Forest Health Research Program Grantee Webinar:

Linking risk of climate change and wildfire to tree nursery inventories to guide cone crop surveys

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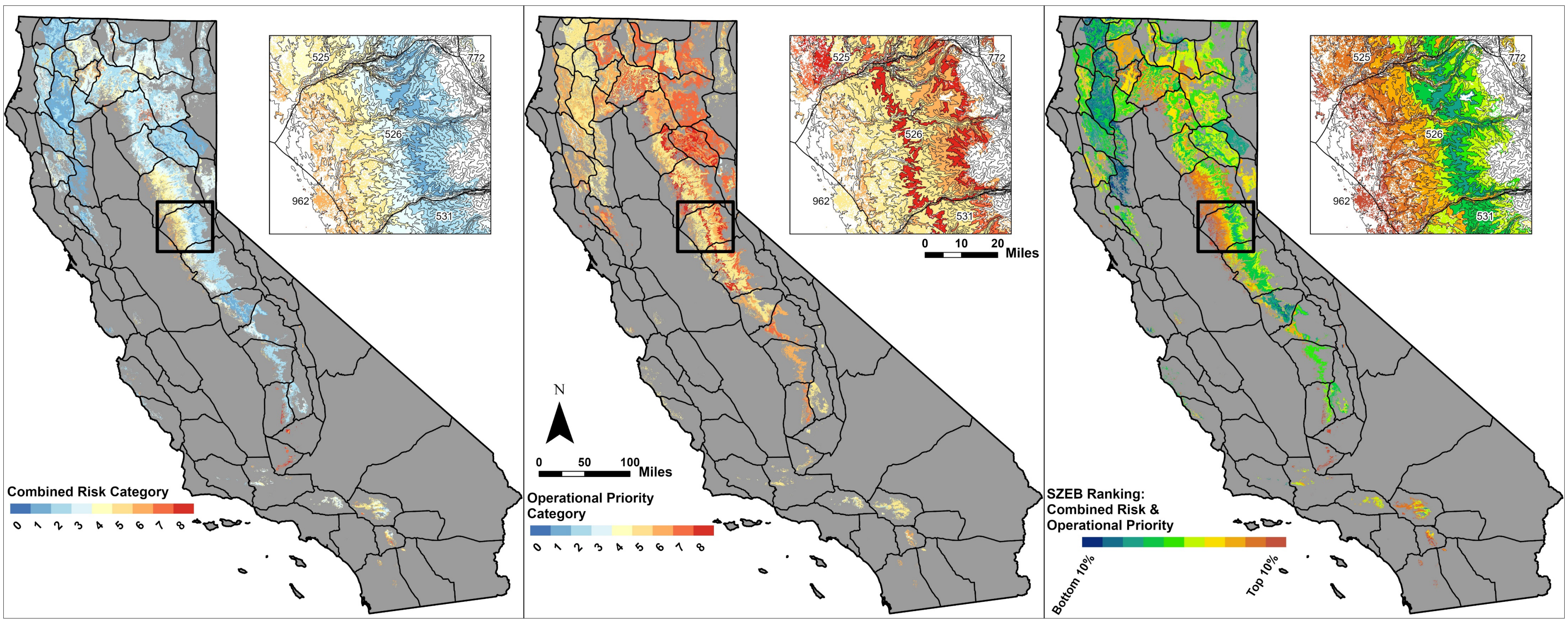
March 21, 2024



Alt title: A triage map for finding at-risk ponderosa pine cones

Thanks to collaborators

Jessie Godfrey, Kristen Shapiro, Ryan Boynton, Clancy McConnel, Cami Pawlak, Matt Ritter, Denia Troxell, Jimi Scheid, Marisol Villarreal, Kuldeep Singh, Steve Ostoja, Chelsea Andreozzi, Emily Moran, Joe Stewart, Jessica Wright, Stewart McMorrow

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With contributing funds from the LA Moran Reforestation Center and UCOP's applied climate science initiative

Background

Main intent: support strategic cone collection operations.

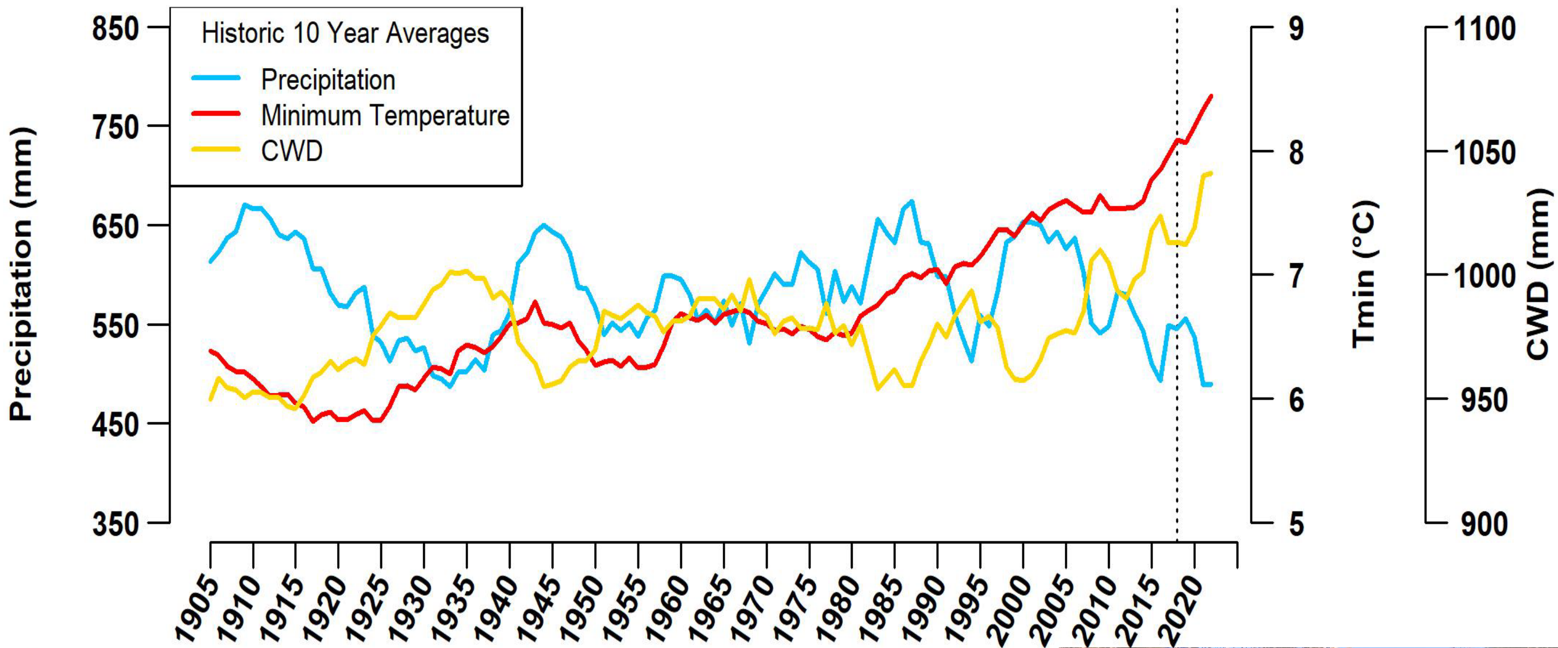
This study compliments a LAMRC-UCD project that digitized the seed lot inventory & explores analog climate applications for reforestation with development of the Climate Adaptive Seed (Lot) Tool (CAST).

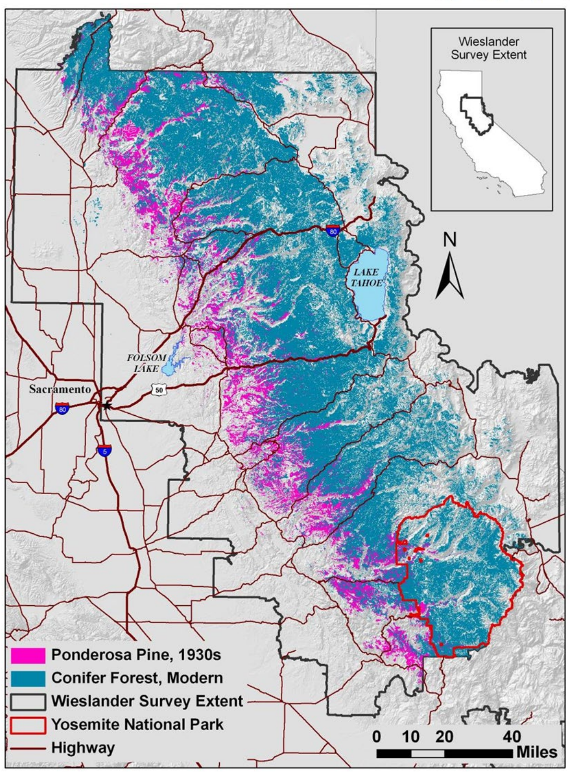
We developed a method for ranking high-risk seed zone/elevation bands by species to better inform cone crop scouting.

This work contributes to integration of 3 projects with recently funded research by Dr. Emily Moran, UC Merced. That project will incorporate her modeling of mast years with this risk assessment approach and the CAST tool.

Presentation Outline

1. Why a Triage Assessment?
2. **Developing species range maps** for 5 conifer species
3. **Environmental Risks**
    a. Climate Exposure and Classifying Risk to each SZEB
    b. Fire Intensity Risk and High Intensity Fire Risk to each SZEB
    c. Combining Climate and Fire Intensity Risk for each SZEB
4. Assessing **Operational Priorities** of each SZEB
    a. Current Landowner Seed Demand
    b. LAMRC-generated Projected Seed Demand
    c. Current Supply (as of 2020)
5. **Final SZEB Ranking** for scouting





Triage

"a preliminary assessment of (patients or casualties) in order to determine the urgency of their need for treatment and the nature of treatment required" *Oxford dictionary*

1. Cone Survey *(June – July)*

CAL FIRE Foresters identify areas where conifer cone crops are present in a large stand of trees. They report that information to CAL FIRE's LAMRC staff for follow-up.

