Using Maps for Vegetation Refugia Planning & Management

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Nov 8, 2019
UC Davis
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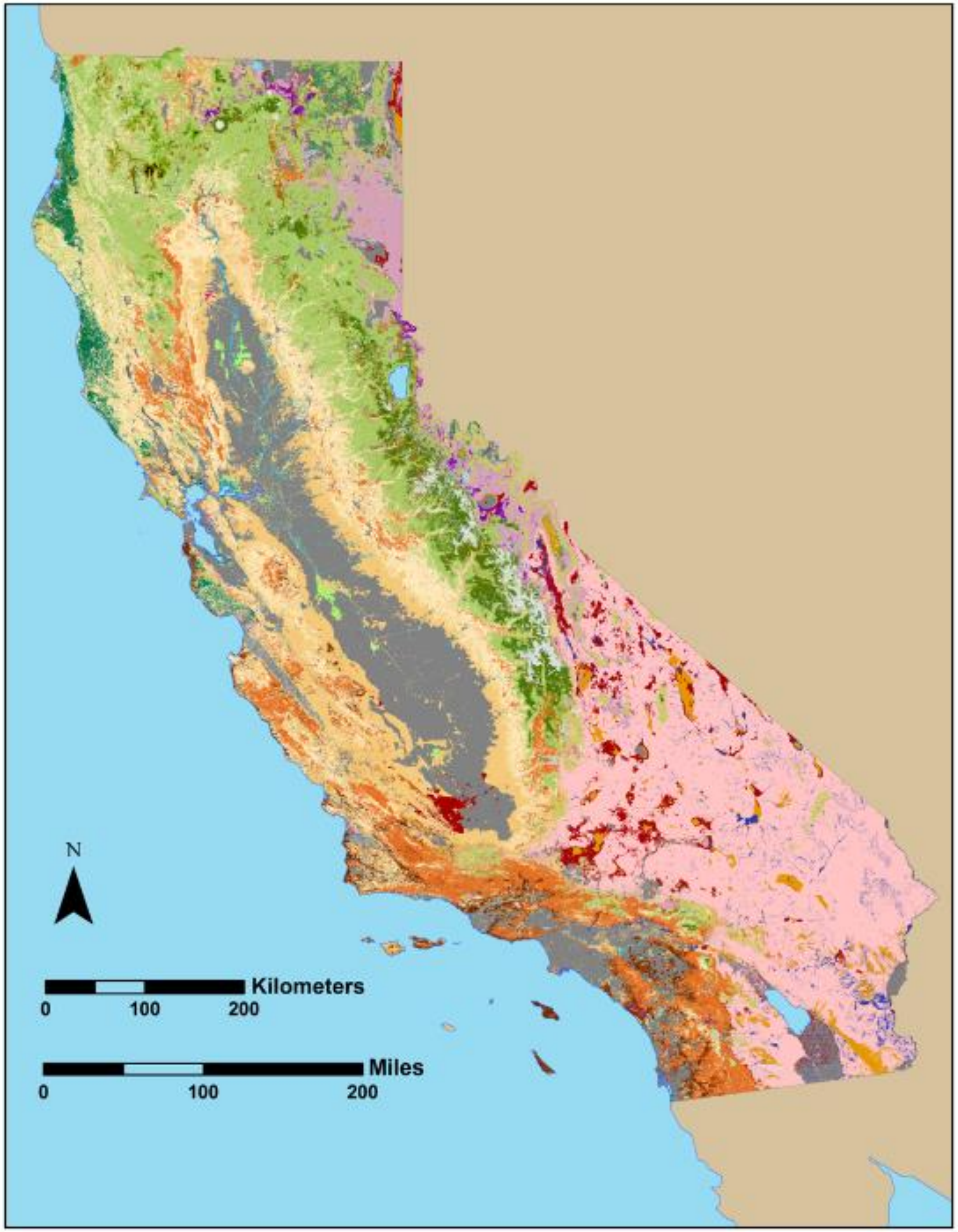
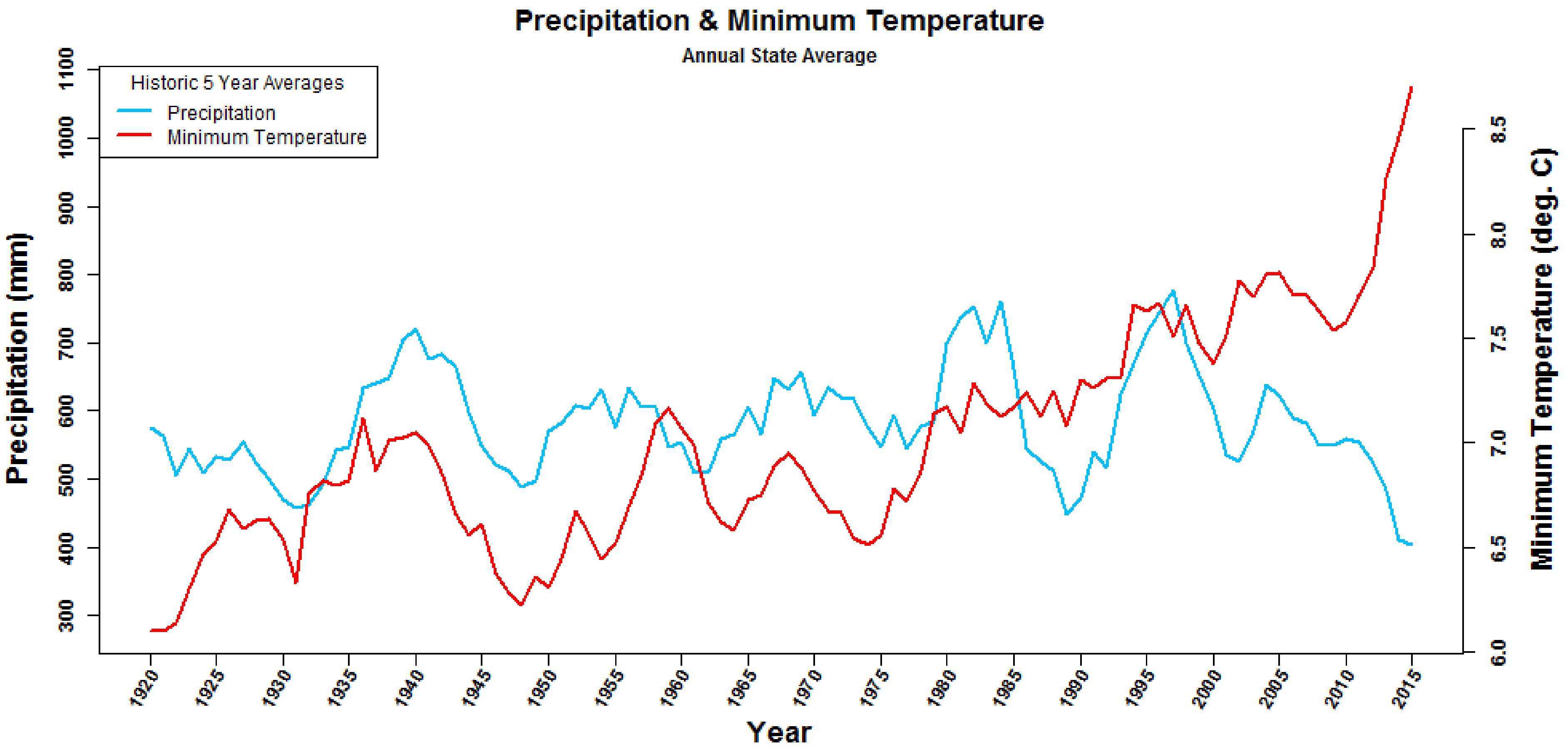

N
Kilometers
0
100
200
Miles
0
100
200

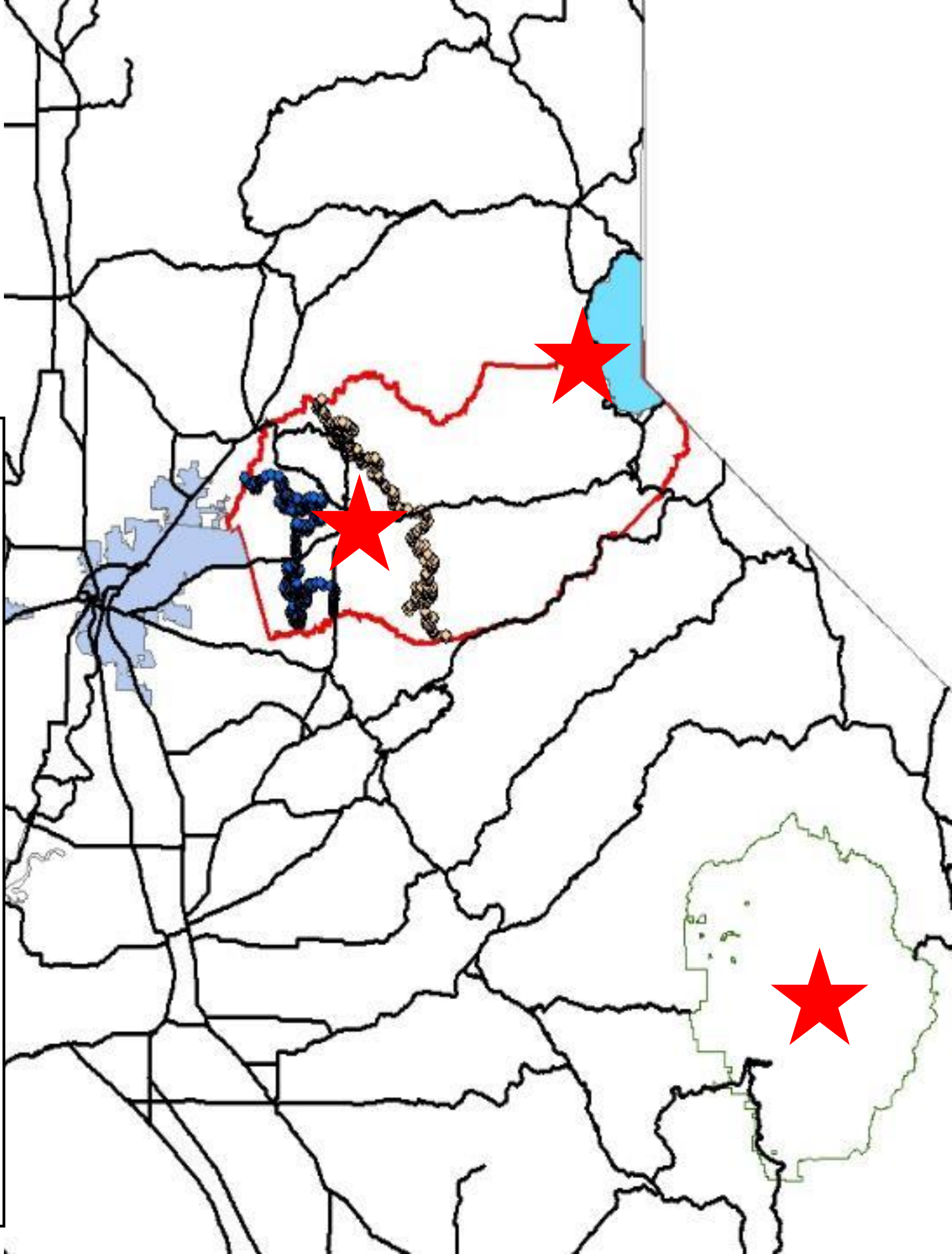
Annual Average Precipitation and Temperature for California

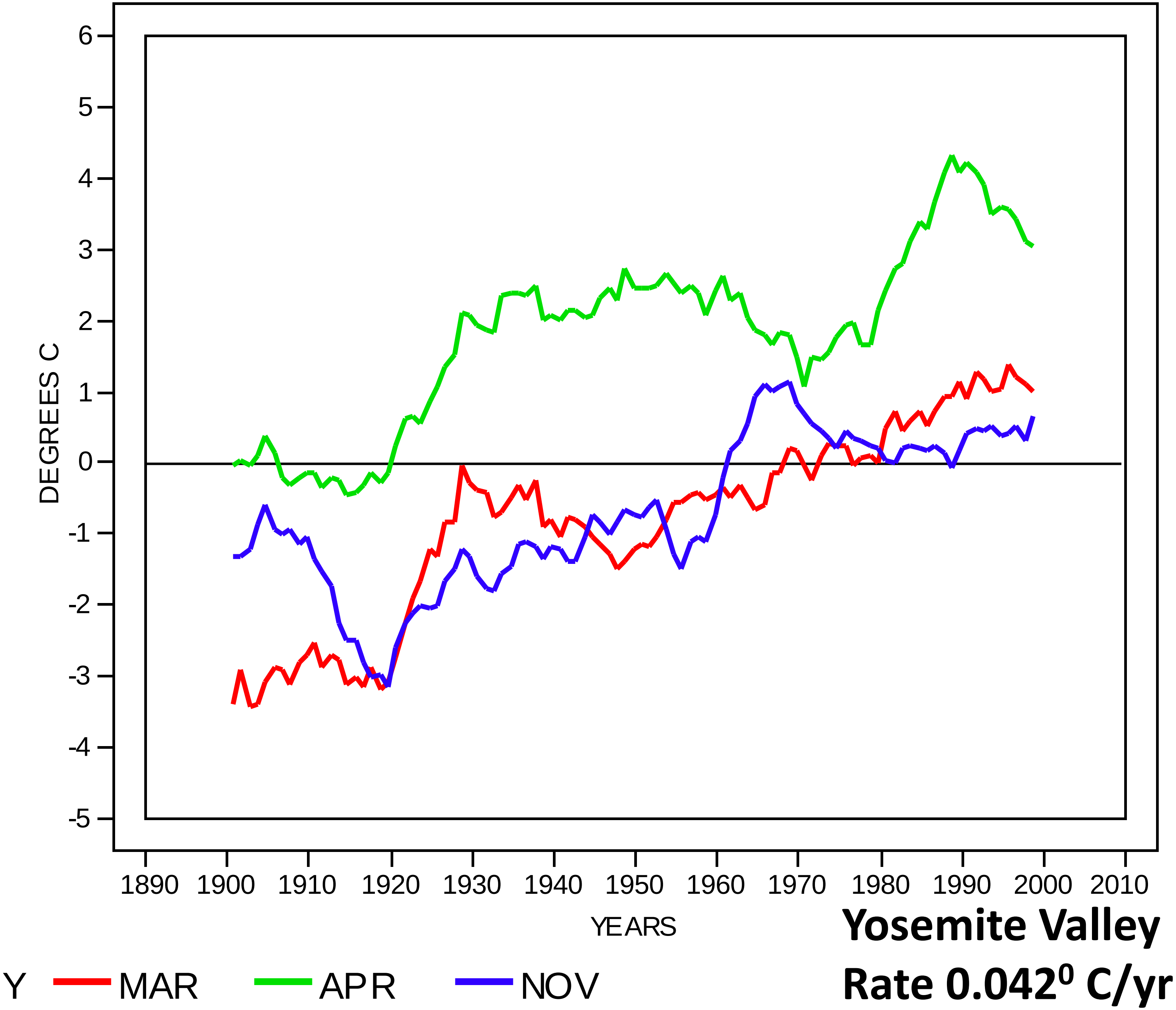


What mechanism causes recruitment limitation?

Weather Stations

		10 yr moving average
	Feet	**Years**
Placerville	**2000**	**53**
Yosemite V.	**4000**	**94**
Tahoe City	**6000**	**93**

