Applying Downscaled Data To Large-Scale Wildlife Corridor Planning

Healy Hamilton
Center for Applied Biodiversity Informatics
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CALIFORNIA ACADEMY OF SCIENCES

- **Climate change is here and is certain to increase in magnitude. Observed spatial, temporal and ecological responses in species and ecosystems are also certain to increase**

- **At the spatial scales of resource management, the rate, magnitude and distribution of climate change impacts are highly uncertain**

- **Ecological forecasting is a relatively young science which must quickly mature to meet the challenges of rapid global change**

VIEWPOINT

Ecological Forecasts: An Emerging Imperative

James S. Clark,[1]* Steven R. Carpenter,[2] Mary Barber,[3] Scott Collins,[4] Andy Dobson,[5] Jonathan A. Foley,[6] David M. Lodge,[7] Mercedes Pascual,[8] Roger Pielke Jr.,[9] William Pizer,[10] Cathy Pringle,[11] Walter V. Reid,[12] Kenneth A. Rose,[13] Osvaldo Sala,[14] William H. Schlesinger,[15] Diana H. Wall,[16] David Wear[17]

Planning and decision-making can be improved by access to reliable

for which uncertainty can be reduced to the

BIOLOGICAL CONSERVATION 142 (2009) 14–32

available at www.sciencedirect.com

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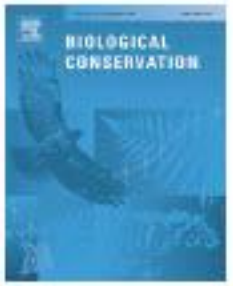
journal homepage: www.elsevier.com/locate/biocon



Review

Biodiversity management in the face of climate change: A review of 22 years of recommendations

Nicole E. Heller, Erika S. Zavaleta*

Environmental Studies Department, University of California, Santa Cruz, Santa Cruz, CA 95606, United States

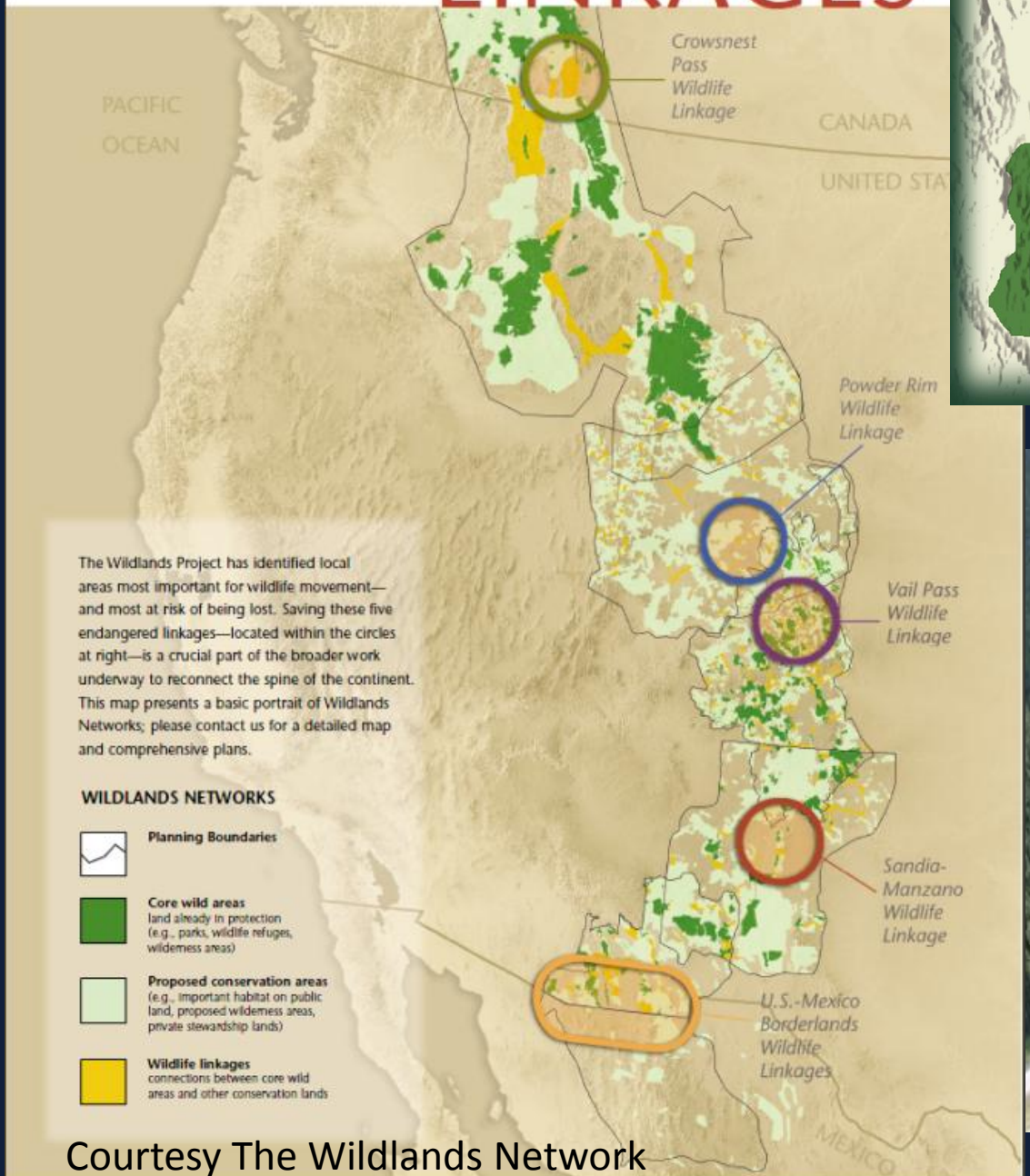
"To improve landscape connectivity, so that species can move, is the most frequent recommendation for climate change adaptation."

The Wildlands Network, with permission

- **Static boundaries of protected areas will no longer hold the species they were designed to conserve**
- **The new geography of conservation is *dynamic***


The Spine of the Continent
WILDLANDS NETWORK
RECONNECTING NATURE IN NORTH AMERICA
ROUND RIVER CONSERVATION STUDIES
YELLOWSTONE TO YUKON CONSERVATION INITIATIVE
AMERICAN WILDLANDS
HEART OF THE WEST COALITION
WESTERN ENVIRONMENTAL LAW CENTER
COLORADO SAFE PASSAGES COALITION
GRAND CANYON WILDLANDS COUNCIL
NEW MEXICO PRIORITY WILDLIFE LINKAGES
DEFENDERS OF WILDLIFE
WILDLANDS NETWORK
NATURALIA, A.C.
Cartography: Kurt A. Menke, GISP
Bird's Eye View
www.BirdsEyeViewGIS.com
Date: January 10, 2009

ENDANGERED LINKAGES



The Wildlands Project has identified local areas most important for wildlife movement—and most at risk of being lost. Saving these five endangered linkages—located within the circles at right—is a crucial part of the broader work underway to reconnect the spine of the continent. This map presents a basic portrait of Wildlands Networks; please contact us for a detailed map and comprehensive plans.

WILDLANDS NETWORKS

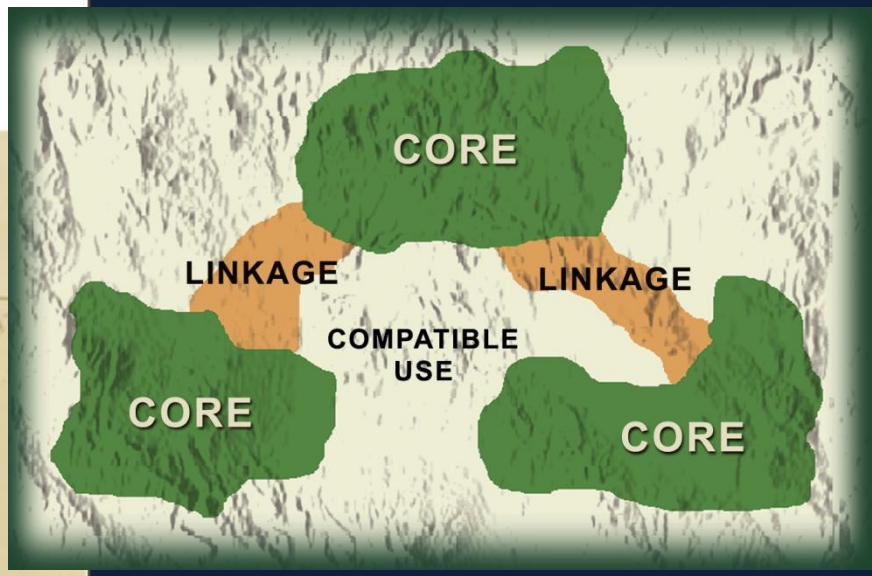
Planning Boundaries

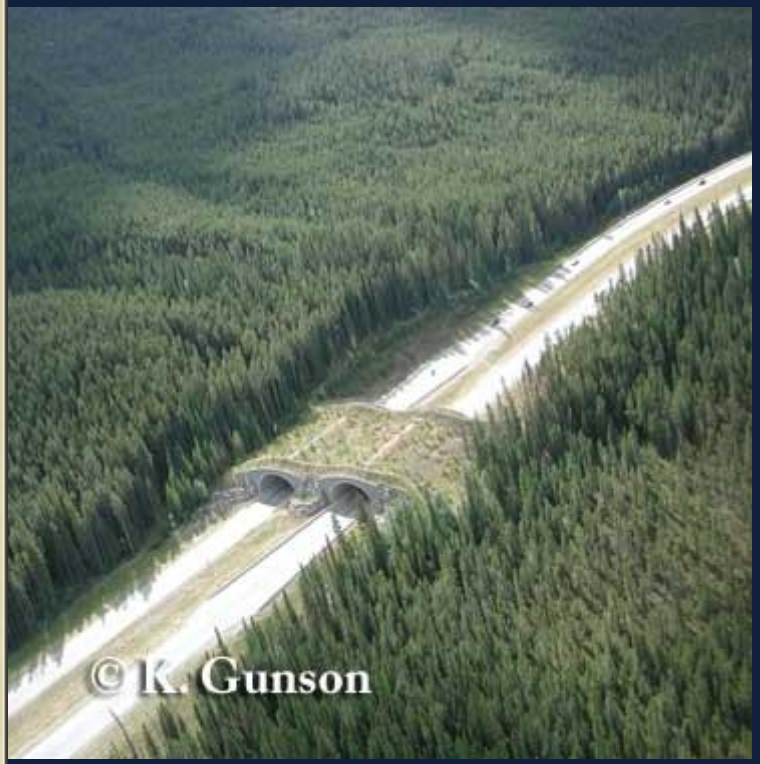
Core wild areas
land already in protection (e.g., parks, wildlife refuges, wilderness areas)

Proposed conservation areas
(e.g., important habitat on public land, proposed wilderness areas, private stewardship lands)

Wildlife linkages
connections between core wild areas and other conservation lands

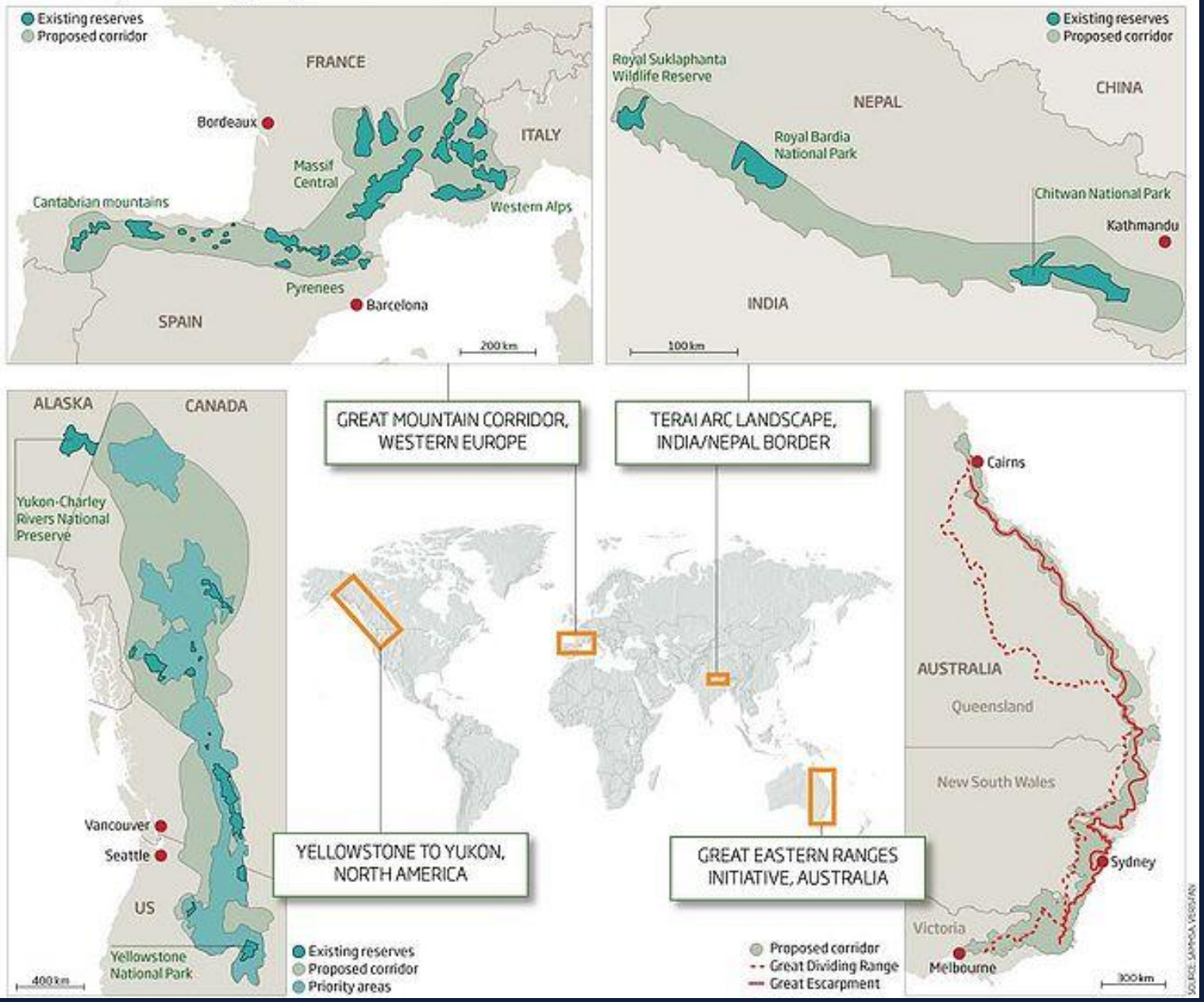
Courtesy The Wildlands Network





Connect the hotspots

From Alaska to Australia vast tracts of wild land are being pieced together to form conservation "megacorridors" linking existing wilderness reserves




Landscape Conservation Cooperatives
LCC
California
Desert
Great Basin
Great Northern
North Pacific
Plains and Prairie Potholes
Southern Rockies
Unclassified

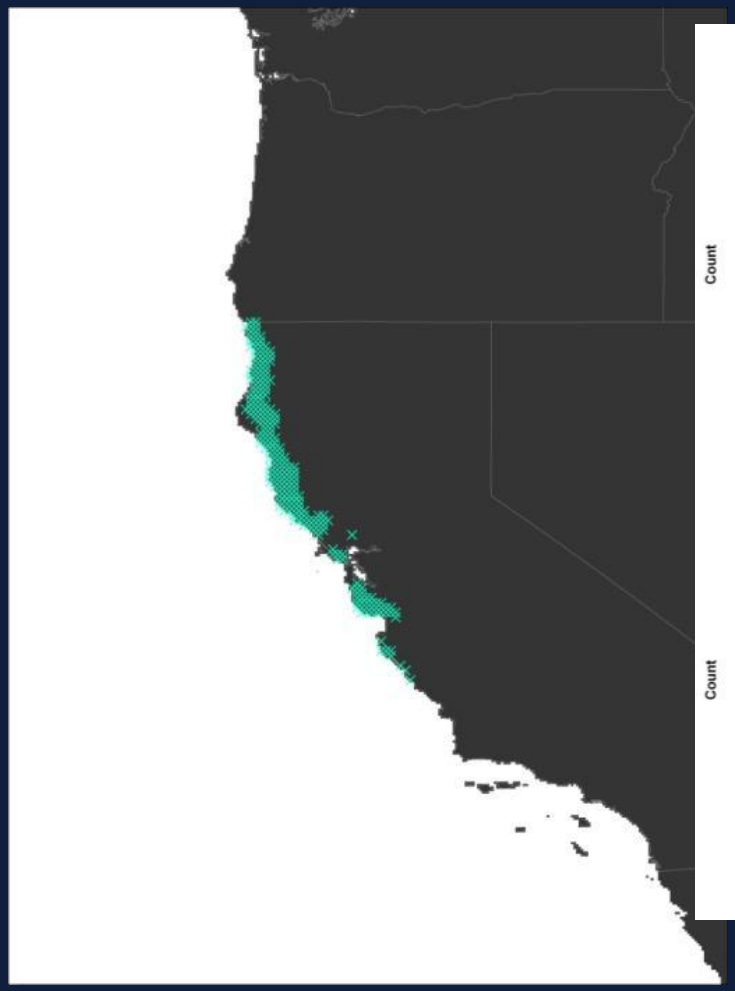
Data and Tools for Predicting Ecological Impacts of Climate Change

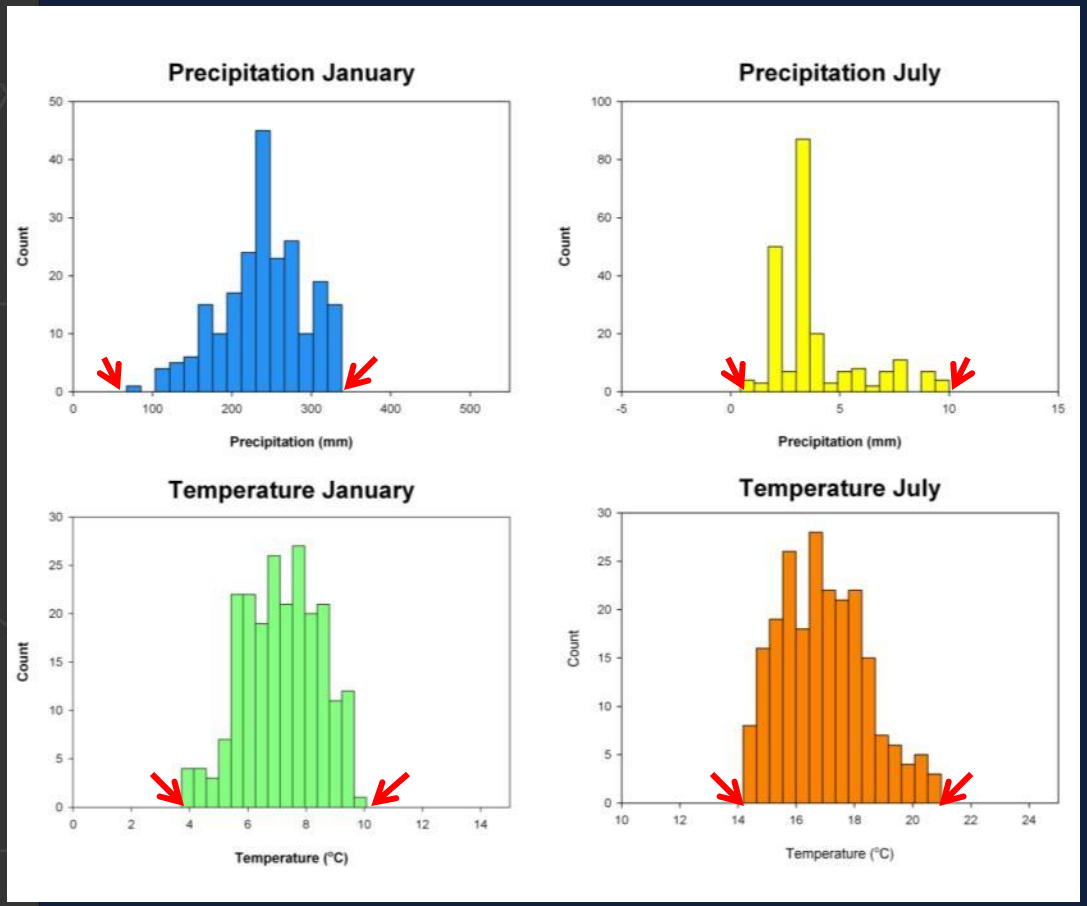
1) Biogeographic data sampling species distributions
2) Distribution (Niche) modeling algorithms
3) Current 'climate surfaces' characterizing environmental space
4) Many climate model outputs
5) Climate model outputs under alternative emissions scenarios
6) Methods to downscale coarse resolution global output to produce higher resolution *future climate surfaces*

Sources of uncertainty in predicting ecological impacts of climate change

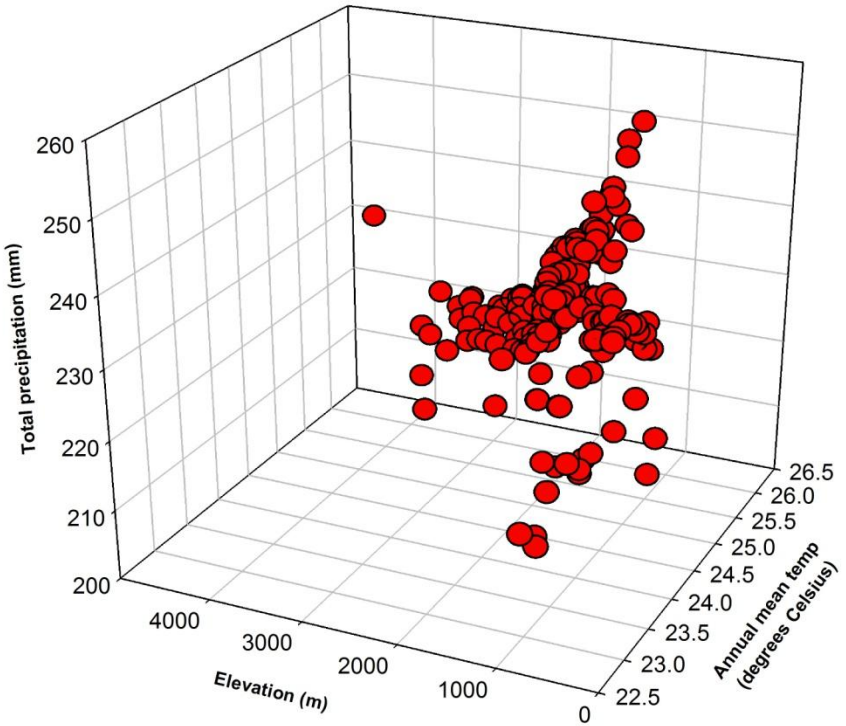
1) Biogeographic data sampling species distributions
2) Distribution modeling algorithms
3) Current 'climate surfaces' characterizing environmental space
4) *Inter*model and *intra*model variation in climate model output
5) Downscaling coarse resolution global output to generate higher resolution *future climate surfaces*
6) Uncertainty in extent of future greenhouse gas emissions

Tools for investigating relationships of species and climate: Ecological niche modeling algorithms

