Challenges of Whitebark Pine Restoration Meeting
Bozeman, MT
Sept 20, 2013

WHITEBARK PINE DISTRIBUTION MODELS UNDER PROJECTED FUTURE CLIMATES IN THE GYA

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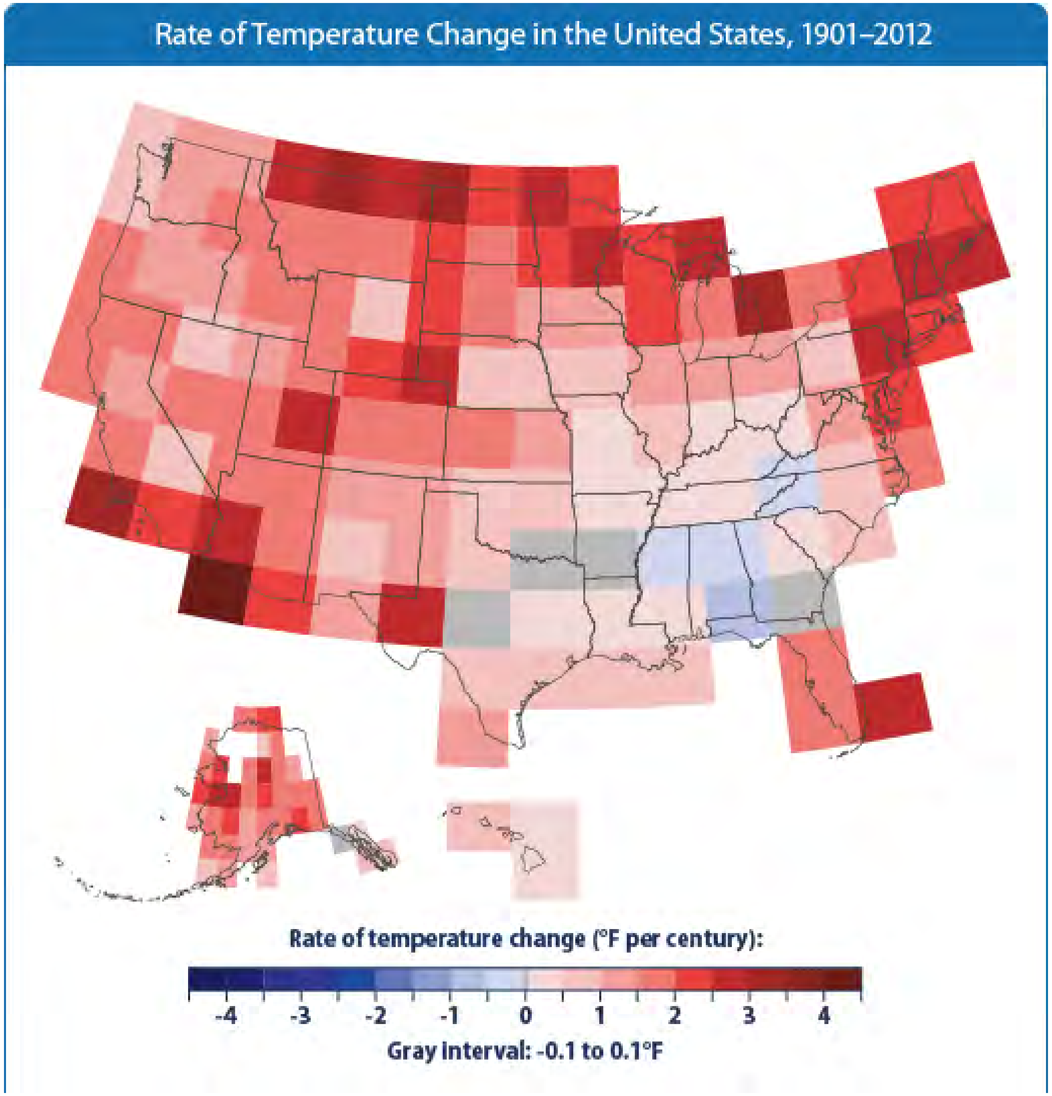
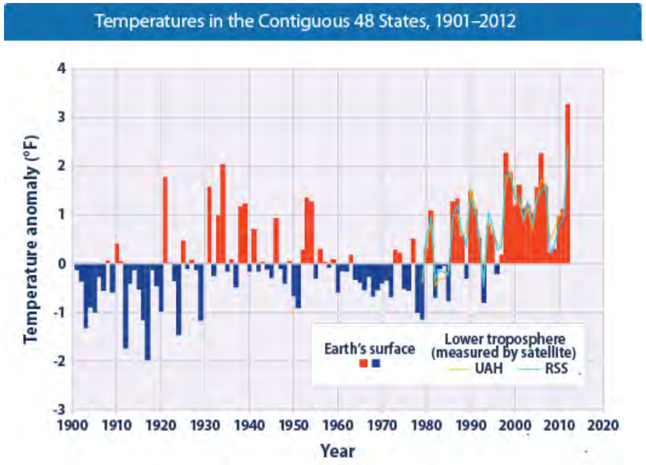
Montana State University

