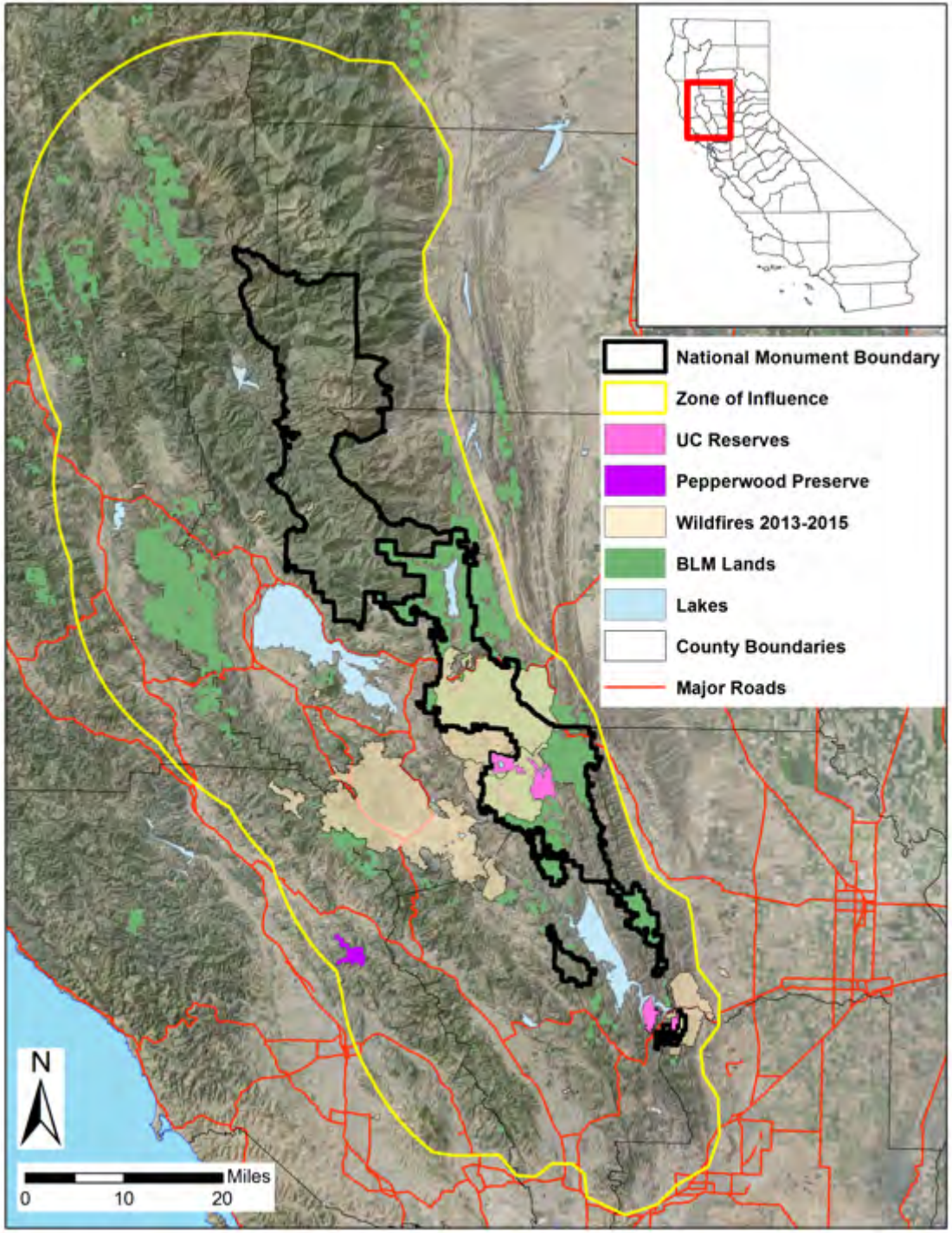
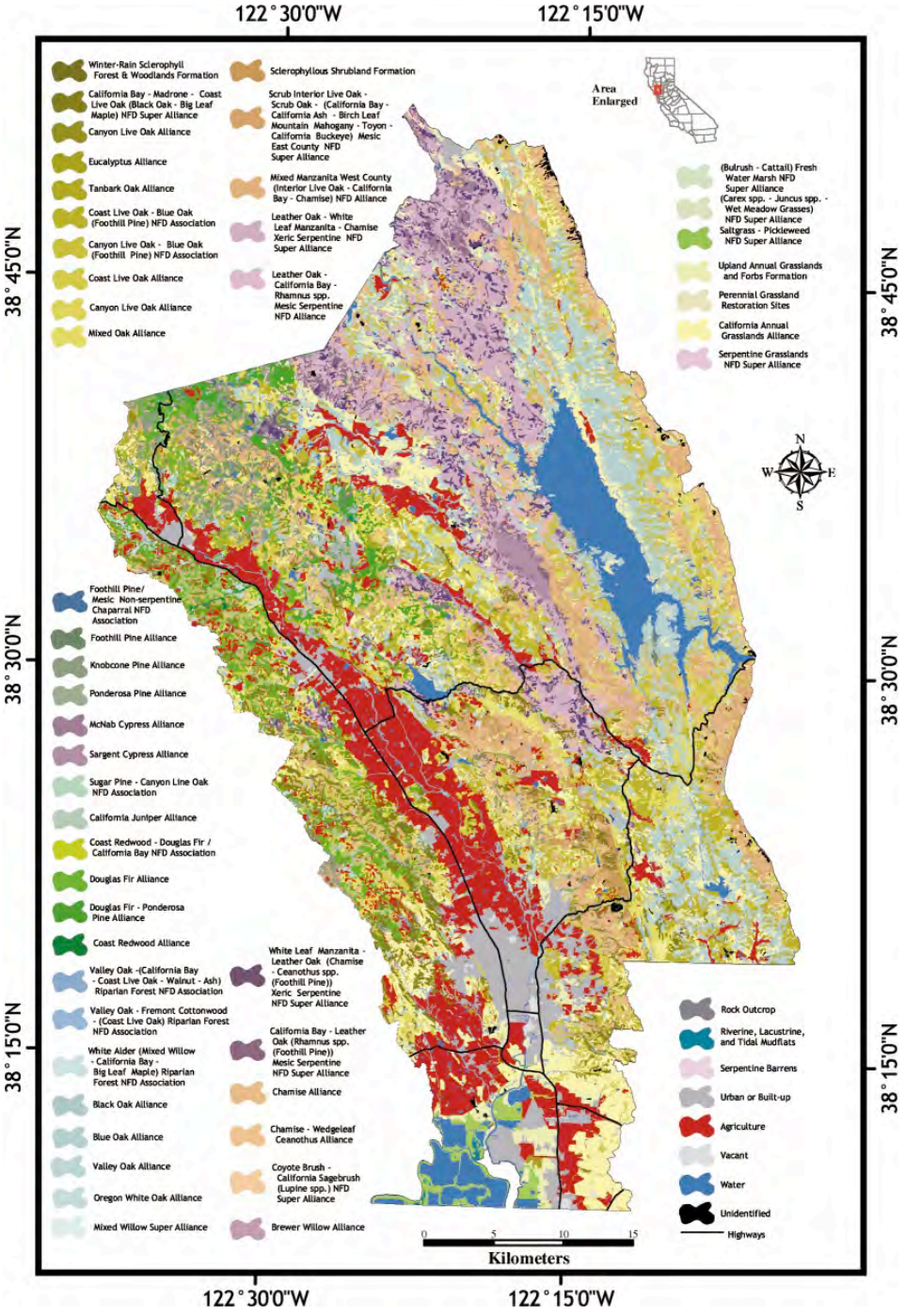


Exposure to climate change, regional GIS compilations and an adventure with historical maps

October 3, 2017
Jim Thorne
jhthorne@ucdavis.edu
University of California, Davis



Outline:

1. UC Davis's Role in Snow Mtn NM
   - A) Technical Support
   - B) Updating the Vegetation Maps

2. Climate Exposure

3. Soil Vegetation Survey Maps – an opportunity not to be missed!

UC Davis' Role with Snow Mountain NM/BLM

To supply technical support and data products for the development of strategic management plans and resource management operations.

About 15 scientists 'on call' if their expertise is needed, including:

- **Geologists**
- **Plant specialists**
- **GIS**
- **Remote Sensing**

BLM has indicated that compiling an up-to-date vegetation map is one of the top priorities.

Administrative Boundaries

- California Protected Areas Database (CPAD)
- City Limits
- County Boundaries
- Incorporated City Limits
- National Conservation Easement Database
- Private Water Districts
- Spheres of Influence
- State Water Districts

Agriculture

- DWR Land Cover
- Farmland Mapping and Monitoring Program

Air

- Air Quality Basins
- Air Quality Districts

Biodiversity

- California Natural Diversity Database (CNDDB)
- Critical Habitats

Census

- American Community Survey
- Population, HU, group quarters
- Racial/ethnic information

Climate Change

- Downscaled Forecasts
  - Hydro-Climatic Variables

Conservation Priority Areas

- Audubon Society Important Bird Areas
- BLM Area of Critical Environmental Concern
- CA Rangeland Coalition Priorities
- DFG Areas of Conservation Emphasis (ACEII)
- TNC Ecoregion Priorities

Energy

- BLM Solar and Wind Projects
- BLM Utility Corridors
- Dept. of Oil, Gas, and Geothermal Resources Districts
- Existing and Proposed solar and wind generation
- Geothermal Leases
- Geothermal Wells
- High Voltage Transmission Lines
- Known Geothermal Resource Areas
- Oil Fields/Administrative Areas

Energy (Continued)

- Oil Well Locations
- Proposed DOE 368 Energy Corridors
- Proposed Energy Corridor on Federal Land
- Renewable Energy Transmission Initiative (RETI) Phase 2B

Habitat

- California Essential Habitat Connectivity
- Dr. Huber's Dissertation Connectivity
- Vernal Pool Complexes

Land Cover

- 2001 National Land Cover Database (NLCD 2001)
- 2006 National Land Cover Database (NLCD 2006)
- BLM Grazing Allotments
- BLM Land Status
- BLM Land Use Plans
- Blue Ridge-Berryessa Natural Areas Map
- California Augmented Multisource Landcover map (CAML)
- CALVEG
- FRAP Best available multi-source
- FRAP Hardwood Rangeland Vegetation
- FRAP Riparian Vegetation in Hardwood Rangelands
- FRAP Vegetation (FVEG)
- Historic Vegetation (CSU Chico)
- Napa County Vegetation Map
- National Landscape Conservation System (NLCS) Wilderness Areas
- National Wetlands Inventory
- Potential natural Plant Communities (Kuchler 1976)
- Taylor Grazing Act Grazing Districts

Land Use Planning

- General Plans

Physical

- National Elevation Dataset (10m)

Recreation

- Bicycle Paths/Lanes (Grade separated/off road)
- Hiking Paths
- Local and Regional Parks

Risk

- Fire Threat

Soils

- SSURGO

Transportation

- Census TIGER
- Rail lines

Urban Growth Forecasts

- PIER

Water Resources

- Groundwater Basins
- Hydrologic Unit Maps
- Lakes
- Major Rivers
- National Hydrography Dataset (NHD) Medium and High Resolution
- Watersheds (CalWater)

Mendocino National Forest - Data list

- 138 datasets

ActivitiestoACTV160_022015
ActivitiestoACTV160_03302012
ActivitiestoACTV160_042013
ActivitiestoACTV160_06192012
ActivitiestoACTV160_06272011
ActivitiestoACTV160_072014
ActivitiestoACTV160_082013
ActivitiestoACTV160_082016
ActivitiestoACTV160_10132010
ActivitiestoACTV160_102012
ActivitiestoACTV160_102014
ActivitiestoACTV160_102015
ActivitiestoACTV160_12072011
ActivitiestoACTV160_122013
ActivityLine
ActivityPoint
ActivityPolygon
FuelsTreatment_pre2007
ProjectArea
Administrative
CulturalFeature
Elevation
Hydrology
LandSurvey
NaturalFeatures
QuadInformation
Recreation
Transportation
FishCriticalHabitat
FishRange
Bedrock_boundary
Bedrock_line
Bedrock_poly
Carbonates
PotentialNOAsbestos
InvasivePlants_CurrentMeasure
RustResistantSugarPine
SSO_GeneConsPlantation
TESPlant_EO_Current
WaterHowelliaPonds
Structure
BAERSoilBurnSeverity

FireResponseArea
FireWeatherZone
FMAZ
FPU_FireMgmtUnit
Helispot
WUI_Defense
WUI_Threat
Geom_AF_poly
Geom_Glacial_poly
Geom_InGorge_poly
Geom_Main_poly
GNIS_Primary_pt
NHDArea
NHDFlowline
NHDLine
NHDPoint
NHDPointEventFC
NHDWaterbody
Basin
Drainage
Region
Subbasin
Subregion
Subwatershed
Watershed
Contour40
AdministrativeForest
BasicOwnership
NCCWHWA_Additions
PLSSSection
PLSSTownship
ProclaimedForest
RangerDistrict
Wilderness
WildernessCA
WildernessMNF
WildScenicRiver
WildScenicRiverStudy
BackcountryAreas
InventoriedRoadlessArea
LandAllocation
LRMP1995MgmtArea

RiparianReserve
SpottedOwlActivityCenter
RecreationSitePolygon
RecreationSitePolyWithAttr
RecSitePolyWithAttr_AsPoint
USGSQuad24k
RMU_Subunit
RMU_Unit
SRI
Compartment
Aspect
ElevationPolygon
Slope10Class
MVUMRoadAllow_062008
MVUMRoadAllow_062012
MVUMTrailAllow_062008
MVUMTrailAllow_062012
NonFSRoad
Road
RoadLinearEvents_062015
RoadLinearEvents_102012
RoadLinearEvents_122013
Trail
TrailLinearEvents_062015
TrailLinearEvents_082016
TrailLinearEvents_102012
TrailLinearEvents_122013
TravelRoute_ln
ExistingVegetation
FireReturnIntervalDeparture
Strata
mnfeveg98_4
ExistingVegetation2005
Strata2005
CFFStream_ln
CFFStream_pl
Lake
Stream
WBD_HU2
WBD_HU4
WBD_HU6
WBD_HU8

WDB_HU10
WDB_HU12
Precipitation
NorthernSpottedOwlObs_pt
NSOCenterOfActivity_06042012
NSOCriticalHabitat2008

The Current Status and Updating of Vegetation Maps

2015 FRAP map is latest statewide vegetation map
Sonoma County Vegetation Map completed June 2017

Napa Vegetation and BRBNA Maps ~2004 (and using 1993 imagery)

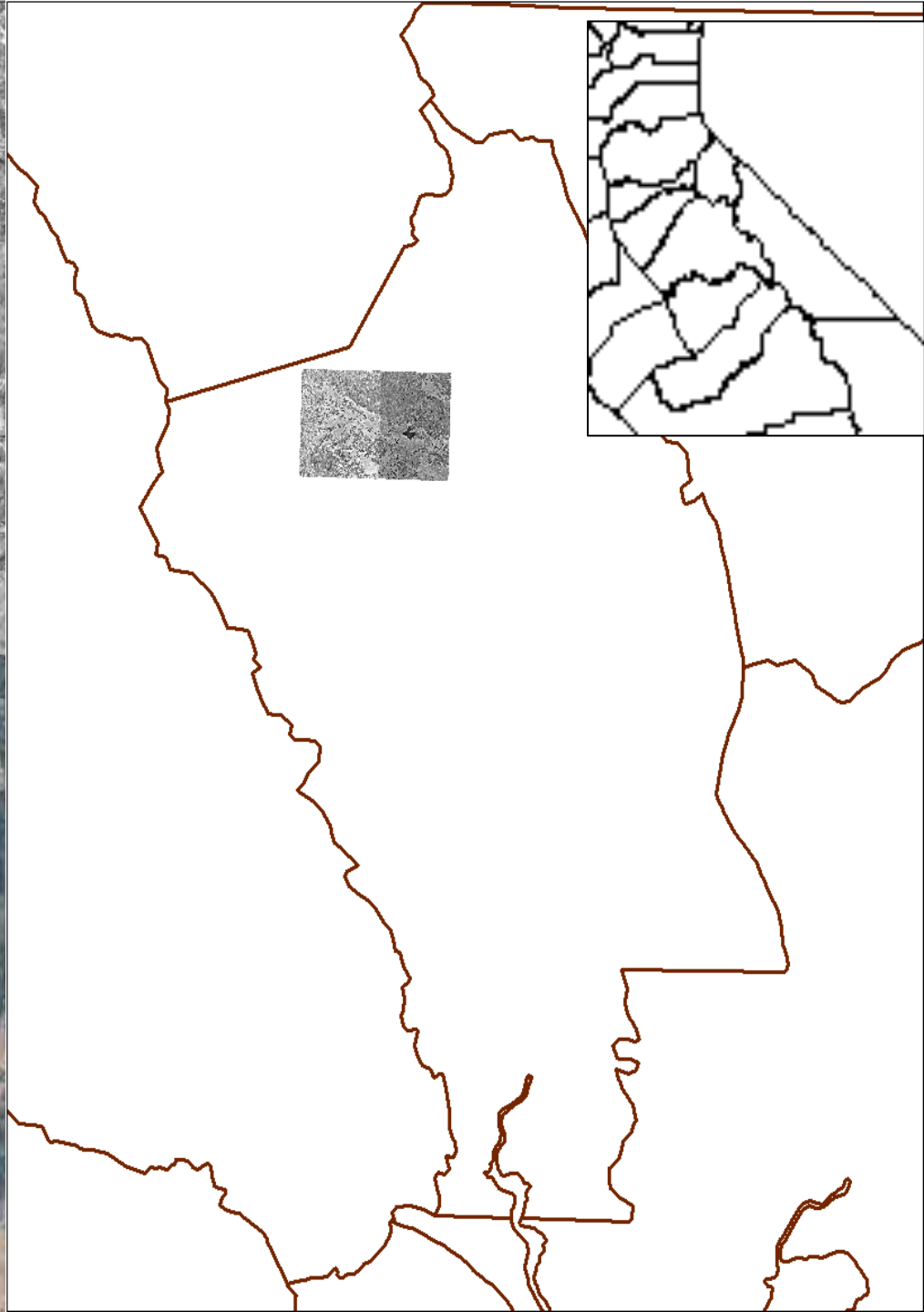
The Napa & BRBNA maps are in the process of being updated

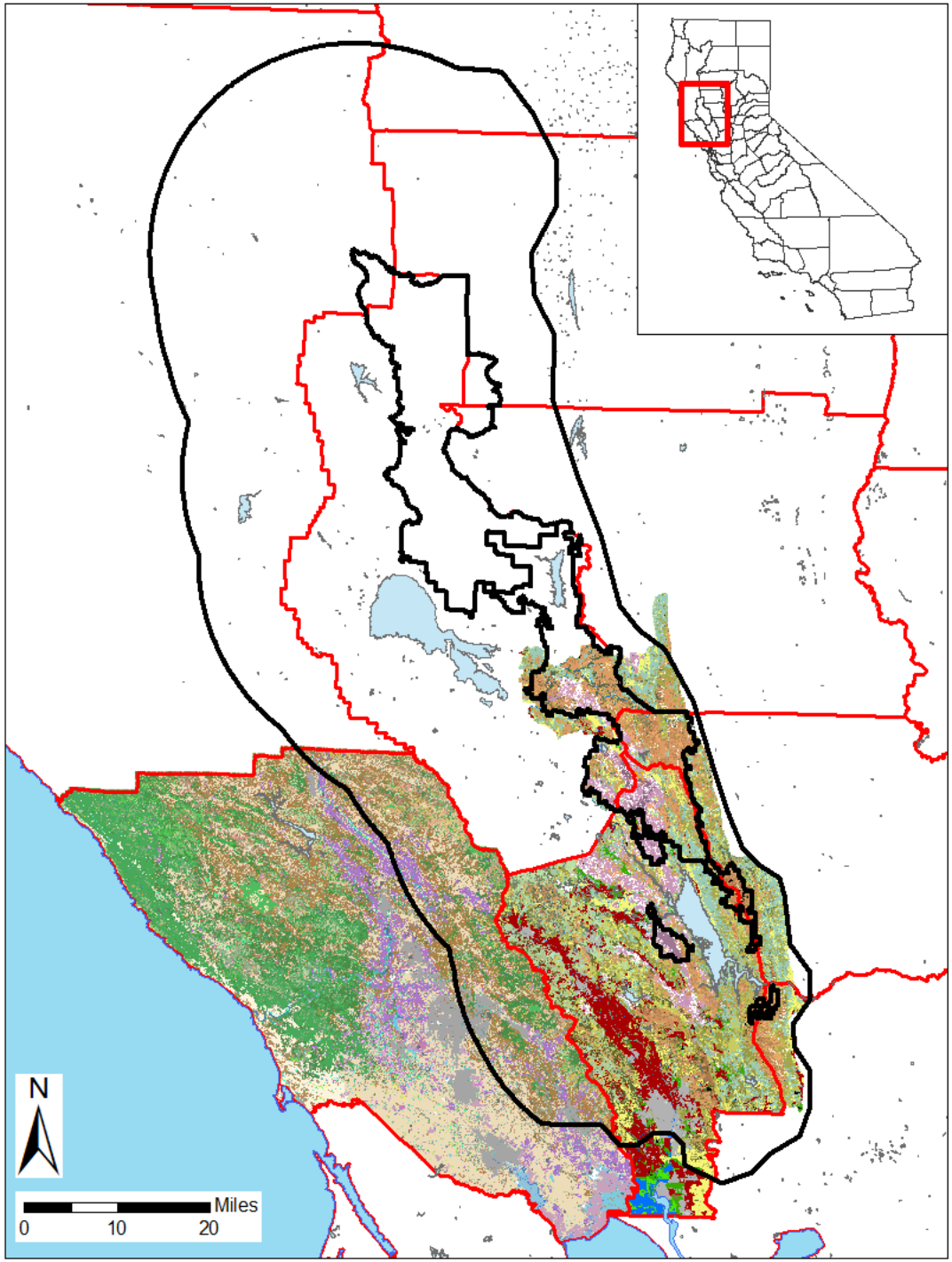
The USFS has EVEG maps, which could also be incorporated.

UCD is looking at how to best combine these to provide baseline vegetation map data to the agencies.