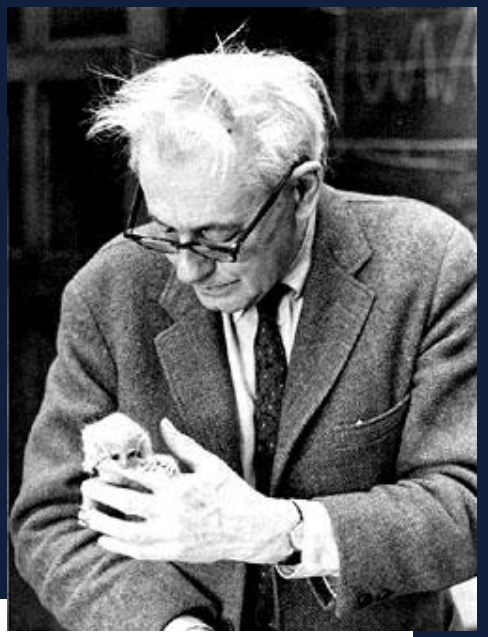


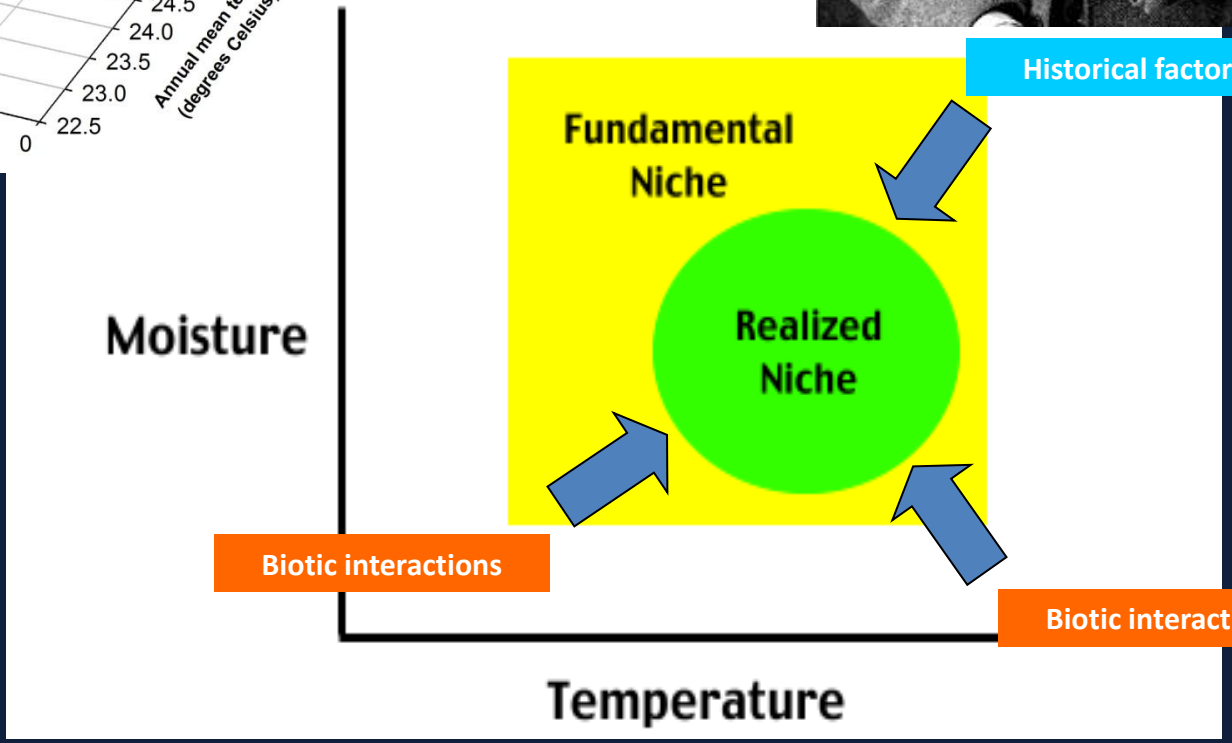


Coast redwood (Sequoia sempervirens)
known occurences



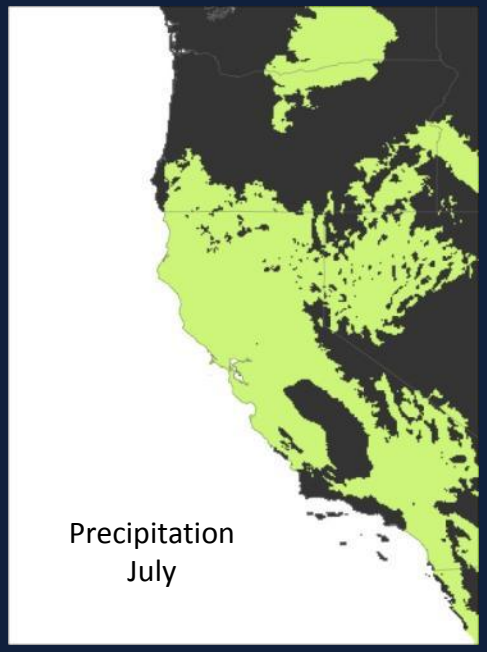
G. Evelyn Hutchinson 1903-1991



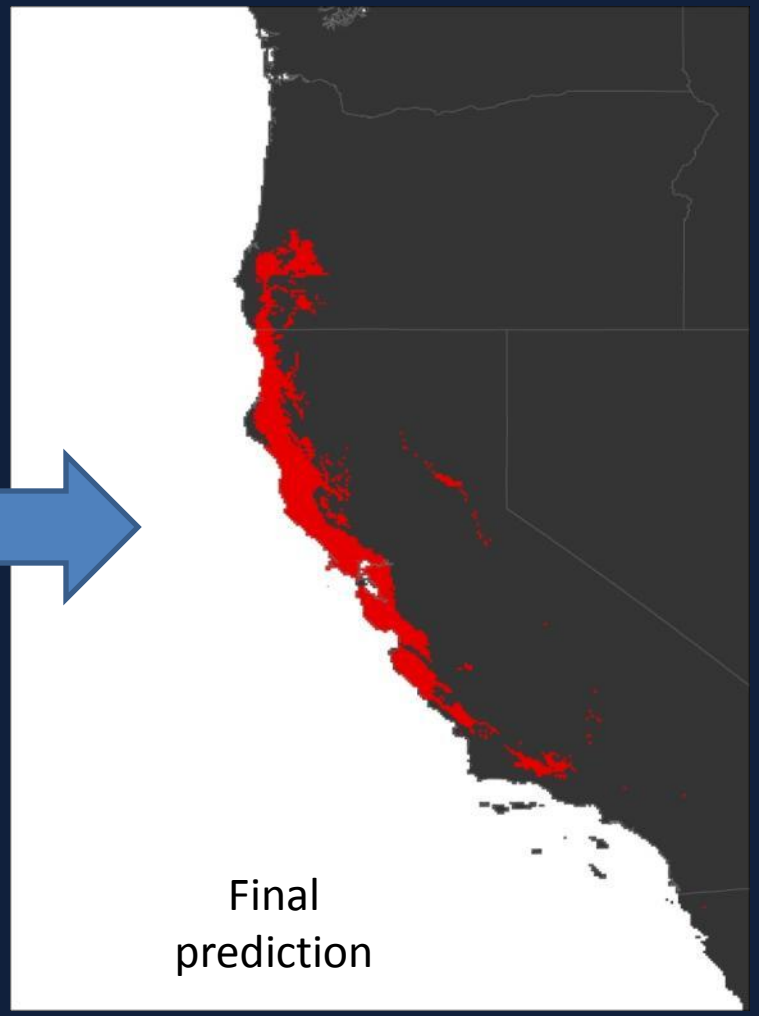



Precipitation
January

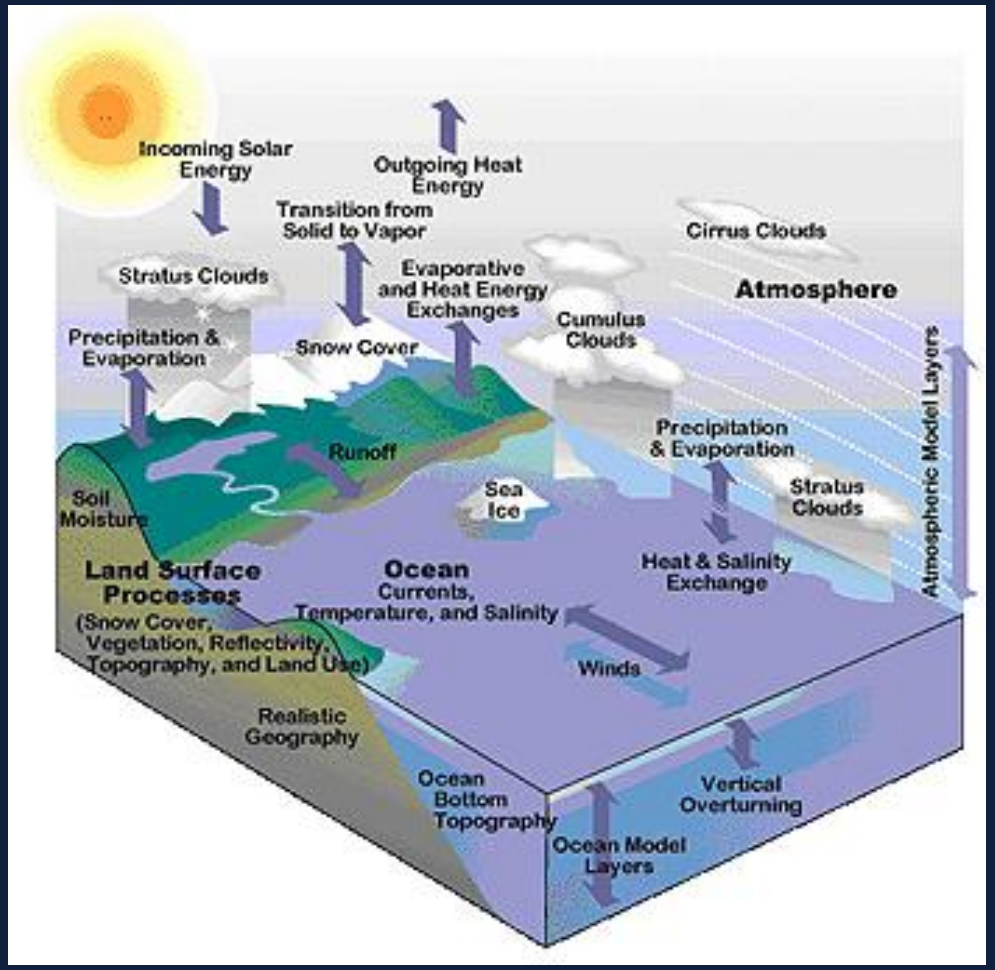

Temperature
January

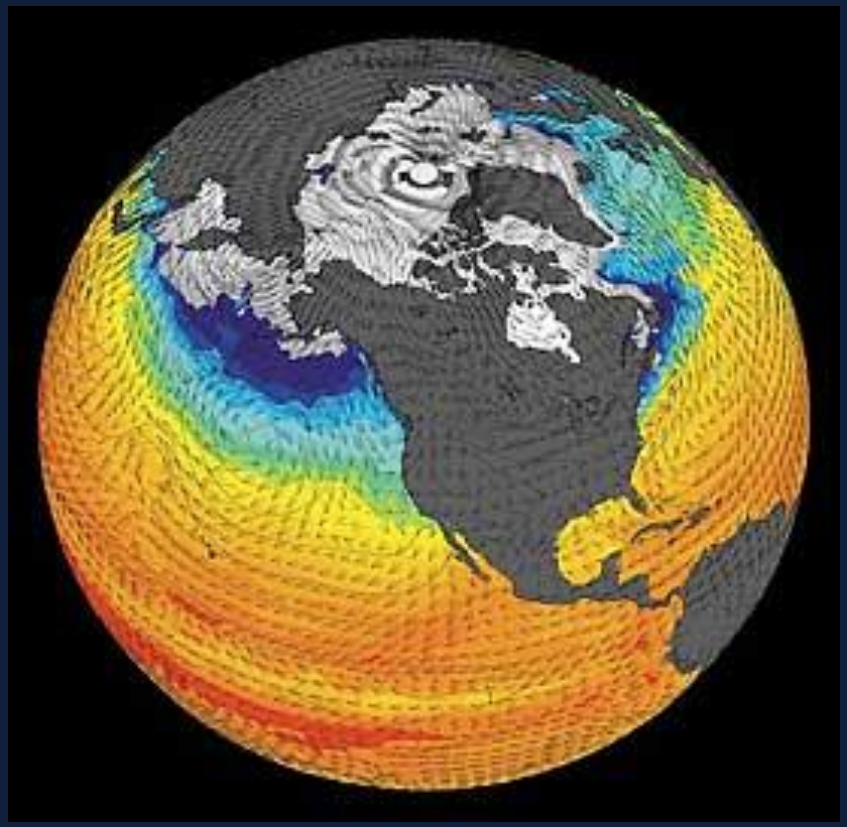

Precipitation
July


Temperature
July


Final
prediction

Global climate models represent the only information we have about the future climate on Earth





PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A

Phil. Trans. R. Soc. A (2007) **365**, 1957–1970
doi:10.1098/rsta.2007.2068
Published online 14 June 2007

Quantification of modelling uncertainties in a large ensemble of climate change simulations

James M. Murphy[1], David M. H. Sexton[1], David N. Barnett[1], Gareth S. Jones[1], Mark J. Webb[1], Matthew Collins[1] & David A. Stainforth[2]

[1]*Hadley Centre for Climate Prediction and Research, Met Office, FitzRoy Road, Exeter EX1 3PB, UK*
[2]*Department of Physics, University of Oxford, Parks Road, Oxford OX1 3PU, UK*

Comprehensive global climate models[1] are the only tools that account for the complex set of processes which will determine future climate change at both a global and regional level. Planners are typically faced with a wide range of predicted changes from different models of unknown relative quality[2,3], owing to large but unquantified uncertainties in the modelling

Publishing Group NATURE | VOL 430 | 12 AUGUST 2004 | www.nature.com/nature

Ensembles and probabilities: a new era in the prediction of climate change

By Mat Collins*

Met Office, Hadley Centre, FitzRoy Road, Exeter EX1 3PB, UK

Phil. Trans. R. Soc. A (2007) **365**, 2053–2075
doi:10.1098/rsta.2007.2076
Published online 14 June 2007

Review

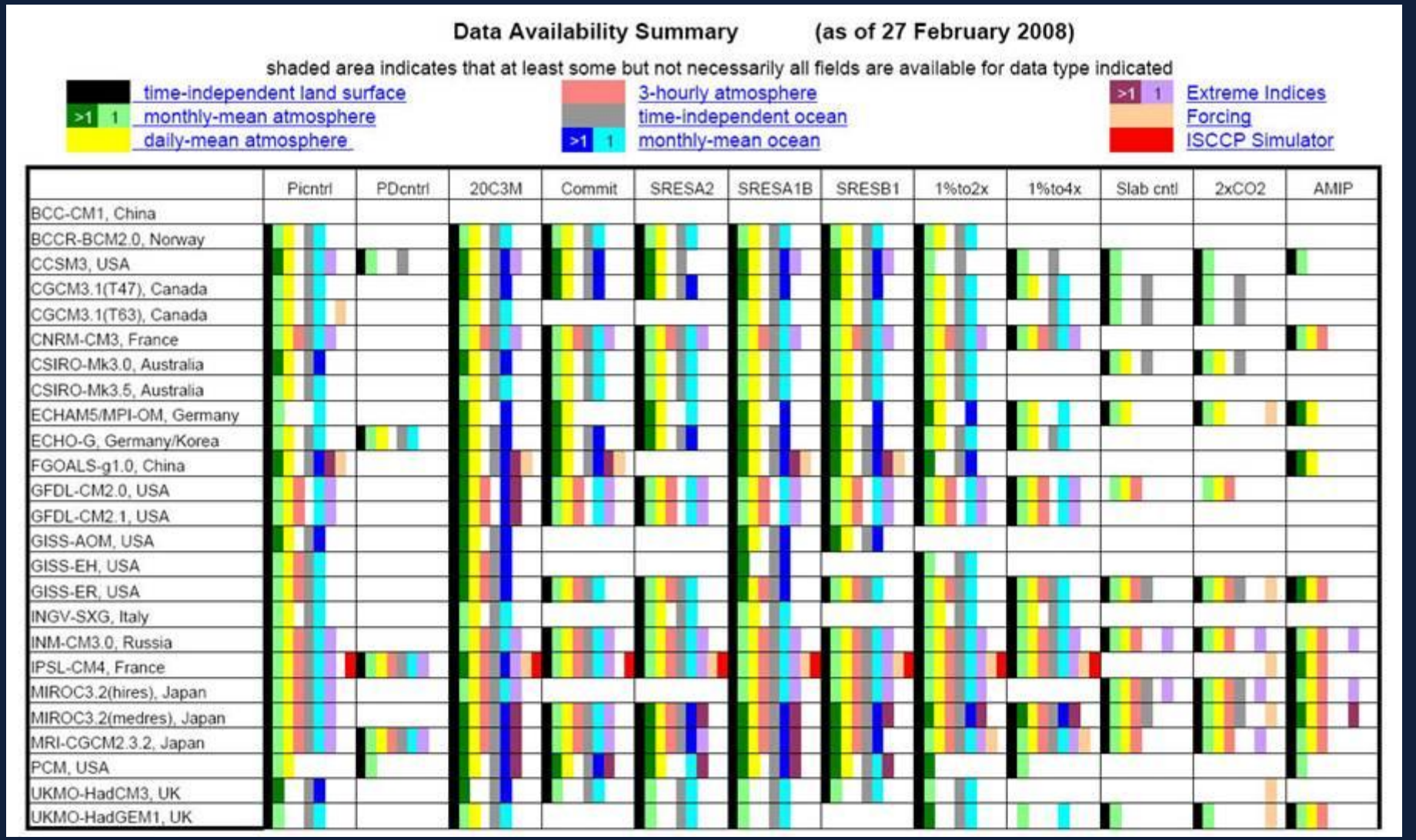
The use of the multi-model ensemble in probabilistic climate projections

By Claudia Tebaldi[1,*] and Reto Knutti[2]

[1]*Institute for the Study of Society and Environment, National Center for Atmospheric Research, PO Box 3000, Boulder, CO 80304, USA*
[2]*Institute for Atmospheric and Climate Science, Swiss Federal Institute of Technology, Universitätstrasse 16 (CHN N 12.1), 8092 Zürich, Switzerland*

World Climate Research Programme (WCRP)

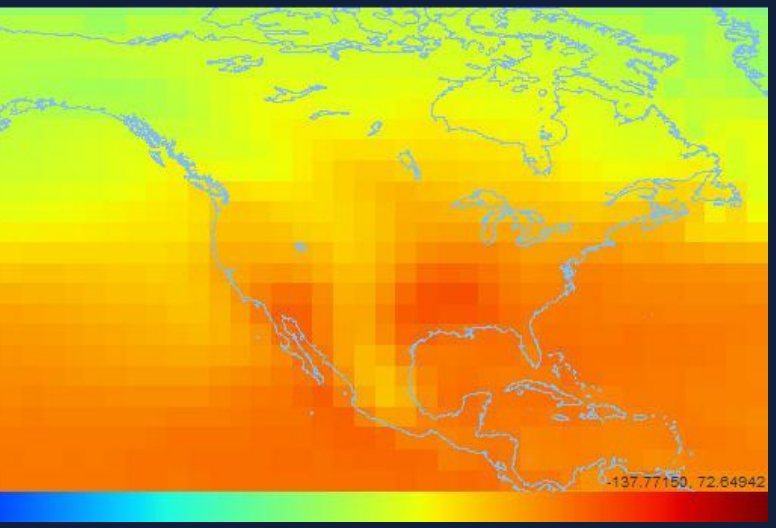
WCRP CMIP3 Multi-Model Dataset Archive at PCMDI



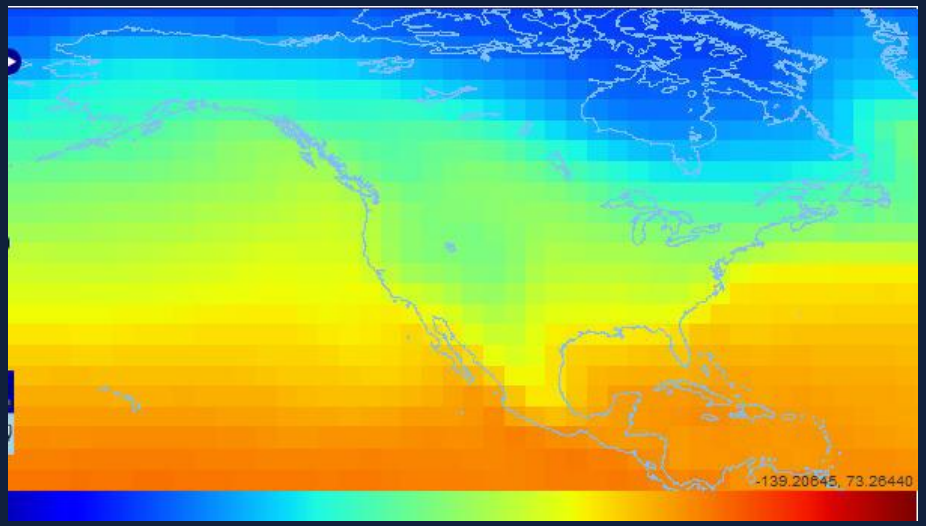
17 GCMs for two emissions scenarios (A2 & B1)

Simple downscaling for monthly Tave, precip

6 GCMs for monthly Tmax & Tmin



CCSM3 Tave July 2037 B1

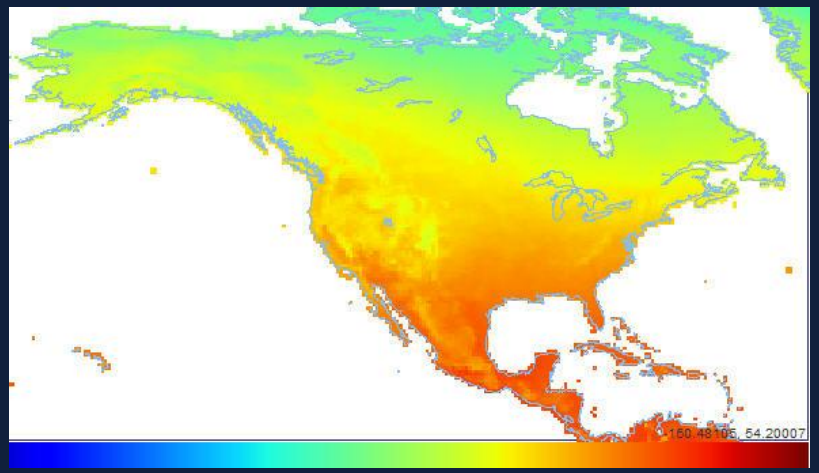


20th century re-analysis, Tave July observed

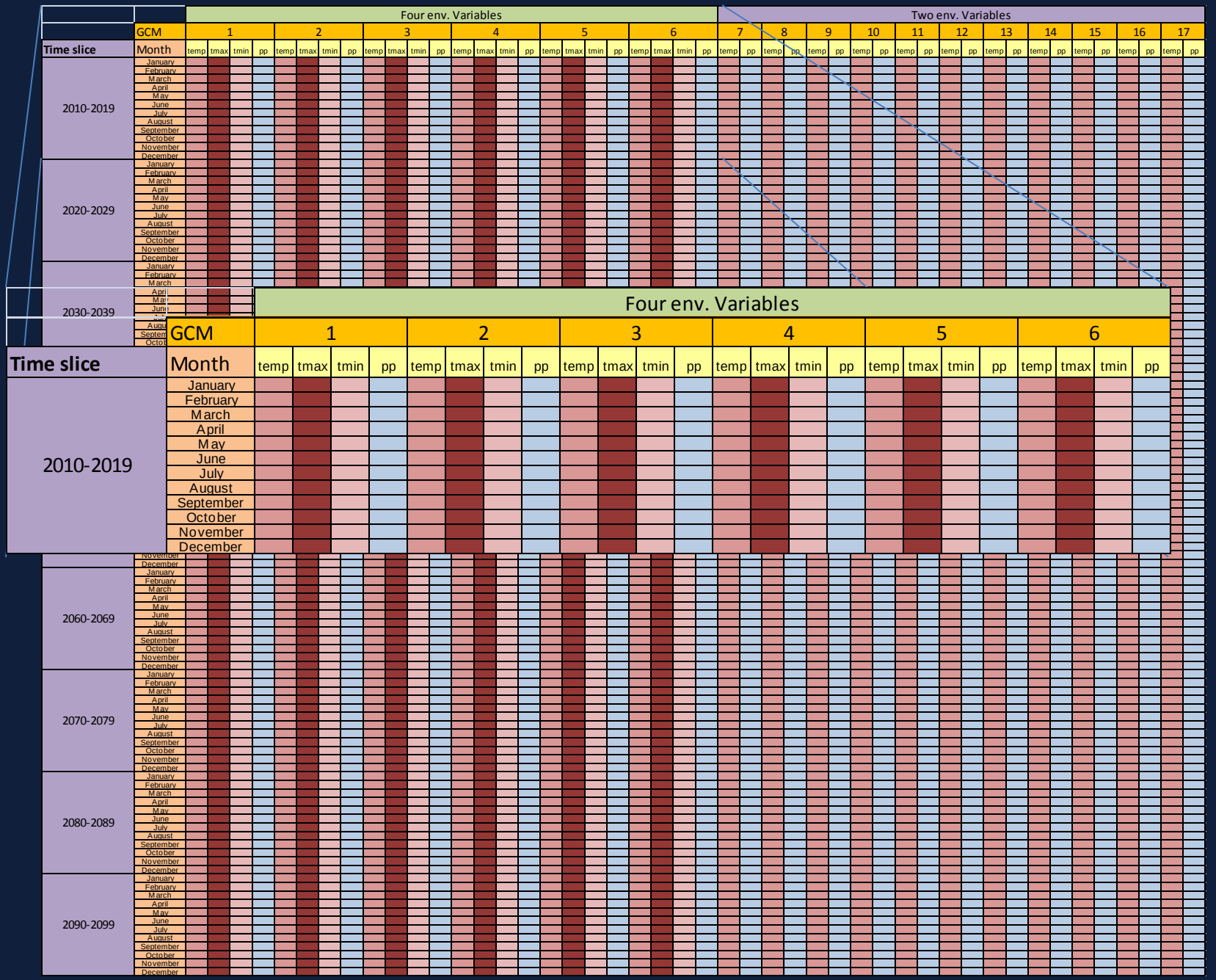
1.2	1.3	0.8
1.5	1.5	1.2

"Deltas"