Tom Olliff

NPS IMR and Great Northern LCC

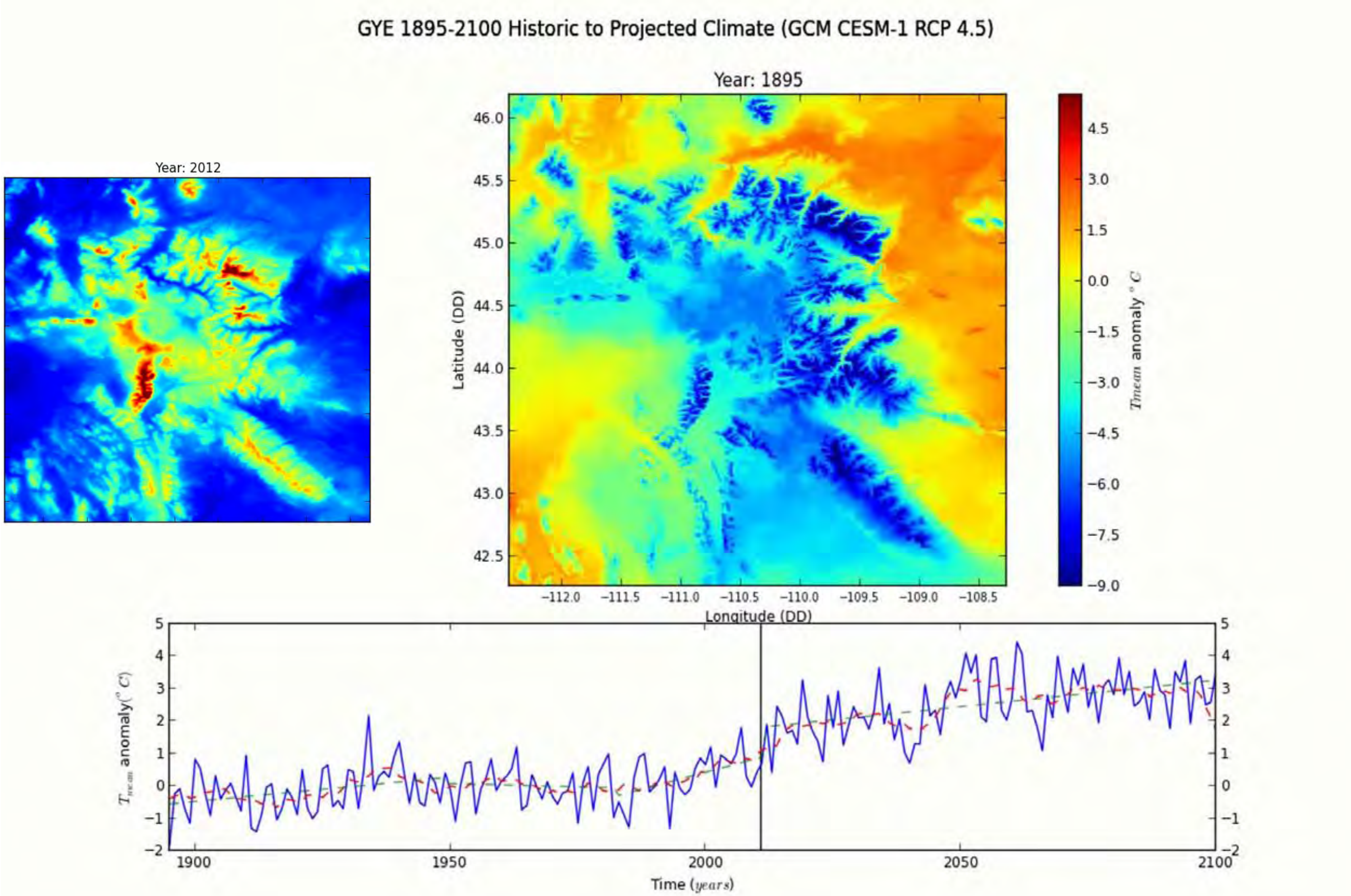
Vegetation response to climate





- Evidence of vegetation die off related to climate induced physiological stress. (Allen et al. 2010)

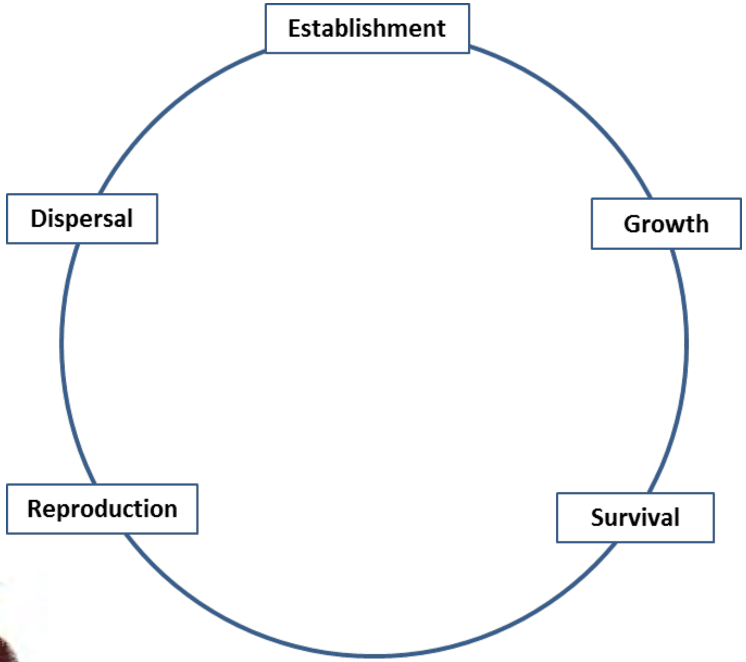
Temperature change in the GYA



Difference in annual temperature from the 1900-2010 mean

Climate and Whitebark Pine

- Climate limits WBP at each life history stage through availability of resources.



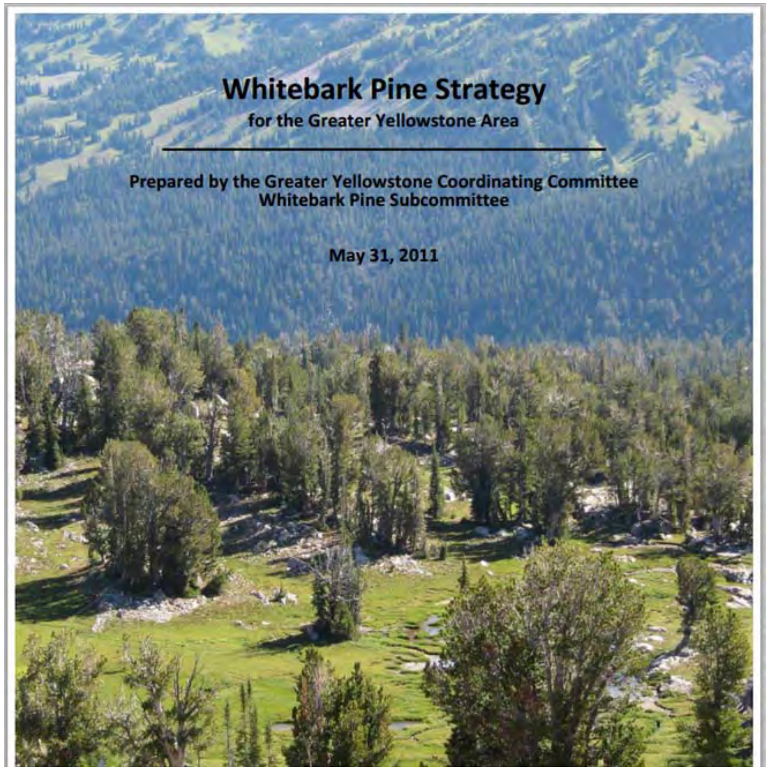
- Indirect impacts

Question (science)

- How will the bioclimatic habitat envelope for Whitebark pine respond to shifts in the GYA climate?