2. Cone Sampling and Cone Collection *(August – September)*

Cones and seeds from potential cone crops identified from surveys are sampled to test for seed quality prior to collection. If cones and seeds meet LAMRC standards, a cone collection will occur. Once collected, conifer crops are delivered to LAMRC for processing.

3. Cone Processing and Seed Extraction *(October – February)*

Seed processing begins by drying out the cone crop and breaking apart the cones with a large tumbler to extract the seed. The seeds are then separated from other debris and lab tested to obtain important information necessary for successful sowing before being placed into cold storage, also known as the Seed Bank.

4. Seed Storage

Once seeds are tested, they are packaged, labeled, and placed in the Seed Bank, a 0°F freezer used for long-term storage.

5. Seedling and Seed Orders

Landowners reach out to the Reforestation Center to place a seedling or seed order. LAMRC staff identify the appropriate seed lots matching the landowner's planting site to ensure seedlings will be well-adapted for growing in that location.

6. Seedling Stratification *(November – January)*

After seeds are weighed out, they are soaked in water for 1 – 2 days and placed in 35°F cold storage to begin the stratification process. Stratification breaks the seed's dormancy and simulates conditions the seeds experience in nature.

7. Sowing *(February – May)*

After the seeds stratify for 7 – 16 weeks, it is time to begin sowing. LAMRC staff prepare soil mixtures and sow the seeds in Styrofoam containers. Once the containers are labeled, they are placed in a greenhouse, where they will grow for the next 6 – 8 months.

8. Growing *(March – November)*

Once the seeds have sprouted, they are moved to a covered outdoor growing area called a shade house. It takes 6 – 8 months for the seedlings to grow to the ideal height of 10". During that time, seedlings are watered, fertilized, monitored for pests and diseases, and trimmed as necessary.

9. Lifting *(December)*

Once the proper size is reached, seedlings are lifted out of the Styrofoam containers, graded for quality, and packed into boxes. The seedlings are placed in cold storage for 1 – 3 months until they are picked up by the landowners who ordered them.

10. Planting *(Winter – Spring)*

When landowners receive their seedlings, they are planted in the field, usually in areas affected by a wildfire. However, some customers plant conifer seedlings for other purposes such as pest control, wind breaks, and landscaping. Who knows, maybe these seedlings will become a seed source one day!

CAL FIRE

www.fire.ca.gov

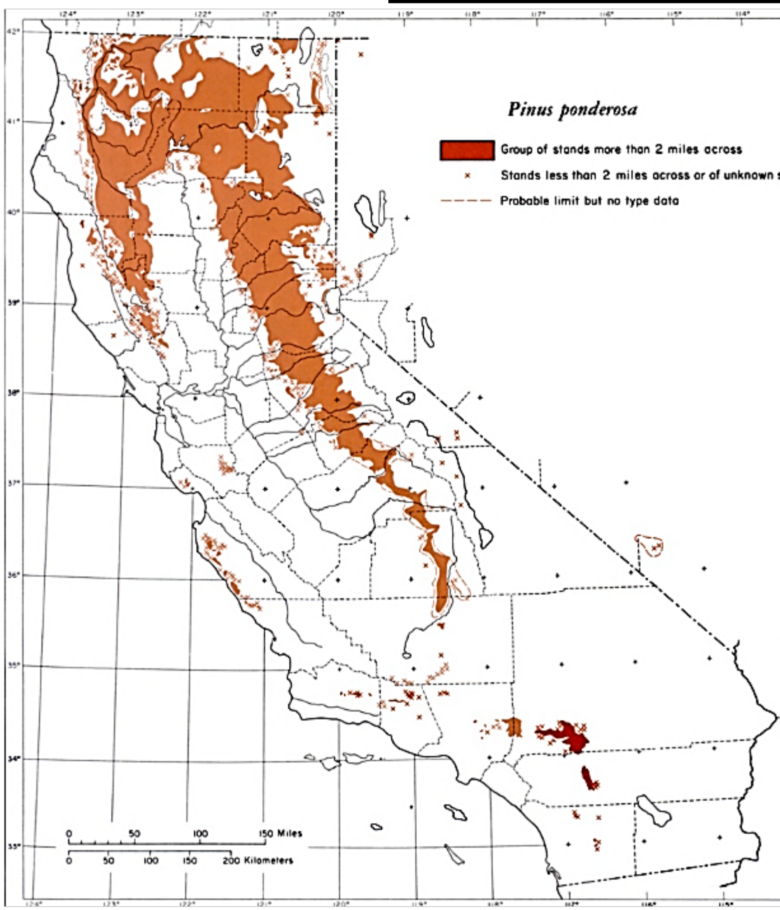
Developing species range maps
5 conifer species
Pinus ponderosa example

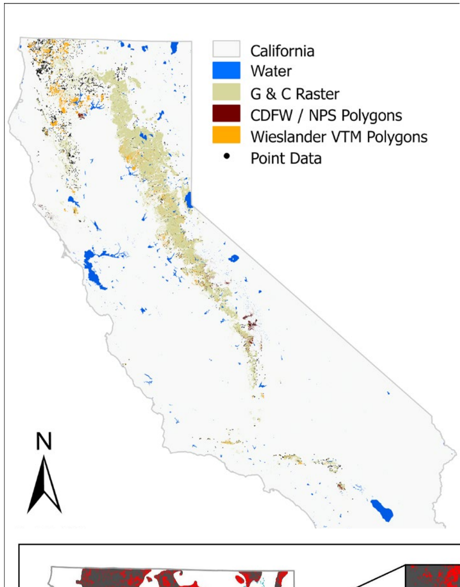
1. **Digitize the range** described by Griffin & Critchfield (G&C, 1972)

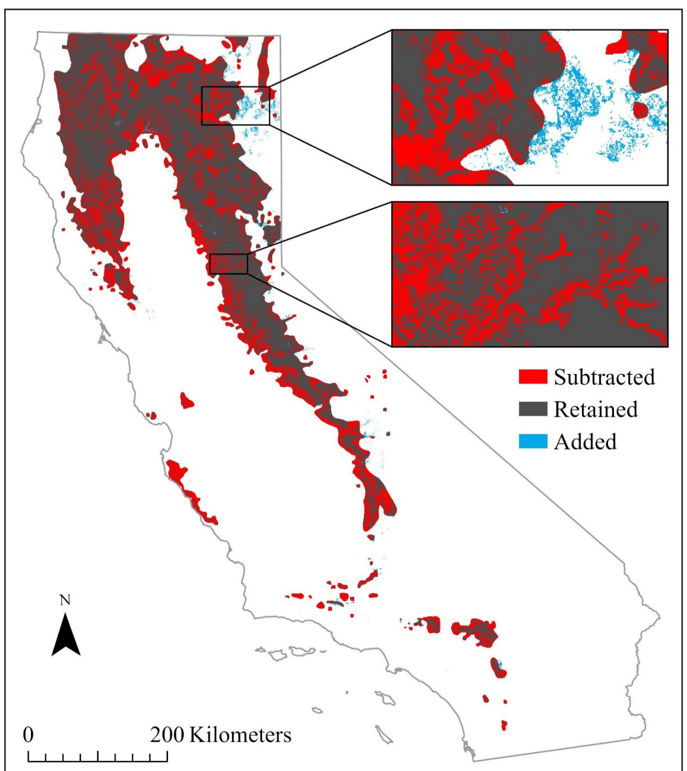
2. **Reduce the G&C extent**
   - -by elevation limits in the California Jepson Manual
   - - by any tree or shrub WHR type that does not include the species as a primary or typical species in its type description

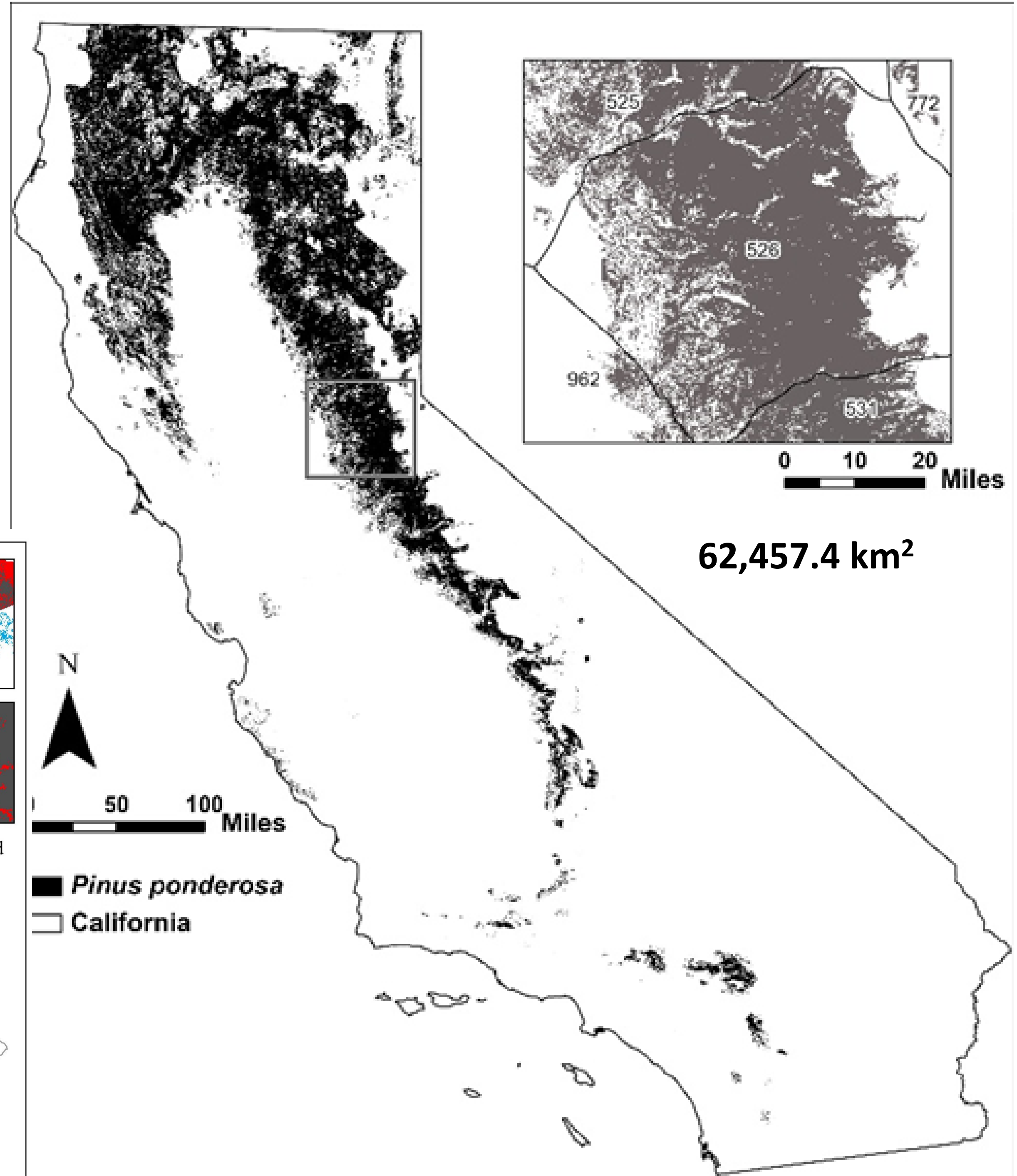
3. **Add areas extracted from**
   - -veg maps from CDFW or NPS
   - -polygons digitized from the original 1940s Wieslander vegetation type map (VTM) surveys
   - -available point data
     Jepson Herbarium
     >30 vegetation plot surveys