N
DOQQ 1993


NAIP 2016




N
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0
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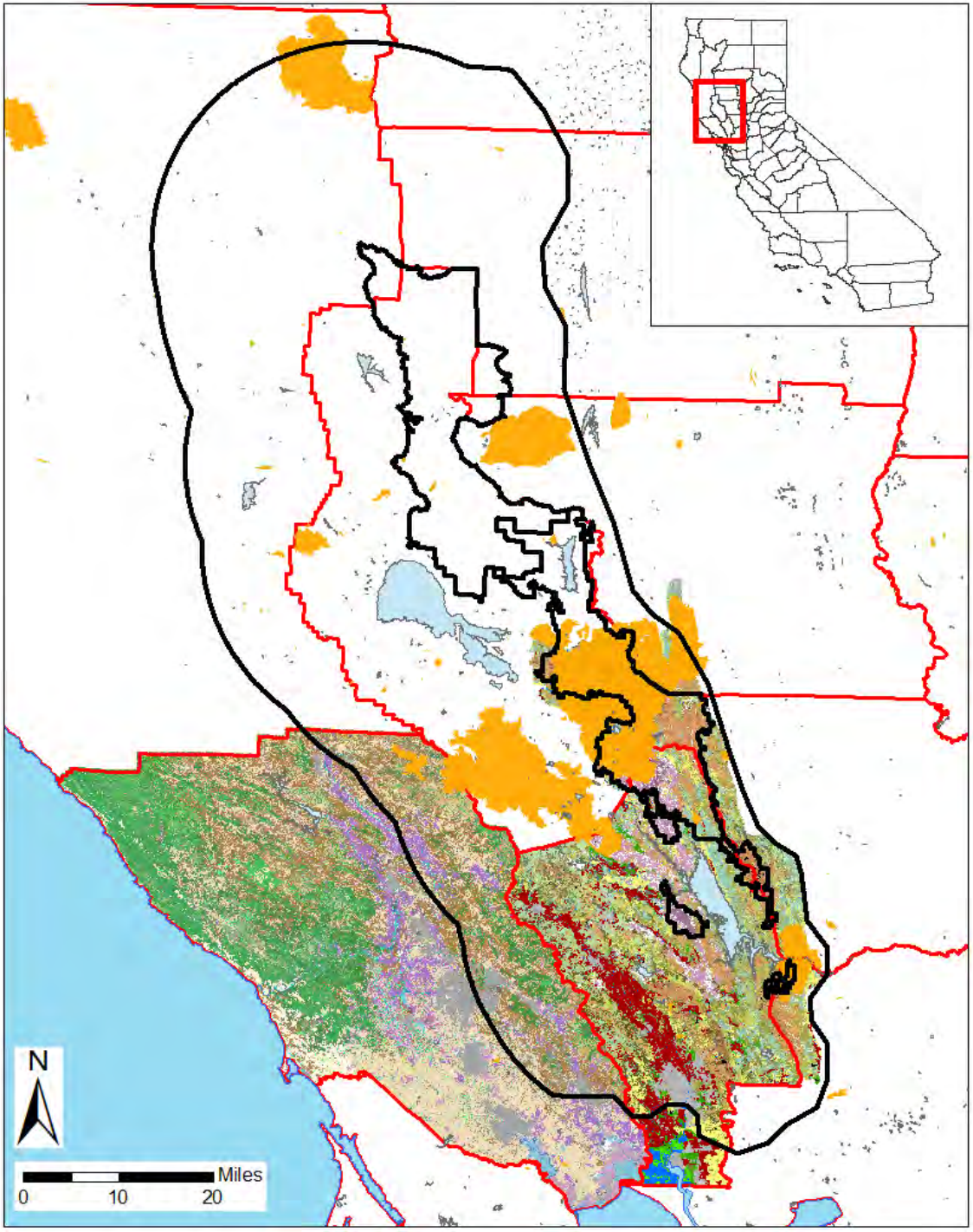
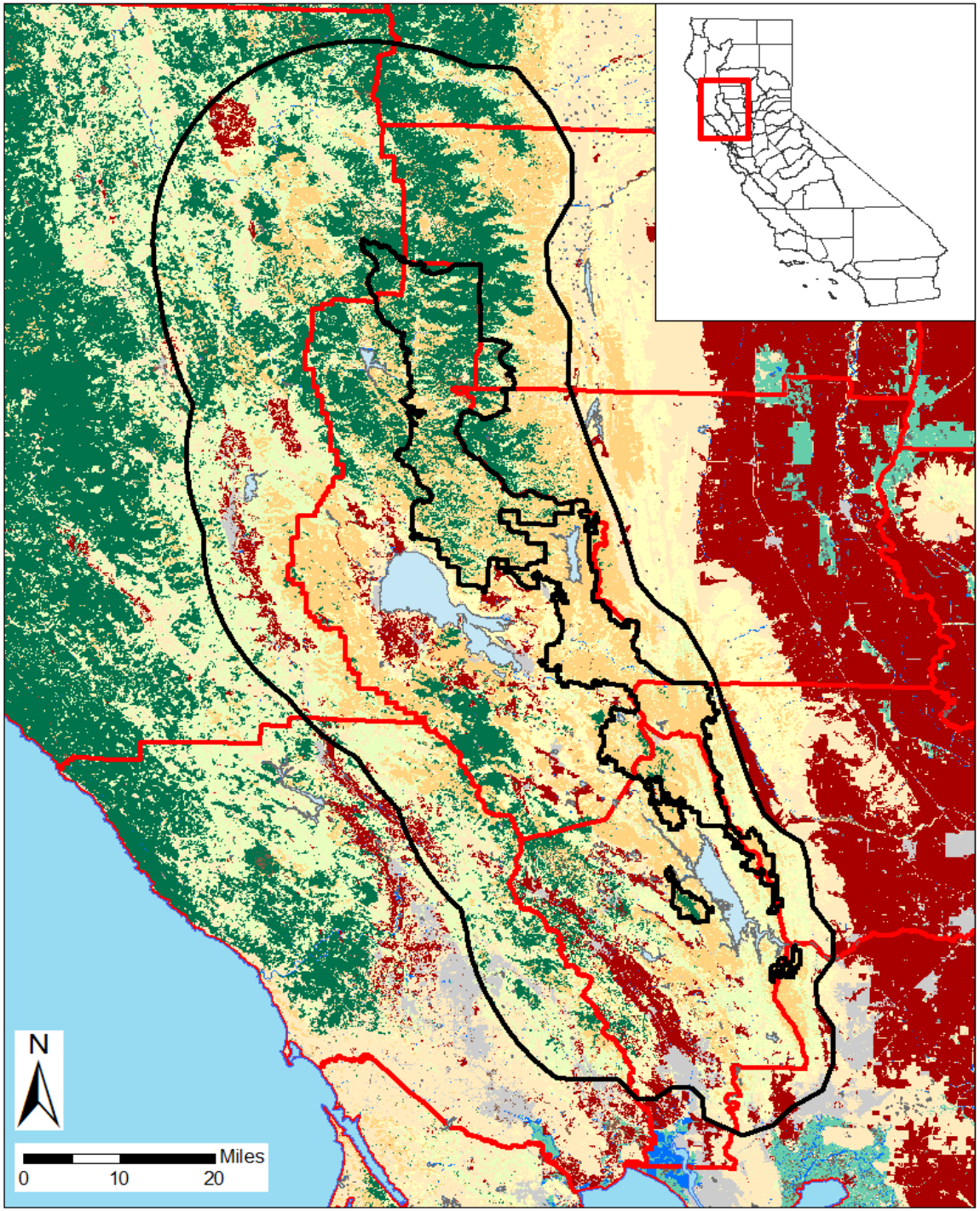
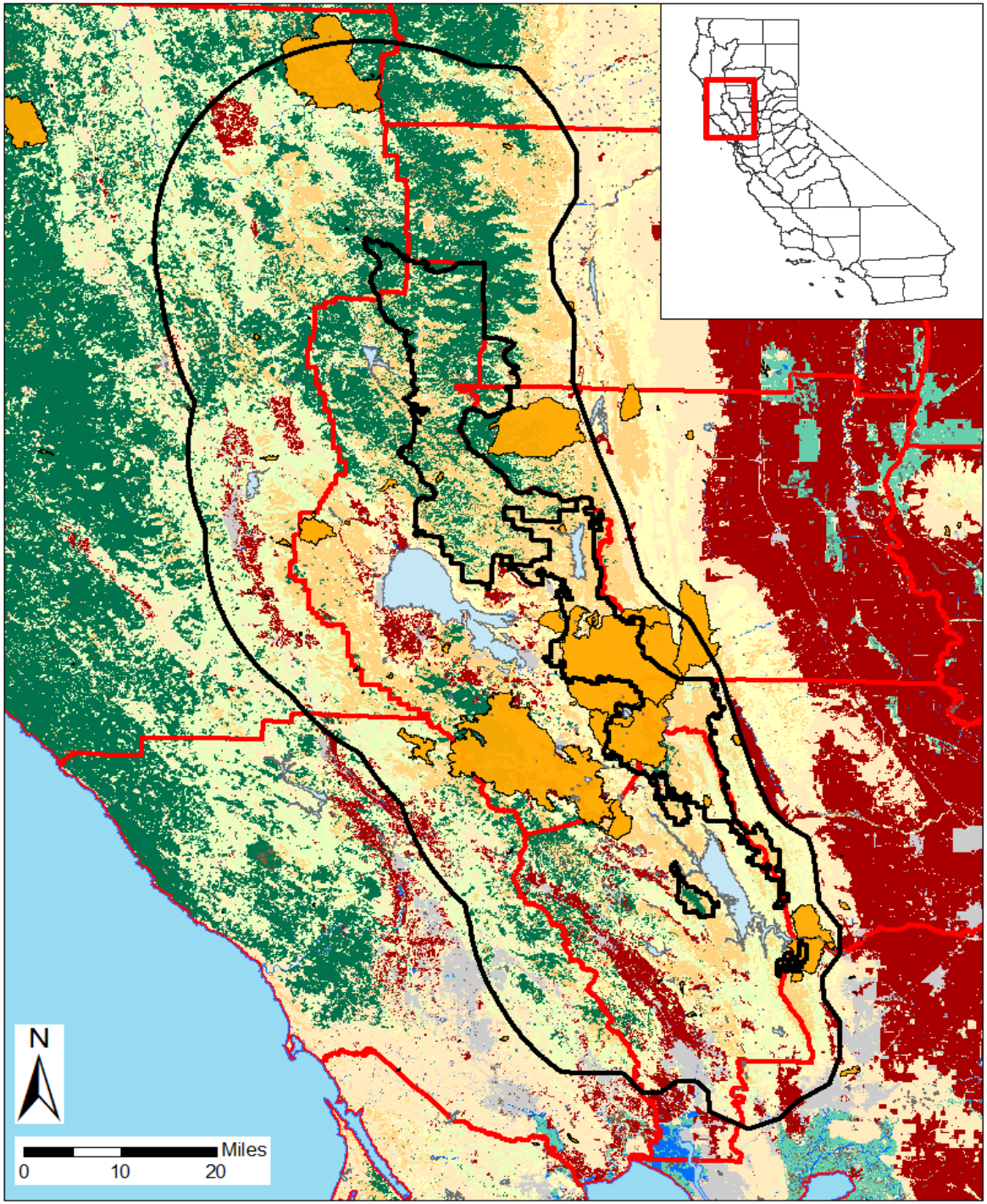


Showing fires since 2010



WHR13NAME

- Agriculture
- Barren/Other
- Conifer Forest
- Conifer Woodland
- Desert Shrub
- Desert Woodland
- Hardwood Forest
- Hardwood Woodland
- Herbaceous
- Shrub
- Urban
- Water
- Wetland



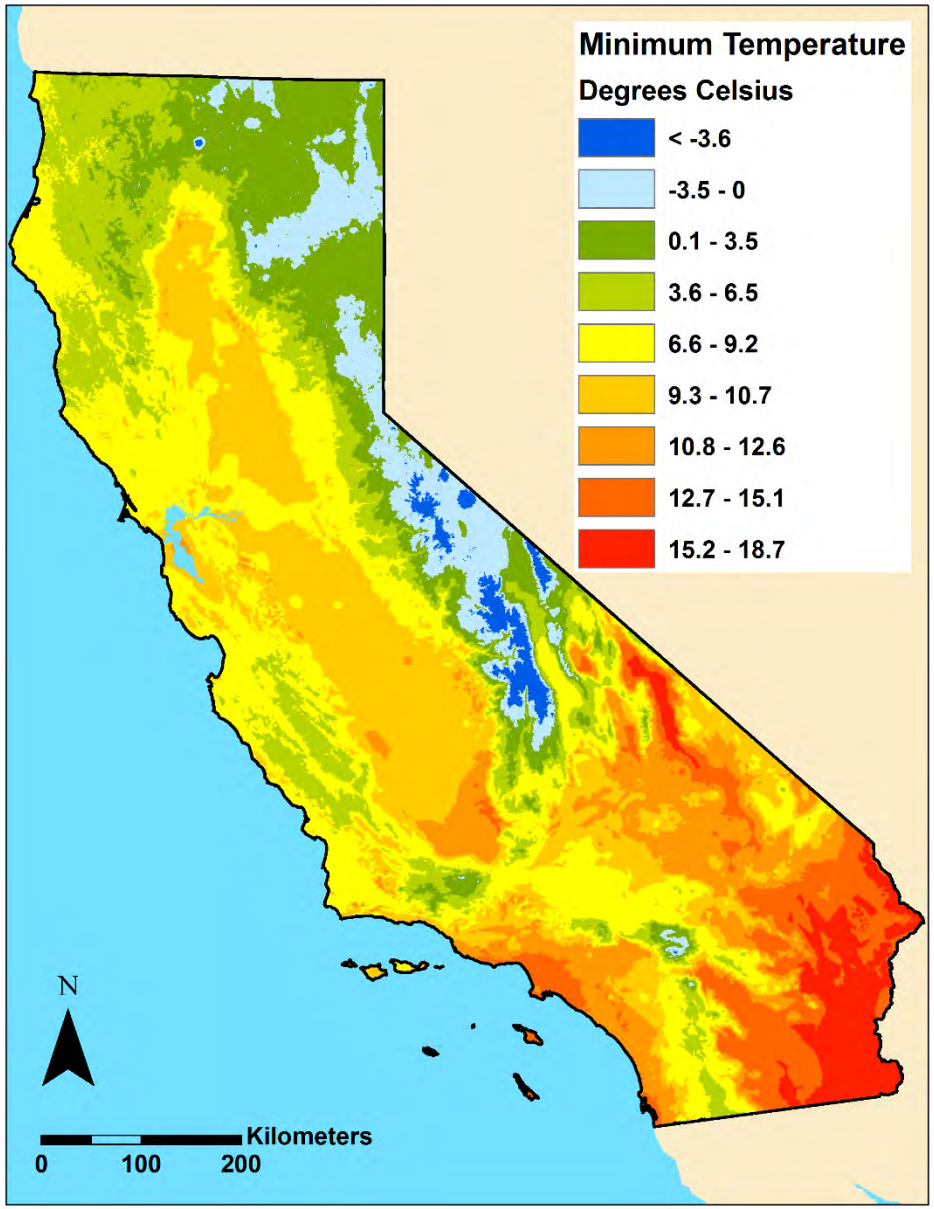
Showing fires since 2010

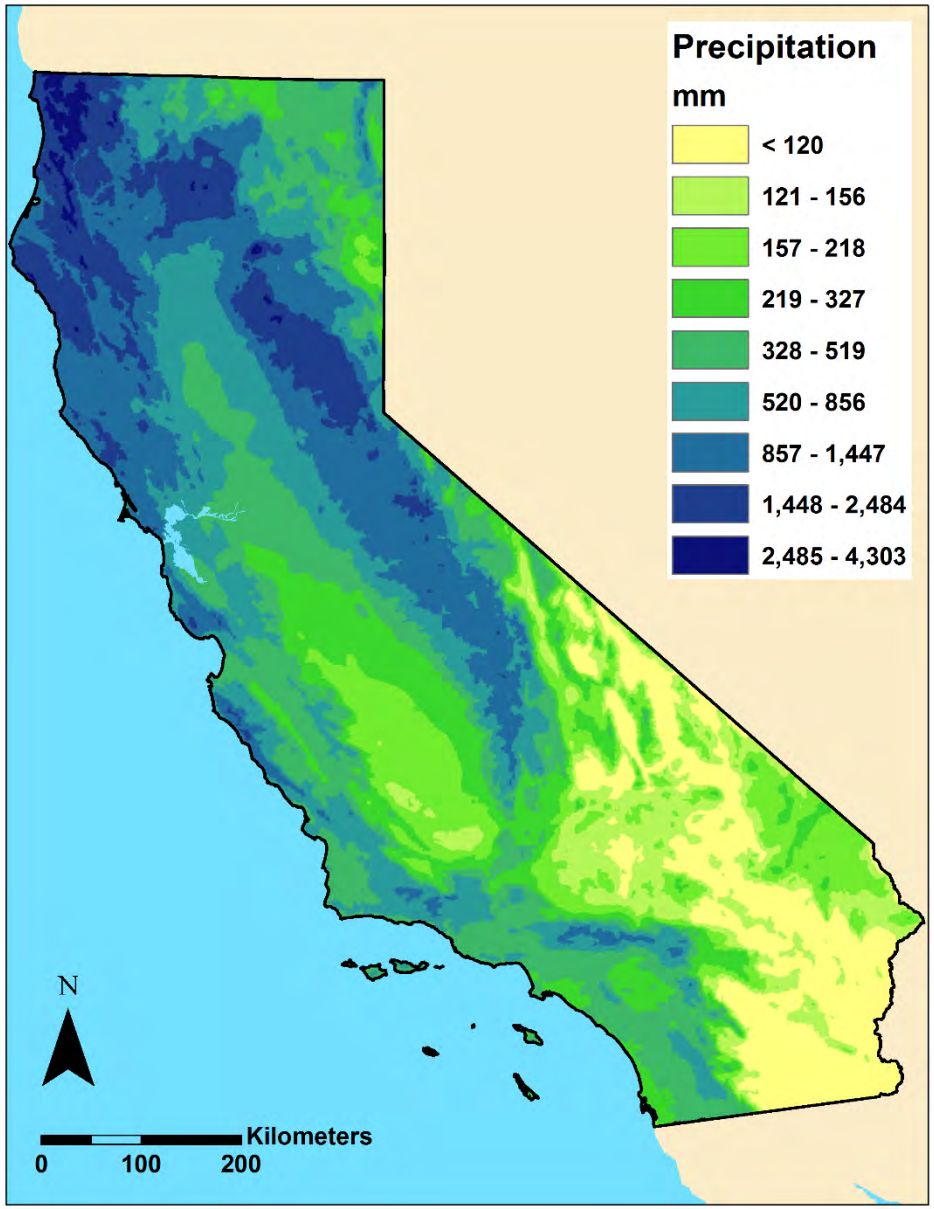
Climate Exposure
The Basin Characterization Model

- A Regional water balance model
- Inputs: Air temperature, precipitation, PET
- Most commonly used outputs: AET, Climatic Water Deficit, Snowpack, Recharge, Runoff
- All BCM hydro-climatic variables:

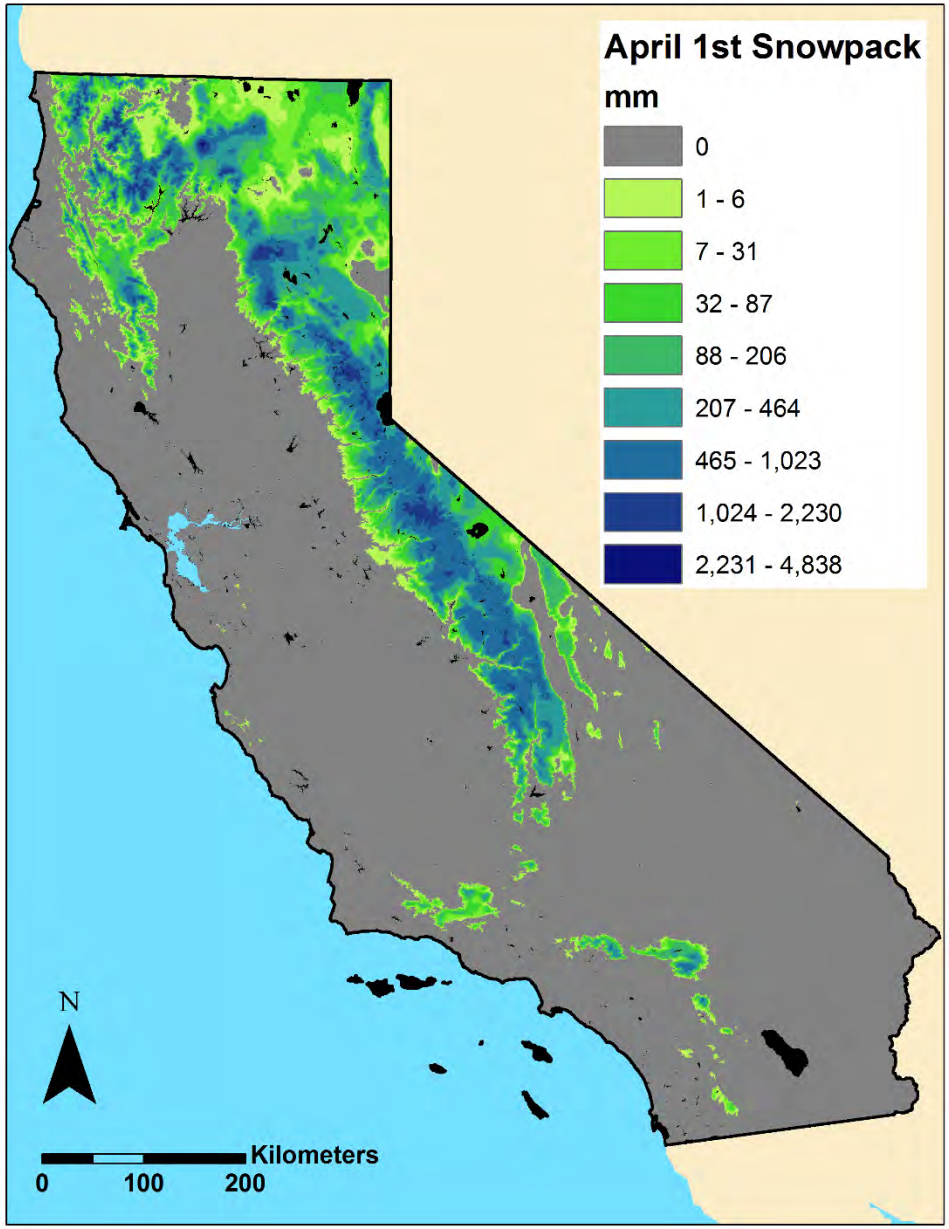
Maximum Temperature	**Recharge**	**Snowfall**
Minimum Temperature	**Climatic Water Deficit**	**Snowpack**
Precipitation	**Actual Evapotranspiration**	**Snowmelt**
Potential Evapotranspiration	**Sublimation**	**Excess Water**
Runoff	**Soil Water Storage**	

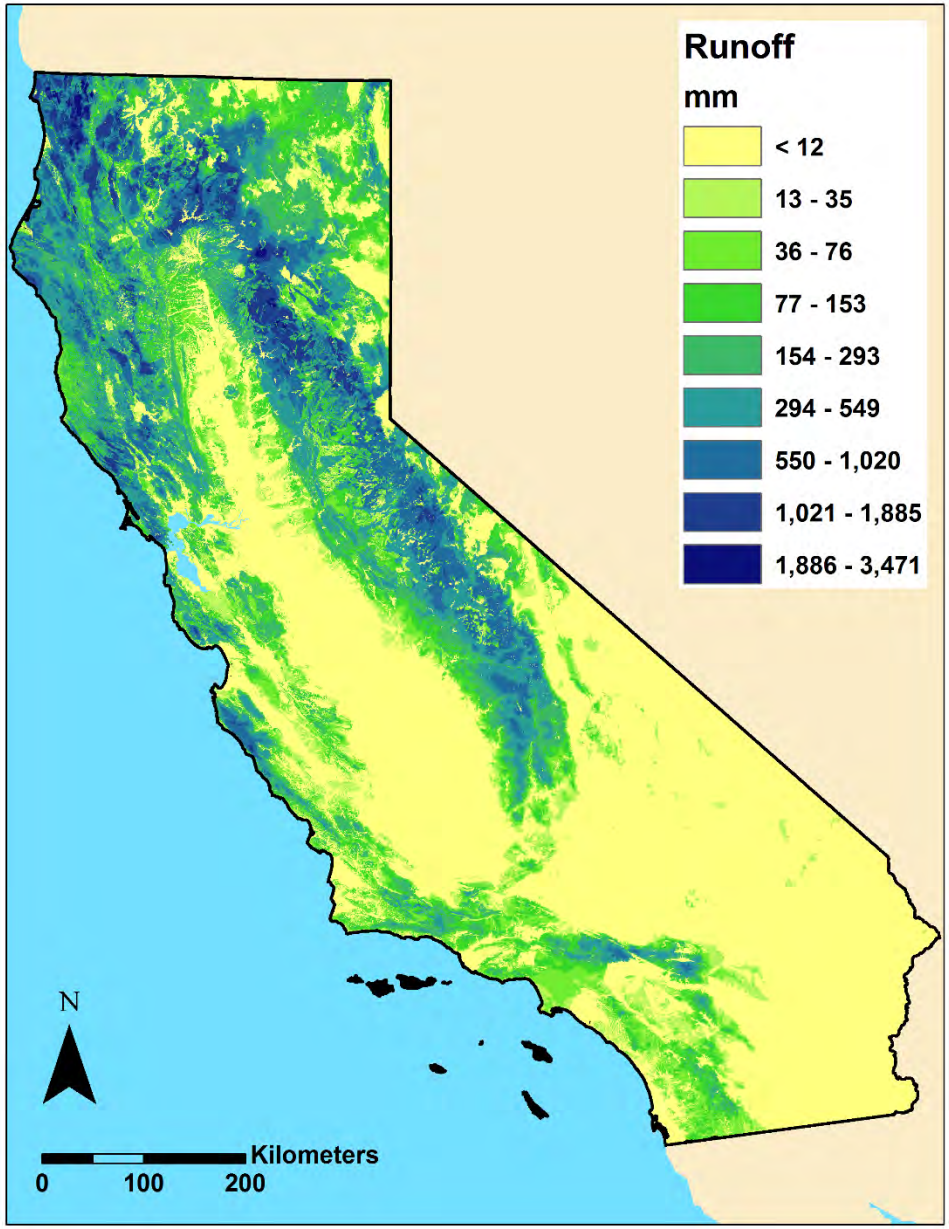
Current Mean Annual Minimum Temperature and Precipitation