Question (applied)

- What locations in GYA will likely have suitable climates for WBP and may be candidates for restoration strategies for GYCC?



<u>Western US</u>

- **NPS I&M Greater Yellowstone Network, Kristen Legg**
- **NPS I&M Rocky Mountain Network, Mike Britten**
- **Greater Yellowstone Coordinating Committee Whitebark Pine Subcommittee, Karl Buermeyer and Virginia Kelly**
- **Grand Teton National Park, Kelly McClosky**
- **Yellowstone National Park, Ann Rodmann**
- **Rocky Mountain National Park, Ben Bobowski**

Science Collaboration

MONTANA NSF EPSCoR

MSU

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Nate Piekielek, Linda Phillips, Tony Chang, Regan Nelson, Erica Garroute, Katie Ireland
<u>Whitlock Lab & IoE</u>
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Helen Naughton

LCC-VP
LANDSCAPE CLIMATE CHANGE VULNERABILITY PROJECT

NORTH CENTRAL CLIMATE SCIENCE CENTER
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Dave Theobald, Conservation Science Partners
Forest Melton, NASA Ames
Scott Goetz, Woods Hole Research Center

Jeff Morresette, Dennis Ojima, NCCSC
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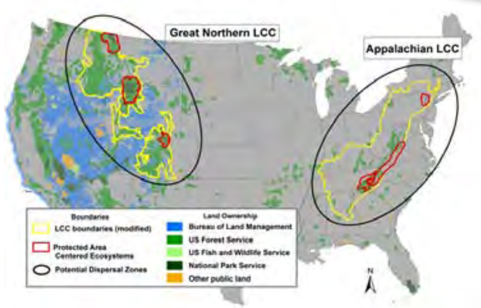
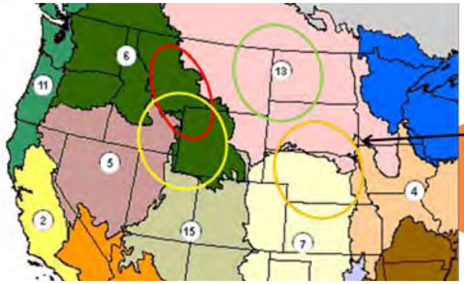
Running Lab, UM
Barry Noon, Susan Skagan, Colorado State University and USGS
Bill Lauenroth Lab, University of Wyoming
Diane Debinski Lab, Iowa State University





Methods (Response Data Sources)

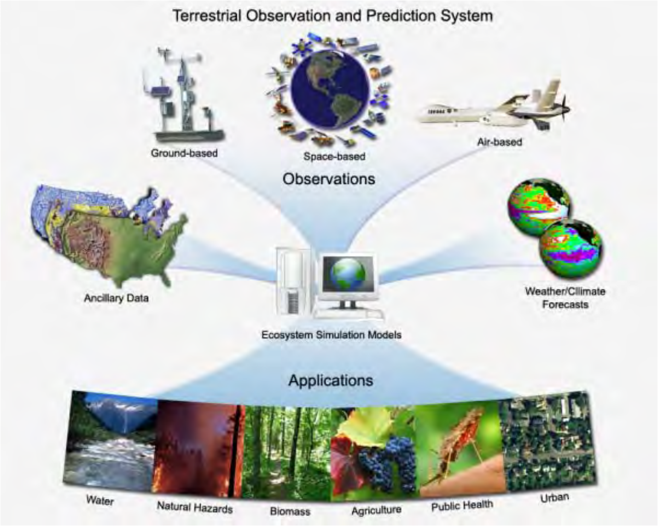
- Current model on "Adult" class tress (DBH≥8")
- 2,569 data points (936 presence, 1,633 absence)

Data Source	Adults	Seedling Saplings	Growth Rates	Mortality (Adults)	Reproduction
GYCC	Stand type Canopy cover Maturity Presence Dominance			Perimeters of burned WBP Canopy damage	
WLIS	Density	Regen		BR presence BR % infection % WBP mortality	
FIA	Presence Density by size class	Seedling Sapling density	DBH remeasure	Remeasurement of marked trees	
GYRN I&M	Density by size class	Density by size class		Mortality rate BR presence	Presence by size class
USDA FS				Pest detection Damage type Severity Dead trees/ac	

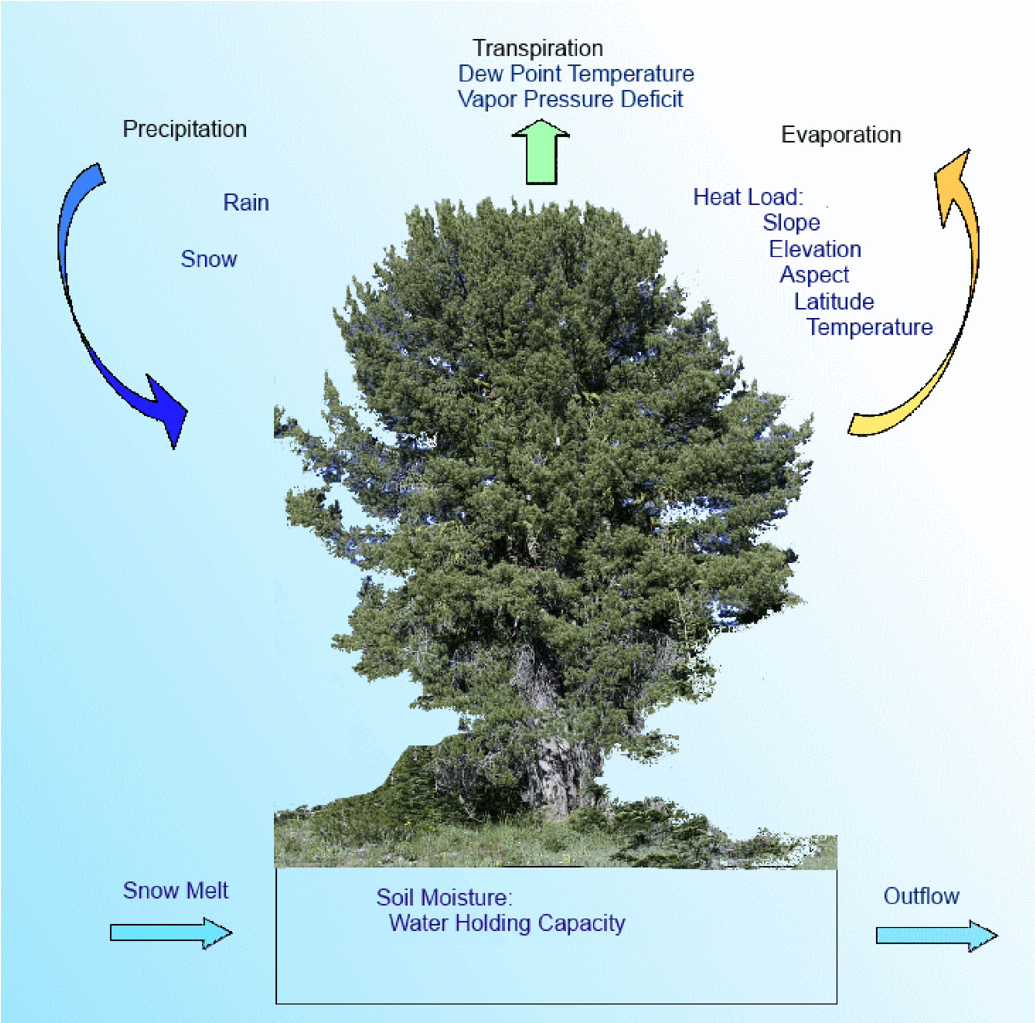
Methods (Predictor Data)