Change factors



Interpolate deltas to 10km^2 spatial resolution for terrestrial Earth surface using Worldclim (Hijmans et al 2005) as a baseline climatology



Four env. Variables
GCM
1
2
3
4
5
6
Time slice
Month
temp
tmax
tmin
pp
2010-2019
January
February
March
April
May
June
July
August
September
October
November
December

9936 *future climate surfaces*

* 2 Scenarios, A2 & B1

Cal Academy Ecological Forecasting group

Miguel Fernandez, Guillermo Duran: GIS, species distribution modeling, programming

Lindsay Irving: Visualization and outreach

Stephanie Auer: Data coordination and data cartography

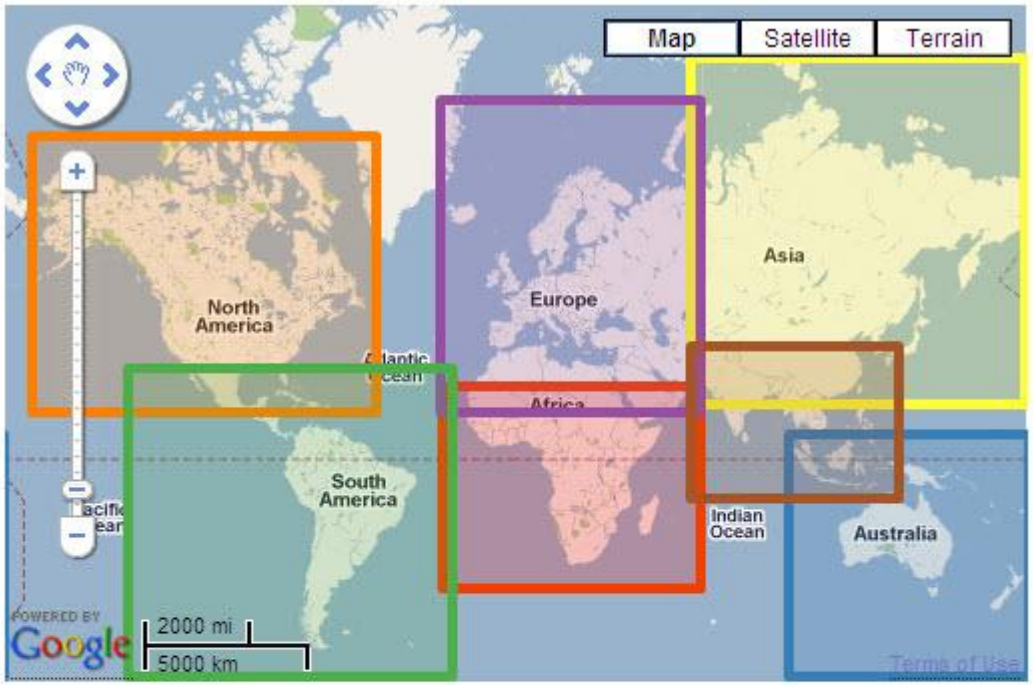
Past and Present Collaborators:

Phil Duffy: Lawrence Livermore Natl Lab and Climate Central

Qinghua Guo: UC Merced Dept of Engineering

EcoClim.org

Spatial climate data for ecological forecasting



DATA DOWNLOAD

Region: North America | Scenario: A2

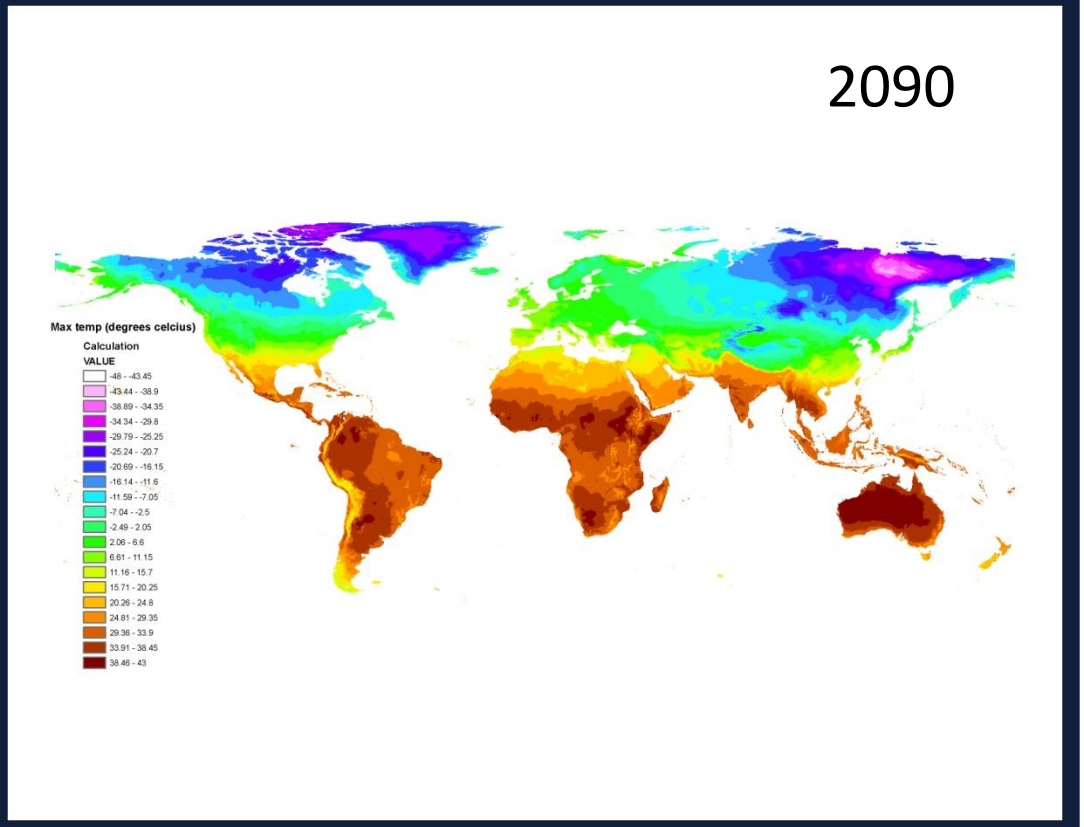
GCM: bccr_bcm2_0 | Year: 2010's

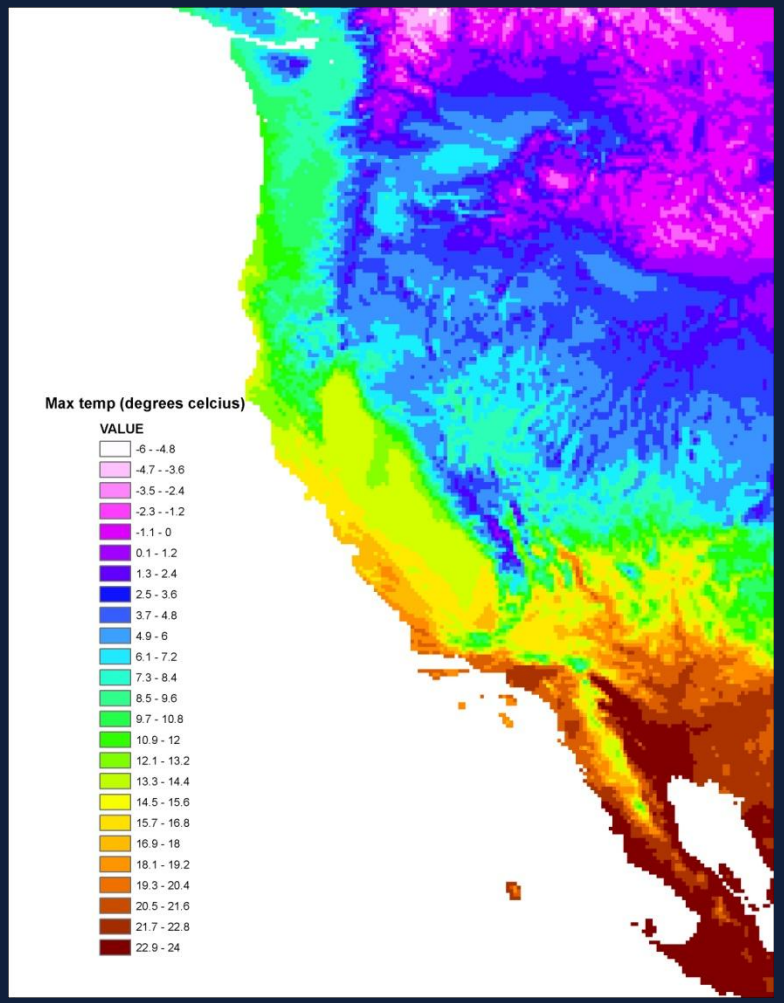
Variable: All Variable

Submit

Decadal variation

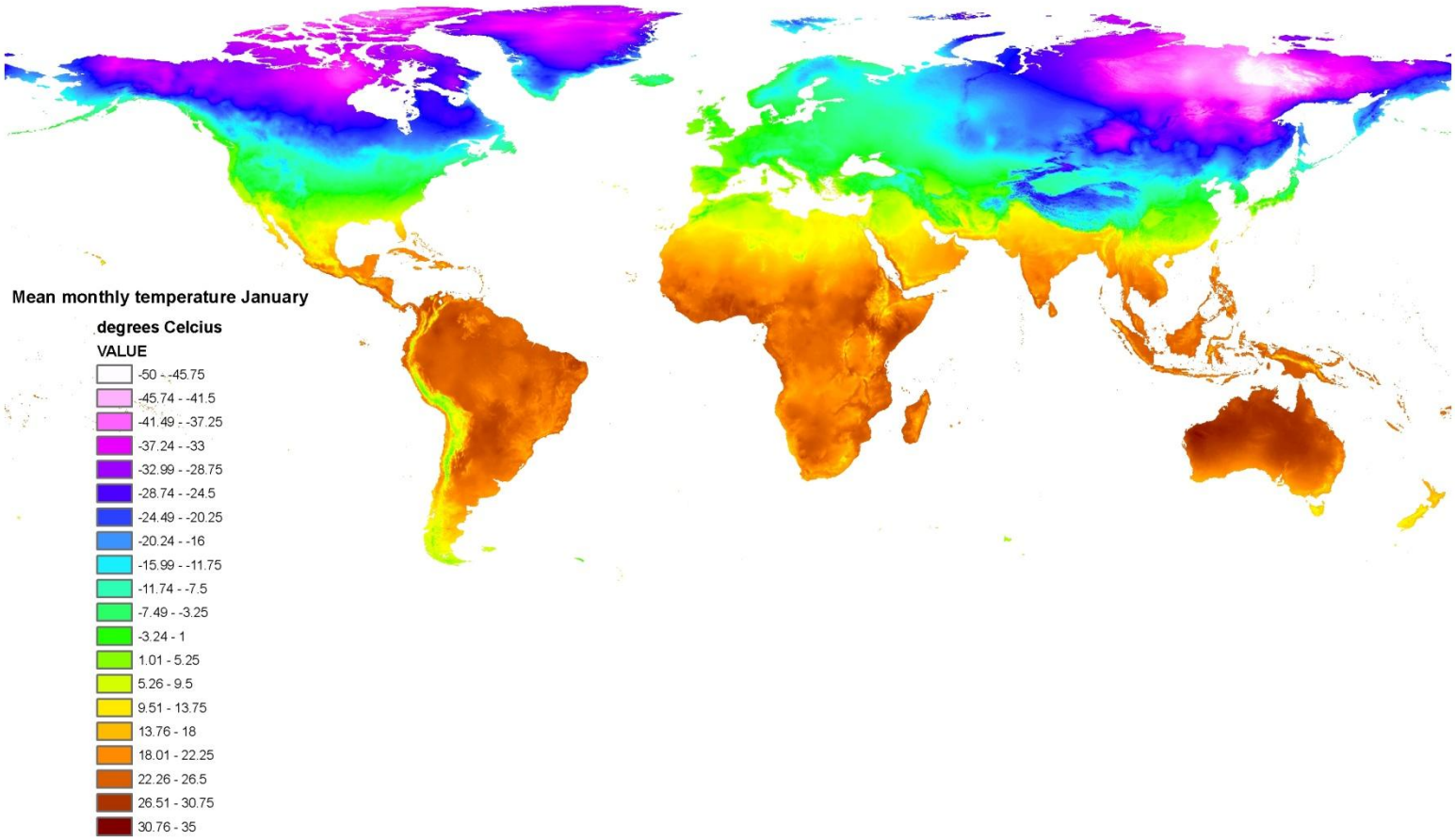
bccr_bcm2_0 JANUARY



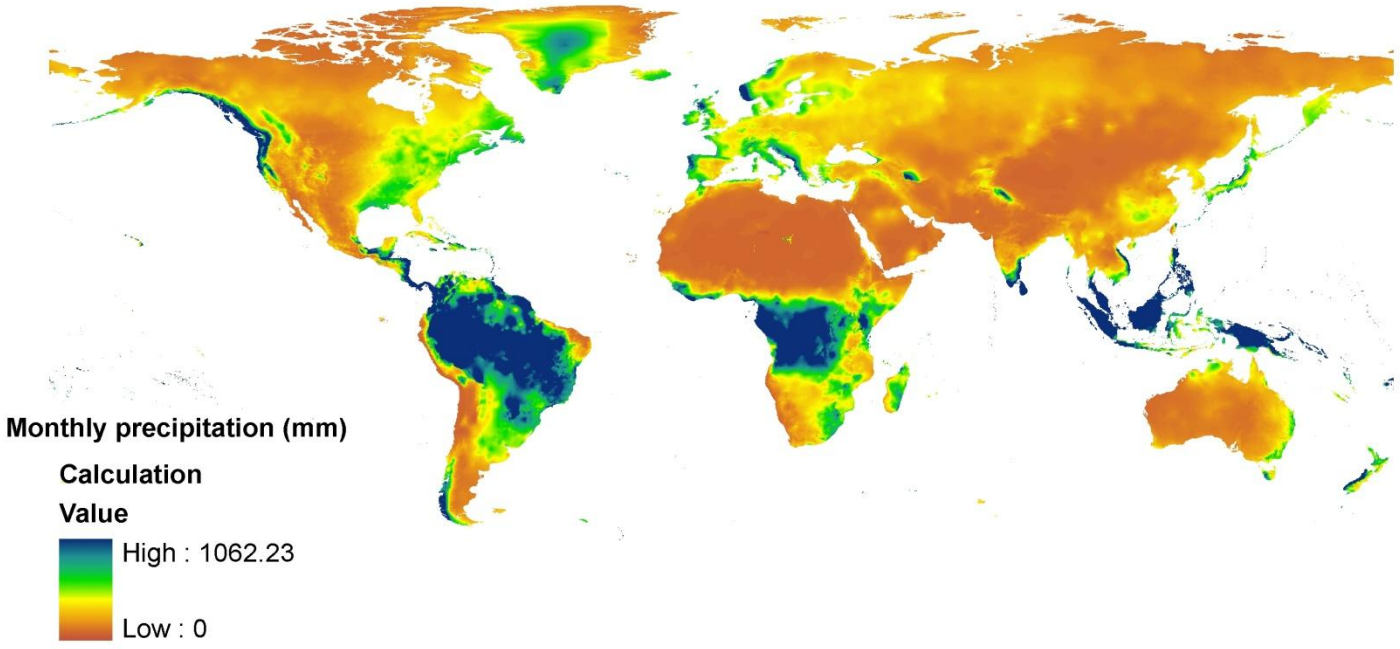


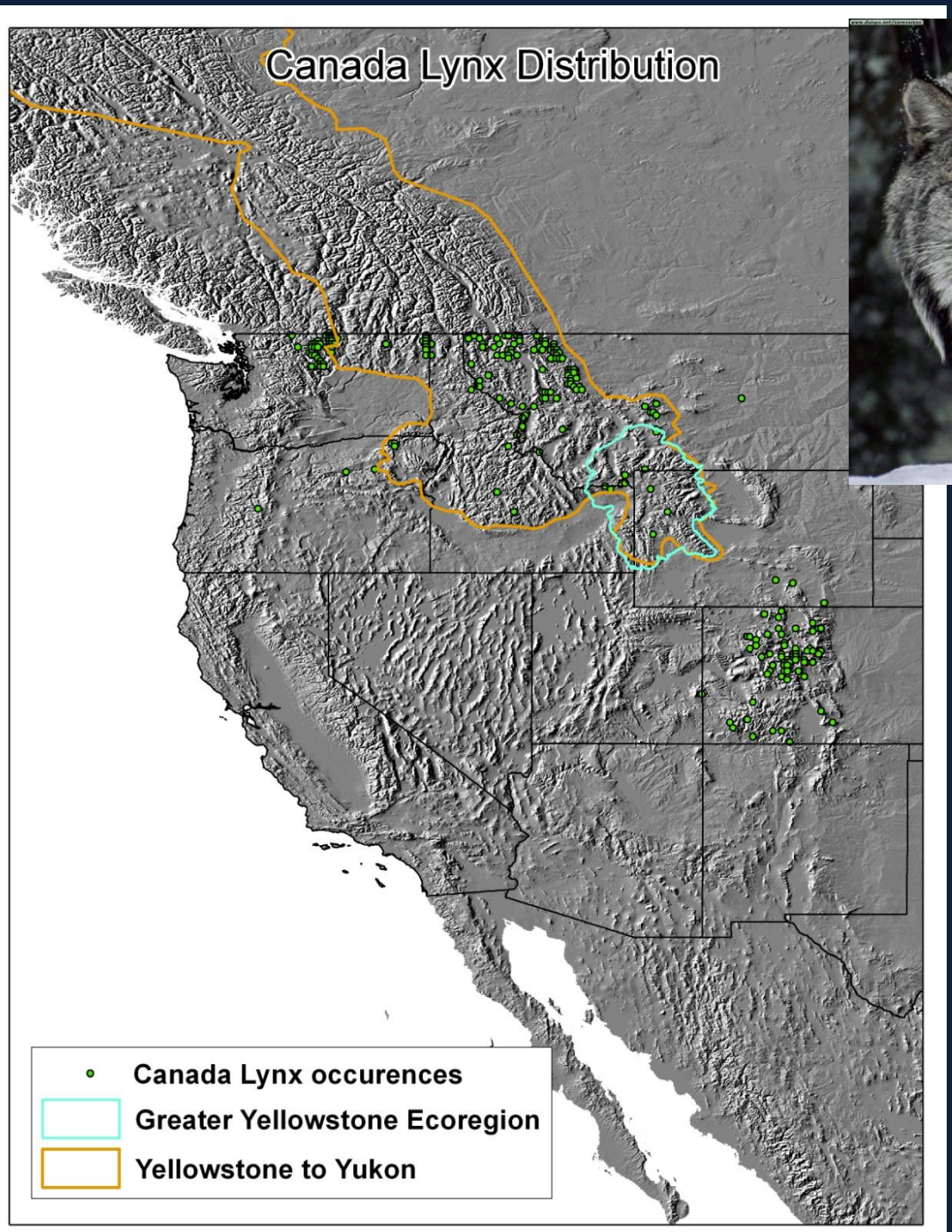
GCM variation

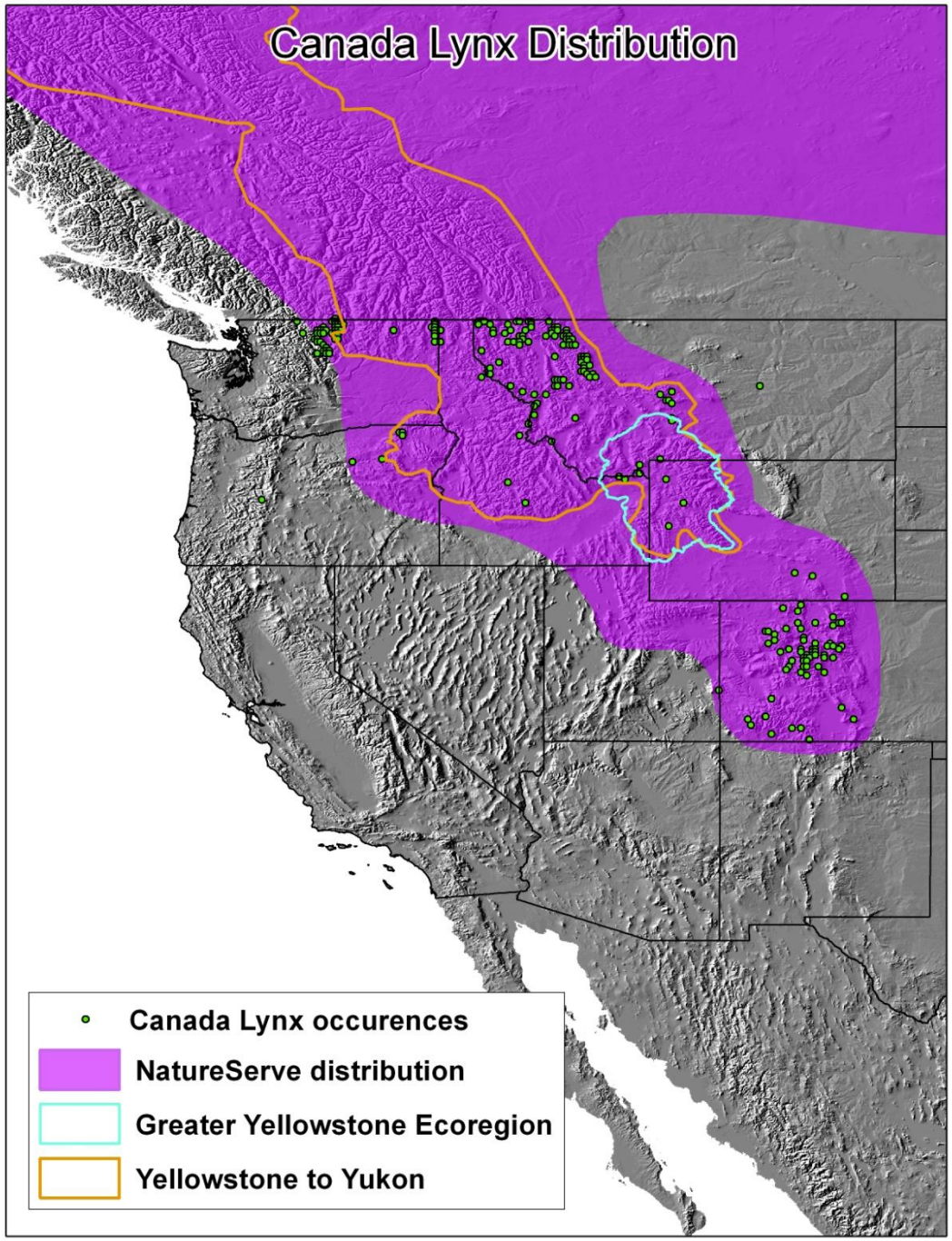
ukmo_hadcm3

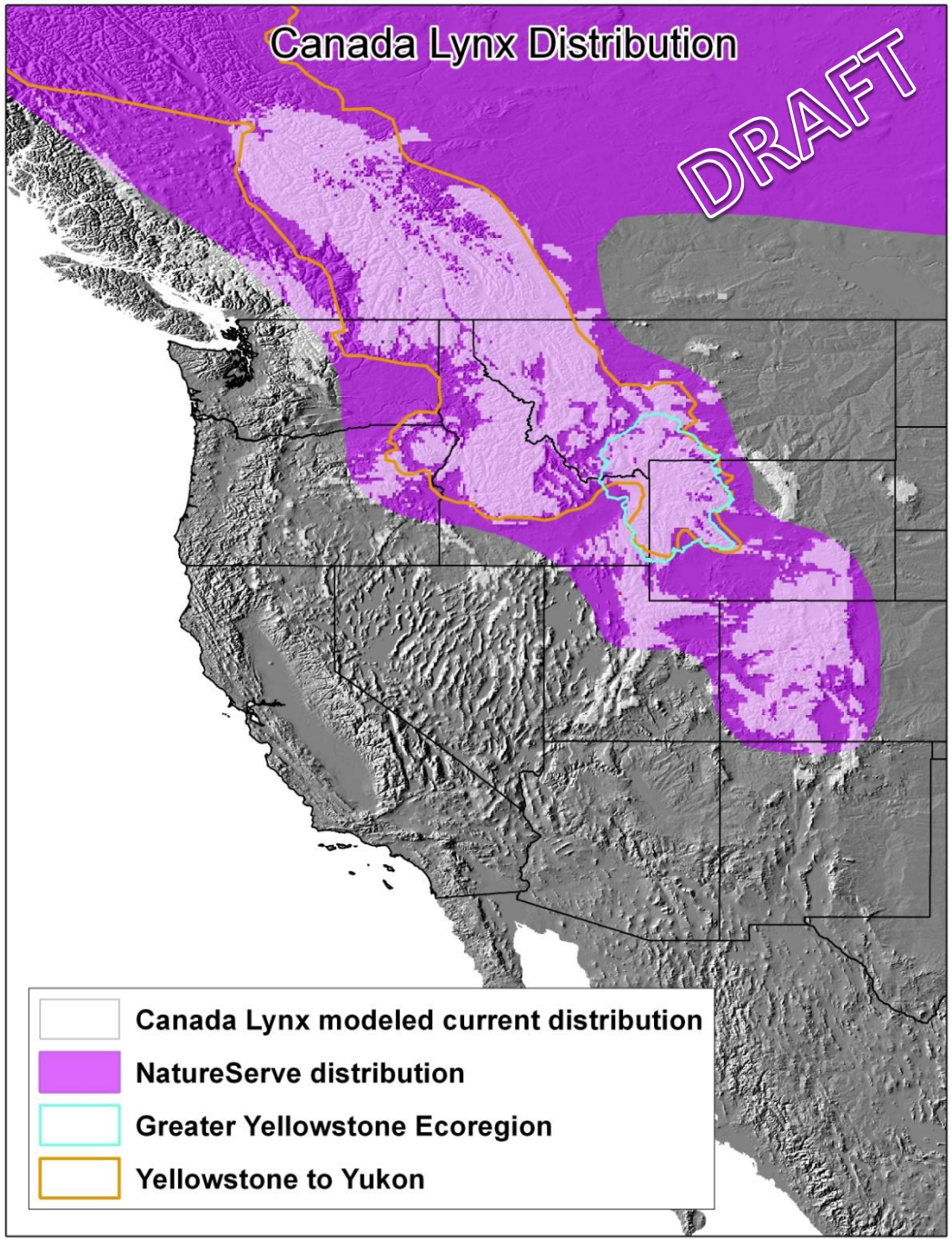


Monthly variation

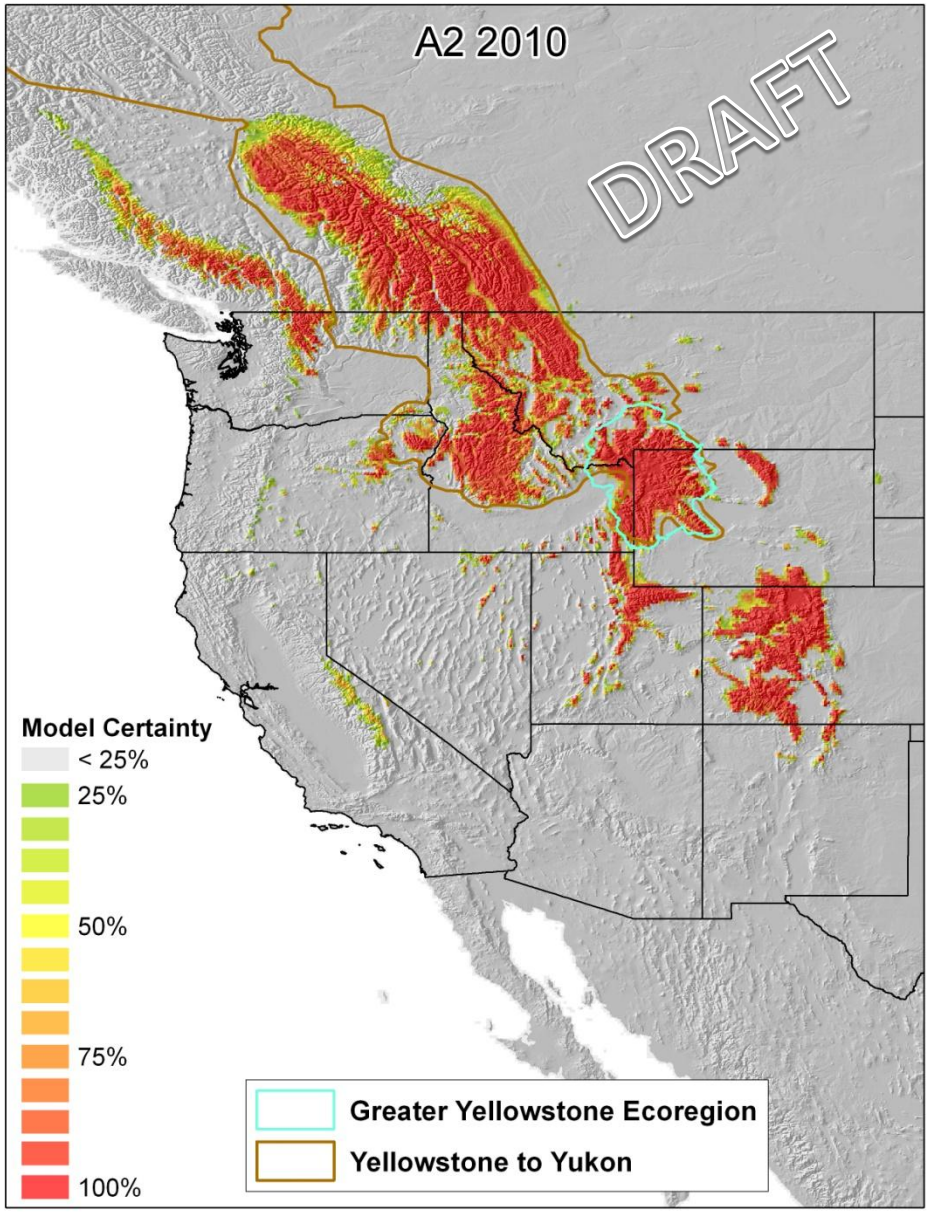


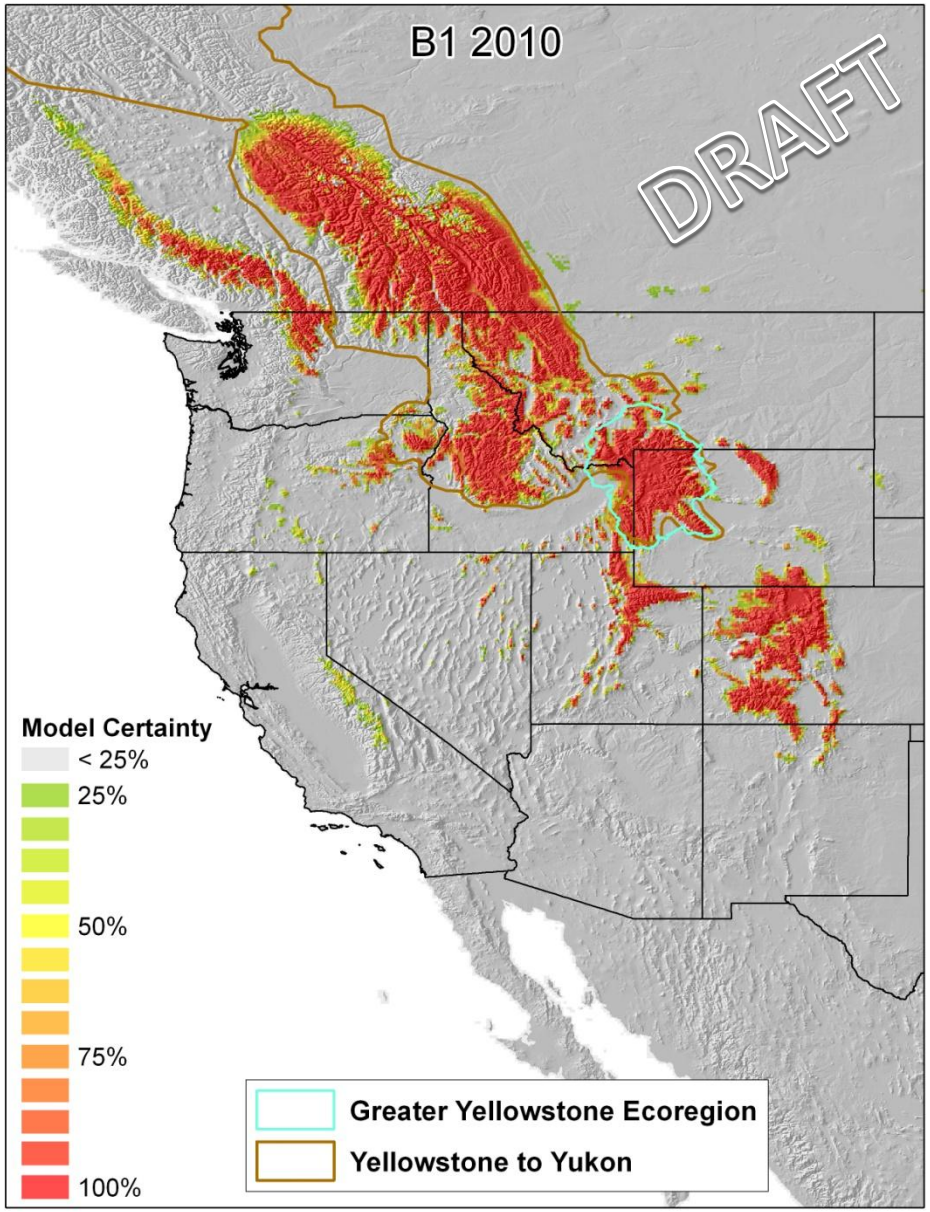

Canada Lynx Distribution
Canada Lynx occurences
Greater Yellowstone Ecoregion
Yellowstone to Yukon


Canada Lynx Distribution
Canada Lynx occurences
NatureServe distribution
Greater Yellowstone Ecoregion
Yellowstone to Yukon

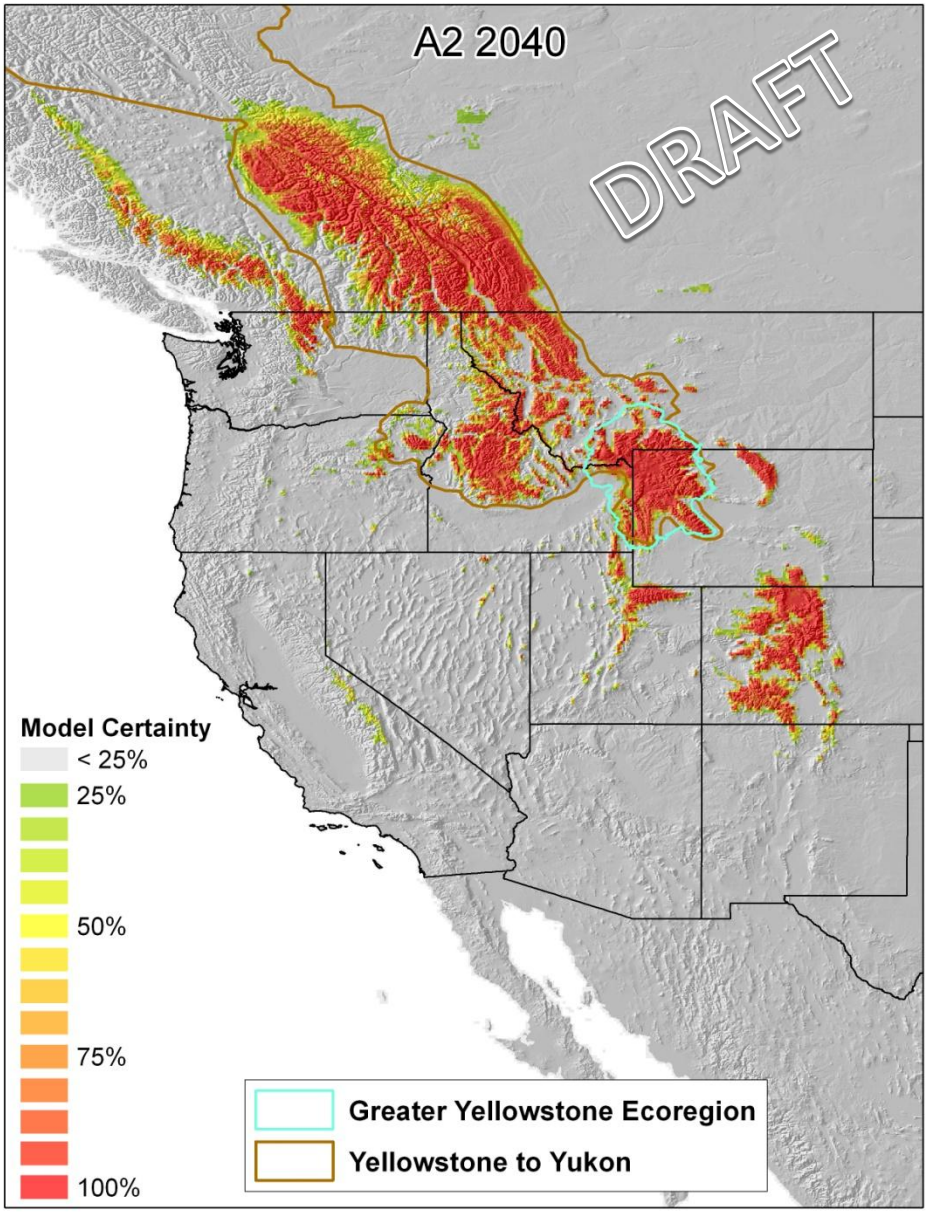

Canada Lynx Distribution
DRAFT
Canada Lynx modeled current distribution
NatureServe distribution
Greater Yellowstone Ecoregion
Yellowstone to Yukon

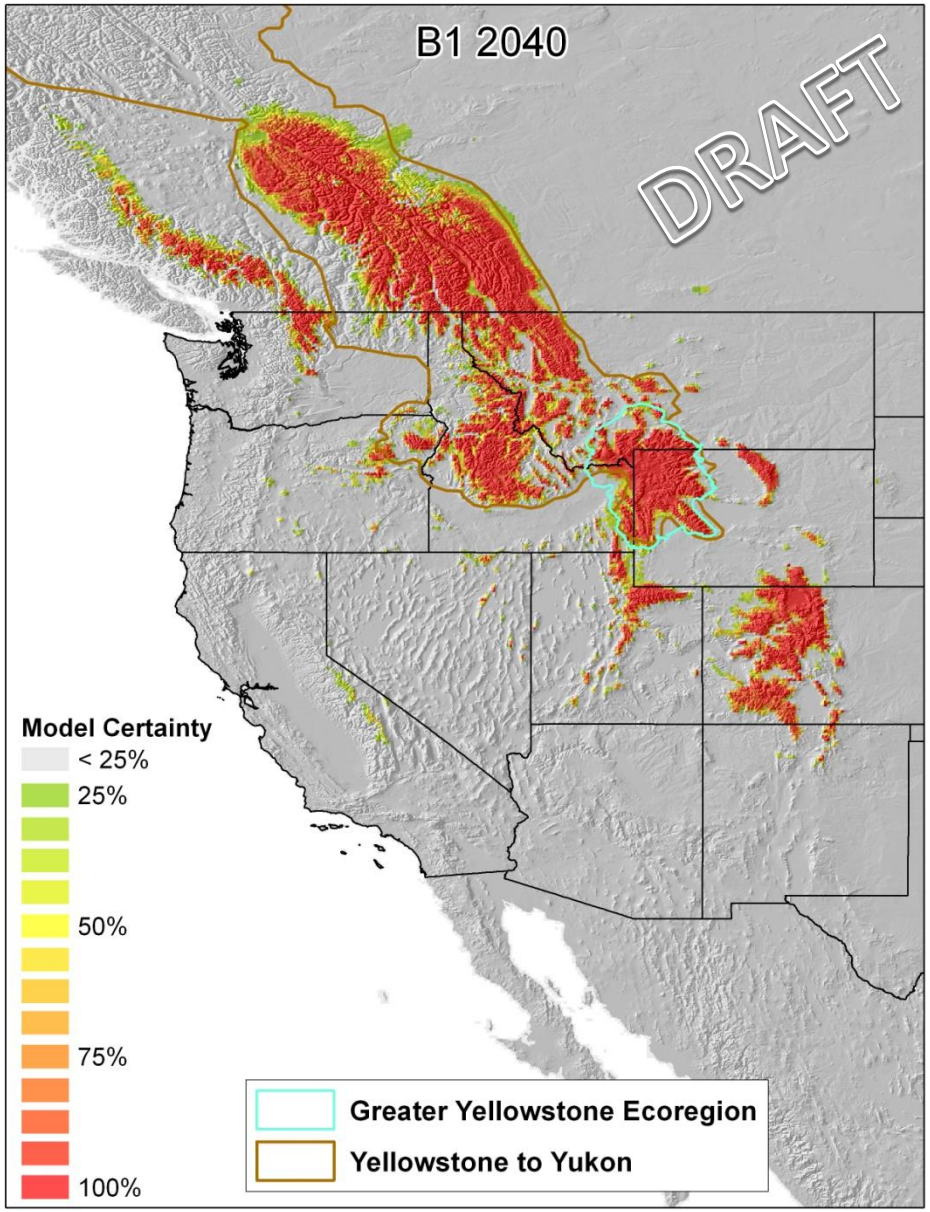
Canada Lynx Future Modeled Distributions



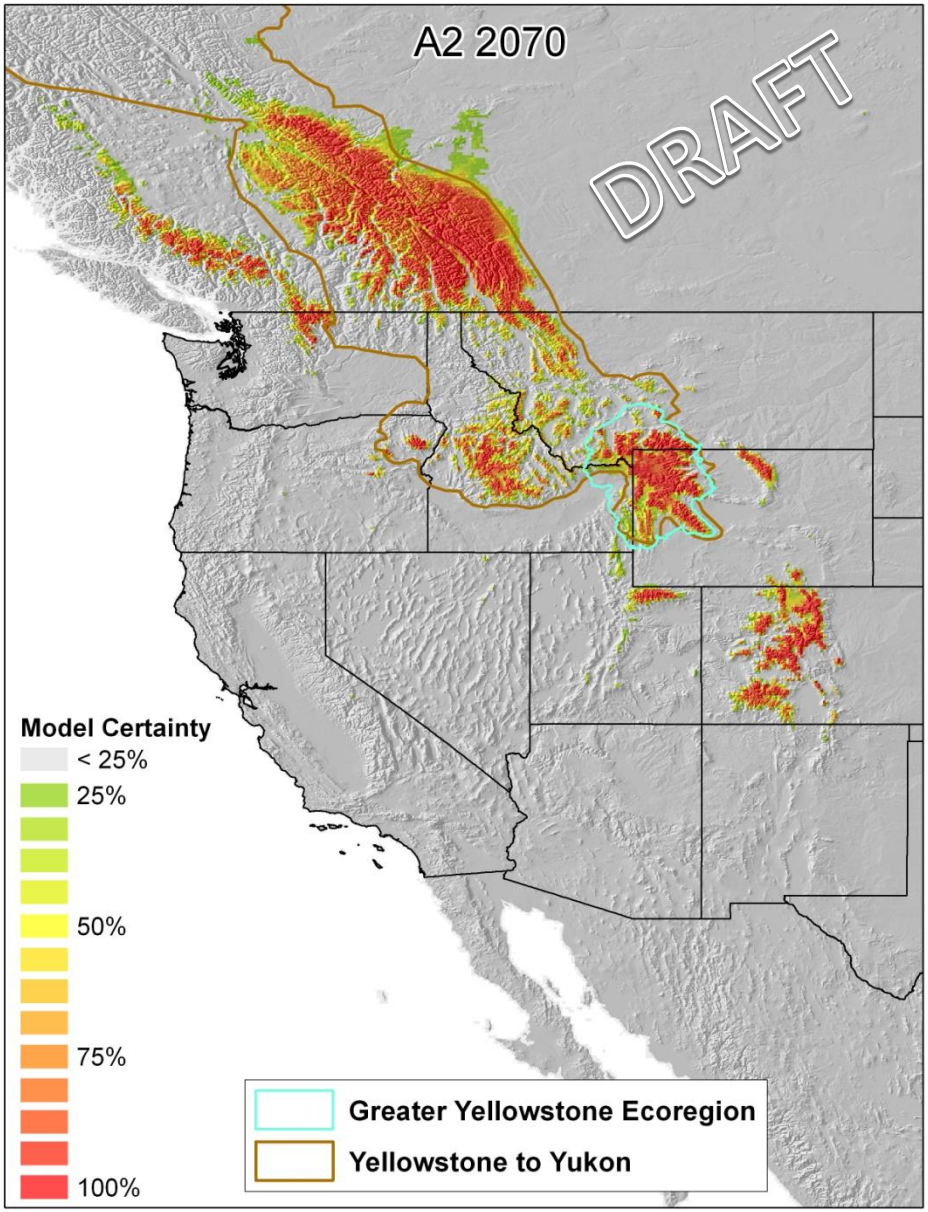


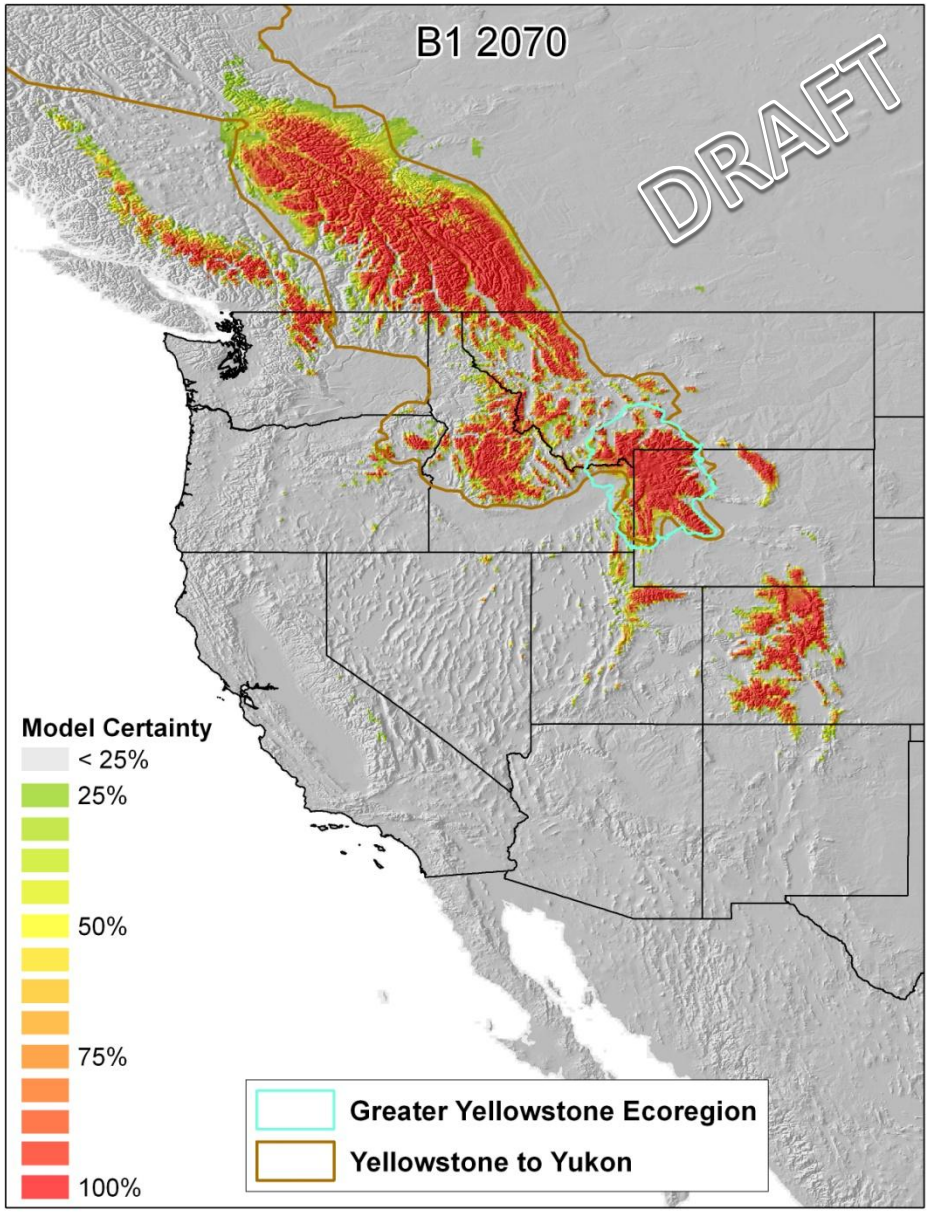
Canada Lynx Future Modeled Distributions