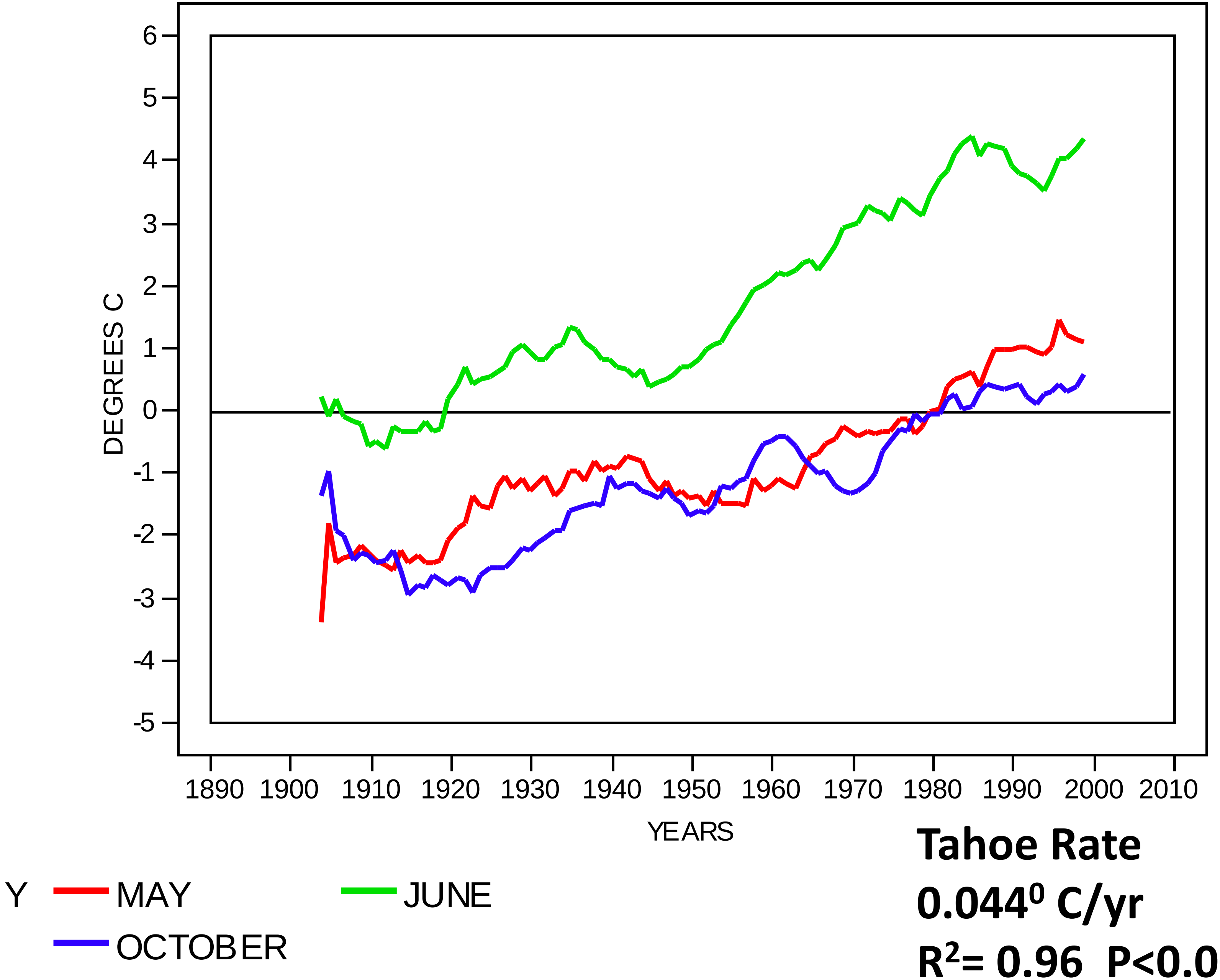




Yosemite Valley

Rate 0.042^0 C/yr

R^2= 0.75 P<0.001



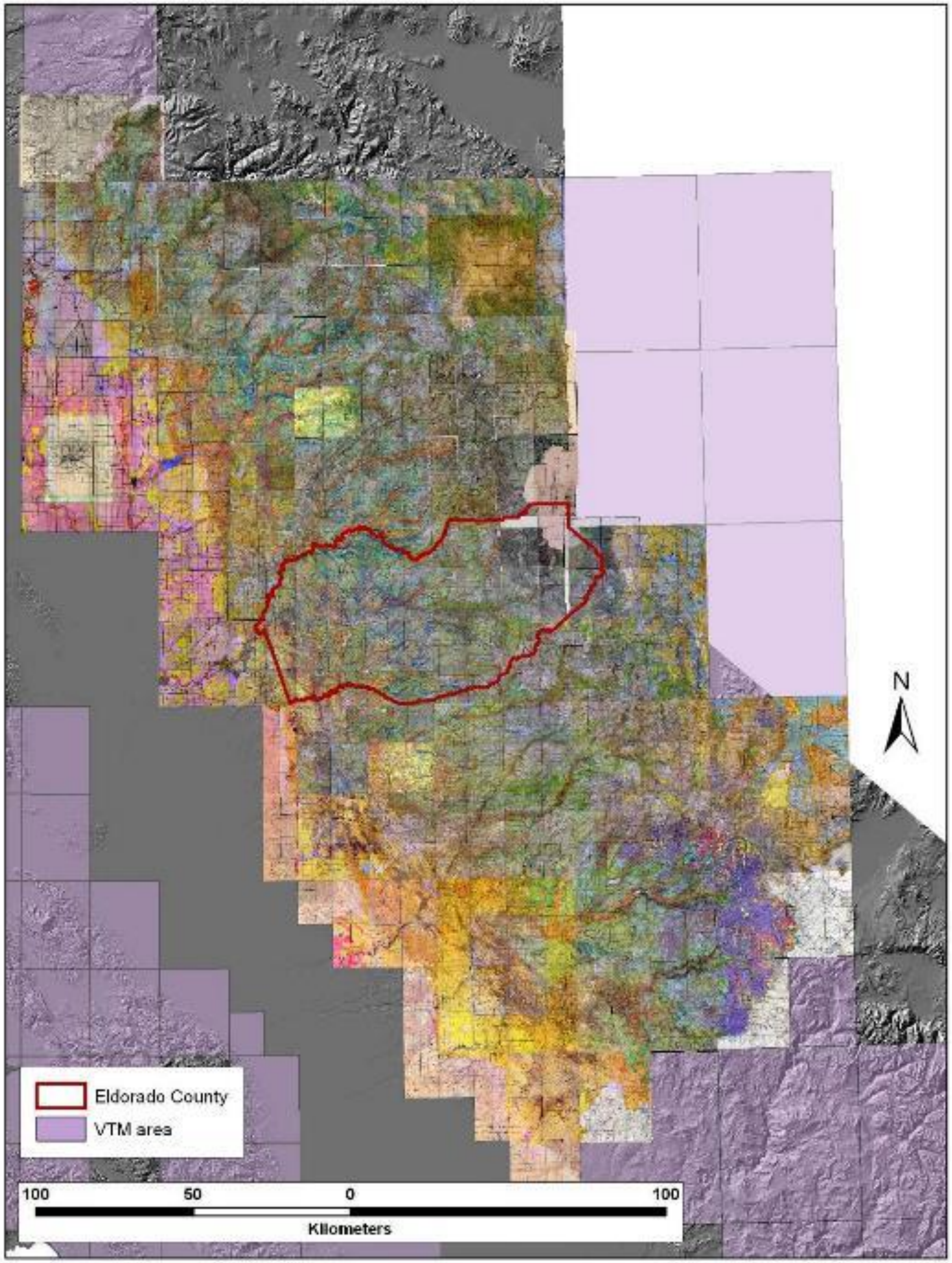
Tahoe Rate

0.044^0 C/yr

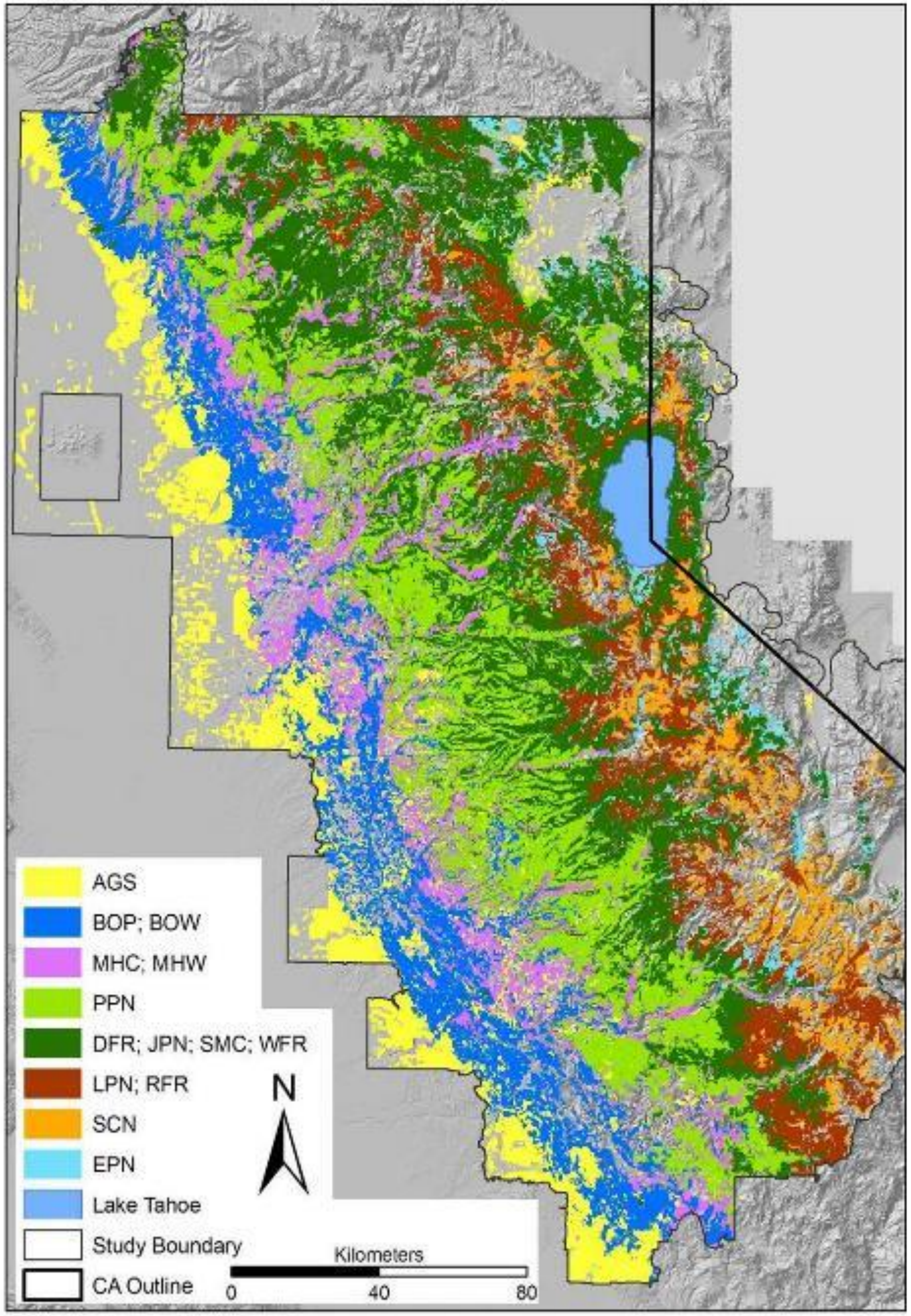
R^2= 0.96 P<0.001

Study Area

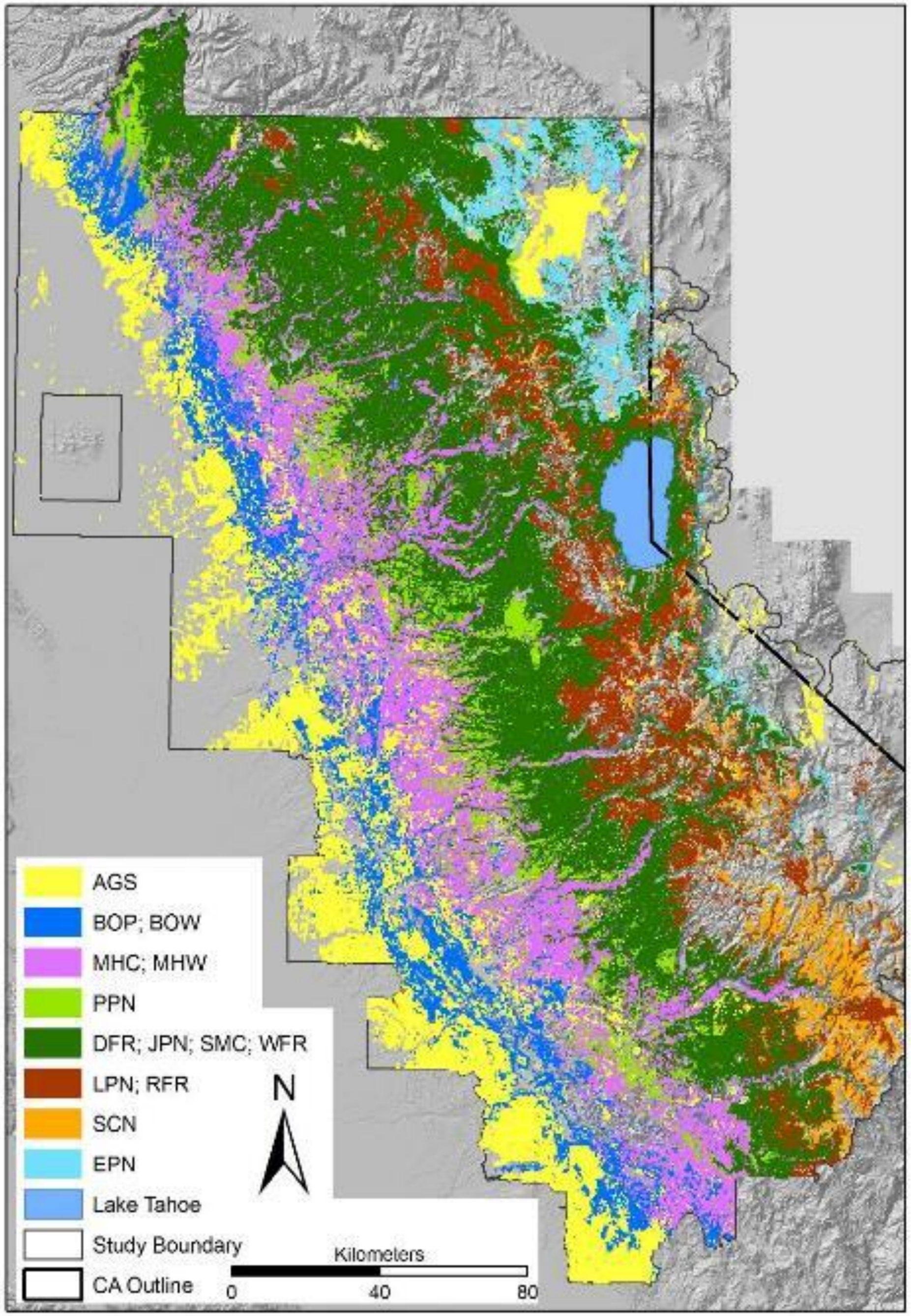
Central & Northern Sierra

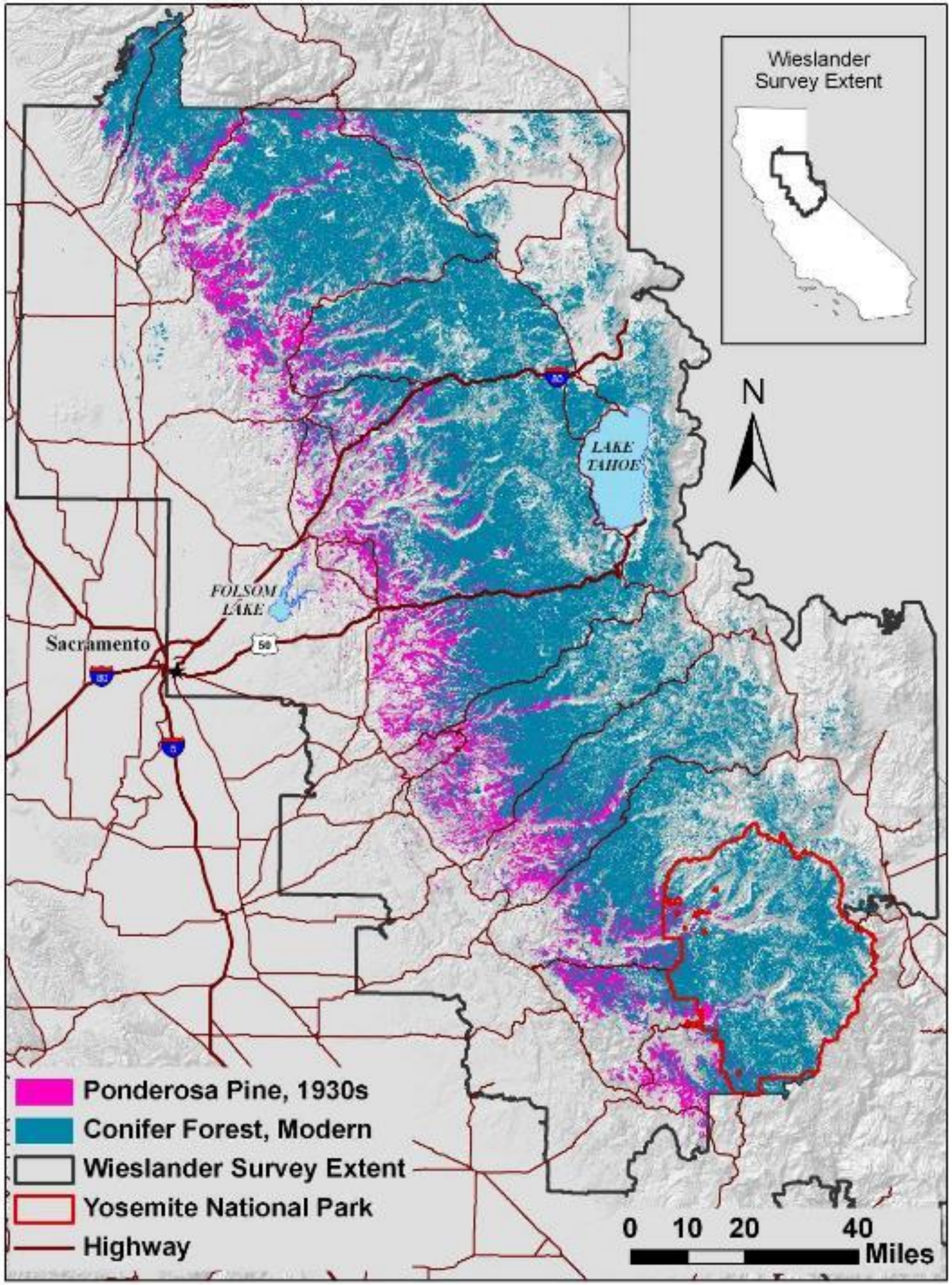

Eldorado County
VTM area
N
100
50
0
100
Kilometers

Historic WHR Types


AGS
BOP; BOW
MHC; MHW
PPN
DFR; JPN; SMC; WFR
LPN; RFR
SCN
EPN
Lake Tahoe
Study Boundary
CA Outline
N
Kilometers
0
40
80

Current WHR Types


AGS
BOP; BOW
MHC; MHW
PPN
DFR; JPN; SMC; WFR
LPN; RFR
SCN
EPN
Lake Tahoe
Study Boundary
CA Outline
N
Kilometers
0
40
80


Wieslander Survey Extent
N
LAKE TAHOE
FOLSOM LAKE
Sacramento
80
50
5
Ponderosa Pine, 1930s
Conifer Forest, Modern
Wieslander Survey Extent
Yosemite National Park
Highway
0 10 20 40
Miles

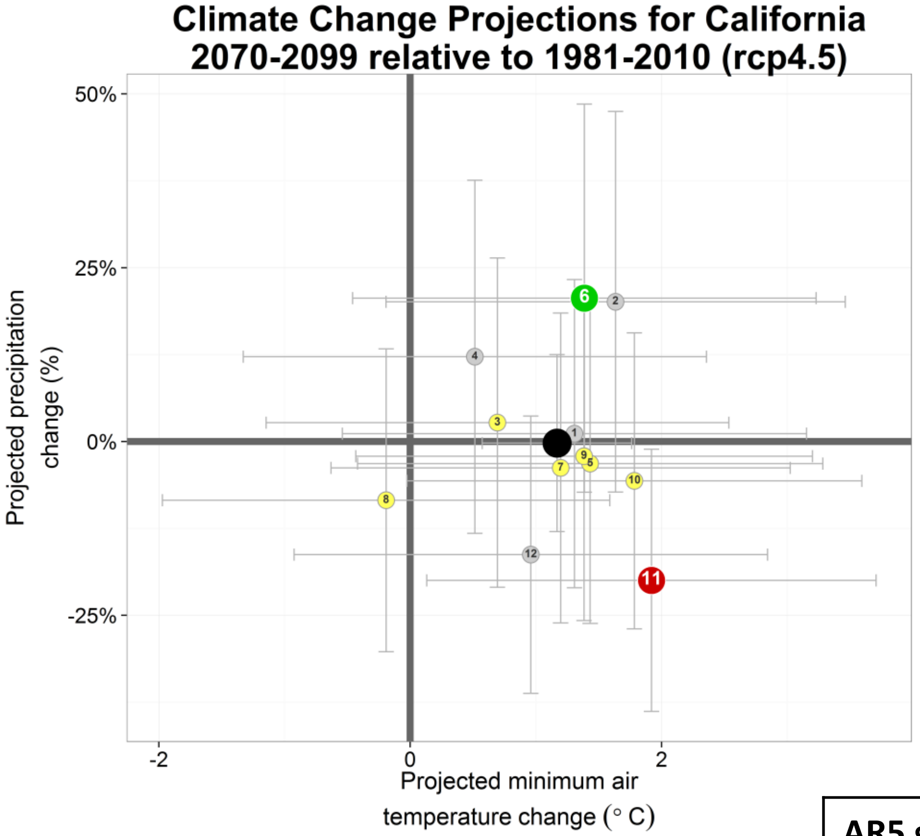
Ponderosa Pine Transition

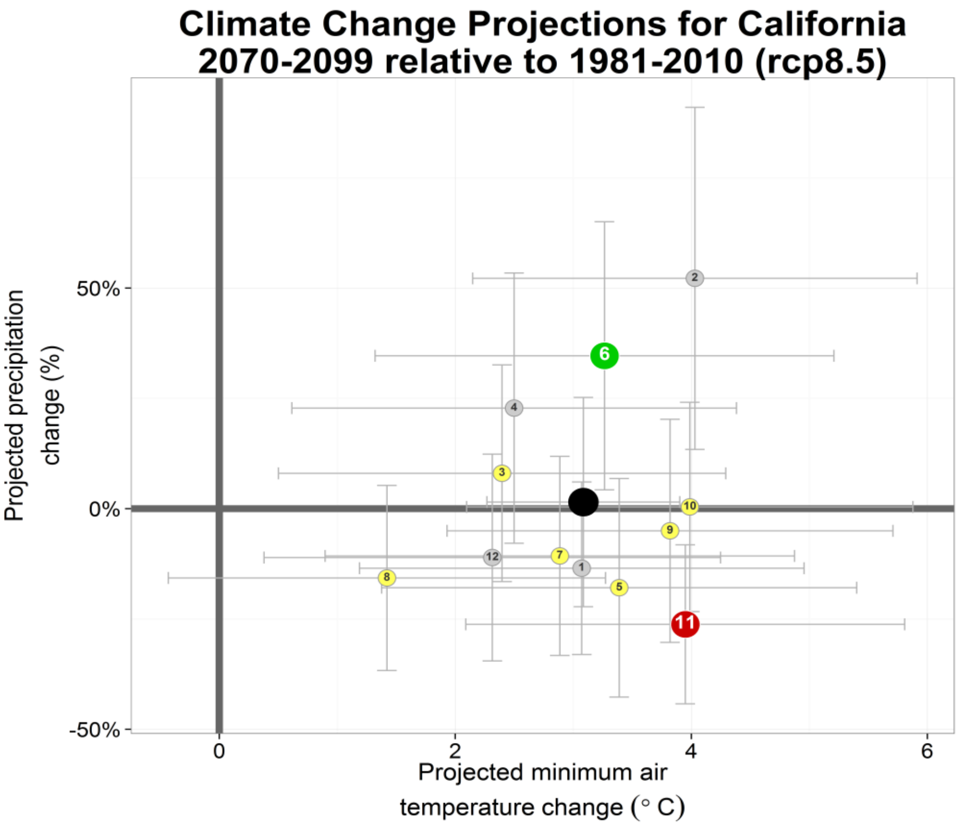
Lower Edge

Well, how about the future?

Climate Change Models

Evaluation of data and climate change models


Climate Change Projections for California
2070-2099 relative to 1981-2010 (rcp4.5)


Climate Change Projections for California
2070-2099 relative to 1981-2010 (rcp8.5)

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

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)

9 Variables

Snow Module

Climate Inputs

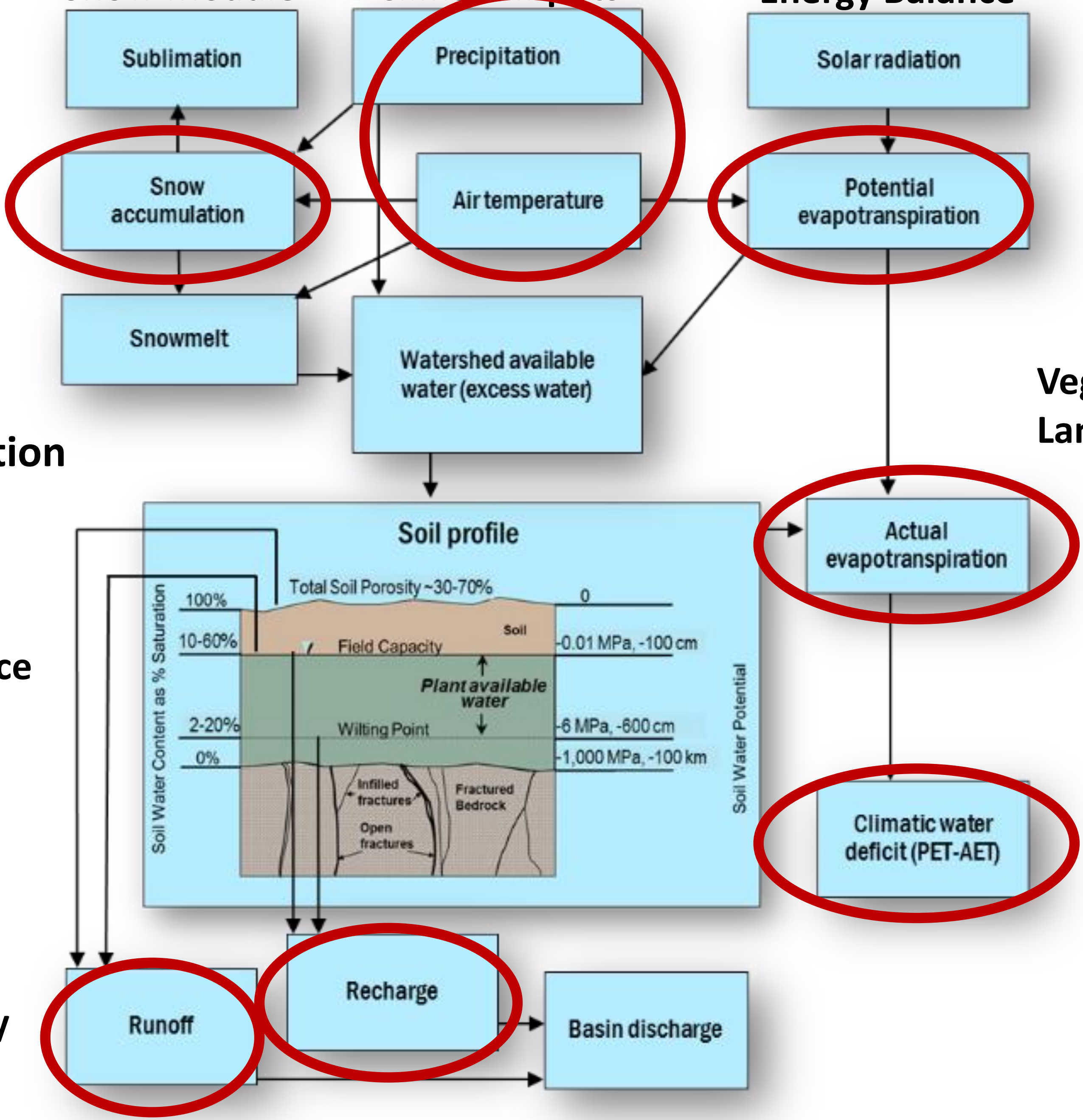
Energy Balance

Basin Characterization Model

Vegetation and Landscape

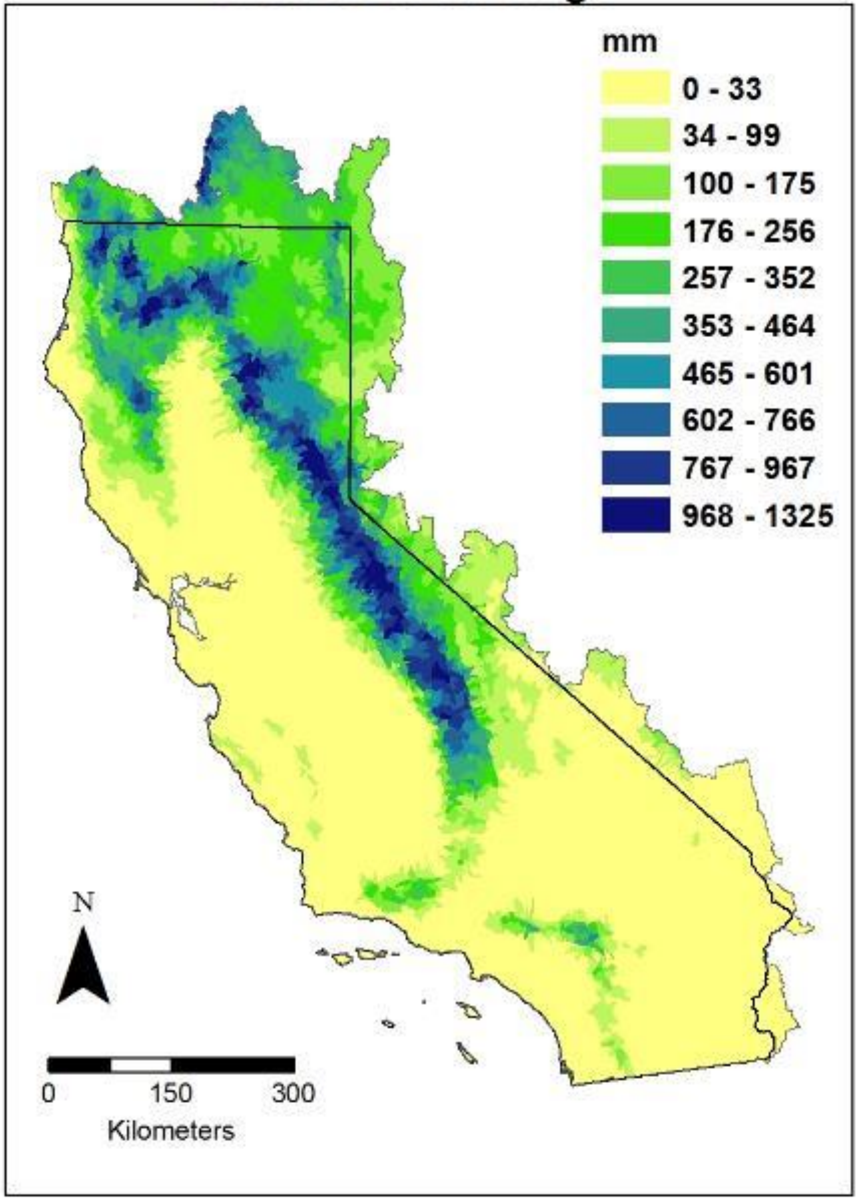
Water Balance

Water Supply

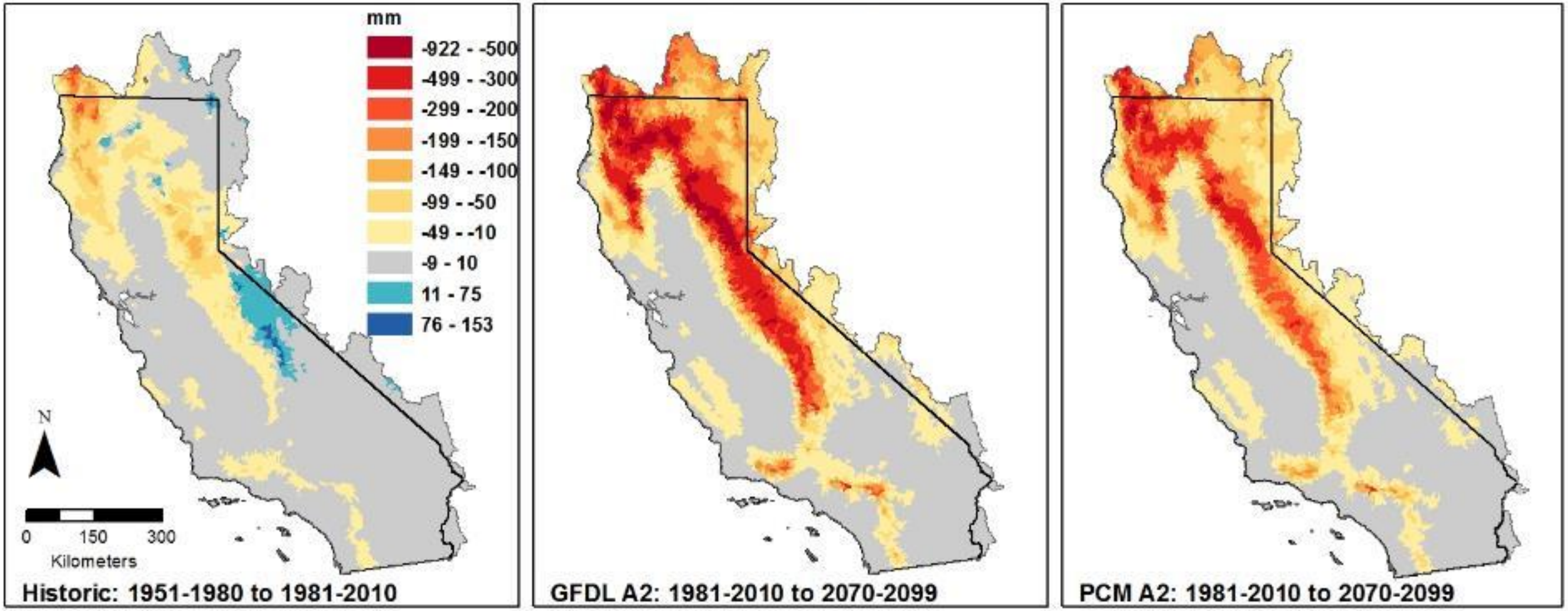

Sublimation
Precipitation
Solar radiation
Snow accumulation
Air temperature
Potential evapotranspiration
Snowmelt
Watershed available water (excess water)
Soil profile
Total Soil Porosity ~30-70%
0
100%
Soil
10-60%
Field Capacity
-0.01 MPa, -100 cm
Plant available water
2-20%
Wilting Point
-6 MPa, -600 cm
0%
-1,000 MPa, -100 km
Infilled fractures
Fractured Bedrock
Open fractures
Soil Water Content as % Saturation
Soil Water Potential
Actual evapotranspiration
Climatic water deficit (PET-AET)
Runoff
Recharge
Basin discharge

Total Snowfall

1981-2010 Average


mm
0 - 33
34 - 99
100 - 175
176 - 256
257 - 352
353 - 464
465 - 601
602 - 766
767 - 967
968 - 1325
N
0
150
300
Kilometers

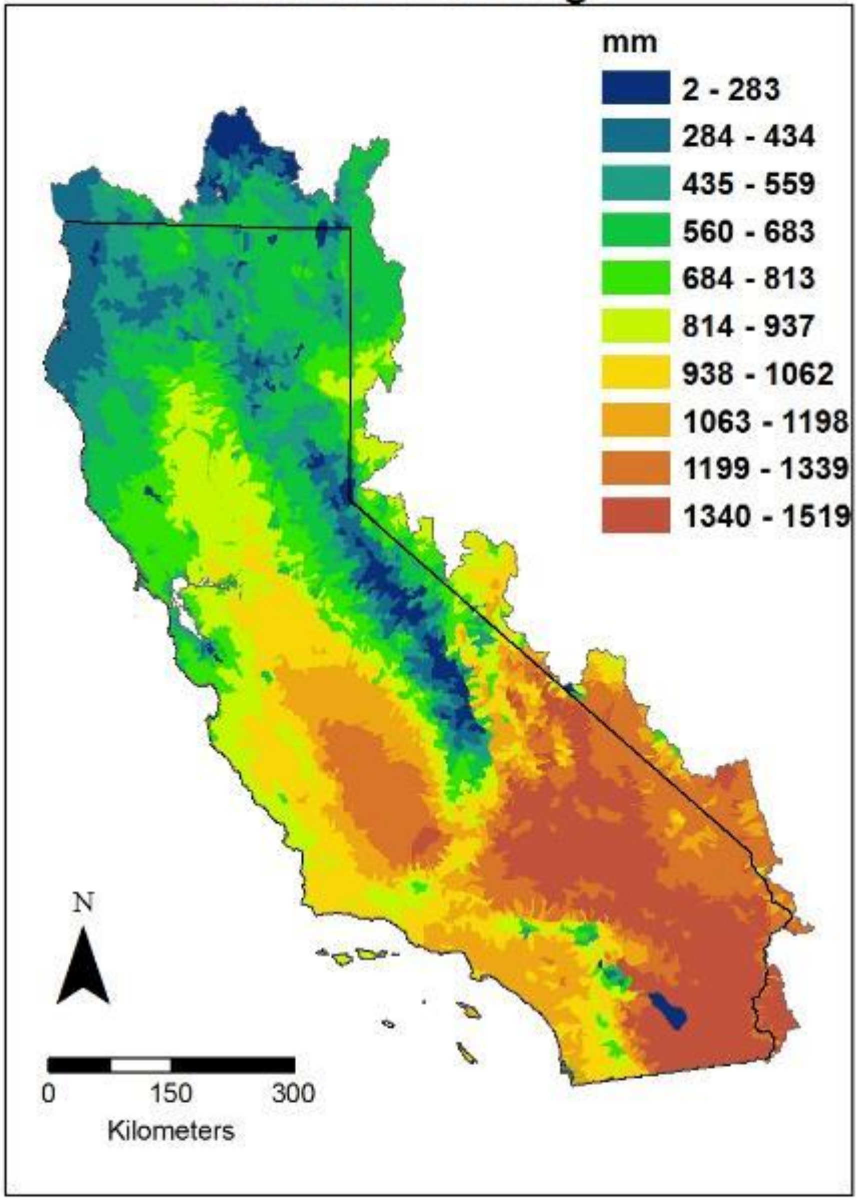
Total Snowfall

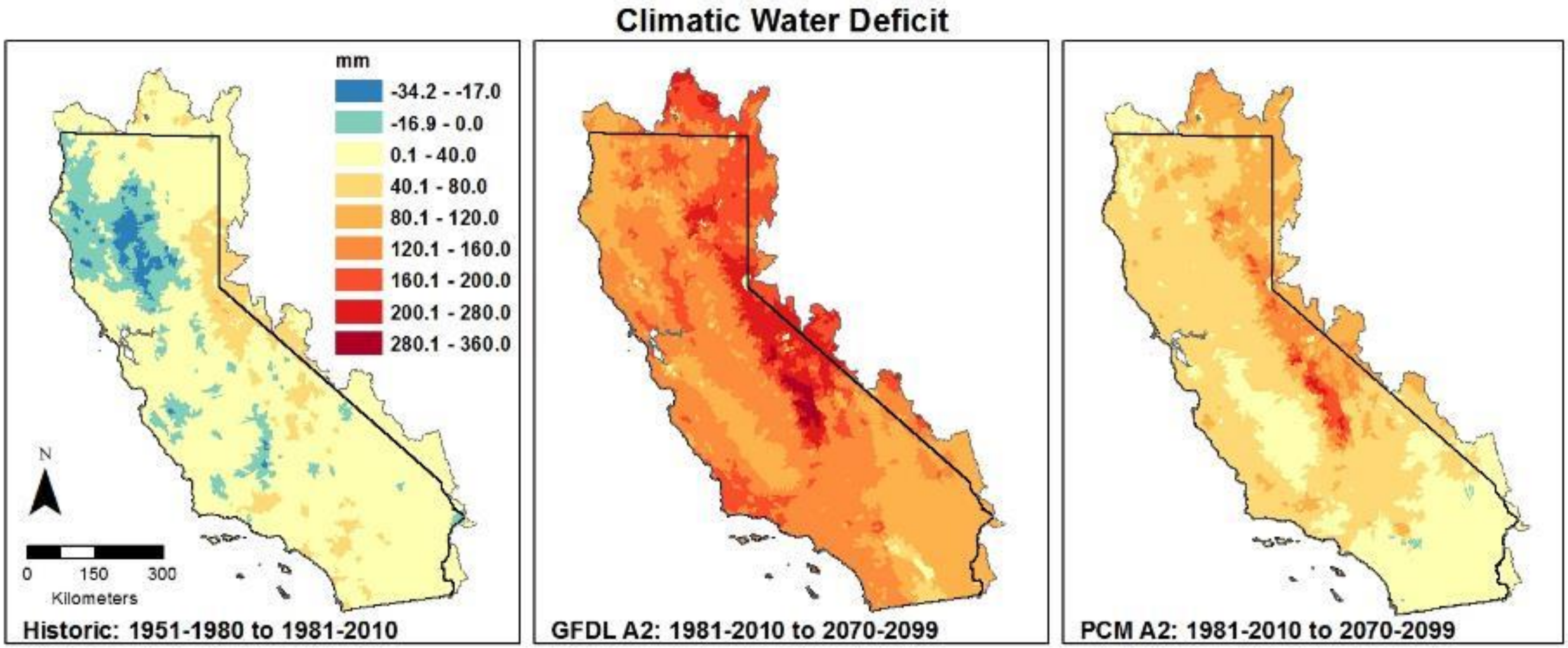


mm
-922 - -500
-499 - -300
-299 - -200
-199 - -150
-149 - -100
-99 - -50
-49 - -10
-9 - 10
11 - 75
76 - 153
N
0
150
300
Kilometers
Historic: 1951-1980 to 1981-2010
GFDL A2: 1981-2010 to 2070-2099
PCM A2: 1981-2010 to 2070-2099