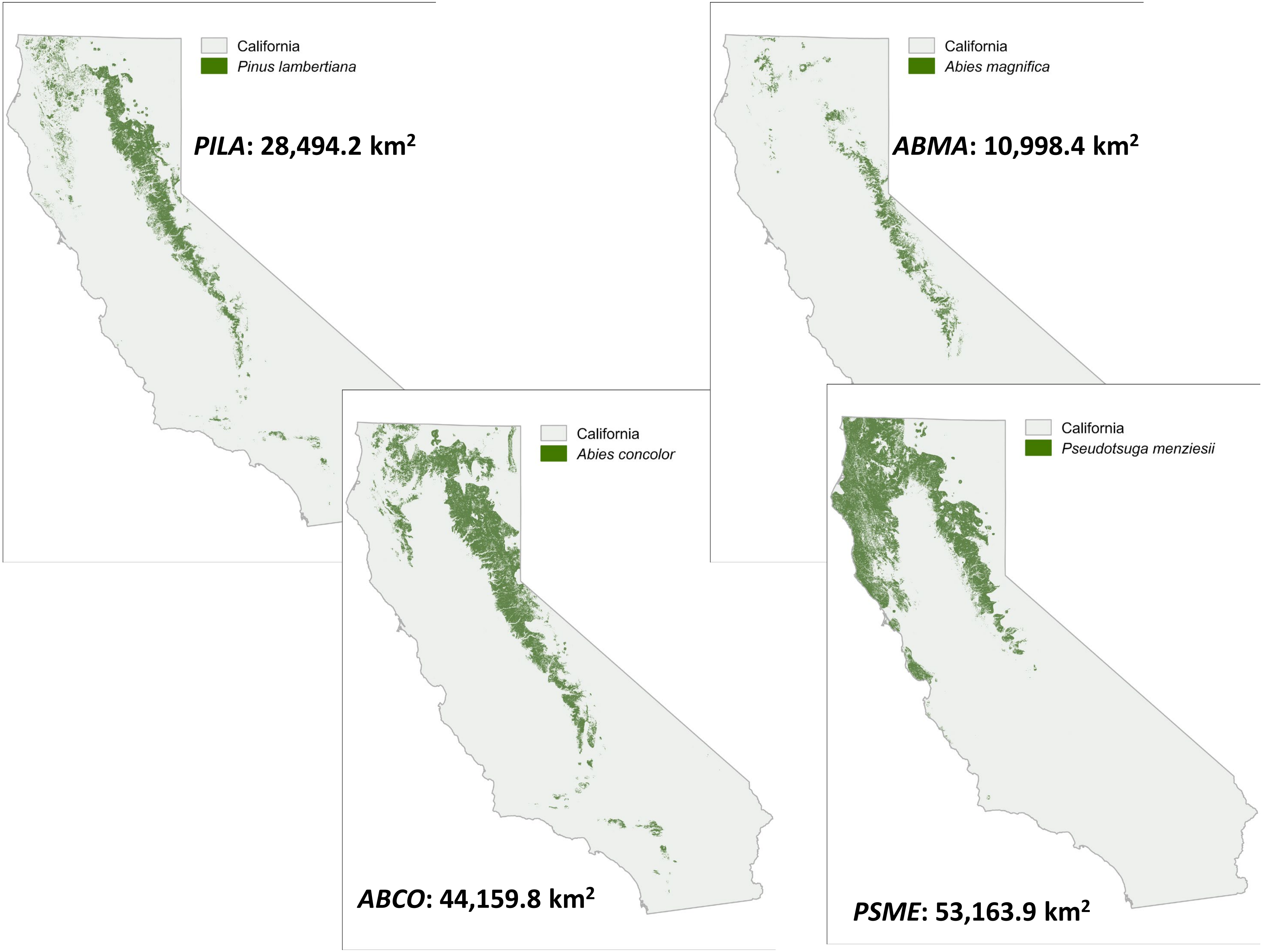
4. **Reduce by**
   - Water bodies (USGS)
   - WHR types e.g. Urban




California
Water
G & C Raster
CDFW / NPS Polygons
Wieslander VTM Polygons
Point Data
N


Subtracted
Retained
Added
N
0
200 Kilometers


525
772
526
962
531
0
10
20
Miles
62,457.4 km²
N
50
100
Miles
Pinus ponderosa
California


California
Pinus lambertiana
PILA: 28,494.2 km²
California
Abies magnifica
ABMA: 10,998.4 km²
California
Abies concolor
ABCO: 44,159.8 km²
California
Pseudotsuga menziesii
PSME: 53,163.9 km²

Environmental Risks

Workflow estimating climate exposure across a species' range

1. **Run a climate exposure analysis (R)**

    a. **characterize the climate space of each PIPO grid cell** with inputs from the USGS's Basin Characterization Model (BCM) for

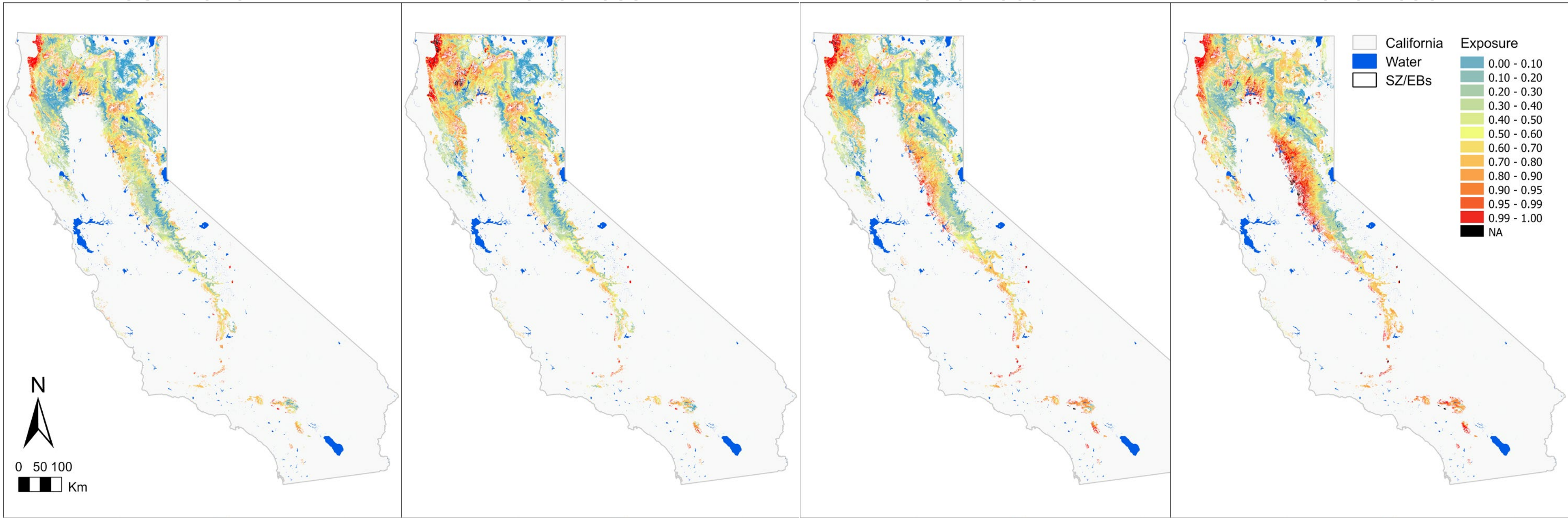
    -one measured/ historic time period (1981-2010)

    -three projected/ future time periods (2010-2039, 2040-2069, 2070-2099)