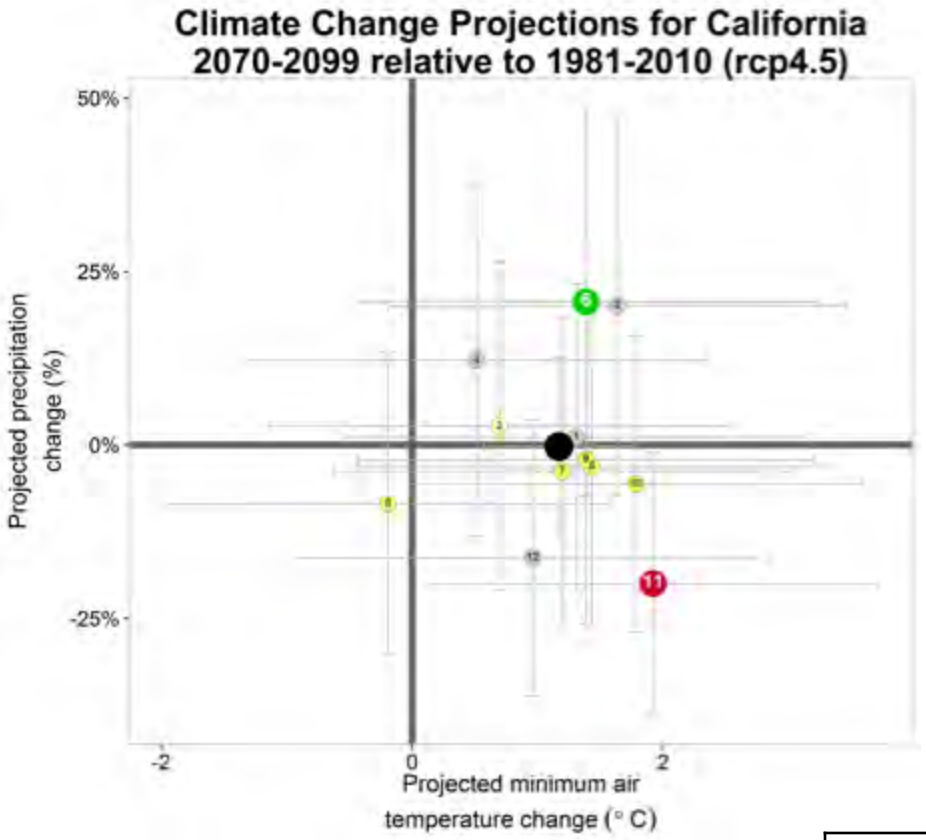


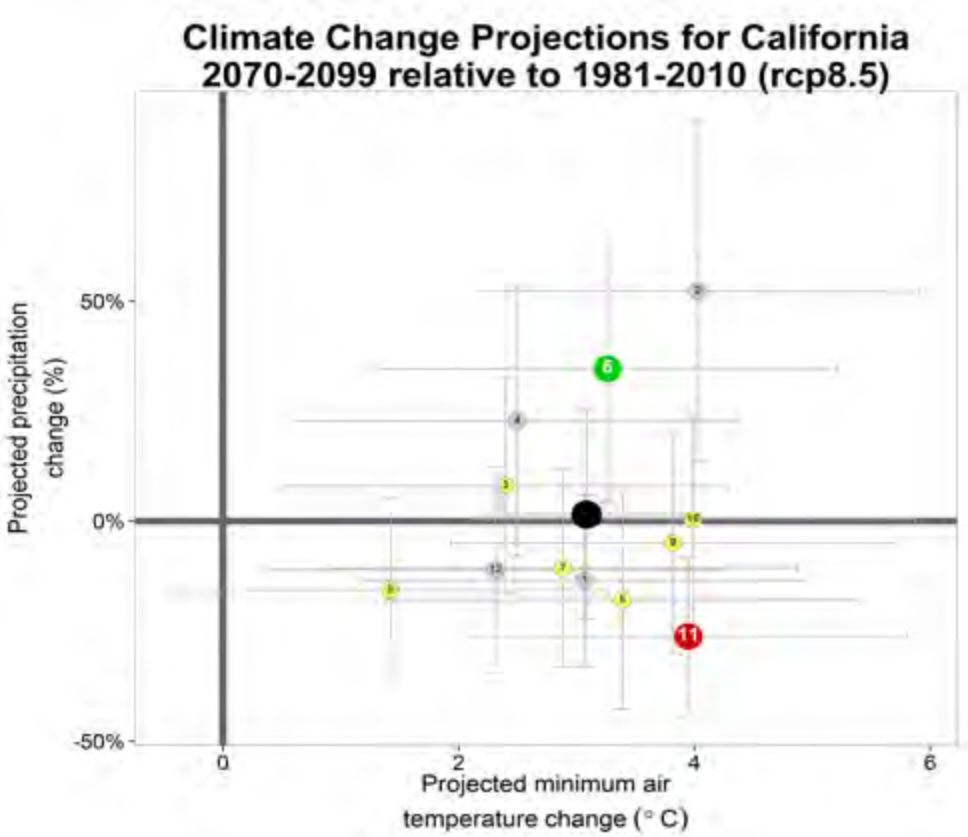
Current Snowpack and Mean Annual Runoff





Evaluation of data and climate change models





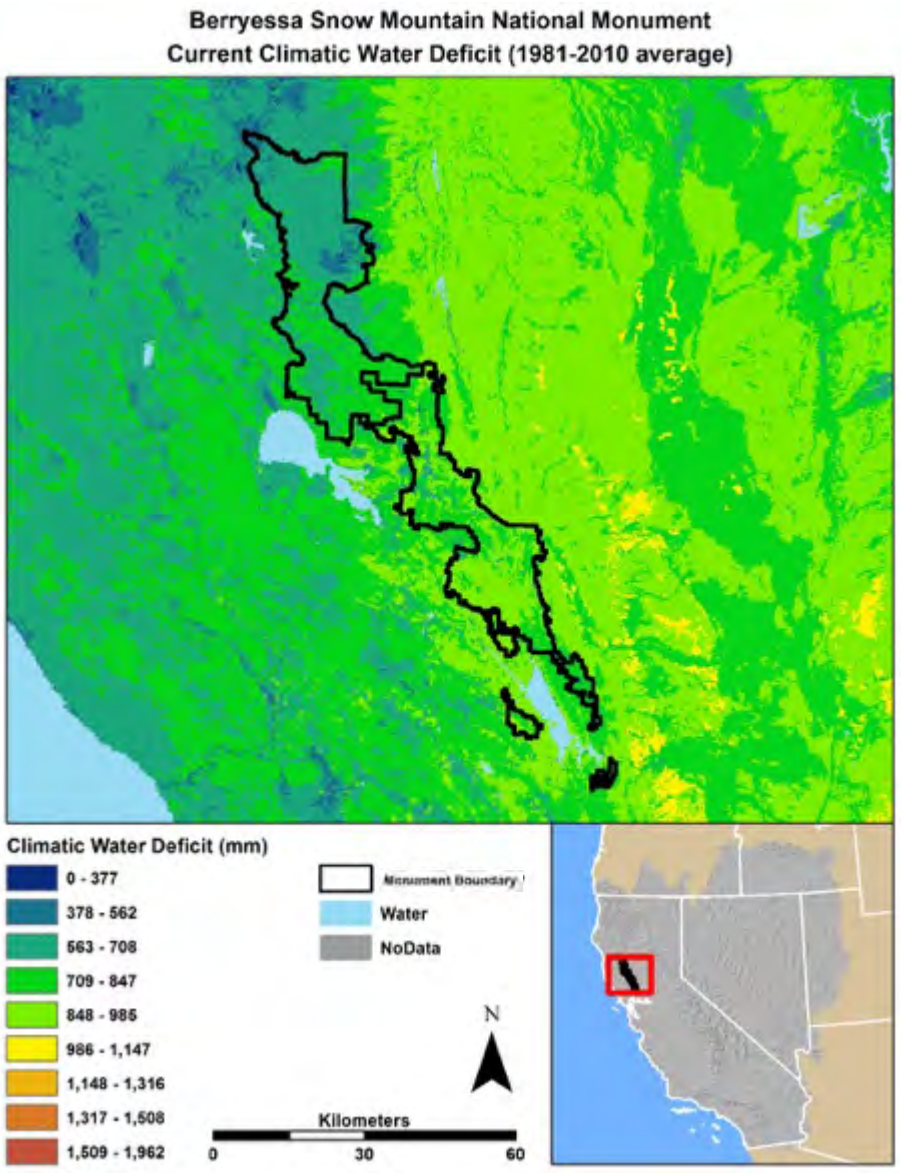
GCM

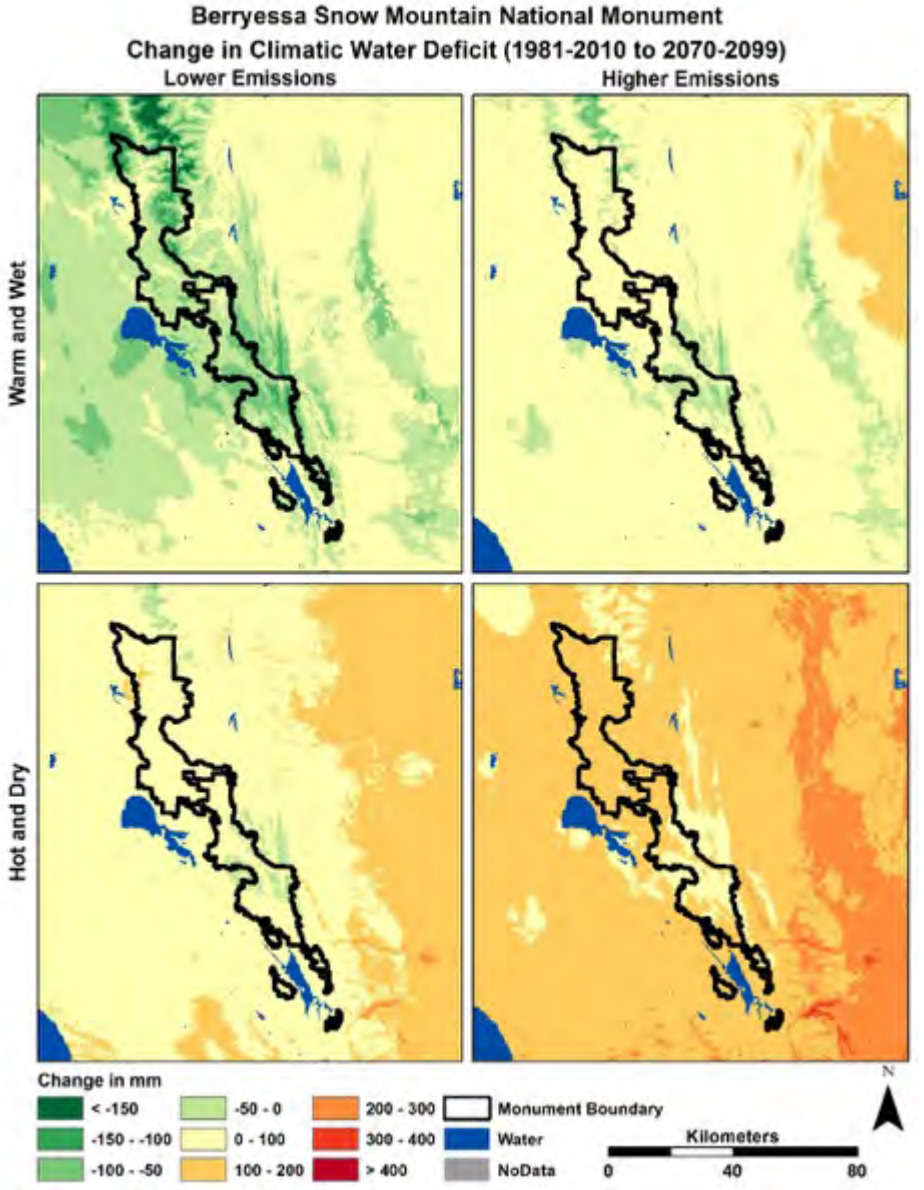
- 1 = access1_0
- 2 = canesm2
- 3 = ccsm4
- 4 = cesm1_bgc
- 5 = cmcc_cm
- 6 = cnrm_cm5
- 7 = gfdl_cm3
- 8 = gfdl_esm2m
- 9 = hadgem2_cc
- 10 = hadgem2_es
- 11 = miroc_esm
- 12 = miroc5
- = ensemble mean

AR5 global warming increase (°C) projections[5]

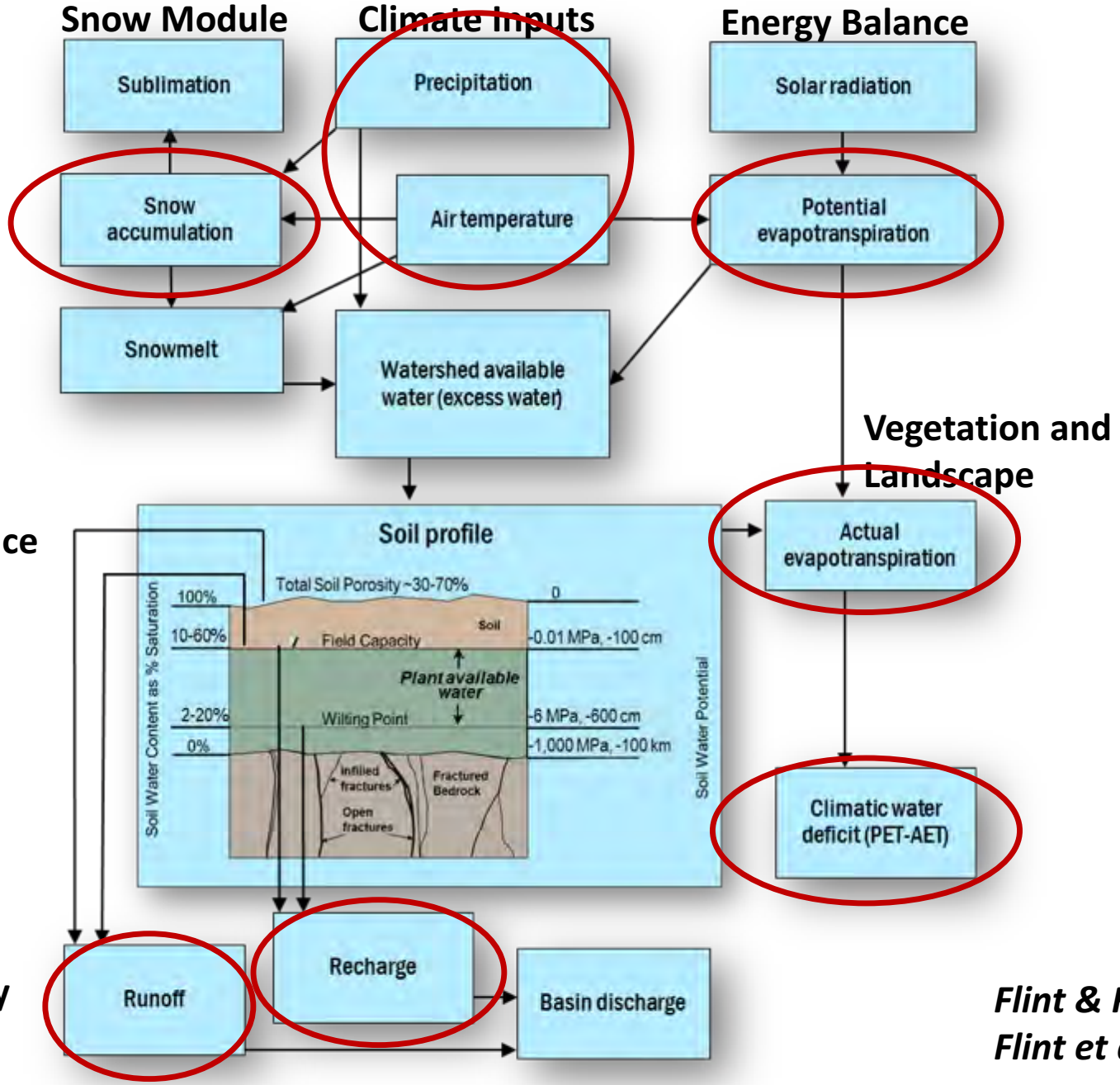
Scenario	2046-2065 Mean and *likely* range	2081-2100 Mean and *likely* range
RCP2.6	1.0 (0.4 to 1.6)	1.0 (0.3 to 1.7)
RCP4.5	1.4 (0.9 to 2.0)	1.8 (1.1 to 2.6)
RCP6.0	1.3 (0.8 to 1.8)	2.2 (1.4 to 3.1)
RCP8.5	2.0 (1.4 to 2.6)	3.7 (2.6 to 4.8)

Current and Future Climatic Water Deficit





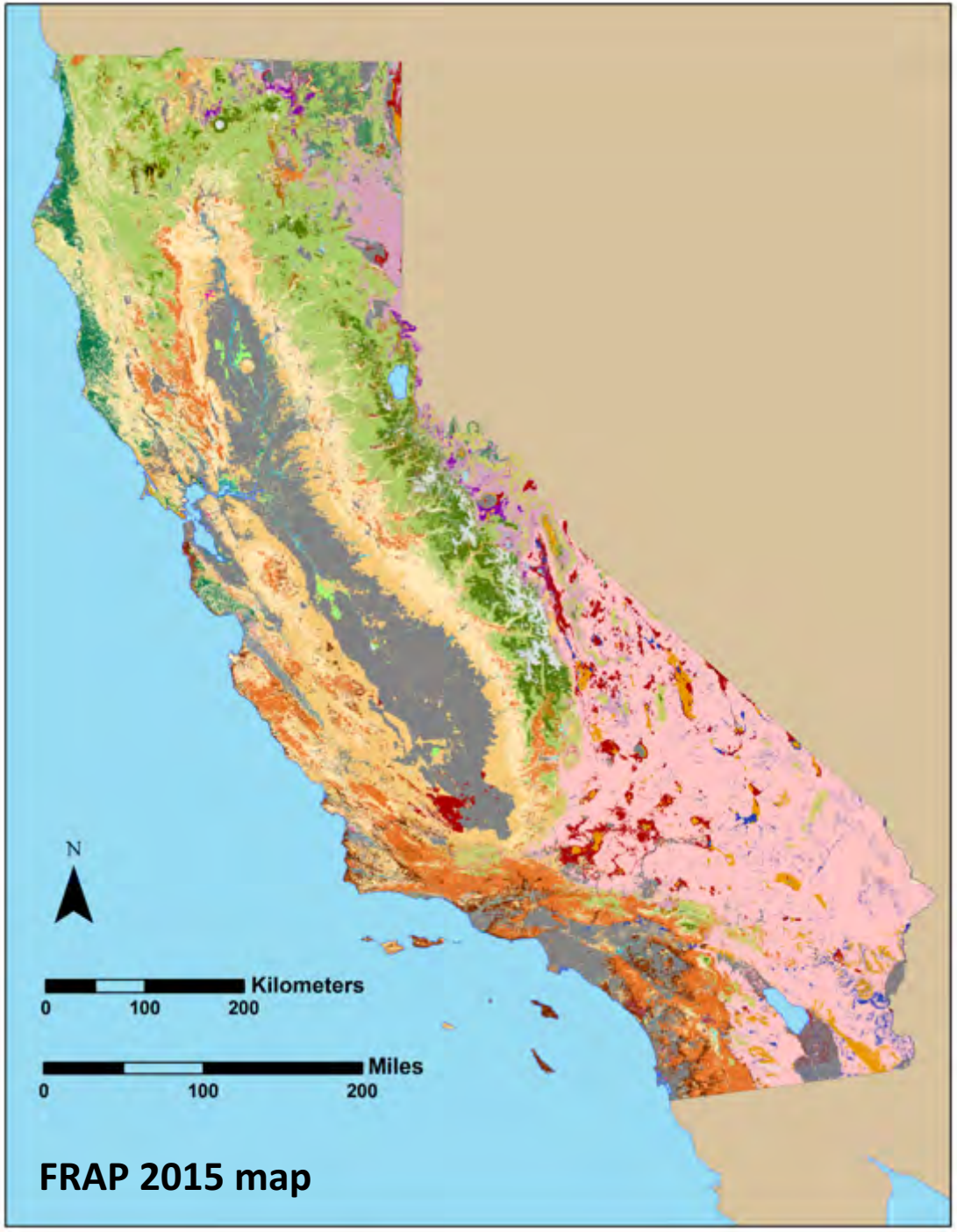
9 Variables



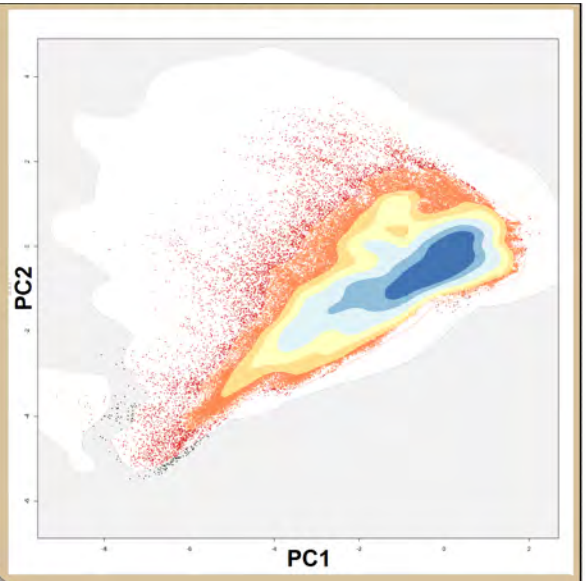
Flint & Flint 2012
Flint et al. 2014

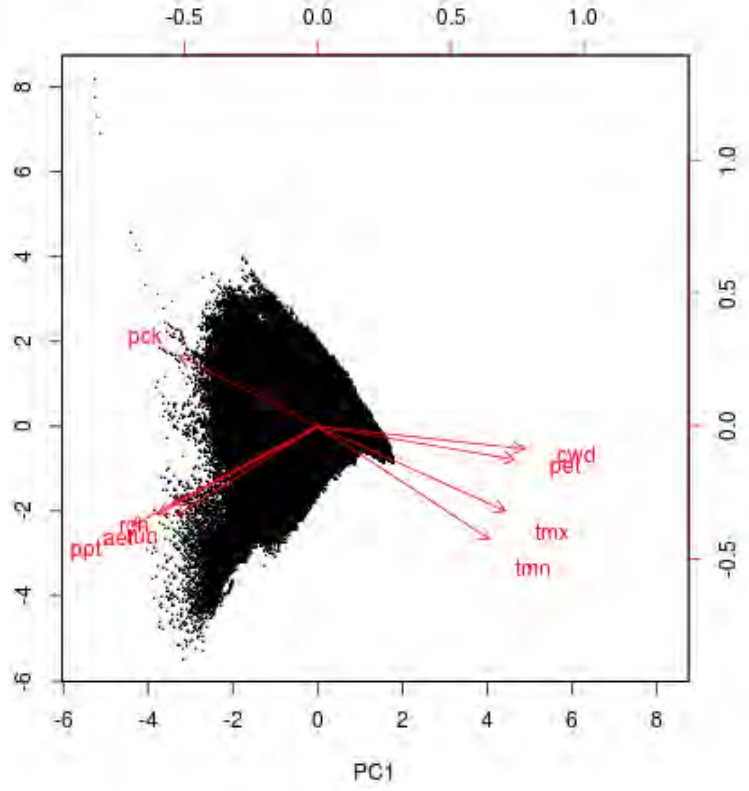
2015 Vegetation Map

CalFire, Ca FWS, & USFS Region 5 compiled the “best available” land cover data



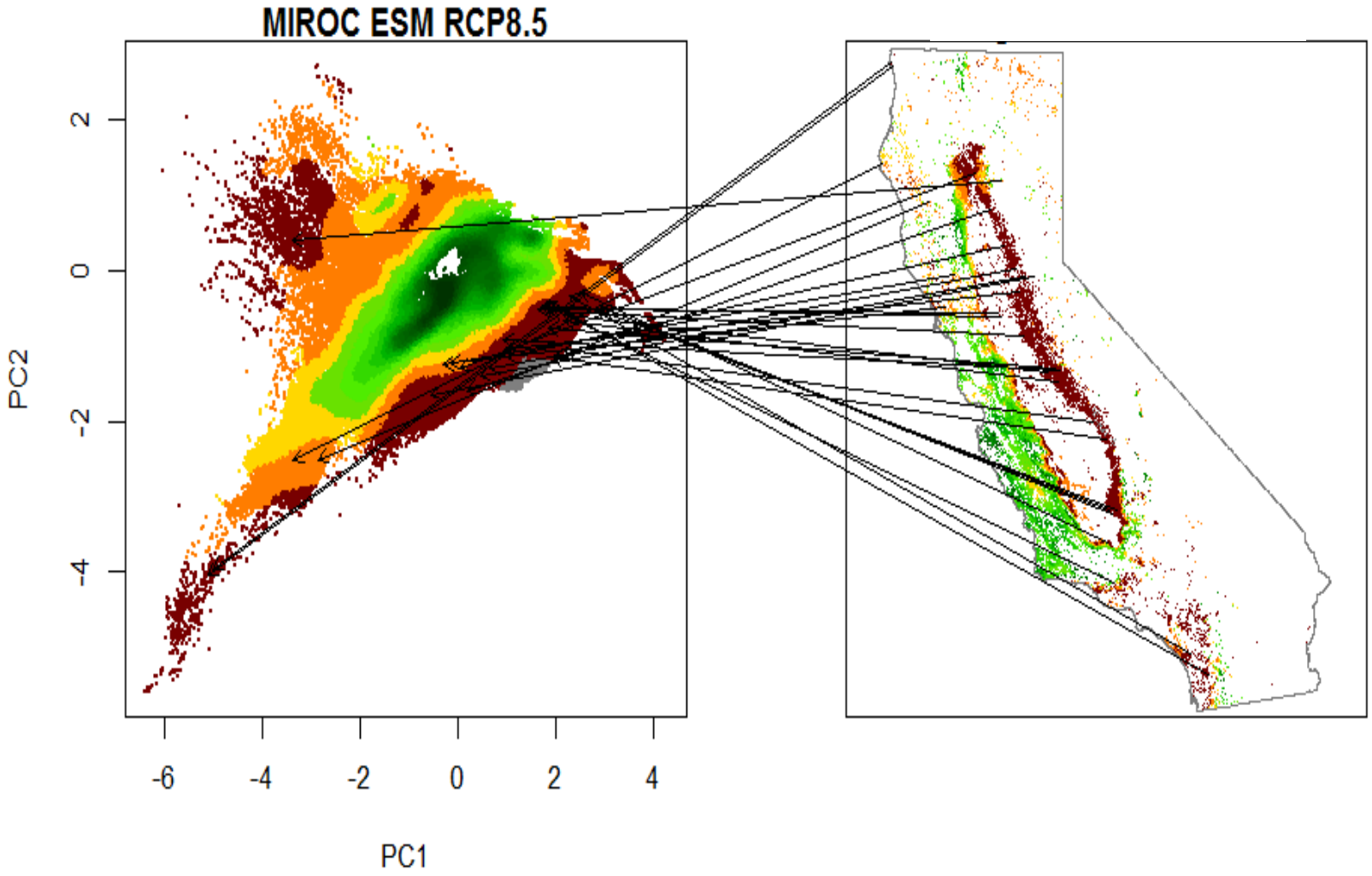
Current Time Climate Classification (1981-2010) for the Vegetation Type Pine Oak