Climatic Water Deficit

1981-2010 Average


mm
2 - 283
284 - 434
435 - 559
560 - 683
684 - 813
814 - 937
938 - 1062
1063 - 1198
1199 - 1339
1340 - 1519
N
0
150
300
Kilometers



Climatic Water Deficit

mm
-34.2 - -17.0
-16.9 - 0.0
0.1 - 40.0
40.1 - 80.0
80.1 - 120.0
120.1 - 160.0
160.1 - 200.0
200.1 - 280.0
280.1 - 360.0
N
0
150
300
Kilometers

Historic: 1951-1980 to 1981-2010

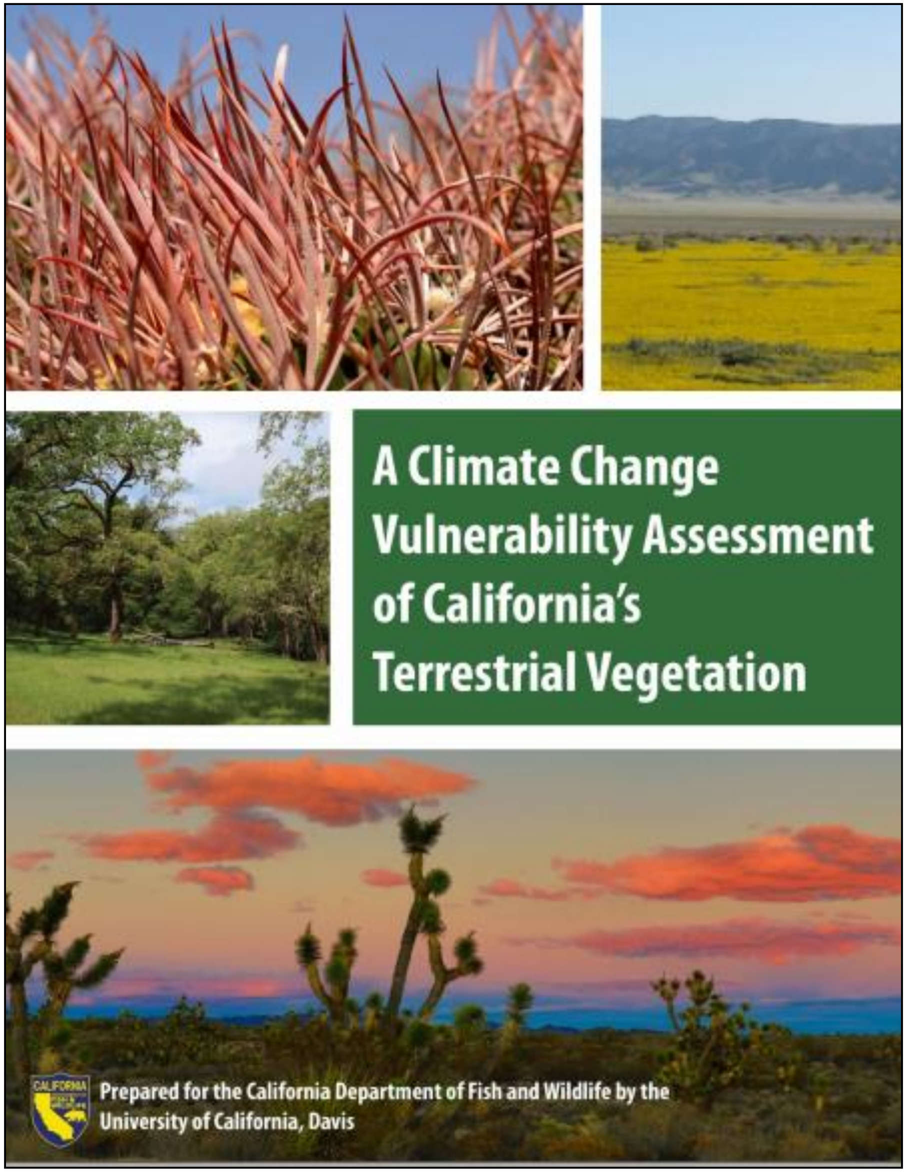
GFDL A2: 1981-2010 to 2070-2099

PCM A2: 1981-2010 to 2070-2099

Where will things persist?

- Conception: Filling an information gap
- CA state funding, to inform the State Wildlife Action Plan 2015 revision

SWAP
California State Wildlife Action Plan

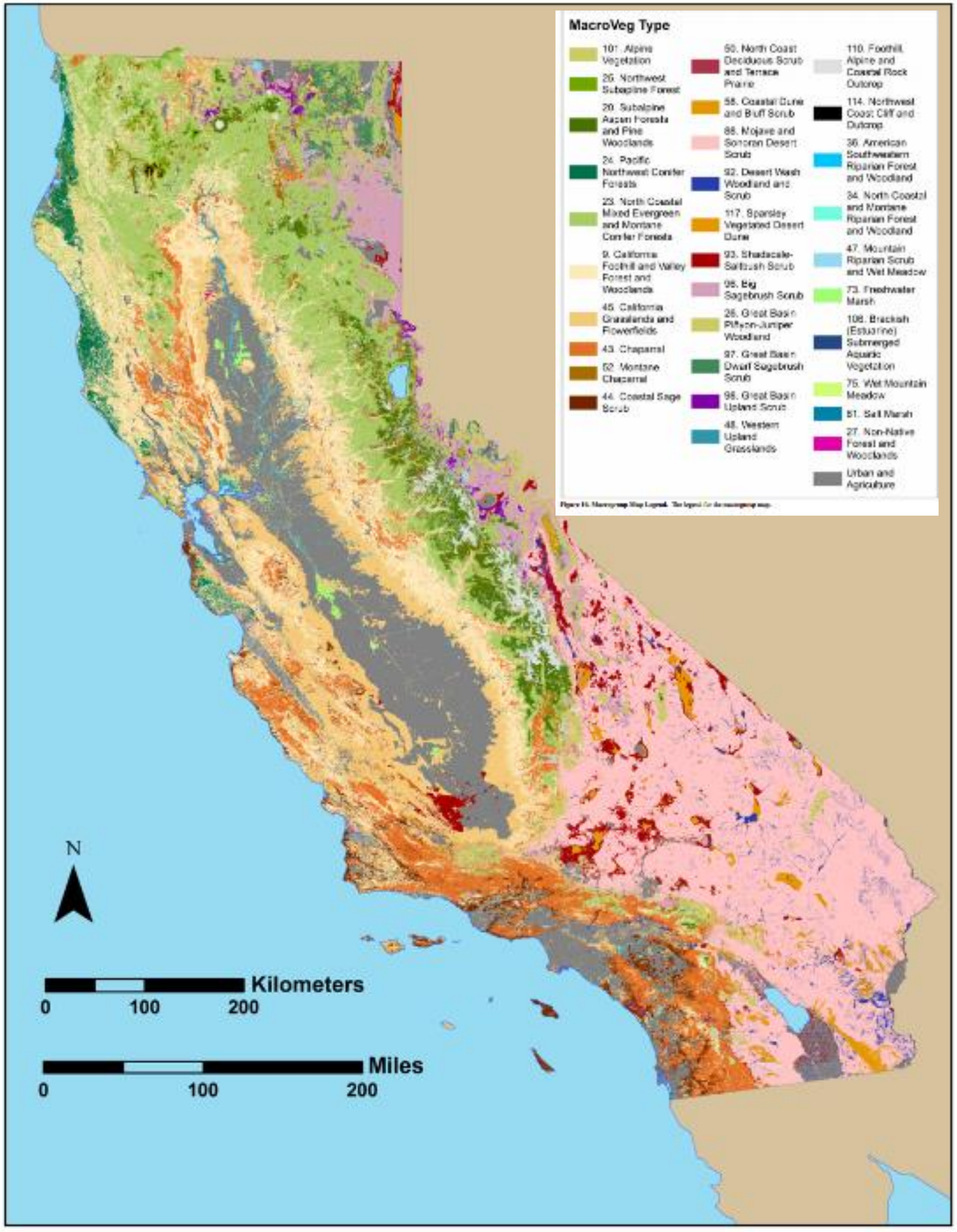


A Climate Change Vulnerability Assessment of California's Terrestrial Vegetation

Prepared for the California Department of Fish and Wildlife by the University of California, Davis

Using Vegetation Maps to Visualize Climate Risk

2015 Vegetation Map
+
Maps of Climate Change

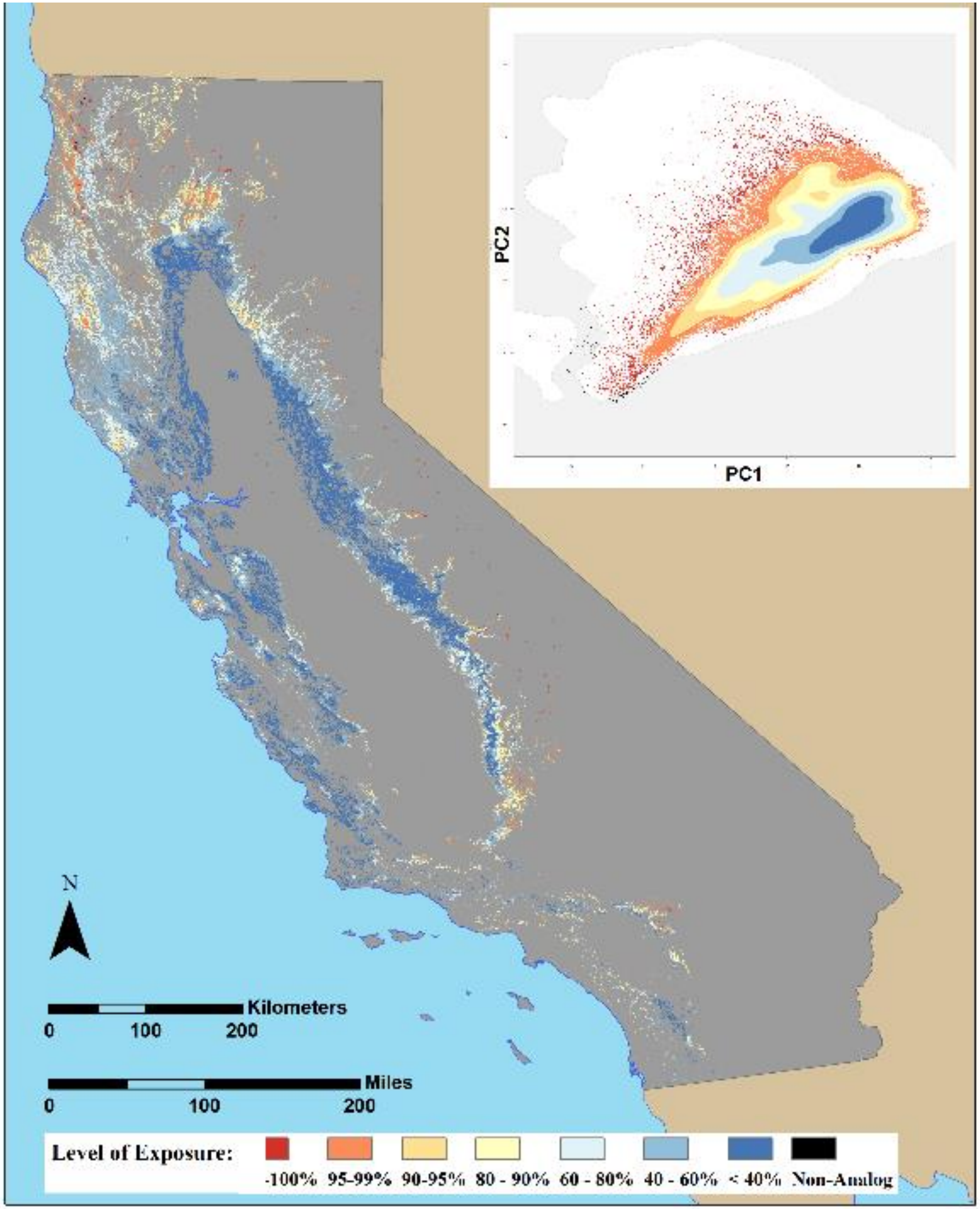

MacroVeg Type
101. Alpine Vegetation
26. Northwest Subalpine Forest
20. Subalpine Aspen Forests and Pine Woodlands
24. Pacific Northwest Conifer Forests
23. North Coastal Mixed Evergreen and Montane Conifer Forests
9. California Foothill and Valley Forest and Woodlands
45. California Grasslands and Flowerfields
43. Chaparral
52. Montane Chaparral
44. Coastal Sage Scrub
50. North Coast Deciduous Scrub and Terrace Prairie
58. Coastal Dune and Bluff Scrub
88. Mojave and Sonoran Desert Scrub
92. Desert Wash Woodland and Scrub
117. Sparsley Vegetated Desert Dune
93. Shadscale-Saltbush Scrub
95. Big Sagebrush Scrub
28. Great Basin Piñyon-Juniper Woodland
97. Great Basin Dwarf Sagebrush Scrub
96. Great Basin Upland Scrub
48. Western Upland Grasslands
110. Foothill, Alpine and Coastal Rock Outcrop
114. Northwest Coast Cliff and Outcrop
36. American Southwestern Riparian Forest and Woodland
34. North Coastal and Montane Riparian Forest and Woodland
47. Mountain Riparian Scrub and Wet Meadow
73. Freshwater Marsh
108. Brackish (Estuarine) Submerged Aquatic Vegetation
75. Wet Mountain Meadow
81. Salt Marsh
27. Non-Native Forest and Woodlands
Urban and Agriculture
N
Kilometers
0
100
200
Miles
0
100
200

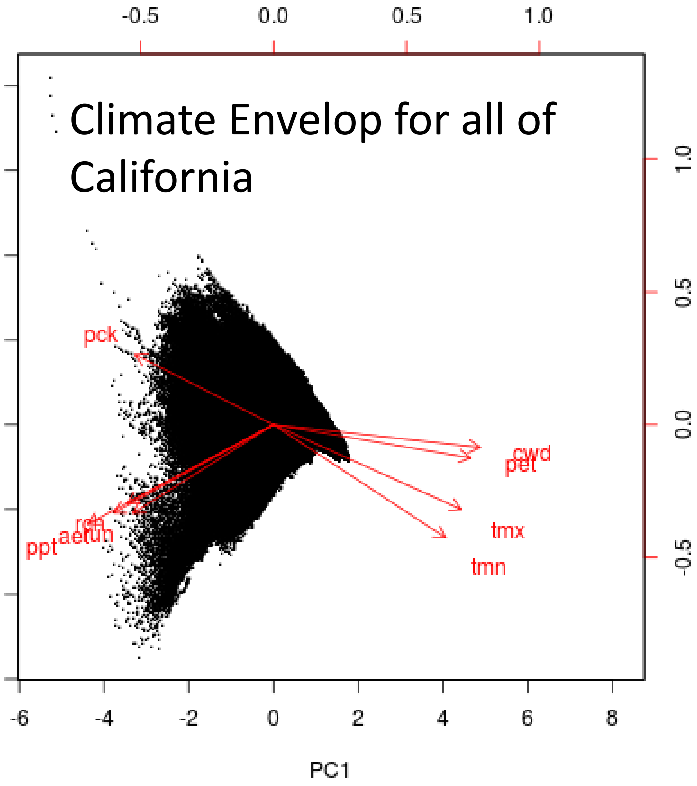
Combine the most recent vegetation map of California with climate data.

This allows leverage of as much as we know about the distribution of the vegetation.

FRAP 2015 map

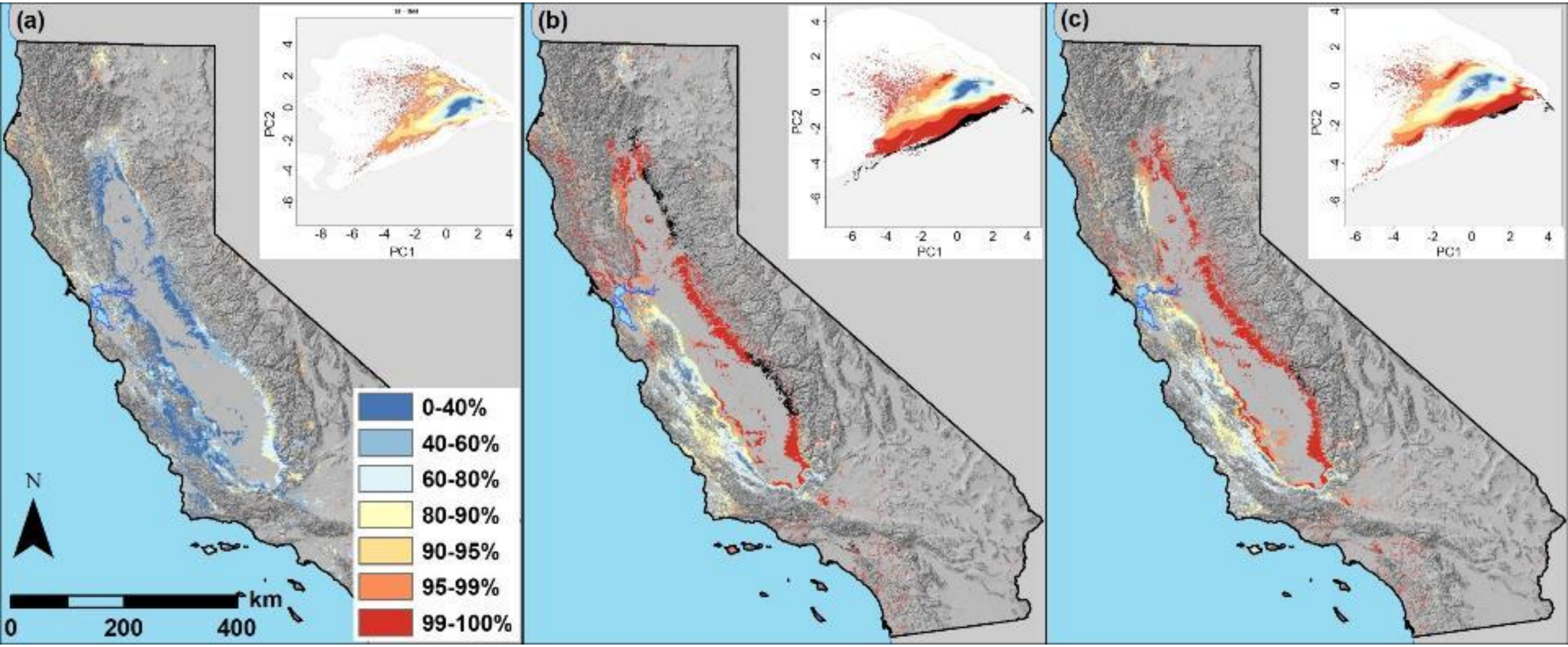
Current Time Climate Classification (1981-2010) for the Vegetation Type Pine Oak


PC2
PC1
N
Kilometers
0
100
200
Miles
0
100
200
Level of Exposure:
-100%
95-99%
90-95%
80 - 90%
60 - 80%
40 - 60%
< 40%
Non-Analog

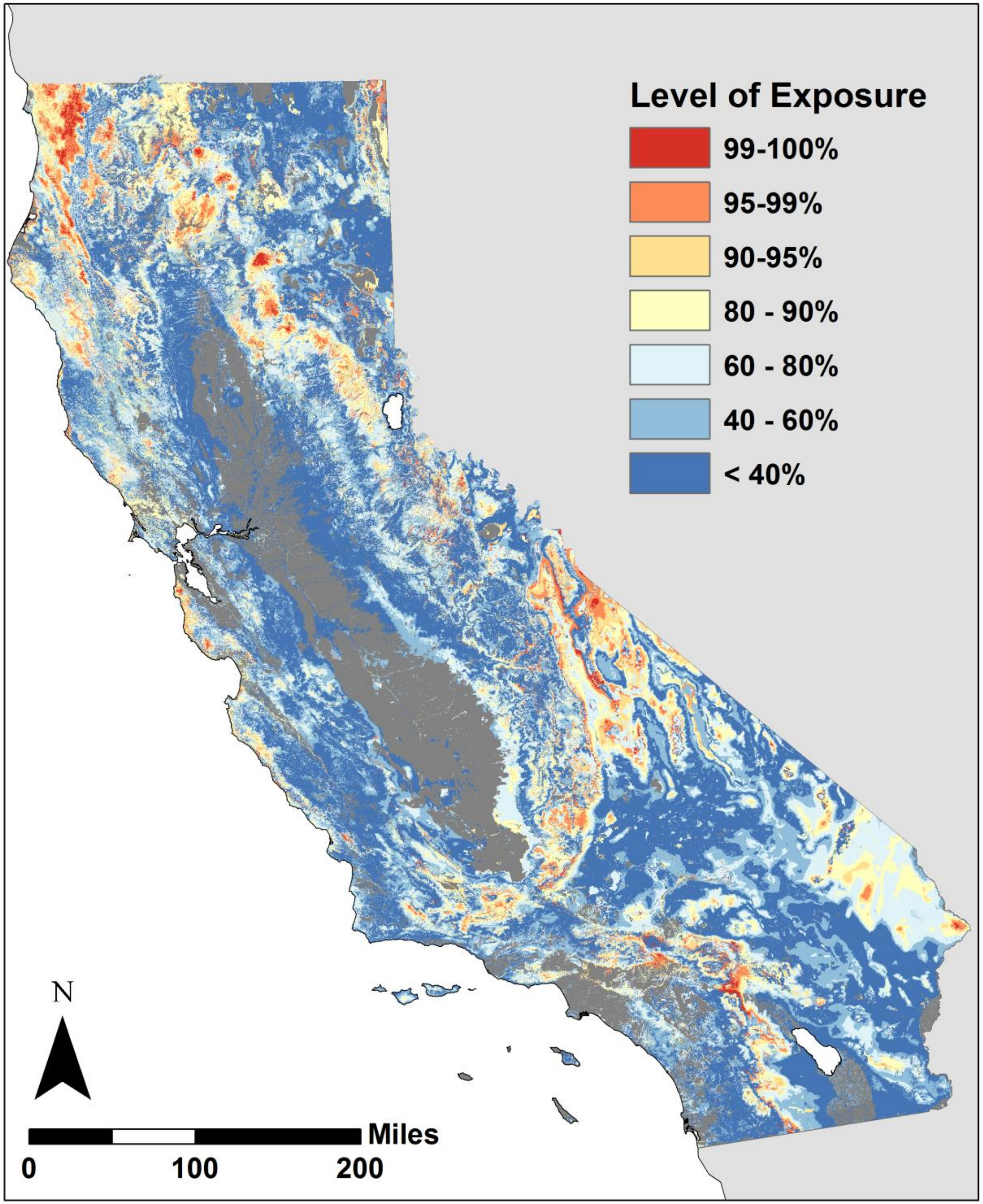


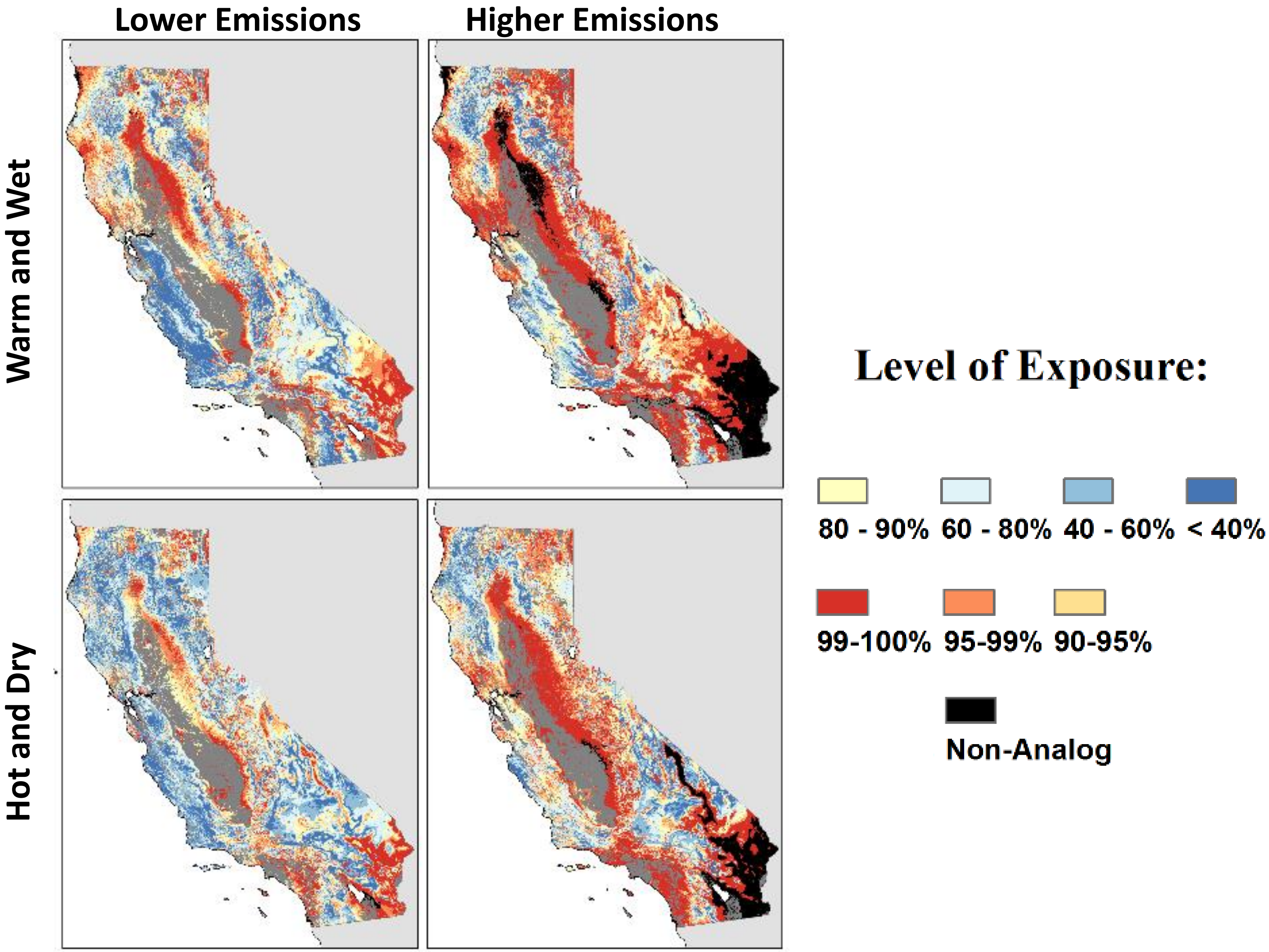
Climate Envelop for all of California

3. Analysis of Vegetation Climate Exposure


(a)
PC2
4
2
0
-2
-4
-6
-8
-6
-4
-2
0
2
4
PC1
0-40%
40-60%
60-80%
80-90%
90-95%
95-99%
99-100%
N
km
0
200
400
(b)
PC2
4
2
0
-2
-4
-6
-6
-4
-2
0
2
4
PC1
(c)
PC2
4
2
0
-2
-4
-6
-6
-4
-2
0
2
4
PC1