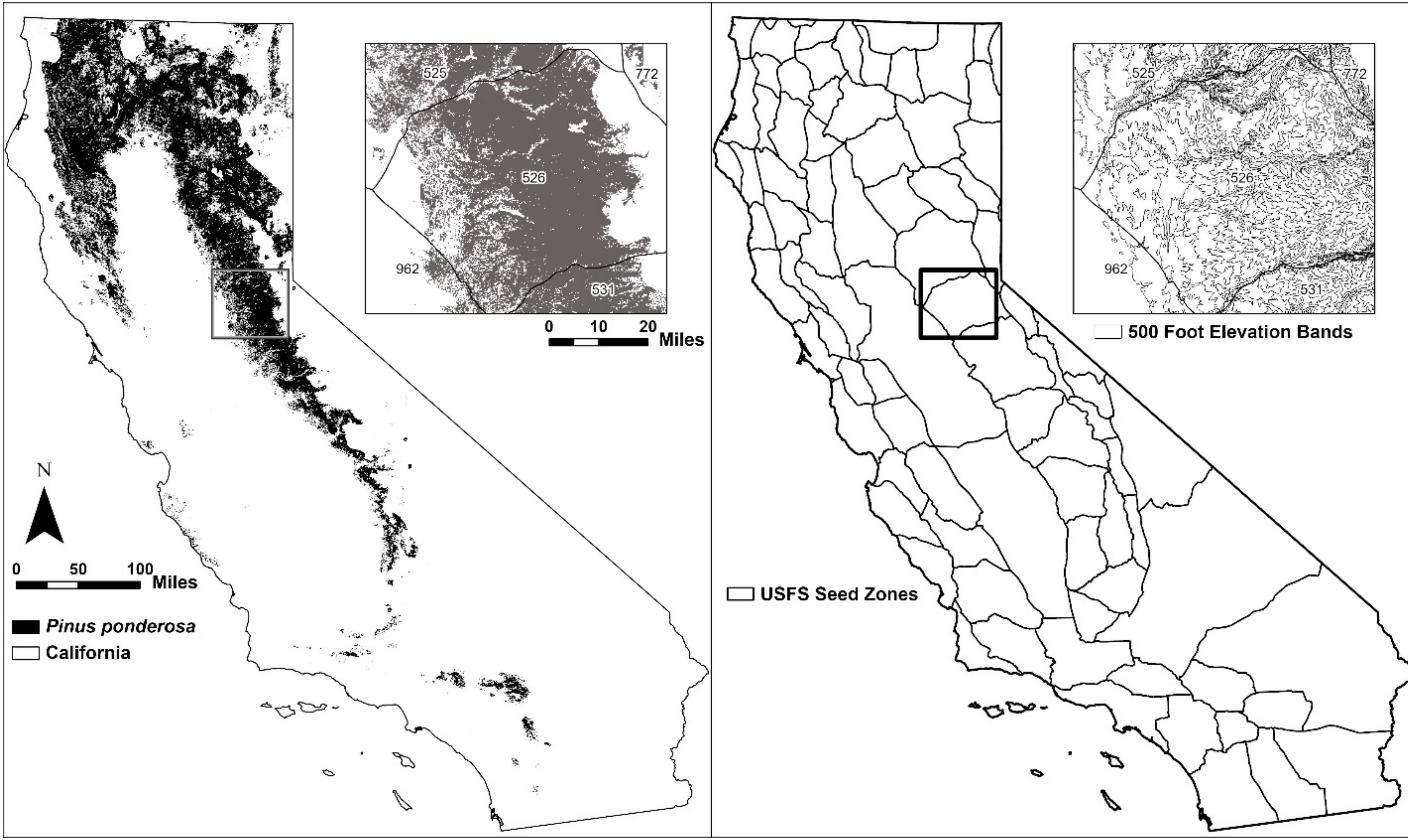
    *For future time periods, at least one global climate model and one emissions scenario is also required; we used the MIROC 5 global climate model (hot and dry with a mid-century drought) and business as usual high emissions scenario Relative Concentration Pathway (RCP) 8.5. (Thorne et al. 2015; 2020)

    b. **rank each cell that falls within PIPO range** by the frequency of the climate conditions it occupies in the measured/ historic time period (1981-2010) across that range

1981-2010 | 2010-2039 | 2040-2069 | 2070-2099



Accounting units will be SZEBs



740 SZEBs intersect with Pipo range

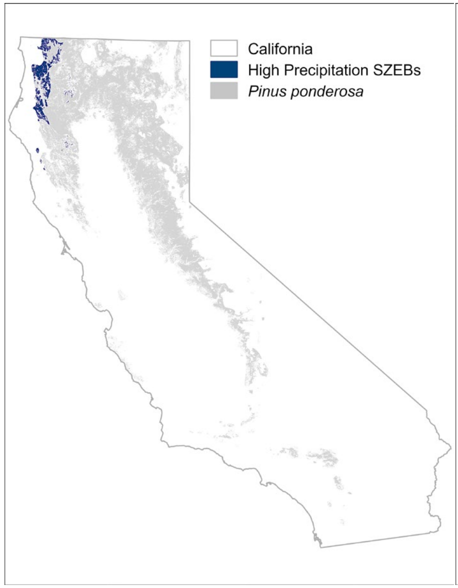
Identifying SZEBs limited to Low Climate Exposure Risk Category –

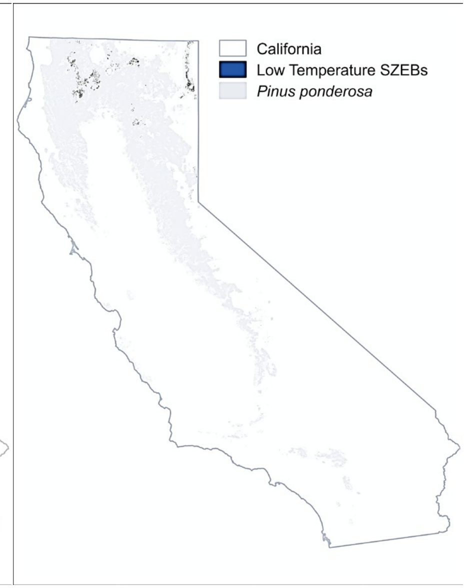
Limiting selection to the hot dry end of the range

1. **Group SZEBs on the the wet and/or cold end of the range's distribution** if

- **10% wettest** (Pipo SZEBs with the highest mean 1981-2010 mean annual precipitation) or

- **10% coldest** (Pipo SZEBs with the lowest mean 1981-2010 mean maximum annual temperature)

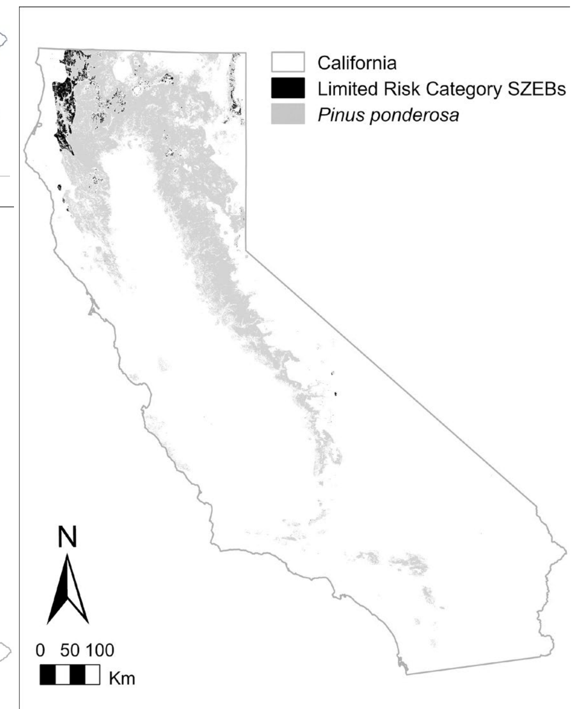




3. If a **SZEB** met these conditions

It was **limited to the lowest climate risk category** regardless of exposure

*184/740 Pipo SZEBs were limited in this way

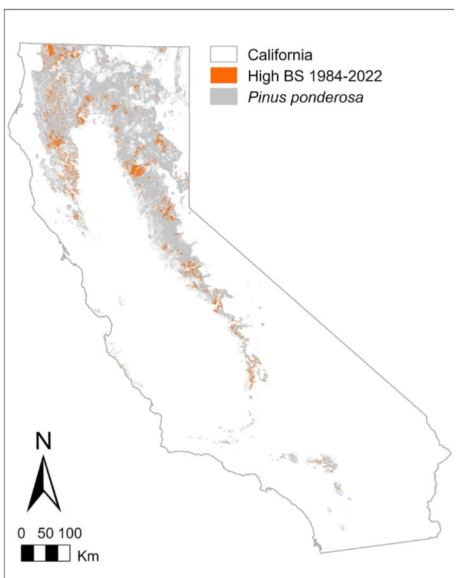


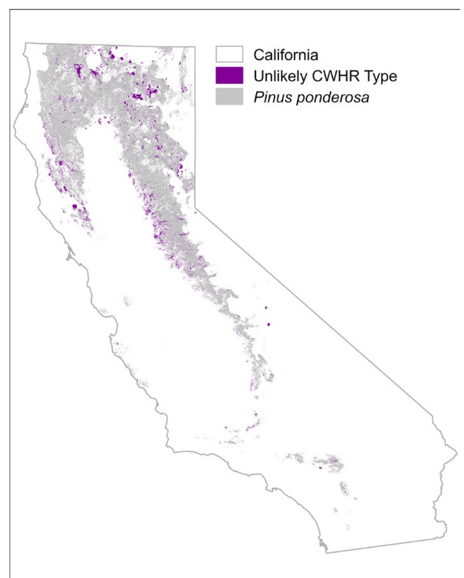
2a. **Identify areas unlikely to currently contain reproductive stands of the species** due to

CWHR type = urban, pasture, cropland

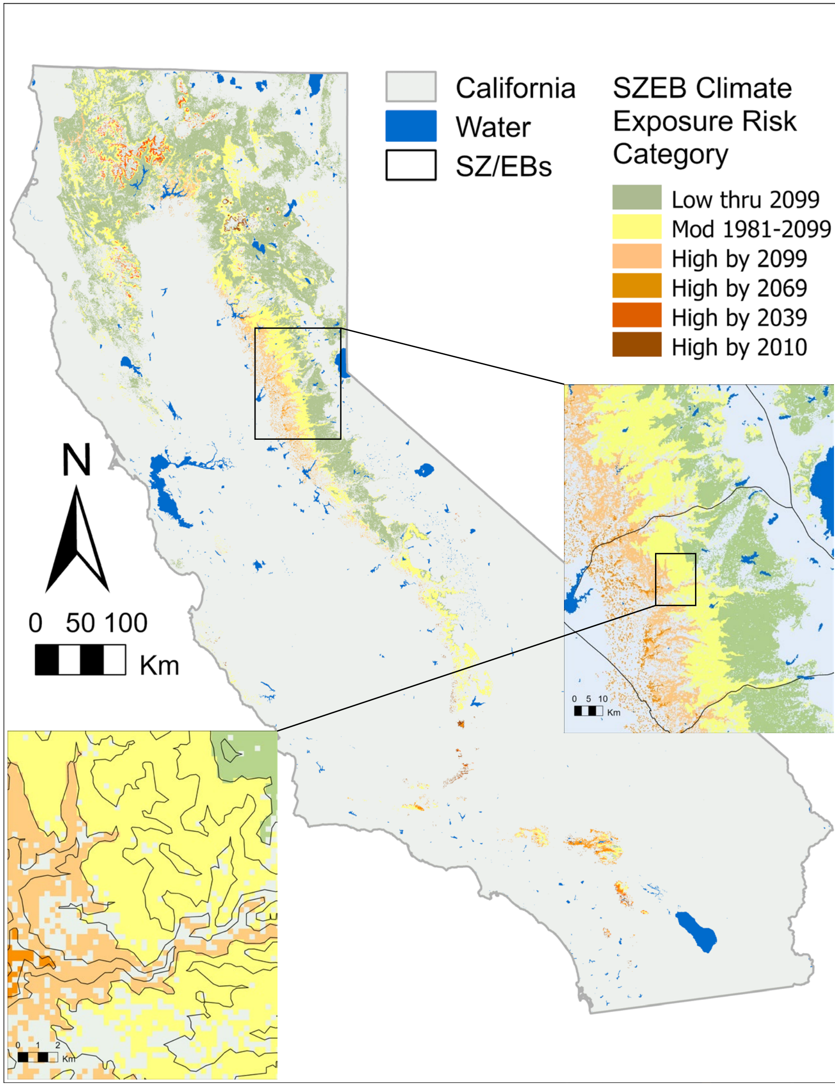
High Severity Burns

2b. **Tabulate remaining PIPO area per SZEB and identify SZEBs now with < 2 cells**