- Historic Climate Data
  - PRISM 800m climate
    - (Daly et al. 2011)
  - (1900-2010) monthly

- Projected Future Climate
  - (NASA TOPS)
  - CMIP5 Downscaled GCMs
  - (2010-2100) monthly



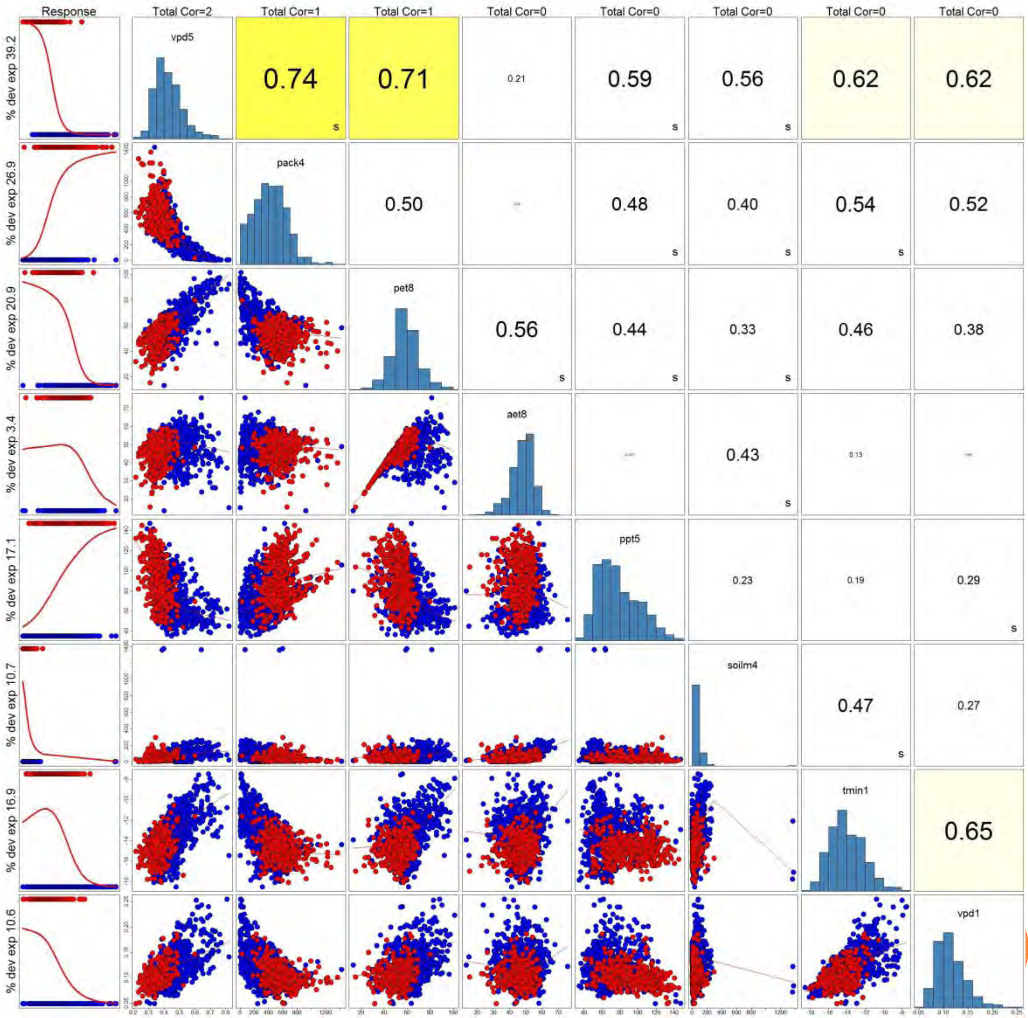
Water Balance Modeling



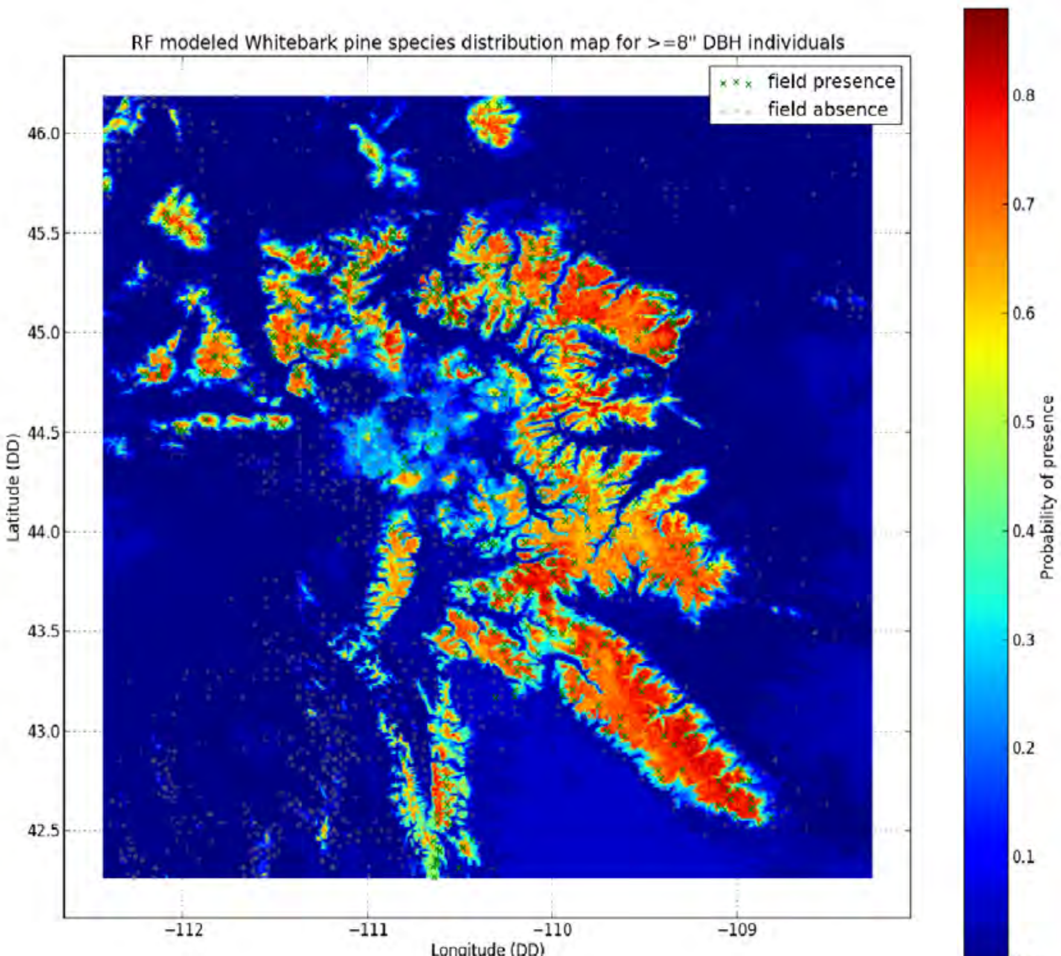