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

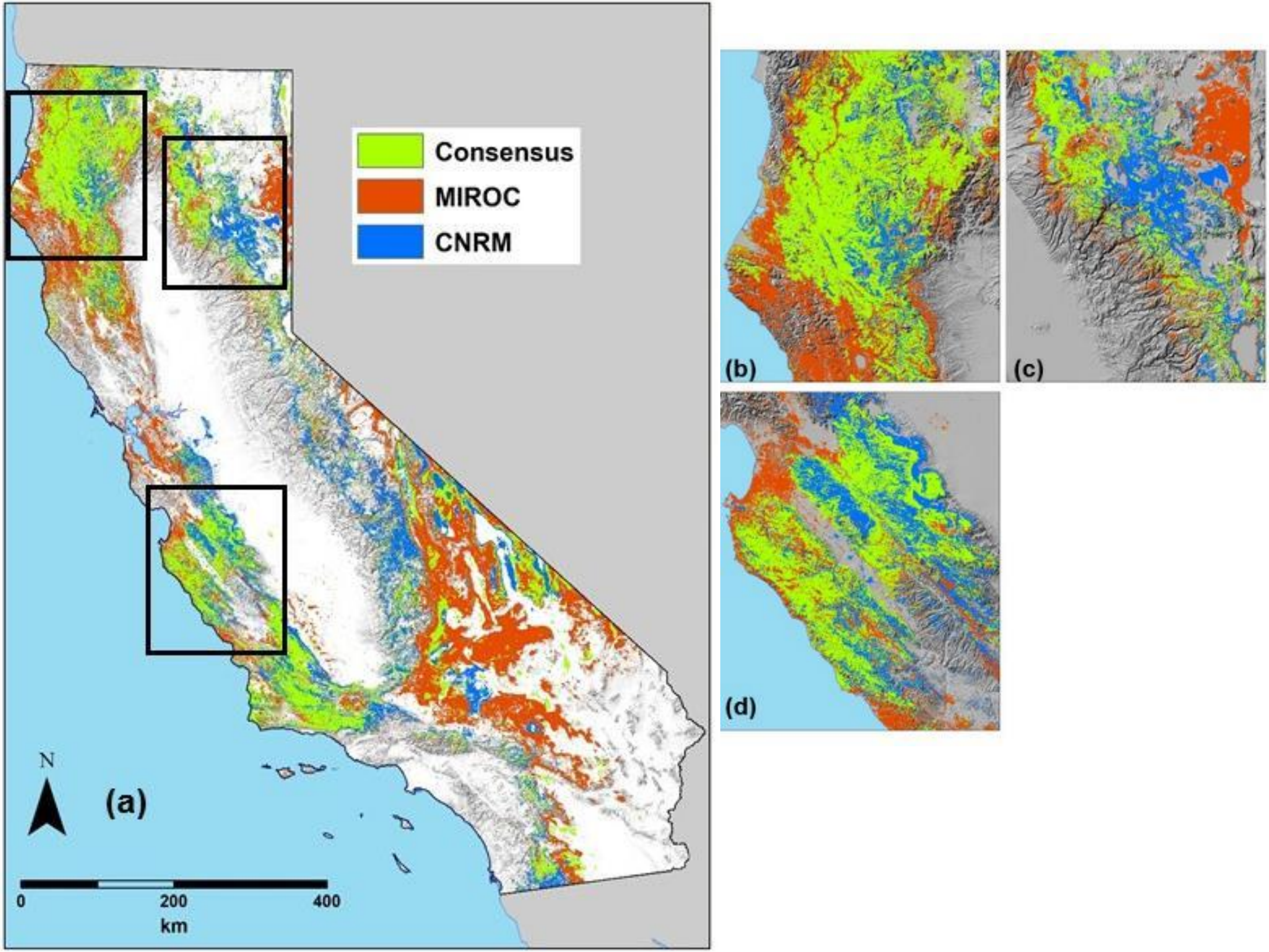

Level of Exposure
99-100%
95-99%
90-95%
80 - 90%
60 - 80%
40 - 60%
< 40%
N
Miles
0
100
200

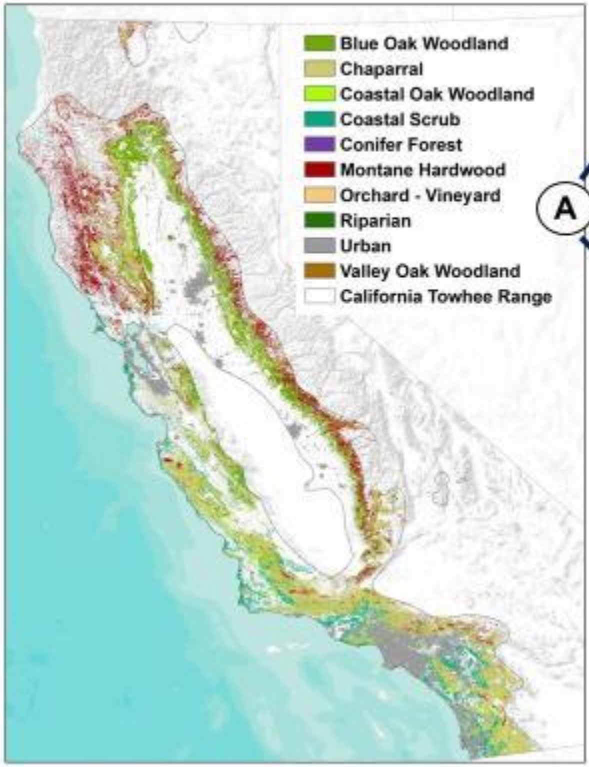

Lower Emissions
Higher Emissions
Warm and Wet
Hot and Dry
Level of Exposure:
80 - 90%
60 - 80%
40 - 60%
< 40%
99-100%
95-99%
90-95%
Non-Analog

Examples of how the framework can be used

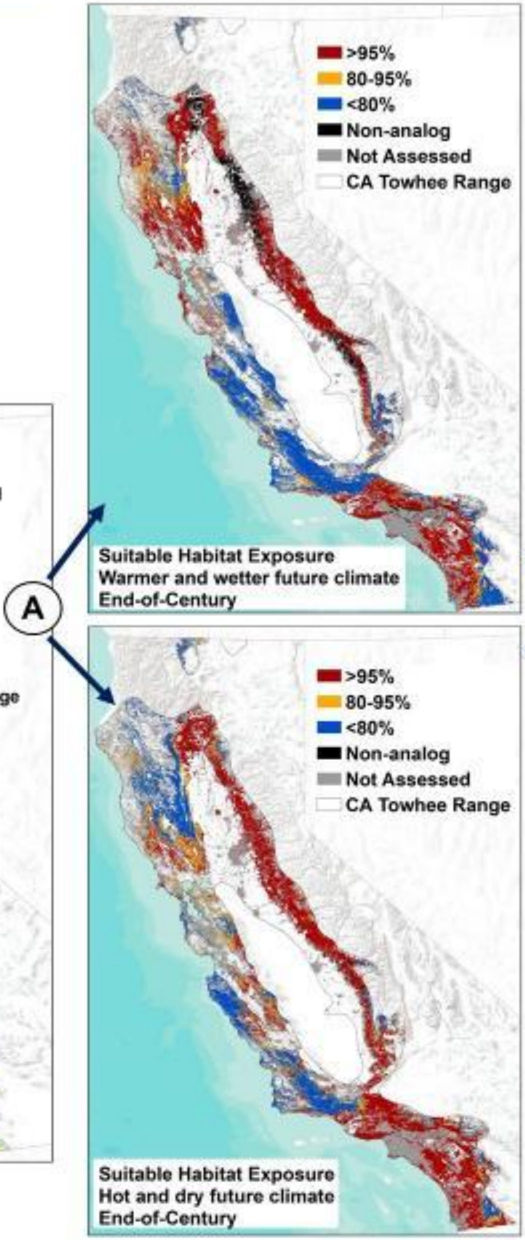
Climate Refugia

Restoration

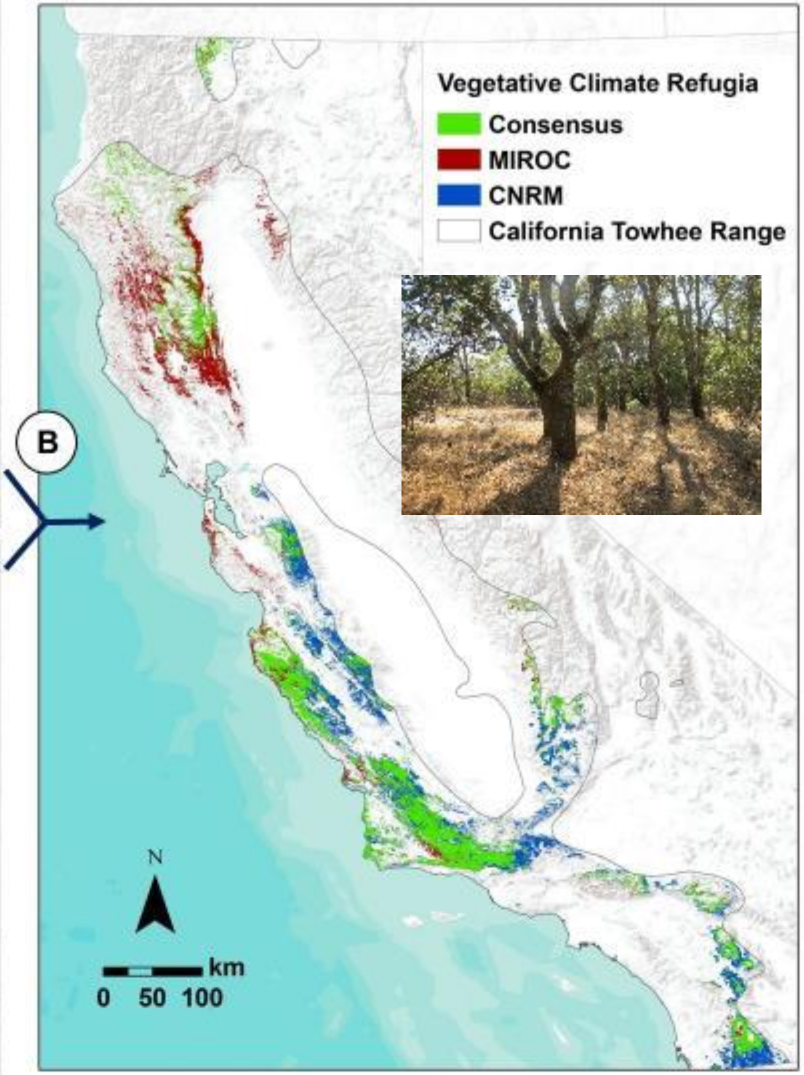

Consensus
MIROC
CNRM
N
(a)
0
200
400
km
(b)
(c)
(d)


Blue Oak Woodland
Chaparral
Coastal Oak Woodland
Coastal Scrub
Conifer Forest
Montane Hardwood
Orchard - Vineyard
Riparian
Urban
Valley Oak Woodland
California Towhee Range

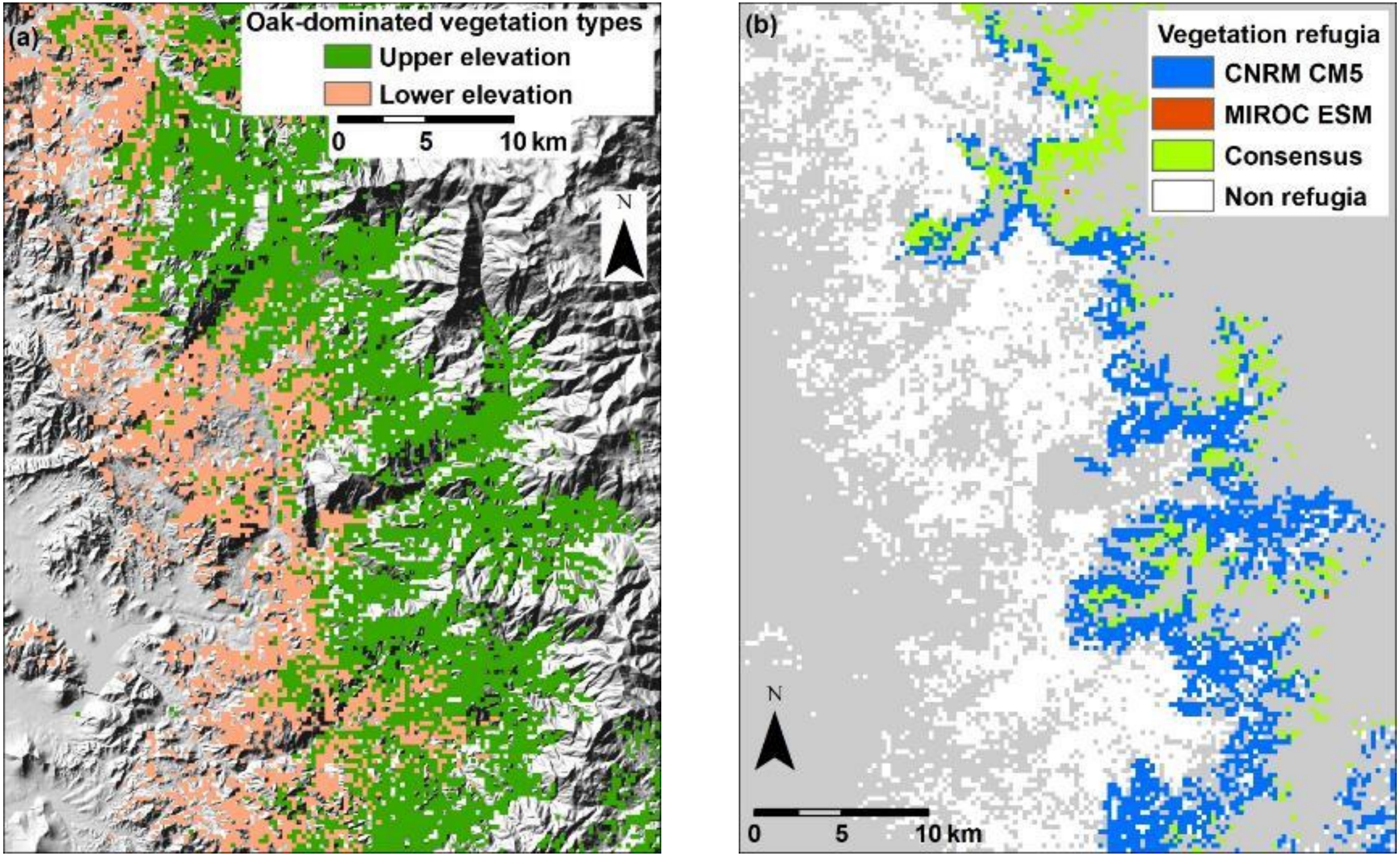
1. Current extent of California Towhee suitable habitat in California.

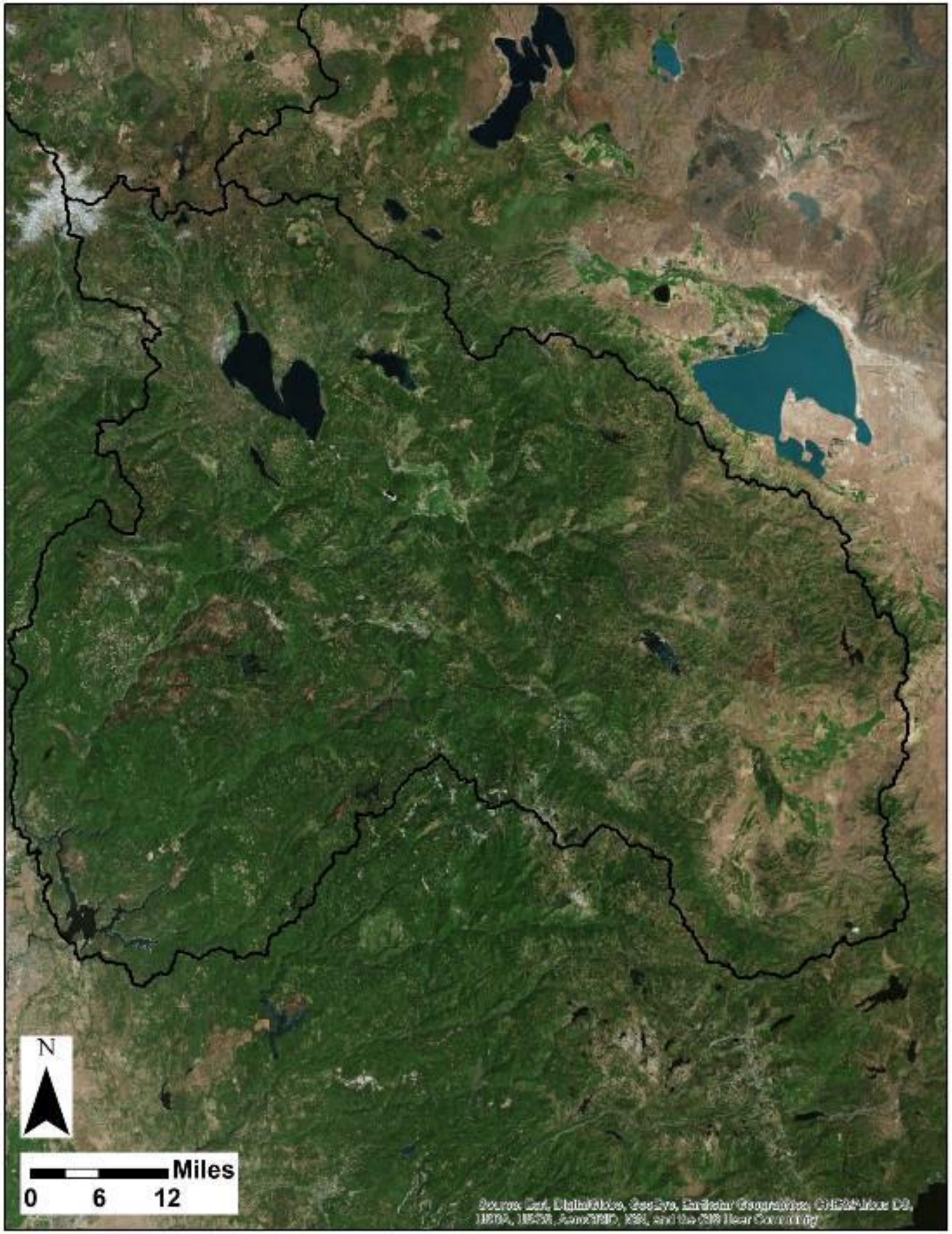

A
>95%
80-95%
<80%
Non-analog
Not Assessed
CA Towhee Range
Suitable Habitat Exposure
Warmer and wetter future climate
End-of-Century
>95%
80-95%
<80%
Non-analog
Not Assessed
CA Towhee Range
Suitable Habitat Exposure
Hot and dry future climate
End-of-Century

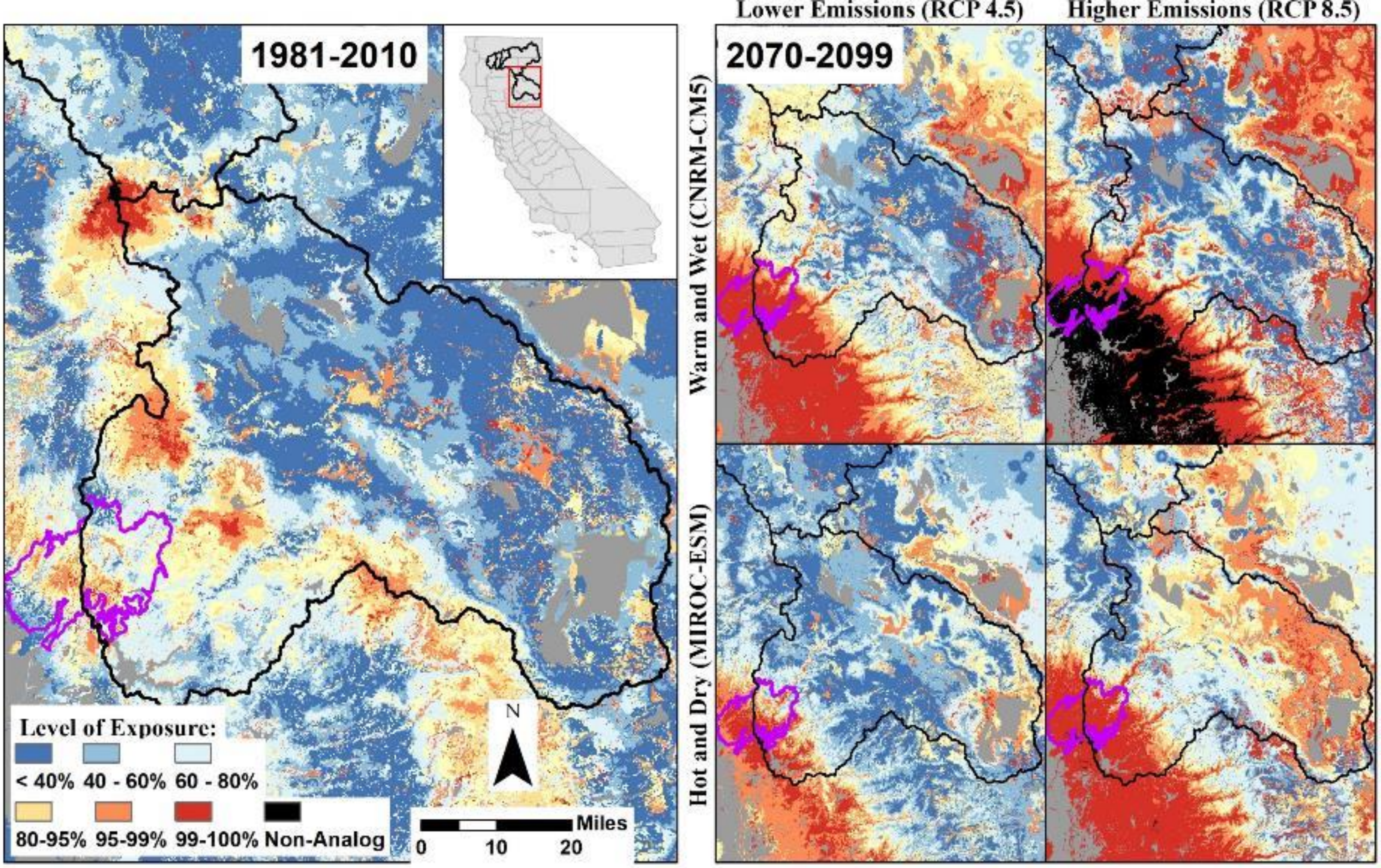
2. Predicted vegetative climate exposure to California Towhee suitable habitat.

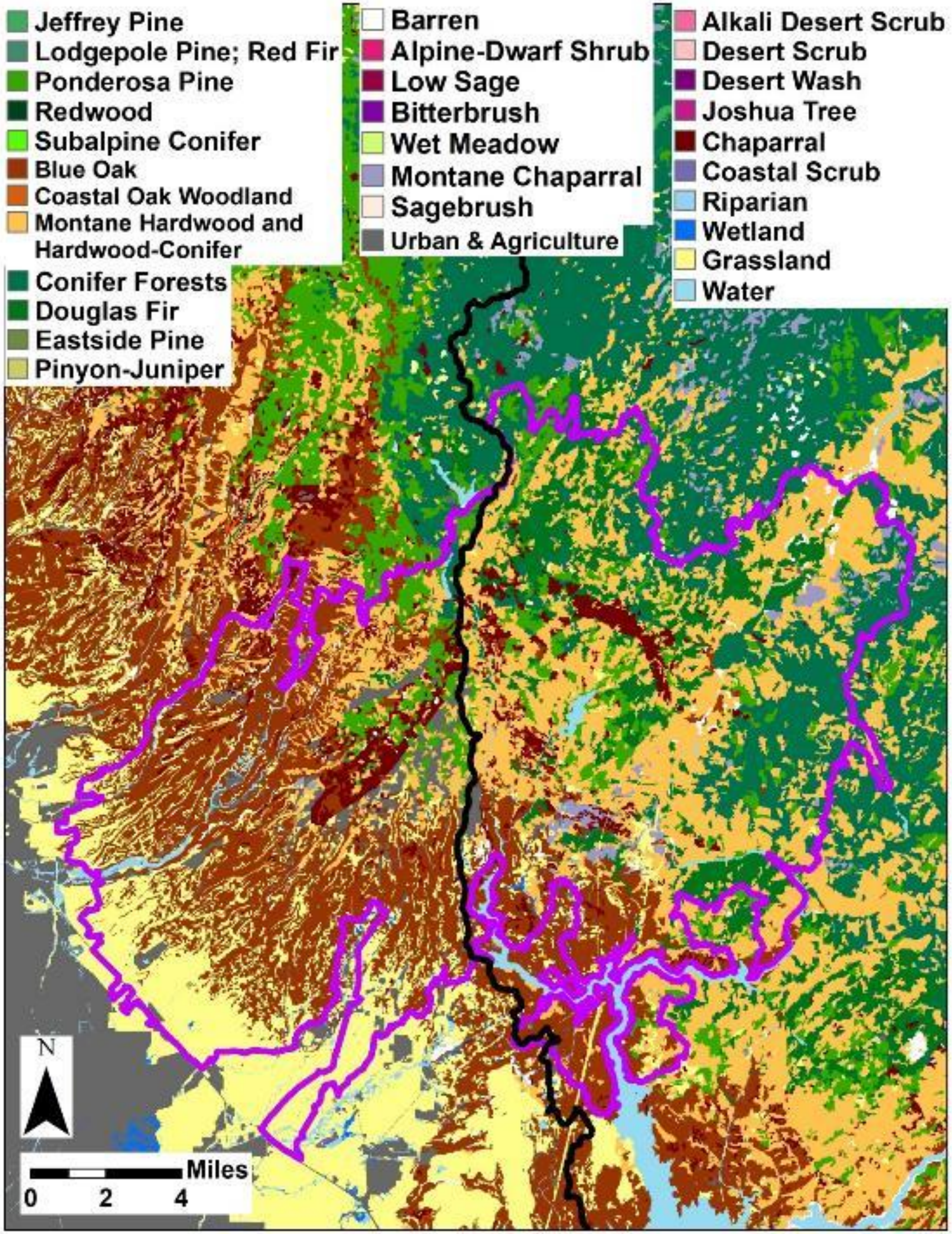

B
Vegetative Climate Refugia
Consensus
MIROC
CNRM
California Towhee Range
N
km
0 50 100

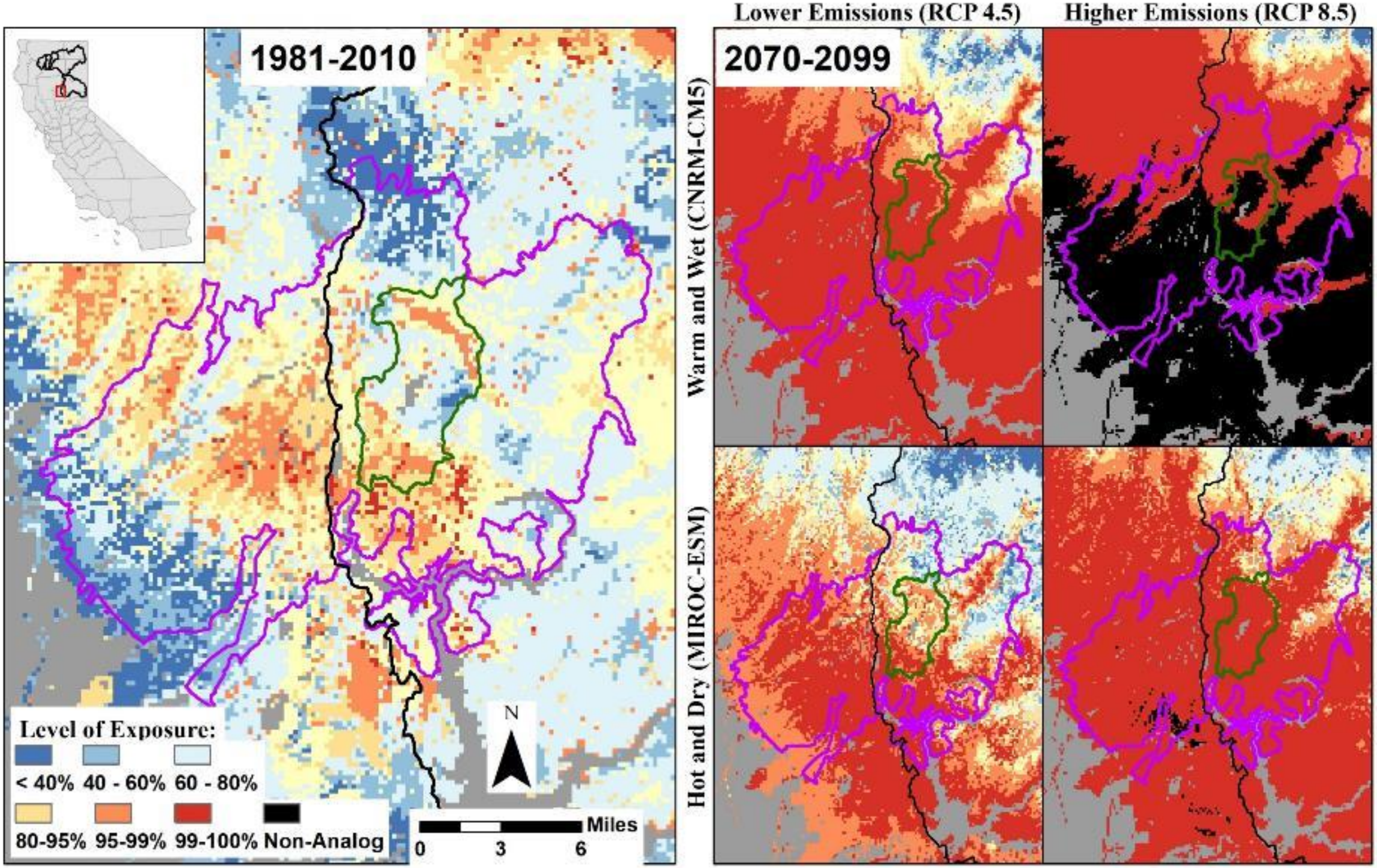
3. Vegetation climate refugia in California Towhee suitable habitat.