Workflow for Climate Exposure Risk Categories – Risk by Pipo range x SZEB x time period



1. Calculate mean climate exposure value of each SZEB for each of the four time periods (1981-2010, 2010-2039, 2040-2069, 2070-2099)

* Non-analog (NA) cells are assigned a value of 1.01 before the mean is calculated

2. Assign SZEBs identified as cold/wet/low PIPO extent into the "Low thru 2099" climate exposure risk category

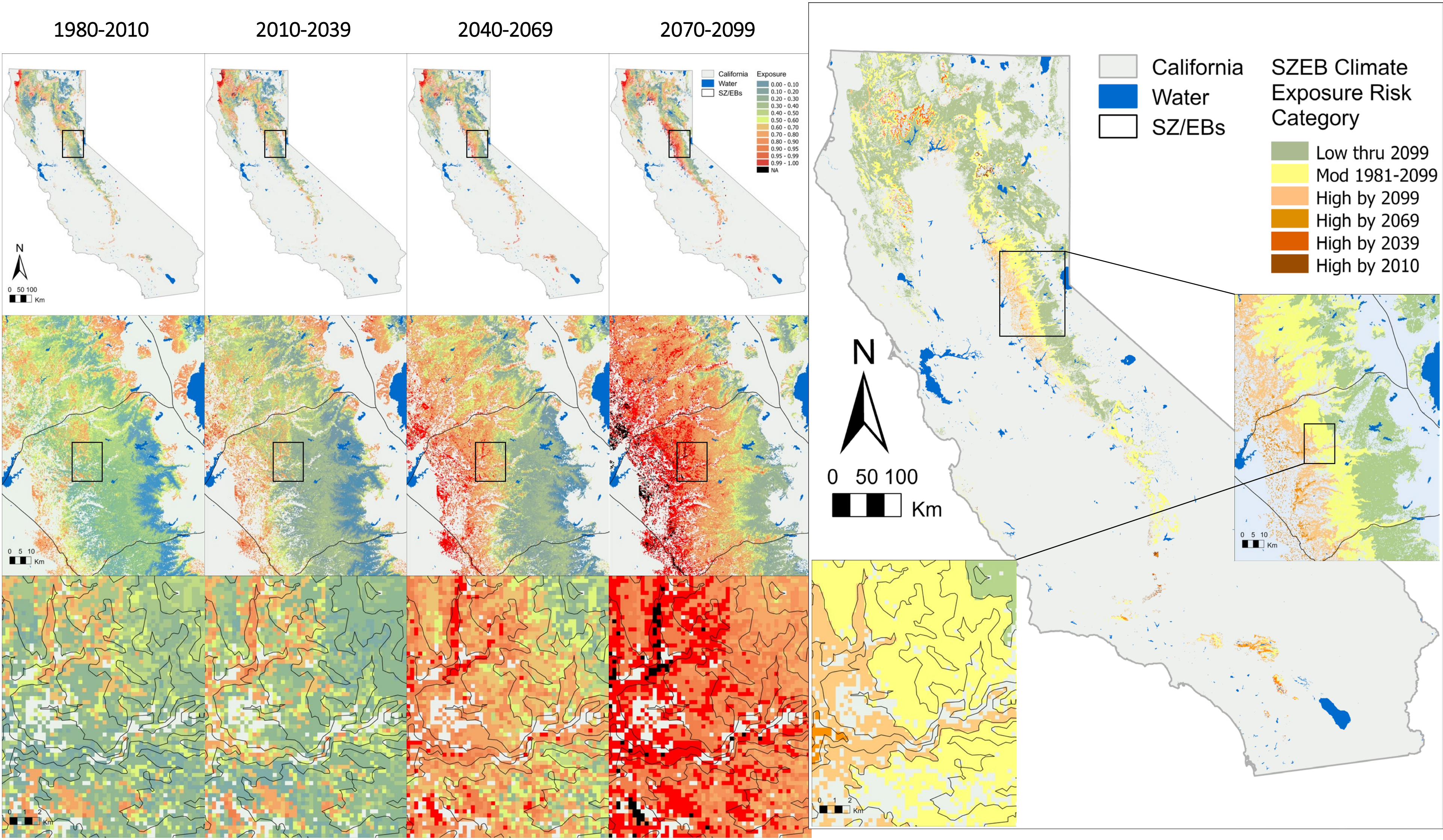
3. For the remaining SZEBs (556), assign climate exposure risk categories in the following order:

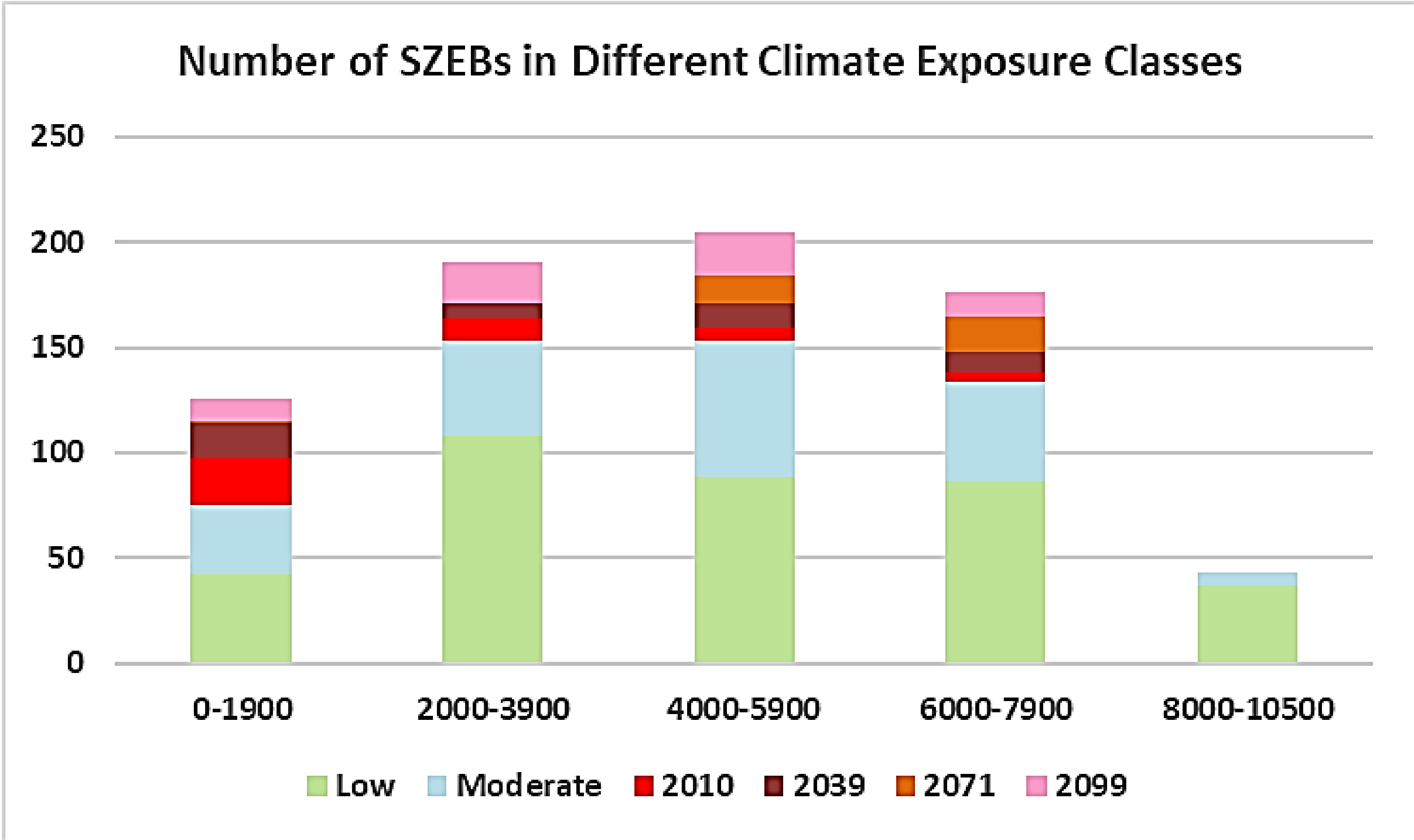
- **-1981-2010 SZEB mean ≥ 0.95 → "High by 2010" (5)**
- **-No category yet assigned + 2010-2039 SZEB mean ≥ 0.95 → "High by 2039" (4)**
- **-No category yet assigned + 2040-2069 SZEB mean ≥ 0.95 → "High by 2069" (3)**
- **-No category yet assigned + 2070-2099 SZEB mean ≥ 0.95 → "High by 2099" (2)**
- **-No category yet assigned + any period SZEB mean ≥ 0.80 → "Mod 1981-2099" (1)**
- **-No category yet assigned → "Low thru 2099" (0)**

The number that follows category labels in parentheses will be used to assign a combined climate exposure and high fire intensity risk category later

4. Climate exposure per SZEB is taken for all PIPO cells, but display removes any recent high-severity burns, unsuitable WHR types and low-area SZEBs

Pinus ponderosa





Of 126 SZEBs in PIPO's 0-2000' elevation, 22 are at high climate risk in the baseline time period with 17 more either projected (or have become since 2010) to be in high climate stress conditions by 2040, and totaling 51 (40.5%) by 2100.

