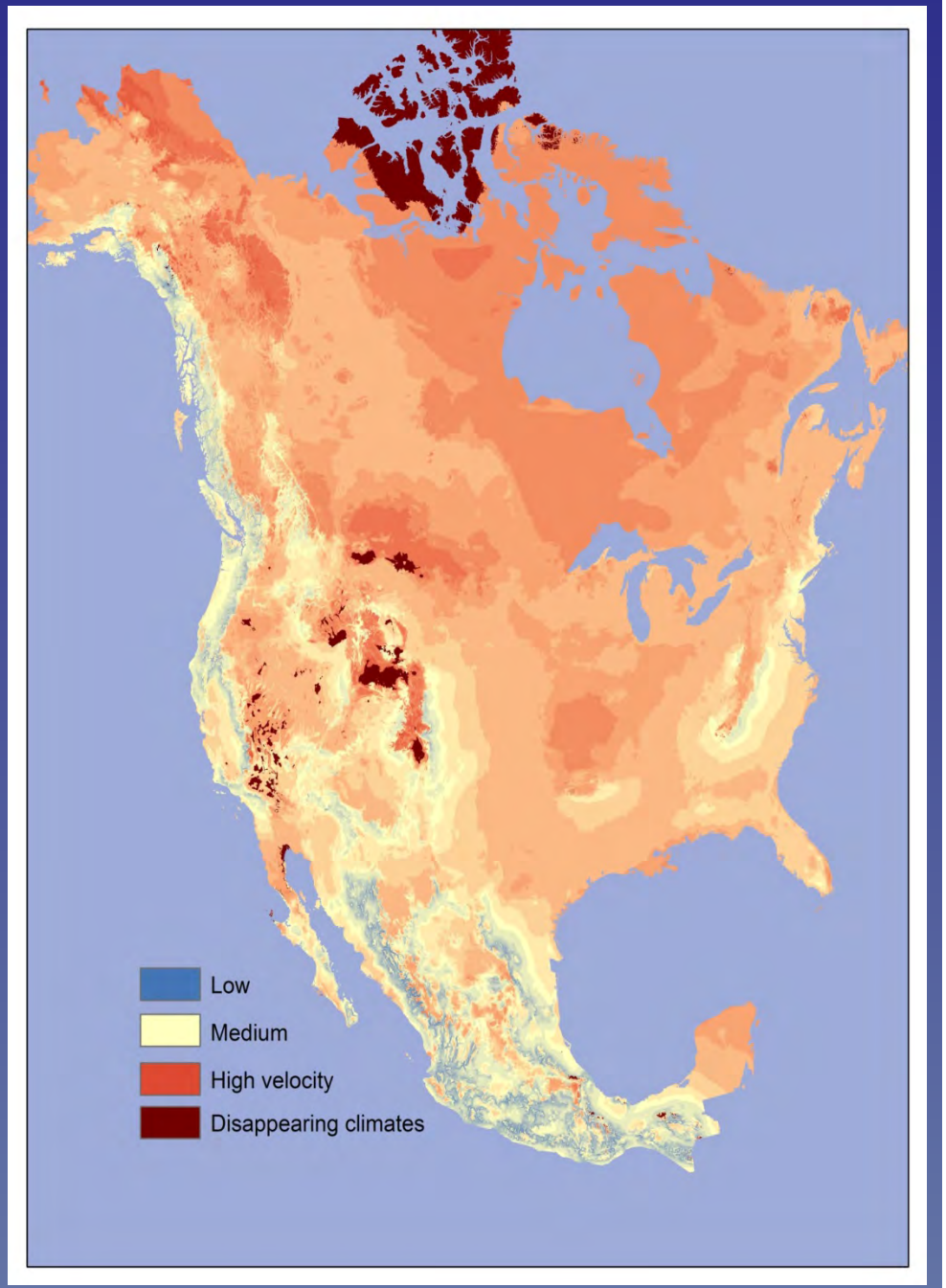
Does not indicate

- 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.