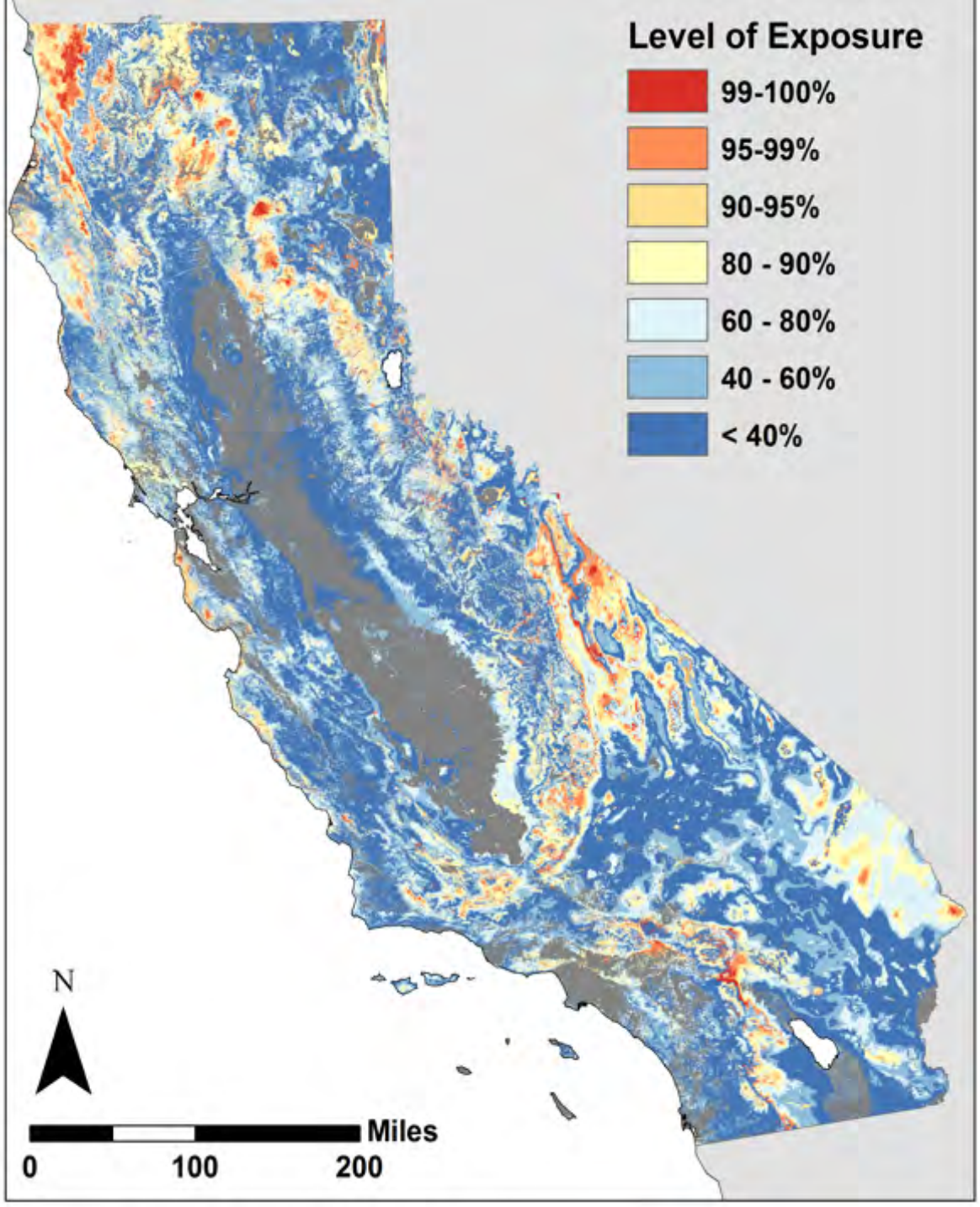




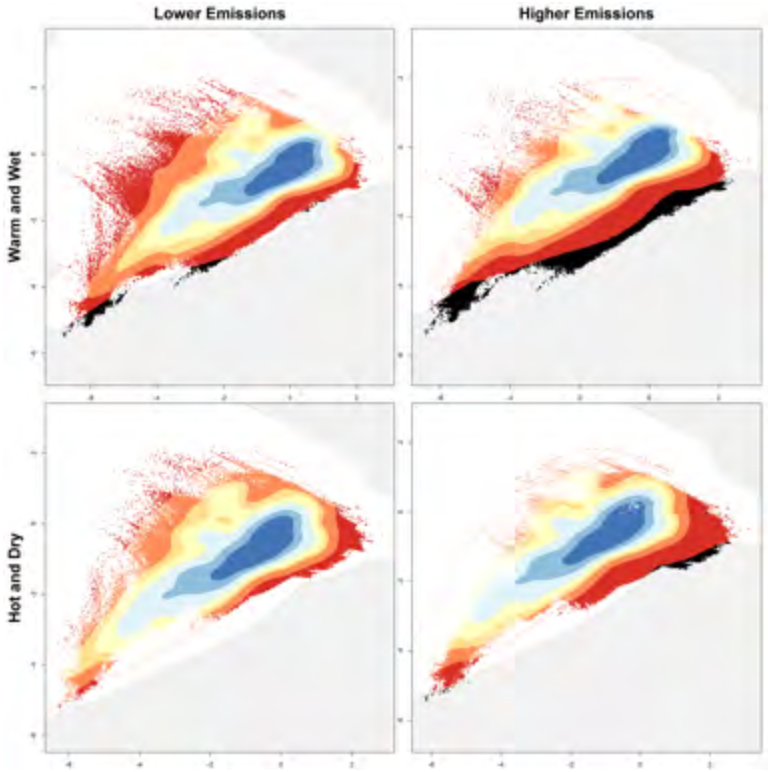
Climate Envelop for all of California

3. Analysis of Vegetation Climate Exposure





Current Time Climate Classification (1981-2010) for all Types of Vegetation

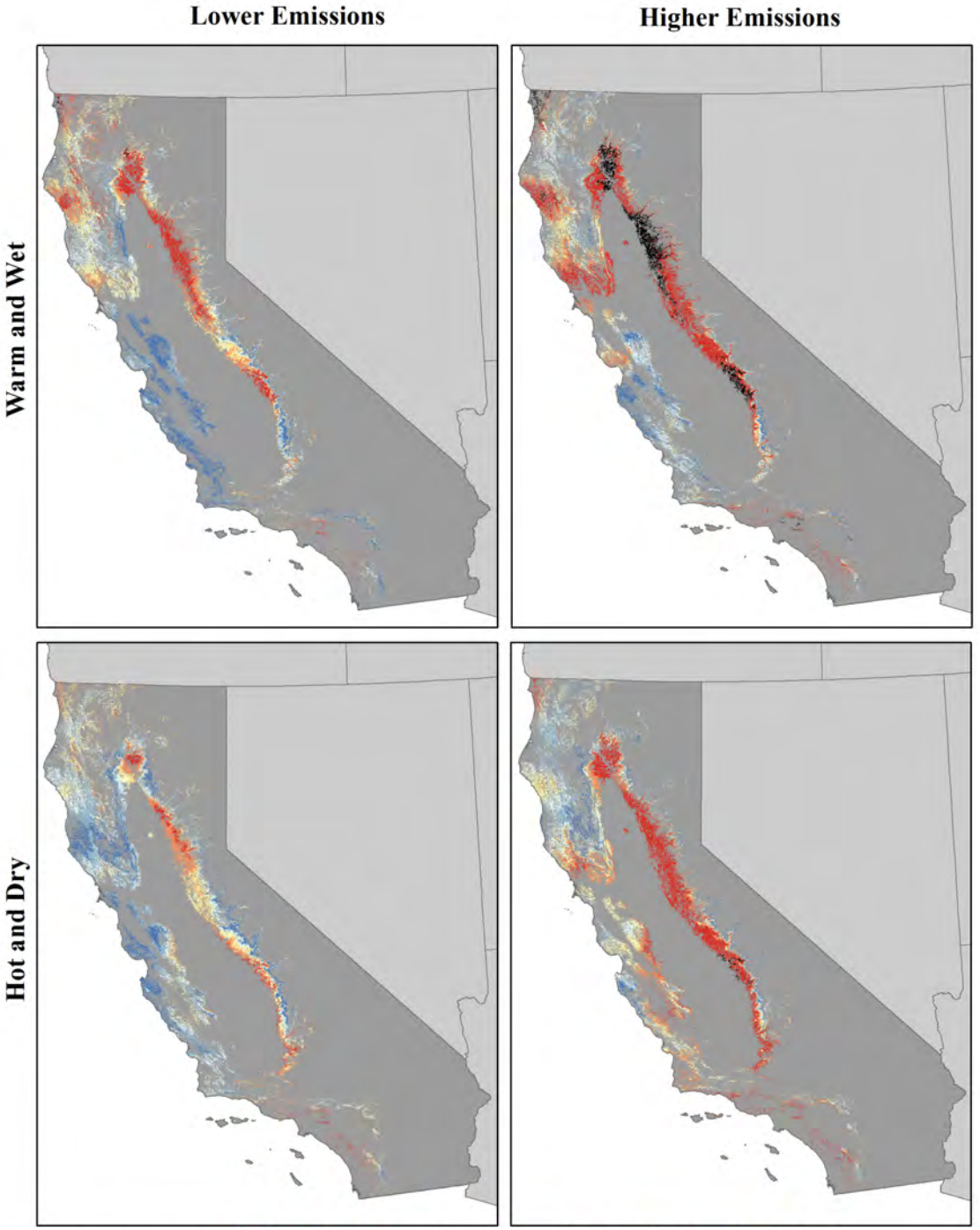


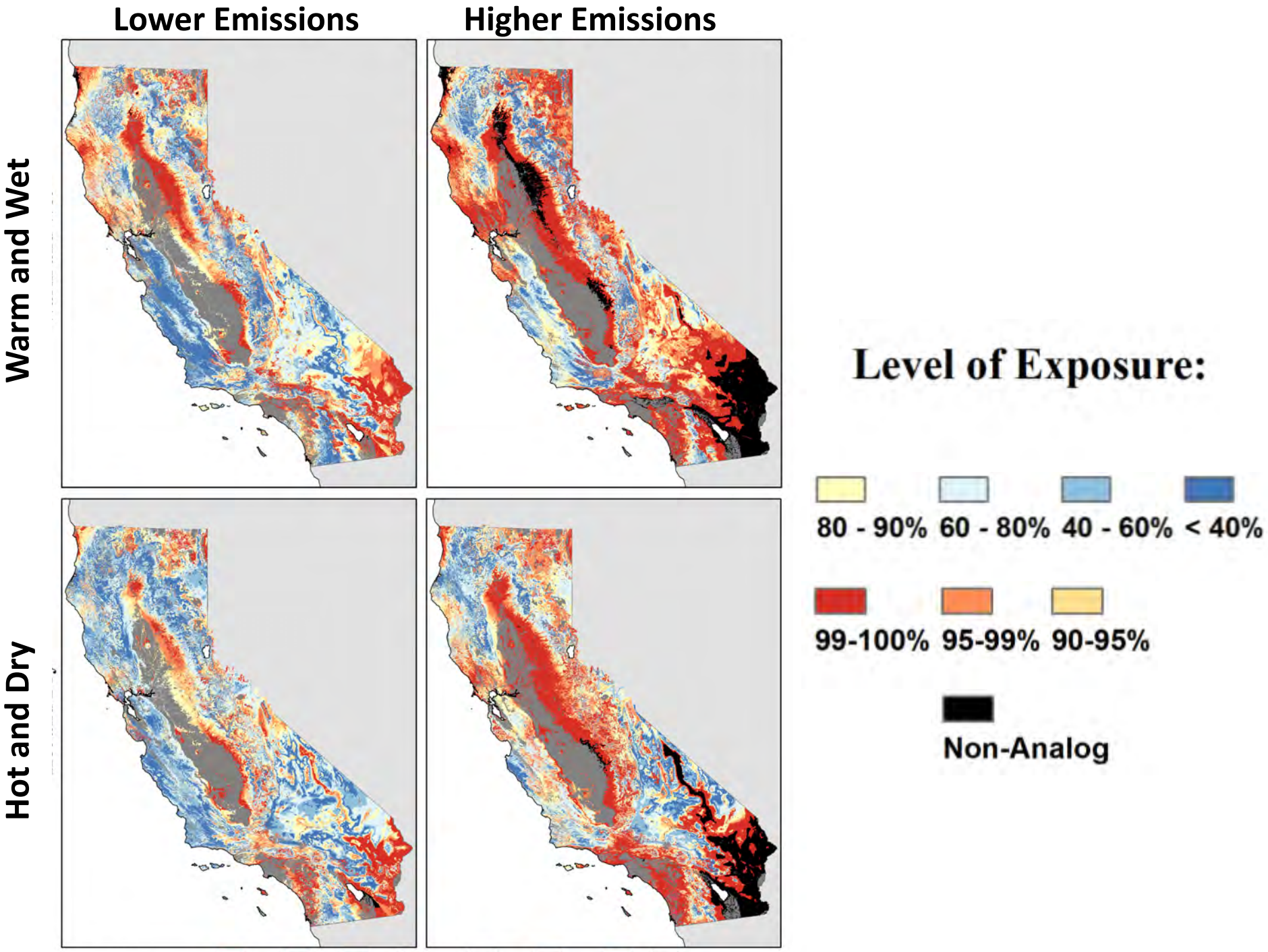
Level of Exposure:

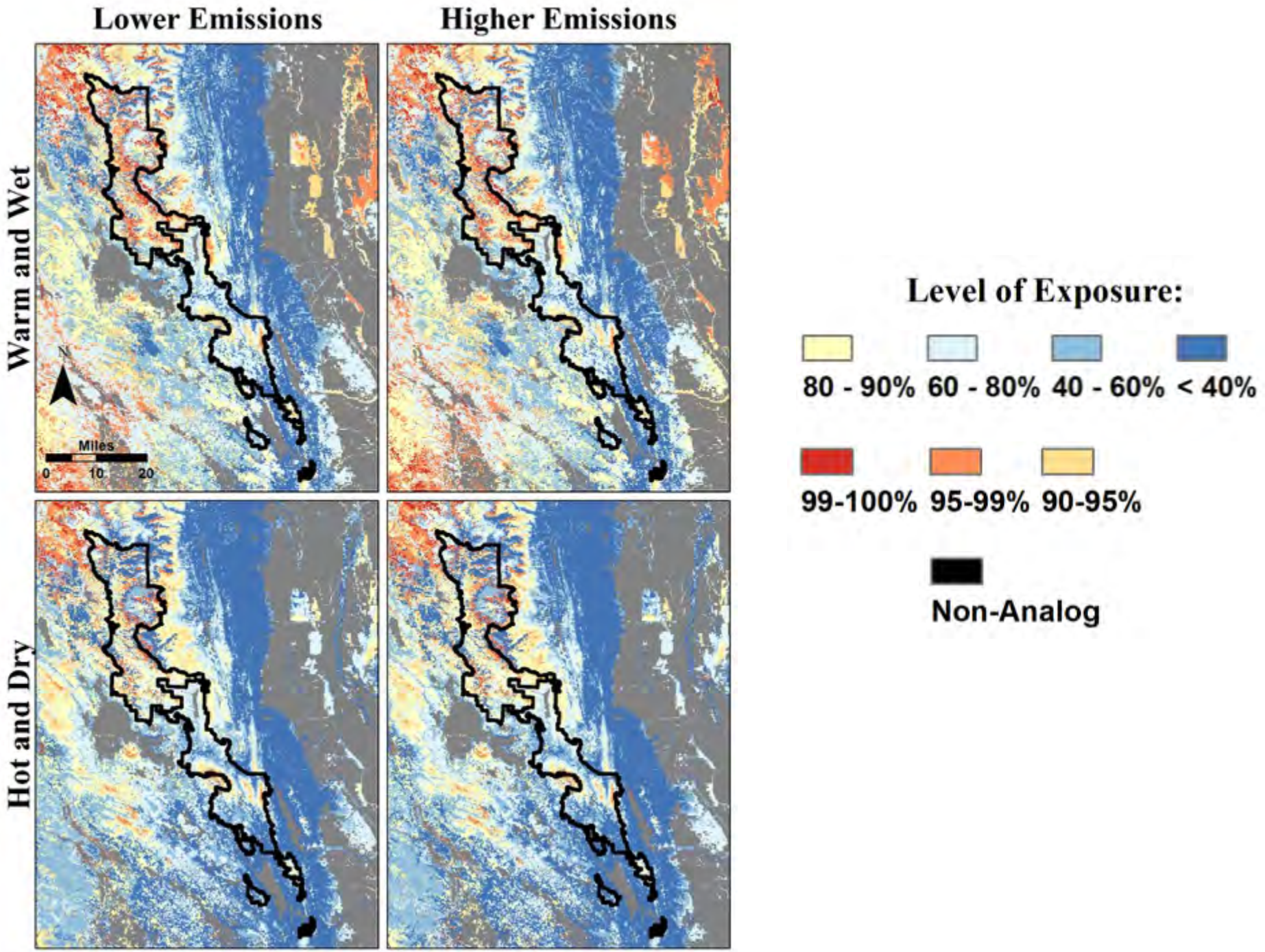
80 - 90% 60 - 80% 40 - 60% < 40%

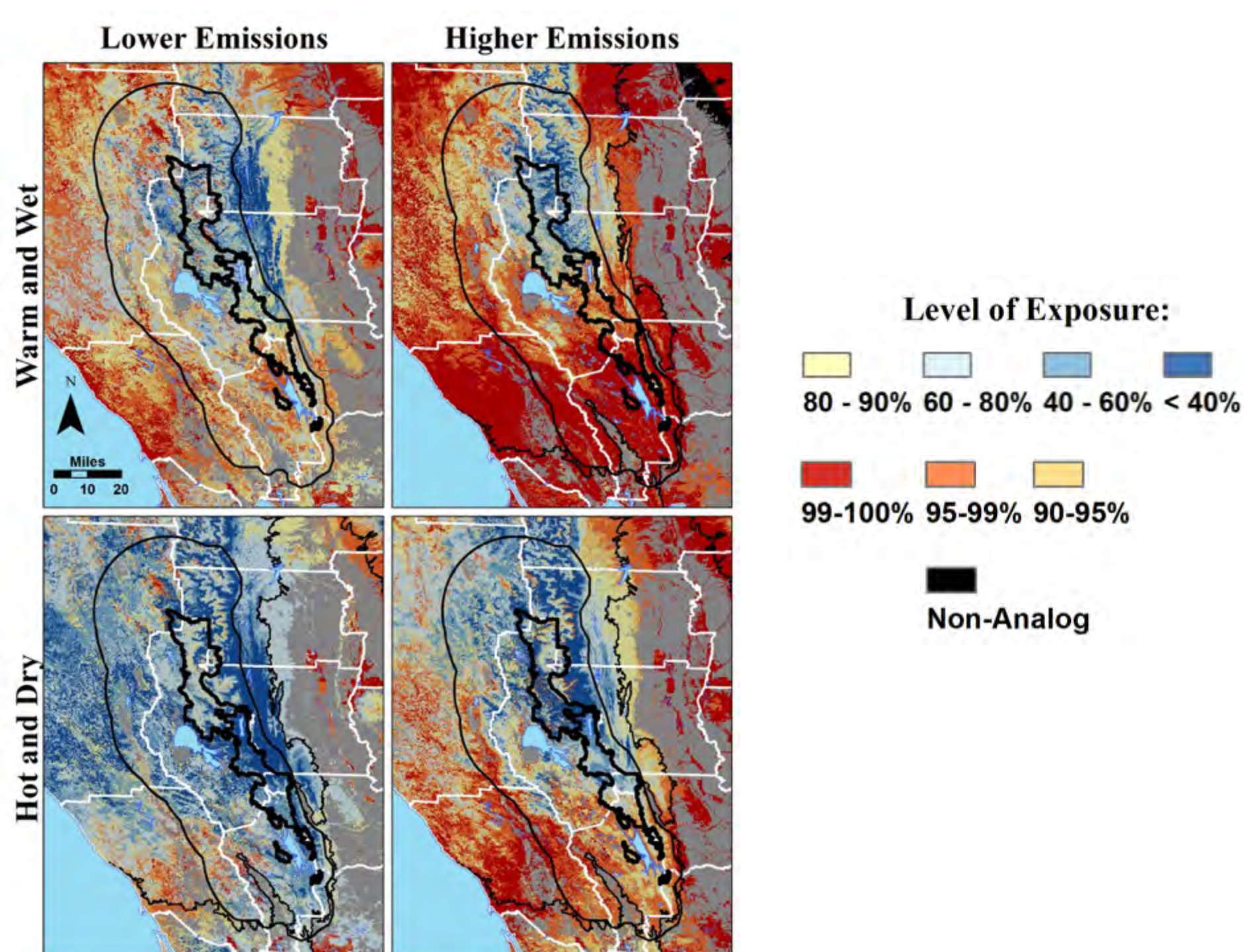
99-100% 95-99% 90-95%

Non-Analog




Lower Emissions
Higher Emissions
Warm and Wet
Hot and Dry
Level of Exposure:
80 - 90%
60 - 80%
40 - 60%
< 40%
99-100%
95-99%
90-95%
Non-Analog


Lower Emissions
Higher Emissions
Warm and Wet
Hot and Dry
N
Miles
0
10
20
Level of Exposure:
80 - 90%
60 - 80%
40 - 60%
< 40%
99-100%
95-99%
90-95%
Non-Analog


Lower Emissions
Higher Emissions
Warm and Wet
Hot and Dry
N
Miles
0 10 20
Level of Exposure:
80 - 90%
60 - 80%
40 - 60%
< 40%
99-100%
95-99%
90-95%
Non-Analog

Total Natural Lands 353,271 km²	Current Time			
	km²	%	km²	%
	282617	80%	17664	5%
	Not Stressed (<80%) by 2100		Stressed (>95%) by 2100	
CNRM 4.5	-112,101	-32%	79,227	22%
CNRM 8.5	-188,033	-53%	178,962	51%
MIROC 4.5	-77,040	-22%	54,574	15%
MIROC 8.5	-157,930	-45%	140,943	40%

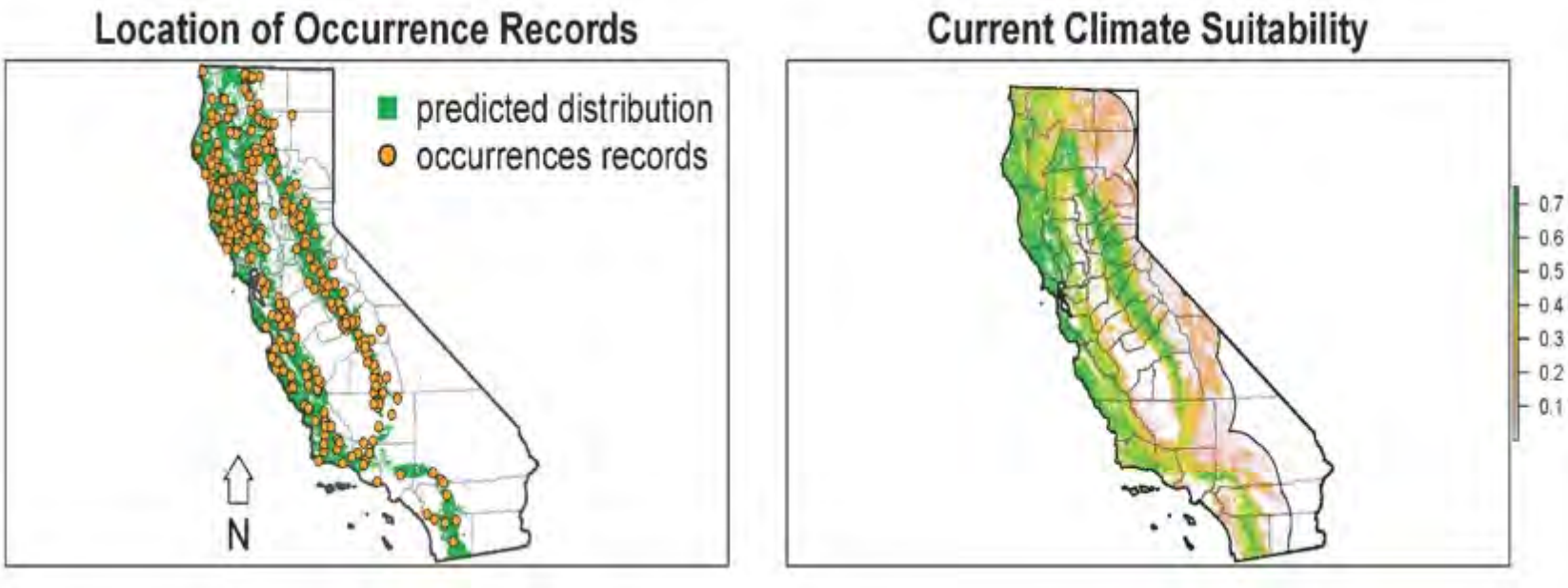
4. Estimation of Climate Vulnerability of Vegetation Types

Vulnerability = Climate Exposure
+ Sensitivity
+ Adaptive Capacity
+ Spatial Disruption (Species Distribution Models)

Sensitivity And Adaptive Capacity

	Sensitivity						Adaptive Capacity			
Species	Climate Temp	Climate Precip	Fire	Germination Agents	Mode Dispersal	Reproductive Lifespan	Fire	Recruitment Mode /Fecundity	Seed Longevity	Species Score
Hardwoods										
Quercus agrifolia	3	3	5	3	2	4	5		1	**3.2**
Quercus englemannii	3	3	4	3	2	3	5		1	**2.8**
Quercus douglasii	4	4	3	3	2	4	3		1	**2.8**
*Pinus sabiniana**	4	3	2	4	5	3	1		4	**3.3**
Quercus chrysolepis	3	3	4	3	2	5	5		1	**3.2**
Quercus lobata	3	3	5	3	2	5	5		1	**3.1**
Quercus wislizeni	4	3	4	3	2	3	5		1	**3.2**
Mean	**3.43**	**3.14**	**3.9**	**3.14**	**2.43**	**3.86**	**4.1**		**1.43**	
					Mean	**3.31**			**2.67**	
Conifers										
Pinus radiata	3	3	1	4	3	3	5		5	**3.4**
Juniperus californica	3	3	1	2	2	3	5		2	**2.6**
Pinus attenuata	4	3	1	4	5	2	5		5	**3.7**
Pinus ponderosa	3	3	5	2	4	5	4		1	**3.4**
Calocedrus decurrens	3	3	5	2	3	5	1		1	**3.1**
Abies concolor	2	2	2	2	4	5	1		1	**2.7**
Mean	**3**	**2.83**	**2.5**	**2.67**	**3.5**	**3.83**	**3.5**		**2.5**	
					Mean	**3.06**			**3.33**	

