SOUTHERN ROCKIES
Landscape Conservation Cooperative

Assessing the Vulnerability of Riparian Wildlife to the Interactive Impacts of Climate Change & Fire within New Mexico

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USDA, Forest Service, Rocky Mountain Research Station

"Vulnerability of Riparian Obligate Species in the Rio Grande to the Interactive Effects of Fire, Hydrological Variation and Climate Change"

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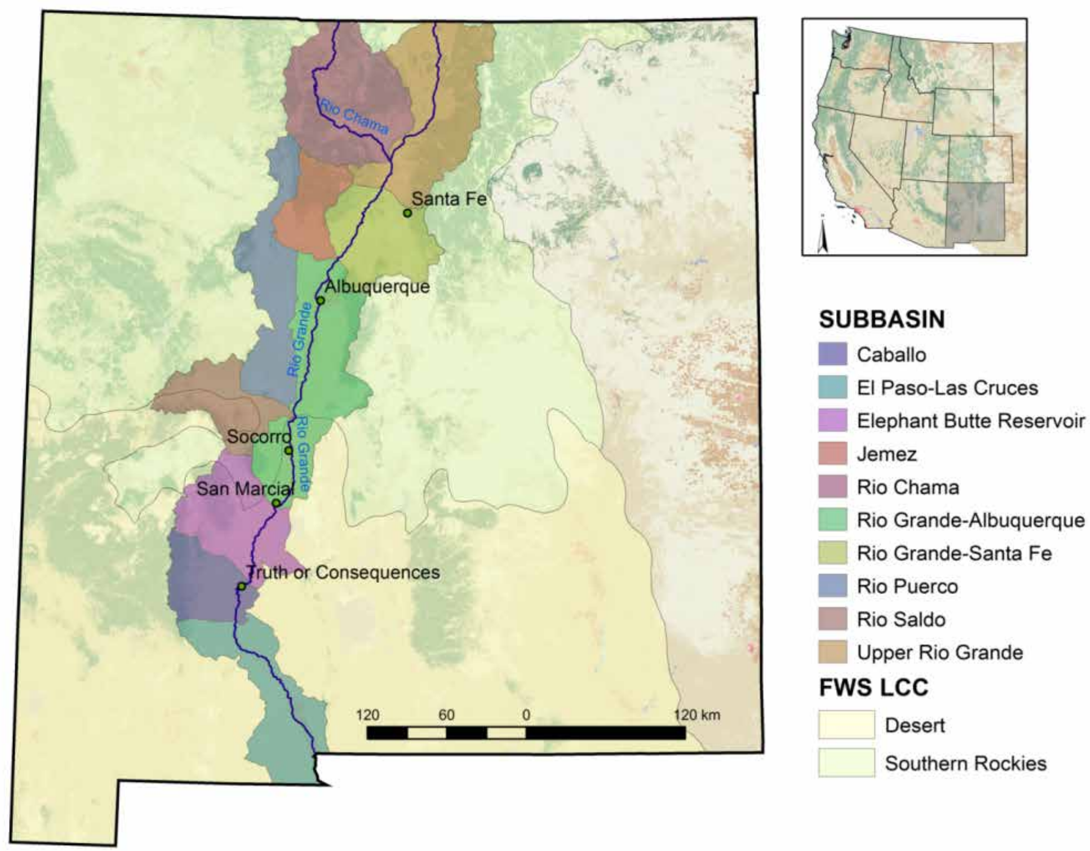
DESERT LANDSCAPE
CONSERVATION COOPERATIVE

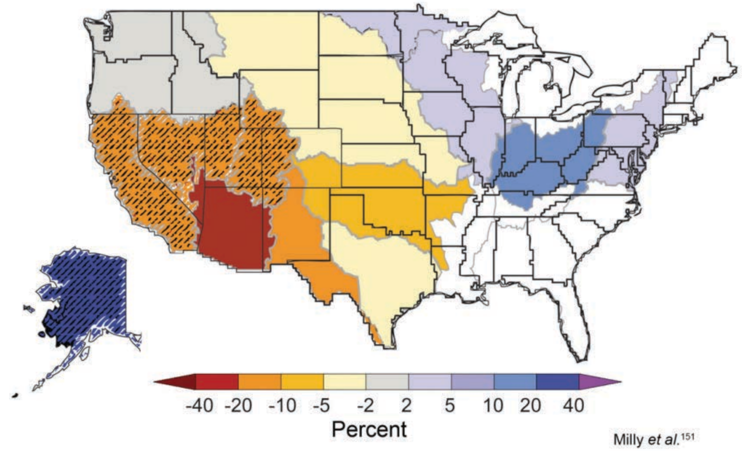
Rocky Mountain Research Station



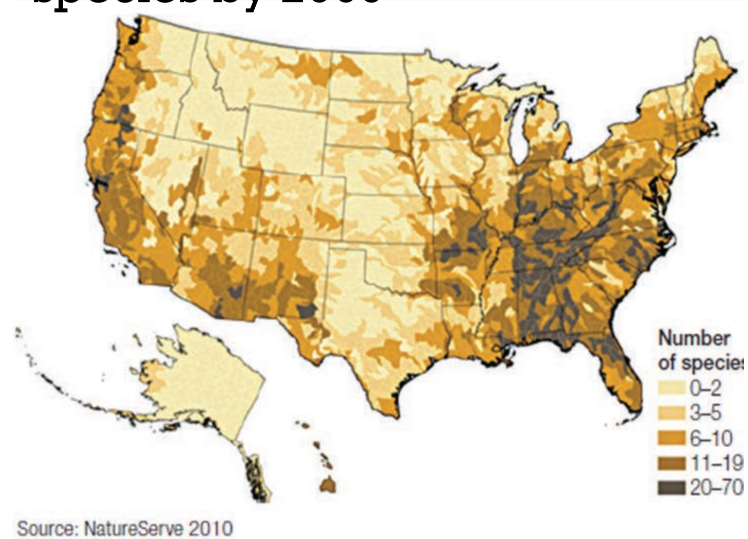
Western aquatic systems face increasing pressures under climate change:

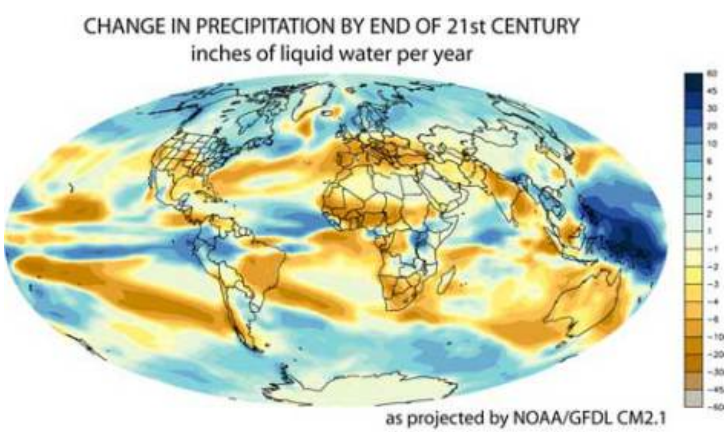
- Increase drought
- More extreme weather
- Disrupted disturbance regime (increased fire)
- Shifts in ecosystems

Percent change in runoff by 2060

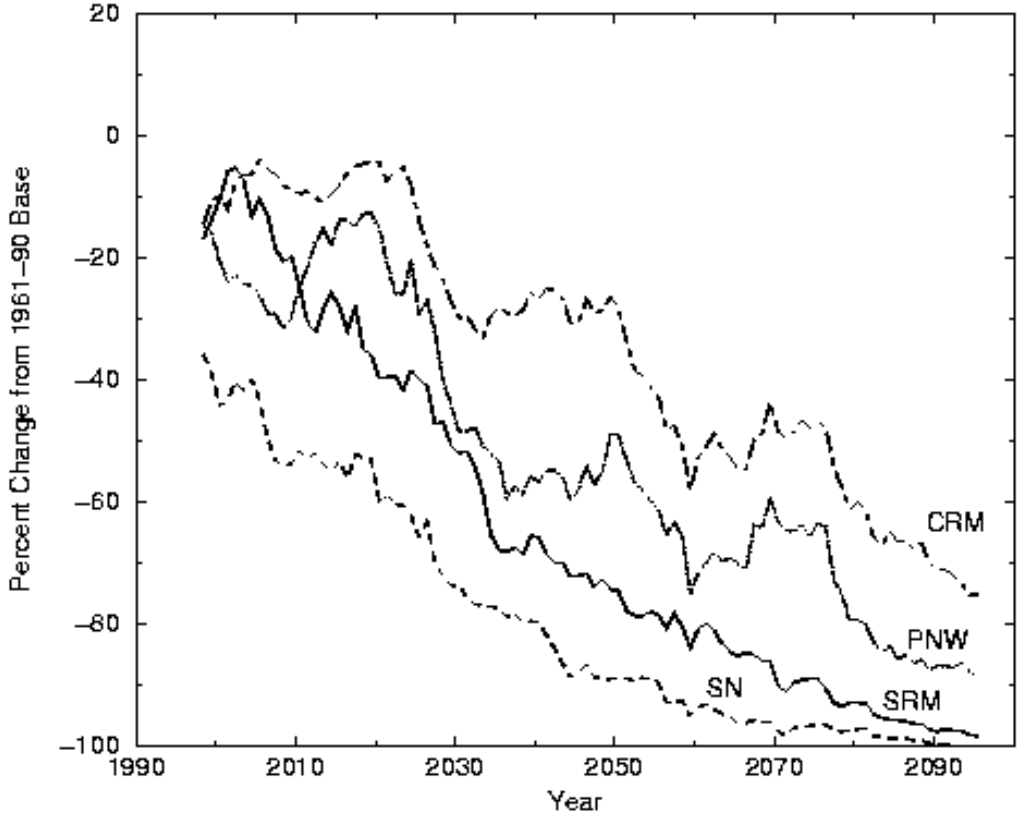


Extinction risk for riparian species by 2060





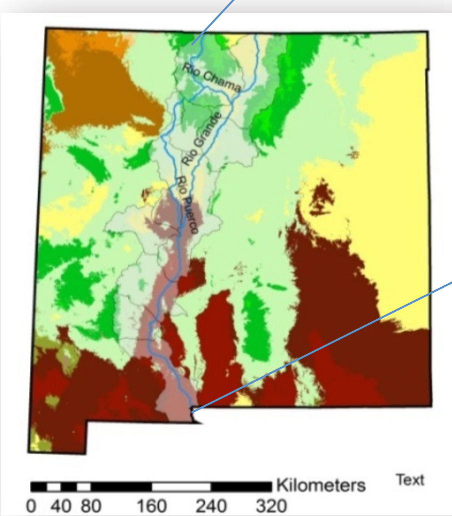
Substantial declines projected in snowpack levels for western watersheds

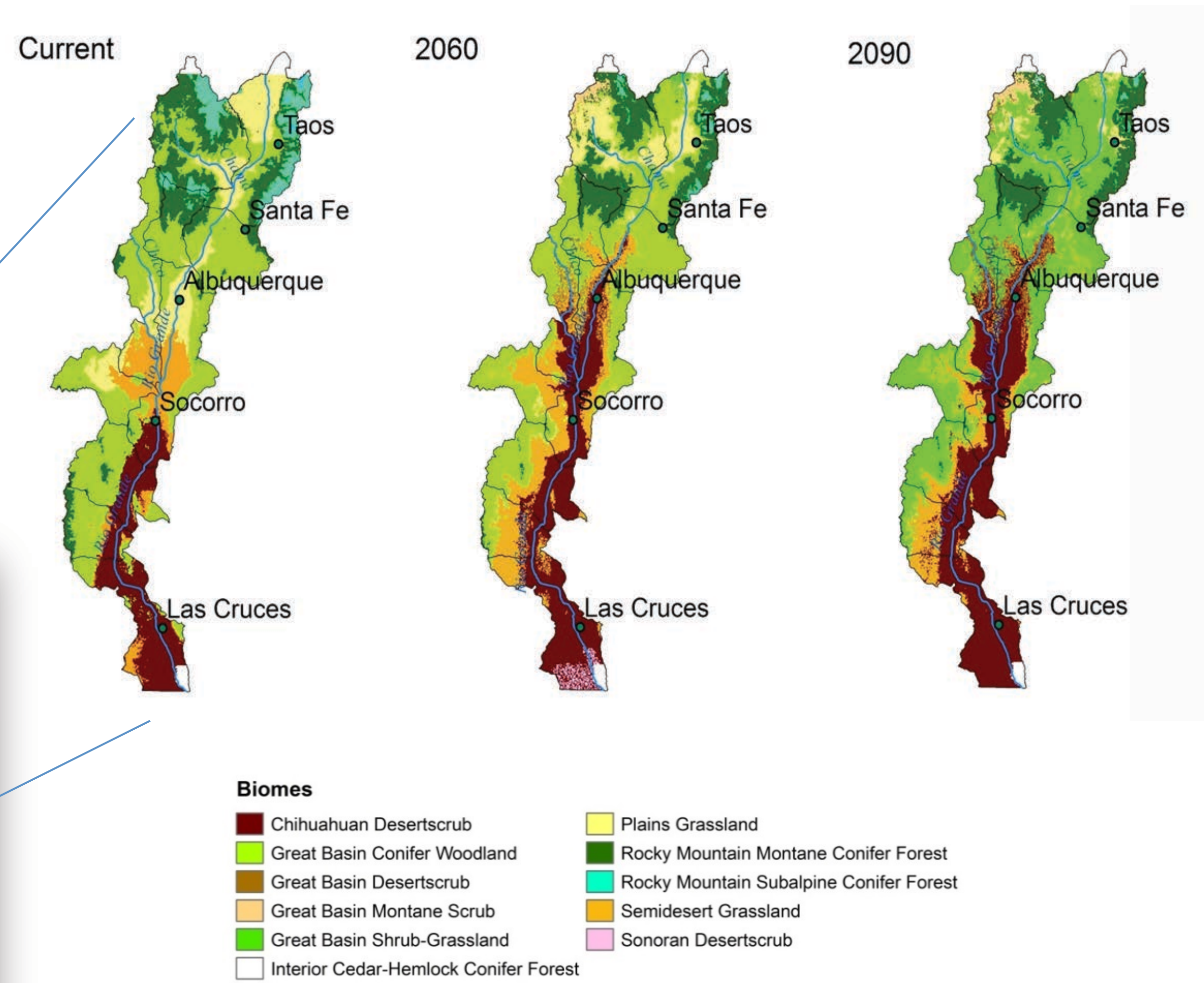


(from USGS 2010)

Photograph courtesy Greg Pederson, Science/ AAAS

Processed based models of future biomes based on 16 climate variables (Rehfeldt et al. 2006, 2012)