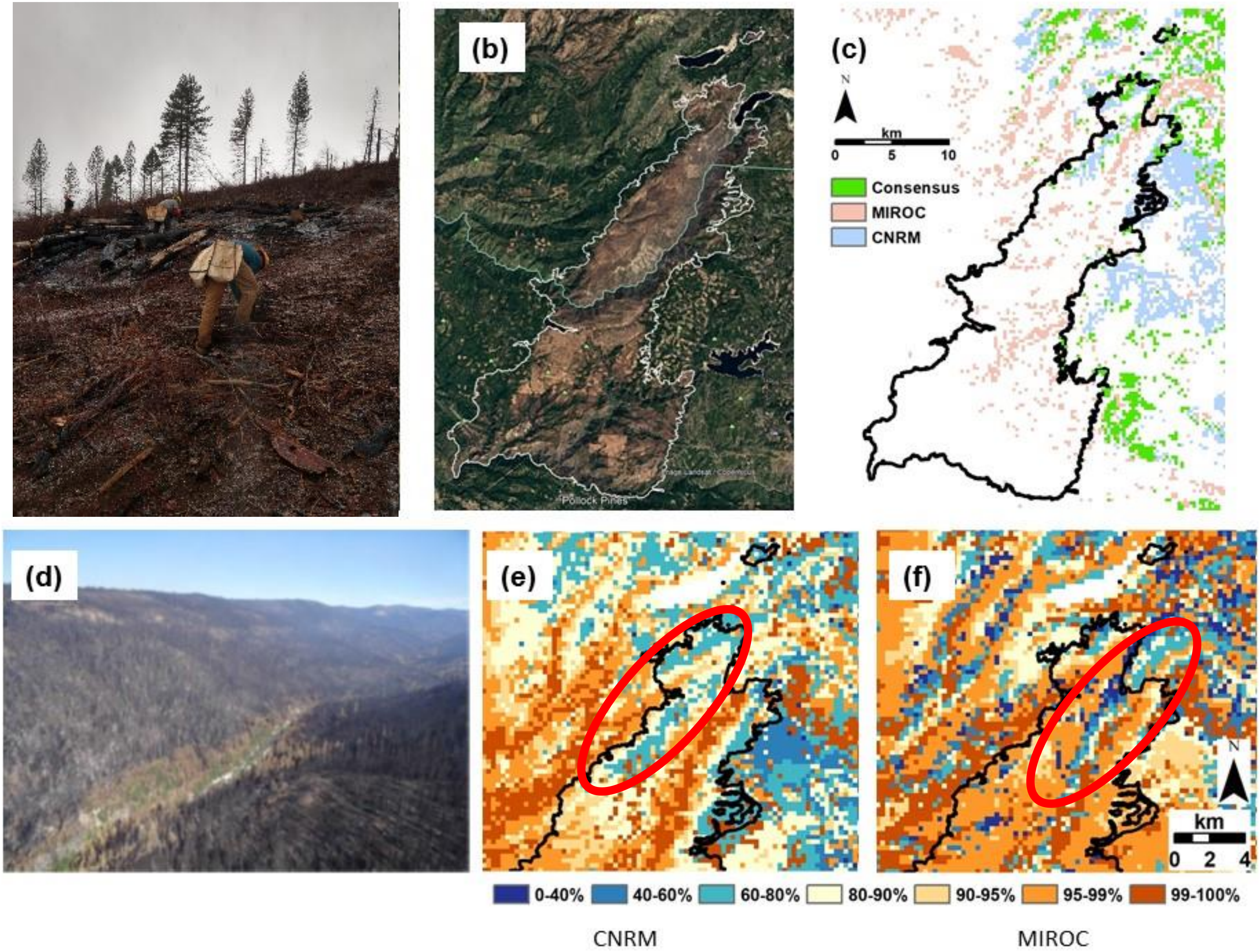

(a)
Oak-dominated vegetation types
Upper elevation
Lower elevation
0
5
10 km
N
(b)
Vegetation refugia
CNRM CM5
MIROC ESM
Consensus
Non refugia
N
0
5
10 km

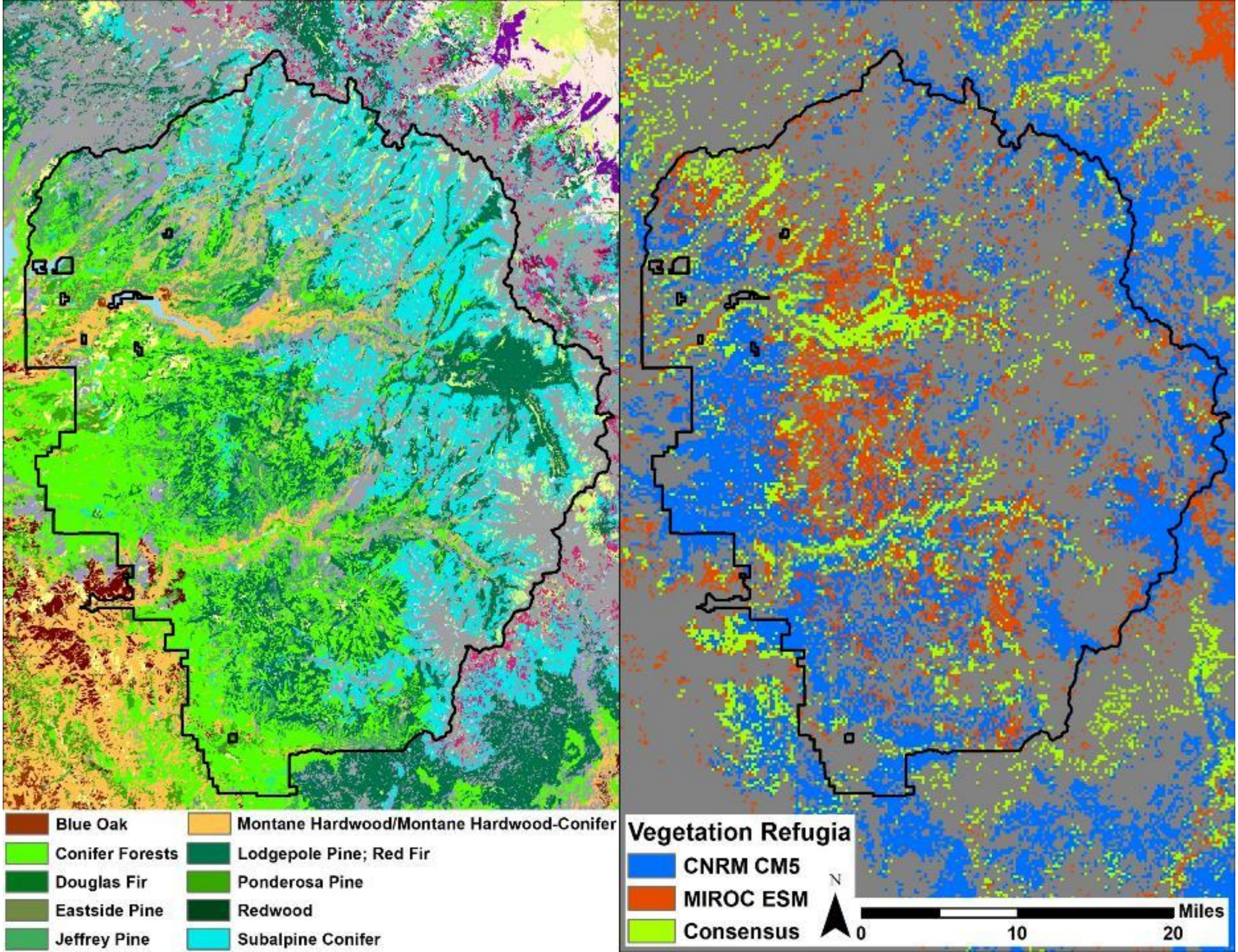

N
Miles
0
6
12
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

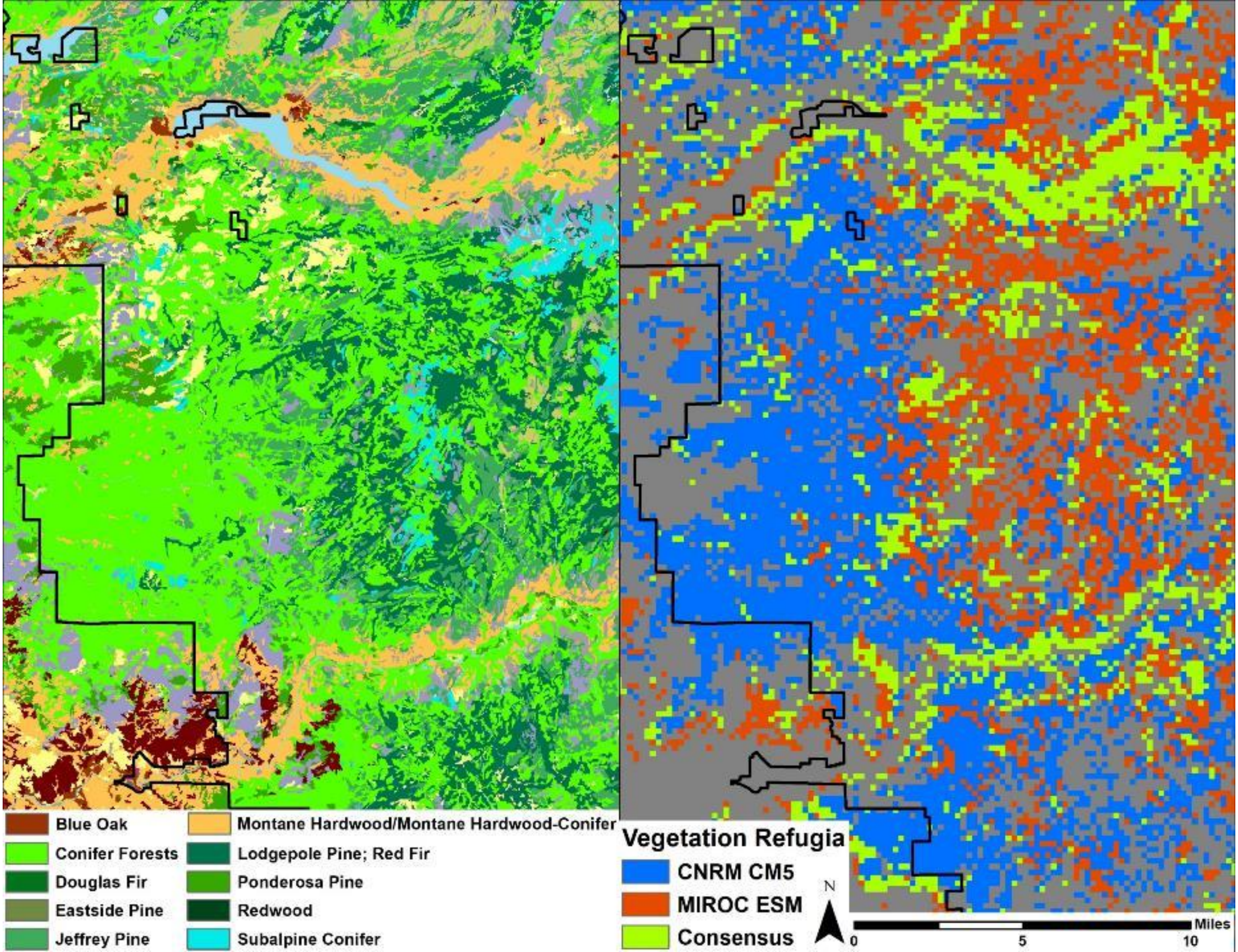

Lower Emissions (RCP 4.5)
Higher Emissions (RCP 8.5)
1981-2010
2070-2099
Warm and Wet (CNRM-CM5)
Hot and Dry (MIROC-ESM)
Level of Exposure:
< 40%
40 - 60%
60 - 80%
80-95%
95-99%
99-100%
Non-Analog
N
Miles
0
10
20


Jeffrey Pine
Lodgepole Pine; Red Fir
Ponderosa Pine
Redwood
Subalpine Conifer
Blue Oak
Coastal Oak Woodland
Montane Hardwood and Hardwood-Conifer
Conifer Forests
Douglas Fir
Eastside Pine
Pinyon-Juniper
Barren
Alpine-Dwarf Shrub
Low Sage
Bitterbrush
Wet Meadow
Montane Chaparral
Sagebrush
Urban & Agriculture
Alkali Desert Scrub
Desert Scrub
Desert Wash
Joshua Tree
Chaparral
Coastal Scrub
Riparian
Wetland
Grassland
Water
N
Miles
0
2
4


1981-2010
Level of Exposure:
< 40%
40 - 60%
60 - 80%
80-95%
95-99%
99-100%
Non-Analog
N
Miles
0
3
6
Lower Emissions (RCP 4.5)
Higher Emissions (RCP 8.5)
2070-2099
Warm and Wet (CNRM-CM5)
Hot and Dry (MIROC-ESM)


(b)
Pollock Pines
(c)
N
km
0
5
10
Consensus
MIROC
CNRM
(d)
(e)
(f)
N
km
0
2
4
0-40%
40-60%
60-80%
80-90%
90-95%
95-99%
99-100%
CNRM
MIROC


Blue Oak
Conifer Forests
Douglas Fir
Eastside Pine
Jeffrey Pine
Montane Hardwood/Montane Hardwood-Conifer
Lodgepole Pine; Red Fir
Ponderosa Pine
Redwood
Subalpine Conifer
Vegetation Refugia
CNRM CM5
MIROC ESM
Consensus
N
Miles
0
10
20


Blue Oak
Conifer Forests
Douglas Fir
Eastside Pine
Jeffrey Pine
Montane Hardwood/Montane Hardwood-Conifer
Lodgepole Pine; Red Fir
Ponderosa Pine
Redwood
Subalpine Conifer
Vegetation Refugia
CNRM CM5
MIROC ESM
Consensus
N
Miles
0
5
10

Thank you!

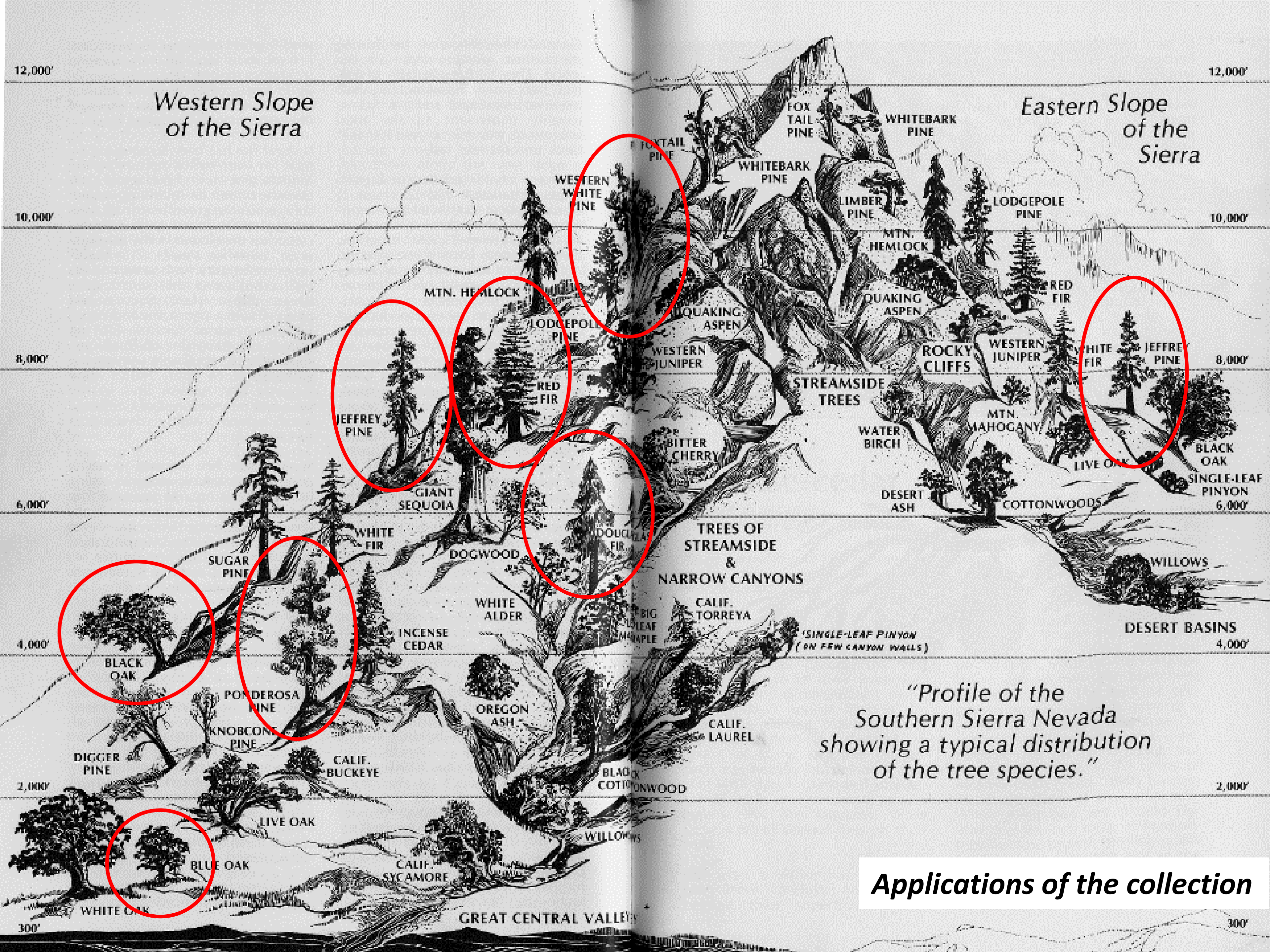
Jim Thorne
jhthorne@ucdavis.edu

Climate Resilience Planning for Key Sacramento River Watersheds

Jim Thorne **September 18 2019**

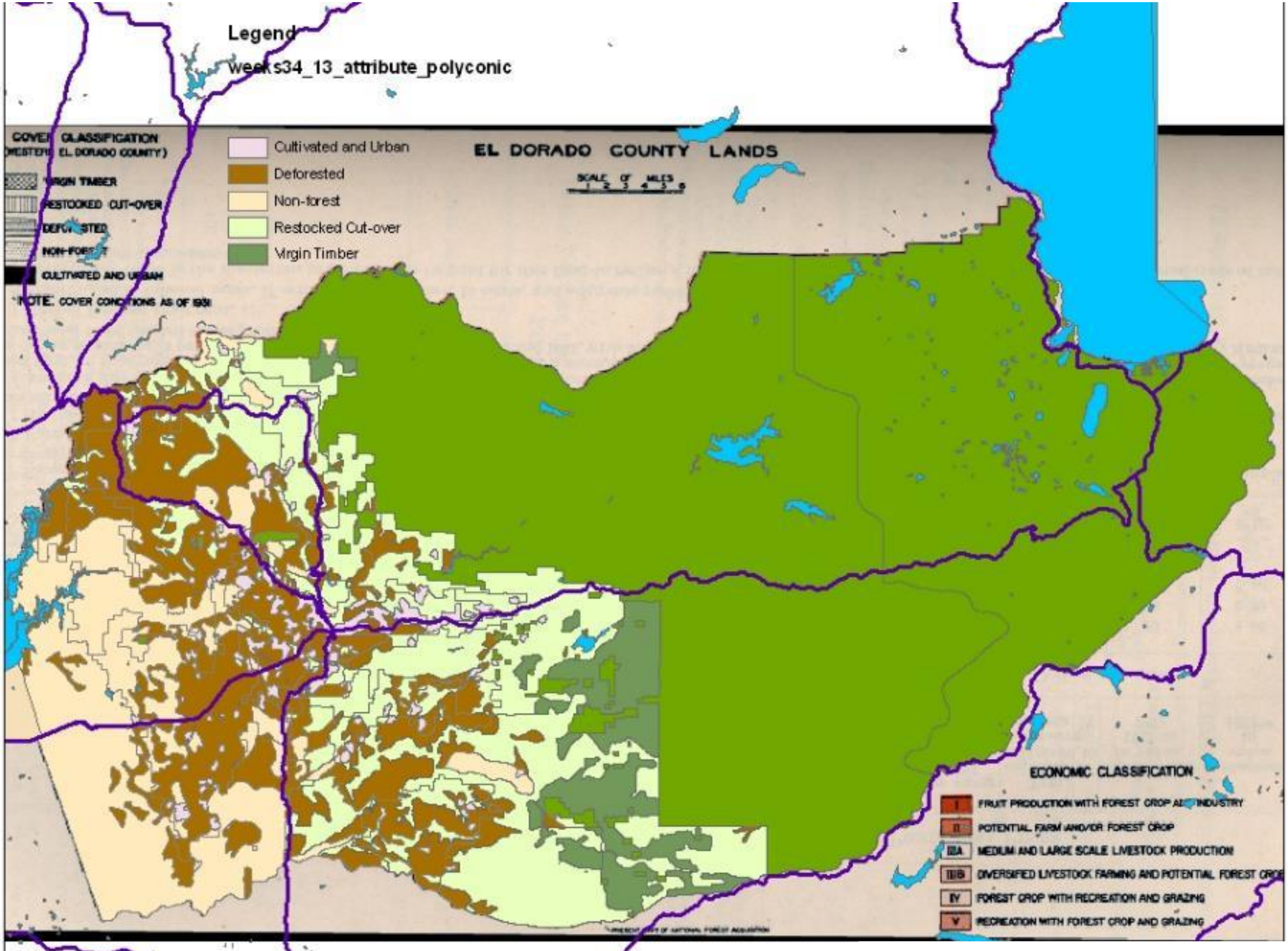
But we gotta do something!

Legacy Inventories – thoughts on collections


12,000'
12,000'
Western Slope of the Sierra
Eastern Slope of the Sierra
FOX TAIL PINE
WHITEBARK PINE
FOXTAIL PINE
WHITEBARK PINE
WESTERN WHITE PINE
LIMBER PINE
LODGEPOLE PINE
10,000'
10,000'
MTN. HEMLOCK
MTN. HEMLOCK
QUAKING ASPEN
QUAKING ASPEN
LODGEPOLE PINE
RED FIR
RED FIR
WESTERN JUNIPER
ROCKY CLIFFS
WESTERN JUNIPER
WHITE FIR
JEFFREY PINE
8,000'
8,000'
STREAMSIDE TREES
JEFFREY PINE
BITTER CHERRY
WATER BIRCH
MTN. MAHOGANY
BLACK OAK
LIVE OAK
SINGLE-LEAF PINYON
GIANT SEQUOIA
DESERT ASH
COTTONWOODS
6,000'
6,000'
WHITE FIR
DOUGLAS FIR
TREES OF STREAMSIDE & NARROW CANYONS
SUGAR PINE
DOGWOOD
WILLOWS
WHITE ALDER
BIG LEAF MAPLE
CALIF. TORREYA
DESERT BASINS
INCENSE CEDAR
SINGLE-LEAF PINYON (ON FEW CANYON WALLS)
4,000'
4,000'
BLACK OAK
PONDEROSA PINE
OREGON ASH
KNOBCONE PINE
CALIF. LAUREL
DIGGER PINE
CALIF. BUCKEYE
BLACK COTTONWOOD
2,000'
2,000'
LIVE OAK
WILLOWS
BLUE OAK
CALIF. SYCAMORE
WHITE OAK
GREAT CENTRAL VALLEY
300'
300'

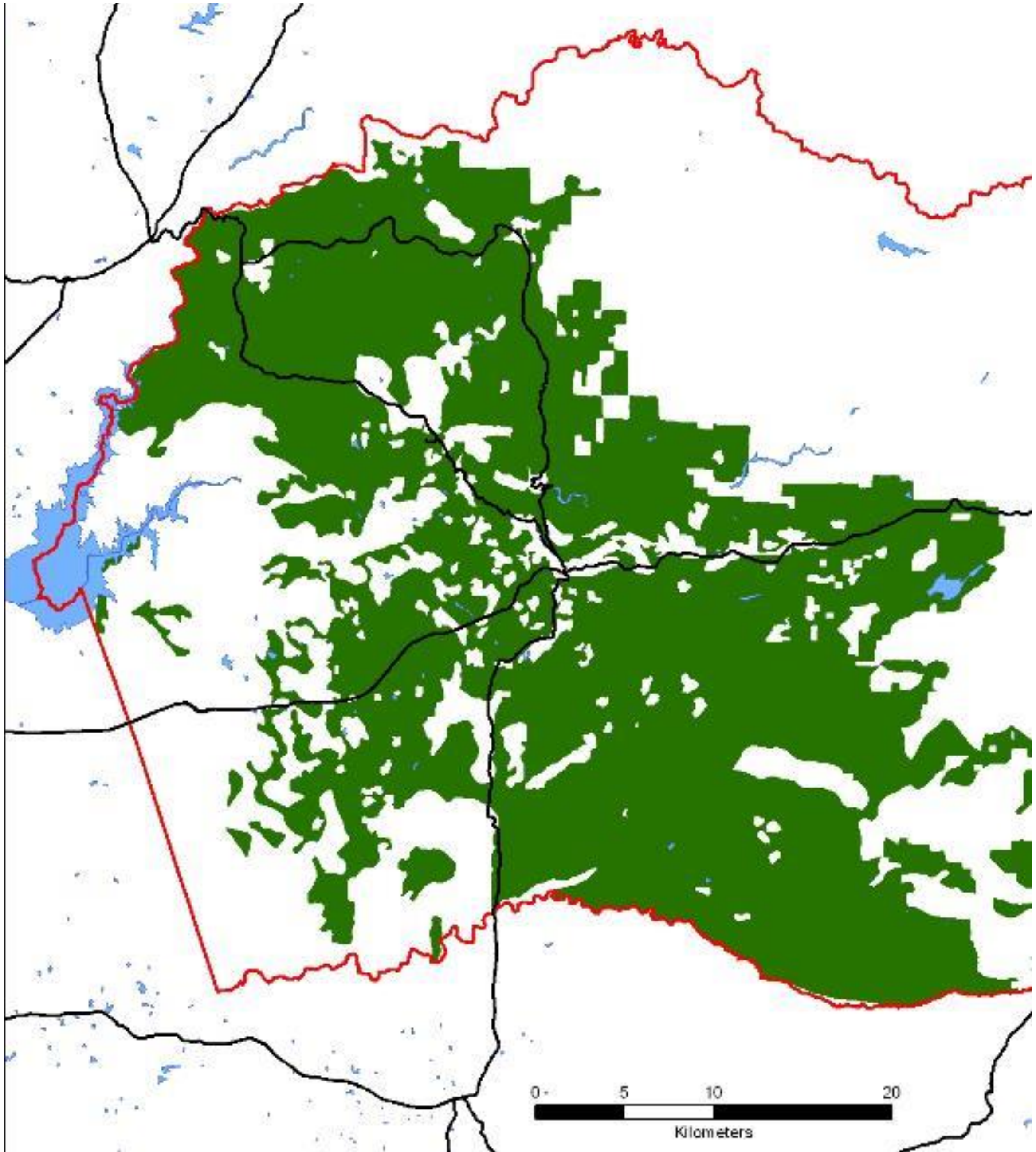
"Profile of the Southern Sierra Nevada showing a typical distribution of the tree species."