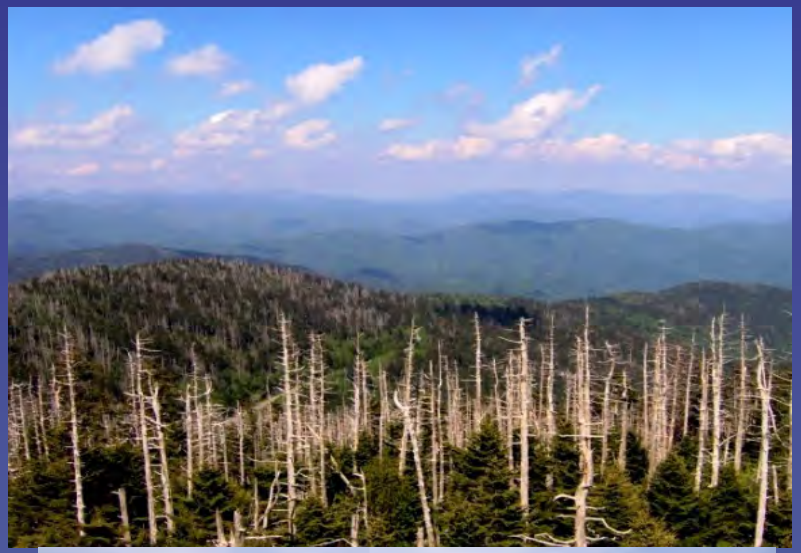
Interior basins

Green River Basin, Wyoming

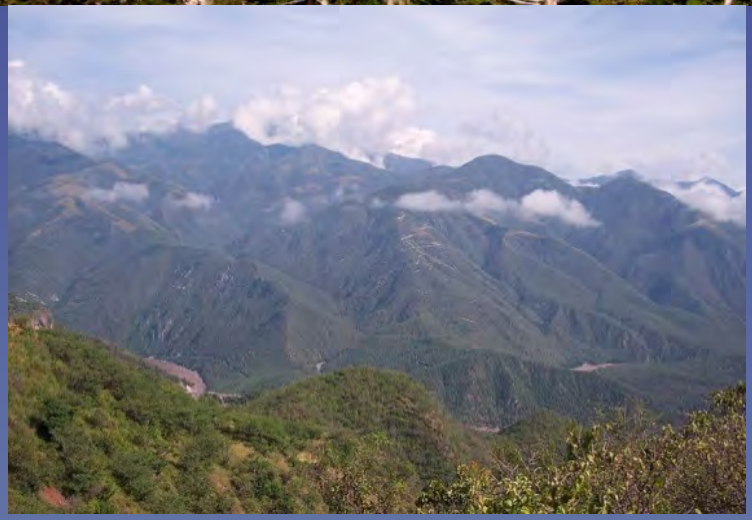
Many valleys of the Great Basin region show high climate velocity or even more extreme threat due to “disappearing” climate.
Cheatgrass and other exotic invasive species have helped drive a shift to a more frequent fire regime in some areas.

High peaks at southern end of mountain range

<u>Southern Appalachians</u>
Characterized by High endemism. Balsam wooly adelgid has killed large proportion of Fraser fir.



<u>Sierra Madre Occidental</u>
The pine-oak forest of this region of northern Mexico is noted for its high biodiversity and large number of endemic species.