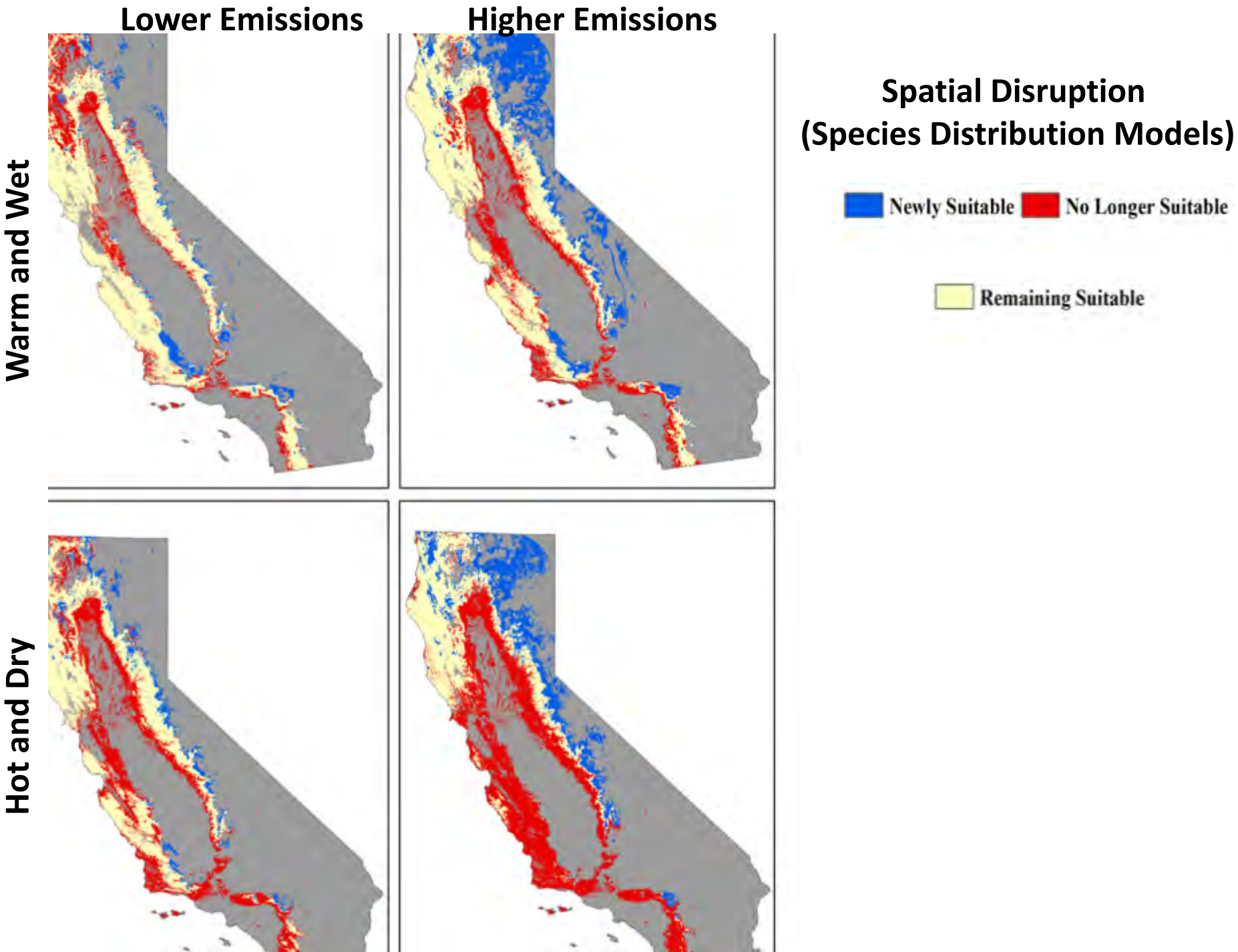
Spatial Disruption (Species Distribution Models)

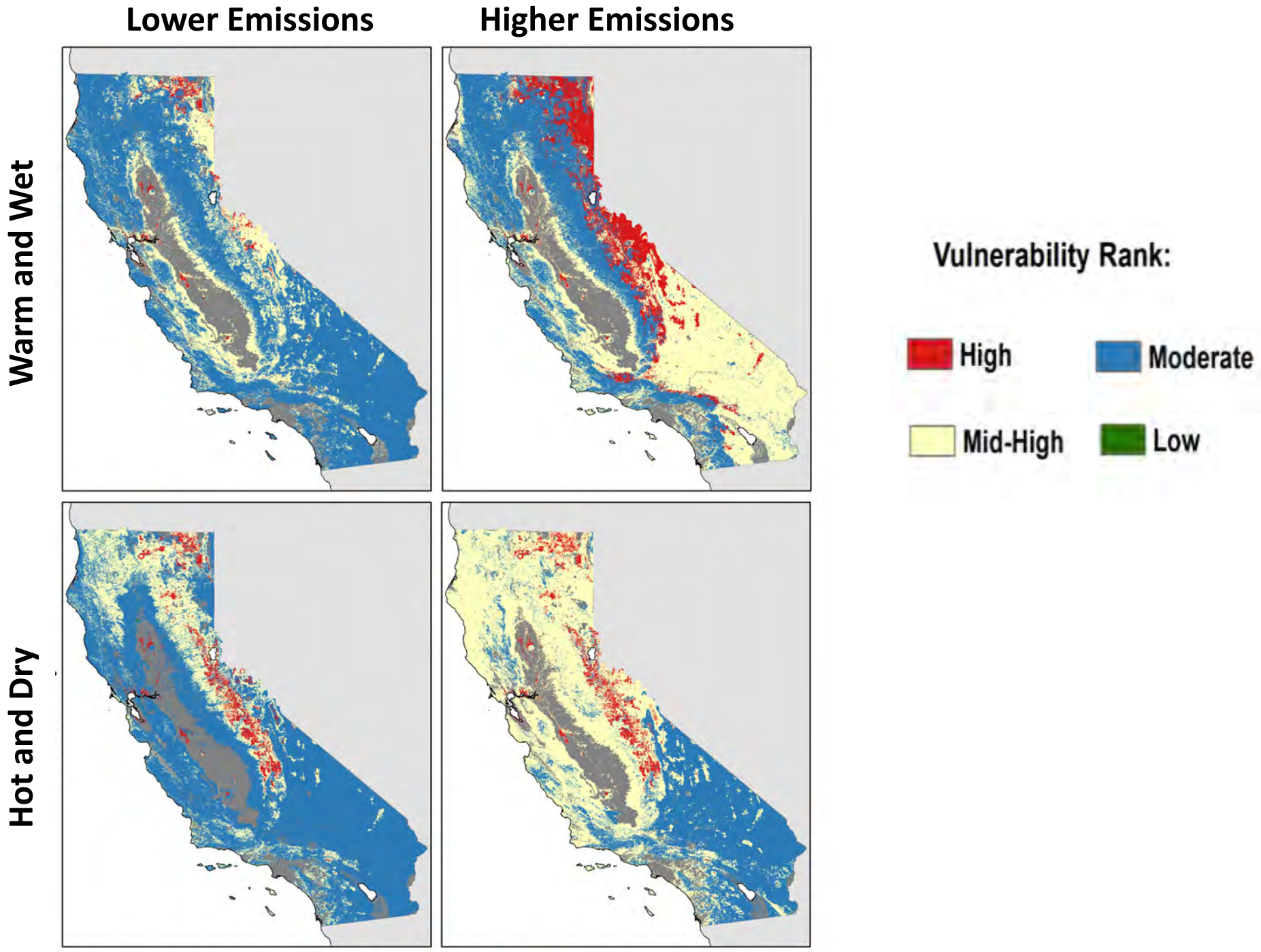


300 randomly selected presence points for each vegetation type

Model Current and Future Climate Suitability

Ratio of Current Range and Current Range Lost


Lower Emissions
Higher Emissions
Warm and Wet
Hot and Dry
Spatial Disruption
(Species Distribution Models)
Newly Suitable
No Longer Suitable
Remaining Suitable


Lower Emissions
Higher Emissions
Warm and Wet
Hot and Dry
Vulnerability Rank:
High
Moderate
Mid-High
Low

Applications

Through Time

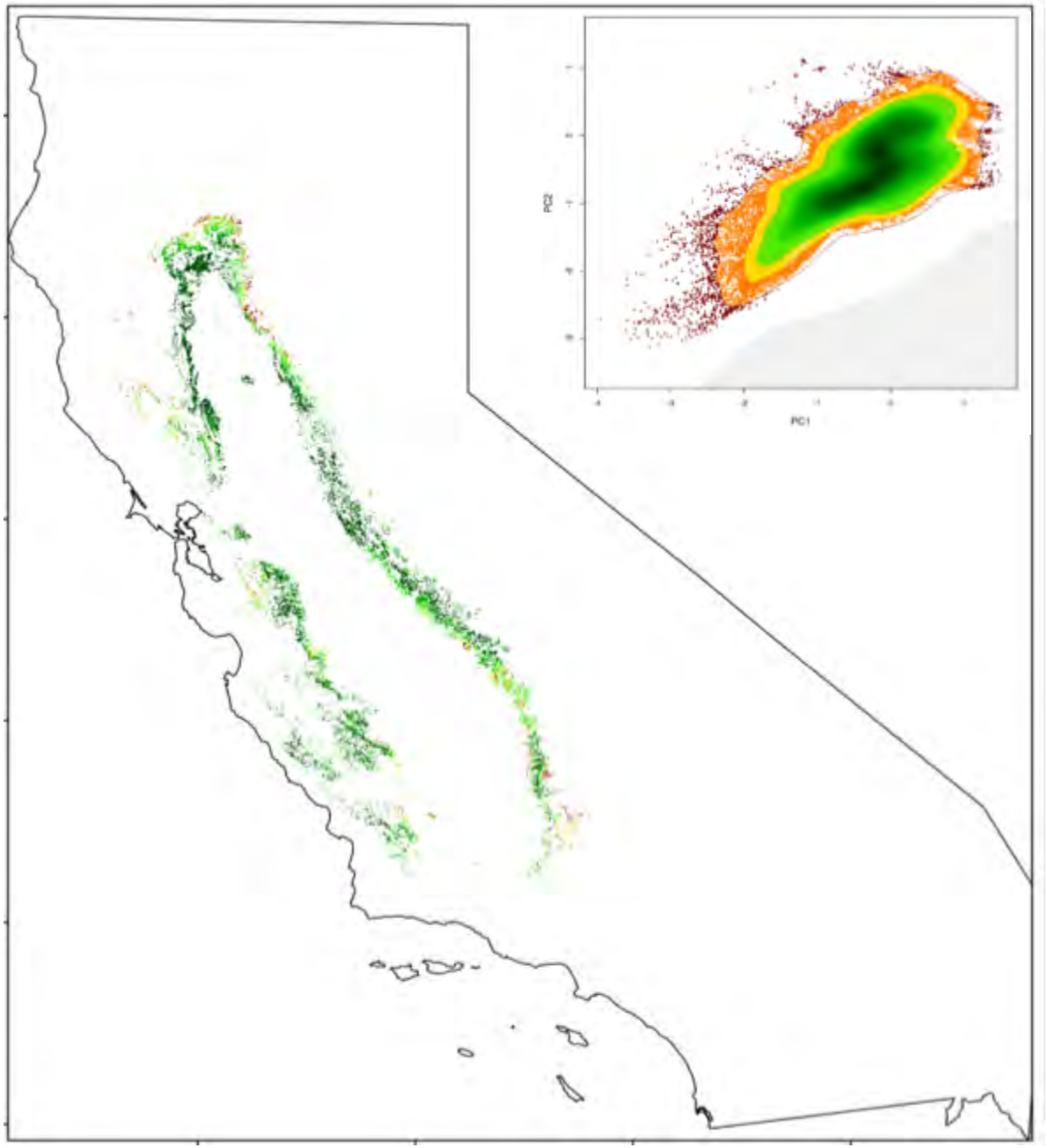
Climate Refugia

Restoration

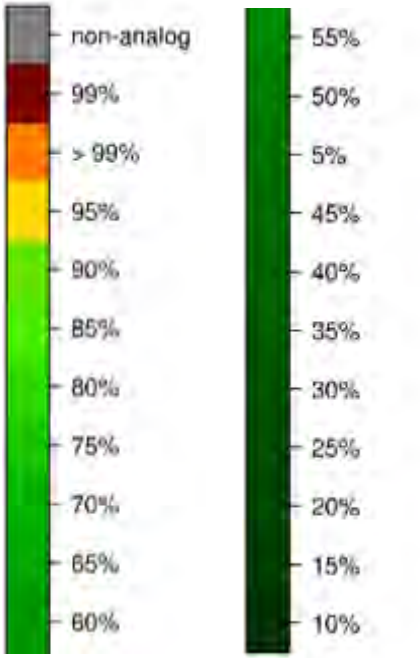
Vulnerability and WHR (Wildlife Habitat Relationships) comparison

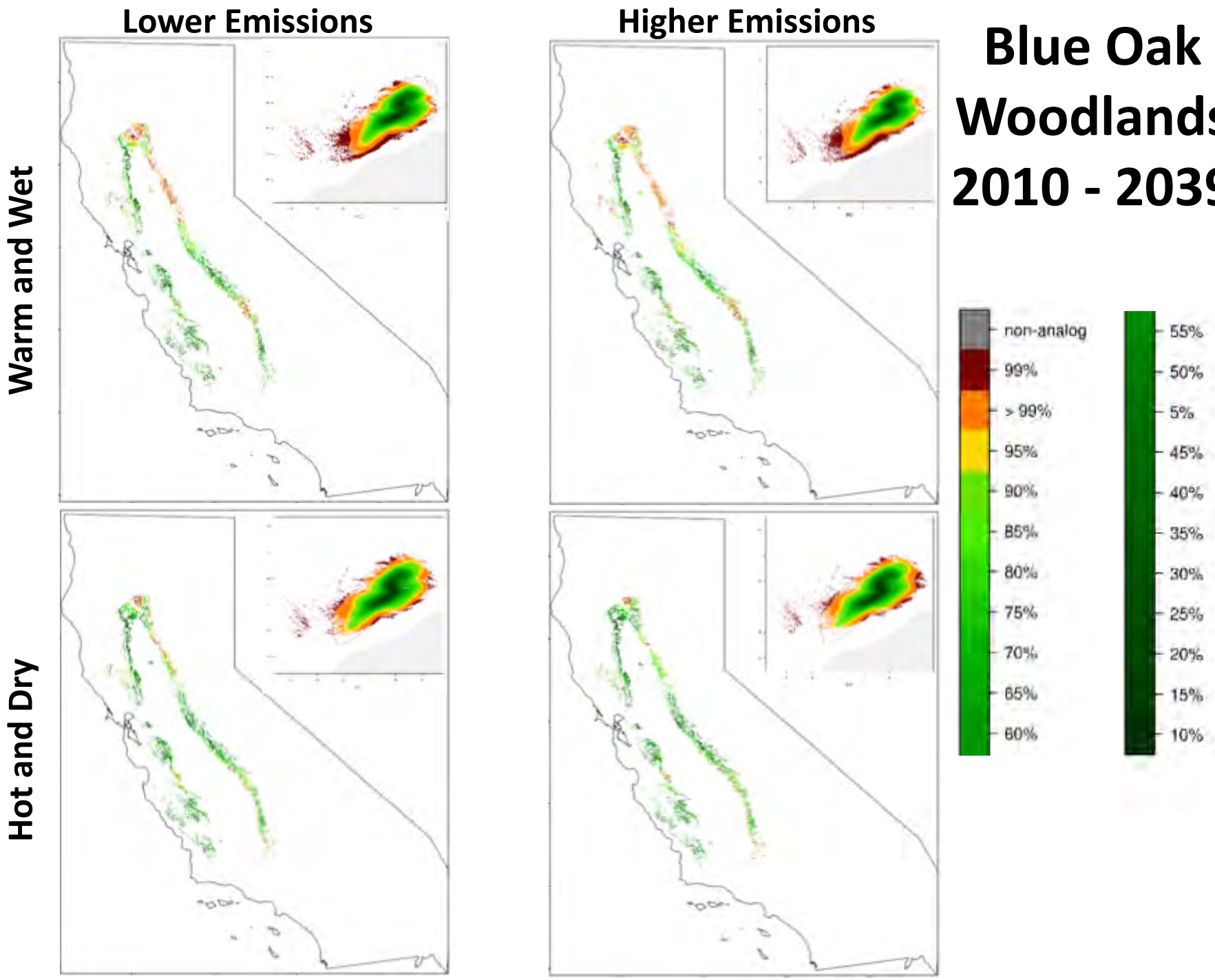
Mammalian vulnerability to climate change

Applications: A. A Study Through Time



Blue Oak Woodlands Current Time Classification




Lower Emissions
Higher Emissions
Warm and Wet
Hot and Dry
Blue Oak Woodlands 2010 - 2039
non-analog
99%
> 99%
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
5%
45%
40%
35%
30%
25%
20%
15%
10%