- Derived monthly water balance variables using Thornthwaite equation.
- Provides 10 additional climate metrics

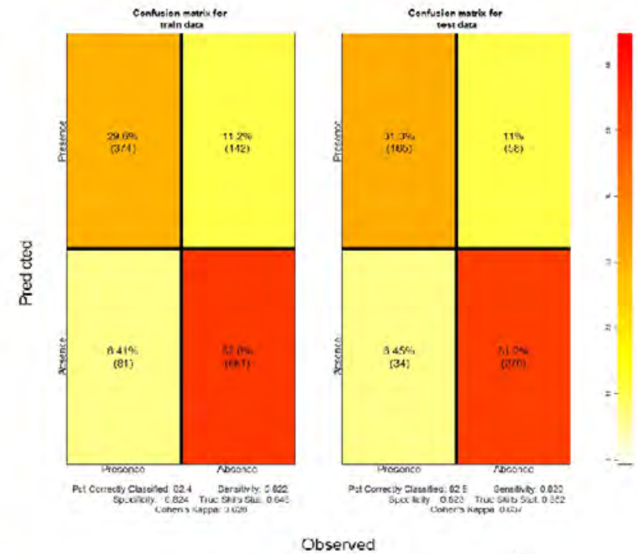
Predictor Variable Selection

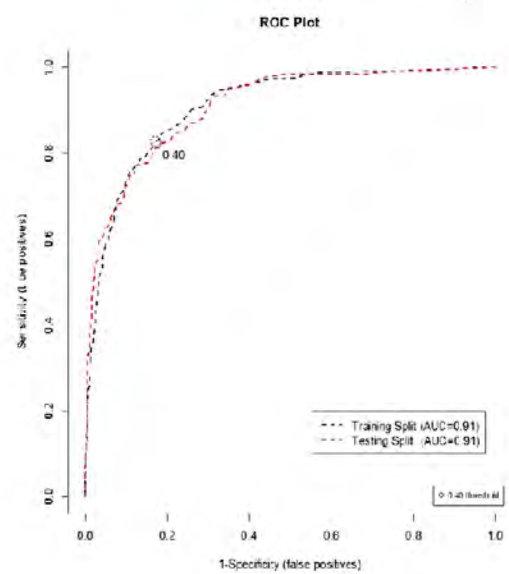
- Climate summarized using 1950-1980 means
- 122 predictor covariates
- Suite considering ecologically meaningful predictors