Applications of the collection

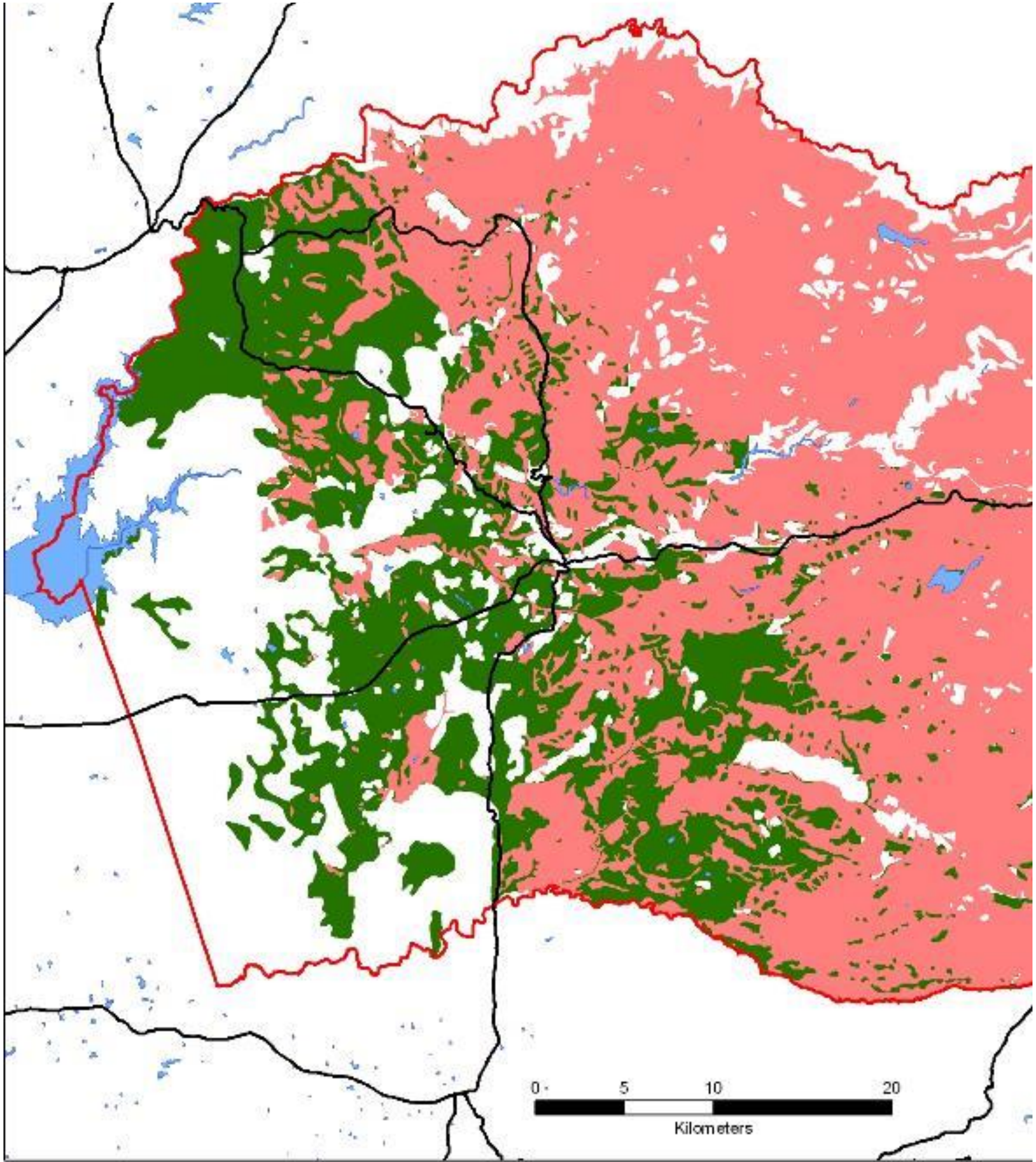

Legend
weeks34_13_attribute_polyconic
Cultivated and Urban
Deforested
Non-forest
Restocked Cut-over
Virgin Timber
COVER CLASSIFICATION
(WESTERN EL DORADO COUNTY)
VIRGIN TIMBER
RESTOCKED CUT-OVER
DEFORESTED
NON-FOREST
CULTIVATED AND URBAN
NOTE: COVER CONDITIONS AS OF 1931
EL DORADO COUNTY LANDS
SCALE OF MILES
1 2 3 4 5 6
ECONOMIC CLASSIFICATION
I FRUIT PRODUCTION WITH FOREST CROP AND INDUSTRY
II POTENTIAL FARM AND/OR FOREST CROP
IIIA MEDIUM AND LARGE SCALE LIVESTOCK PRODUCTION
IIIB DIVERSIFIED LIVESTOCK FARMING AND POTENTIAL FOREST CROP
IV FOREST CROP WITH RECREATION AND GRAZING
V RECREATION WITH FOREST CROP AND GRAZING

Applications of the collection

Ponderosa western extent 1850- Wieslander Report


0
5
10
20
Kilometers

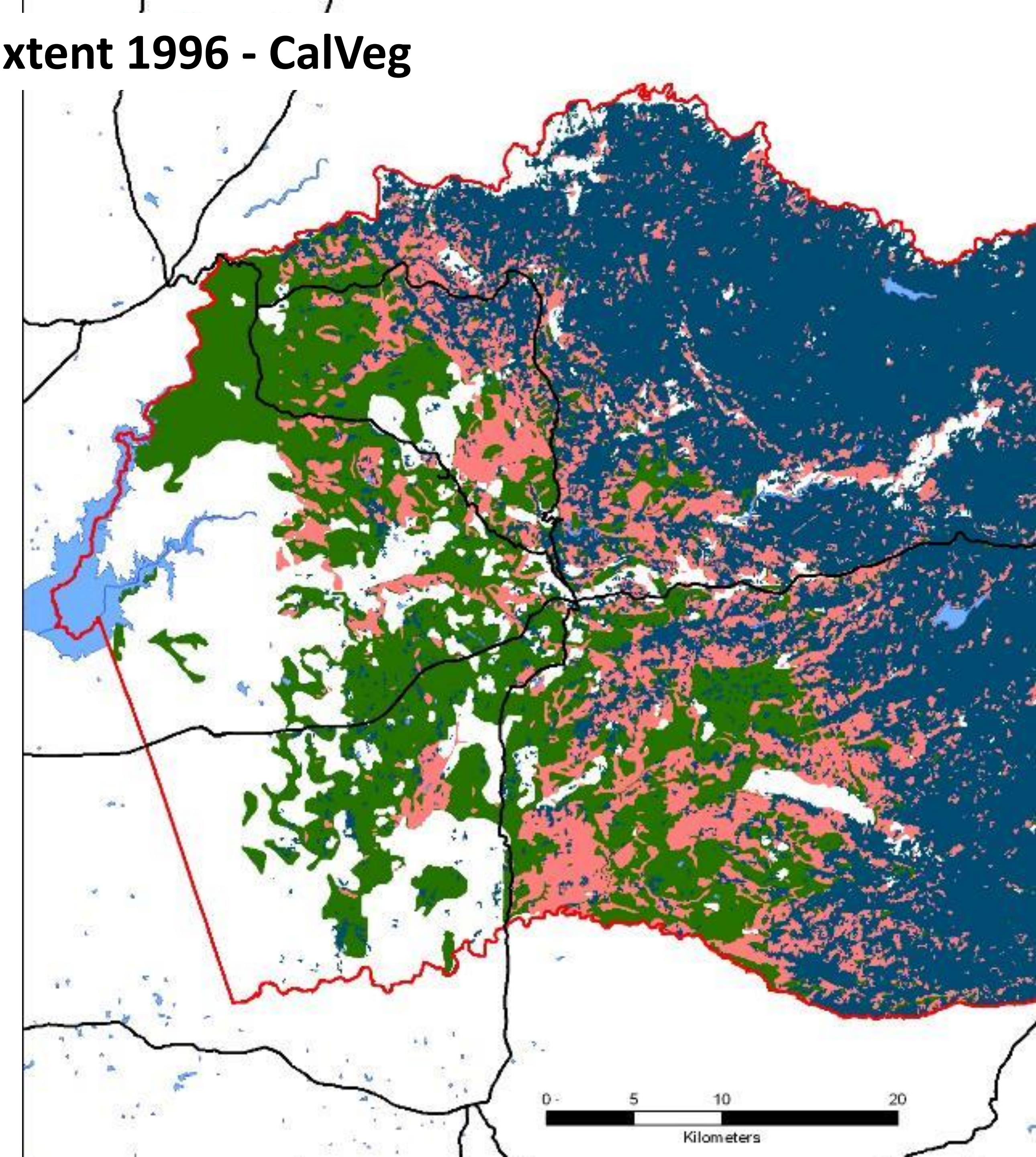
Ponderosa Western Extent 1934- Wieslander

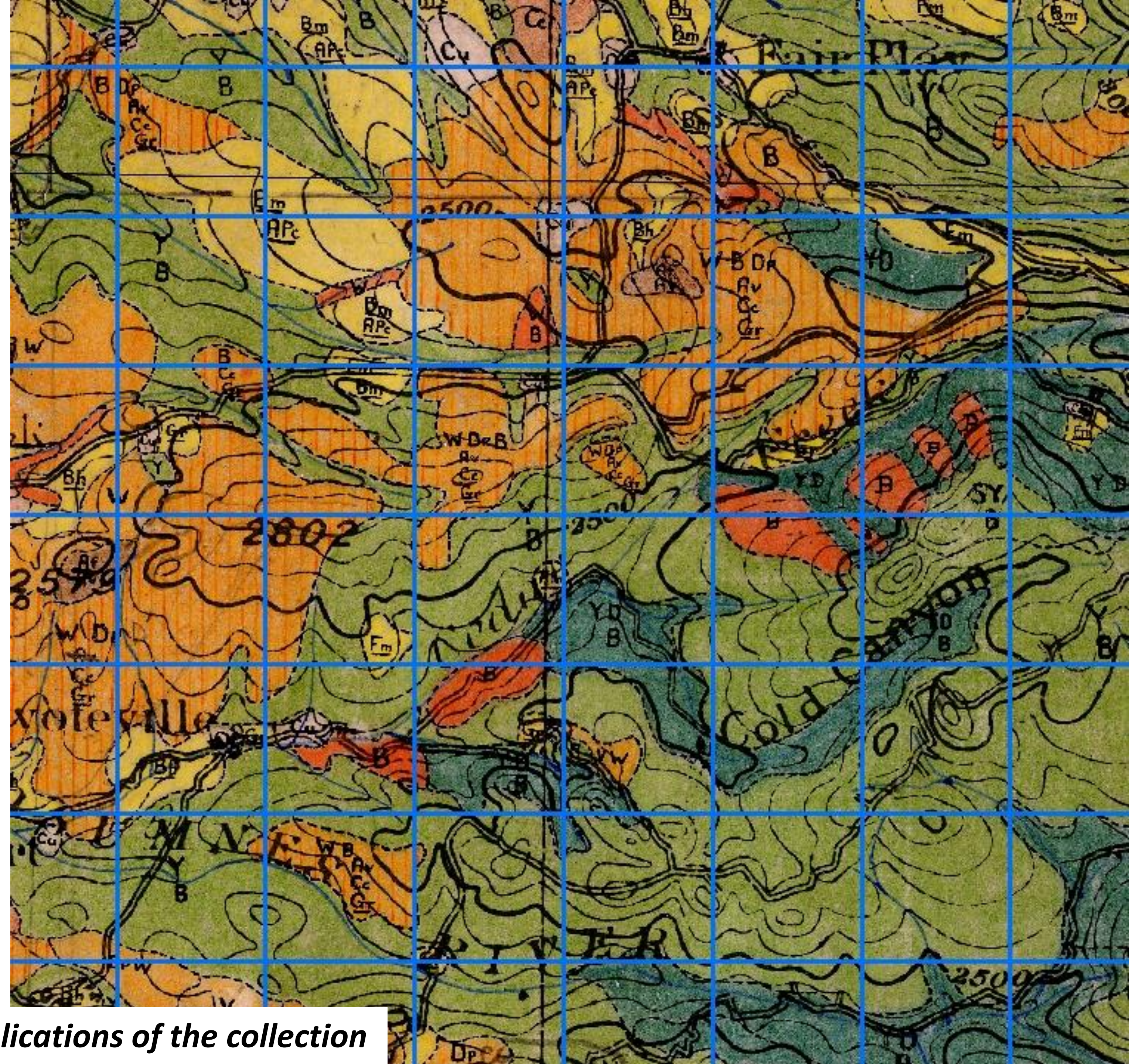

0
5
10
20
Kilometers

Applications of the collection

Ponderosa Western Extent 1996 - CalVeg

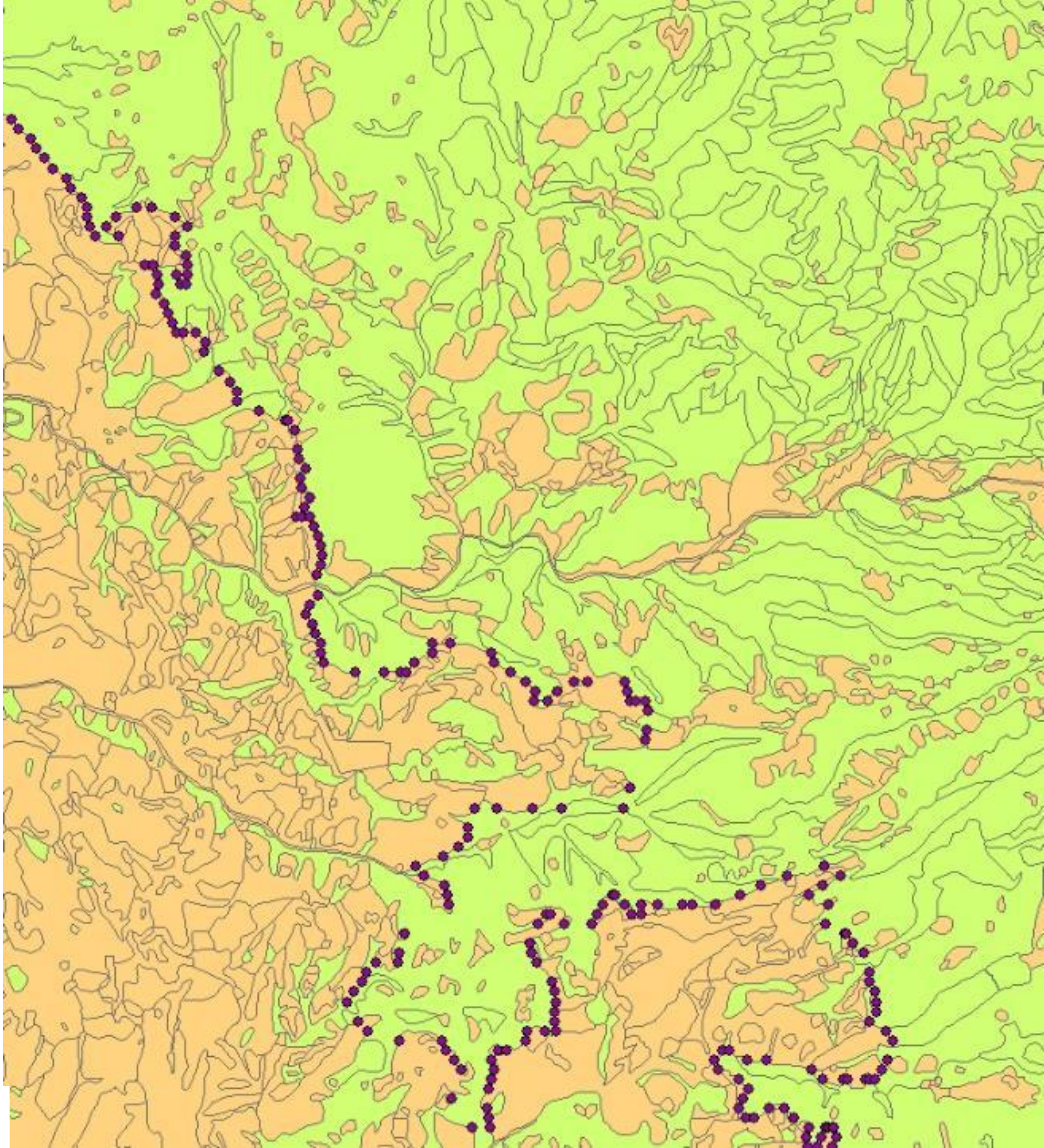
How to quantify this mess?


0
5
10
20
Kilometers

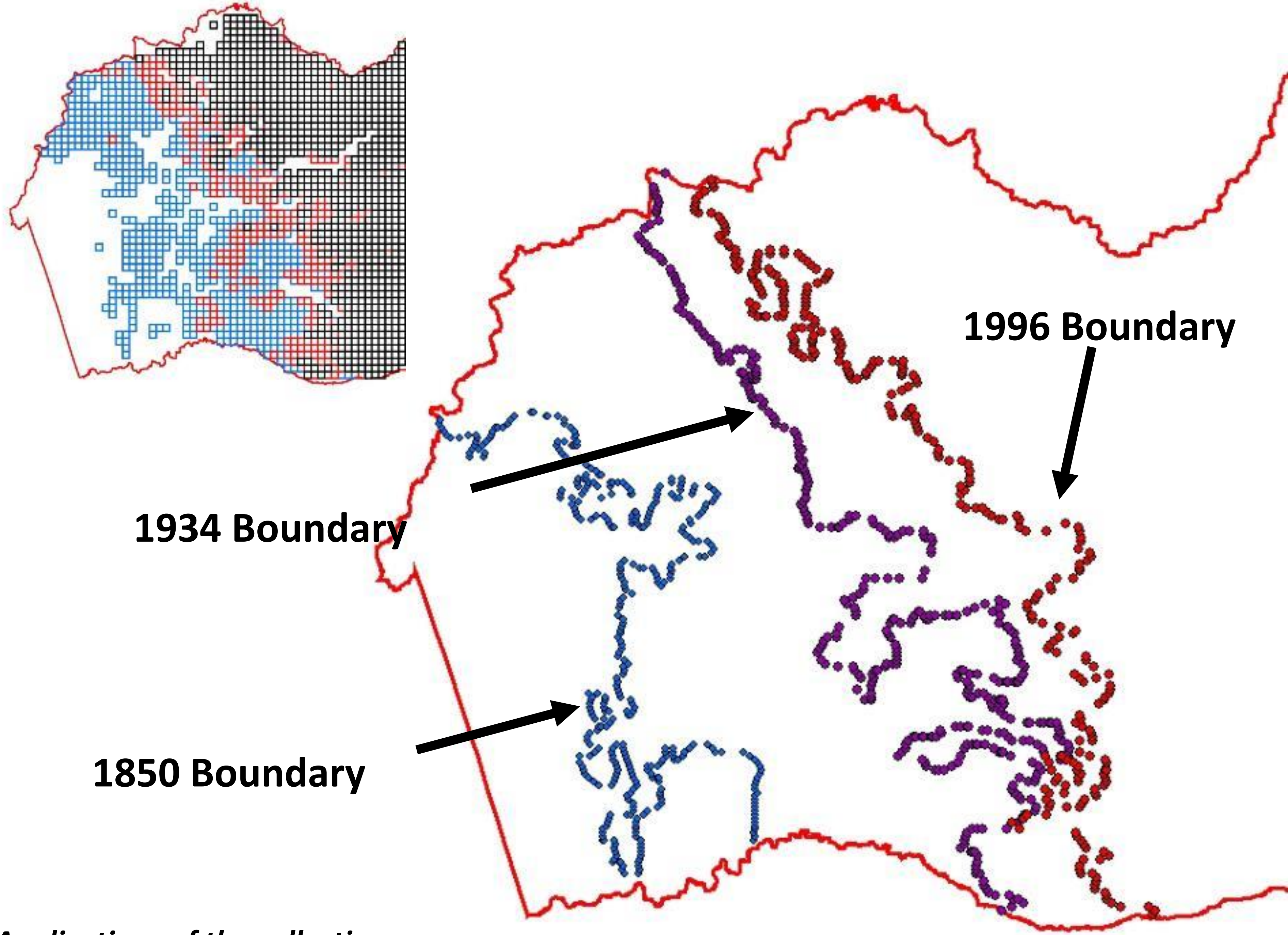

Fair Play
2500
2802
2500
Cold Canyon
River
Coloteville
2509

Applications of the collection

The 1934 Edge
Defined as 75% forest
and adding any polygons
that attached to the edge

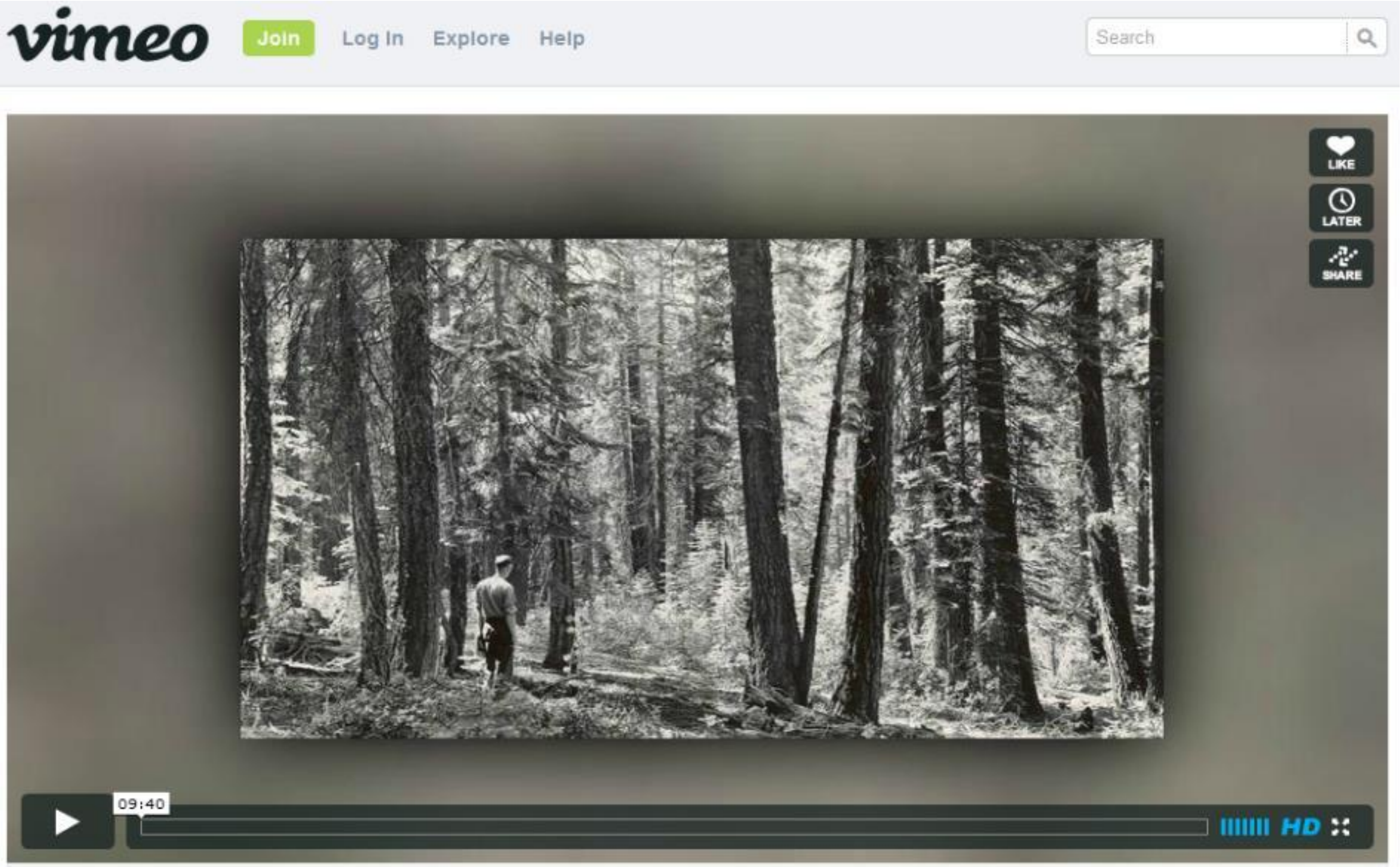


Applications of the collection

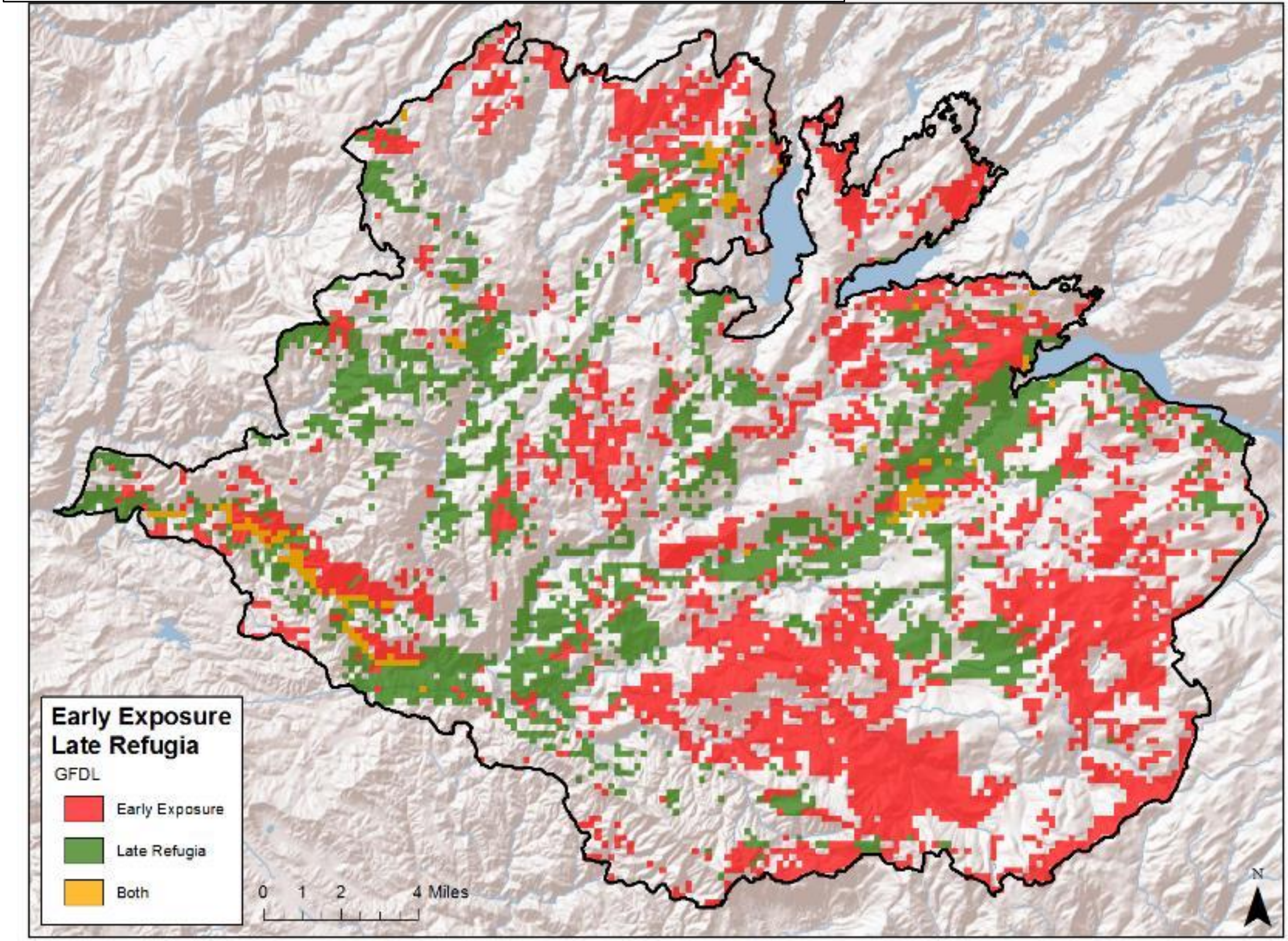

1996 Boundary
1934 Boundary
1850 Boundary

Applications of the collection

2D on vimeo: http://vimeo.com/41524838
3D on youtube: http://www.youtube.com/watch?v=ZGo-vI4Ey44