The remainder stay in low or moderate projected climate stress. There is a in the 2000-4000', 4000-6000', and 6000-8000' elevations, with 19.4, 25.4, and 23.9% of their respective SZEBs showing high climate stress by 2100.

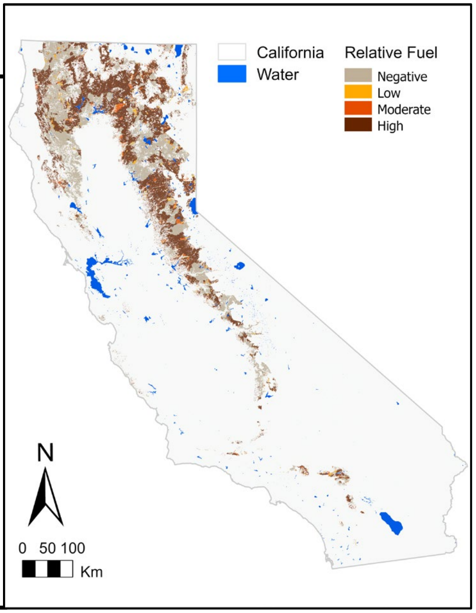
The upslope climate stress progression is seen, these elevations show a higher proportion of SZEBs entering high climate stress by end-century, relative to the number currently in high exposure.

SZEBs Limited to Low Fire Intensity Risk Category

1. **Generate a raster index for high intensity fire risk in 2023 fire year** based on
   - **the Fire Return Interval Departure (FRID)** raster data's mean reference fire return interval
   - the FRID's years since last fire (YSLF) field updated through 2021 combined with 2022 burn perimeters from Rapid Assessment of Vegetation Conditional After Wildfire (RAVG) dataset to update through the 2022 fire season
   - the formula **1-(meanRefFRI/YSLF)**

***Resulting negative values indicate that a cell has burned within the range of its meanRefFRI while the higher the positive value, the longer its been since the last fire relative to the meanRefFRI (i.e. the higher the relative fuel load and so the higher the risk of high intensity fire)**

- Low = 0 to 0.33, or 0 to 1.5 x the meanRefFRI
- Moderate = 0.33 to 0.67, or 1.5 to 3 x the meanRefFRI
- High = 0.67-0.904 (max observed), or 3 to ~10 x the meanRefFRI

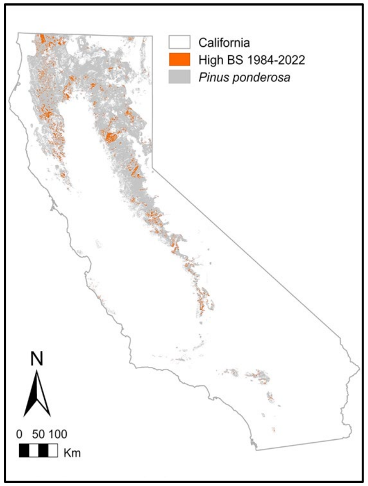


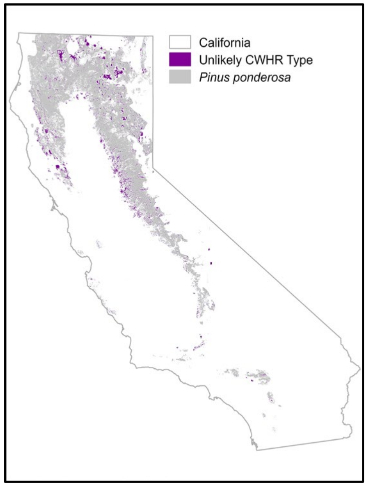
2a. **Identify areas unlikely to currently contain reproductive PIPO stands** due to
- **CWHR type** (e.g. urban, pasture, cropland)
- **High Severity Burns**

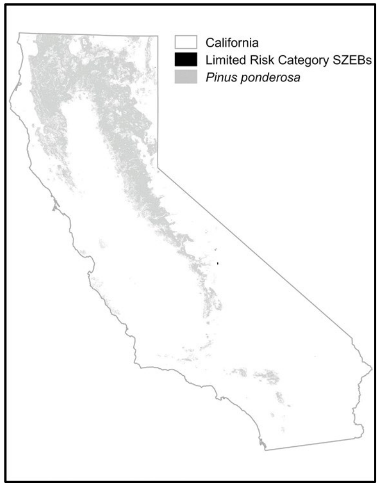
2b. **Tabulate the remaining species area within each SZEB and identify SZEBs now with < 2 cells**

2c. If a SZEB had **< 2 cells** after CWHR types or high severity burn areas are removed, this SZEB was **limited to the lowest fire intensity risk category** regardless of relative fuel

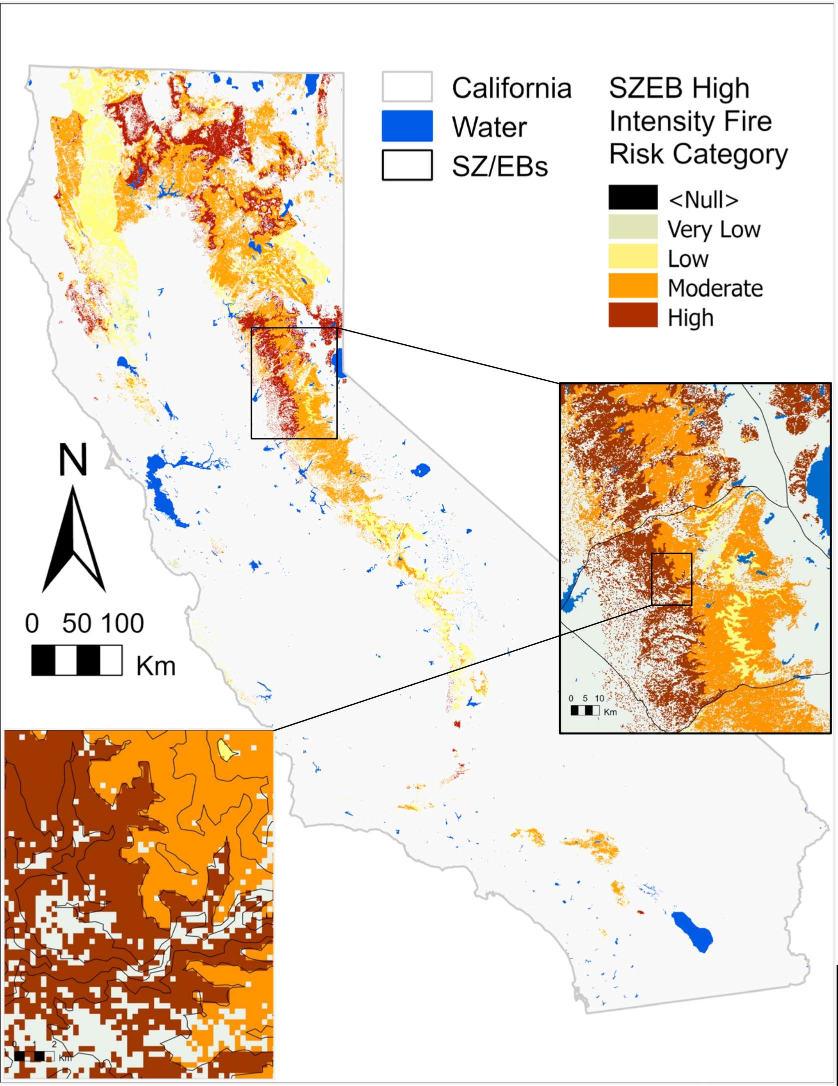
*Before area reductions, 47/74 Pipo SZEBs had 1 cell; after, 74/740 had 0-1 cells and were limited in this way







Assigning High Burn Intensity Risk Categories



1. **Calculate the mean relative fuel load heading into the 2023 fire year**

* Cells with a negative value are reclassified as "0" before the mean is calculated

2. **Assign any SZEBs identified on the last slide** (low area) **into the "Very Low" high intensity fire risk category**, regardless of their mean relative fuel load values

3. Because the underlying fire return interval departure (FRID) dataset does not assign a mean reference fire return interval value to every grid cell in California, **some very small SZEBs may have a <Null> mean value**