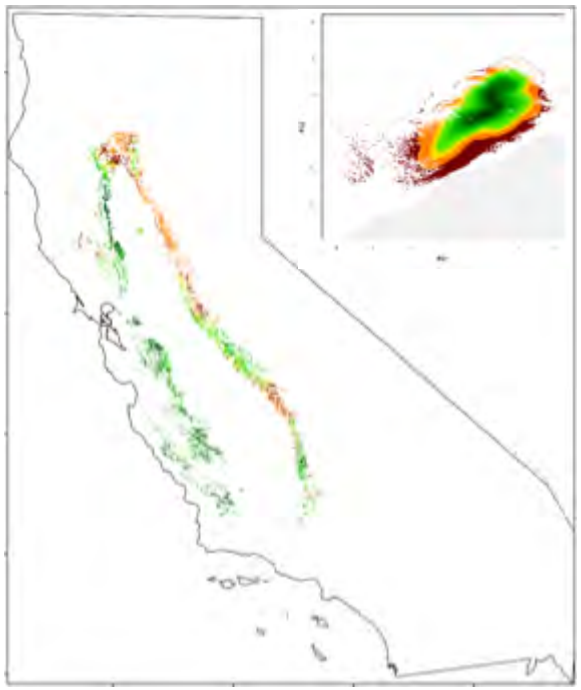
Blue Oak Woodlands 2040 - 2069

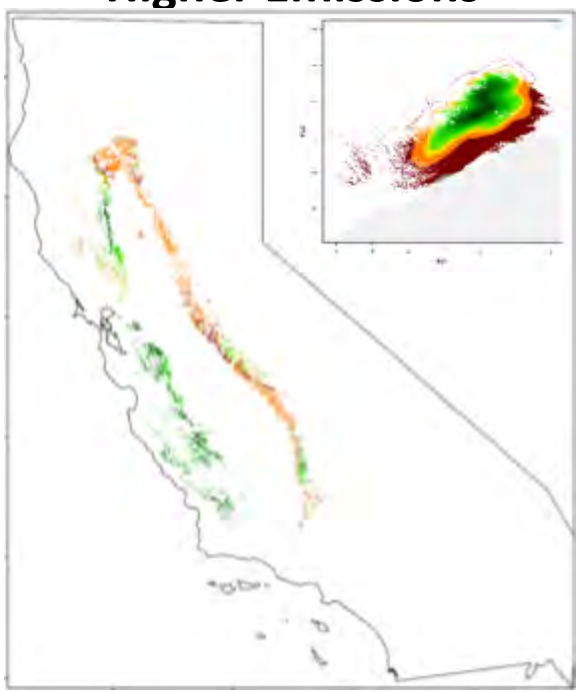
Lower Emissions

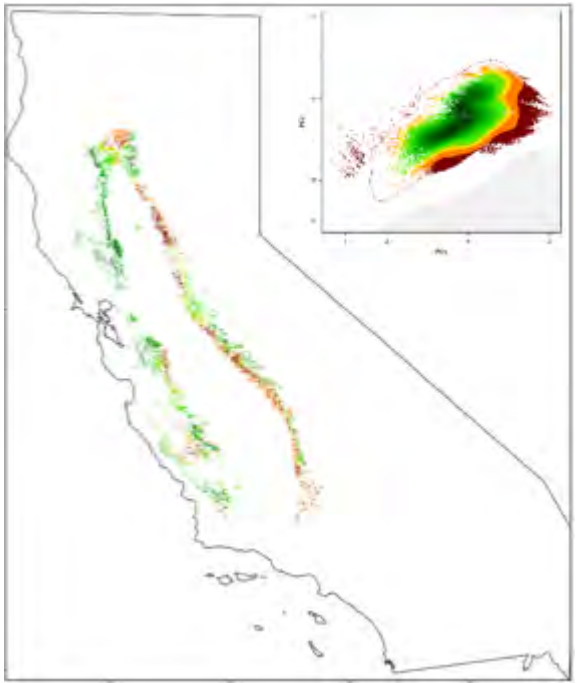
Higher Emissions

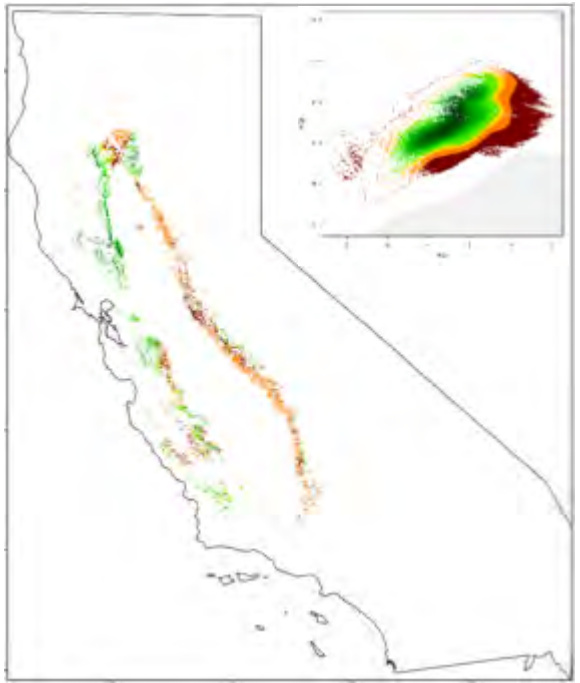
Warm and Wet

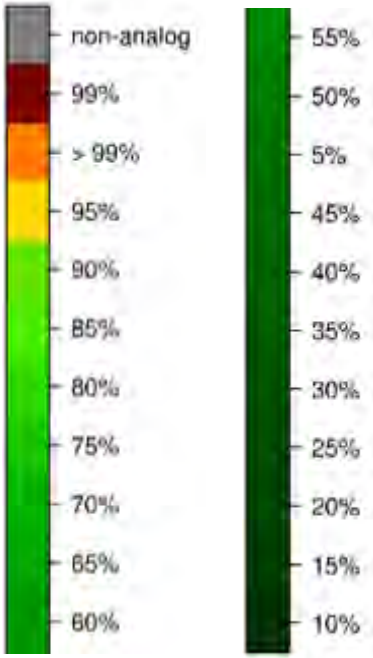
Hot and Dry











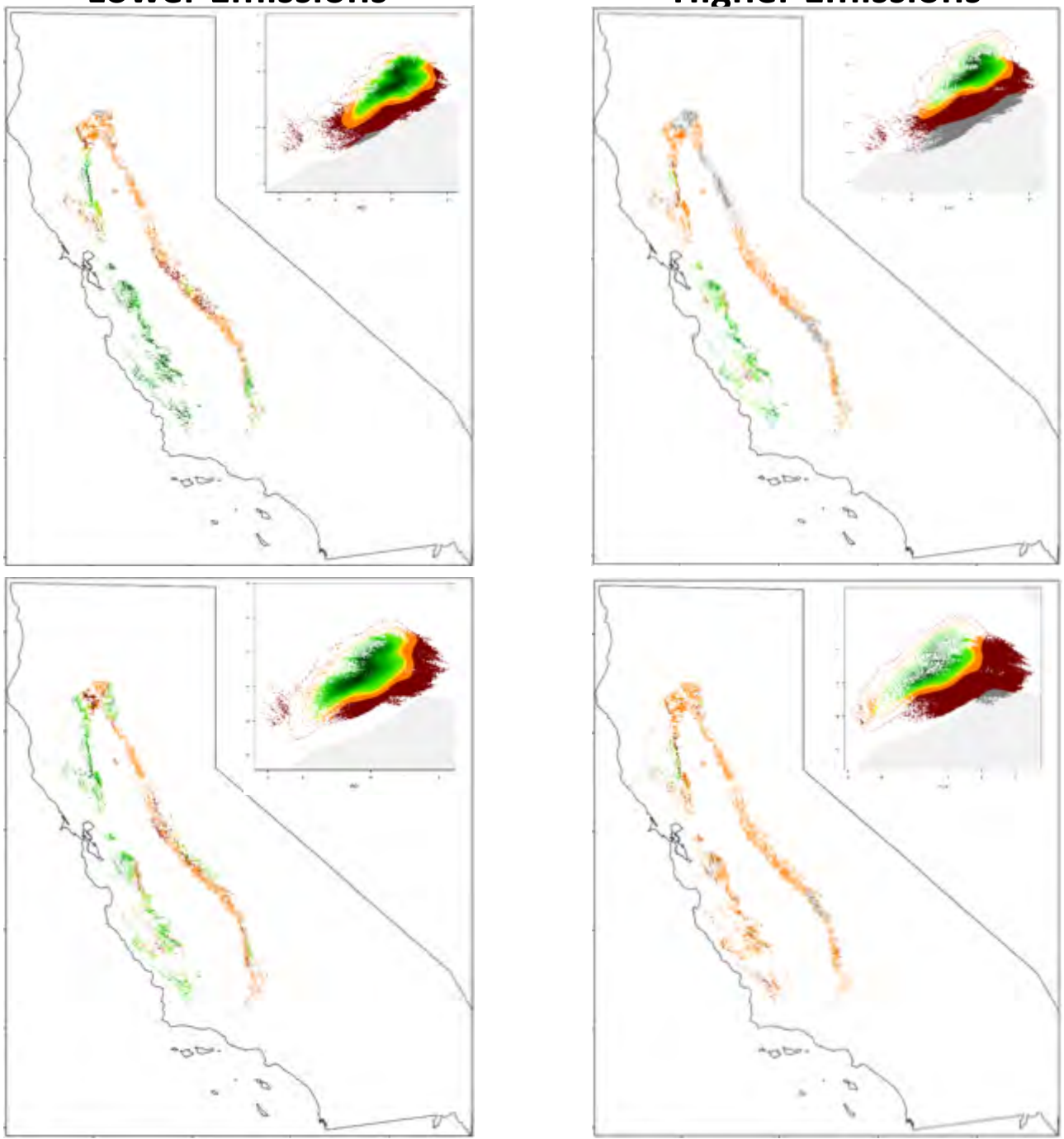
Blue Oak Woodlands 2070 - 2099

Lower Emissions

Higher Emissions

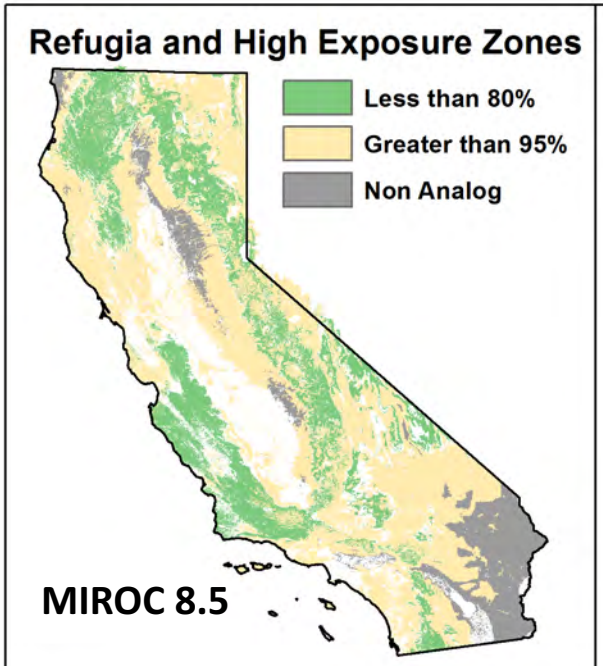
Warm and Wet

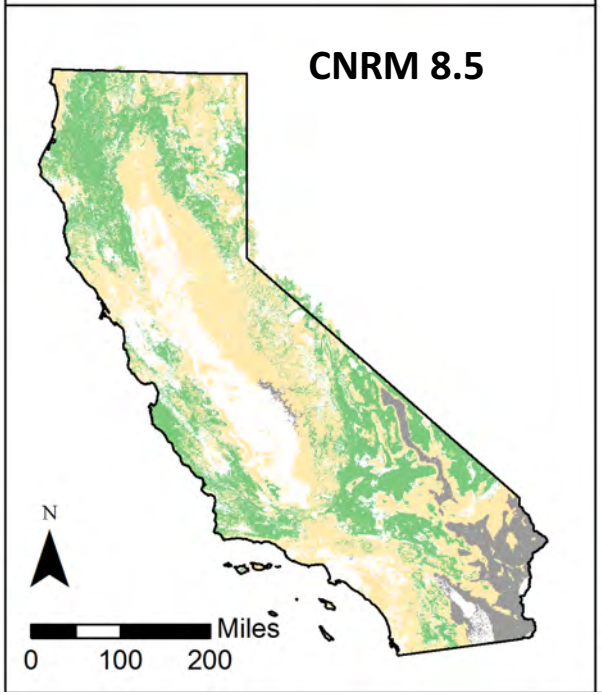
Hot and Dry

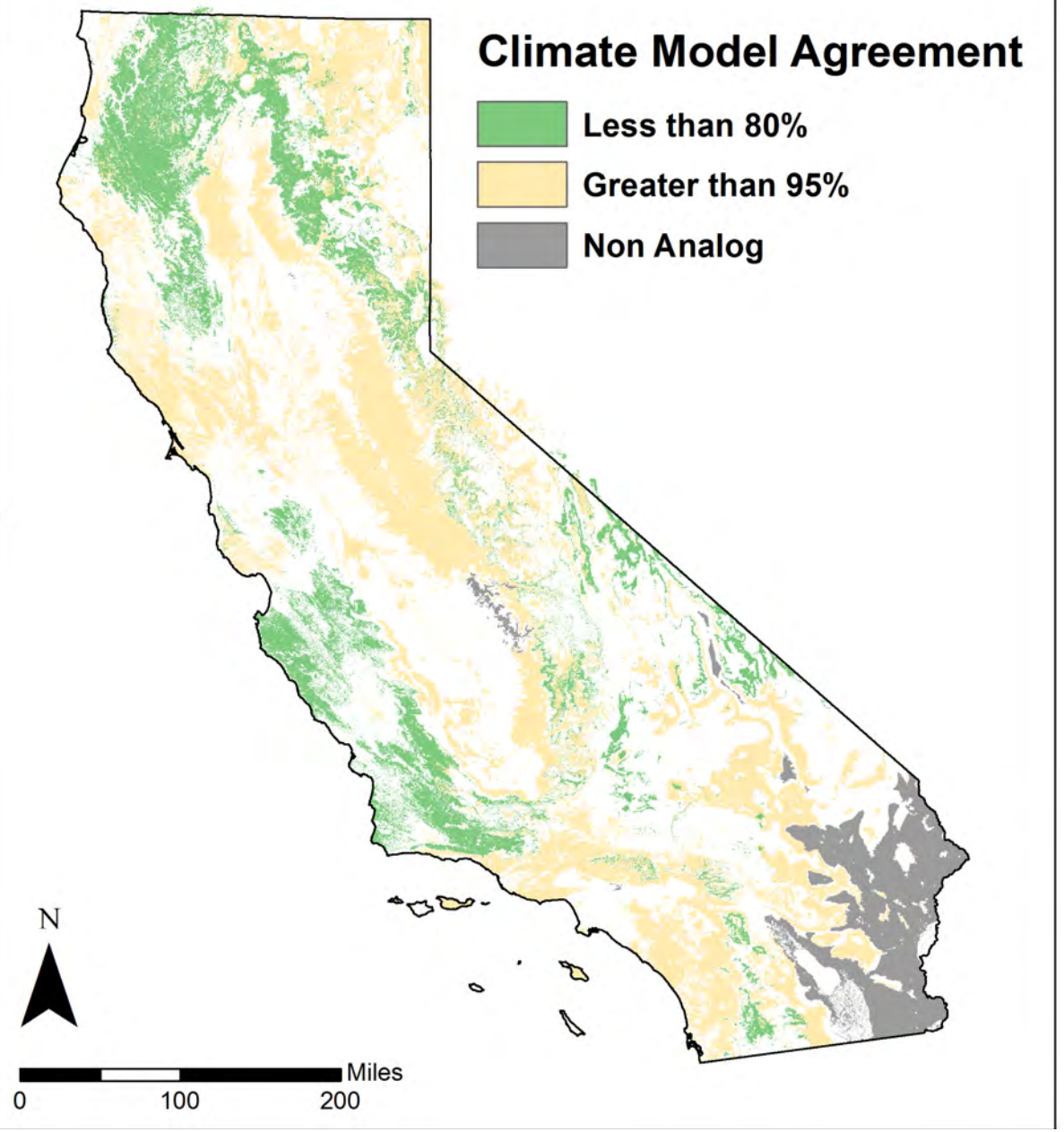


Applications:

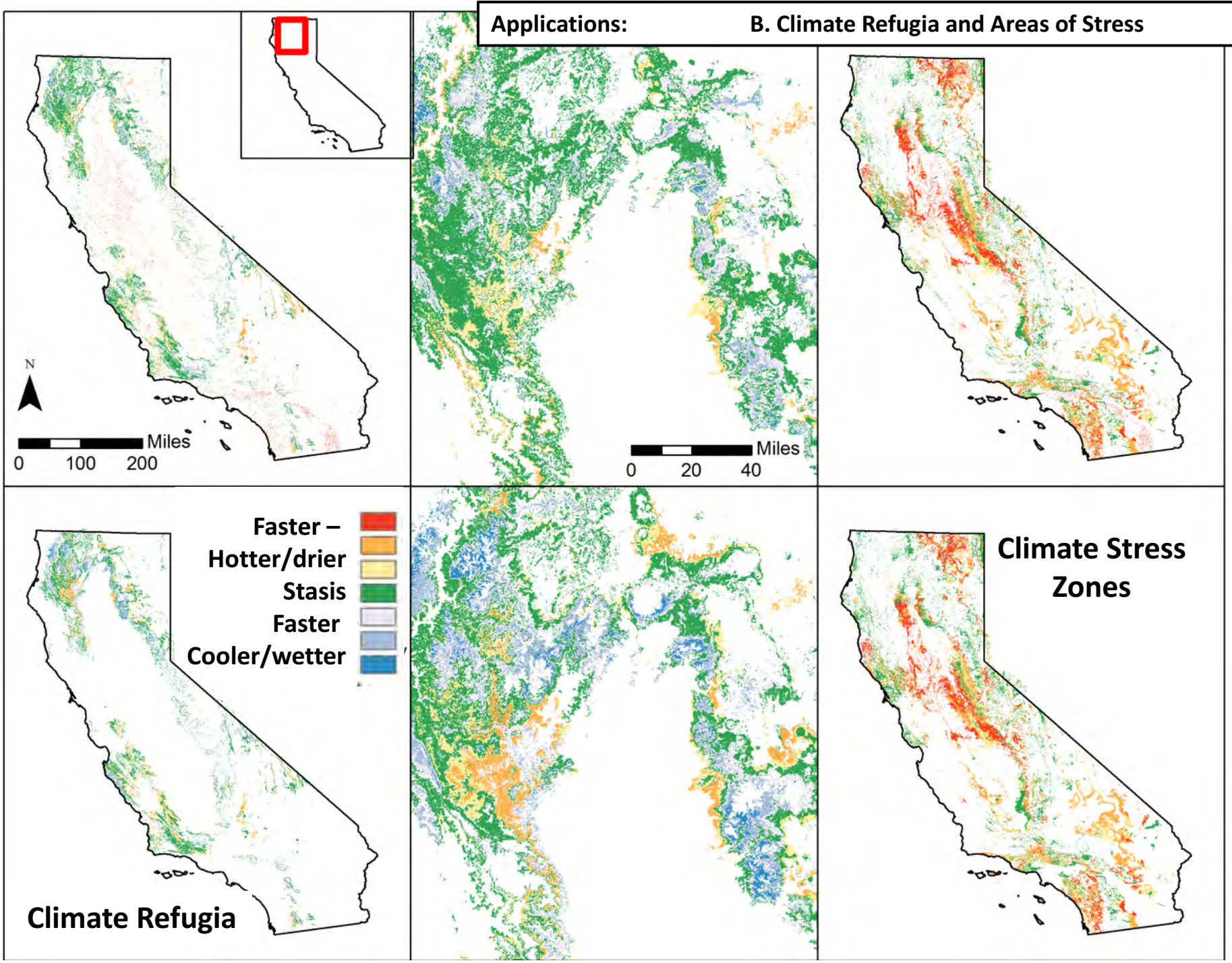
B. Climate Refugia and Areas of Stress



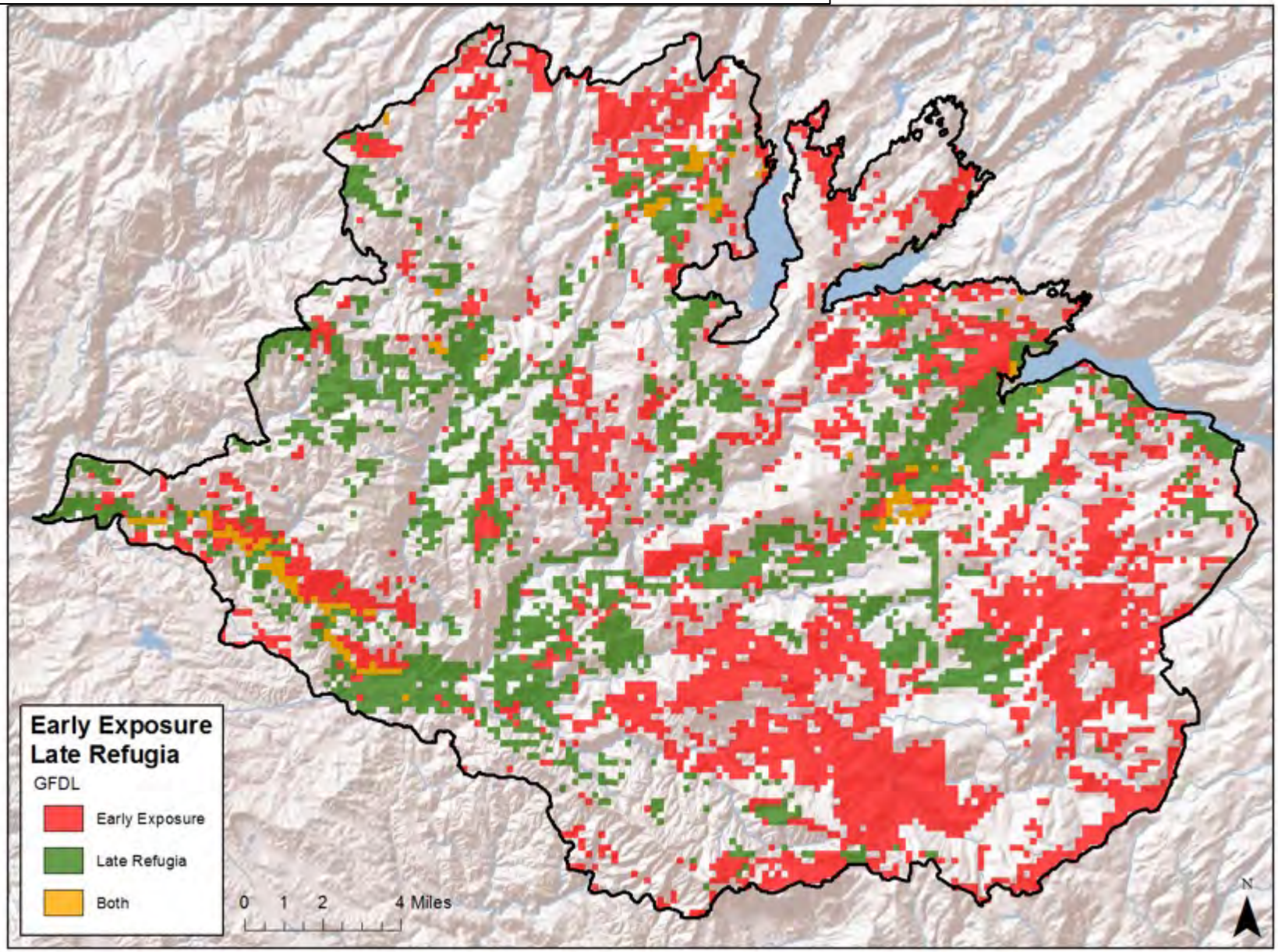




Applications: **B. Climate Refugia and Areas of Stress**

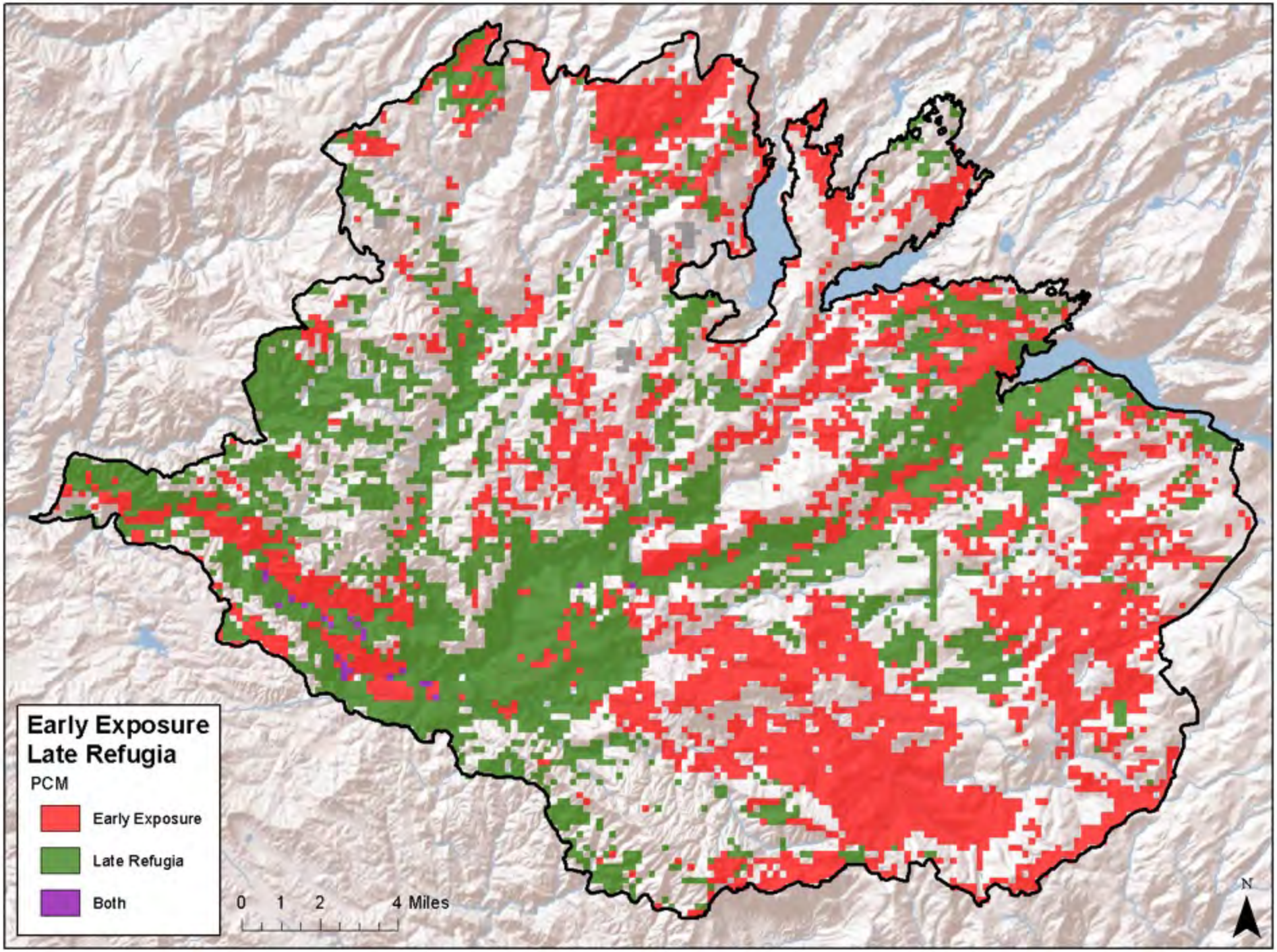


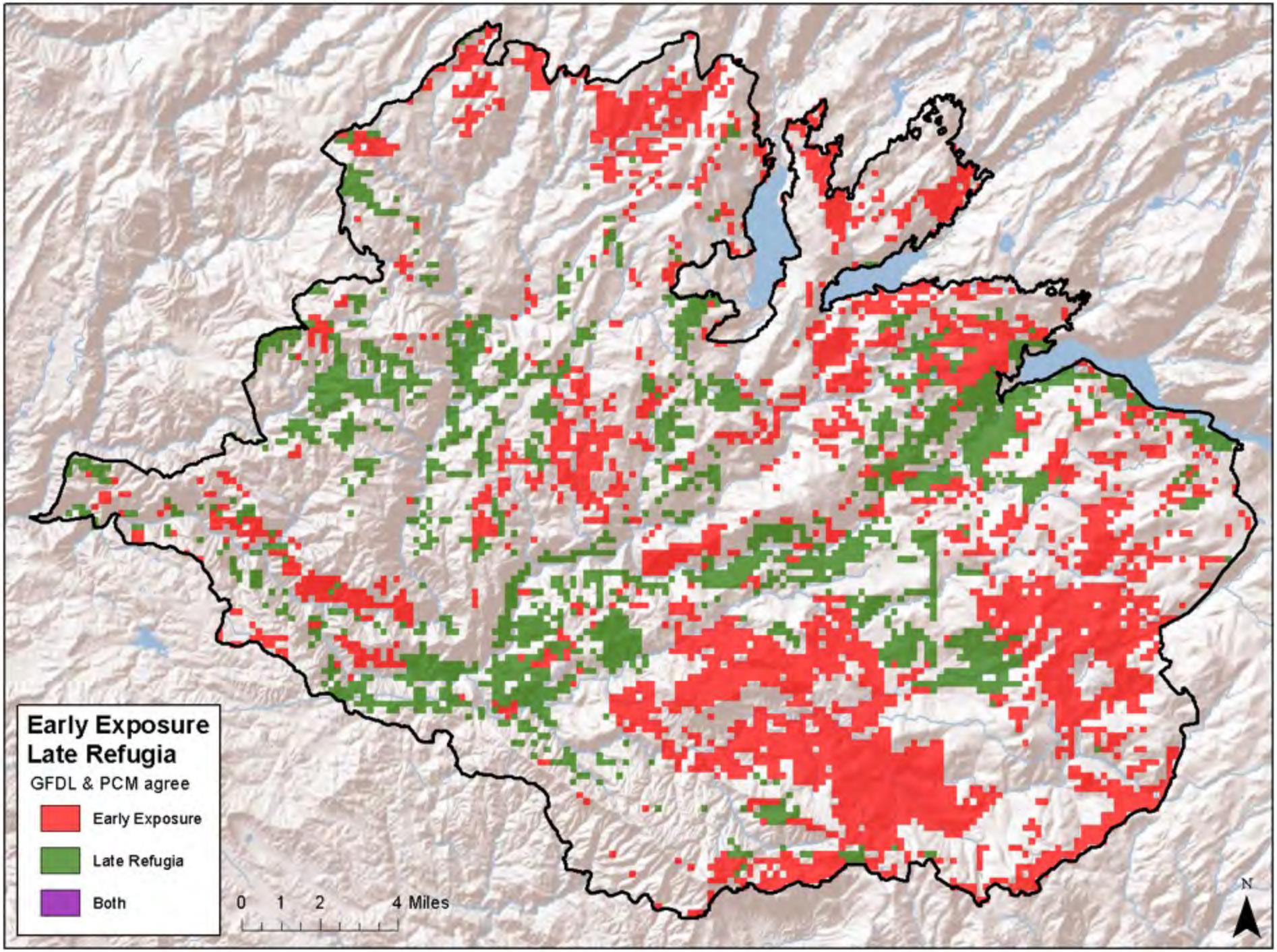
Applications C. Restoration after Wildfire

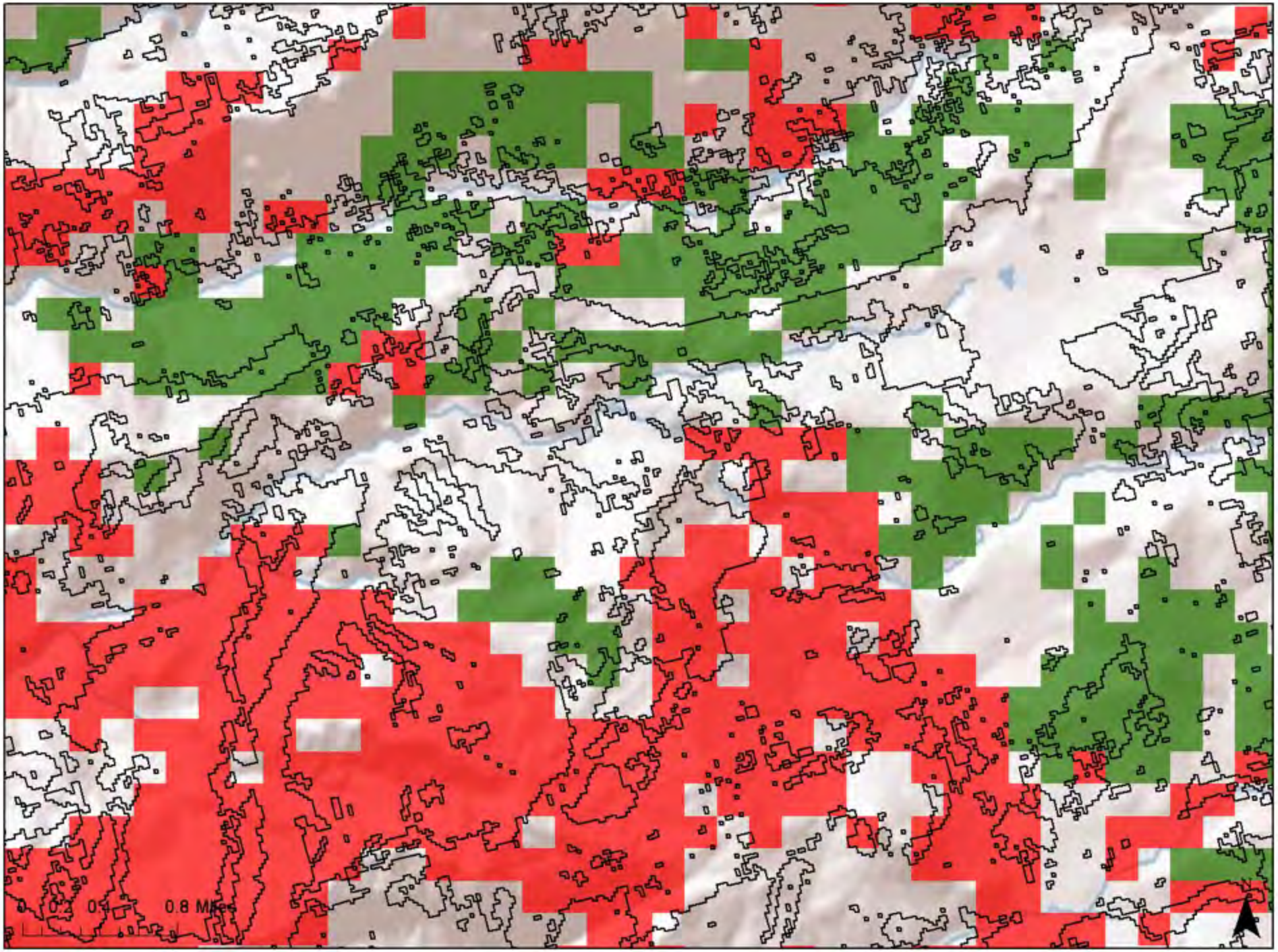


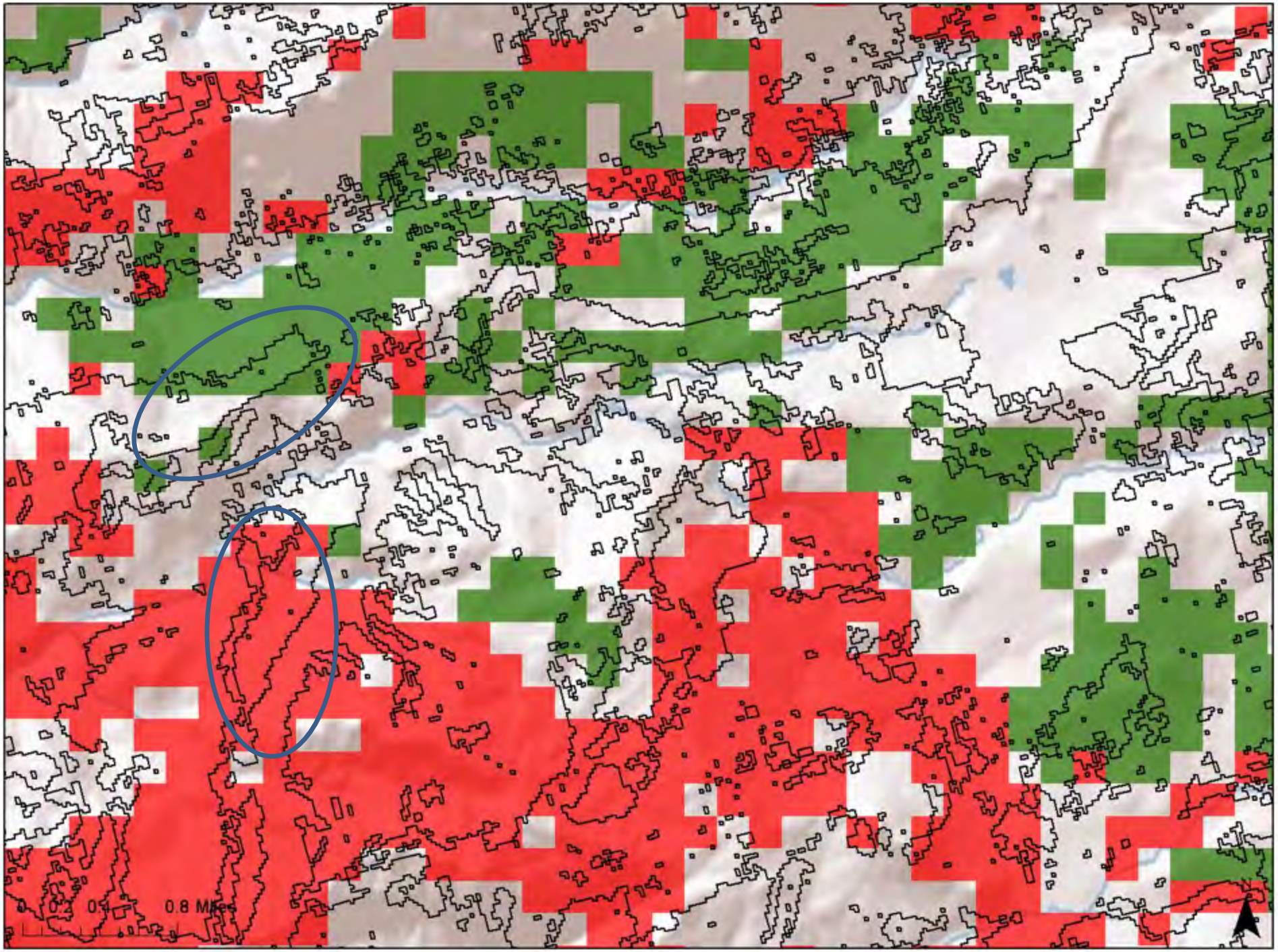
Green – places that remain within bioclimatic envelope at end of century.