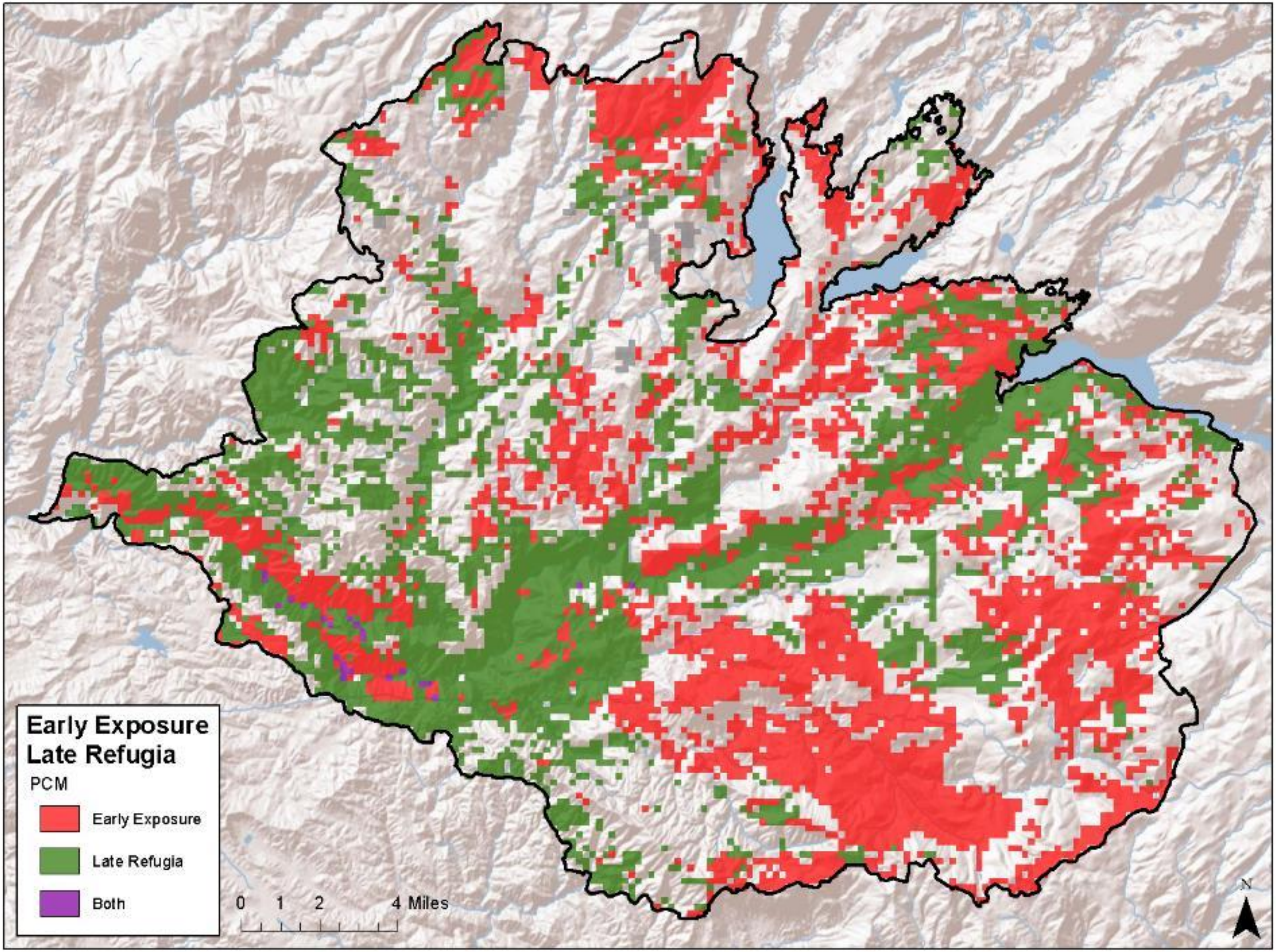

vimeo
Join
Log In
Explore
Help
Search
LIKE
LATER
SHARE
09:40
HD

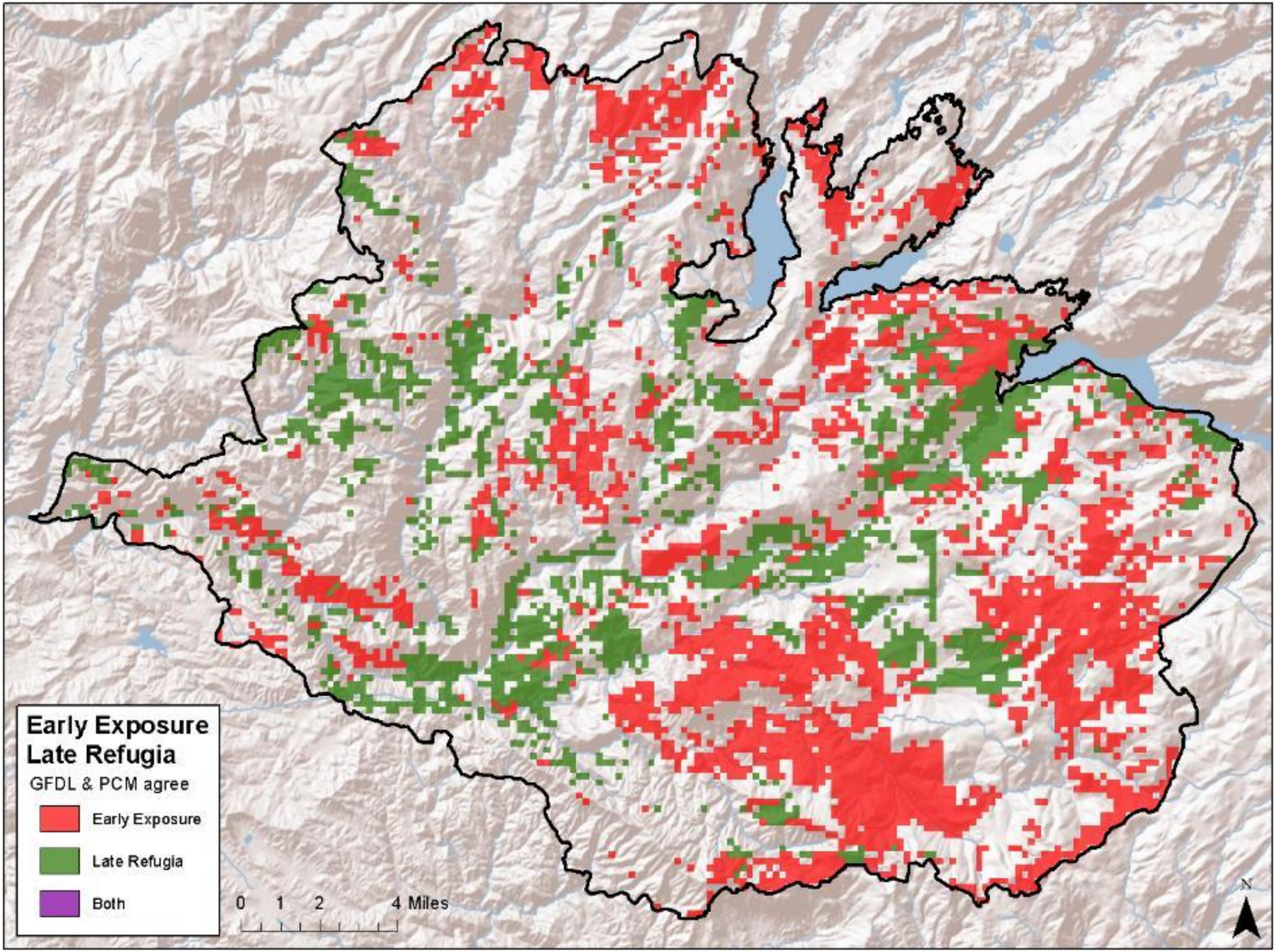
Applications C. Restoration after Wildfire

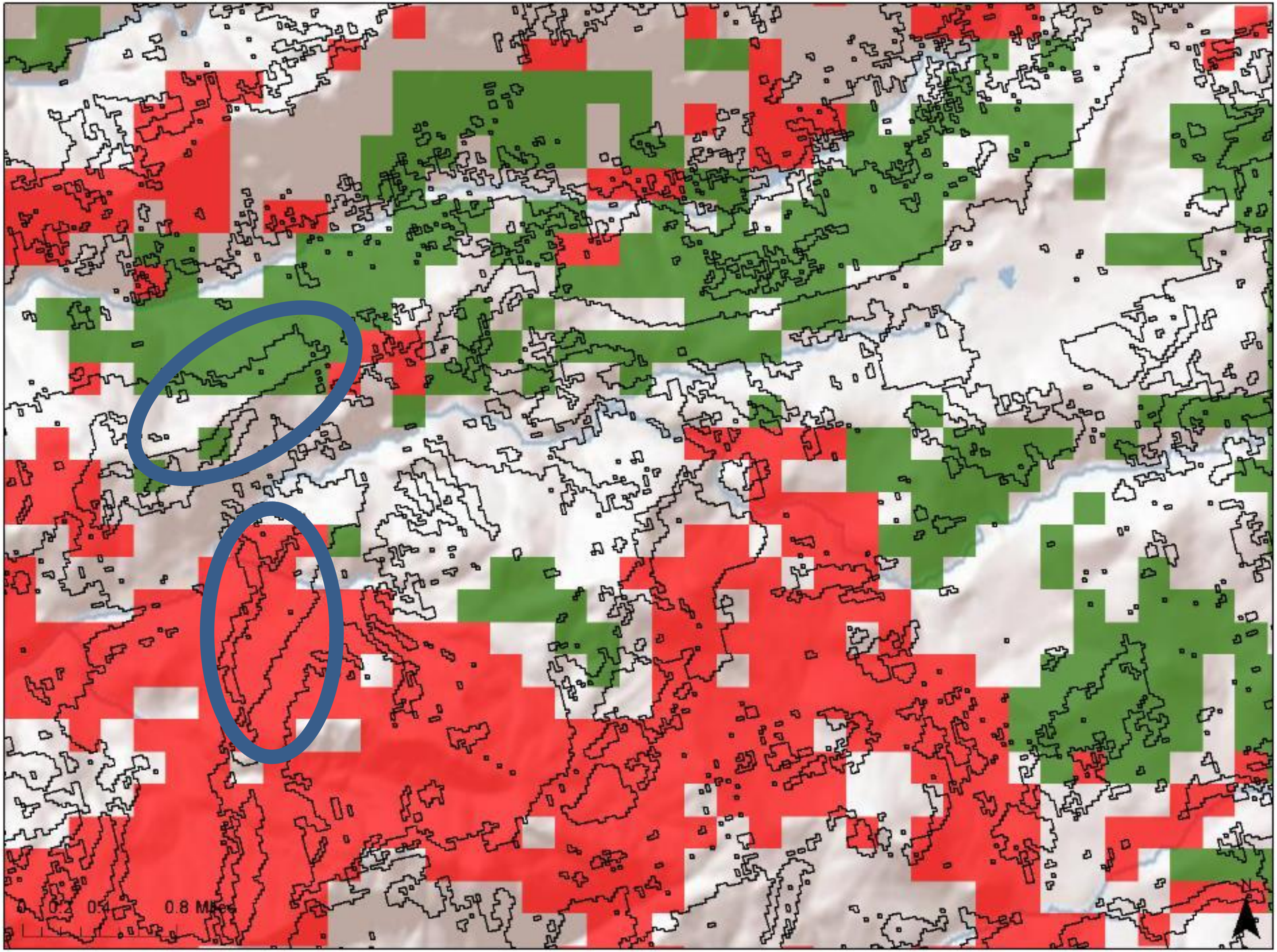

Early Exposure
Late Refugia
GFDL
🟥 Early Exposure
🟩 Late Refugia
🟧 Both
0 1 2 4 Miles
N

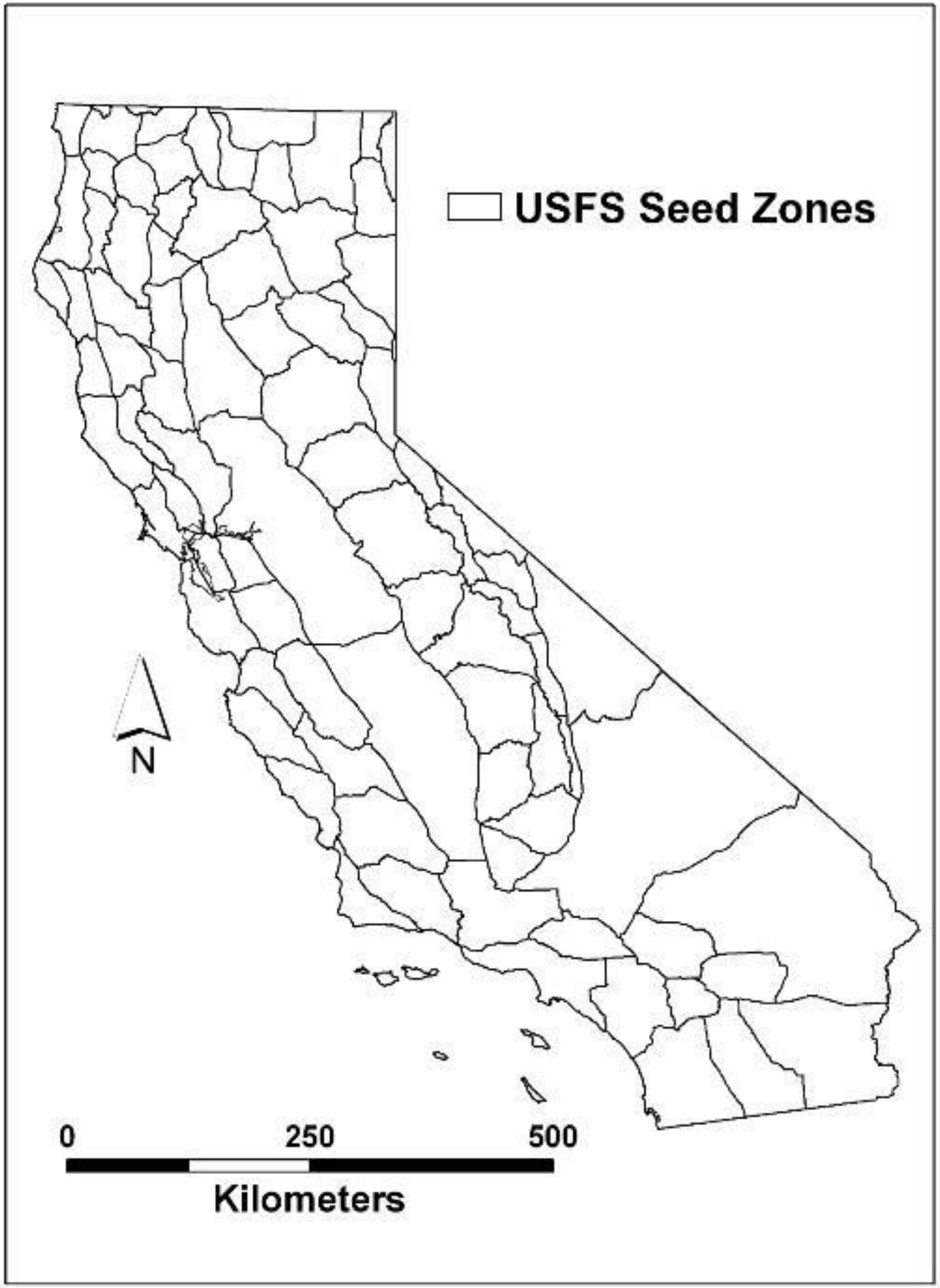
Green – places that remain within bioclimatic envelope at end of century.

Red: places that fall outside of bioclimatic envelope by 2040

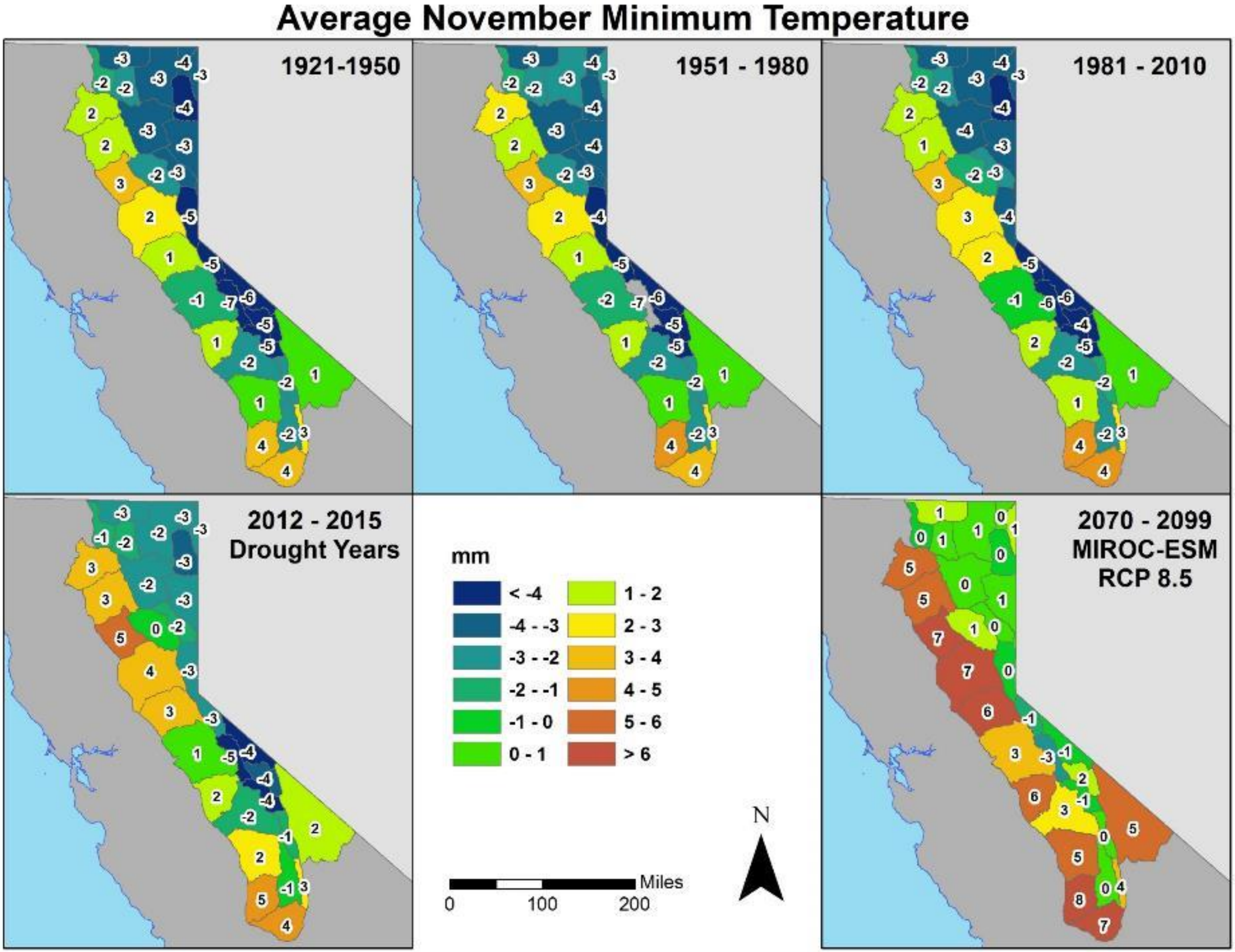

Early Exposure
Late Refugia
PCM
🟥 Early Exposure
🟩 Late Refugia
🟪 Both
0 1 2 4 Miles
N

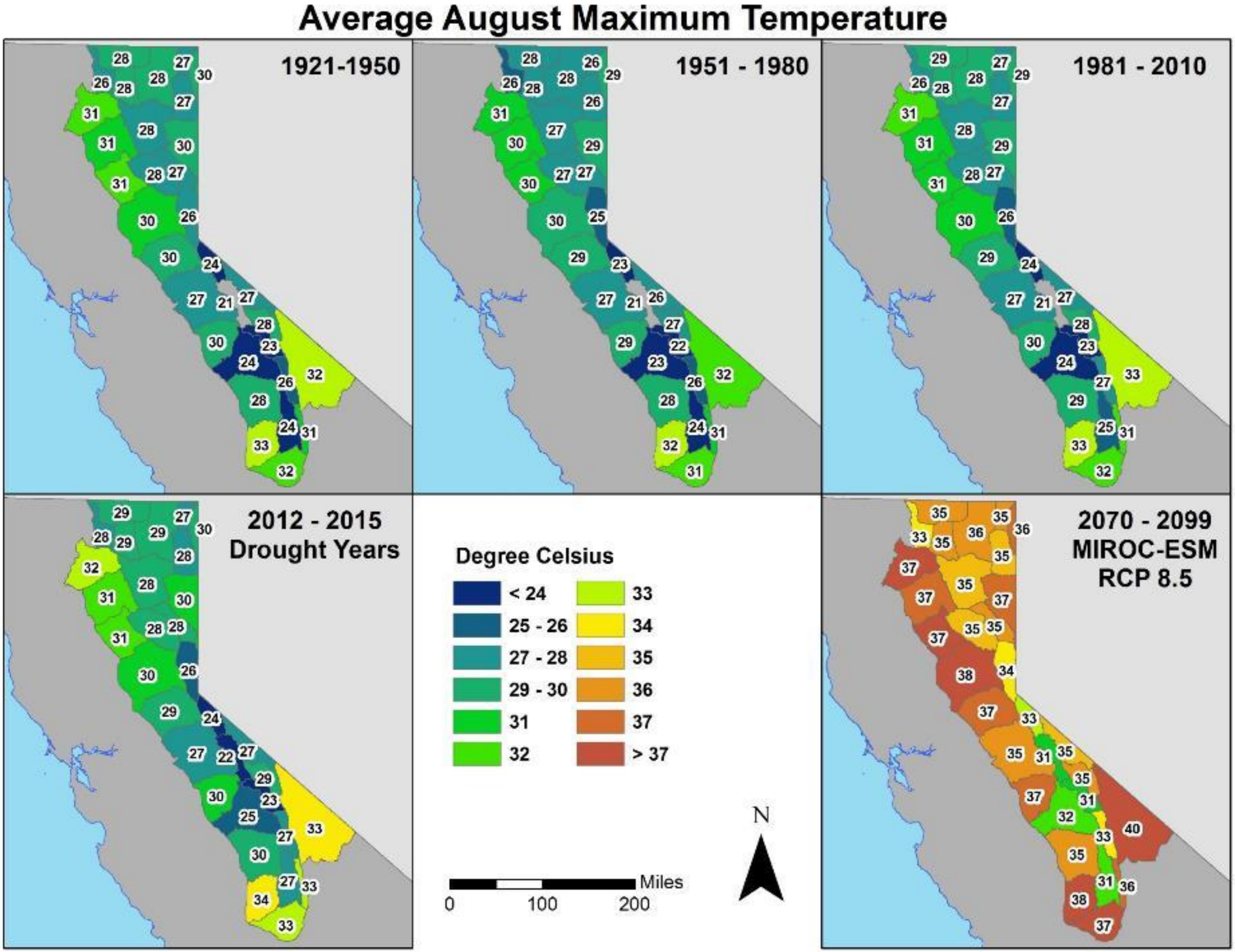

Early Exposure
Late Refugia
GFDL & PCM agree
🟥 Early Exposure
🟩 Late Refugia
🟪 Both
0 1 2 4 Miles
N

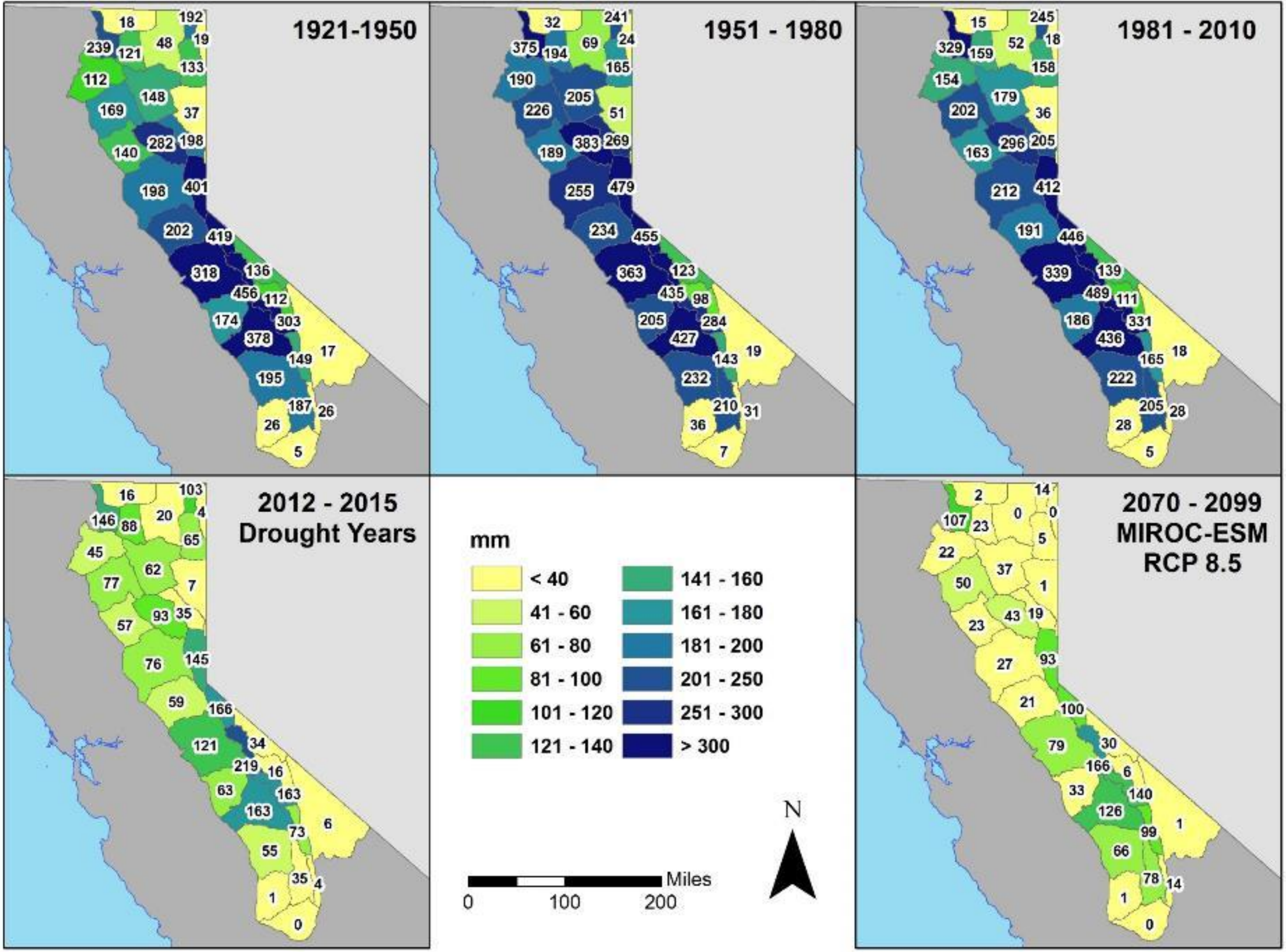

0
0.2
0.4
0.8 Miles
N



▭ USFS Seed Zones
N
0
250
500
Kilometers


Average November Minimum Temperature
1921-1950
1951 - 1980
1981 - 2010
2012 - 2015
Drought Years
2070 - 2099
MIROC-ESM
RCP 8.5
mm
< -4
-4 - -3
-3 - -2
-2 - -1
-1 - 0
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
> 6
Miles
0
100
200
N

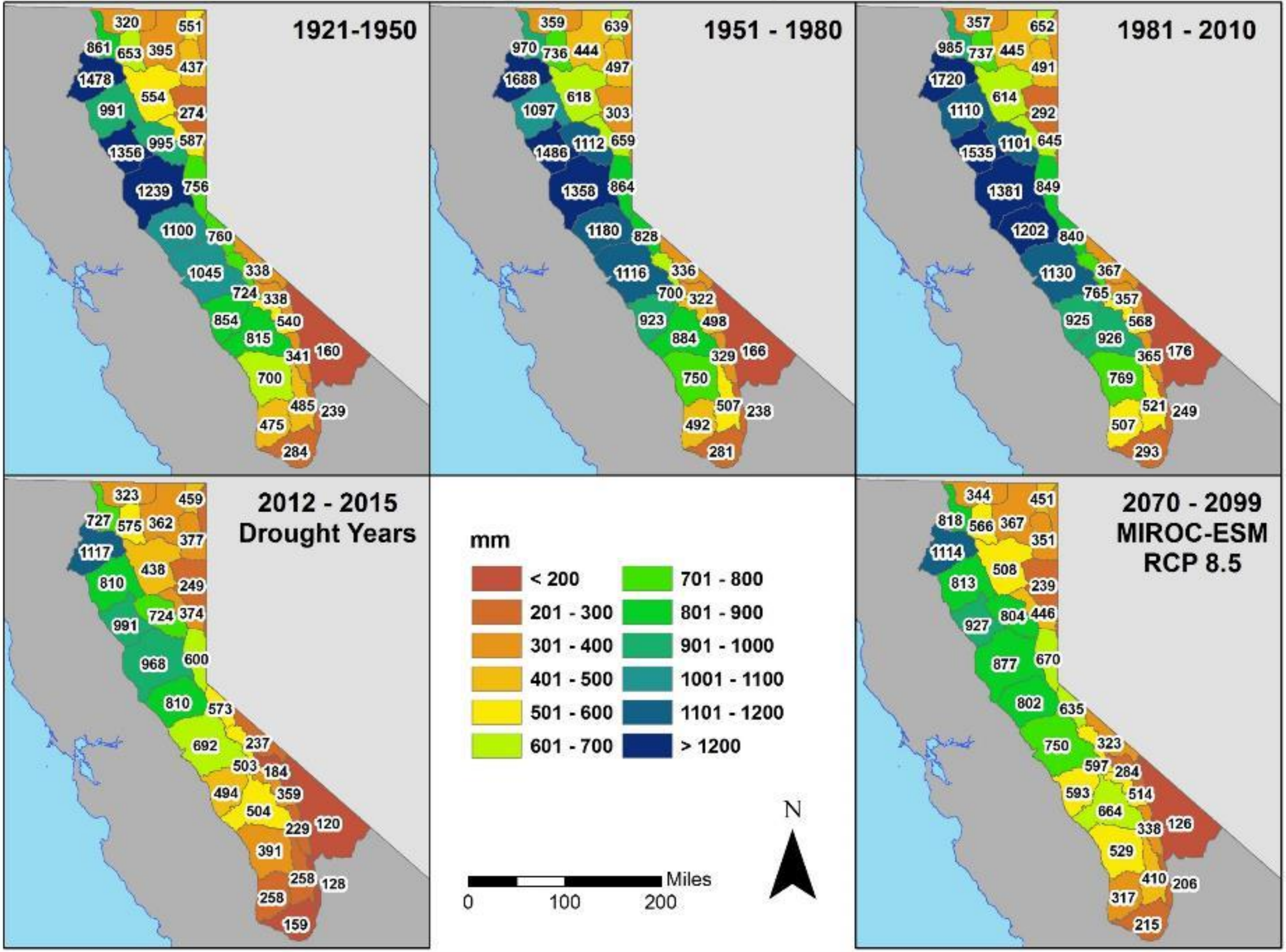

Average August Maximum Temperature
1921-1950
28
27
30
26
28
28
27
31
28
31
30
28
27
31
30
26
30
24
27
21
27
28
30
23
24
32
26
28
24
31
33
32
1951 - 1980
28
26
29
26
28
28
26
31
27
30
29
27
27
30
30
25
29
23
27
21
26
27
29
22
23
32
26
28
24
31
32
31
1981 - 2010
29
27
29
26
28
28
27
31
28
31
29
28
27
31
30
26
29
24
27
21
27
28
30
23
24
33
27
29
25
31
33
32
2012 - 2015
Drought Years
29
27
30
28
29
29
28
32
28
31
30
28
28
31
30
26
29
24
27
22
27
29
30
23
25
33
27
30
27
33
34
33
Degree Celsius
< 24
25 - 26
27 - 28
29 - 30
31
32
33
34
35
36
37
> 37
Miles
0
100
200
N
2070 - 2099
MIROC-ESM
RCP 8.5
35
35
36
33
35
36
35
37
35
37
37
35
35
37
34
38
37
33
35
31
35
35
37
31
32
40
33
35
31
36
38
37