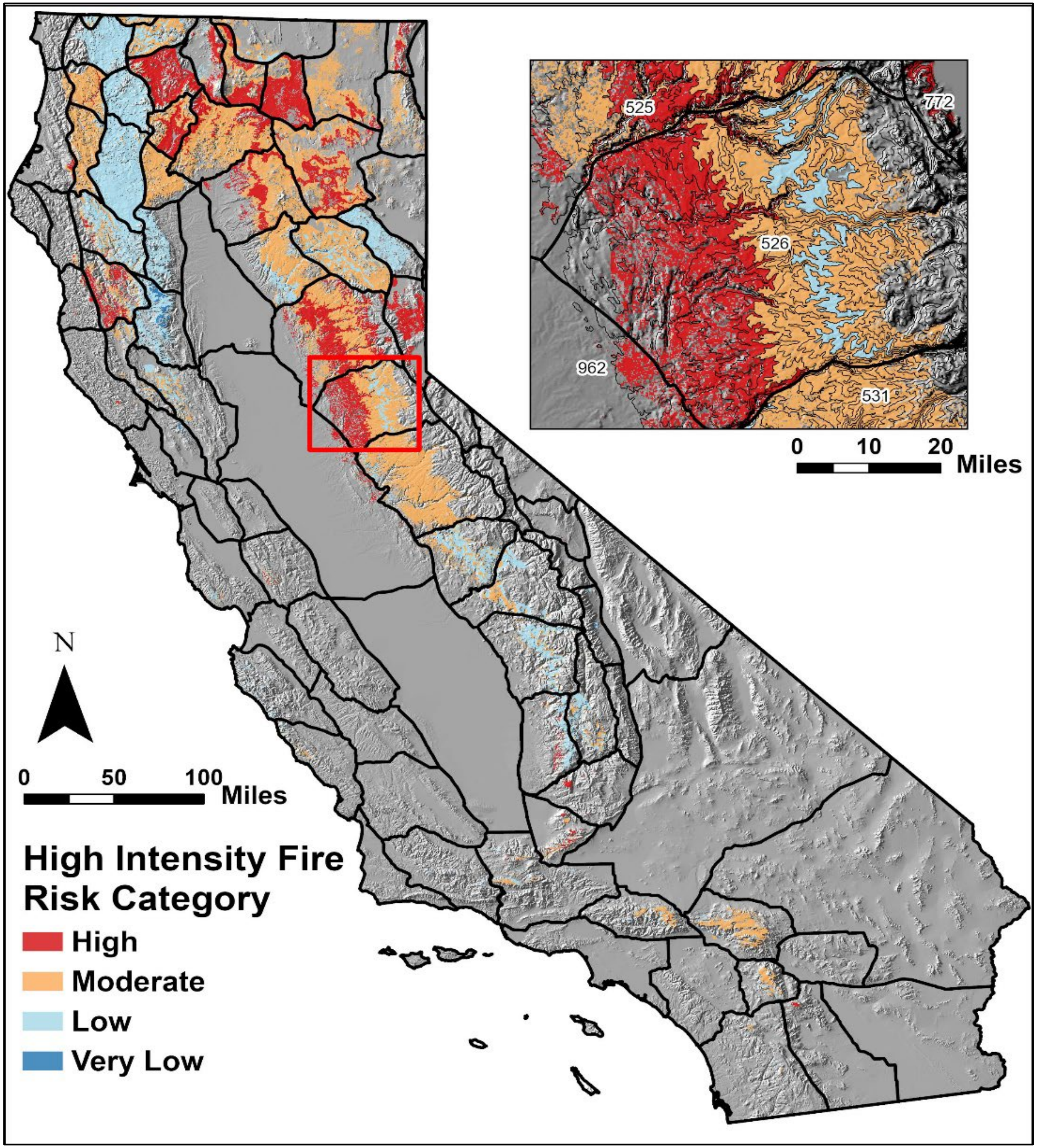
*28/740 *P. ponderosa* SZEBs were assigned a "Null" value, but only 1/740 had not already been assigned into the "Very Low" high intensity fire risk category due to low area

4. **For the remaining SZEBs** (555 for *P. ponderosa*), **assign high intensity fire risk categories as follows**

- **-SZEB mean > 0.67 → "High" (3)**
- **-0.67 ≥ SZEB mean > 0.33 → "Moderate" (2)**
- **-0.33 ≥ SZEB mean > 0 → "Low" (1)**
- **-SZEB mean = 0 → "Very Low" (0)**

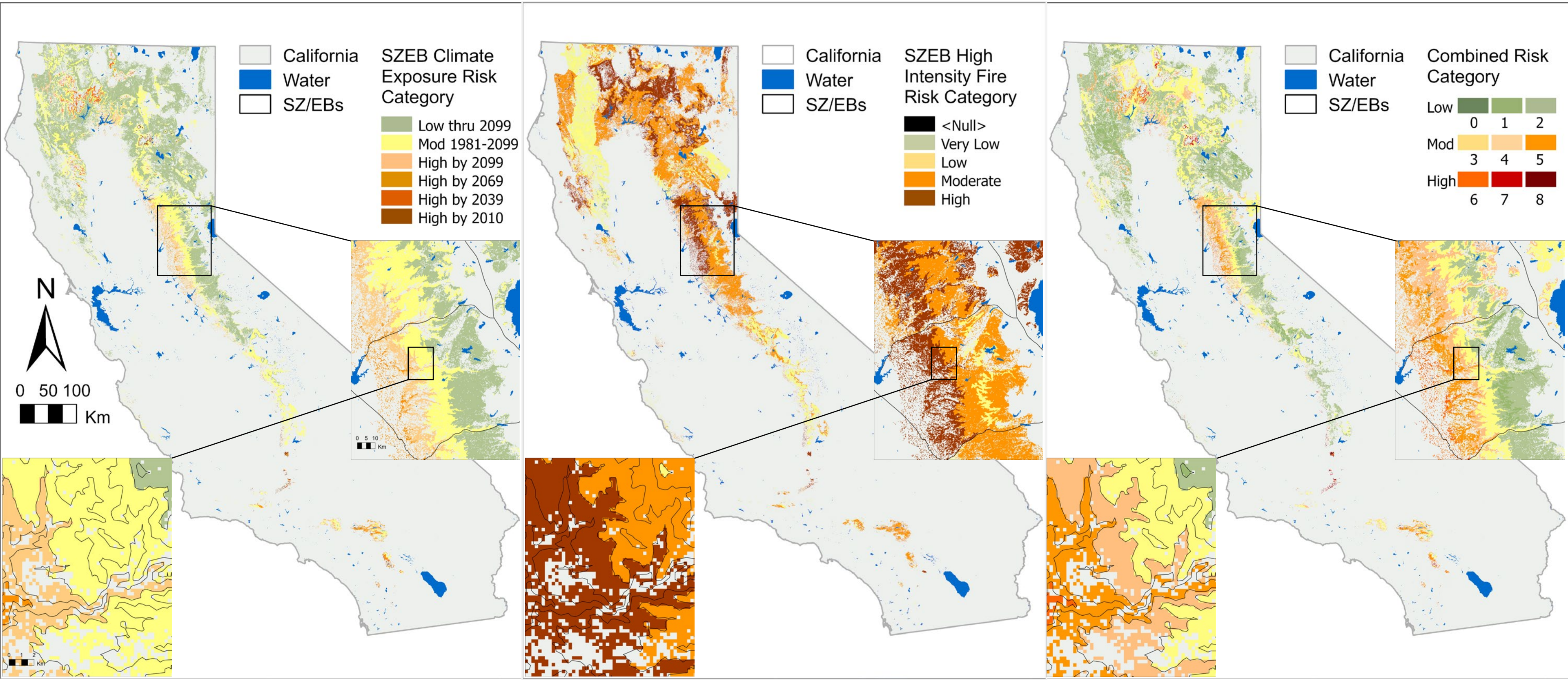
*The number that follows category labels in parentheses will be used to assign a combined climate exposure and high fire intensity risk category later

5. Although the mean relative fuel rating for each SZEB is taken across all grid cells in the PIPO distribution per SZEB, **display SZEB high intensity fire risk categories but remove grid cells identified as low area, recently burned at high severity, or CWHR type unlikely to currently include the species like "Urban"**

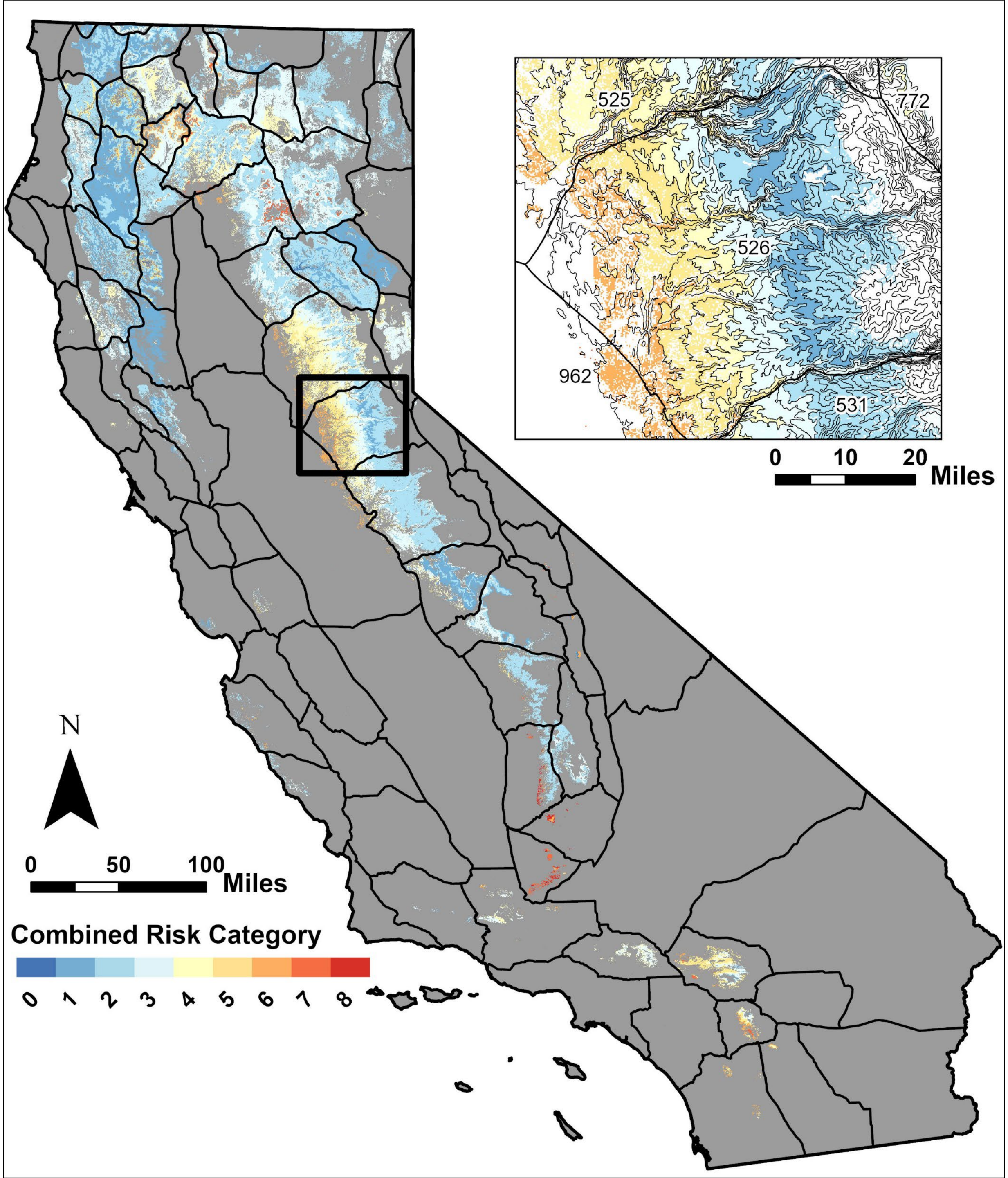


525
772
526
962
531
0 10 20 Miles
N
0 50 100 Miles
High Intensity Fire Risk Category
High
Moderate
Low
Very Low