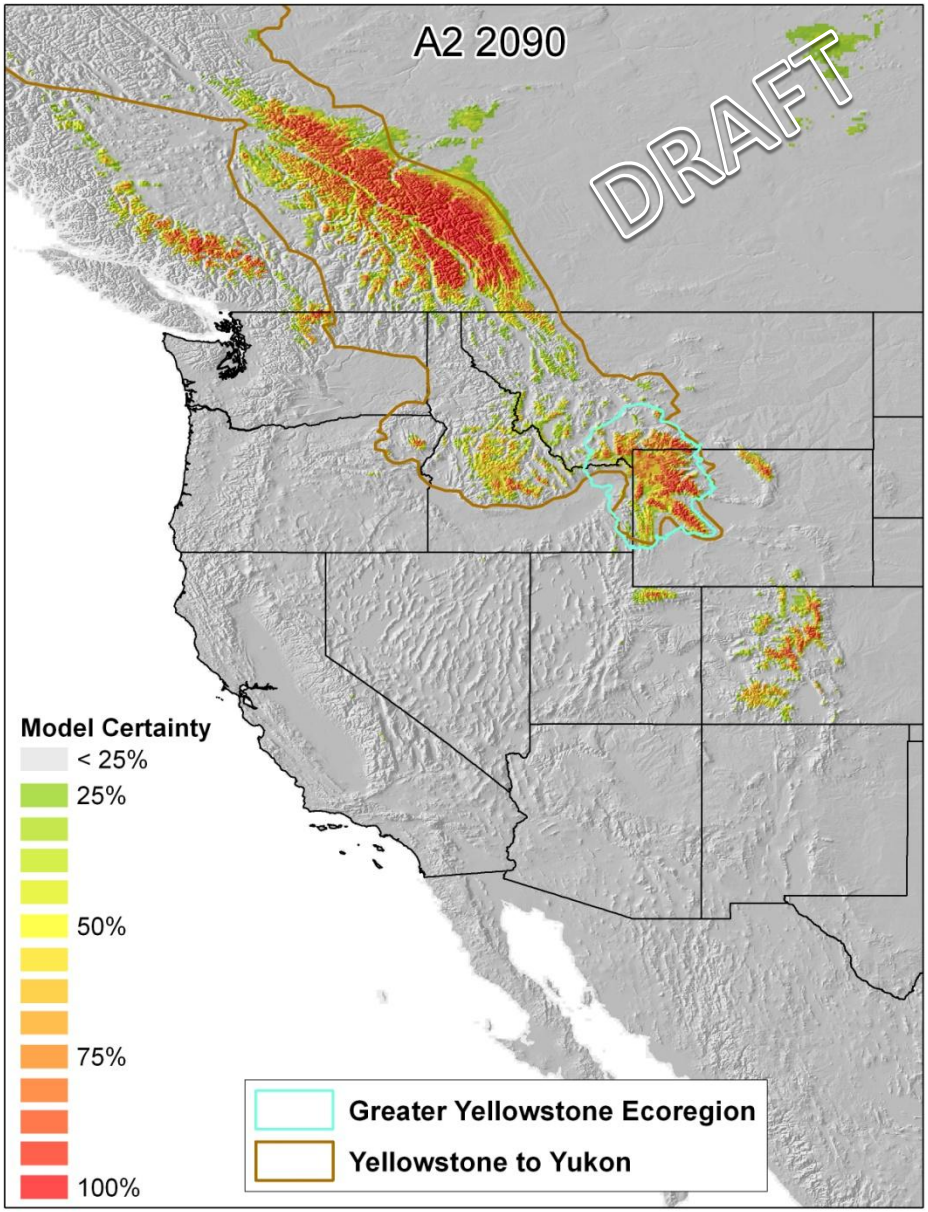


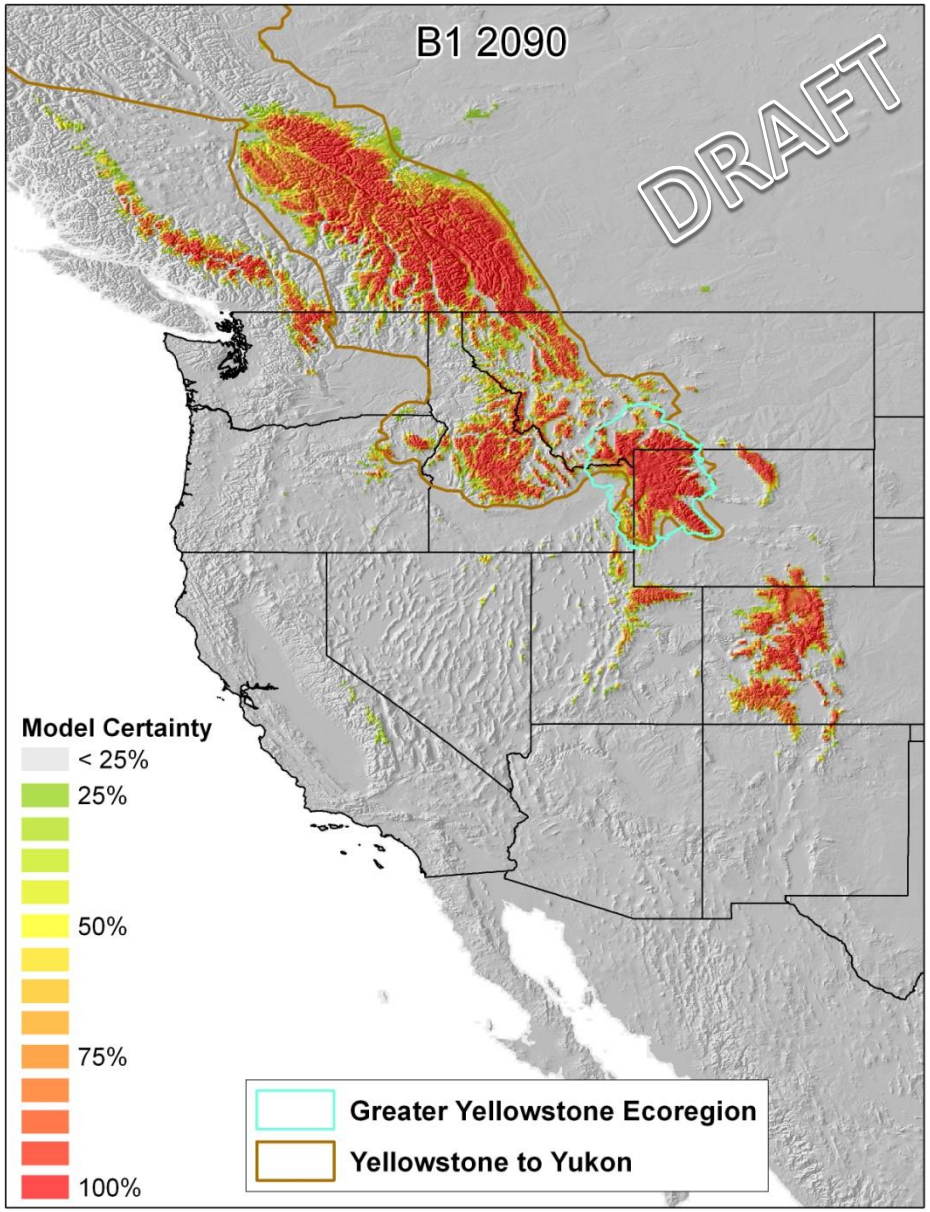
Canada Lynx Future Modeled Distributions





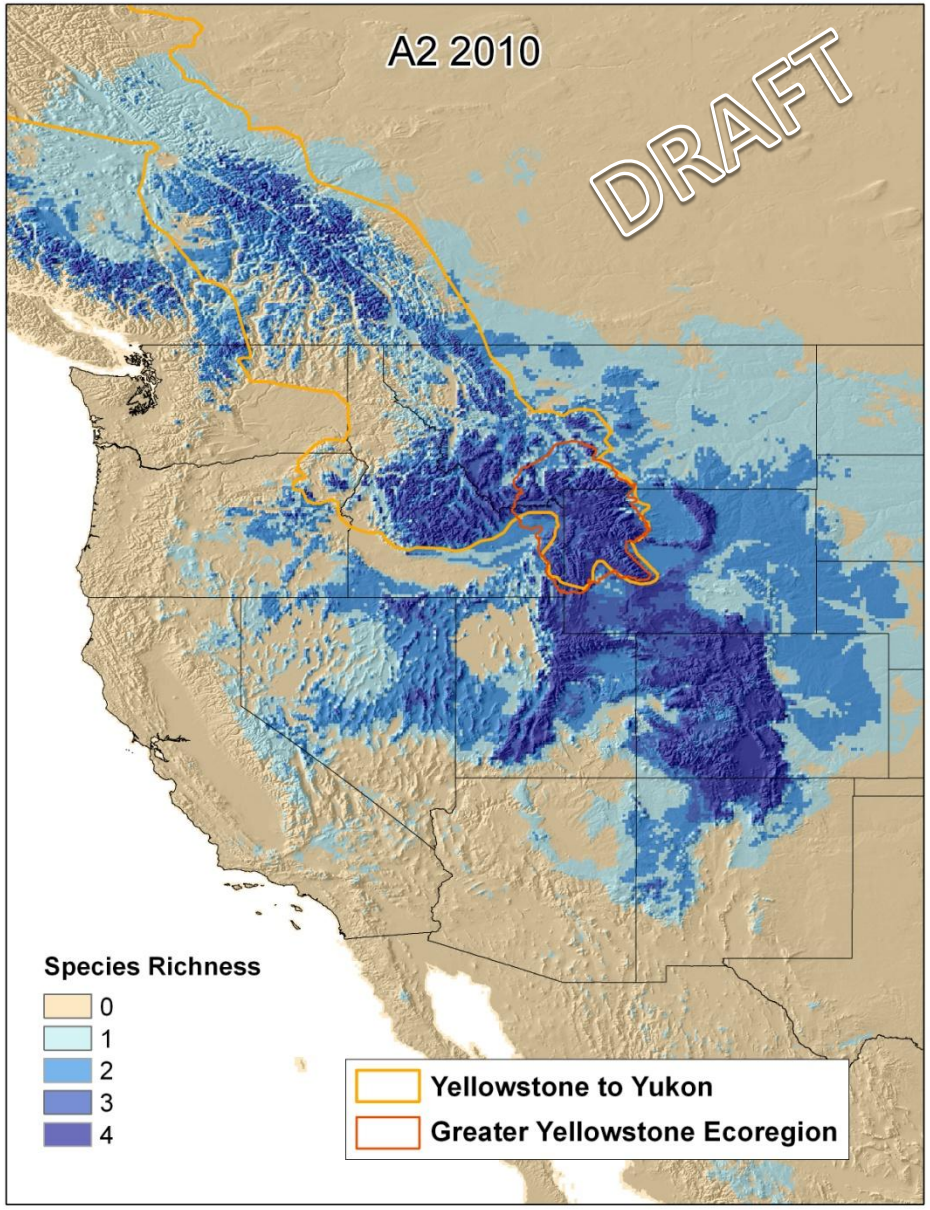
Canada Lynx Future Modeled Distributions

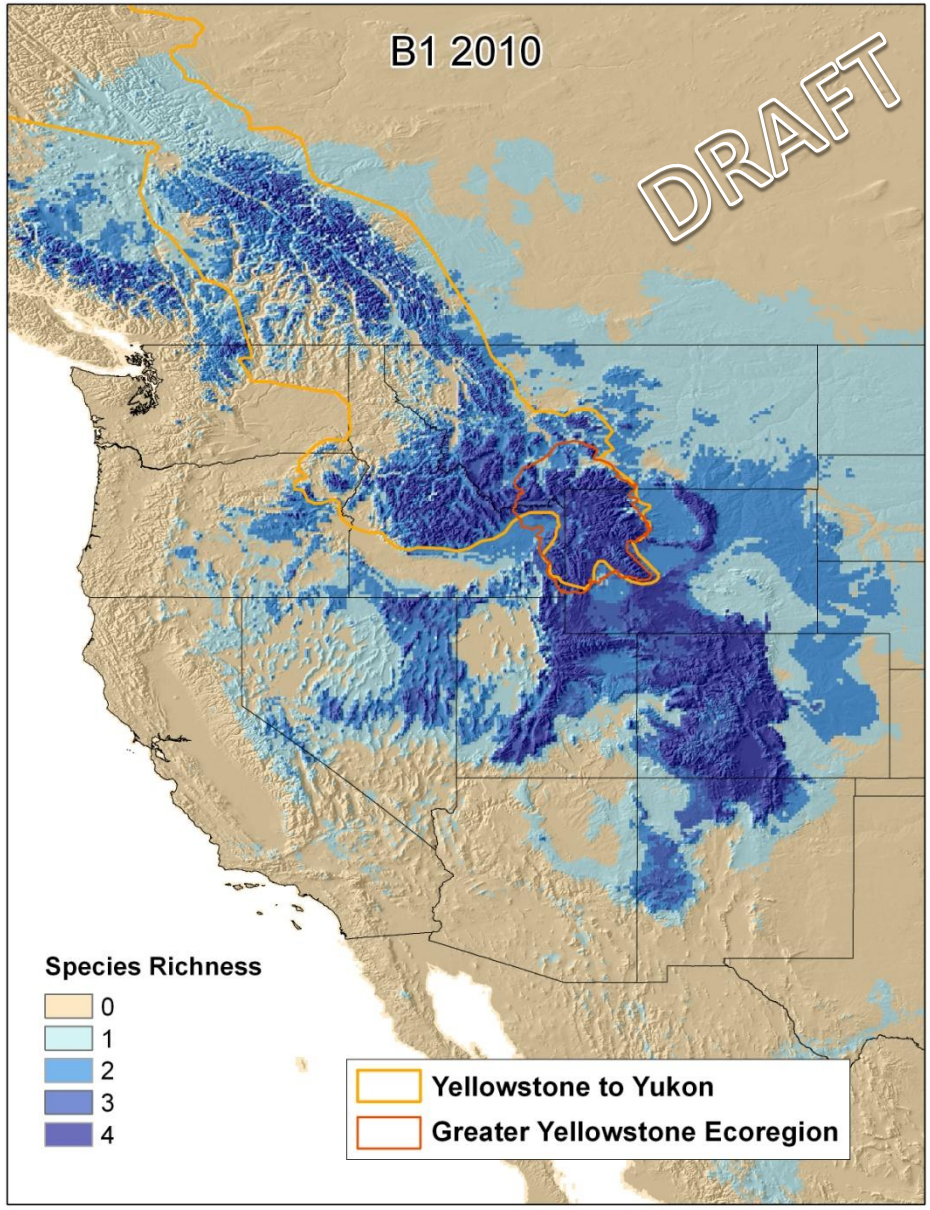




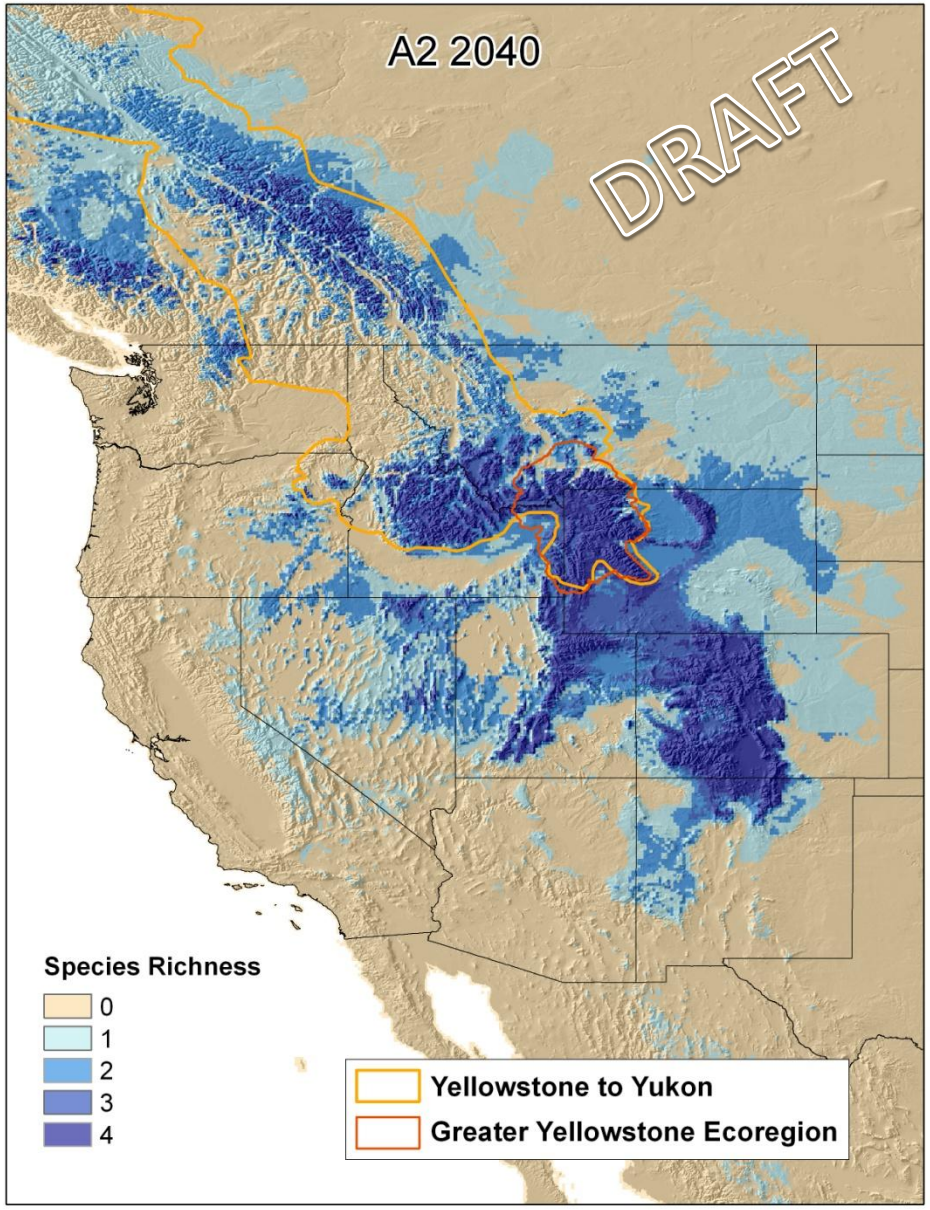

© Richard Mousel / CritterZone.com

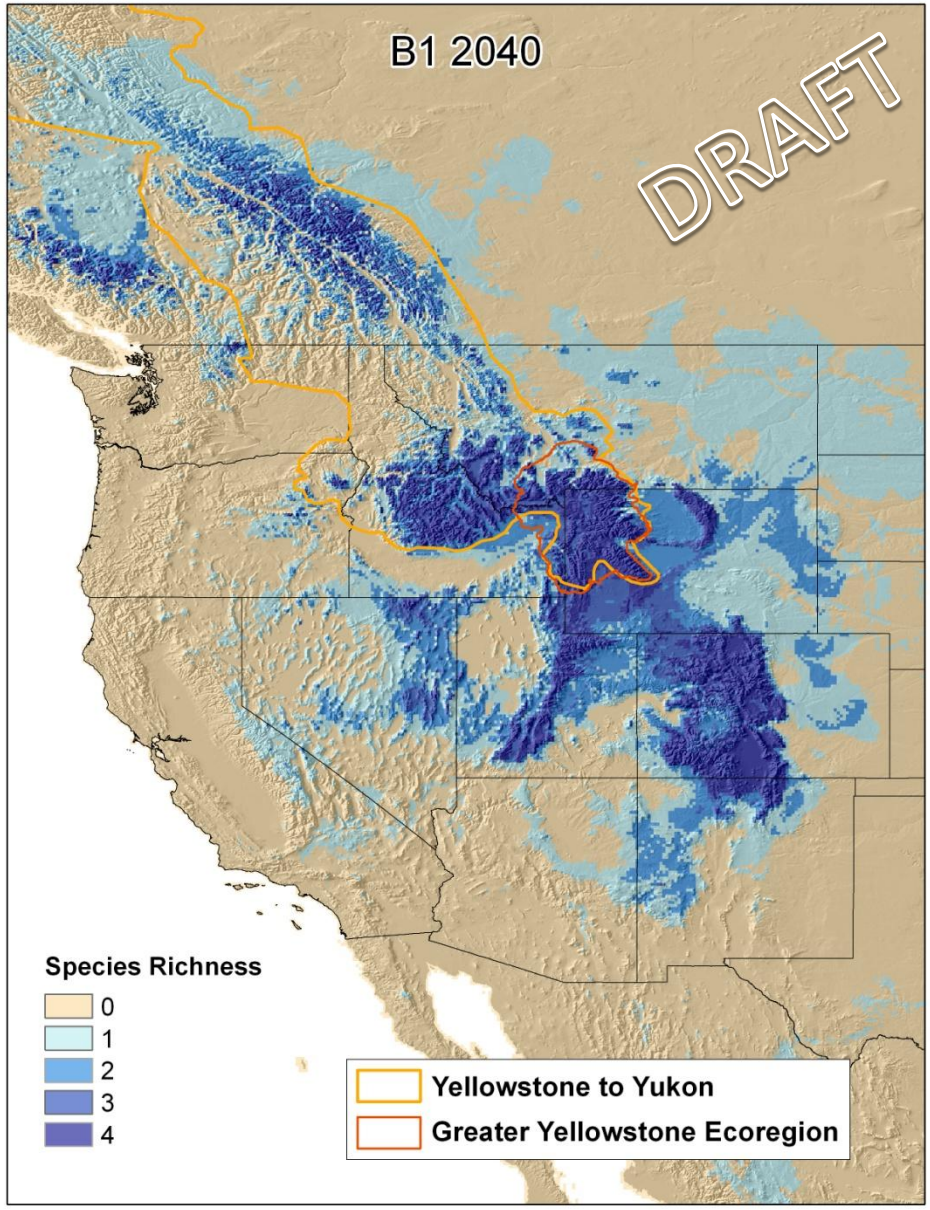
Modeled Winter Ranges:
Bighorn Sheep, Mule Deer, Elk, and Moose