Red: places that fall outside of bioclimatic envelope by 2040

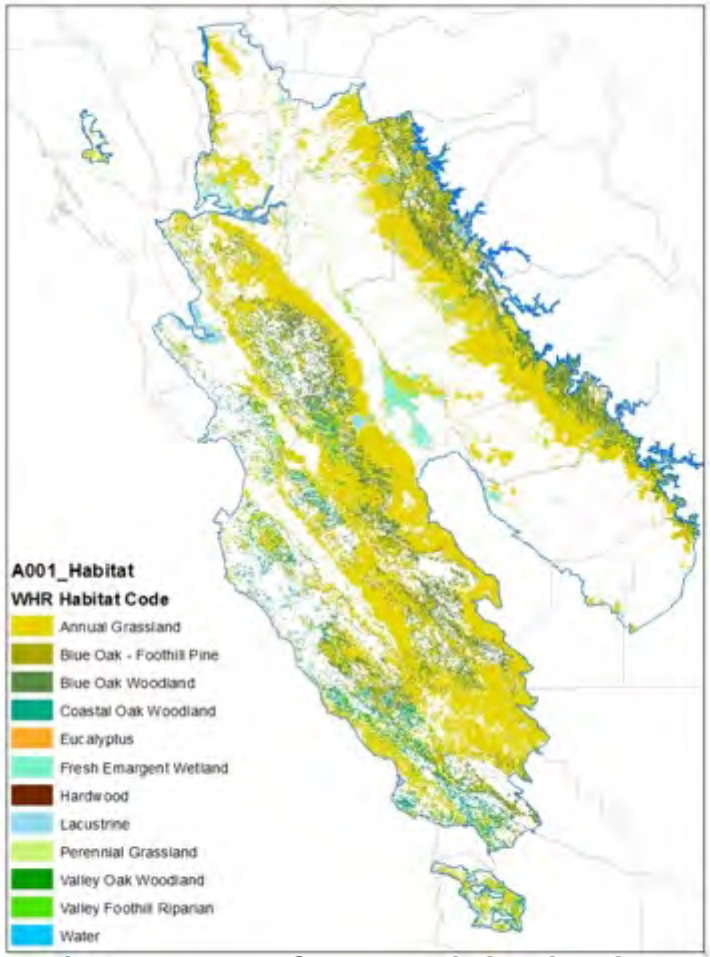

Early Exposure
Late Refugia
PCM
Early Exposure
Late Refugia
Both
0 1 2 4 Miles
N


Early Exposure
Late Refugia
GFDL & PCM agree
Early Exposure
Late Refugia
Both
0 1 2 4 Miles
N


0.4 0 0.8 Miles

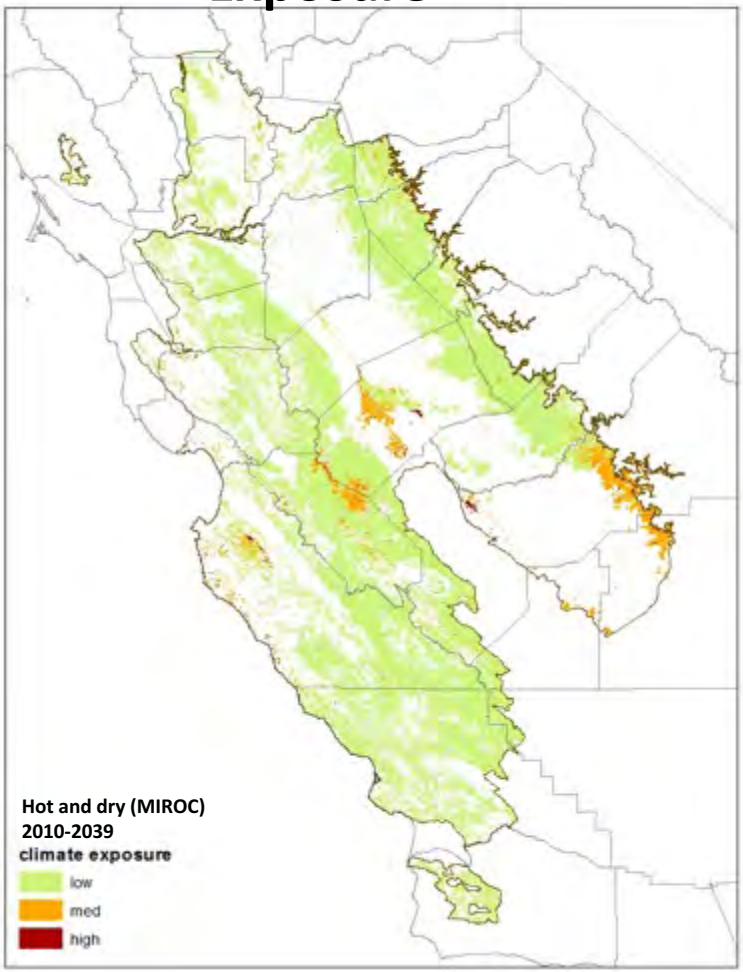

0.4 0.0 0.8 Miles

Vulnerability & WHR: California tiger salamander



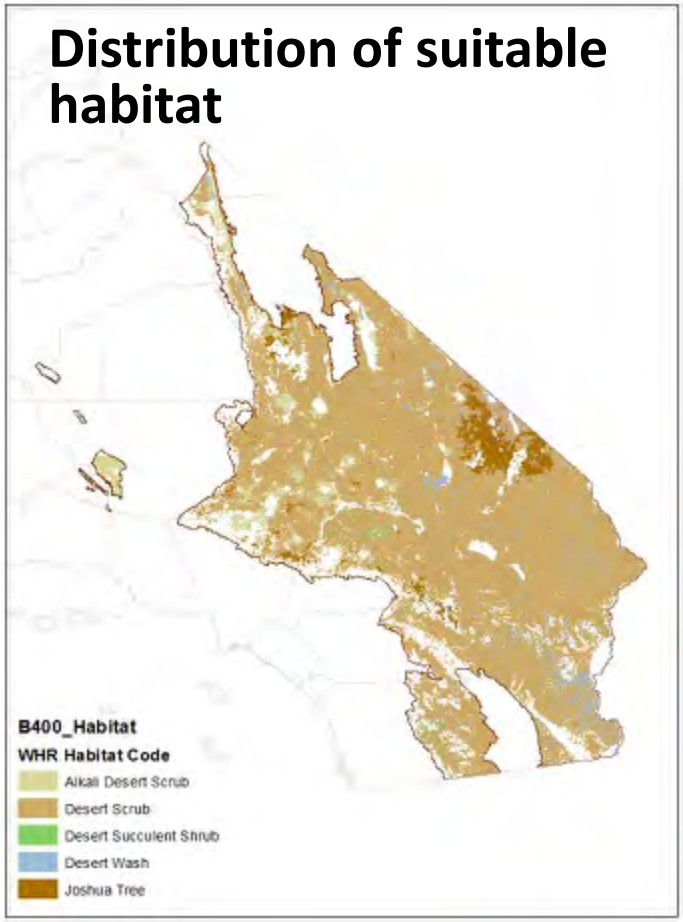
Distribution of suitable habitat

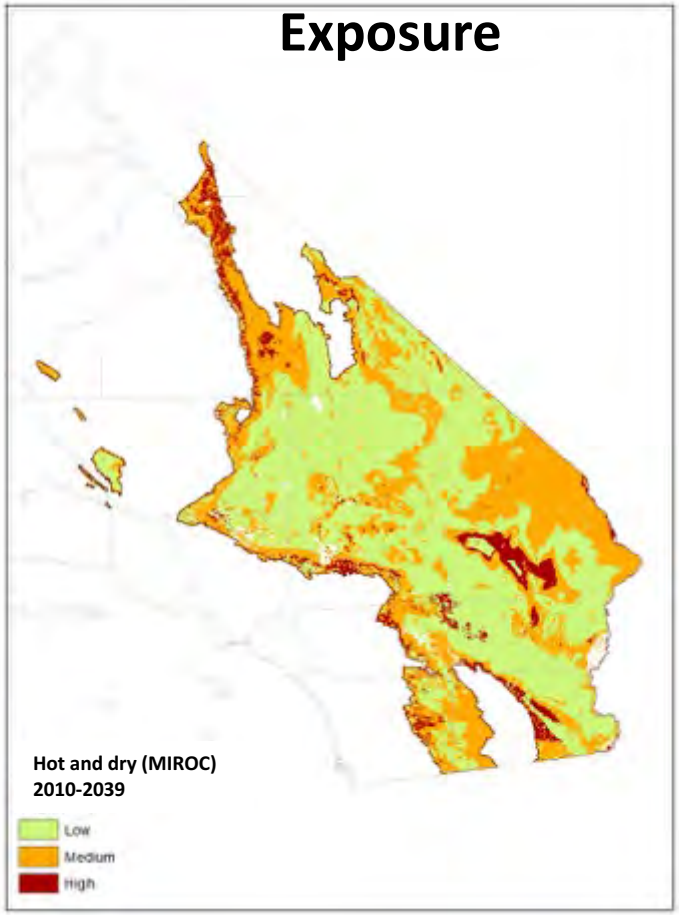
Exposure



Courtesy of Melanie Gogol-Prokurat

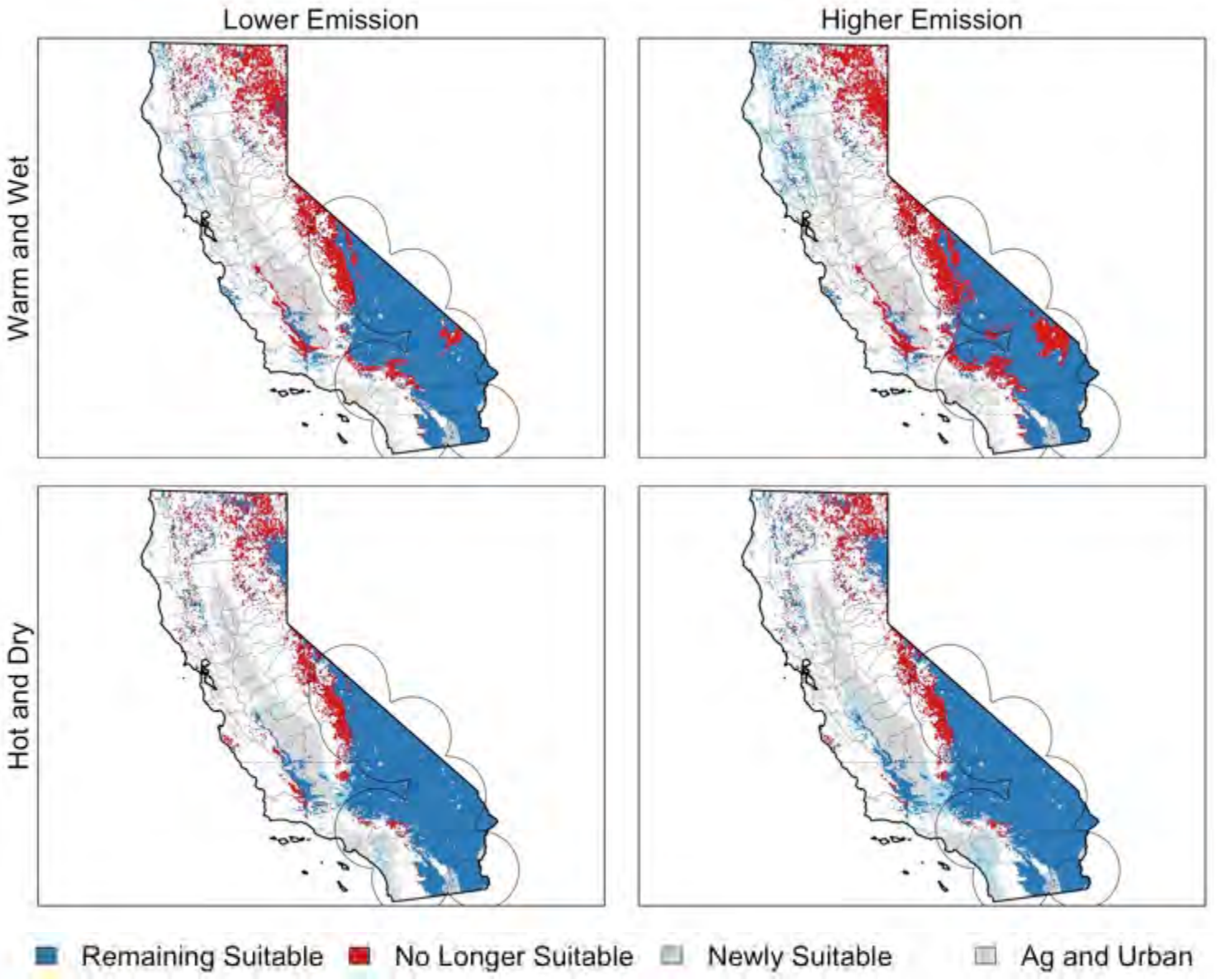
Vulnerability & WHR : LeConte's thrasher





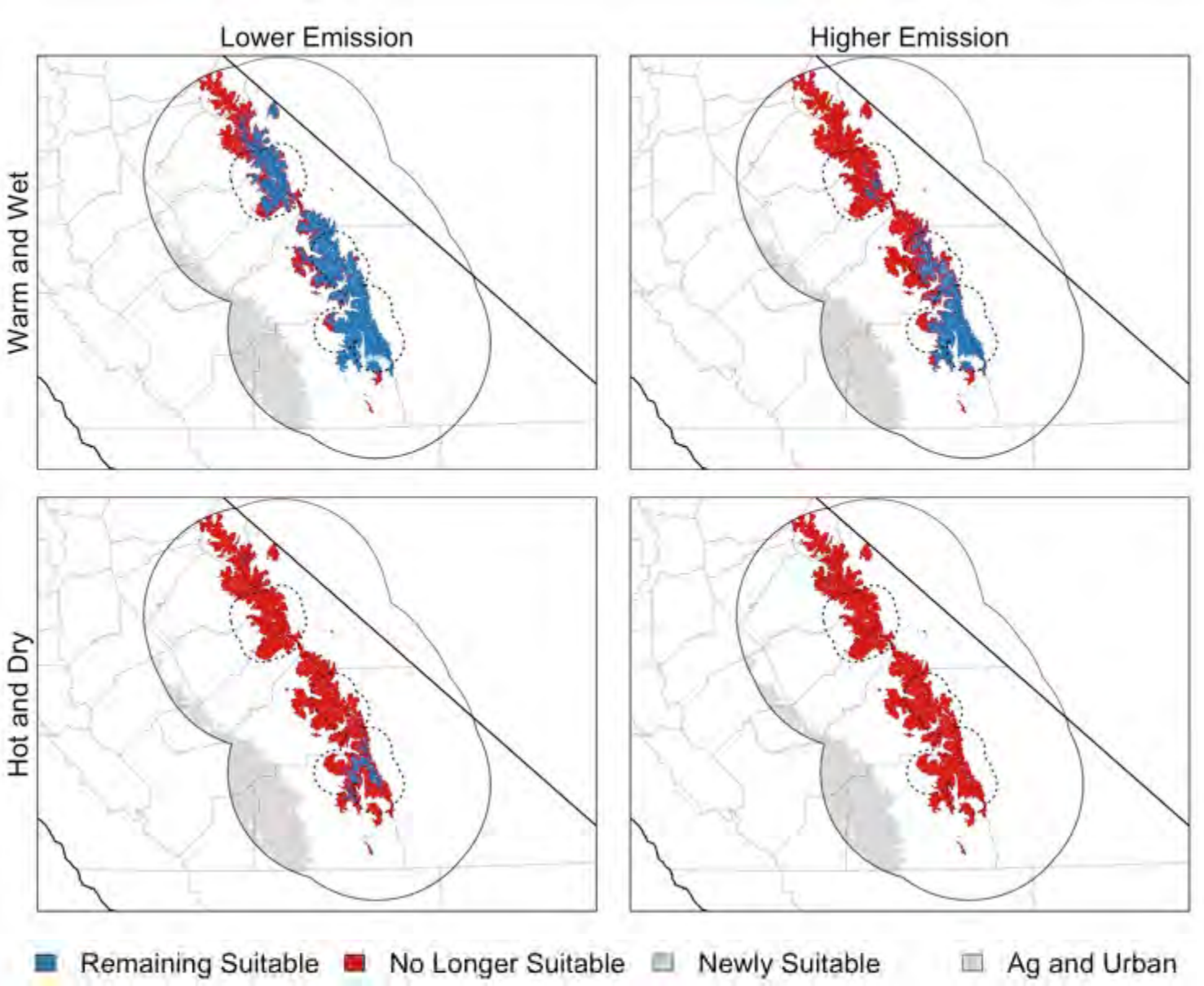
Courtesy of Melanie Gogol-Prokurat

Vulnerability of CA Mammals: Desert Bighorn Sheep
Projected Change in Habitat Suitability, 2085



Vulnerability of CA Mammals: Alpine Chipmunk Projected Change in Habitat Suitability, 2085

92% contraction (upslope shift) of historical elevation range (Moritz et al. 2008).

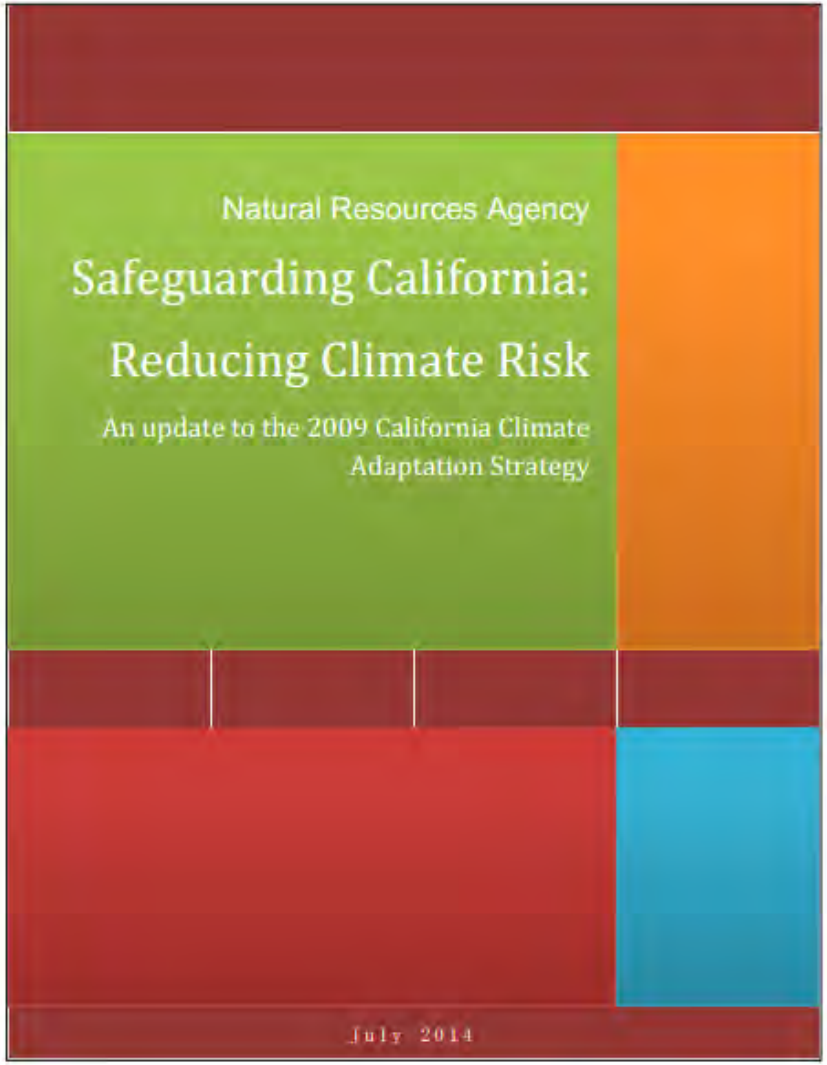


Applications

- Management and decision-making
  - Conservation planning & land acquisition
    - Vulnerability and refugia data
  - Grant programs and solicitations
    - Prop 1
    - GGRF (Greenhouse Gas Reduction Fund)
    - Others