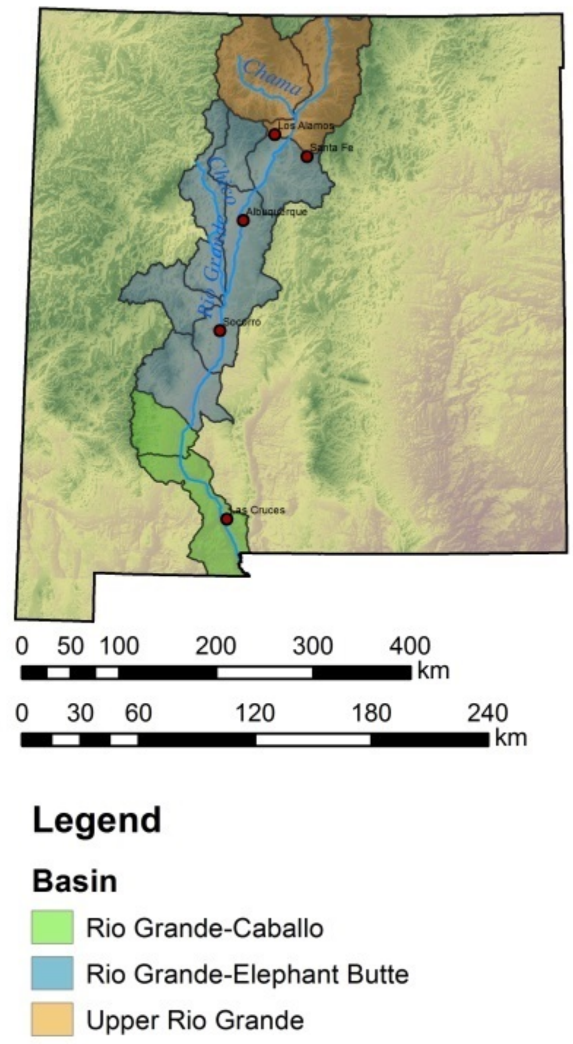
Data available: http://forest.moscowfsl.wsu.edu/climate/

Increasing challenges for wildlife management

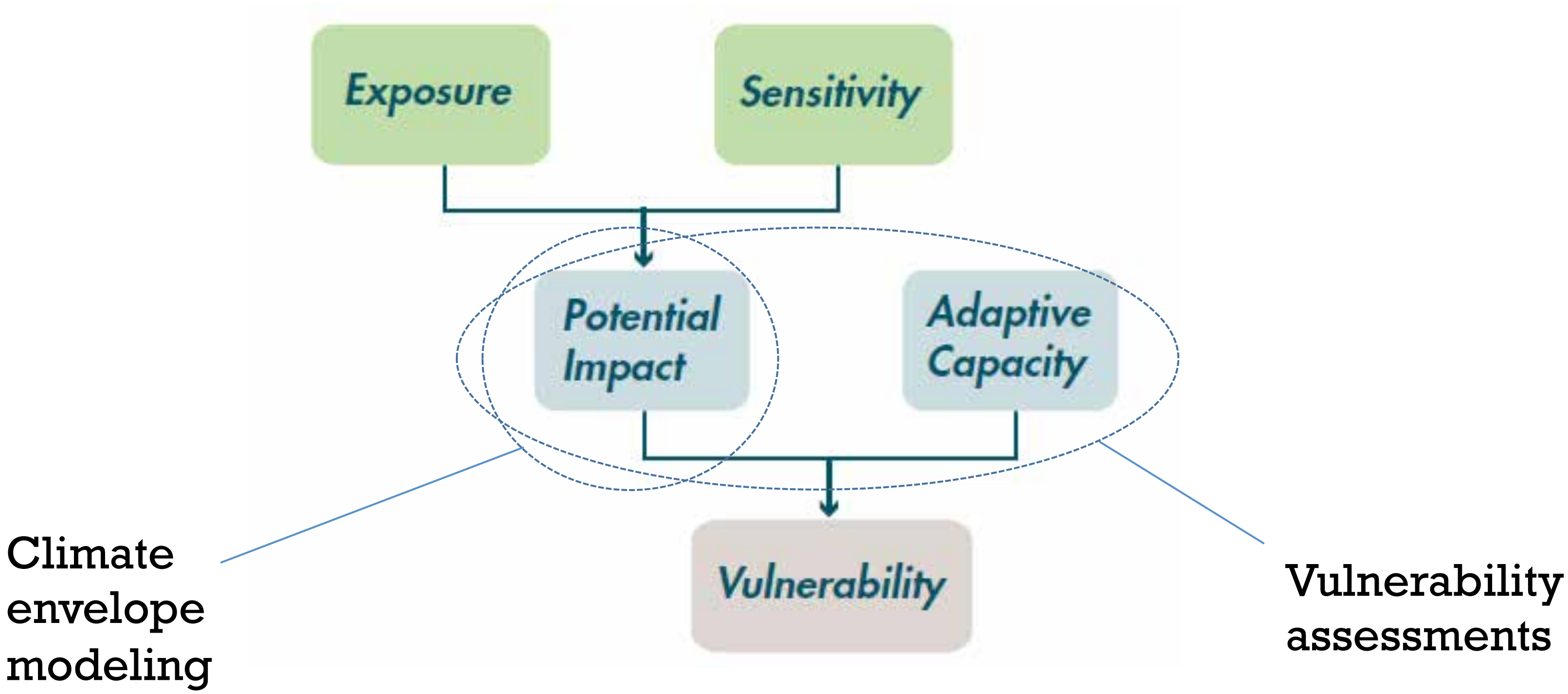
- Multiple interacting climate effects
- Changes are uncertain
- Adaptation plans are needed but information and tools are lacking

We developed a framework for integrating multiple data inputs to produce a series of vulnerability assessment products.

We apply this system to 12 species inhabiting the Rio Grande Bosque.

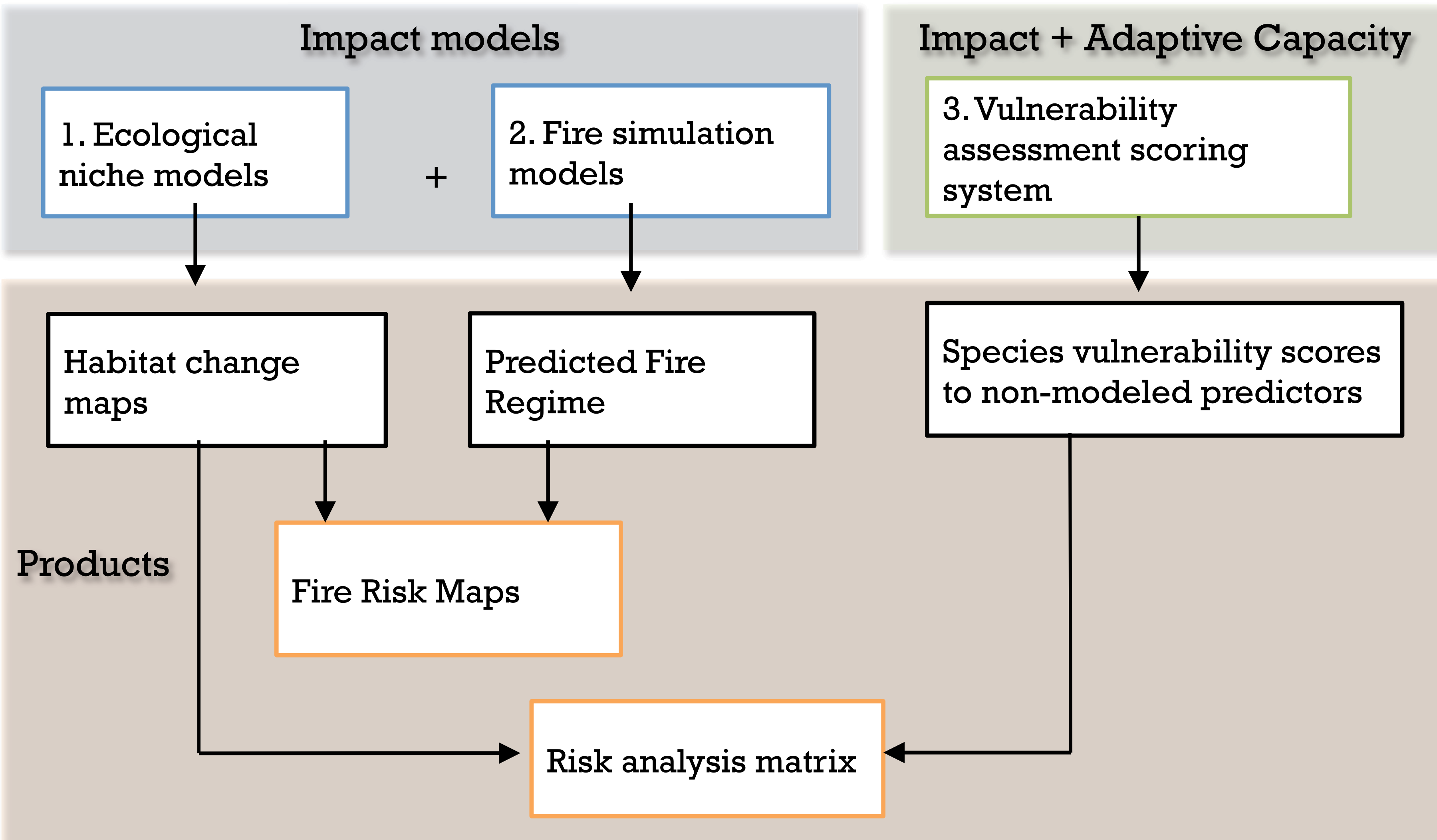


Based on the concept of climate change vulnerability



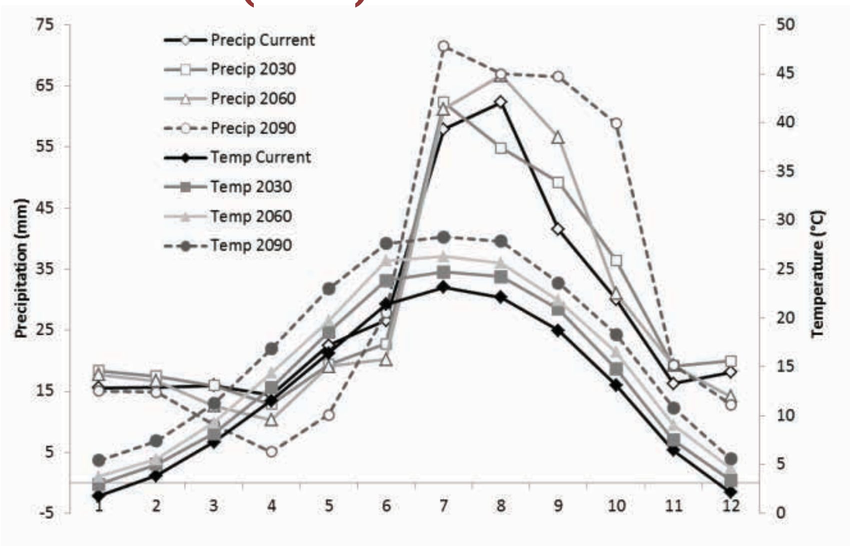
From Glick et al., 2011

Framework for assessing species' vulnerability

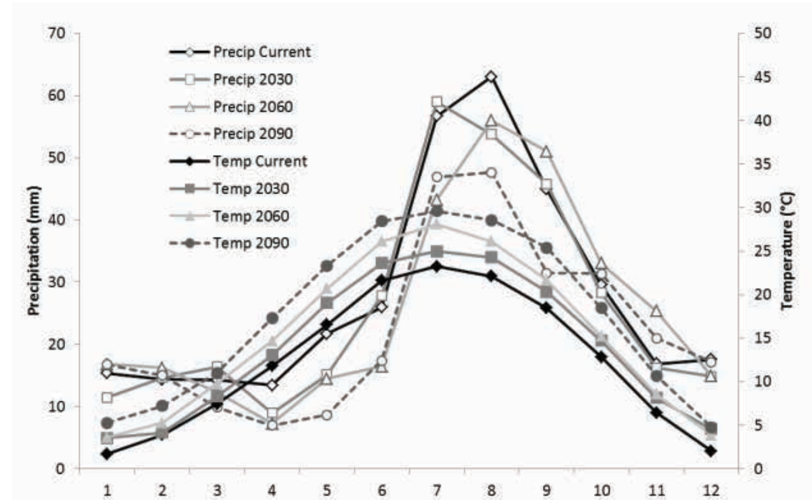


Scenario Based Assessment

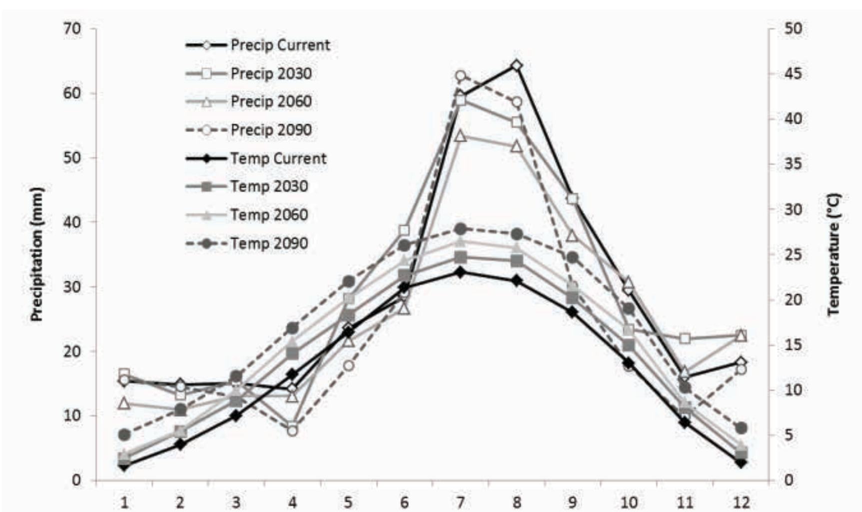
Had cm3 (mild)

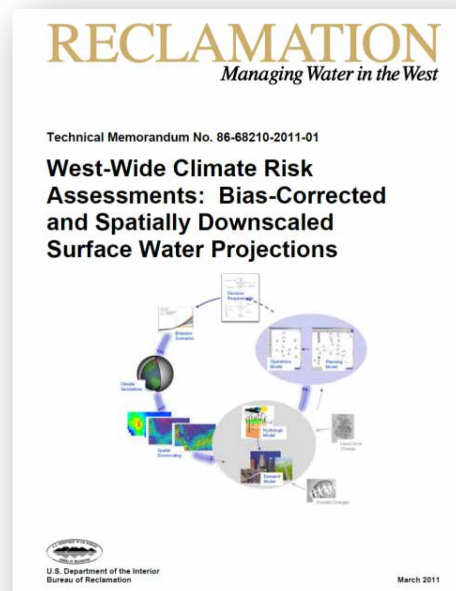


Gfdl cm2.1 (harsh)



Cgcm3.1 (intermediate)





Step 1. Ecological Niche Models

Species selected based on conservation interest, habitat use, and availability of data

Records gathered from museum and published records

MaxEnt (3.3) used to model suitable habitat

	Common Name	Species
1	SW flycatcher	*Empidonax traillii extimus*
2	W. yellow billed cuckoo	*Coccyzus americanus*
3	Lucy's warbler	*Oreothlypis luciae*
4	Northern leopard frog	*Rana pipiens*
5	American bullfrog	*Rana catesbeianus*
6	Black-necked garter snake	*Thamnophis cyrtopsis*
7	Western painted turtle	*Chrysemys picta bellii*
8	NM meadow jumping mouse	*Zapus hudsonius luteus*
9	Hispid cotton rat	*Sigmodon hispidus*
10	Occult bat or Arizona bat	*Myotis occultus*
11	Yuma myotis	*Myotis yumanensis*
12	Long-legged bat	*Myotis volans*