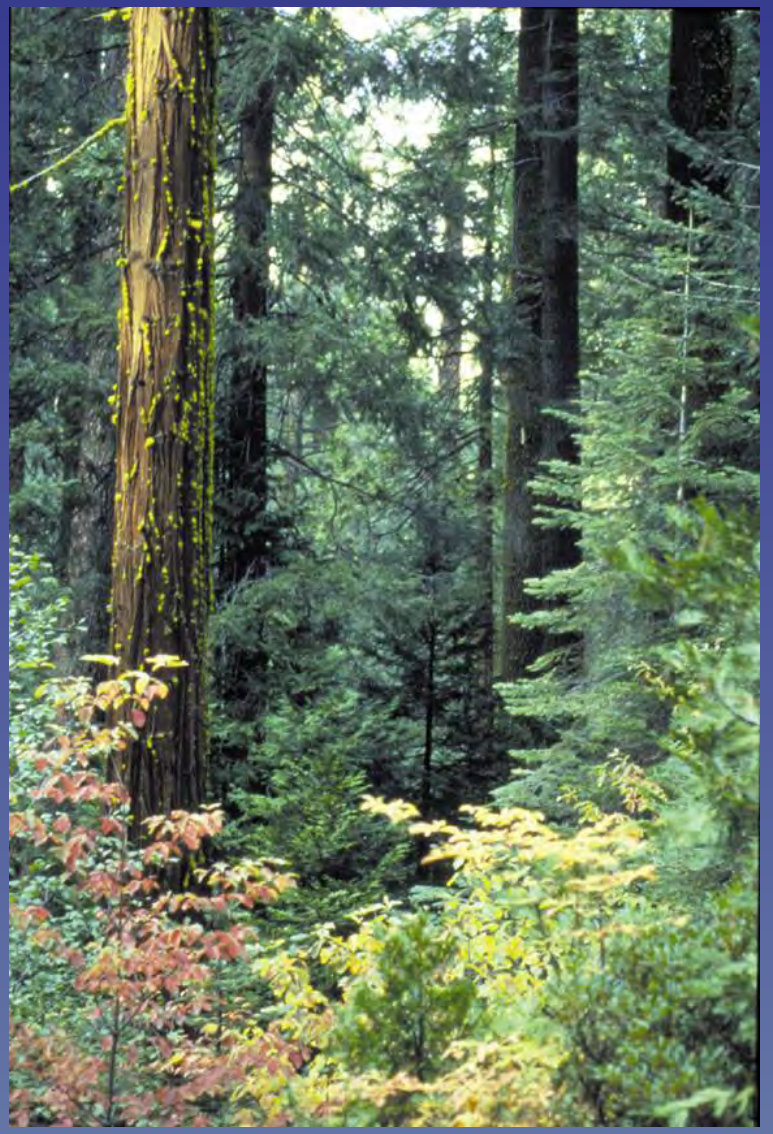


What areas are potential refugia?

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

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

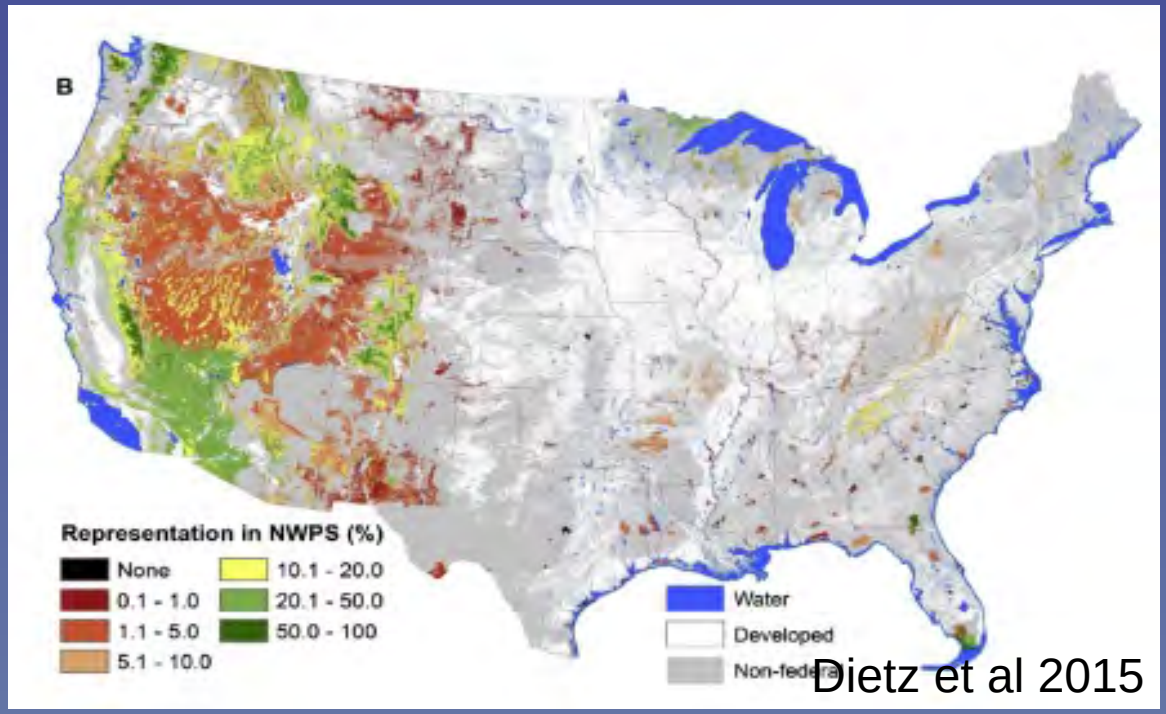
But different processes drive patterns at local, regional, and continental scales.