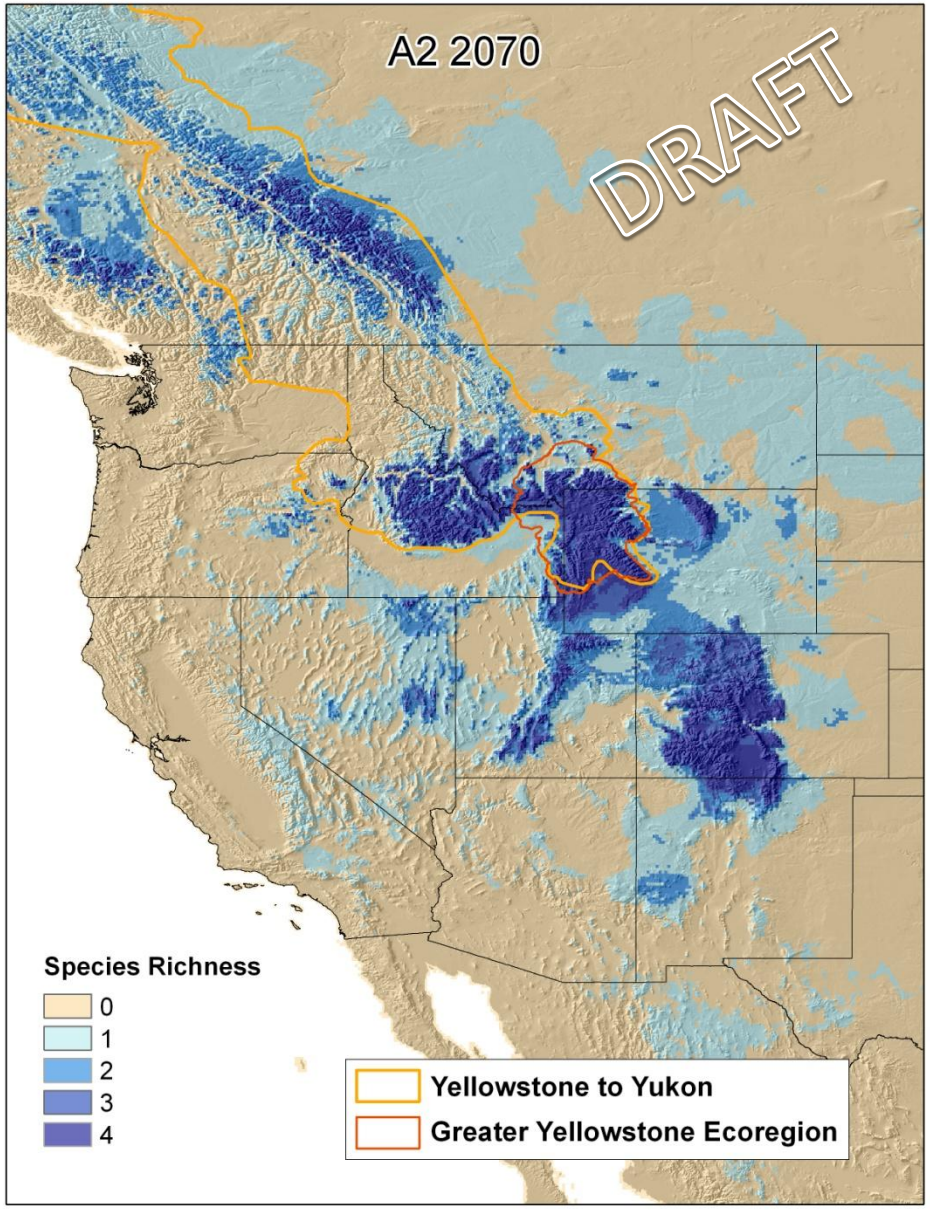


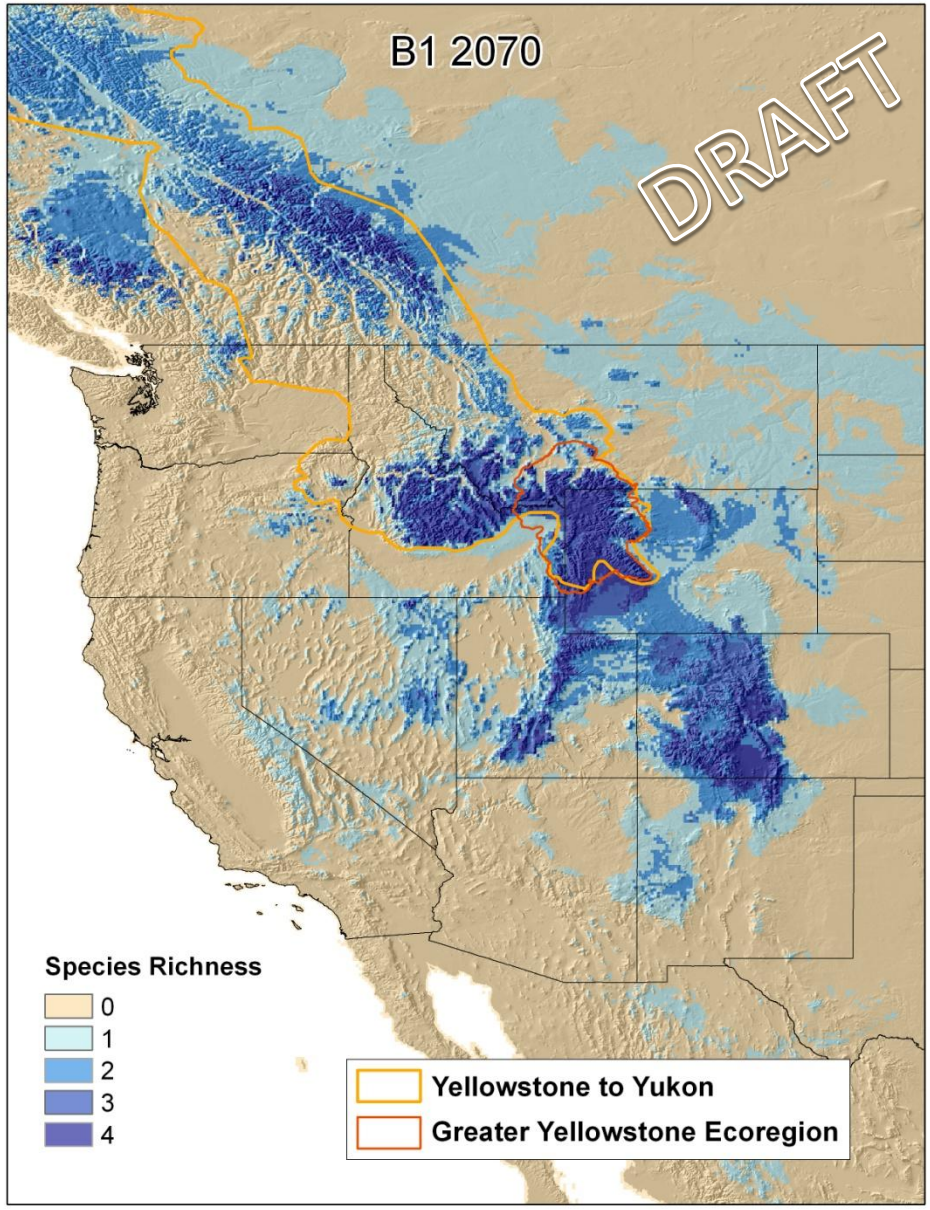
Modeled Winter Ranges:
Bighorn Sheep, Mule Deer, Elk, and Moose



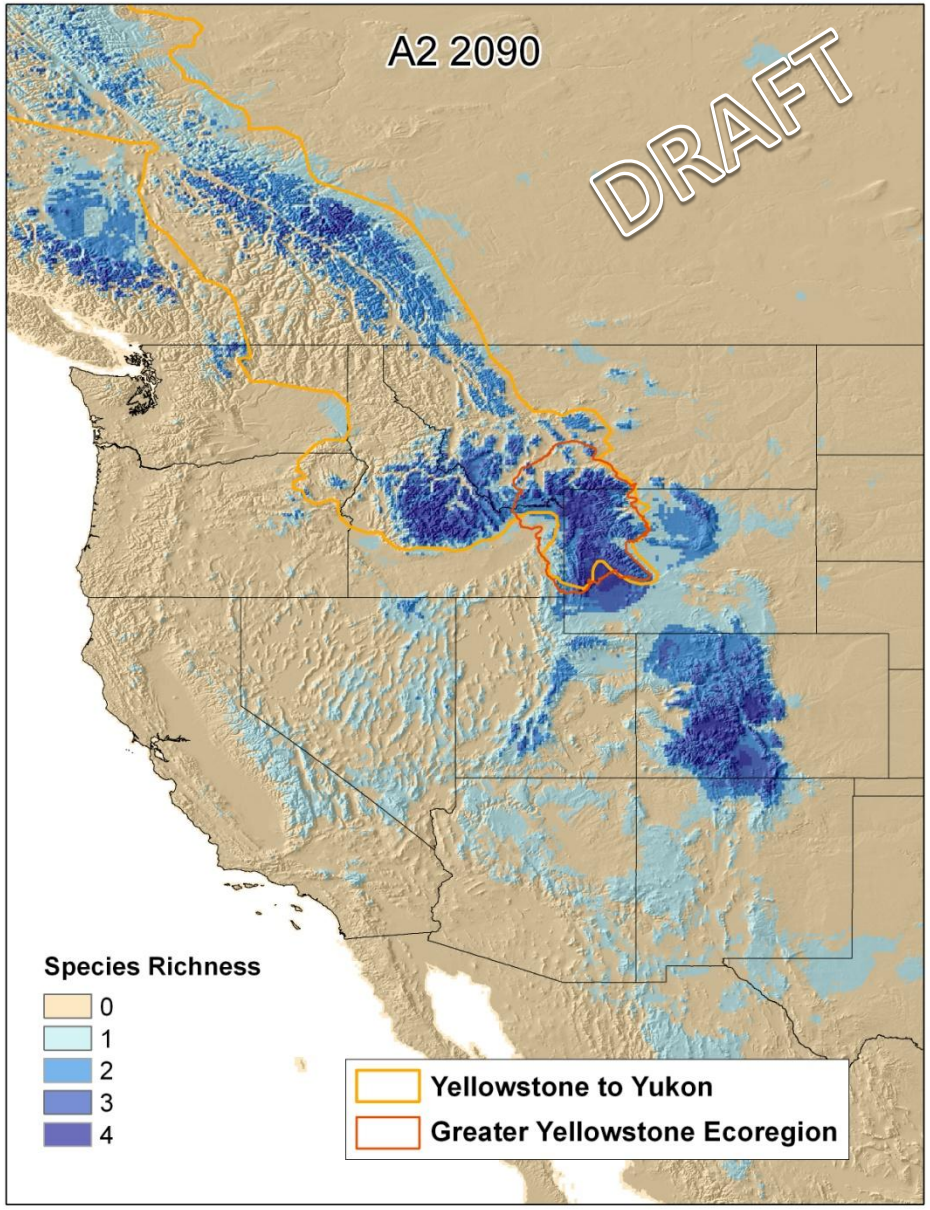


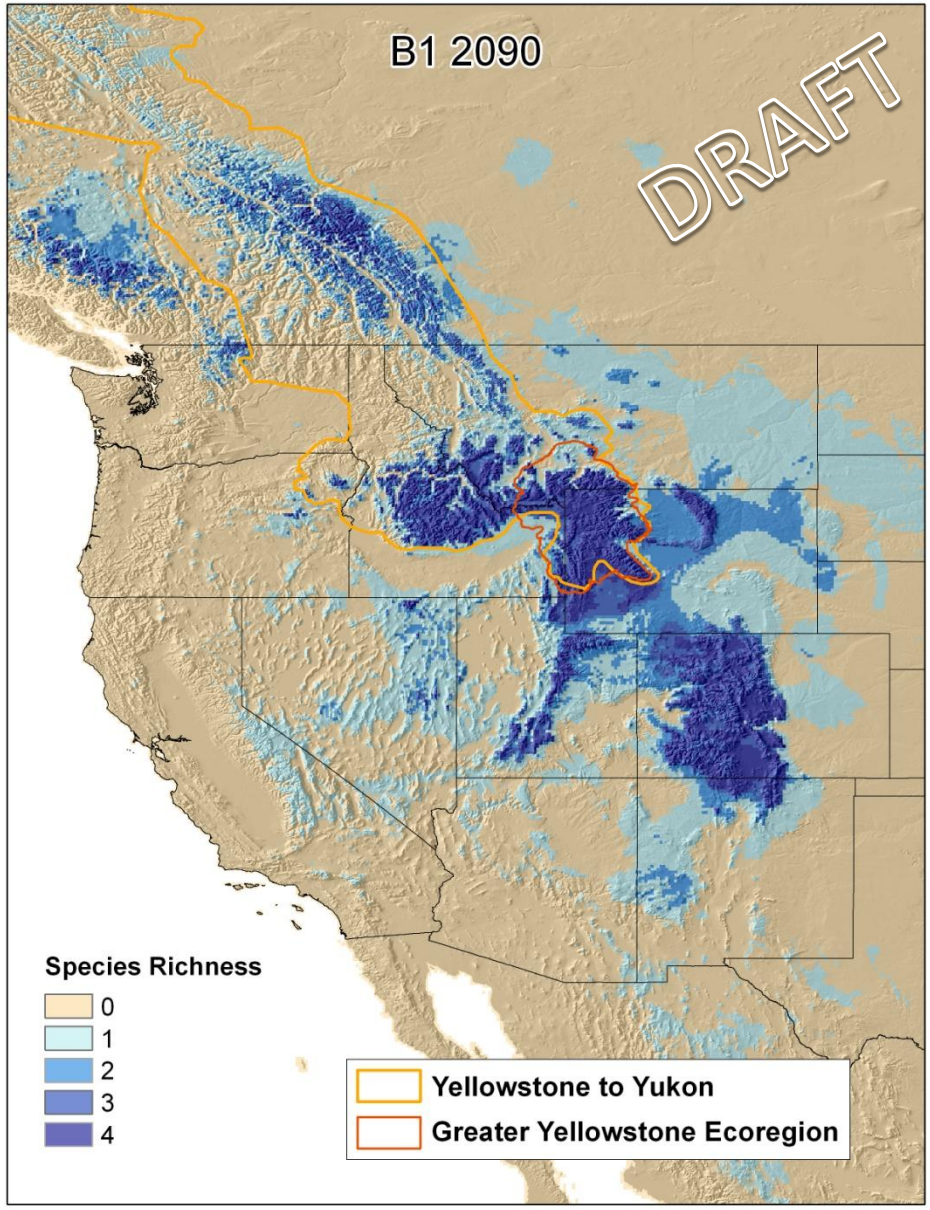
Modeled Winter Ranges:
Bighorn Sheep, Mule Deer, Elk, and Moose

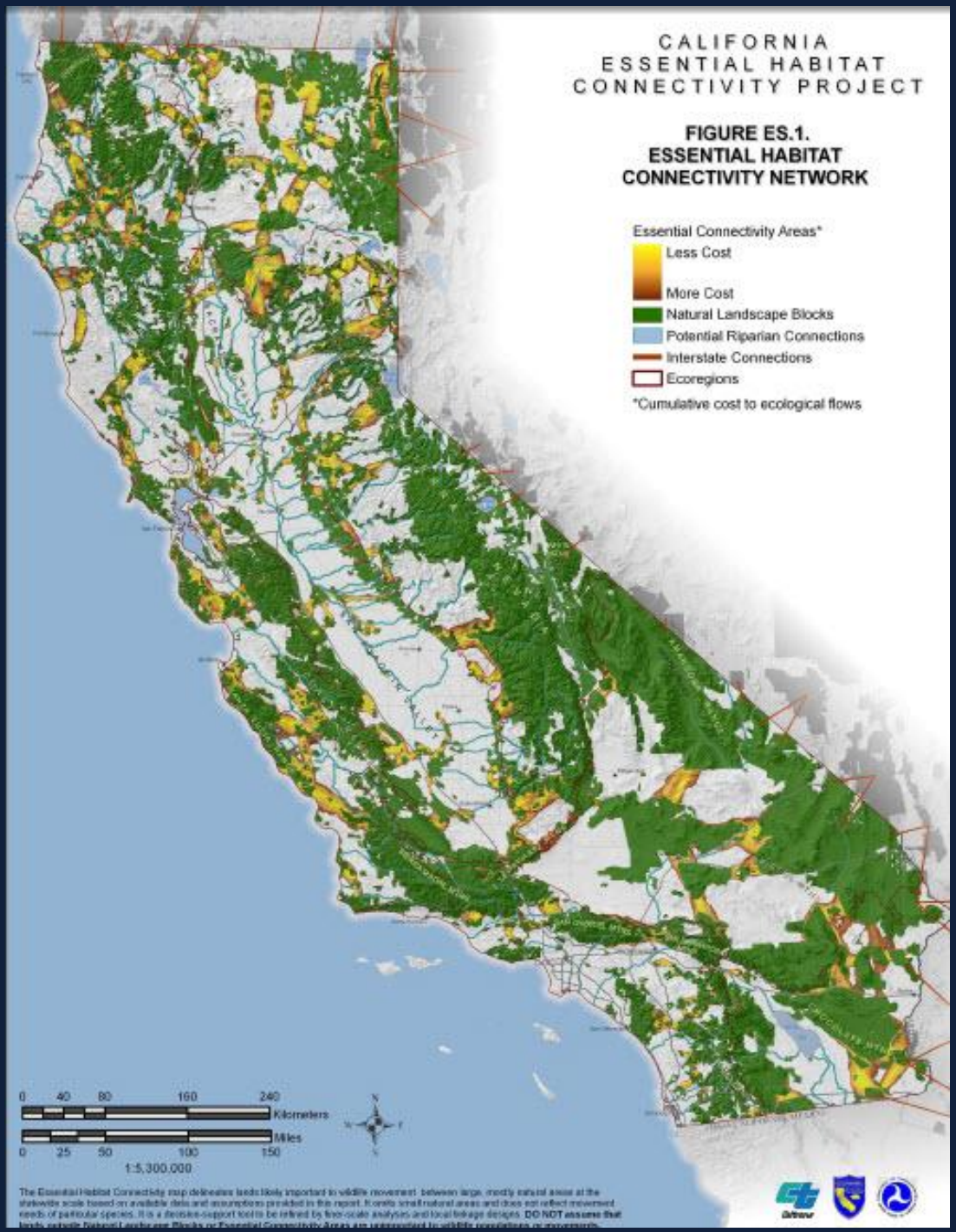


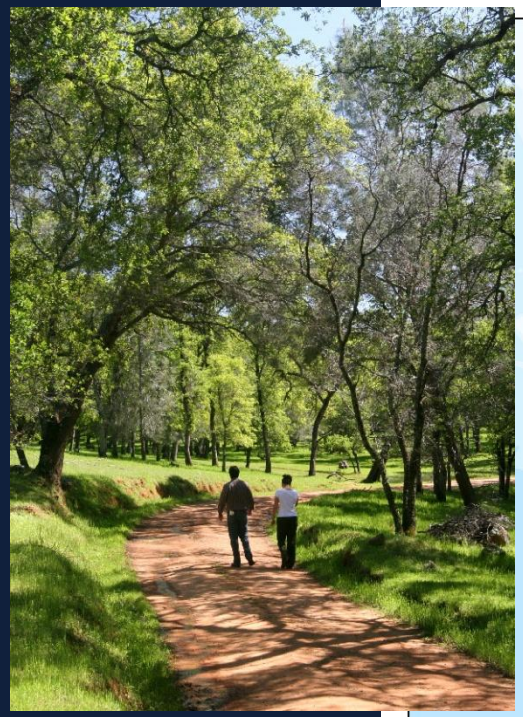


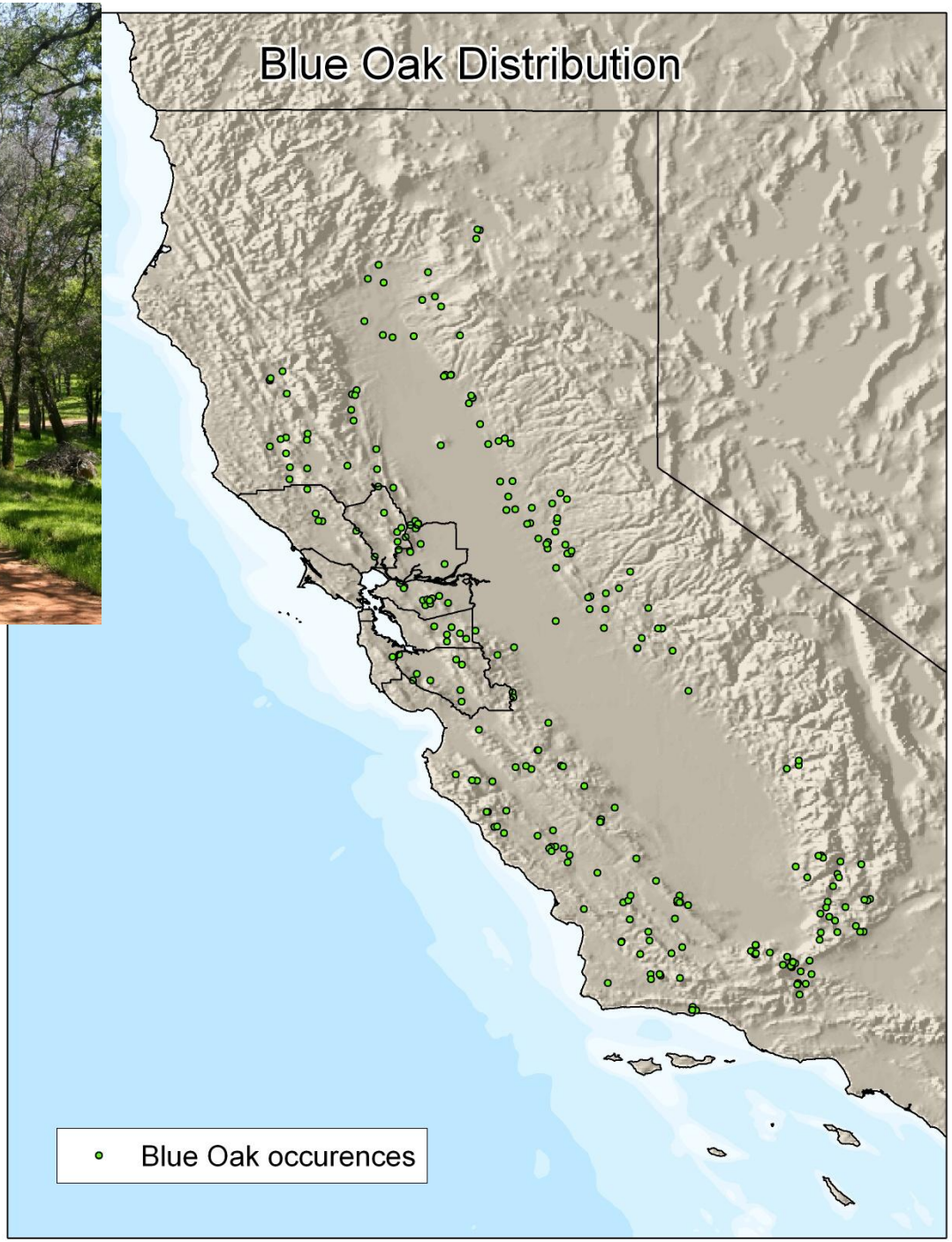
Modeled Winter Ranges:
Bighorn Sheep, Mule Deer, Elk, and Moose