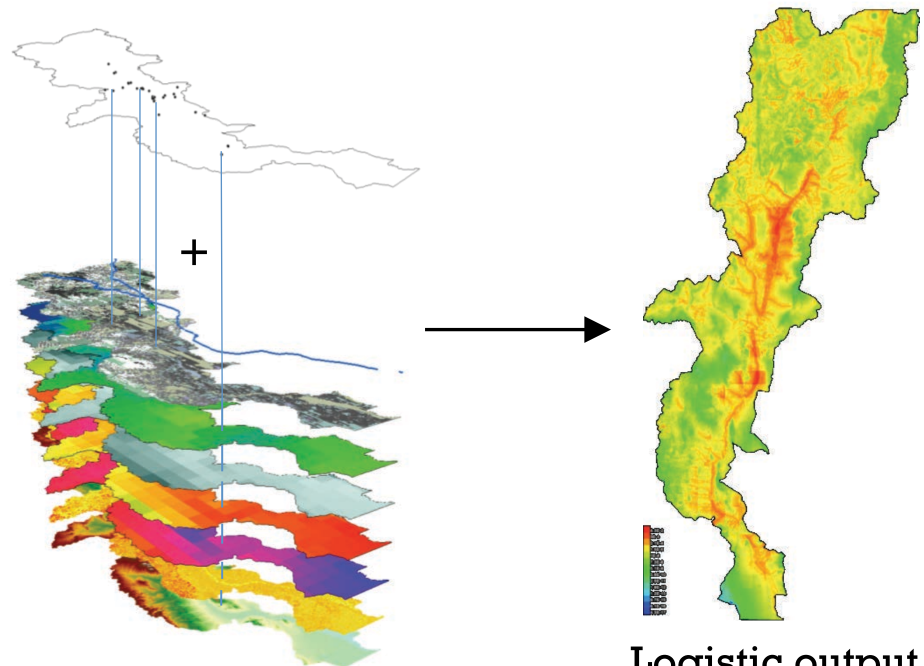
Finch et al., 1997; Malaney et al., 2012

MaNIS/HerpNet/ORNIS Data Portals

MaxEnt creates probability surface for species presence based on relationship between species observations and environmental variable

- Well suited for presence only analyses
- Unique models created for each species or species group

Environmental data:
19 bioclimate (e.g. tmax, tmin)
5 hydrological (e.g. runoff, pet)
4 biophysical (e.g. elevation, distance to water)
1 biome data layers

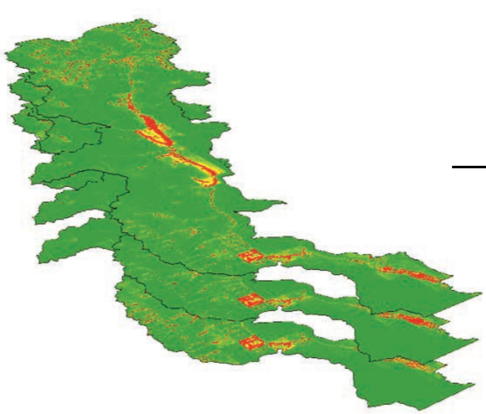


Logistic output for current distribution

Output presented for individual scenarios and in consensus maps

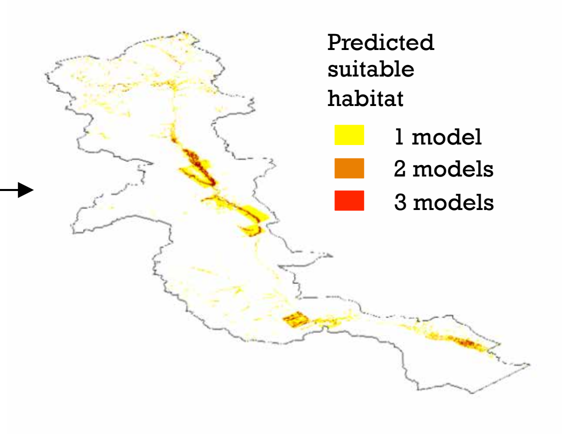
Correlates from modeled current habitat	X	Cgcm 3.1 Gdfl 2.1 Had cm3	X	3 time periods (2030, 2060, and 2090)

Logistic output for each climate scenario

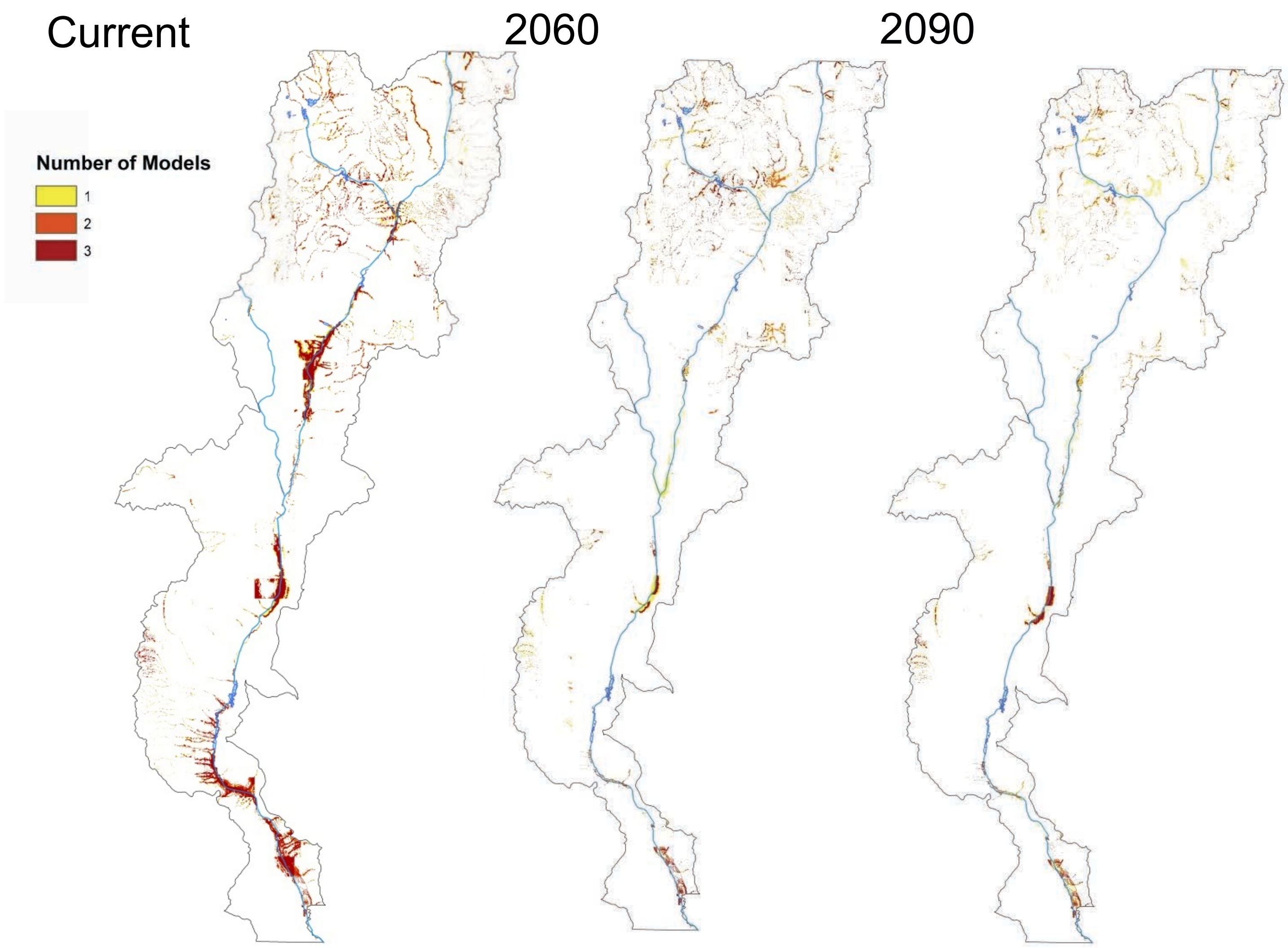


Convert to a binomial layer (suitable vs. nonsuitable)

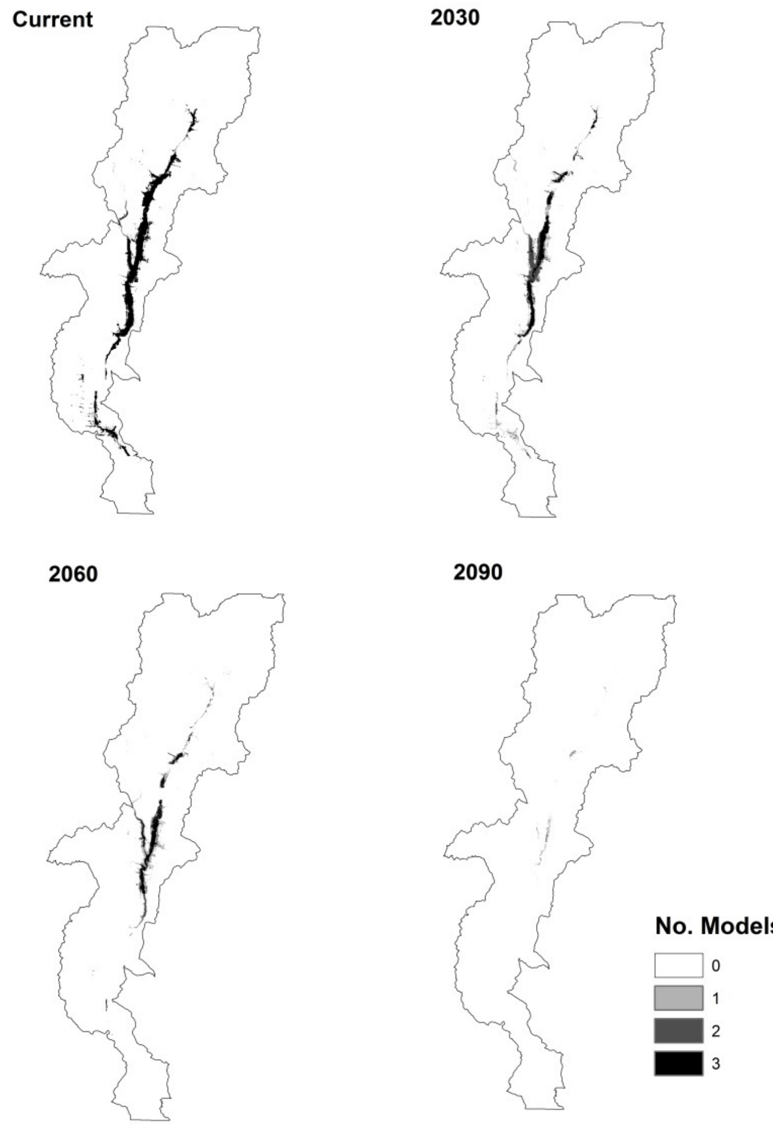
Consensus layer



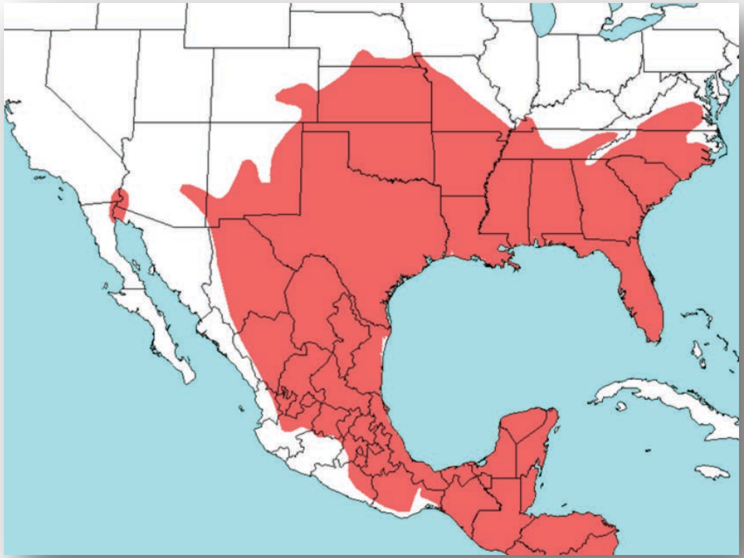
Southwestern Willow Flycatcher: Suitable habitat

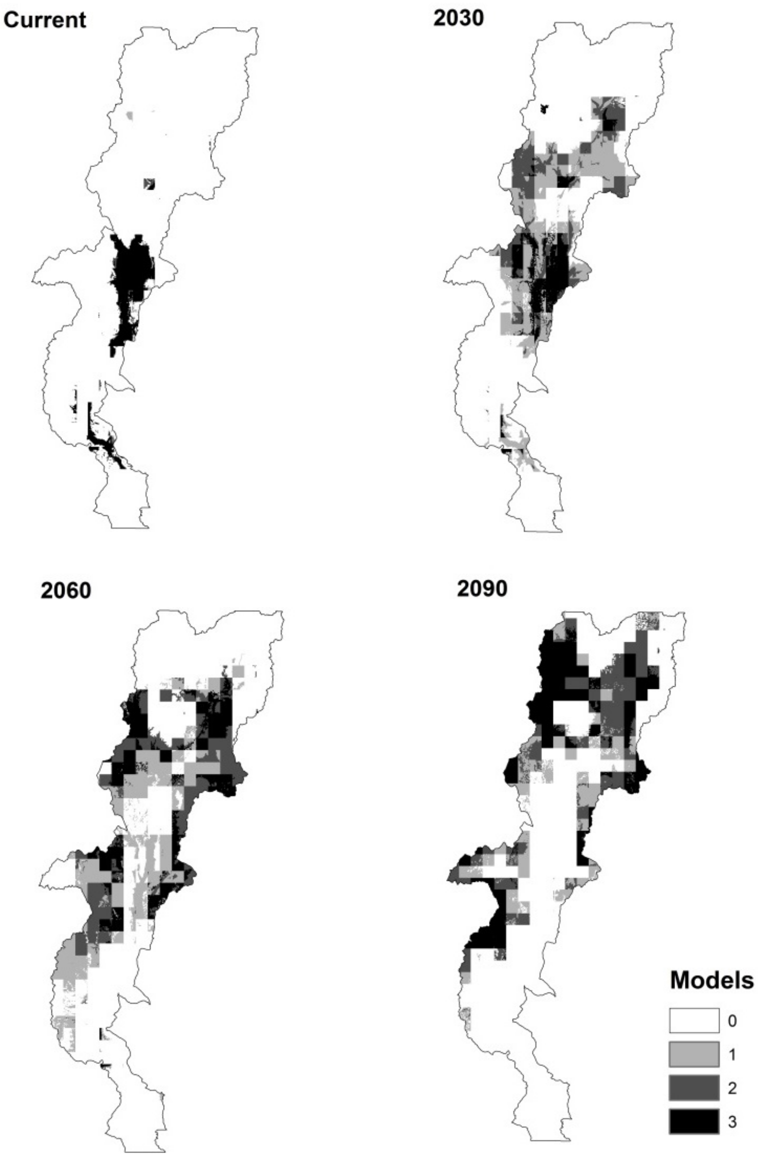


Western painted turtle (*Chrysemys picta bellii*)