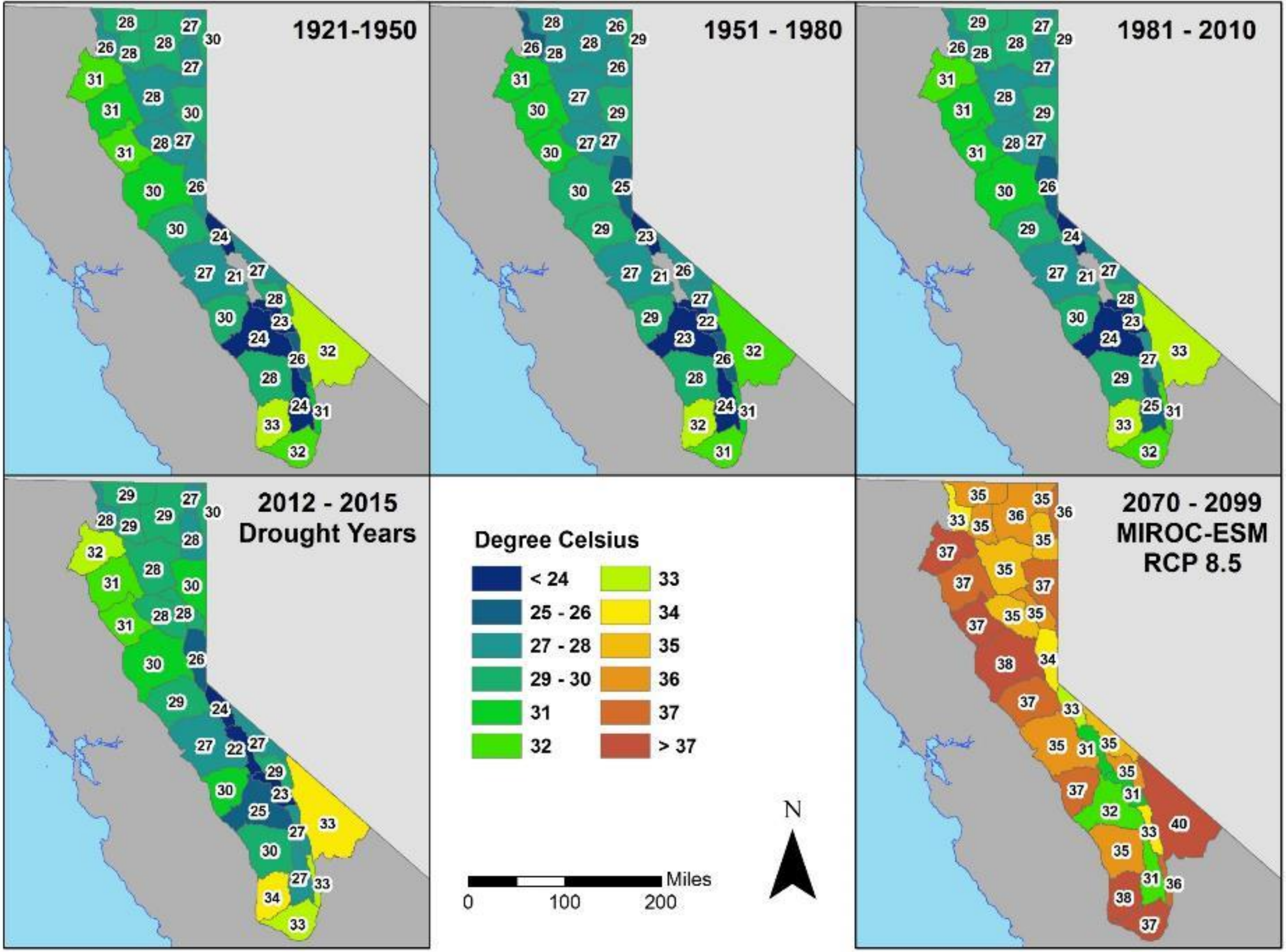
Average April 1st Snowpack

1921-1950
18
192
48
19
239
121
133
112
148
169
37
282
198
140
401
198
202
419
318
136
456
112
174
303
378
149
17
195
187
26
26
5
1951 - 1980
32
241
69
24
375
194
165
190
205
226
51
383
269
189
479
255
234
455
363
123
435
98
205
284
427
143
19
232
210
31
36
7
1981 - 2010
15
245
52
18
329
159
158
154
179
202
36
296
205
163
412
212
191
446
339
139
489
111
186
331
436
165
18
222
205
28
28
5
2012 - 2015
Drought Years
16
103
20
4
146
88
65
45
62
77
7
93
35
57
76
145
59
166
121
34
219
16
63
163
163
73
6
55
35
4
1
0
mm
< 40
41 - 60
61 - 80
81 - 100
101 - 120
121 - 140
141 - 160
161 - 180
181 - 200
201 - 250
251 - 300
> 300
Miles
0
100
200
N
2070 - 2099
MIROC-ESM
RCP 8.5
2
14
0
0
107
23
5
22
37
50
1
43
19
23
93
27
21
100
79
30
166
6
33
140
126
99
1
66
78
14
1
0

Average Annual Precipitation


1921-1950
320
551
861
653
395
437
1478
554
991
274
995
587
1356
1239
756
1100
760
1045
338
724
338
854
540
815
341
160
700
485
239
475
284
1951 - 1980
359
639
970
736
444
497
1688
618
1097
303
1112
659
1486
1358
864
1180
828
1116
336
700
322
923
498
884
329
166
750
507
238
492
281
1981 - 2010
357
652
985
737
445
491
1720
614
1110
292
1101
645
1535
1381
849
1202
840
1130
367
765
357
925
568
926
365
176
769
521
249
507
293
2012 - 2015
Drought Years
323
459
727
575
362
377
1117
438
810
249
991
724
374
968
600
810
573
692
237
503
184
494
359
504
229
120
391
258
128
258
159
mm
< 200
201 - 300
301 - 400
401 - 500
501 - 600
601 - 700
701 - 800
801 - 900
901 - 1000
1001 - 1100
1101 - 1200
> 1200
0
100
200
Miles
N
2070 - 2099
MIROC-ESM
RCP 8.5
344
451
818
566
367
351
1114
508
813
239
927
804
446
877
670
802
635
750
323
597
284
593
514
664
338
126
529
410
206
317
215

Average August Maximum Temperature


1921-1950
28
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31
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26
30
24
27
21
27
28
30
23
24
32
26
28
24
31
33
32
1951 - 1980
28
26
29
26
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32
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32
31
1981 - 2010
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33
27
29
25
31
33
32
2012 - 2015
Drought Years
29
27
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28
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27
33
34
33
Degree Celsius
< 24
25 - 26
27 - 28
29 - 30
31
32
33
34
35
36
37
> 37
Miles
0
100
200
N
2070 - 2099
MIROC-ESM
RCP 8.5
35
35
36
33
35
36
35
37
35
37
37
35
35
37
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35
31
35
35
37
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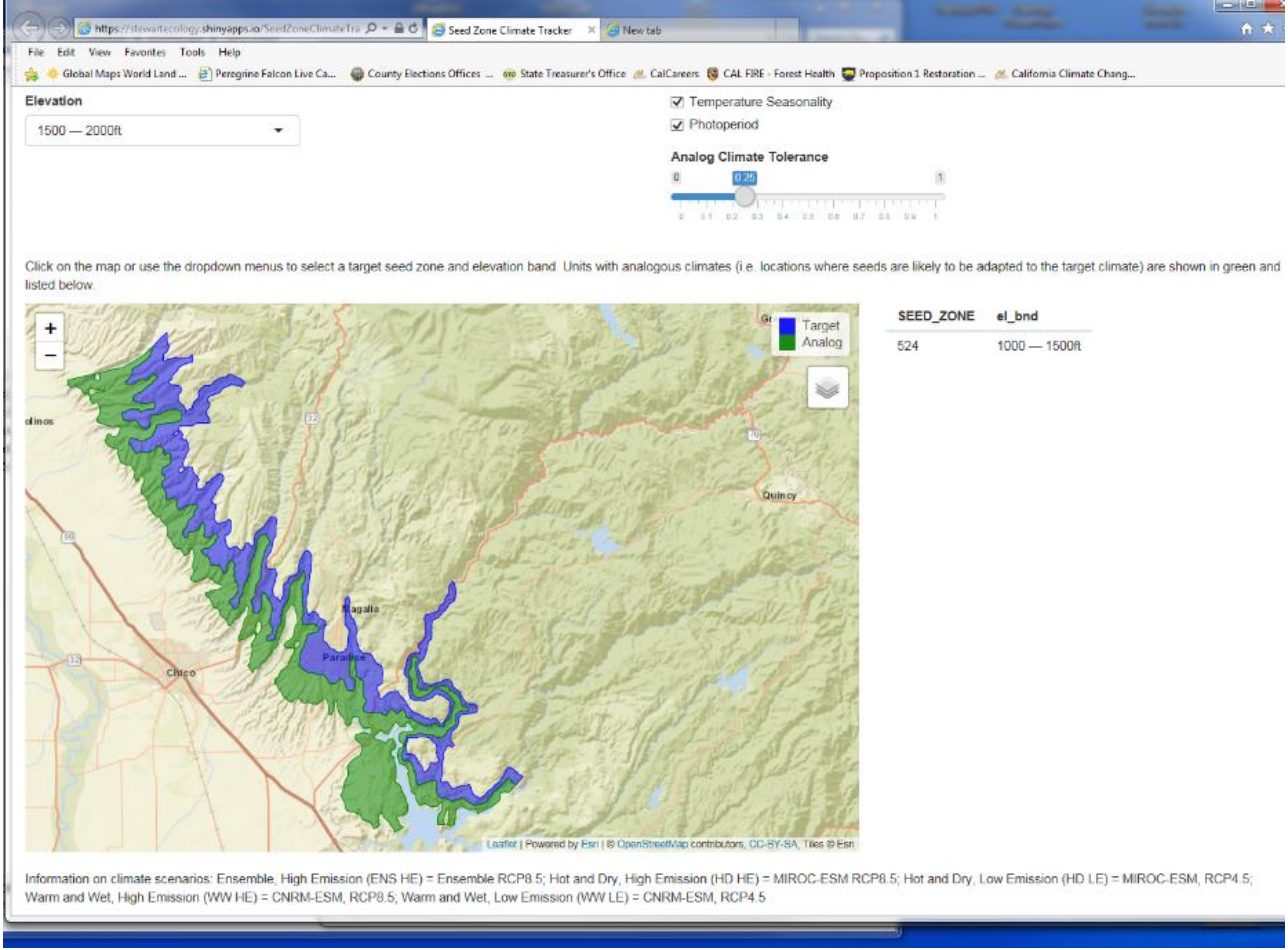
32
33
40
35
31
36
38
37


https://stewartecology.shinyapps.io/SeedZoneClimateTra
Seed Zone Climate Tracker
New tab
File Edit View Favorites Tools Help
Global Maps World Land ...
Peregrine Falcon Live Ca...
County Elections Offices ...
State Treasurer's Office
CalCareers
CAL FIRE - Forest Health
Proposition 1 Restoration ...
California Climate Chang...
+
−
Target
Analog
Quincy
Magalia
Paradise
Chico
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Elevation

1500 — 2000ft

☑ Temperature Seasonality

☑ Photoperiod

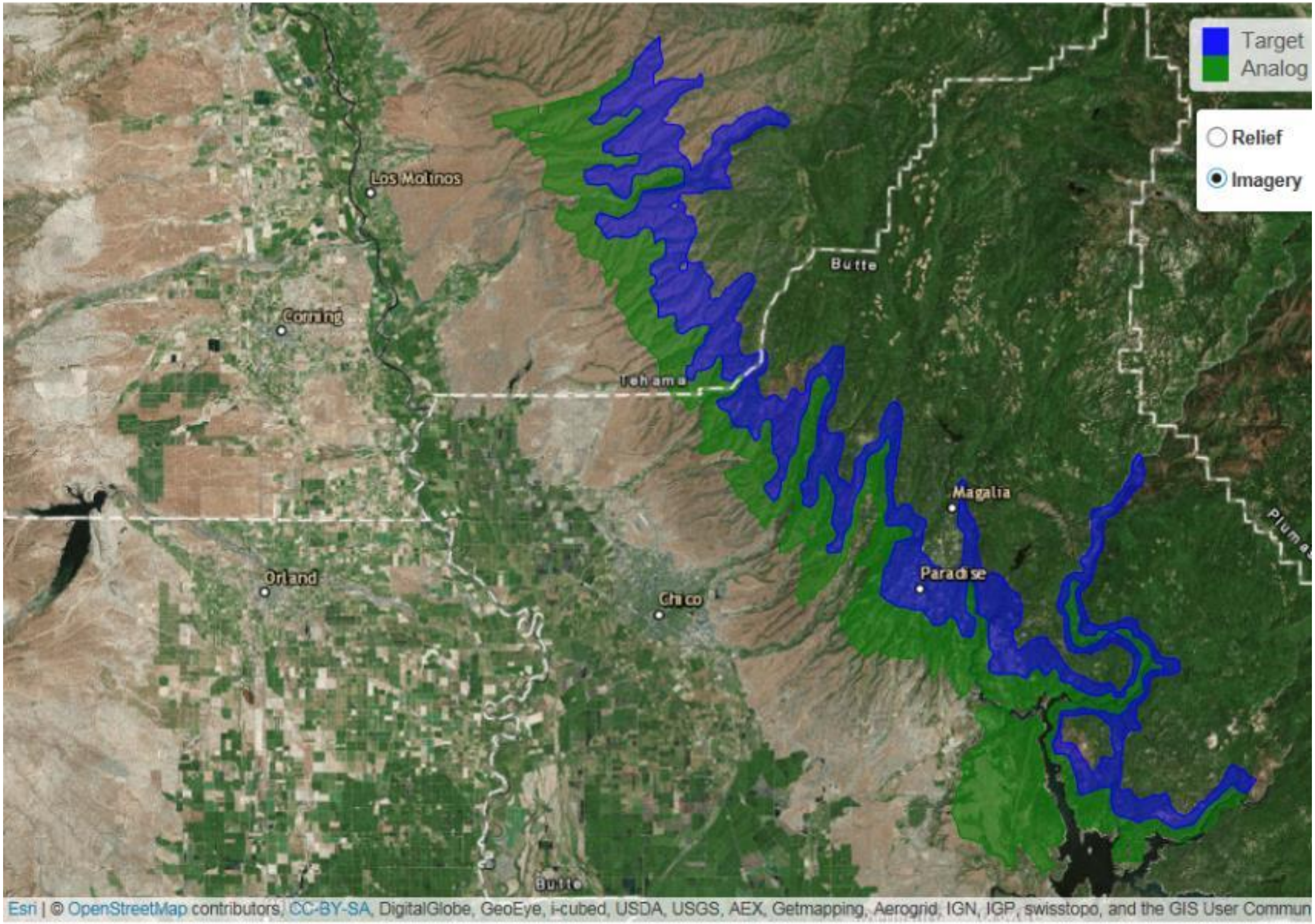
Analog Climate Tolerance

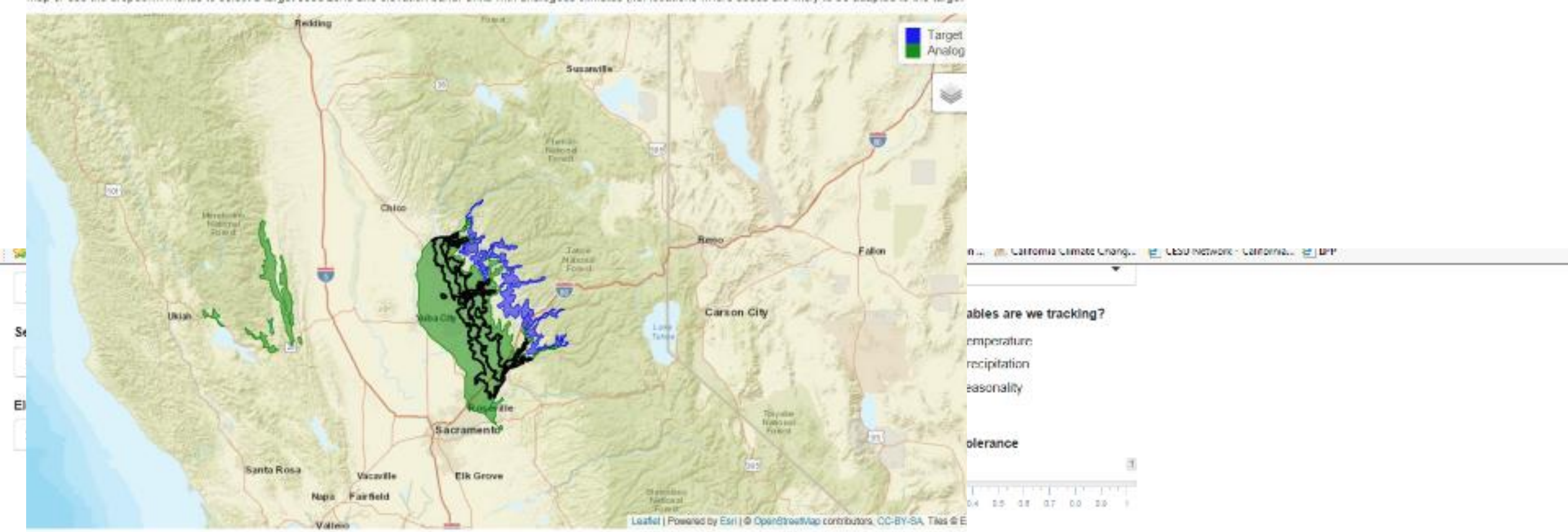
0 0.25 1

Click on the map or use the dropdown menus to select a target seed zone and elevation band. Units with analogous climates (i.e. locations where seeds are likely to be adapted to the target climate) are shown in green and listed below.

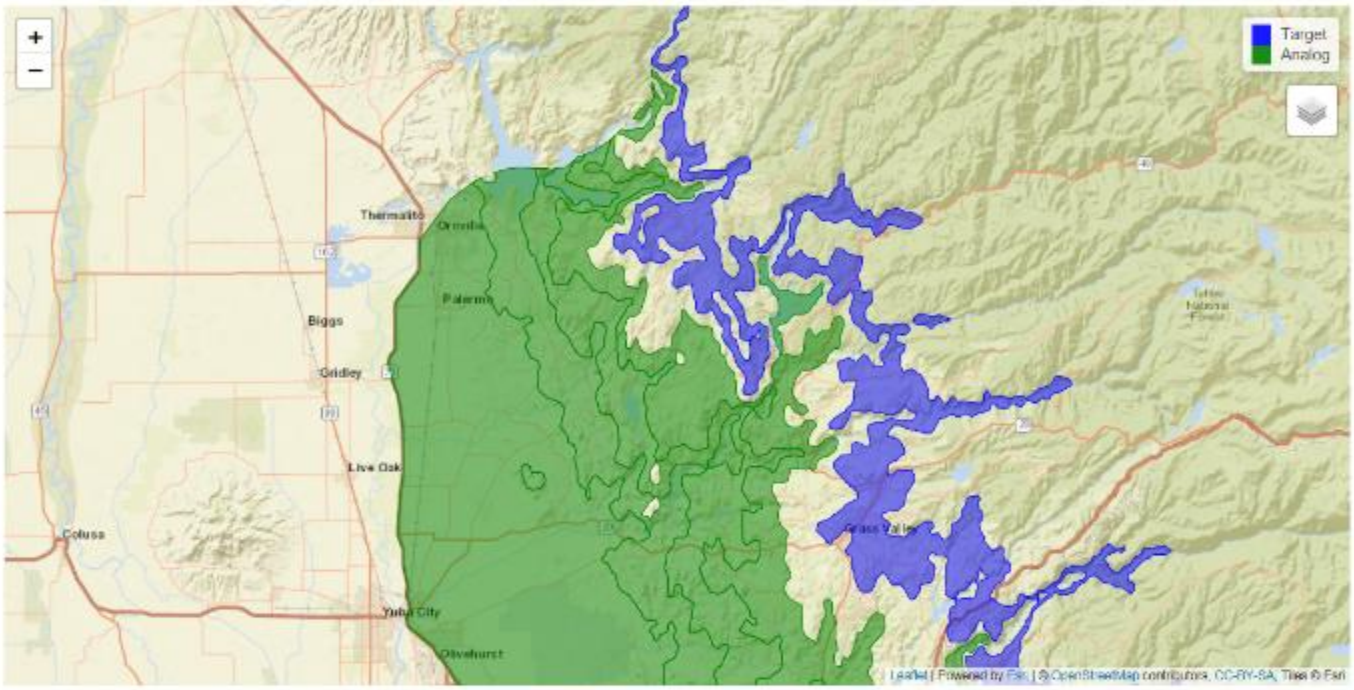
SEED_ZONE	el_bnd
524	1000 — 1500ft

Information on climate scenarios: Ensemble, High Emission (ENS HE) = Ensemble RCP8.5; Hot and Dry, High Emission (HD HE) = MIROC-ESM RCP8.5; Hot and Dry, Low Emission (HD LE) = MIROC-ESM, RCP4.5; Warm and Wet, High Emission (WW HE) = CNRM-ESM, RCP8.5; Warm and Wet, Low Emission (WW LE) = CNRM-ESM, RCP4.5


Target
Analog
○ Relief
● Imagery
Los Molinos
Corning
Butte
Tehama
Magalia
Paradise
Orland
Chico
Plumas
Butte
Esri | © OpenStreetMap contributors, CC-BY-SA, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Commun


Target
Analog
Redding
Susanville
Chico
Reno
Fallon
Carson City
Ukiah
Yuba City
Roseville
Sacramento
Santa Rosa
Vacaville
Elk Grove
Napa
Fairfield
Vallejo
California Climate Chang...
CESU Network - California...
BPP
Se
El
ables are we tracking?
emperature
recipitation
easonality
olerance
0.4
0.5
0.6
0.7
0.8
0.9
1
Leaflet | Powered by Esri | © OpenStreetMap contributors, CC-BY-SA, Tiles © E

Click on the map or use the dropdown menus to select a target seed zone and elevation band. Units with analogous climates (i.e. locations where seeds are likely to be adapted to the target climate) are shown in green and listed below.


+
−
Target
Analog
Thermalito
Oroville
Palermo
Biggs
Gridley
Live Oak
Colusa
Yuba City
Olivehurst
Grass Valley
Tahoe National Forest
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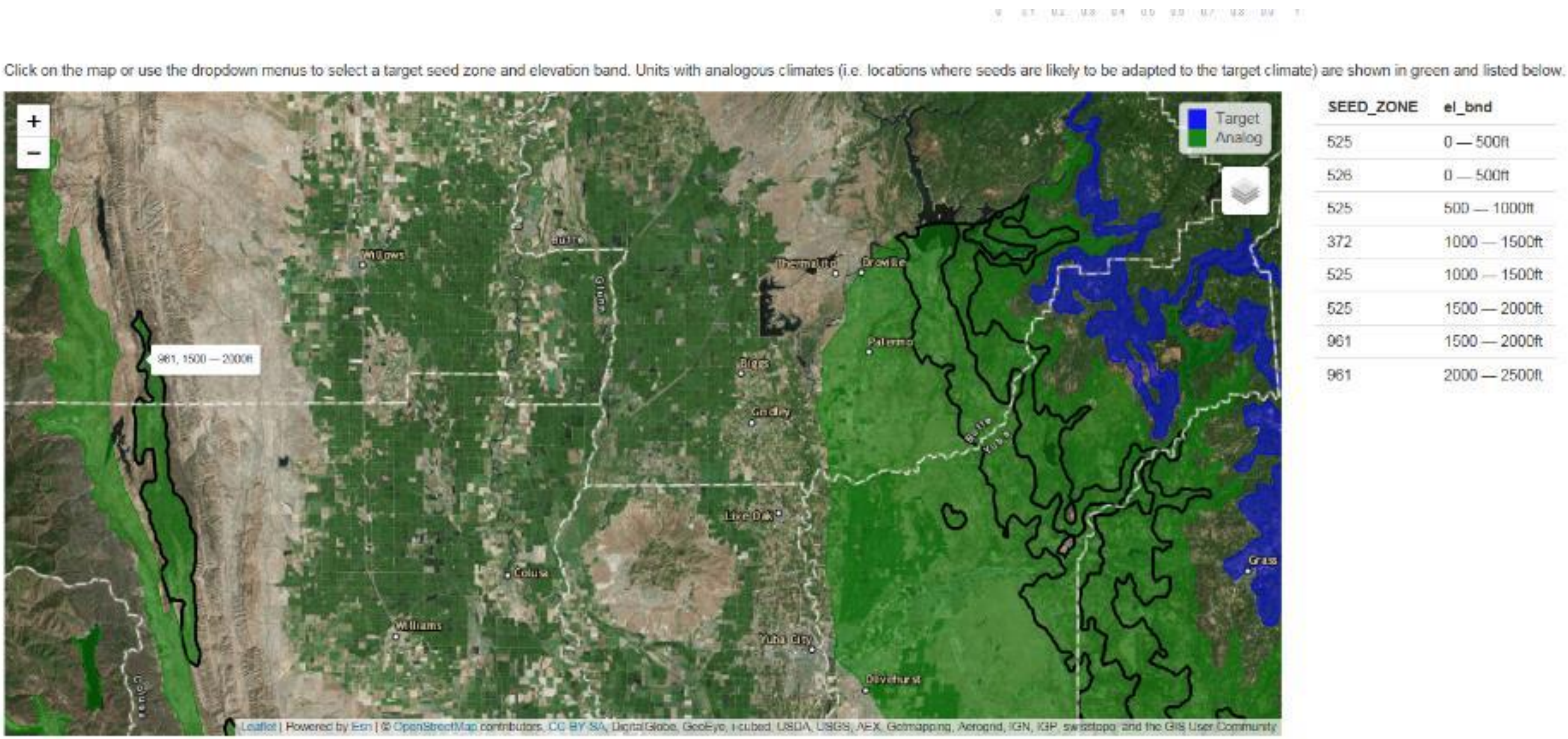
SEED_ZONE	el_bnd
525	0 — 500ft
526	0 — 500ft
525	500 — 1000ft
372	1000 — 1500ft
525	1000 — 1500ft
525	1500 — 2000ft
961	1500 — 2000ft
961	2000 — 2500ft


0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Click on the map or use the dropdown menus to select a target seed zone and elevation band. Units with analogous climates (i.e. locations where seeds are likely to be adapted to the target climate) are shown in green and listed below.

+
−
Target
Analog
Willows
Butte
Glenn
Thermalito
Oroville
Palermo
Biggs
Gridley
Butte
Yuba
Live Oak
Colusa
Williams
Yuba City
Olivehurst
Grass
Colusa
961, 1500 — 2000ft

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SEED_ZONE	el_bnd
525	0 — 500ft
526	0 — 500ft
525	500 — 1000ft
372	1000 — 1500ft
525	1000 — 1500ft
525	1500 — 2000ft
961	1500 — 2000ft
961	2000 — 2500ft

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**	