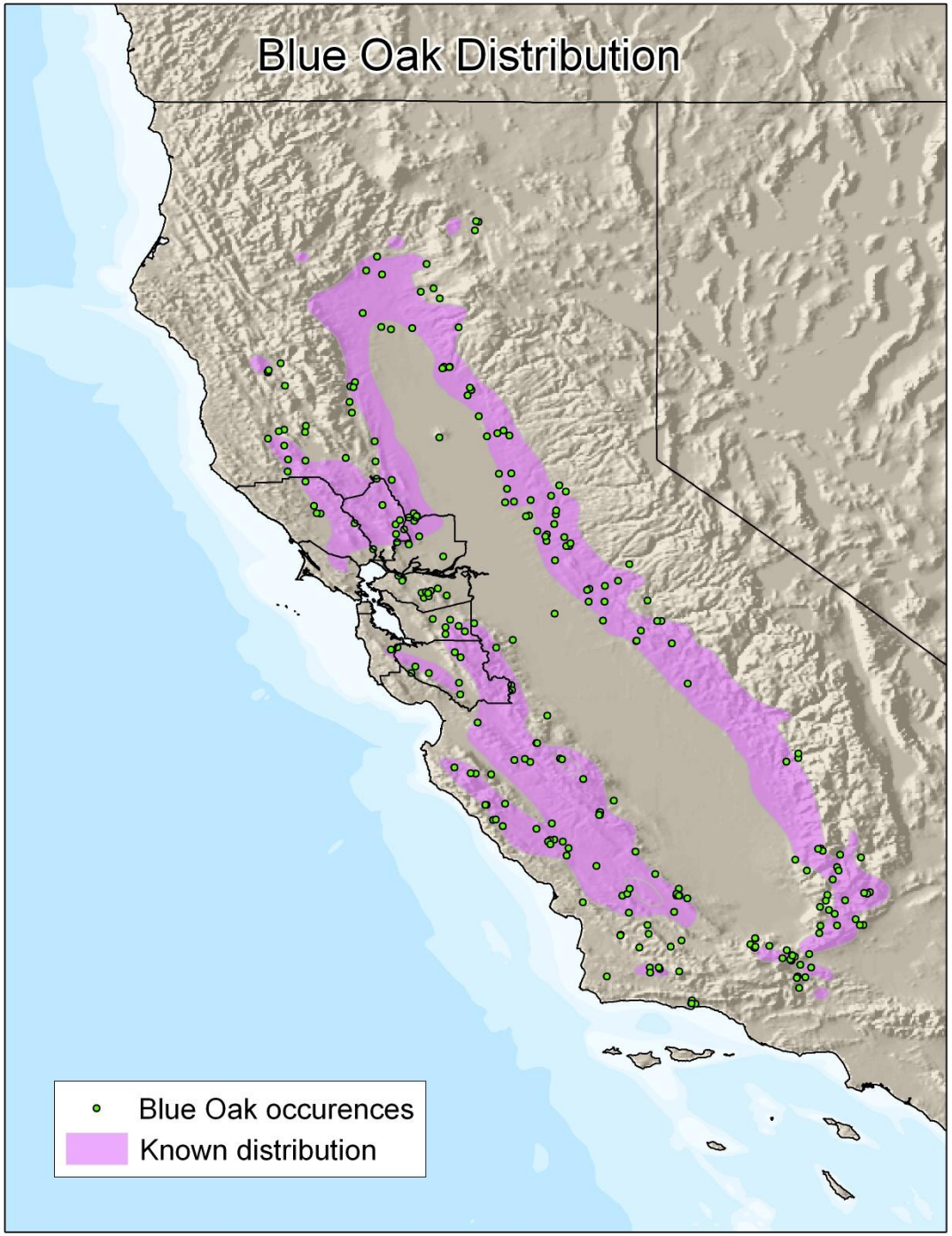


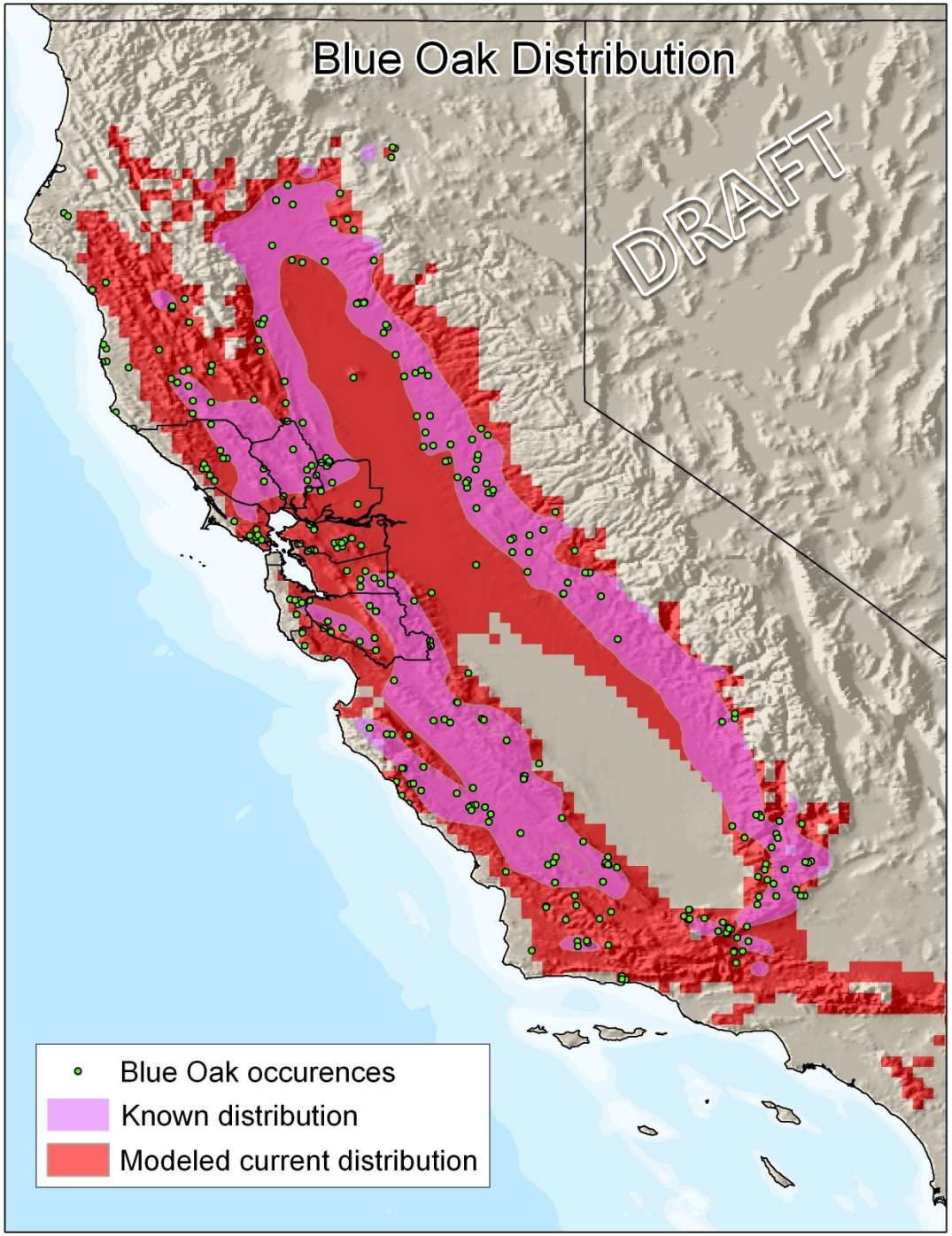



CALIFORNIA
ESSENTIAL HABITAT
CONNECTIVITY PROJECT
FIGURE ES.1.
ESSENTIAL HABITAT
CONNECTIVITY NETWORK
Essential Connectivity Areas*
Less Cost
More Cost
Natural Landscape Blocks
Potential Riparian Connections
Interstate Connections
Ecoregions
*Cumulative cost to ecological flows
0 40 80 160 240
Kilometers
0 25 50 100 150
Miles
1:5,300,000
The Essential Habitat Connectivity map delineates lands likely important to wildlife movement between large, mostly natural areas at the statewide scale based on available data and assumptions provided in this report. It omits small natural areas and does not reflect movement needs of particular species. It is a decision-support tool to be refined by fine-scale analyses and local linkage designs. DO NOT assume that lands outside Natural Landscape Blocks or Essential Connectivity Areas are unimportant to wildlife populations or movements.

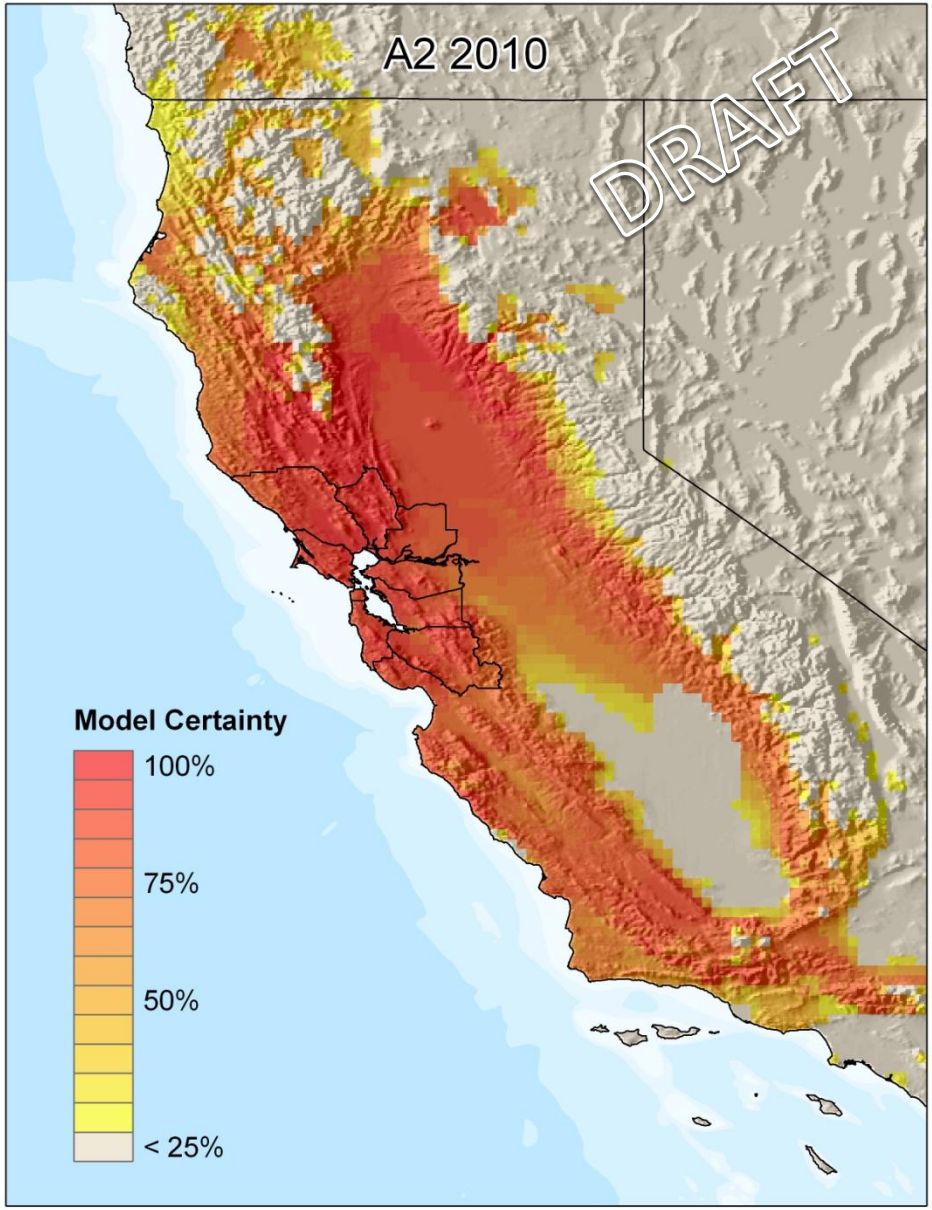


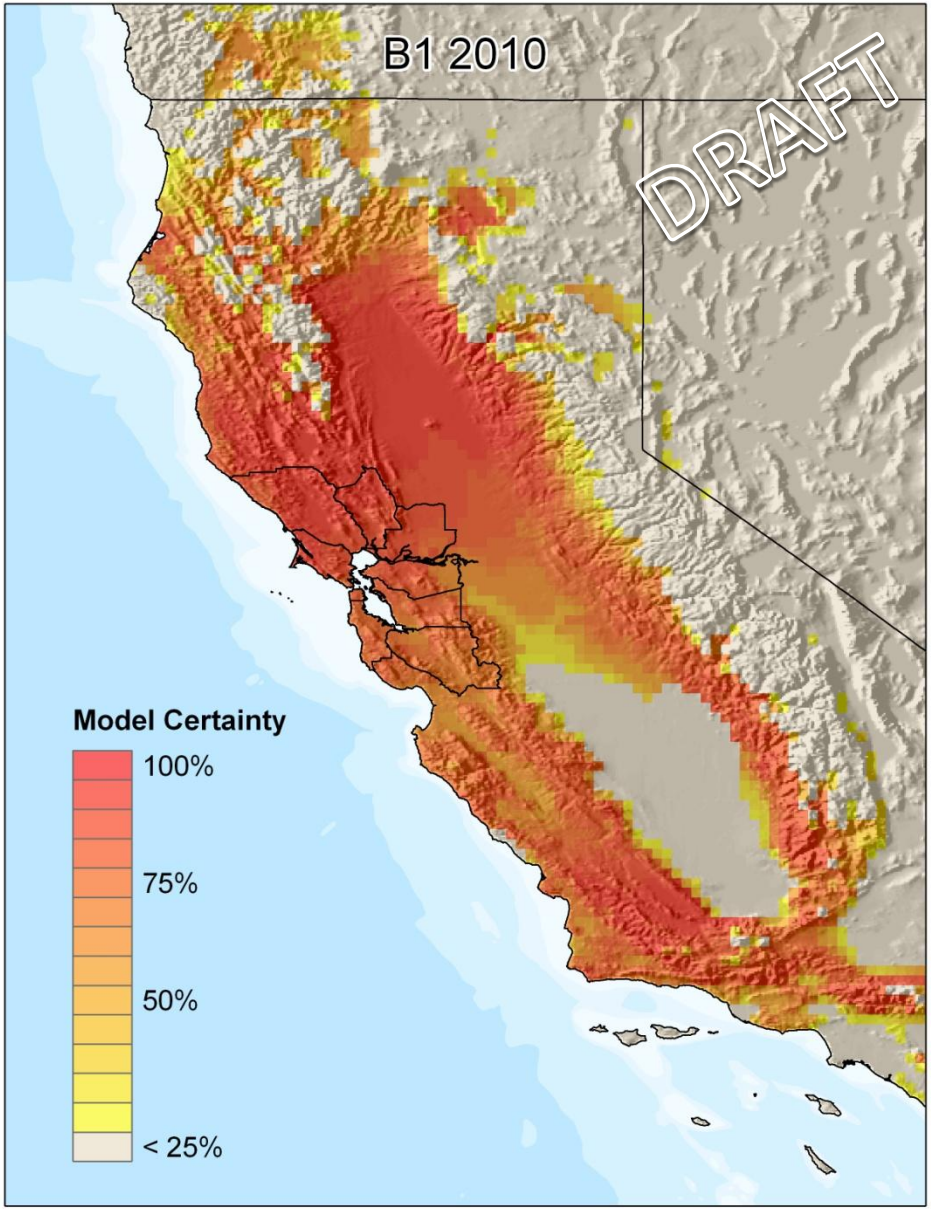

Blue Oak Distribution
Blue Oak occurences


Blue Oak Distribution
Blue Oak occurences
Known distribution

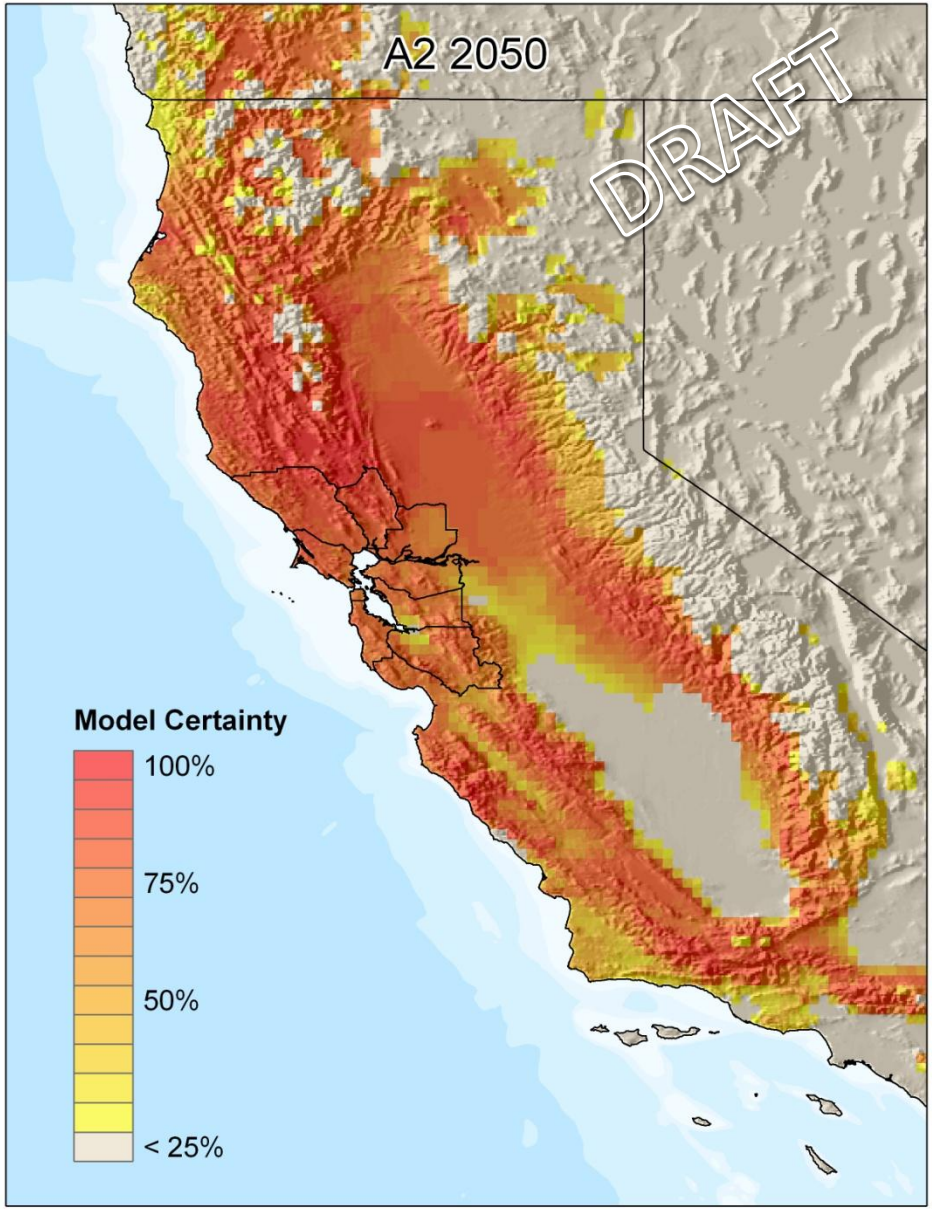

Blue Oak Distribution
DRAFT
Blue Oak occurences
Known distribution
Modeled current distribution