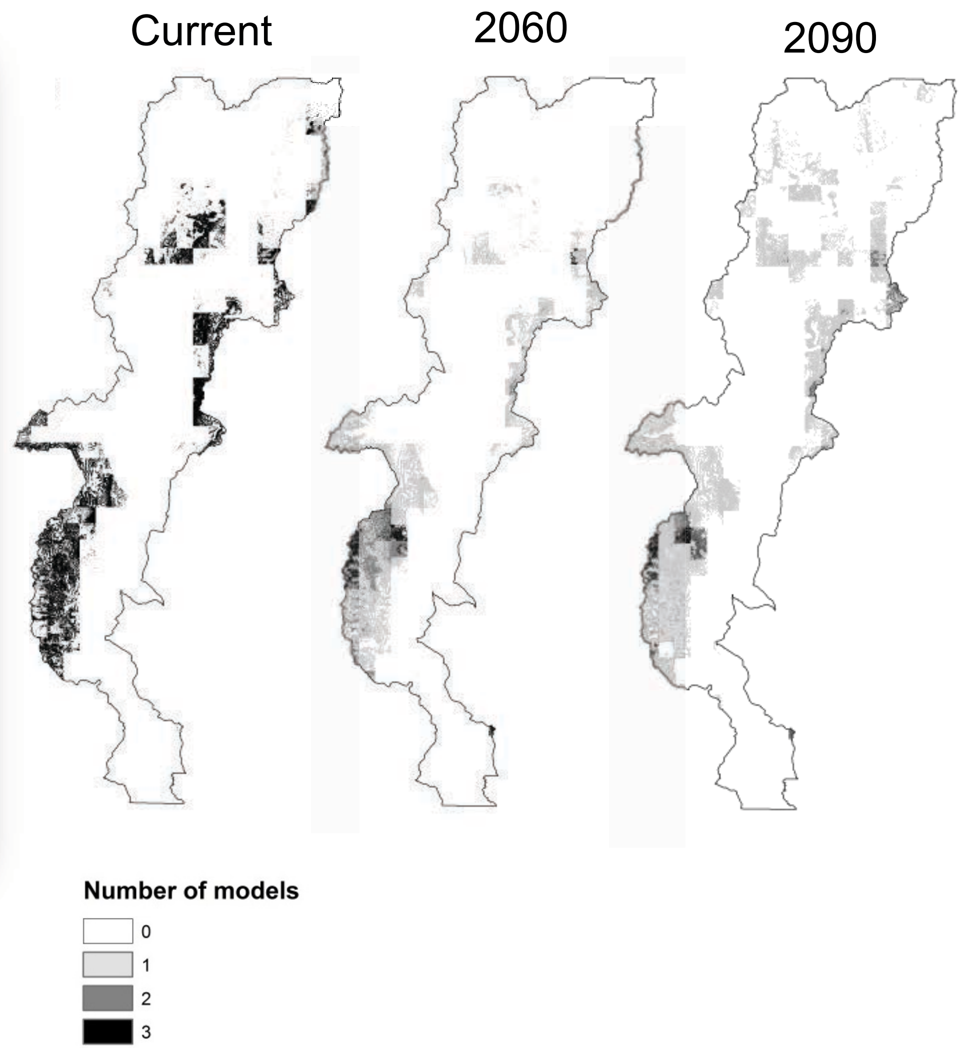
Hispid cotton rat
(Sigmodon hispidus)



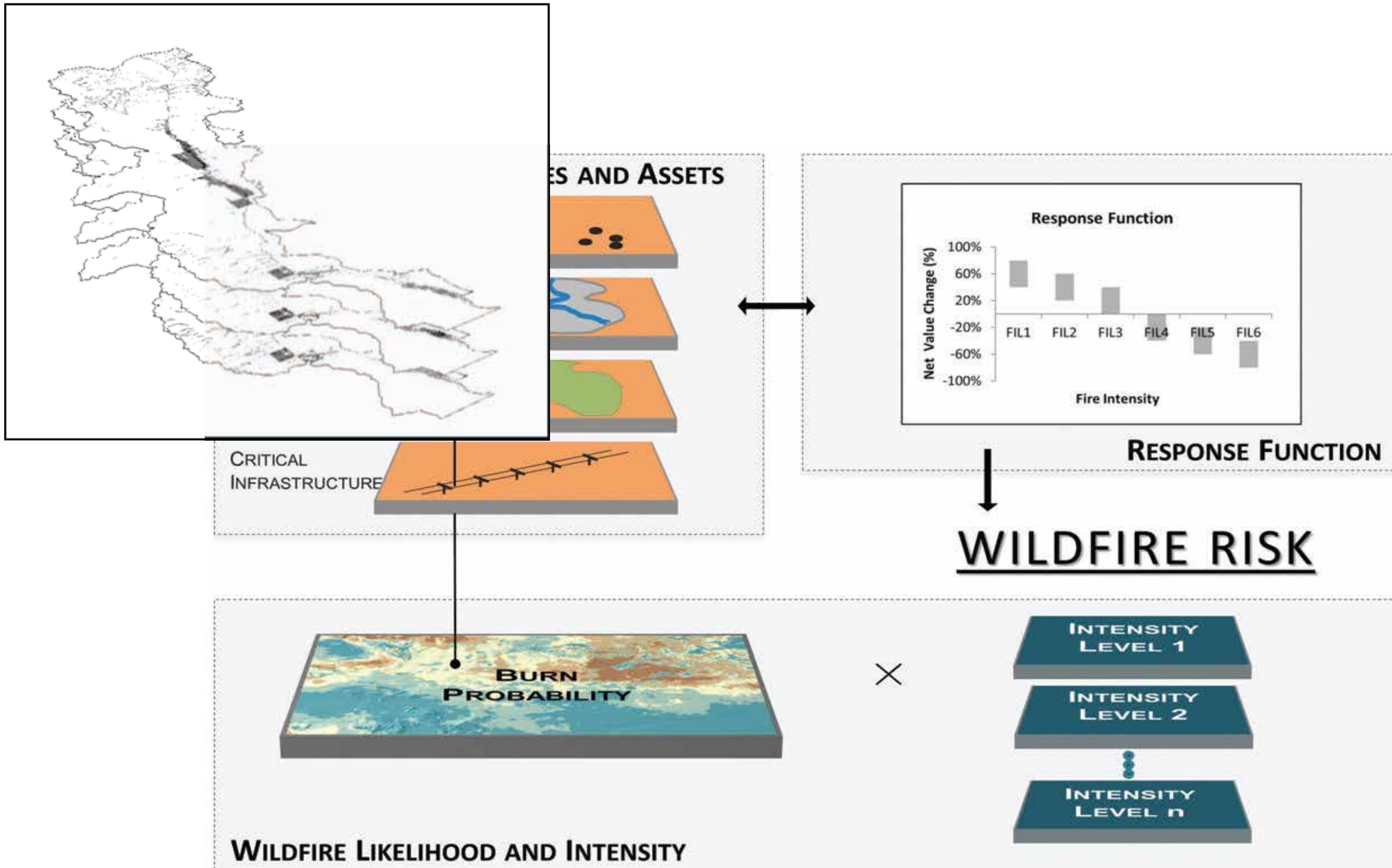


Long-legged Myotis (*Myotis volans*)

Geographical distribution of
(Warner & Czapleski, 1984)



Step 2. Creating fire risk layer for species

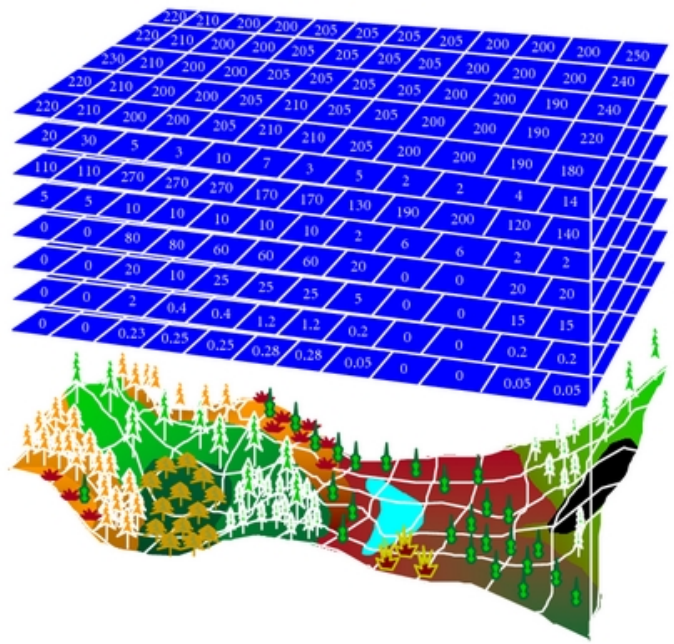


Geospatial concept of wildfire risk assessment framework (Scott et al. 2013)

Large Fire Simulation (FSim) system

(Finney et al. 2011)

- Simulates large fires on an annual basis
- Incorporates the effects of fire suppression
- Inputs from LANDFIRE project
- Outputs Overall burn probability, Relative burn probabilities at six flame lengths, and Mean fireline intensity



Rachel Loehman

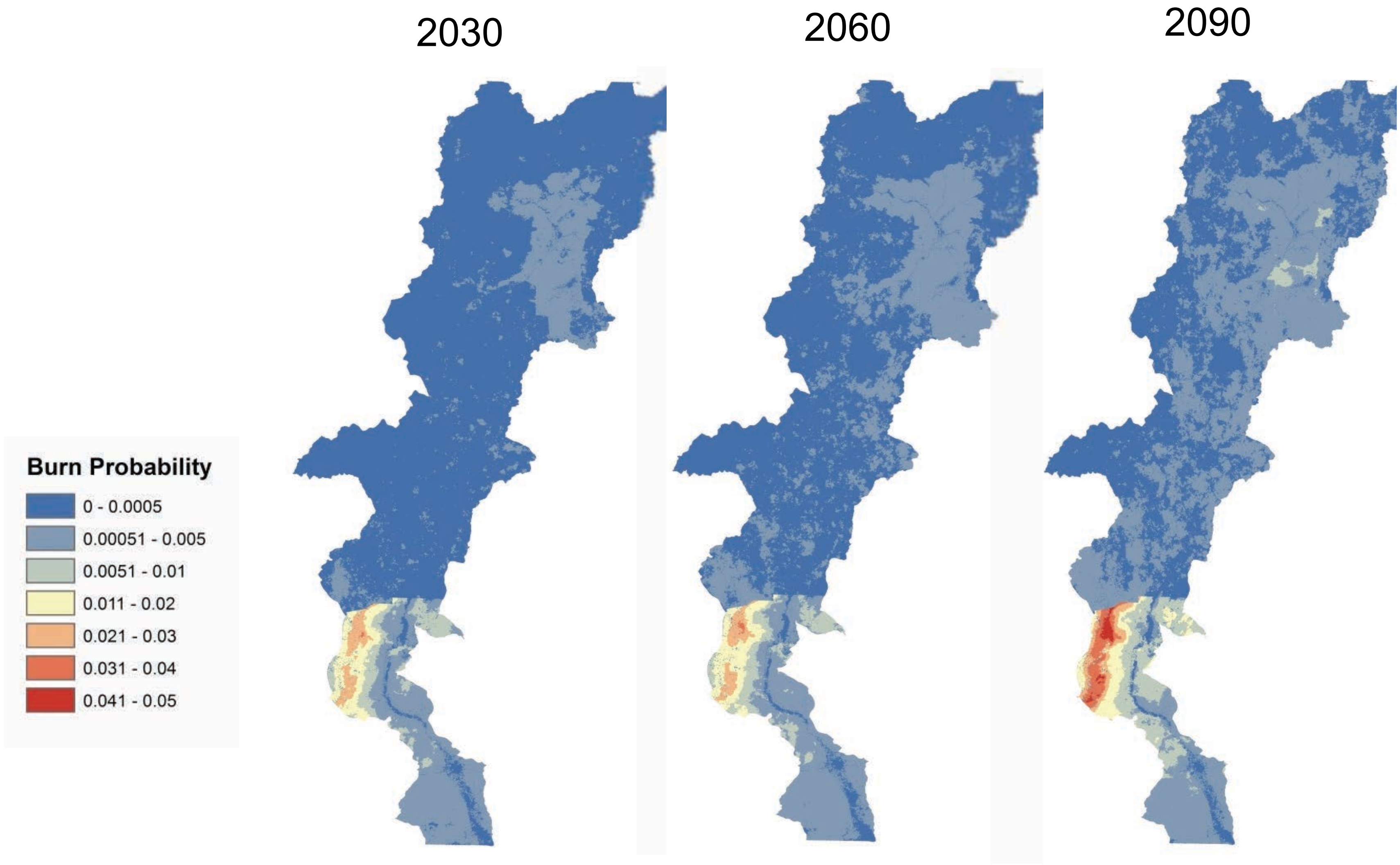
Lisa Holsinger

USDA

Fire, Fuel, and Smoke Science Program

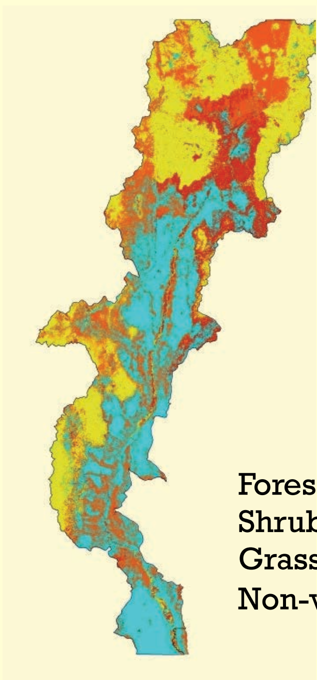
Rocky Mountain Research Station

Mean Annual Burn Probability



Creating Fire Type Layer

Vegetation type*



Forest
Shrub
Grass
Non-veg

X

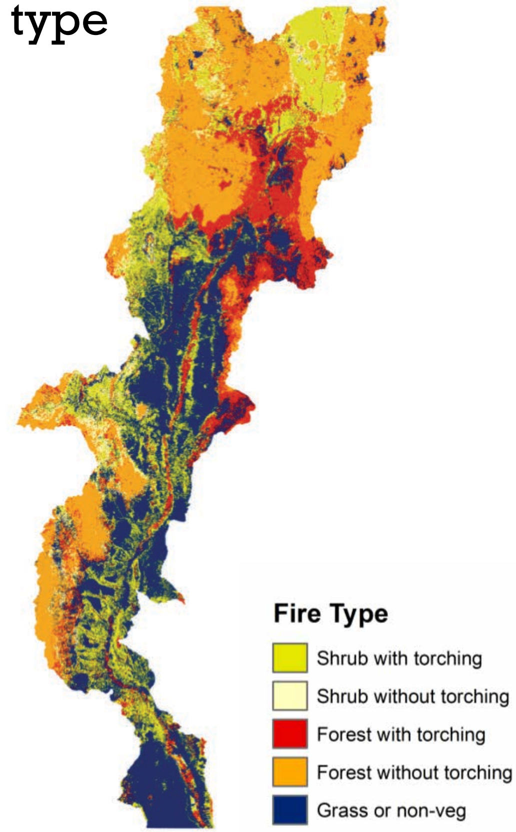
Canopy Base Height (CBH)*

Torching (cfl>cbh)
Non-torching (cfl<chb)