RESULTS

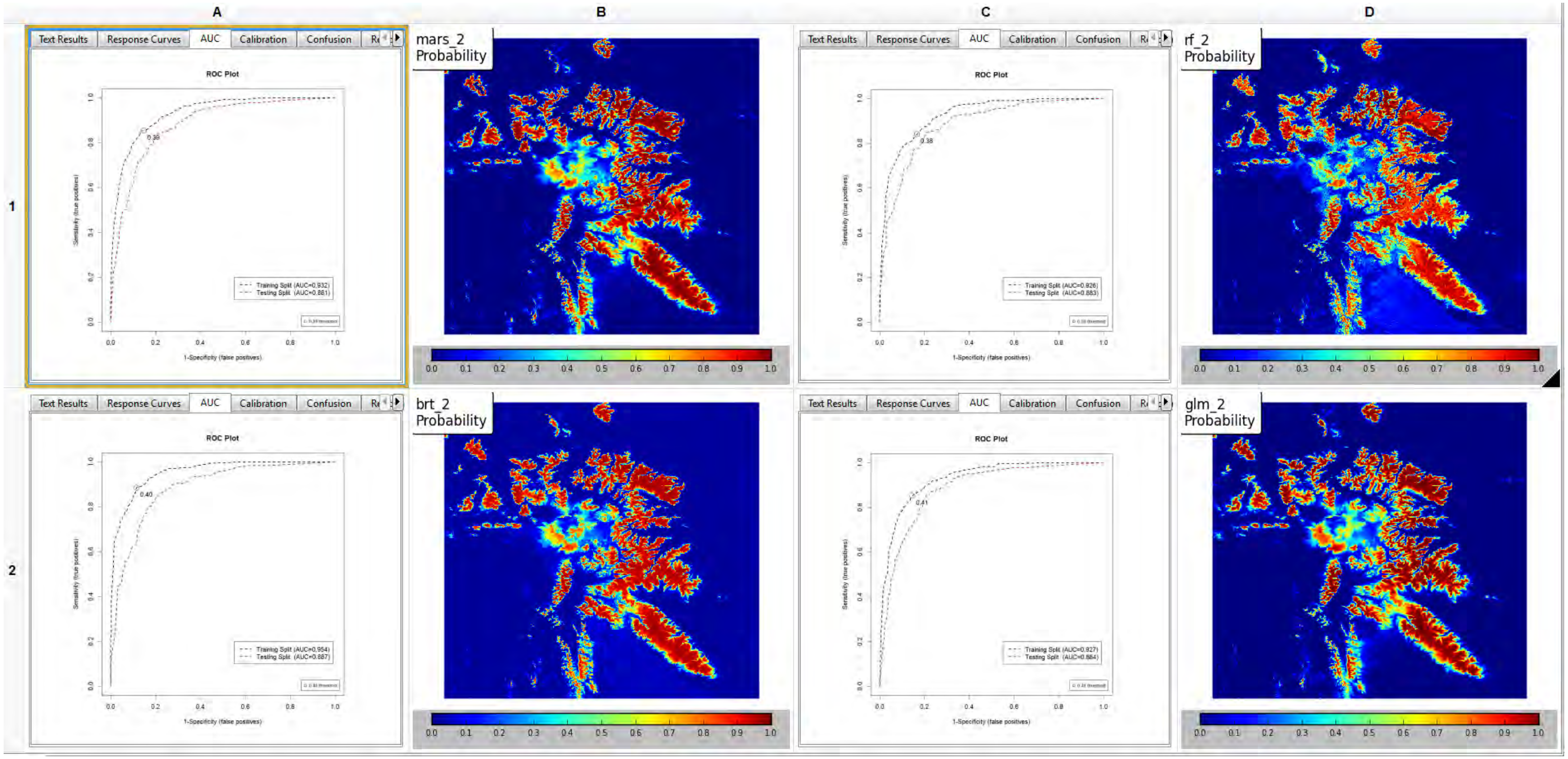




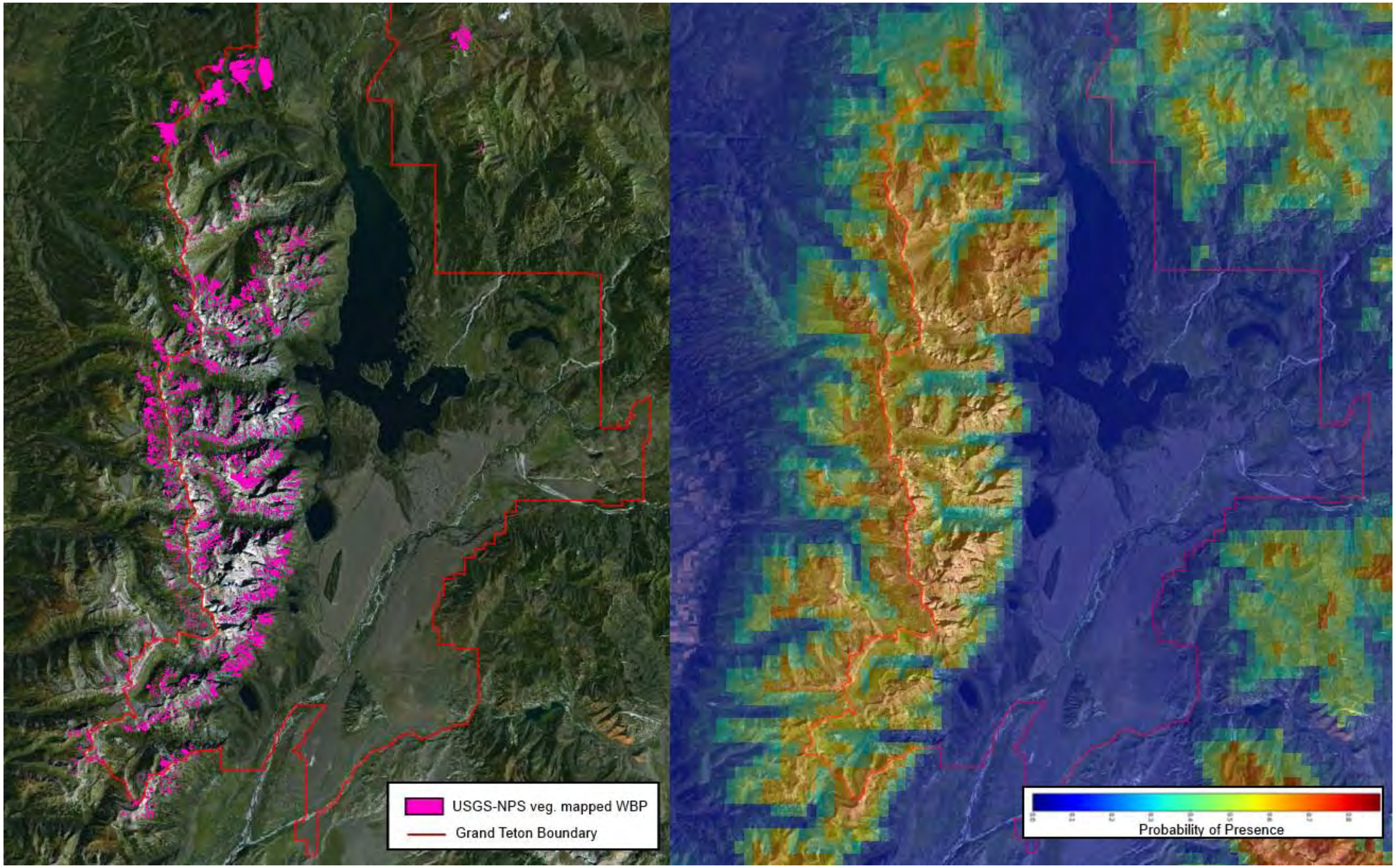


Leading predictors:
Tmax8, VPD8, PET7, SWE5, Tmin1

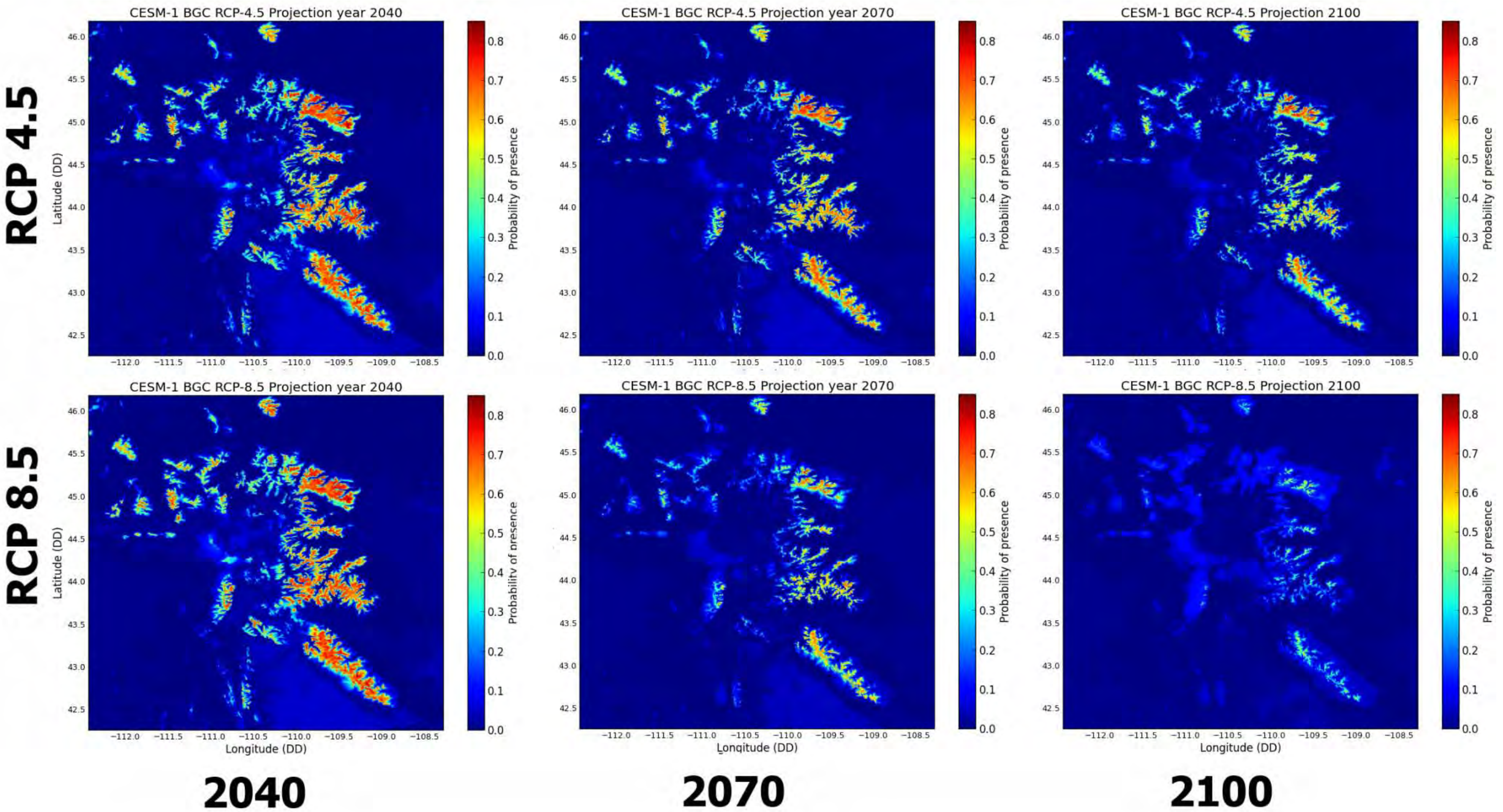
Diagnostic: Multi-method Model Fitting



Diagnostics



Future Projections

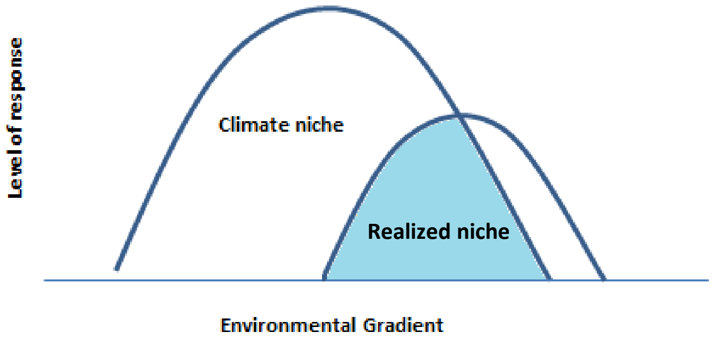


Geographic properties of areas of suitable climate

Prob. Presence > 50%	Current	2040	2070	2100
Area	28,732 km^2	10,227 km^2 (65% reduction)	6,160 km^2 (79% reduction)	3,949 km^2 (86% reduction)