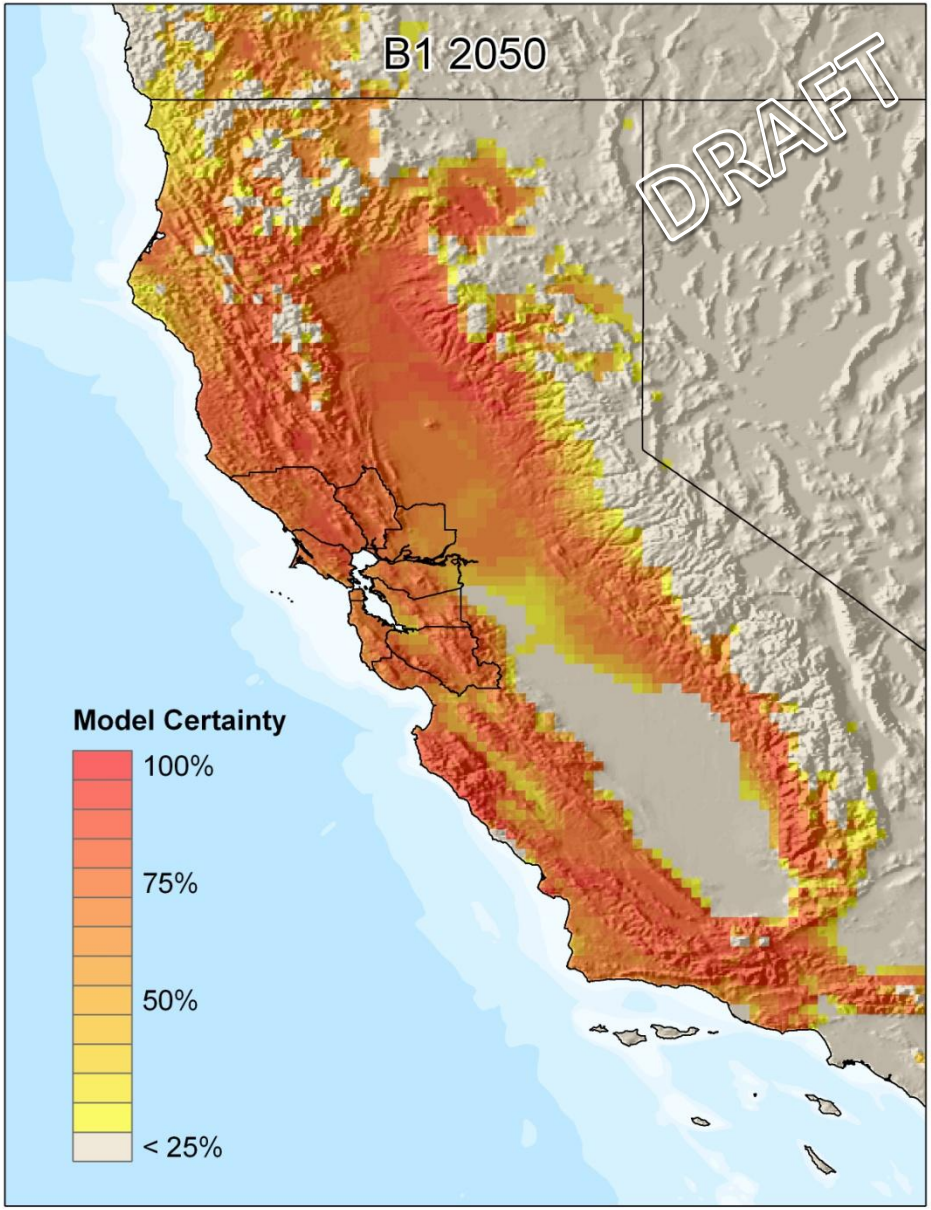
Blue Oak Modeled Future Distributions



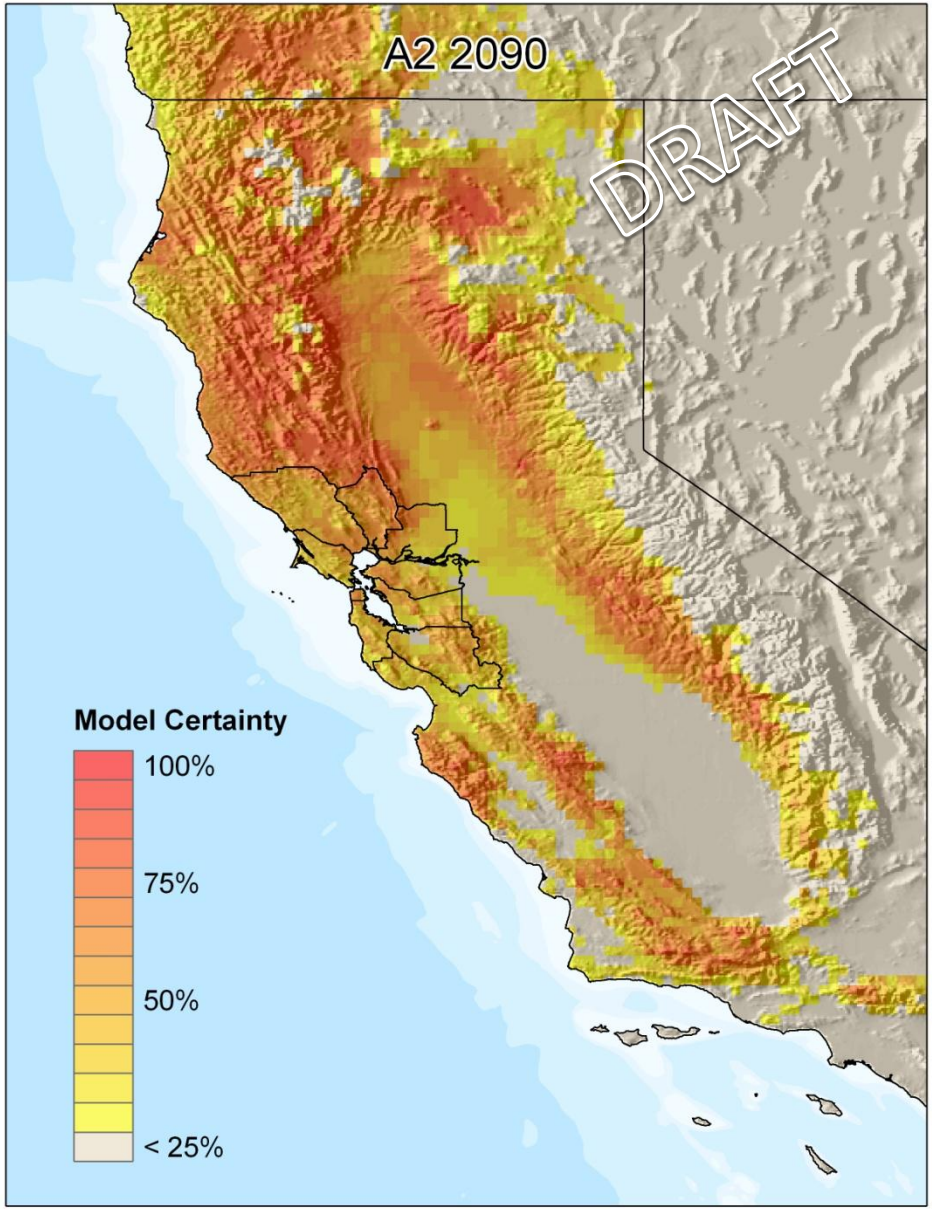


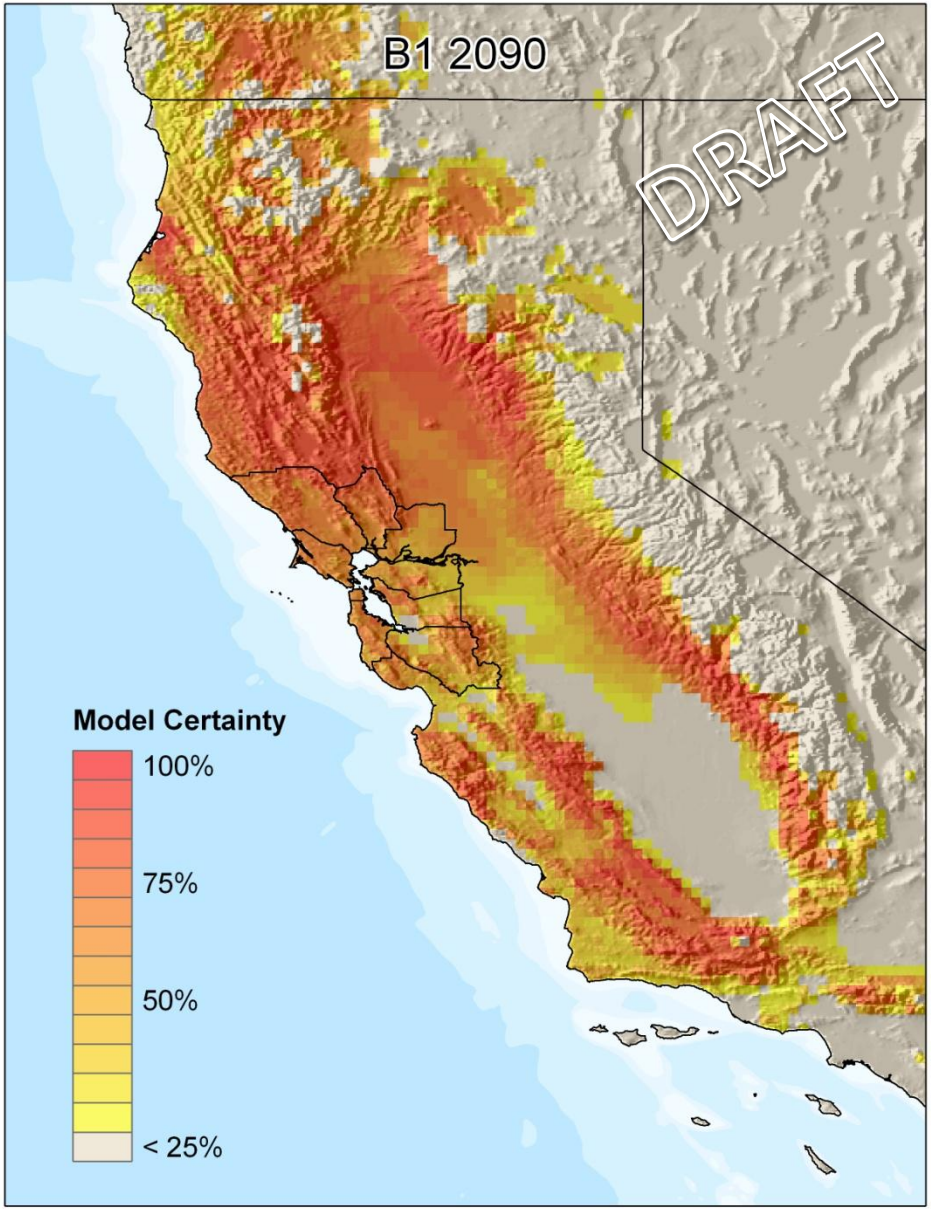
Blue Oak Modeled Future Distributions



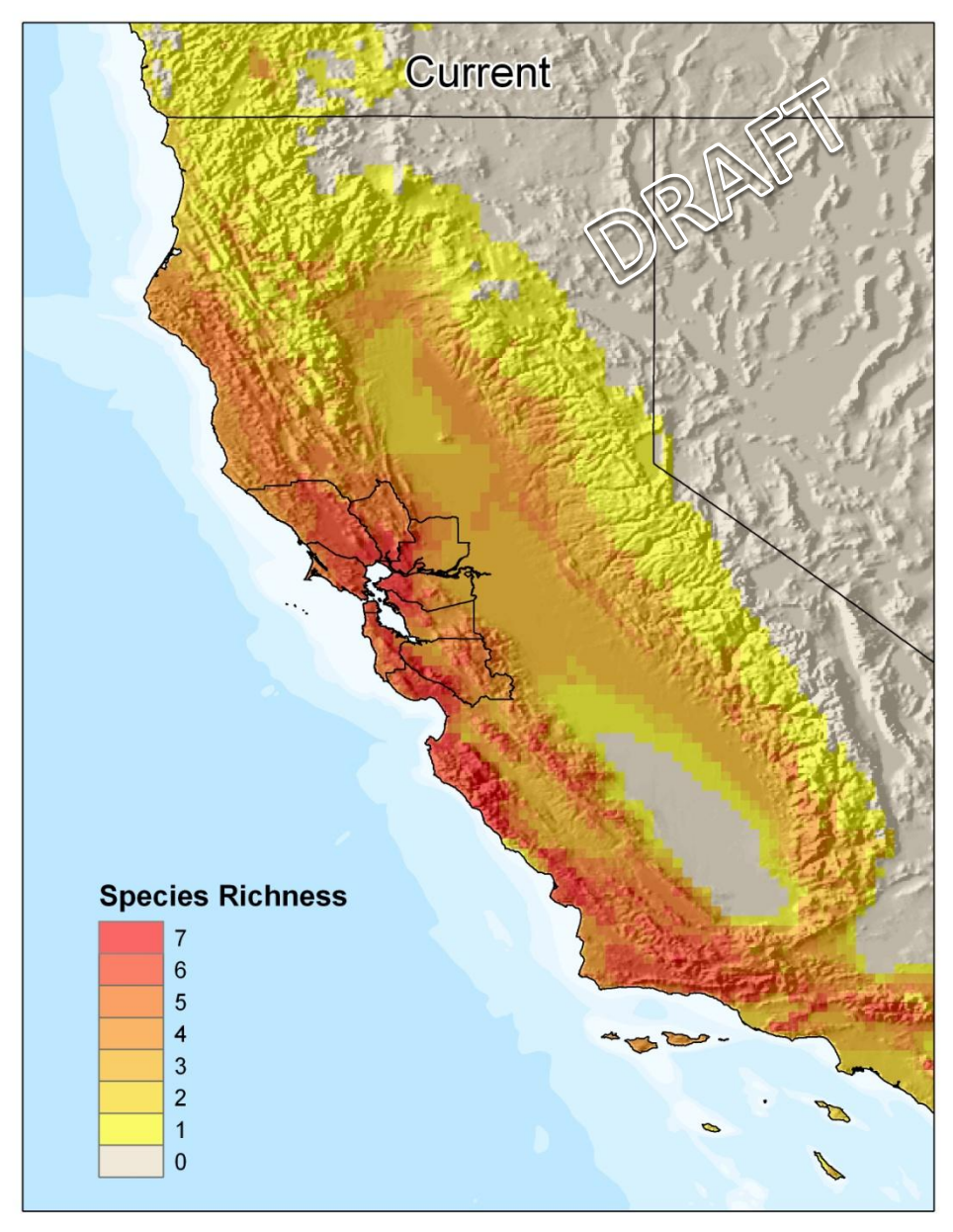


Blue Oak Modeled Future Distributions

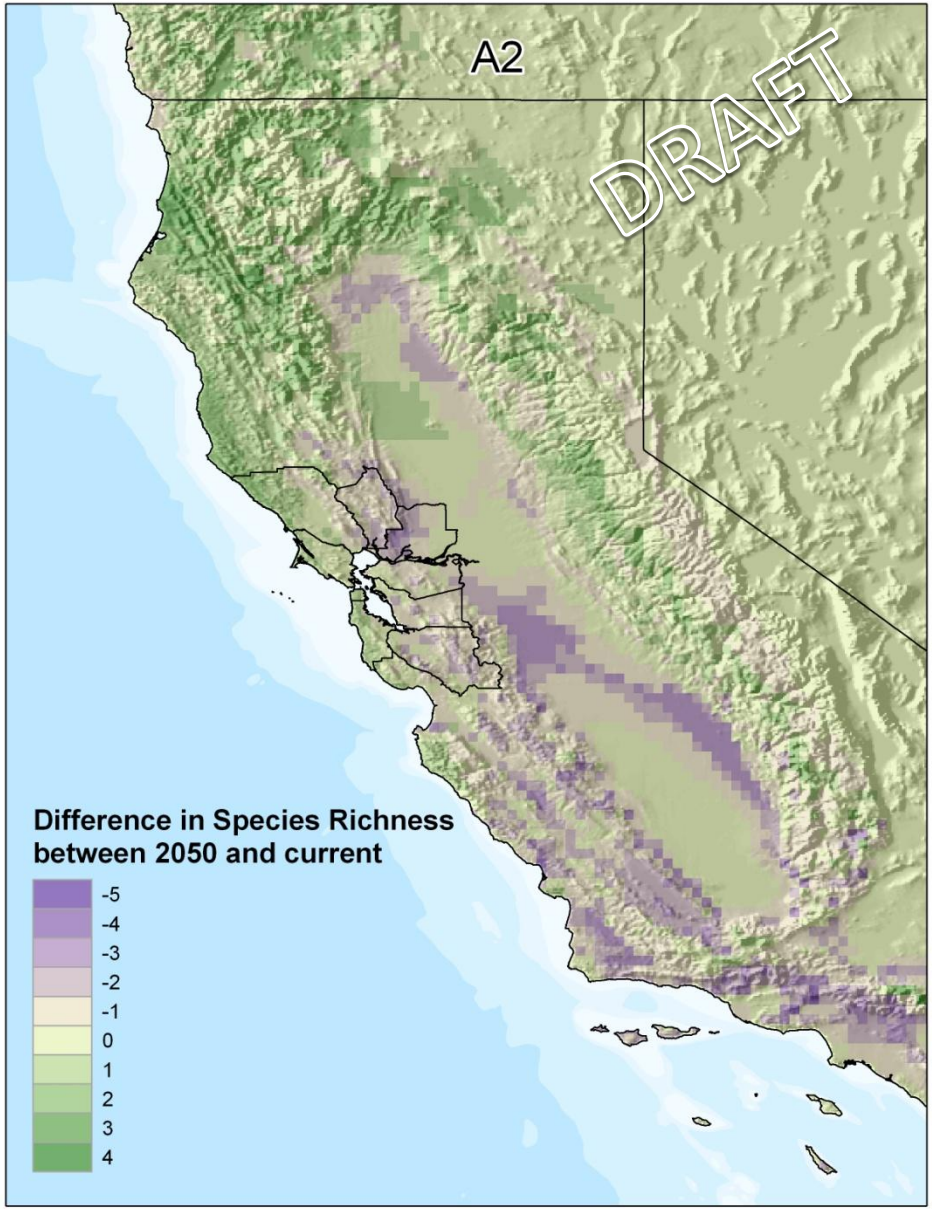


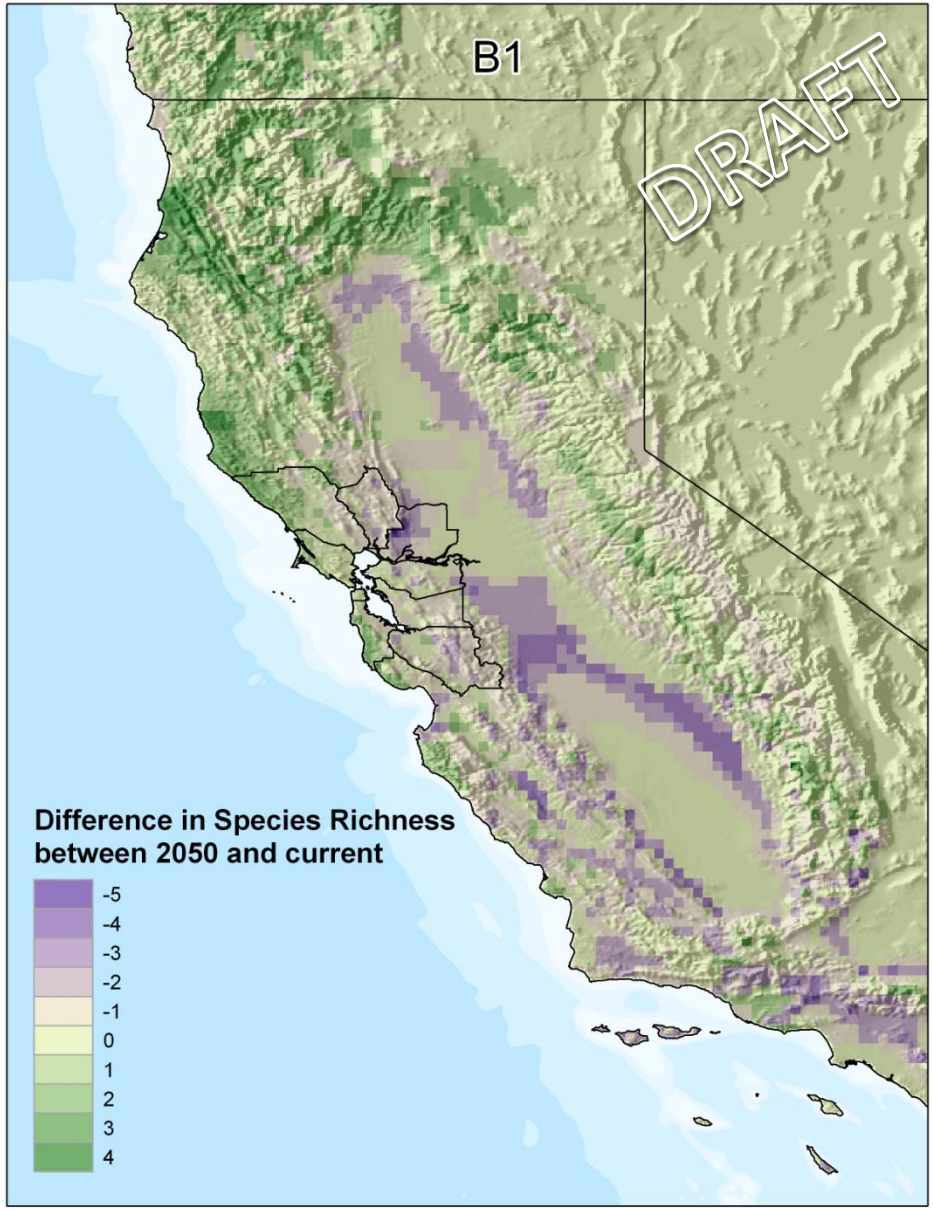


Modeled Ranges for California Flora

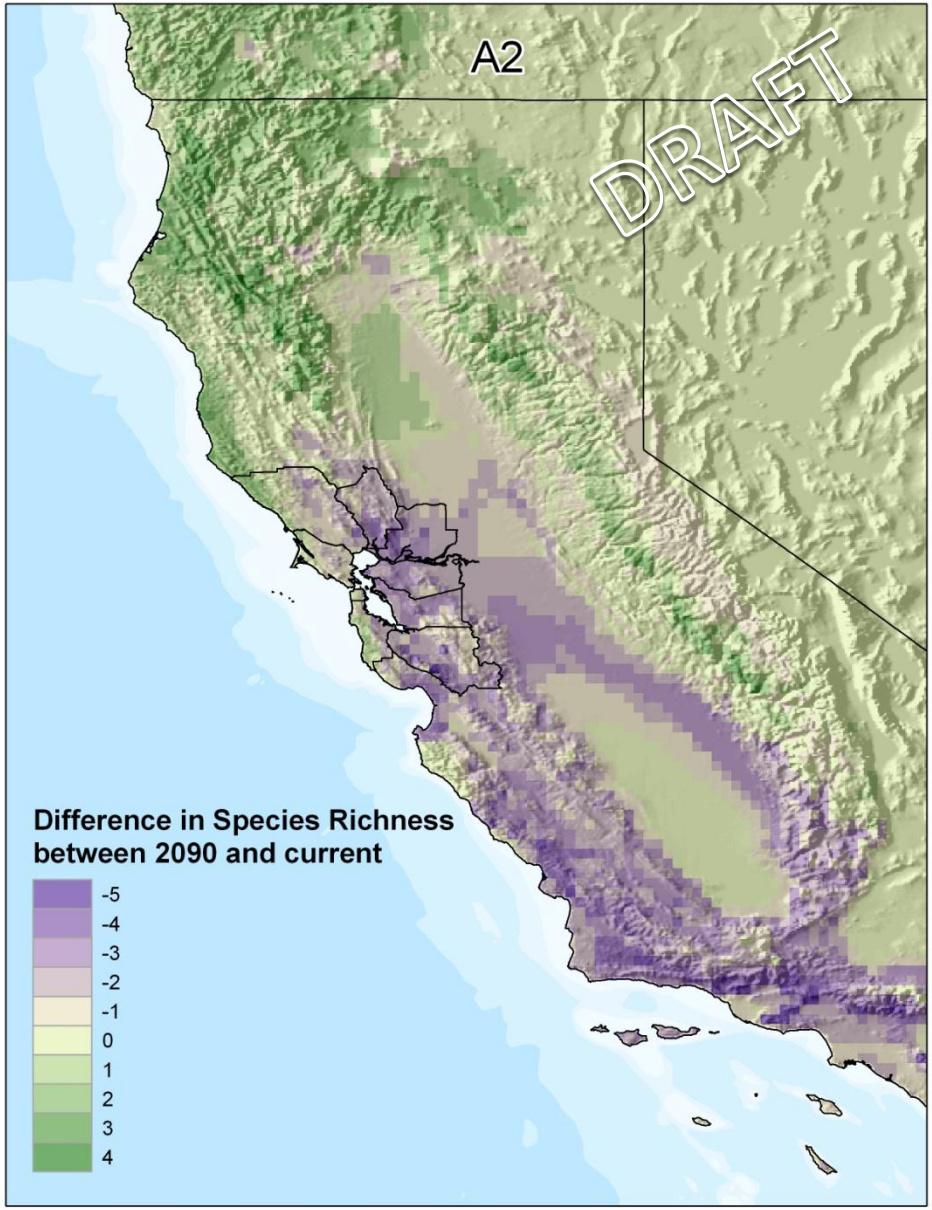


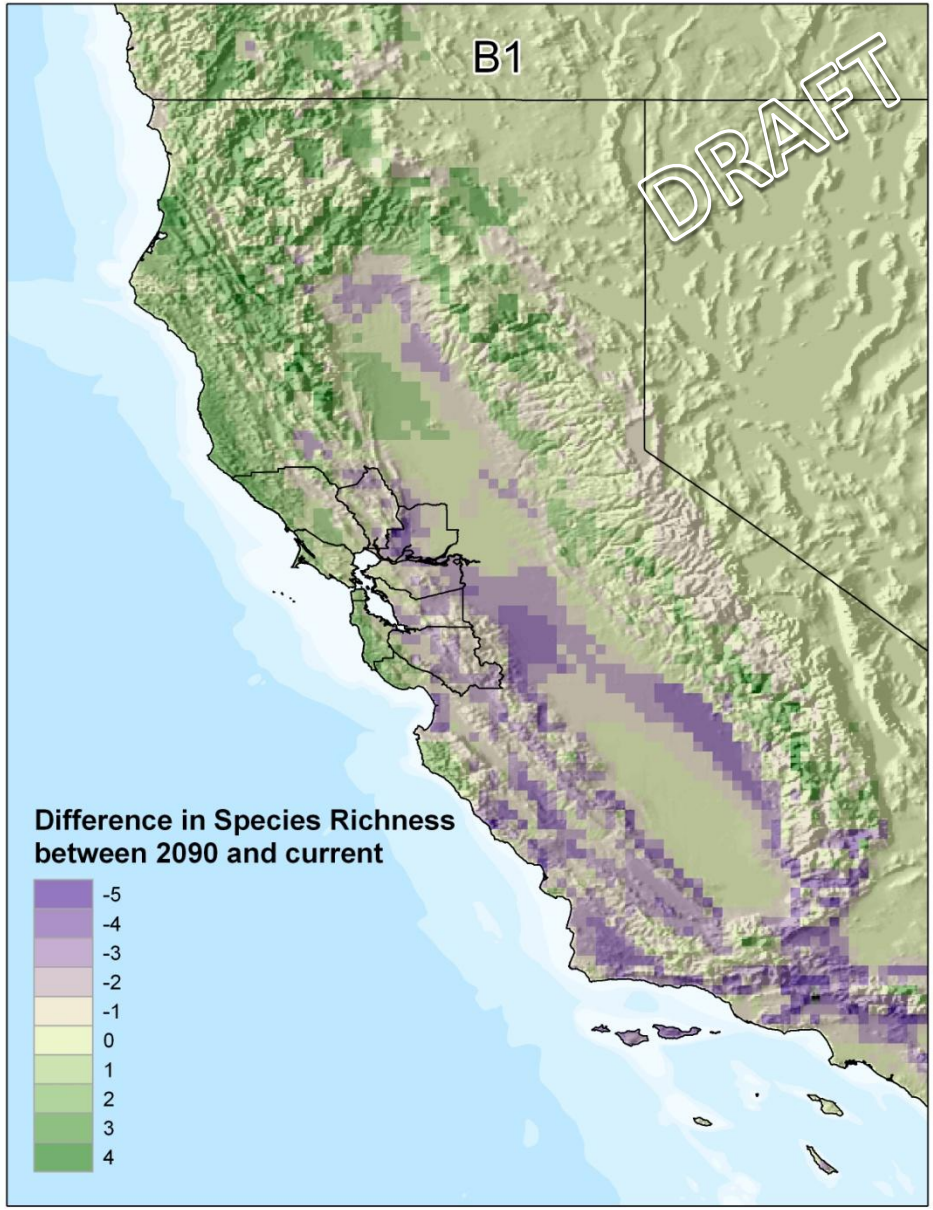
Modeled Ranges for California Flora





Modeled Ranges for California Flora






LCC
California
Desert
Great Basin
Great Northern
North Pacific
Plains and Prairie Potholes
Southern Rockies


"Terrestrial ecosystems store almost three times as much carbon as is in the atmosphere...The maintenance of existing carbon reservoirs is among the highest priorities in striving for climate change mitigation."
The Natural Fix, UNEP 2009

Carbon mitigation and biodiversity conservation = opportunity for win-win-win management

- Reducing emissions by conserving intact systems
- Managing for an increase in carbon sequestration capacity on degraded lands
- Conserving habitat for plant and animal species and ecosystem services

Forested watersheds will absorb the impacts of extreme precipitation events, preventing downstream flooding

Healthy wetlands act as a sponge to counter the effects of sea level rise

FORESTS FOREVER

Your Voice to Protect California's Forests

Governor signs 'Carbon Sink Act'!

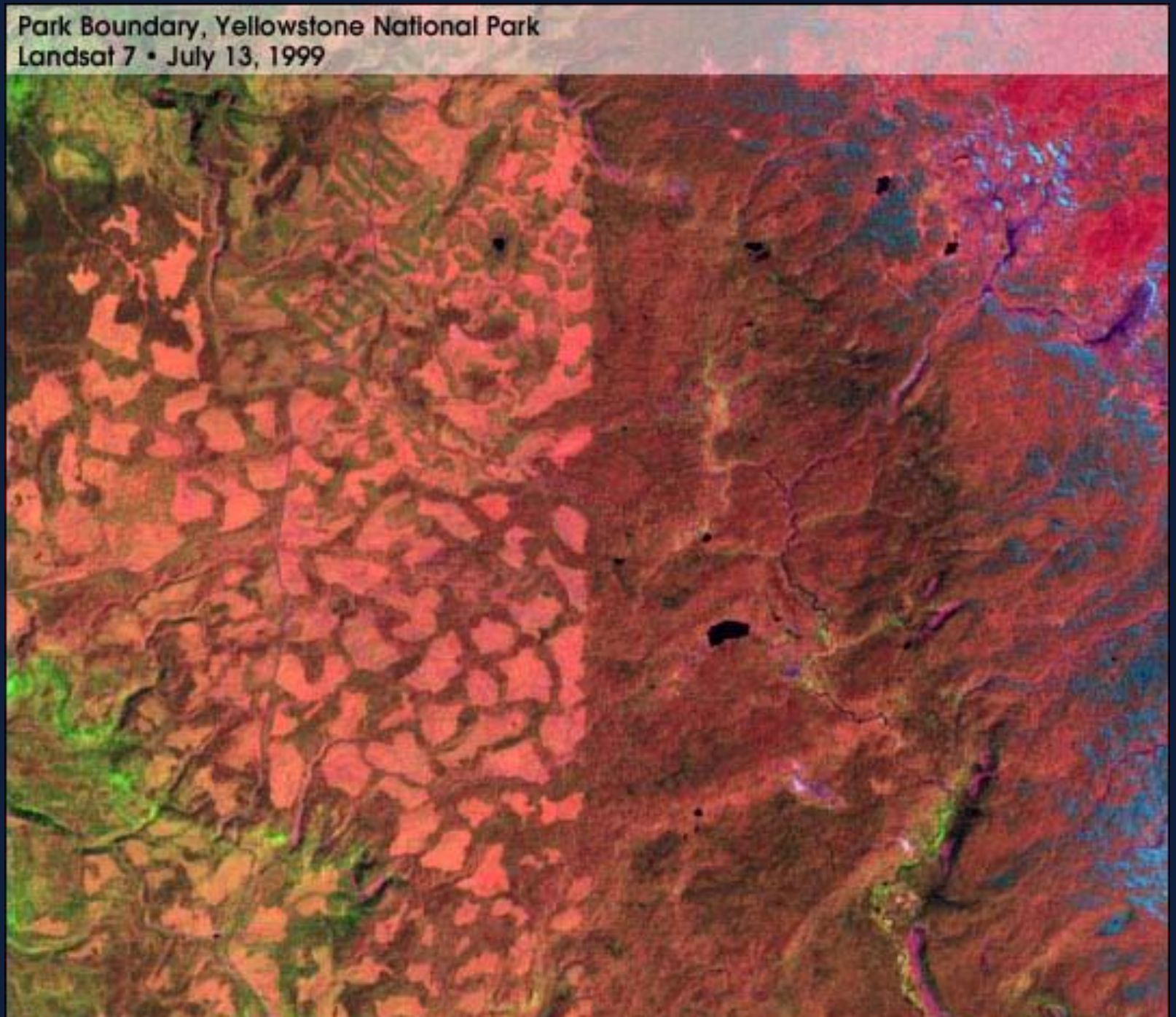
Bill to tally forest CO2 becomes state law

IUCN

A New Vision for Biodiversity Conservation

Strategic Plan for the Convention on Biological Diversity (CBD) 2011-2020

Tenth Meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD COP10), 18-29 October, 2010, Nagoya, Japan)


Park Boundary, Yellowstone National Park
Landsat 7 • July 13, 1999

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