How can the data be used?

National case study: The Wilderness Society

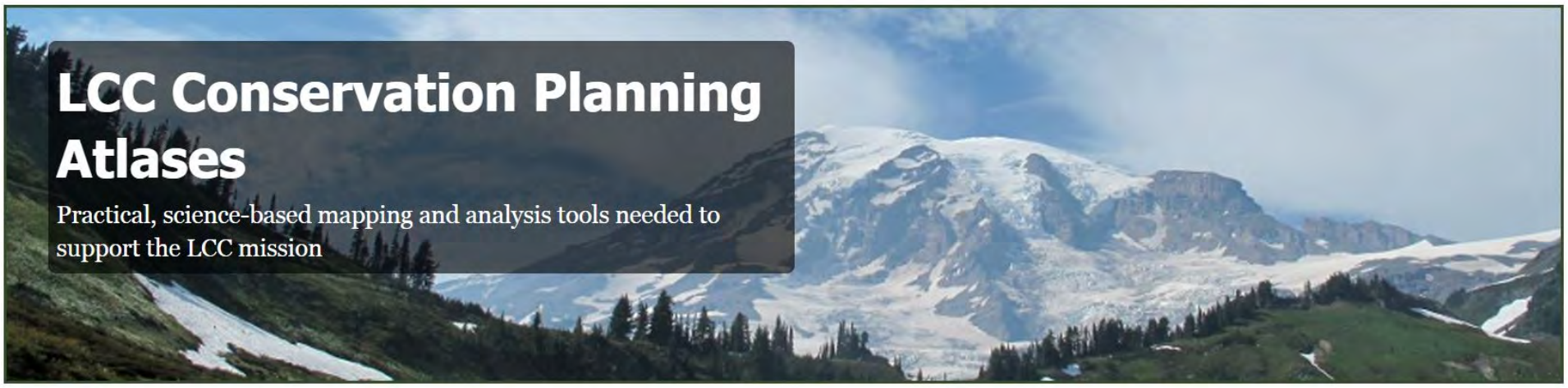
Travis Belote of The Wilderness Society is using AdaptWest downscaled climate and climate velocity data to assess climate change related threats to the National Wilderness System.