Conditional Flame Length (CFL)

* Derived from Landfire Biophysical Settings (BpS) data

Fire type



Conditional Flame Length (CFL) layers for each time period were classified into four categories (taking after Calkin et al. 2010): 1. Low = 0-0.61 -> 0.62; 2. Mod=0.61-1.83 -> 1.83; 3. High=1.83-3.66 -> 3.66; 4. Very High=3.66-7.62 -> 7.62

Classified species risk to each fire type

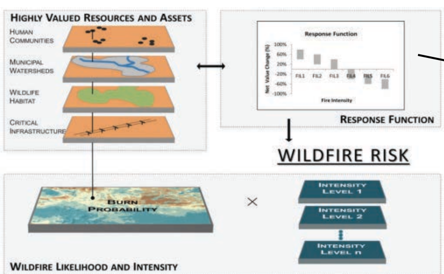
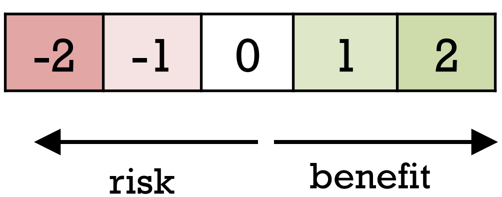
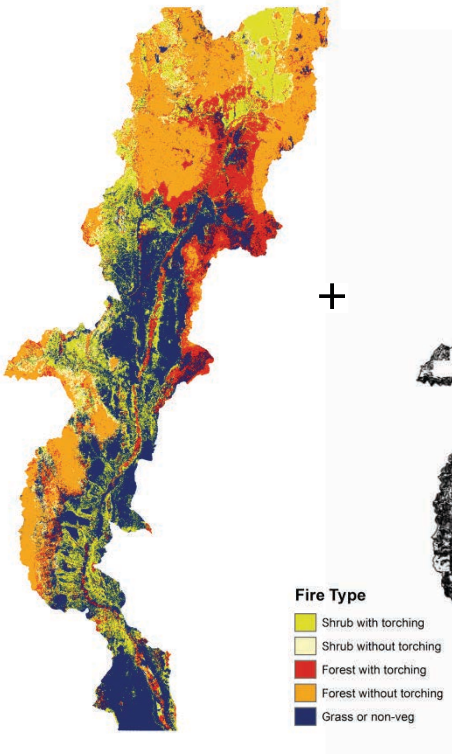


Table 1. Species response scores used for fire risk maps.

Species	shrub with torching	shrub without torching	forest with torching	forest without torching	grass or non-veg
Empidonax t. extimus	-2	-1	-2	-1	0
Oriothlypis luciae	-2	-2	-2	-1	0
Coccyzus a. occidentalis	-2	-1	-2	-1	0
Myotis yumanensis -	0	0	-2	0	0
M. yumanensis -foraging	1	1	1	1	0
Myotis occultus - roosting	0	0	-2	0	0
M. occultus - foraging	1	1	1	1	0
M. volans - roosting	0	0	-2	0	0
M. volans - foraging	1	1	1	1	0
Sigmodon hispidus	-2	-1	-2	-1	-1
Zapus h. luteus	-2	-1	-2	-1	-2
Chrysemys picta belli	-2	-1	-2	-1	-1



Fire risk map



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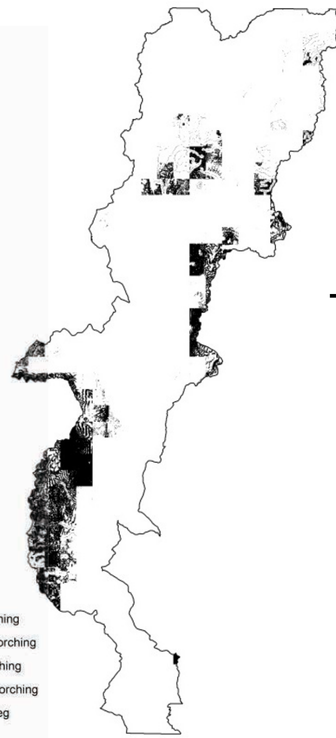

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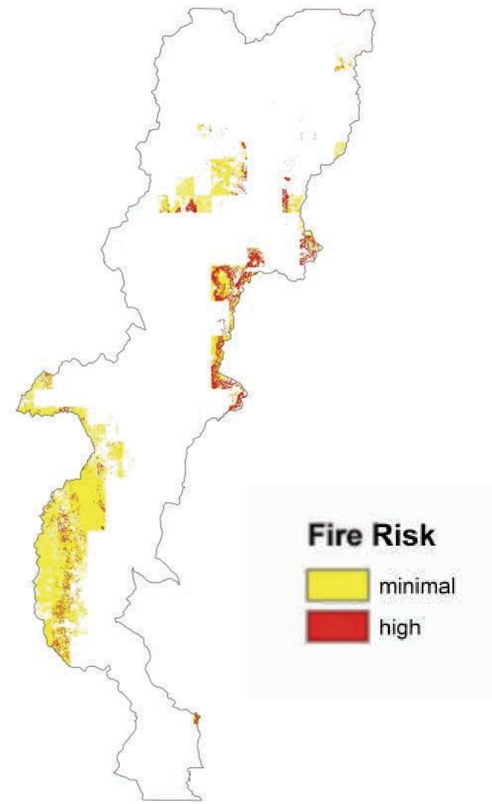
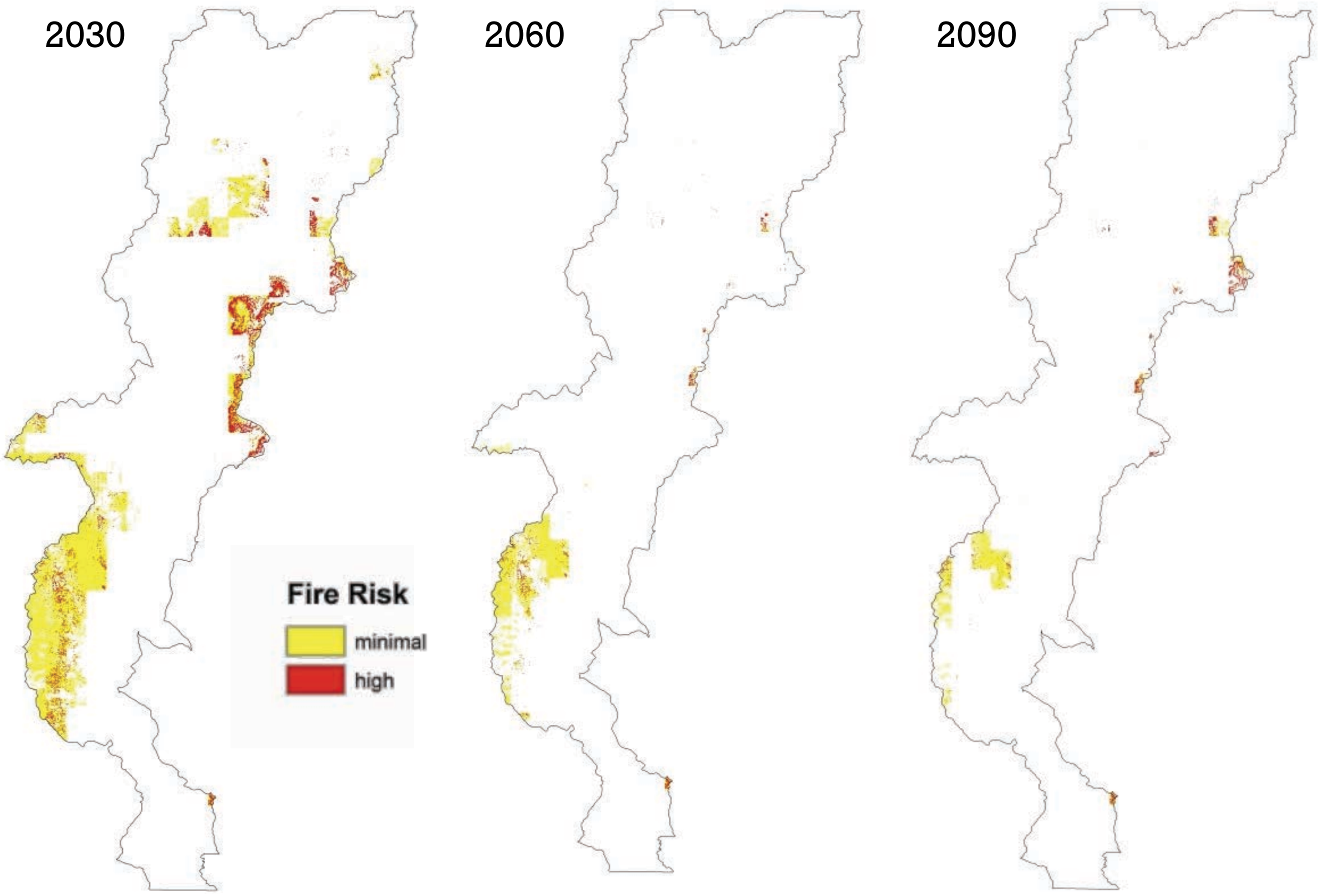
Response scores

1	0
2	0
3	-2
4	0
5	0

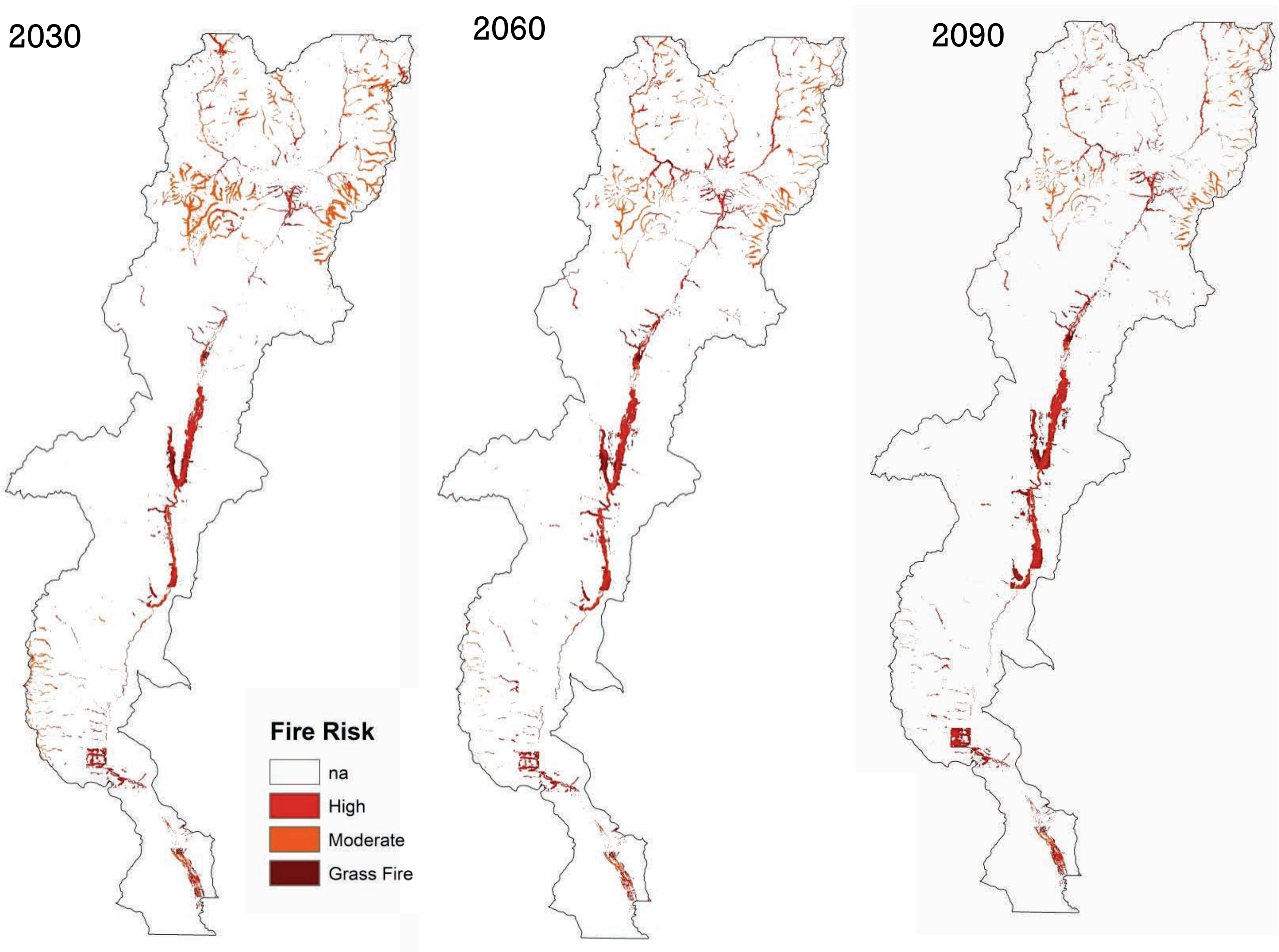
=



Myotis volans: Consensus predictions for suitable habitat X Fire risk



Zapus luteus: Consensus predictions for suitable habitat X Fire risk



Impact models

Useful for

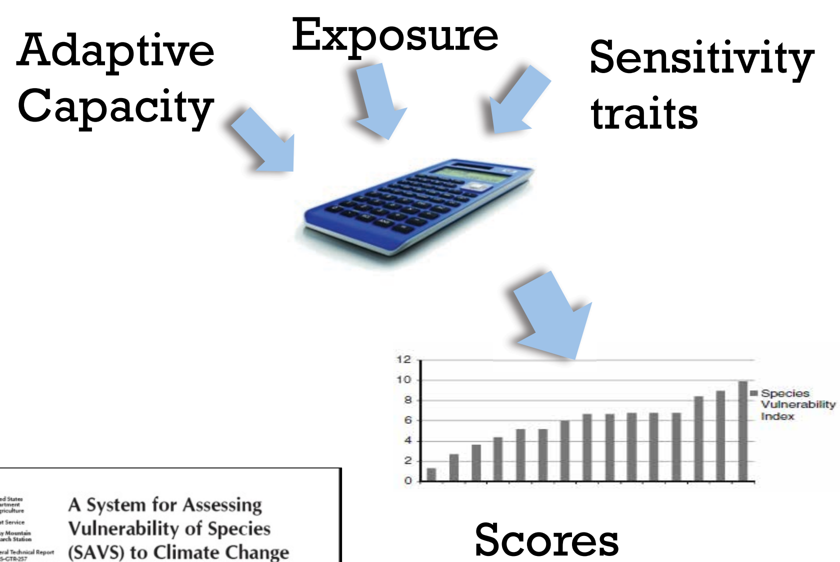
- Estimating magnitude impact
- Provide information on refugia
- Identifying need for intervention
- Scenario based exercises

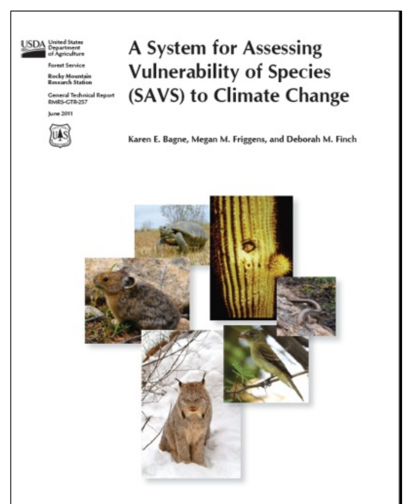
Not useful for:

- Predicting future distributions of species
- Predicting species adaptive capacity
- Predicting indirect exposure and sensitivity

Step 3. Vulnerability scoring for non-modeled climate impacts

- System for Assessing Vulnerability (SAVS) to Climate Change (Bagne et al., 2011)
- 22 Species traits predictive of species response to climate impacts
- Includes traits relating to habitat, physiology, phenology and biotic interactions



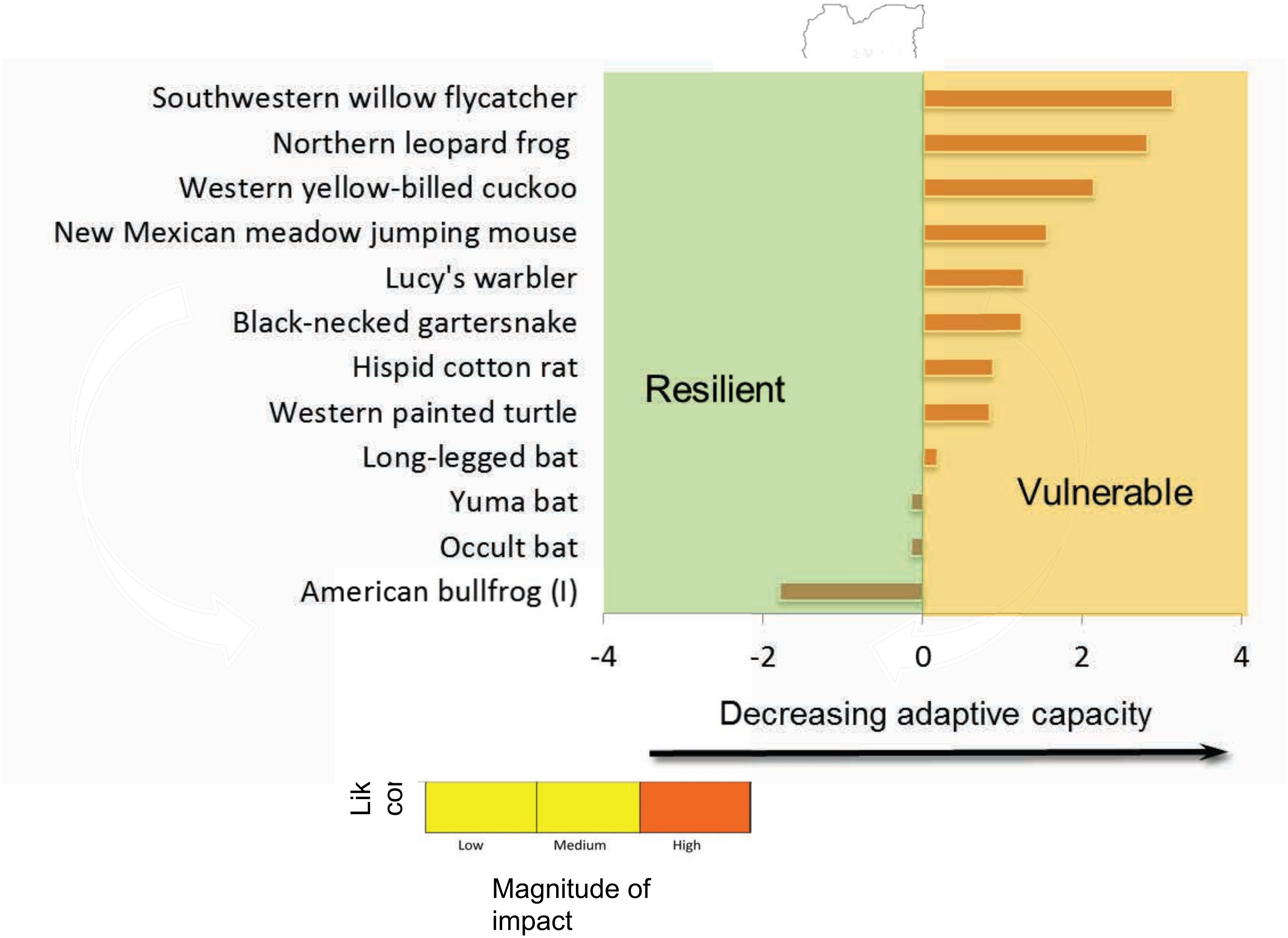

A System for Assessing Vulnerability of Species (SAVS) to Climate Change

Karen E. Bagne, Megan M. Friggens, and Deborah M. Finch

Modified SAVS vulnerability scoring system

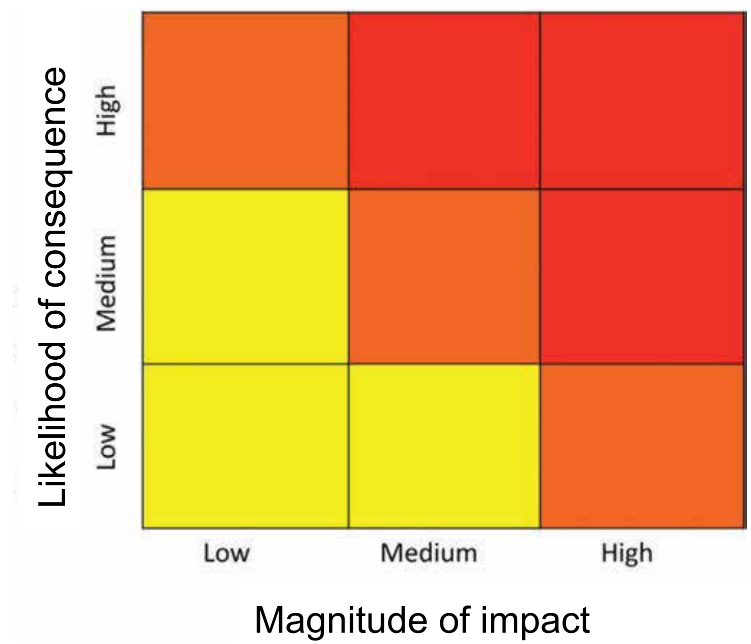
Questions	Characteristic
1. Changes to non-modeled habitat components	Exposure
2. Change in habitat quality	Exposure
3. Dispersal ability (Site fidelity or other limitations)	Adaptive Capacity
4. Reliance on migratory or transitional habitats	Sensitivity
5. Increase or decrease in physiological range limitation	Adaptive Capacity/Sensitivity
6. Sex ratios determined by temperature or food changes	Sensitivity
7. Response to predicted extreme weather events/disturbances	Sensitivity
8. Changes to daily activity period	Sensitivity
9. Variable life history traits or coping strategies	Adaptive Capacity
10. Ability to outlive limiting conditions	Sensitivity
11. Migrates/hibernates in response to weather cues	Sensitivity
12. Reliance on weather mediated resource (e.g. insect emergence)	Sensitivity
13. Spatial or temporal separation between critical resources and life history stages	Sensitivity
14. Can adjust timing of critical activities	Adaptive Capacity
15. Likelihood for decreased food resource	Sensitivity
16. Likelihood of increase predation	Sensitivity
17. Loss of important symbiotic species	Sensitivity
18. Increase in high mortality/morbidity disease	Sensitivity
19. Increased competitive pressures	Sensitivity

Vulnerability scores for RG species

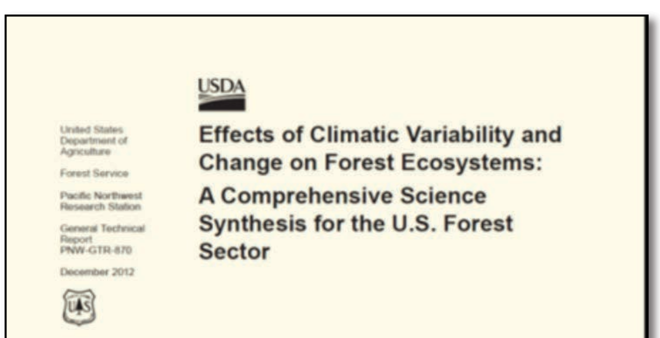


Using risk matrix for climate change studies

- Risk analysis is helpful for identifying or distinguishing between management strategies
- Indicated for situations where there is not enough time or resources to address all risks
- First applied by Iverson et al., 2011 (trees), Mathews and Friggens, 2013 (birds)



Modified from Yohe and Leichenko, 2010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United States Department of Agriculture

Forest Service

Pacific Northwest Research Station

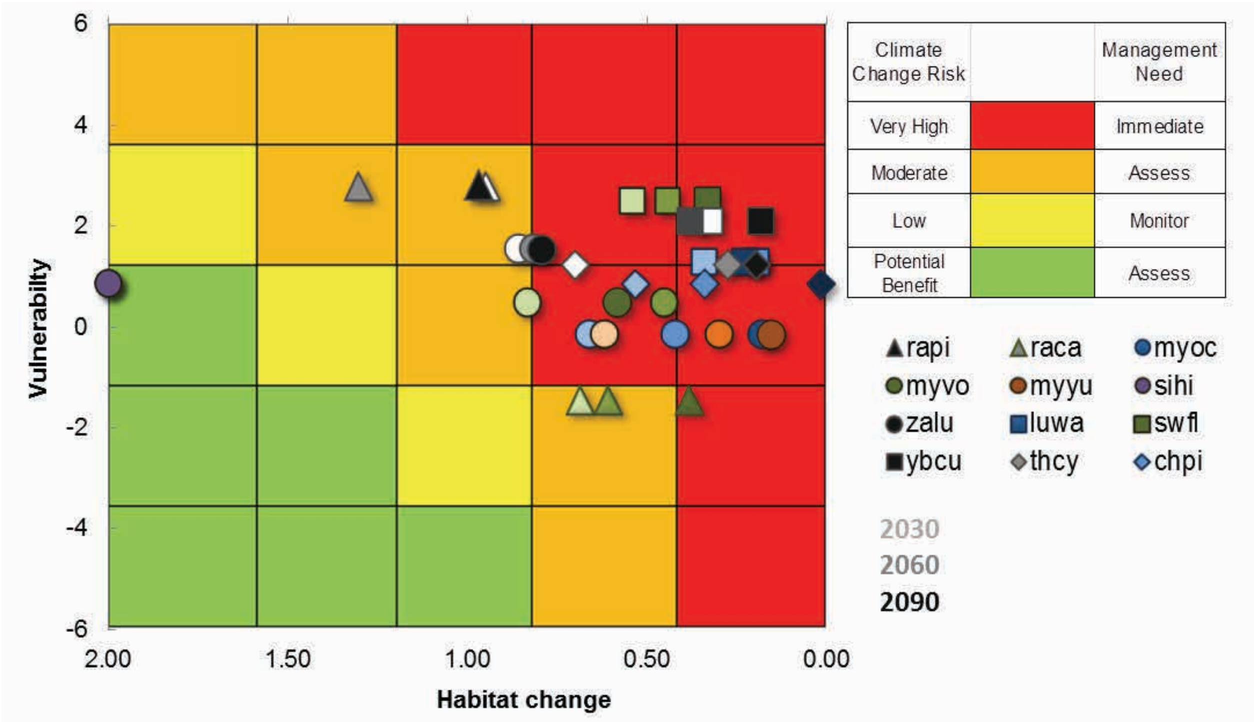
General Technical Report PNW-GTR-870

December 2012

Effects of Climatic Variability and Change on Forest Ecosystems:

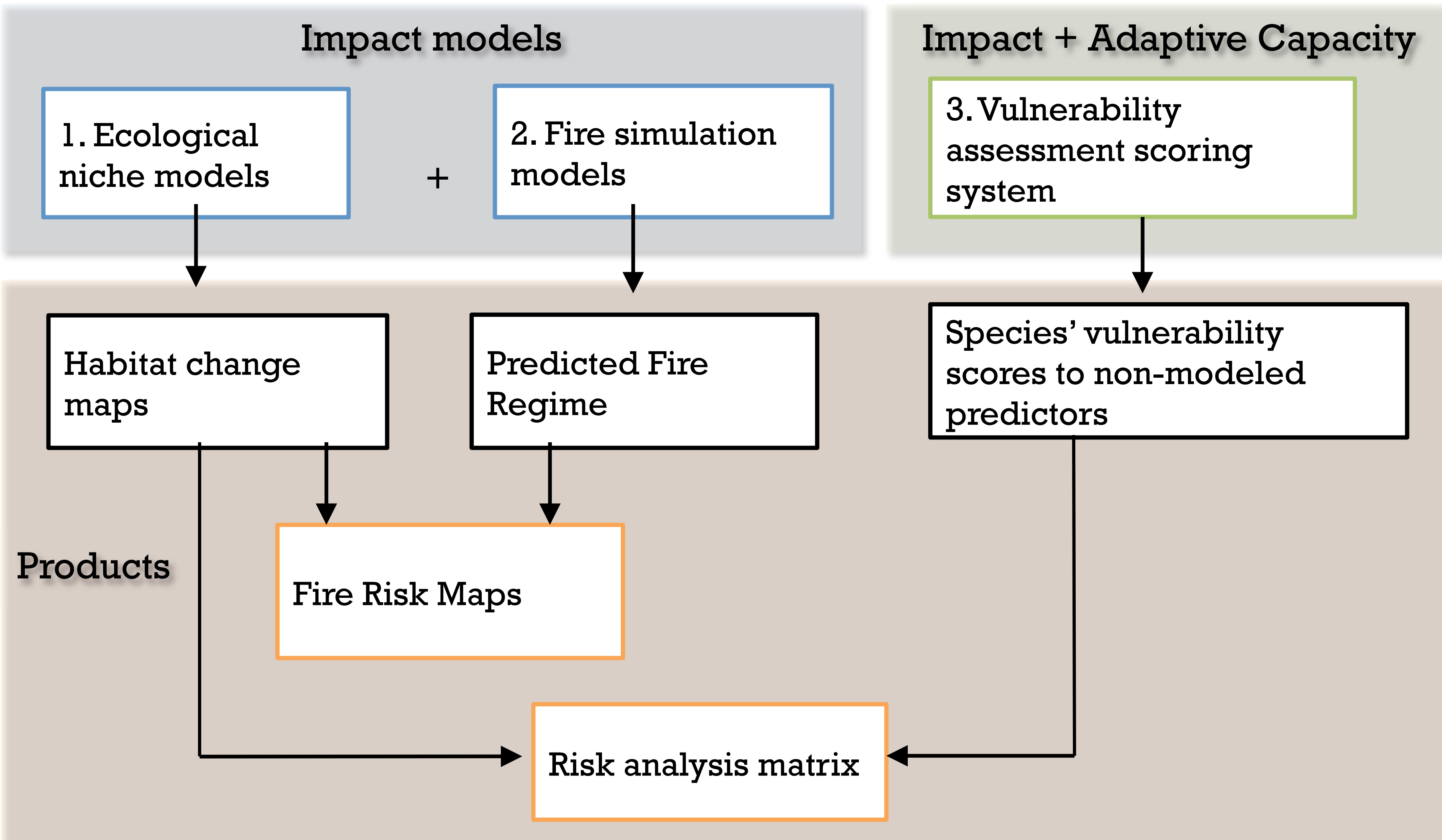
A Comprehensive Science Synthesis for the U.S. Forest Sector