Mean elevation	2,974 m (9,754 ft)	3,214 m (10,541 ft)	3,288 m (10,784 ft)	3,363 m (11,030 ft)
Elevation Range	2,226 – 4,101 m (7,301 – 11,030 ft)	2,478-4101 m (8,127 – 11,030 ft)	2,545-4,101 m (8,347 – 11,030 ft)	2,643-4,101 m (8,669 – 11,030 ft)

Implications for GYCC WBP strategy

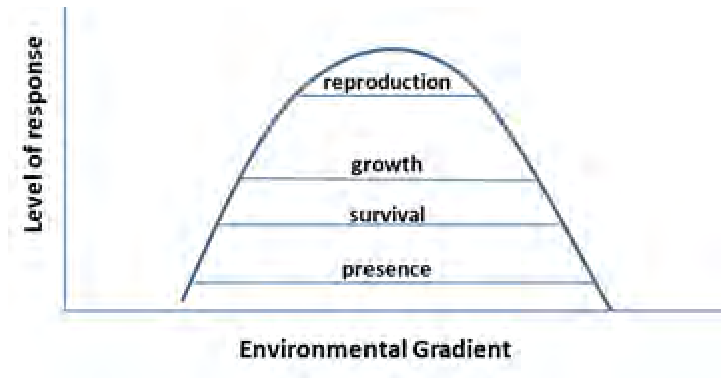
- Analysis identifies loss of historic bioclimatic habitat by the year 2100
- Areas and locations of climate suitable habitat for restoration of adult WBP