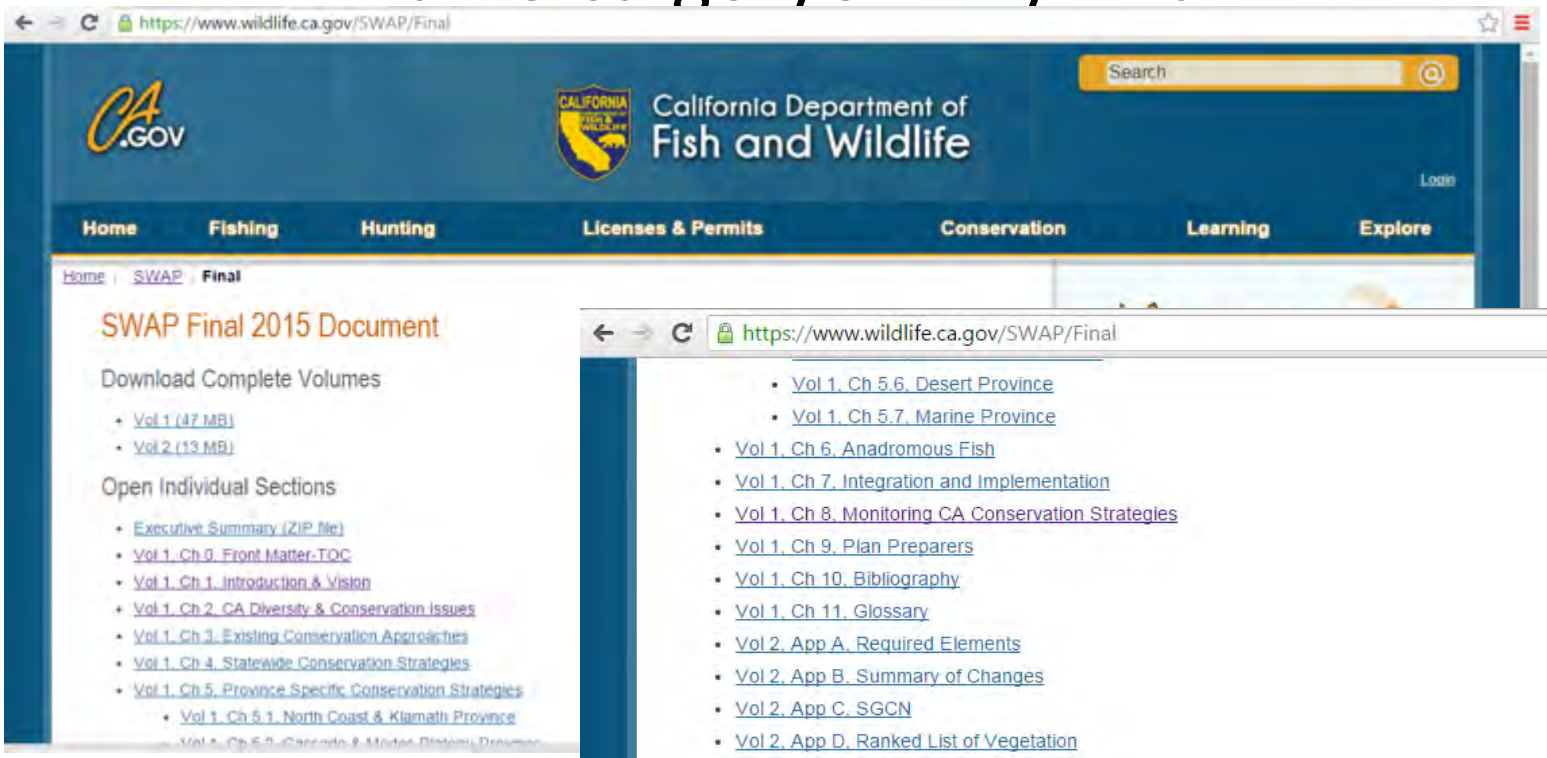
Application

- Feed into state climate adaptation strategy updates
- Other adaptation efforts



Report online at…

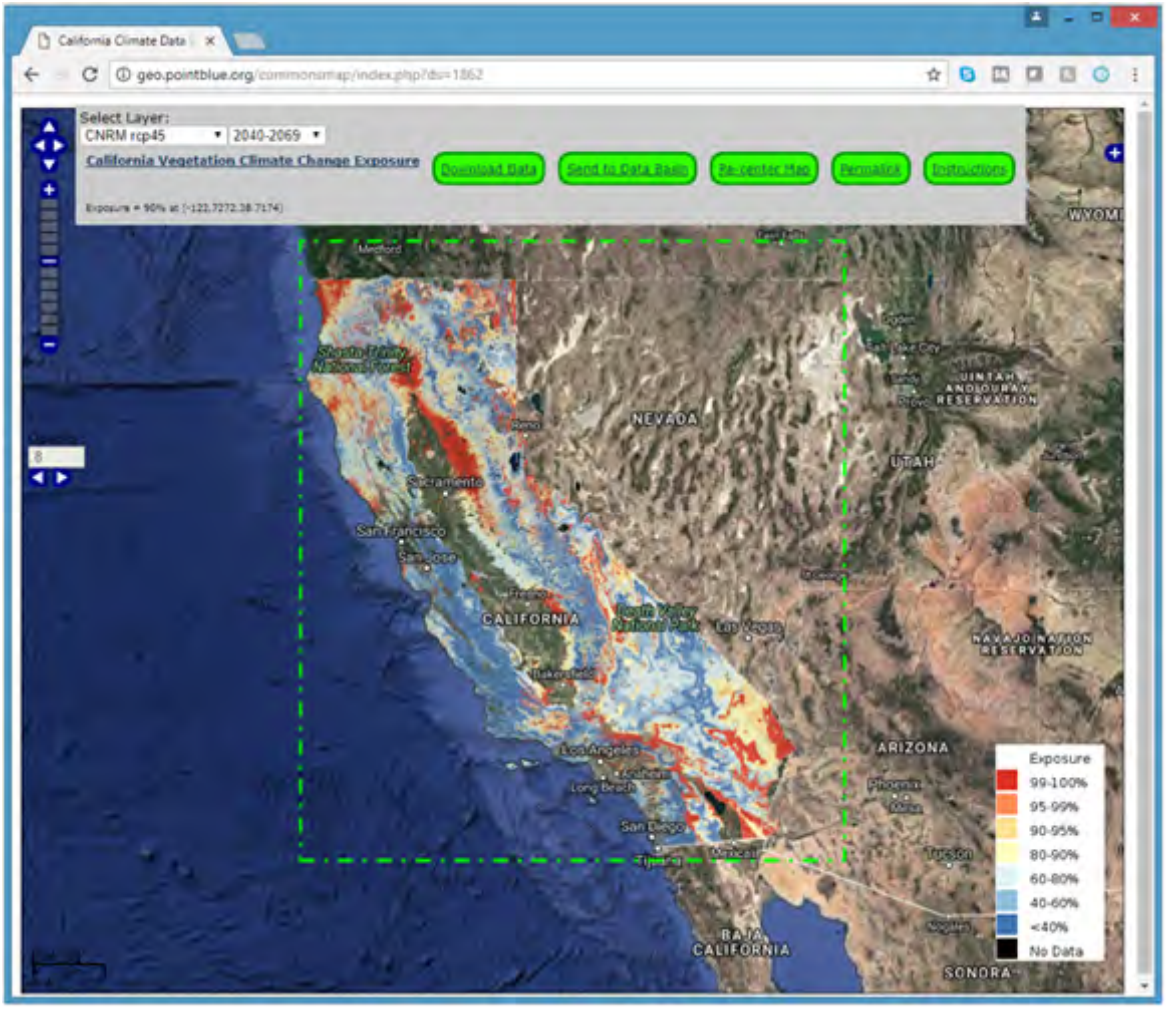
www.wildlife.ca.gov/SWAP/Final



Report online at…

climate.calcommons.org/bib/climate-change-vulnerability-assessment-california's-terrestrial-vegetation

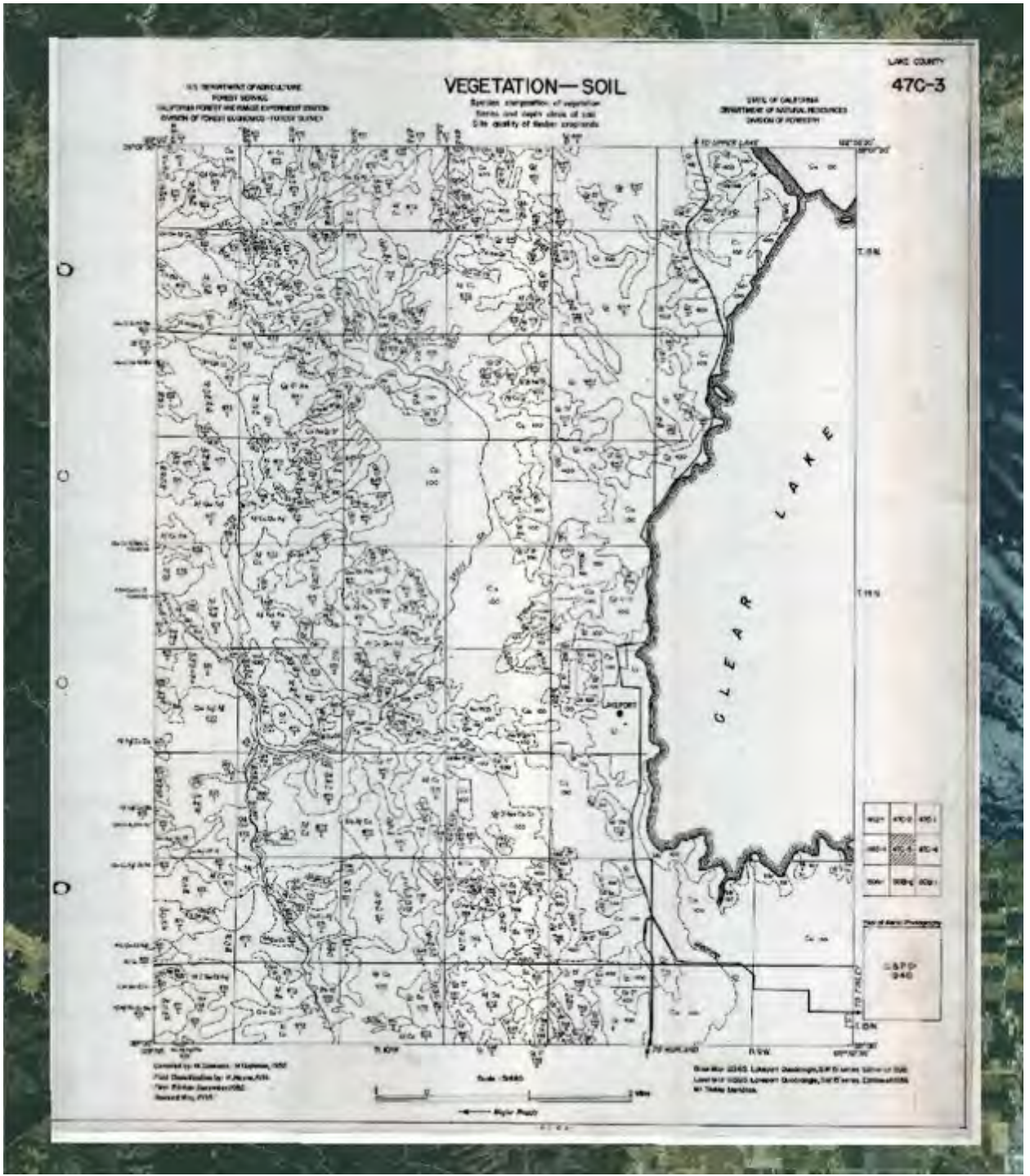
Data online through the California Climate Commons

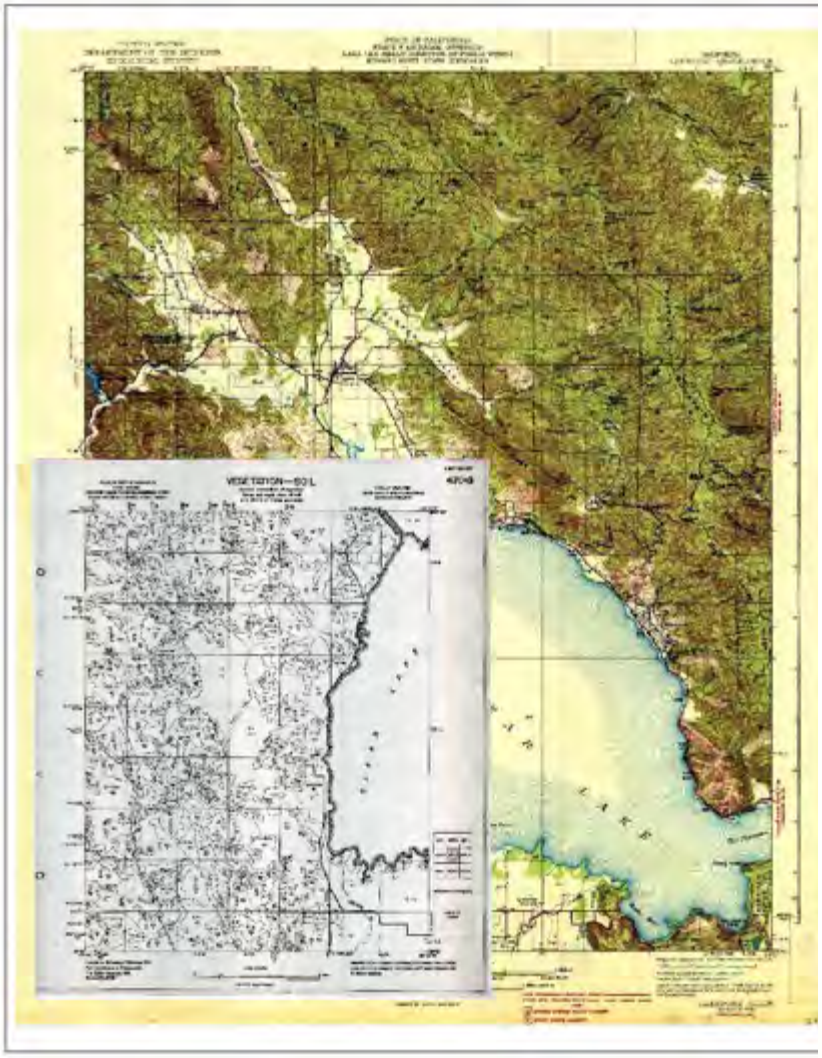


Soil Vegetation Survey Maps

From the late 40s- 1970s Landcover mapping by a Combo of UC Berkeley and USFS, funded by State of California!

Never fully digitized
Contain detailed legacy data for NorCal



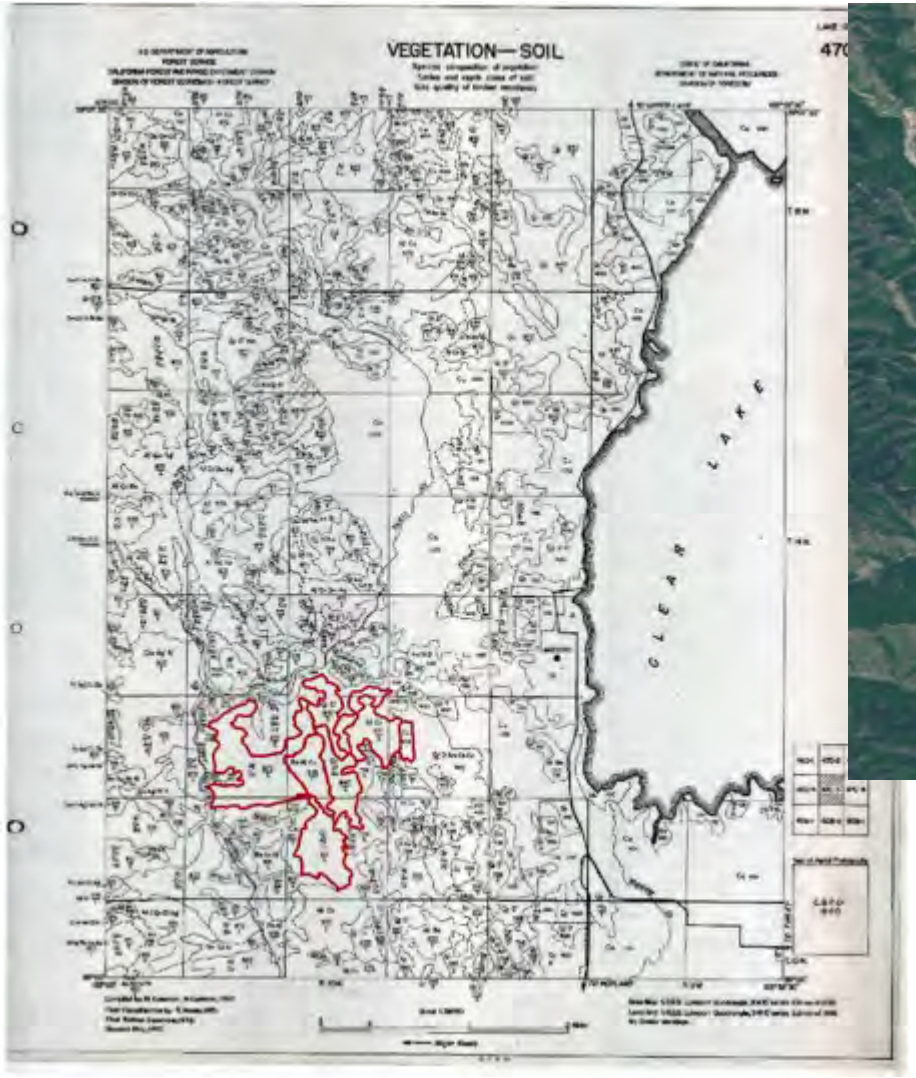


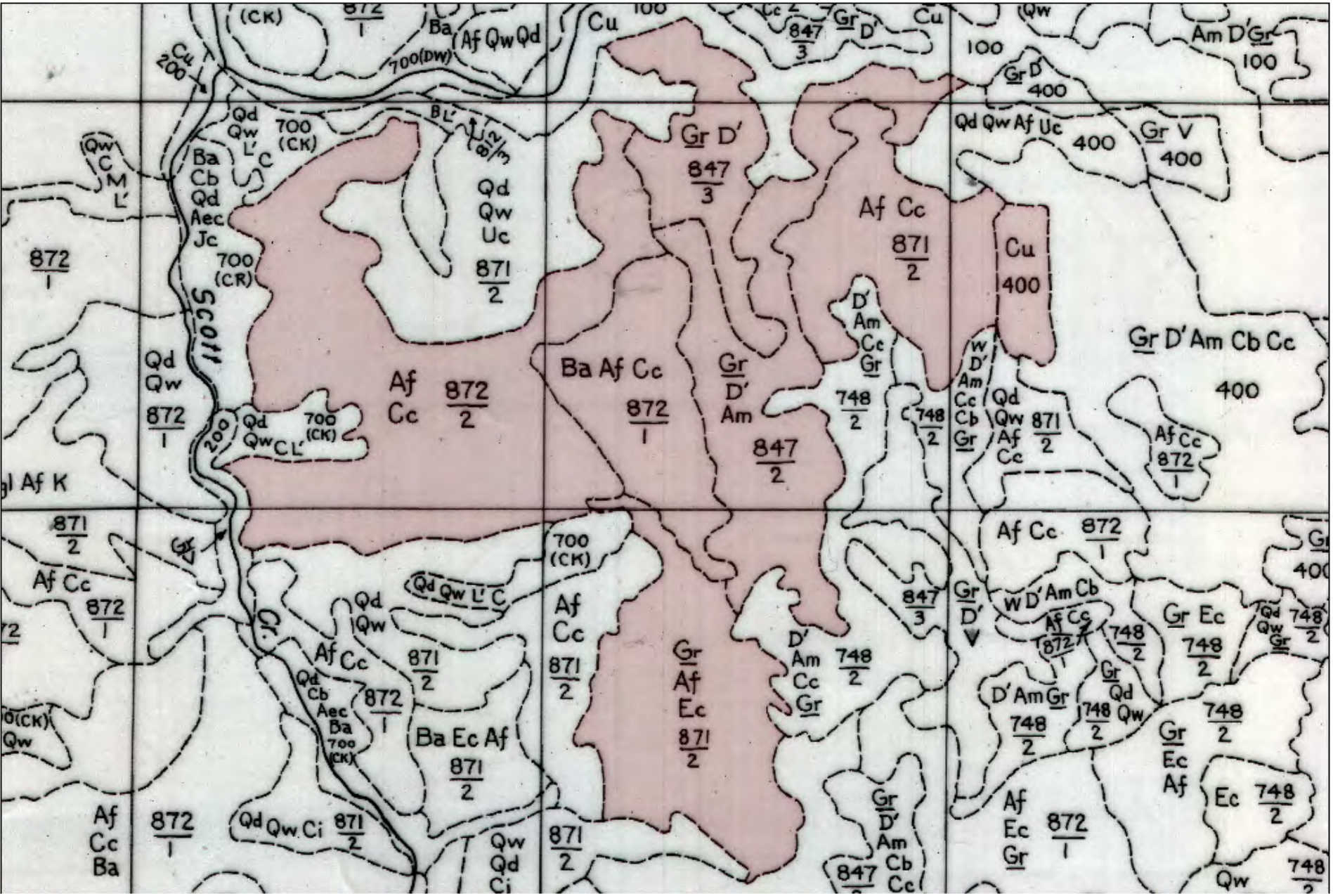
Northwest

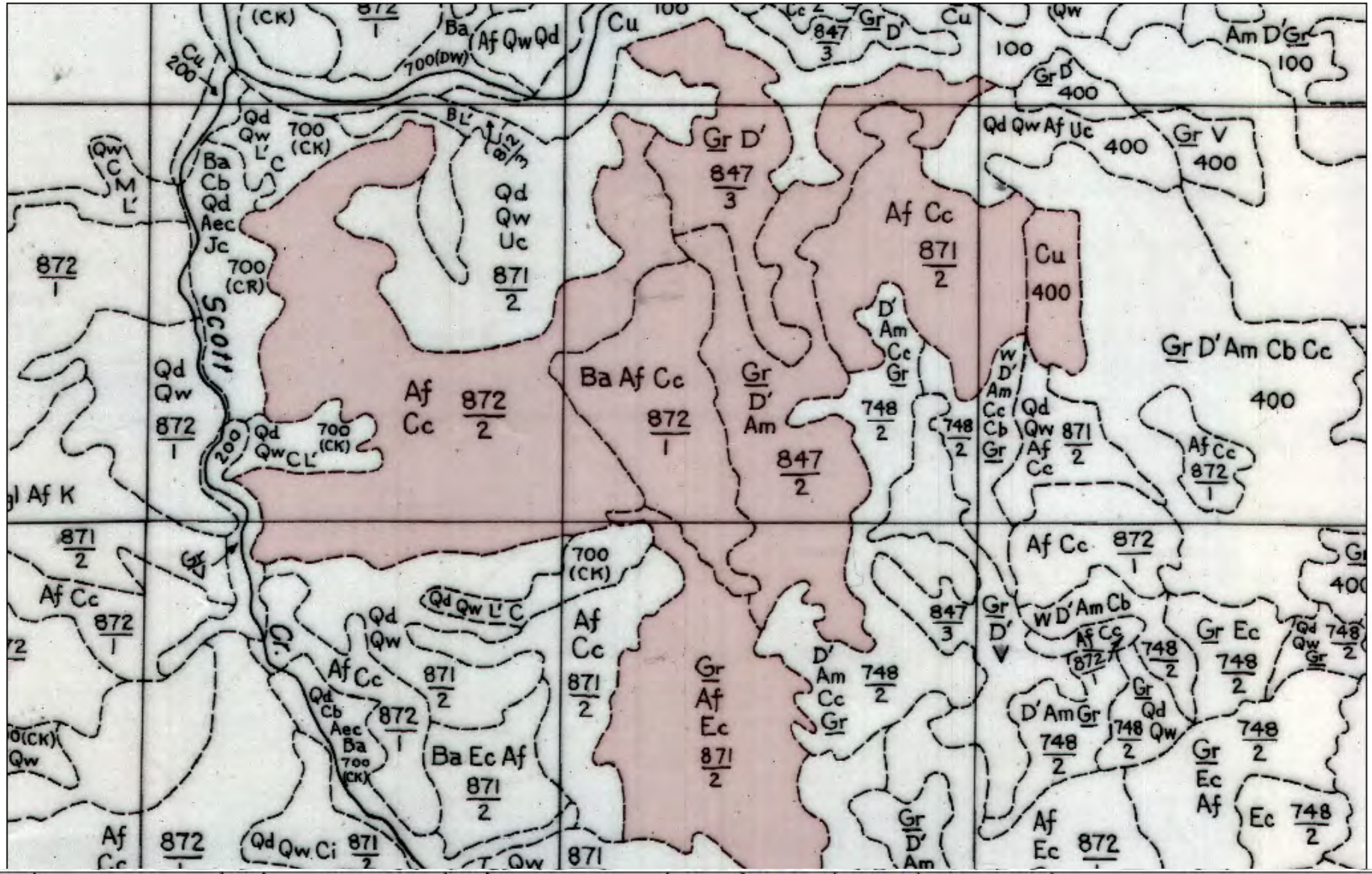
Northeast

Southwest

Southeast


VEGETATION—SOIL
CLEAR LAKE


(CK)
872/1
Ba
Af Qw Qd
700(DW)
Cu
200
Cu
100
Cc 2
847/3
Gr D'
Cu
Qw
Am D'Gr
100
Gr D
400
Qd Qw L' C
700 (CK)
BL'
12/8 1/3
Qd Qw Uc
871/2
Gr D'
847/3
Af Cc
871/2
Qd Qw Af Uc
400
Gr V
400
Qw C M L'
Ba Cb Qd Aec Jc
700 (CR)
872/1
SC011
Cu
400
D' Am Cc Gr
748/2
Gr D' Am Cb Cc
400
W D' Am Cc Cb Gr
Qd Qw Af Cc
871/2
Af Cc
872/1
Qd Qw
872/1
200
Qd Qw C L'
700 (CK)
Af Cc 872/2
Ba Af Cc
872/1
Gr D' Am
847/2
748/2
gl Af K
871/2
Af Cc
872/1
Gr
700 (CK)
Qd Qw L' C
Af Cc
871/2
847/3
Gr D'
W D' Am Cb
Af Cc
872/1
748/2
Gr Ec
748/2
Qd Qw Gr
748/2
Cr
Qd Qw
Af Cc
871/2
Qd Cb Aec Ba 700 (CK)
872/1
Ba Ec Af
871/2
Gr Af Ec
871/2
D' Am Cc Gr
748/2
D' Am Gr
748/2
Gr Qd Qw
748/2
748/2
Gr Ec Af
Ec 748/2
Af Cc Ba
872/1
Qd Qw Ci
871/2
Qw Qd Ci
871/2
Af Ec Gr
872/1
Gr D' Am Cb Cc
847/2
Qw
748/2



Id	SP1	SP1_NAME	SP2	SP2_NAME	SP3	SP3_NAME	SOIL_ID	SOIL_NAME	Depth_ID	Depht_Class	COMMENTS
1	Af	Adenostoma fasciculatum	Cc	Ceanothus cuneatus			872	Maymen	2	1 to 2 feet	
2	Ba	Bare	Af	Adenostoma fasciculatum	Cc	Ceanothus cuneatus	872	Maymen	1	less than 1 foot	
3	Gr	Grasses	Af	Adenostoma fasciculatum	Ec	Eriodictyon californicum	871	Los Gatos	2	1 to 2 feet	
4	Gr	Grasses	D'	Quercus Douglasii			847	Laughlin	3	2 to 3 feet	
5	Gr	Grasses	D'	Quercus Douglasii	Am	Arcotostaphylos manzanita	847	Laughlin	2	1 to 2 feet	
6	Cu	Cultivated					400		0		Unclassified secondary soils, terrace/benchlands
7	Af	Adenostoma fasciculatum	Cc	Ceanothus cuneatus			871	Los Gatos	2	1 to 2 feet	

California State Report

https://www.wildlife.ca.gov/SWAP/Final

Thank you for your attention

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Armand Gonzales and Junko Hoshi, CDFW (SWAP leads)

Steve Schoenig and Melanie Gogol-Prokurat, CDFW (Biogeographic Data Branch)