Risk Matrix for 12 species inhabiting riparian areas along the Rio Grande



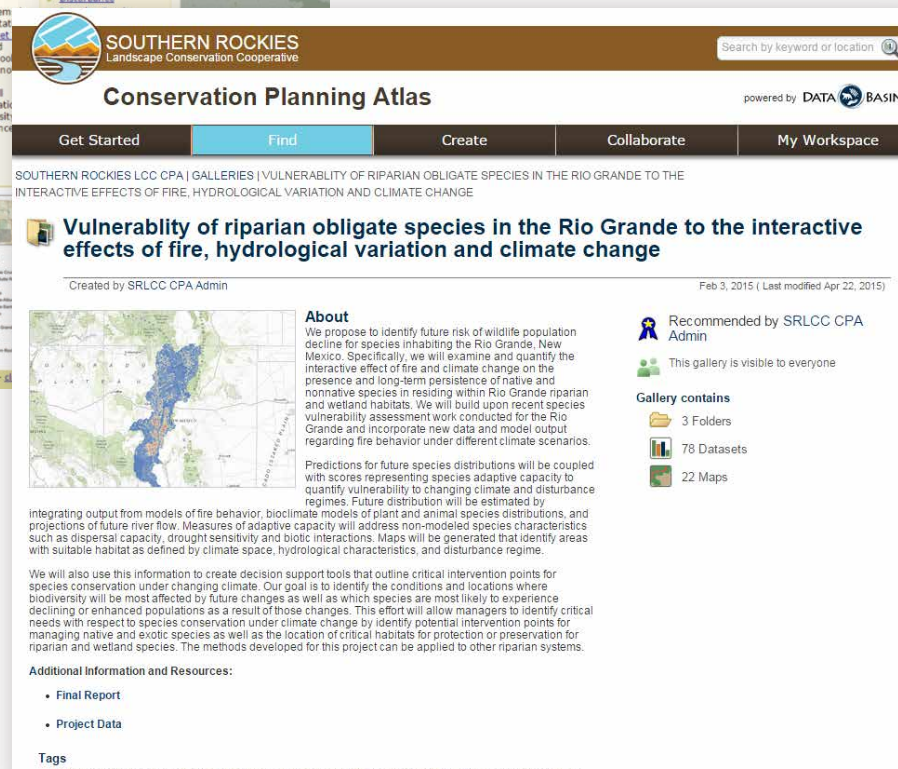
rapi= Lithobates (*Rana) pipiens* (Northern Leopard frog), raca= *L. (Rana) catesbeiana* (American bullfrog), myoc=*Myotis occultus* (Occult bat), myvo= *M. volans* (long-legged bat), myyu= *M. yumanensis* (Yuma bat), sihi=*Sigmodon hispidus* (Hispid cotton rat), zalu=*Zapus luteus* (New Mexico Meadow jumping mouse), luwa= Lucy's warbler (*Oreothlypis luciae*), swfl=Southwestern willow flycatcher (*Empidonax traillii extimus*), ybcu= Yellow-billed cuckoo (*Coccyzus a. occidentalis*), thcy= *Thamnophis cyrtopsis* (black-necked gartersnake), and chpi= *Chrysemys picta belli* (Western painted turtle).

Framework for assessing species' vulnerability



To find data and more information:

[RMRS Project Page:](http://www.fs.fed.us/rm/grassland-shrubland-desert/research/projects/vulnerable-obligate-species/) http://www.fs.fed.us/rm/grassland-shrubland-desert/research/projects/vulnerable-obligate-species/



[The Southern Rockies Conservation Planning Atlas:](http://srlcc.databasin.org/)
http://srlcc.databasin.org/

Skip to [slide](#) demonstration


Thank you!!
meganfriggens@fs.fed.us

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www.fs.fed.us/rm/grassland-shrubland-desert/research/projects/vulnerable-obligate-species/

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Vulnerability of Riparian Obligate Species in the Rio Grande

Project Title

Vulnerability of Riparian Obligate Species in the Rio Grande to the Interactive Effects of Fire, Hydrological Variation and Climate Change

View final report (pdf) »

Abstract

Overview

The interaction of fire and climate change is predicted to have extreme effects for ecosystems in the interior western U.S. Climate will drive changes to river flows through modified precipitation regimes and higher temperatures that increase evapotranspiration rates (e.g. see Furniss et al. 2013). These changes will in turn increase the risk of severe fires within riparian woodland habitats, affecting species composition, function and structure. Resource managers need tools that identify the likely future of riparian habitats under various climate and fire scenarios, not only to focus limited resources on the most critical needs, but to identify opportunities for promoting natural regeneration of riparian woodland and wetland habitats. This project will create decision support tools to help outline critical intervention points for species conservation under changing climate. Our goal is to identify the conditions and locations where biodiversity will be most affected by future changes as well as which species are most likely to experience declining or enhanced populations as a result of those changes.

Background

The current project is using a coupled modeling approach that combines species distribution modeling (Iverson et al. 2011), fire behavior models (e.g. Finney et al., 2010), and vulnerability assessment methods (Bagne et al. 2011) to generate spatially explicit estimates of species vulnerability to the interactive effects of climate change and fire. This project is focused on habitats and animal species along the Rio Grande, NM (Figure 1).

Figure 1: Boundaries of Rio Grande study site - click to enlarge

The dominant vegetation along the Rio Grande transitions from mixed conifer woodlands to the north to open scrubland habitat in the south. The Bosque, or riparian forest, along the Rio Grande has high value for wildlife, but because of

Project Products

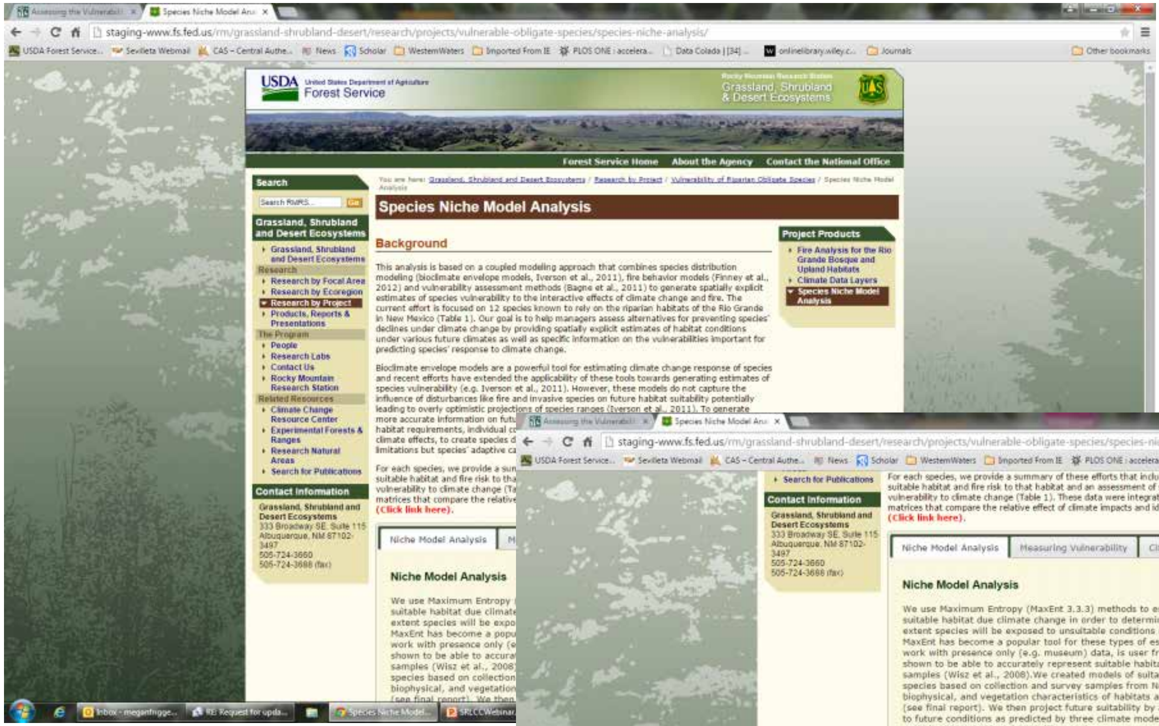
- Fire Analysis and Predictions
- Climate Data Layers
- Species Niche Model Analysis

Project Focal Areas

- Disturbance
- Invasive Species
- Restoration
- Ecosystem Sustainability & Management
- Climate Change

Project Ecoregions

- Subtropical Deserts
- The Great Plains including the Black Hills


staging-www.fs.fed.us/rm/grassland-shrubland-desert/research/projects/vulnerable-obligate-species/species-niche-analysis/
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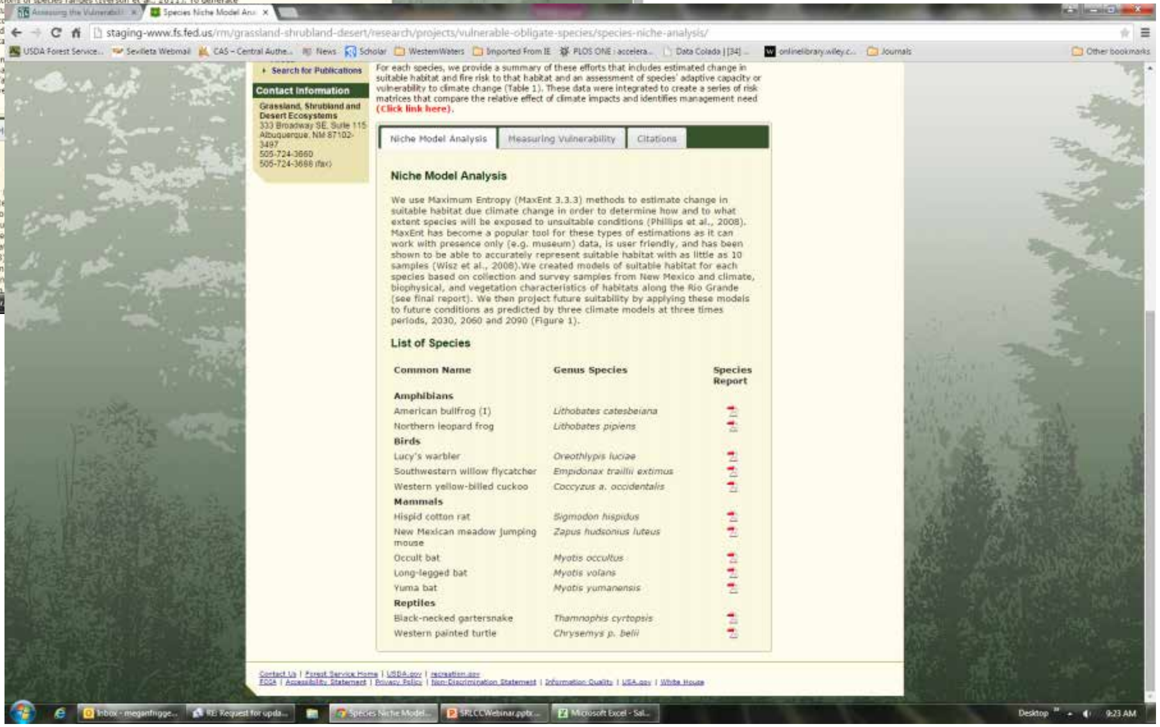
Species Niche Model Analysis
Background
This analysis is based on a coupled modeling approach that combines species distribution modeling (bioclimate envelope models, Iverson et al., 2011), fire behavior models (Finney et al., 2012) and vulnerability assessment methods (Bagne et al., 2011) to generate spatially explicit estimates of species vulnerability to the interactive effects of climate change and fire. The current effort is focused on 12 species known to rely on the riparian habitats of the Rio Grande in New Mexico (Table 1). Our goal is to help managers assess alternatives for preventing species' declines under climate change by providing spatially explicit estimates of habitat conditions under various future climates as well as specific information on the vulnerabilities important for predicting species' response to climate change.
Bioclimate envelope models are a powerful tool for estimating climate change response of species and recent efforts have extended the applicability of these tools towards generating estimates of species vulnerability (e.g. Iverson et al., 2011). However, these models do not capture the influence of disturbances like fire and invasive species on future habitat suitability potentially leading to overly optimistic projections of species ranges (Iverson et al., 2011).
Project Products
Fire Analysis for the Rio Grande Bosque and Upland Habitats
Climate Data Layers
Species Niche Model Analysis
Contact Information
Grassland, Shrubland and Desert Ecosystems
333 Broadway SE, Suite 115
Albuquerque, NM 87102-3497
505-724-3660
505-724-3688 (fax)


For each species, we provide a summary of these efforts that includes estimated change in suitable habitat and fire risk to that habitat and an assessment of species' adaptive capacity or vulnerability to climate change (Table 1). These data were integrated to create a series of risk matrices that compare the relative effect of climate impacts and identifies management need (Click link here).
Niche Model Analysis
Measuring Vulnerability
Citations
Niche Model Analysis
We use Maximum Entropy (MaxEnt 3.3.3) methods to estimate change in suitable habitat due climate change in order to determine how and to what extent species will be exposed to unsuitable conditions (Phillips et al., 2008). MaxEnt has become a popular tool for these types of estimations as it can work with presence only (e.g. museum) data, is user friendly, and has been shown to be able to accurately represent suitable habitat with as little as 10 samples (Wisz et al., 2008).We created models of suitable habitat for each species based on collection and survey samples from New Mexico and climate, biophysical, and vegetation characteristics of habitats along the Rio Grande (see final report). We then project future suitability by applying these models to future conditions as predicted by three climate models at three times periods, 2030, 2060 and 2090 (Figure 1).
List of Species
Common Name
Genus Species
Species Report
Amphibians
American bullfrog (I)
Lithobates catesbeiana
Northern leopard frog
Lithobates pipiens
Birds
Lucy's warbler
Oreothlypis luciae
Southwestern willow flycatcher
Empidonax traillii extimus
Western yellow-billed cuckoo
Coccyzus a. occidentalis
Mammals
Hispid cotton rat
Sigmodon hispidus
New Mexican meadow jumping mouse
Zapus hudsonius luteus
Occult bat
Myotis occultus
Long-legged bat
Myotis volans
Yuma bat
Myotis yumanensis
Reptiles
Black-necked gartersnake
Thamnophis cyrtopsis
Western painted turtle
Chrysemys p. belli

Vulnerablity of riparian obligate species in the Rio Grande to the interactive effects of fire, hydrological variation and climate change

Created by SRLCC CPA Admin

Feb 3, 2015 (Last modified May 13, 2015)

About

We propose to identify future risk of wildlife population decline for species inhabiting the Rio Grande, New Mexico. Specifically, we will examine and quantify the interactive effect of fire and climate change on the presence and long-term persistence of native and nonnative species in residing within Rio Grande riparian and wetland habitats. We will build upon recent species vulnerability assessment work conducted for the Rio Grande and incorporate new data and model output regarding fire behavior under different climate scenarios.

Predictions for future species distributions will be coupled with scores representing species adaptive capacity to quantify vulnerability to changing climate and disturbance regimes. Future distribution will be estimated by integrating output from models of fire behavior, bioclimate models of plant and animal species distributions, and projections of future river flow. Measures of adaptive capacity will address non-modeled species characteristics such as dispersal capacity, drought sensitivity and biotic interactions. Maps will be generated that identify areas with suitable habitat as defined by climate space, hydrological characteristics, and disturbance regime.