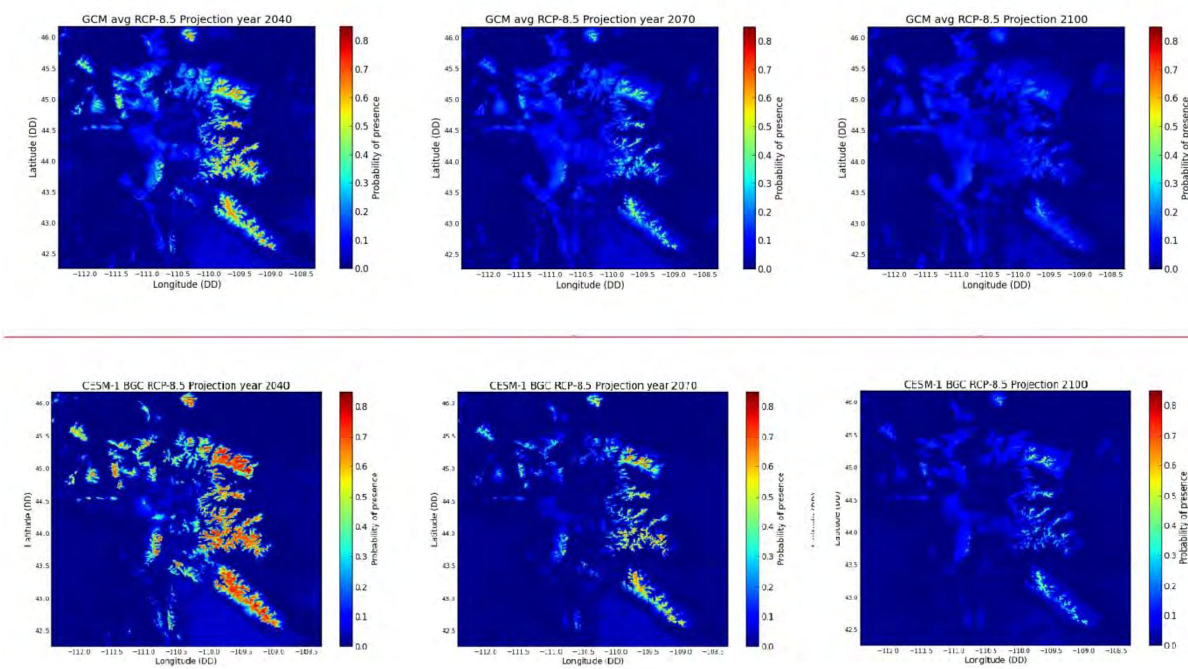
- Ignorant of other disturbances to species

NEXT STEPS…

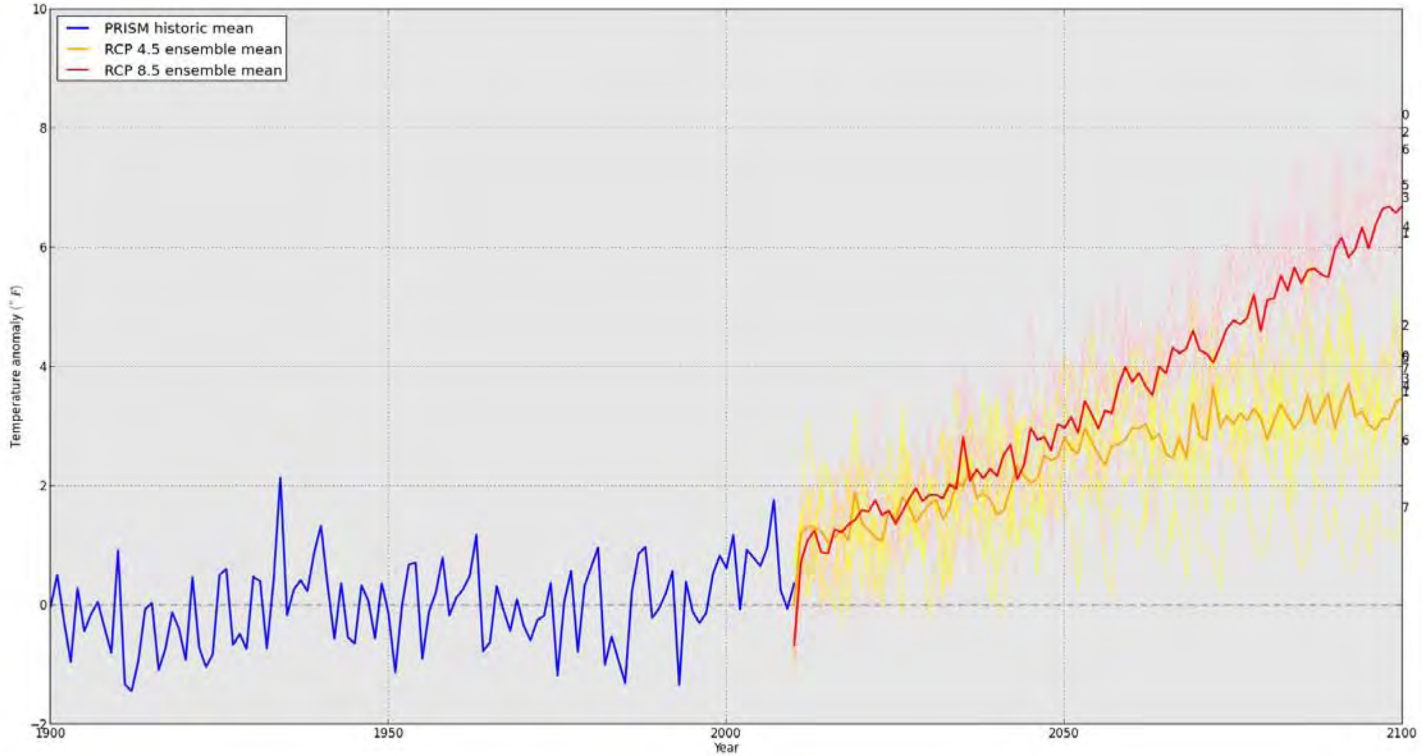
- Envelope analysis to reveal climatic suitable areas for other life history stages



- Expansion of model to more GCMs and scenarios



GCM VARIABILITY



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Questions