Dietz et al 2015

Regional case study: Landscape Conservation Cooperatives

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

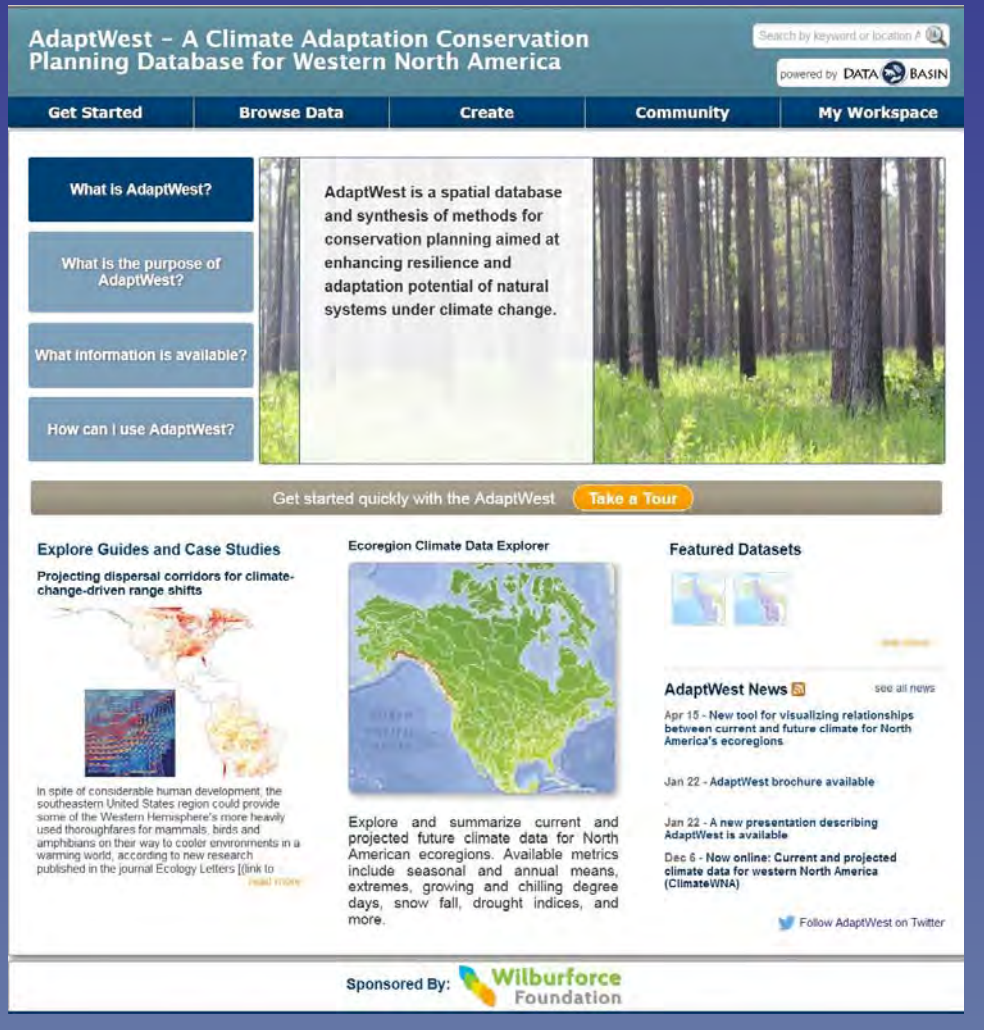


Regional case study: Heart of The Rockies Initiative

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.

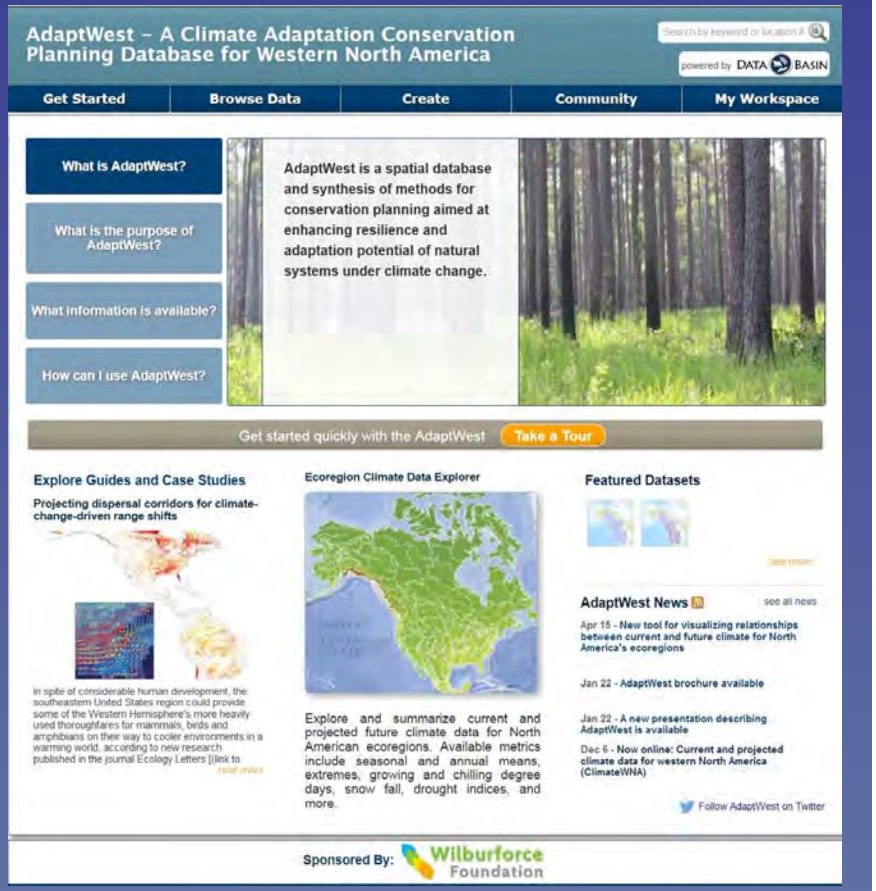
Local case study:
NGO or Land Trust

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



Other uses?

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



For more information and to get involved:

- Visit http://adaptwest.databasin.org
- Follow @adaptwest on Twitter for updates on newly available data and webinars
- Contact via email:
  carlos (at) klamathconservation.org