We will also use this information to create decision support tools that outline critical intervention points for species conservation under changing climate. Our goal is to identify the conditions and locations where biodiversity will be most affected by future changes as well as which species are most likely to experience declining or enhanced populations as a result of those changes. This effort will allow managers to identify critical needs with respect to species conservation under climate change by identify potential intervention points for managing native and exotic species as well as the location of critical habitats for protection or preservation for riparian and wetland species. The methods developed for this project can be applied to other riparian systems.

Additional Information and Resources served from LC MAP:

- Final Report
- Project Data

Tags

native species, wetlands, species distribution, fire, climate change, vulnerability, riparian, decision support tools, non-native species, LCC, GIS, riparian obligate species

Recommended by SRLCC CPA Admin

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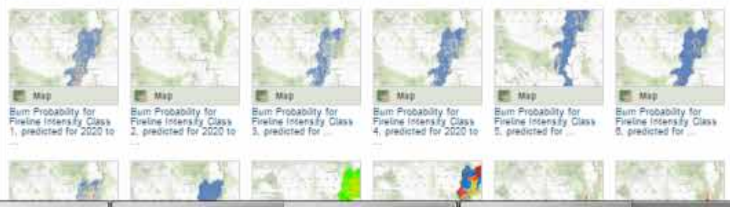

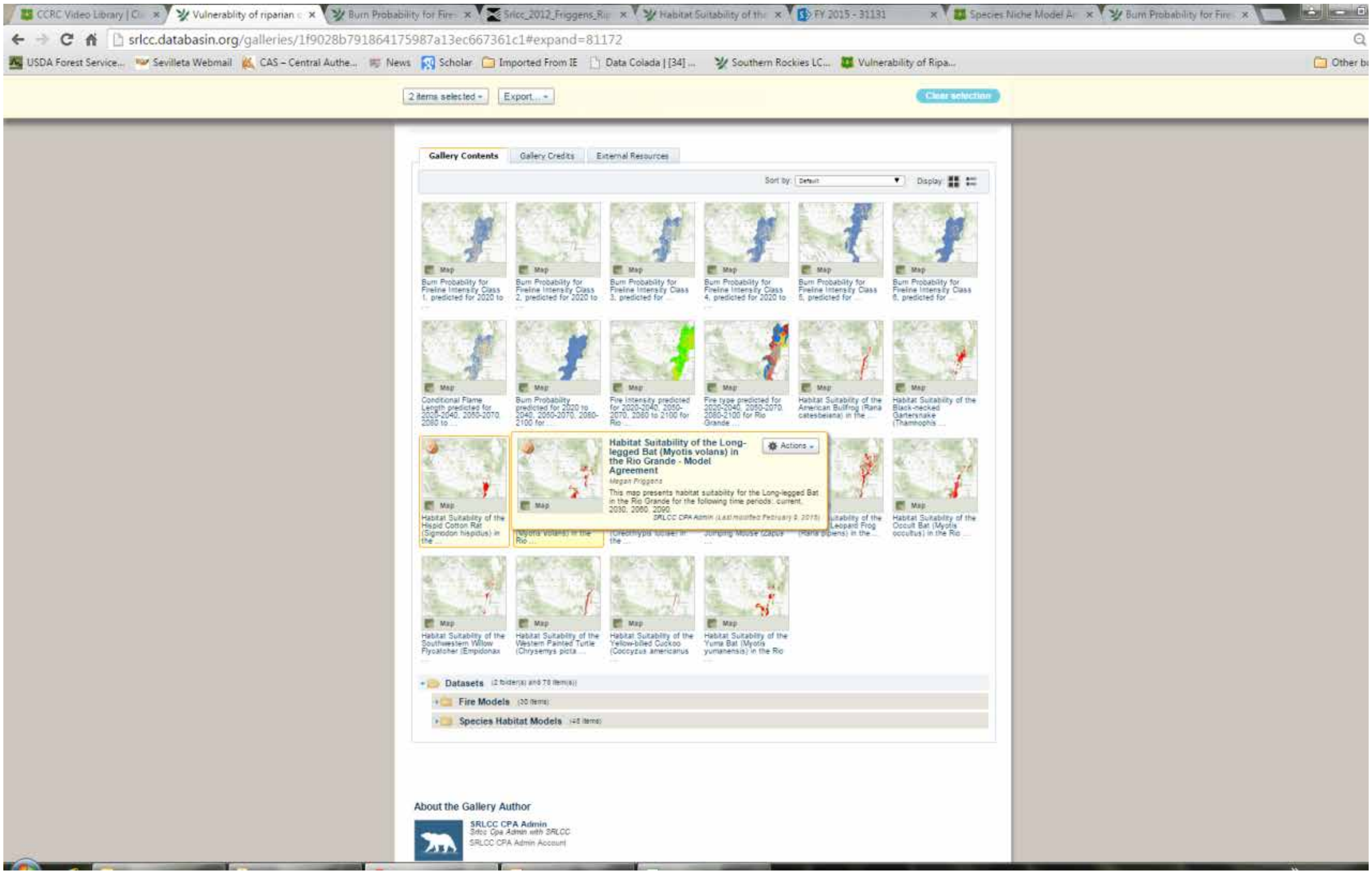

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Fire type predicted for 2020-2040, 2050-2070, 2080-2100 for Rio Grande ...
Habitat Suitability of the American Bullfrog (Rana catesbeiana) in the ...
Habitat Suitability of the Black-necked Gartersnake (Thamnophis ...
Habitat Suitability of the Hispid Cotton Rat (Sigmodon hispidus) in the ...
Habitat Suitability of the Long-legged Bat (Myotis volans) in the Rio Grande - Model Agreement
Megan Friggens
This map presents habitat suitability for the Long-legged Bat in the Rio Grande for the following time periods: current, 2030, 2060, 2090
Actions
Habitat Suitability of the Occult Bat (Myotis occultus) in the Rio ...
Habitat Suitability of the Southwestern Willow Flycatcher (Empidonax ...
Habitat Suitability of the Western Painted Turtle (Chrysemys picta ...
Habitat Suitability of the Yellow-billed Cuckoo (Coccyzus americanus ...
Habitat Suitability of the Yuma Bat (Myotis yumanensis) in the Rio ...
Datasets
Fire Models
Species Habitat Models
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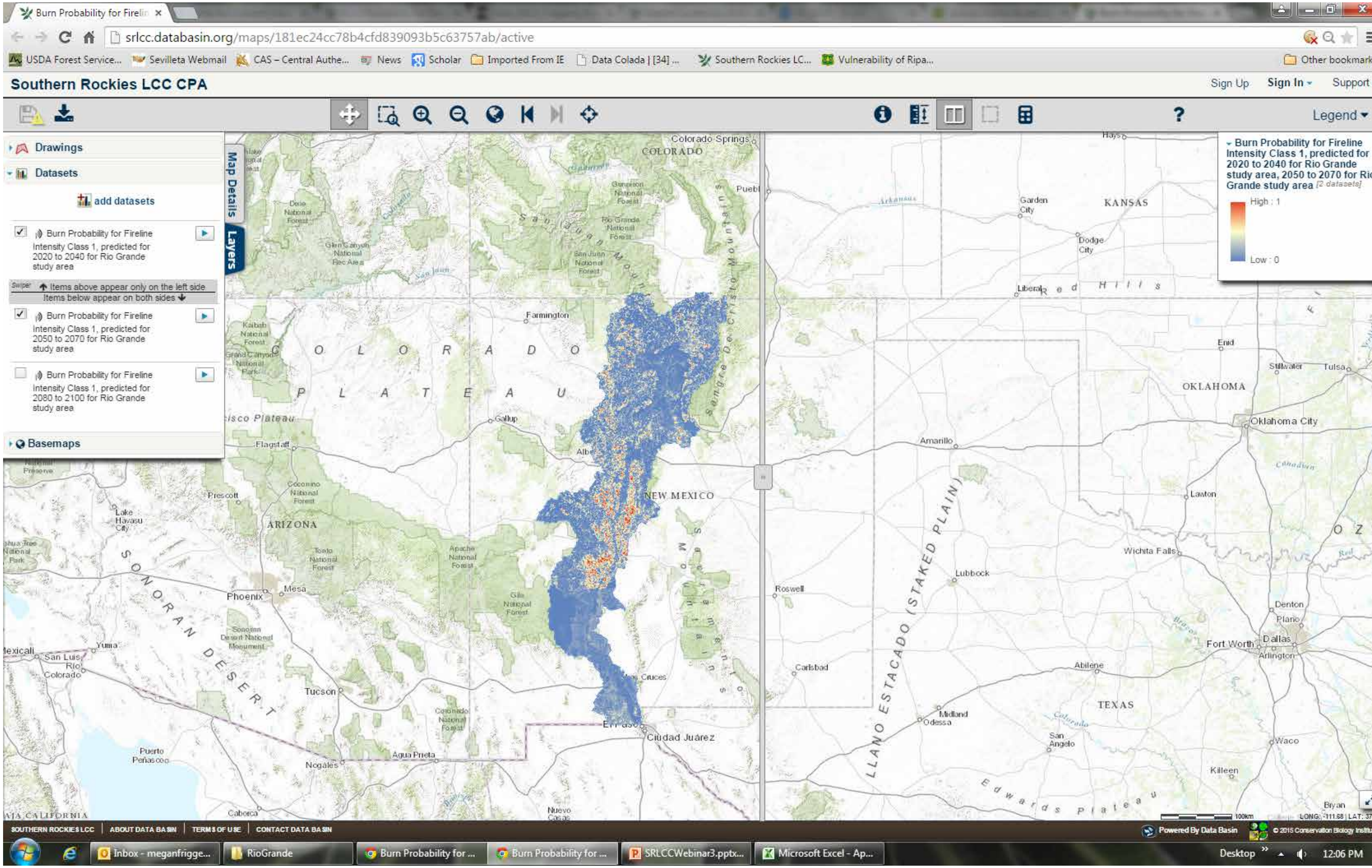

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Burn Probability for Fireline Intensity Class 1, predicted for 2050 to 2070 for Rio Grande study area
Burn Probability for Fireline Intensity Class 1, predicted for 2080 to 2100 for Rio Grande study area
Basemaps
Map Details
Layers
Burn Probability for Fireline Intensity Class 1, predicted for 2020 to 2040 for Rio Grande study area, 2050 to 2070 for Rio Grande study area [2 datasets]
High : 1
Low : 0
COLORADO
NEW MEXICO
ARIZONA
TEXAS
OKLAHOMA
KANSAS
COLORADO PLATEAU
SONORAN DESERT
LLANO ESTACADO (STAKED PLAIN)
Colorado Springs
Farmington
Gallup
Flagstaff
Prescott
Phoenix
Mesa
Tucson
Ciudad Juárez
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Carlsbad
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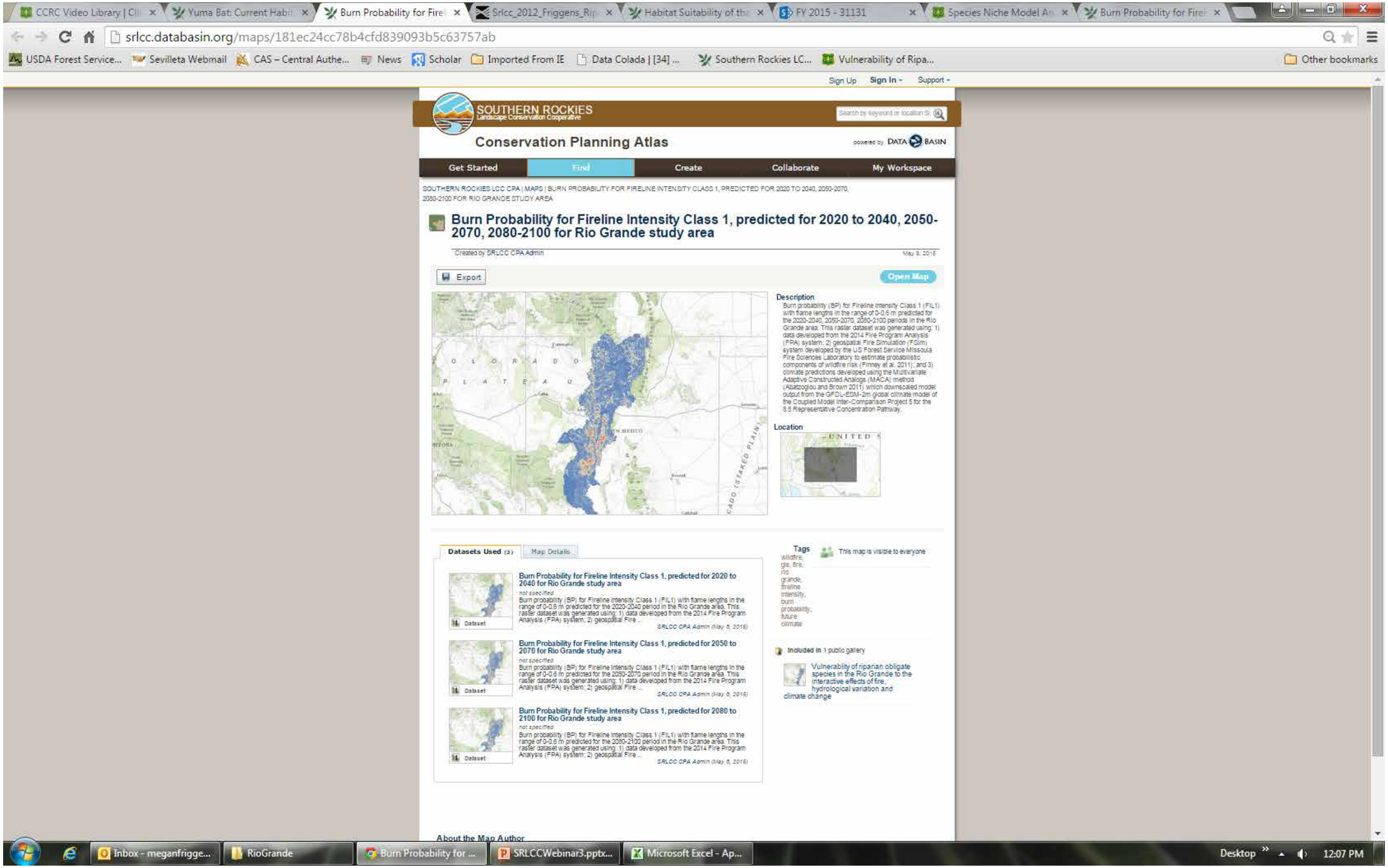

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My Workspace
Burn Probability for Fireline Intensity Class 1, predicted for 2020 to 2040, 2050-2070, 2080-2100 for Rio Grande study area
Export
Open Map
Description
Location
Datasets Used (3)
Map Details
Burn Probability for Fireline Intensity Class 1, predicted for 2020 to 2040 for Rio Grande study area
Burn Probability for Fireline Intensity Class 1, predicted for 2050 to 2070 for Rio Grande study area
Burn Probability for Fireline Intensity Class 1, predicted for 2080 to 2100 for Rio Grande study area
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