Combined Risk Categories



1. Sum SZEB Climate Exposure Risk Category Values (0-5) and SZEB High Intensity Fire Risk Category Values (0-3) to **assign 9 combined risk categories (0-8)**

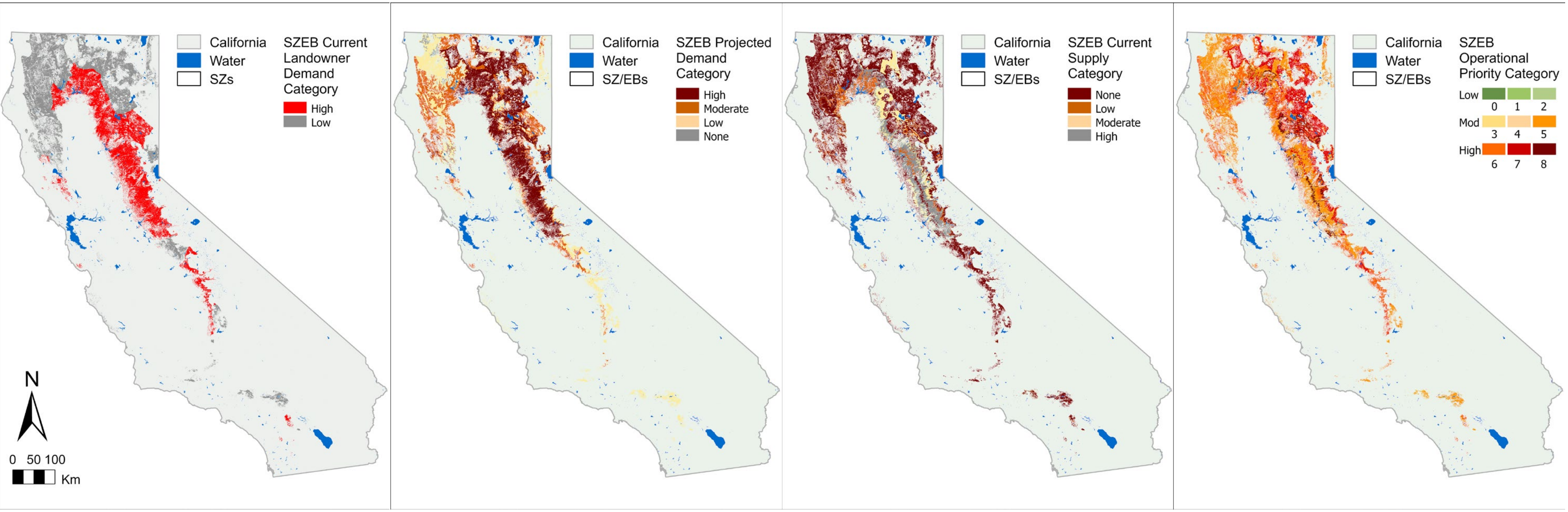


525
772
526
962
531
0 10 20
Miles
N
0 50 100
Miles
Combined Risk Category
0 1 2 3 4 5 6 7 8

Operational Priorities

Workflow Operational Priority Categories

Current Demand (0-1) + Projected Demand (0-3) + Current Supply (1-4) = Operational Priority (0-8)



1. **Assign a Current Landowner Demand** category to each SZEB based on LAMRC orders

   - SZEB in a high demand SZ→ **"High"** (1)
   - SZEB not in a high demand SZ→ **"Low"** (0)

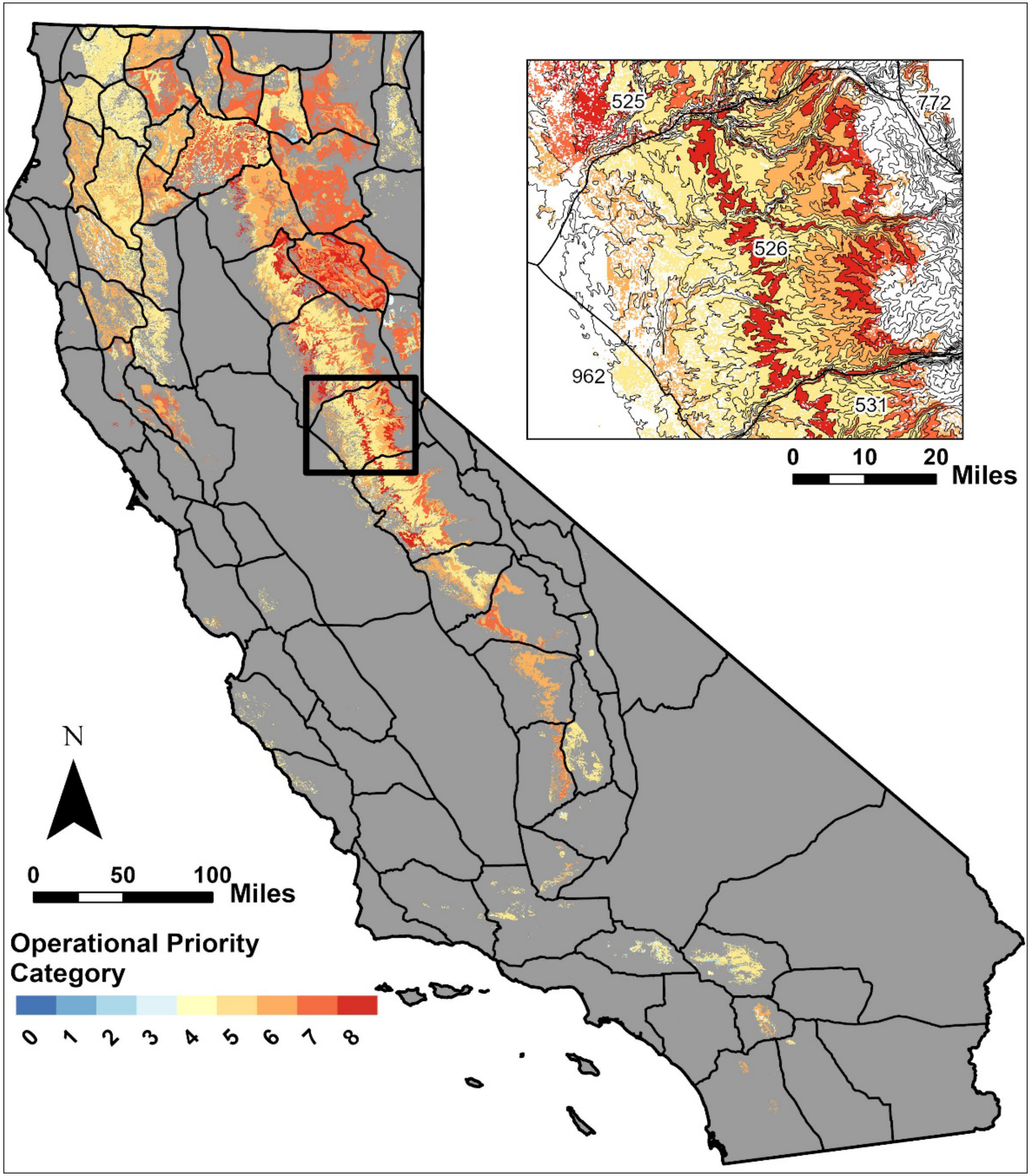
2. **Assign a Projected Demand category** to each SZEB based on the projected bushels of seed needed to reforest 25% of privately owned forested acres

   - 50+ bushels → **"High"** (3)
   - 10-50 bushels → **"Mod"** (2)
   - 0-10 bushels → **"Low"** (1)
   - 0 bushels → **"None"** (0)

3. **Assign a Current Supply** category to each SZEB based on the LAMRC seedbank's 2021 inventory

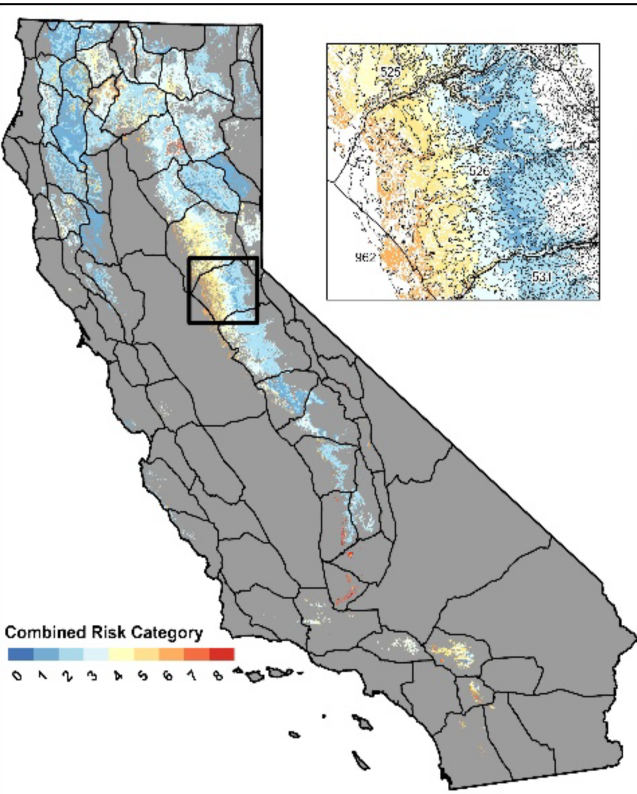
   - 0 bushels → **"None"** (4)
   - 0-10 bushels → **"Low"** (3)
   - 10-50 bushels → **"Mod"** (2)
   - 50+ bushels → **"High"** (1)

4. **Sum SZEB Operational Demands Current Demand** (0-1), **Projected Demand** category values (0-3), and **Current Supply** category values (0-4) to assign **8 Operational Priority categories (0-8).**

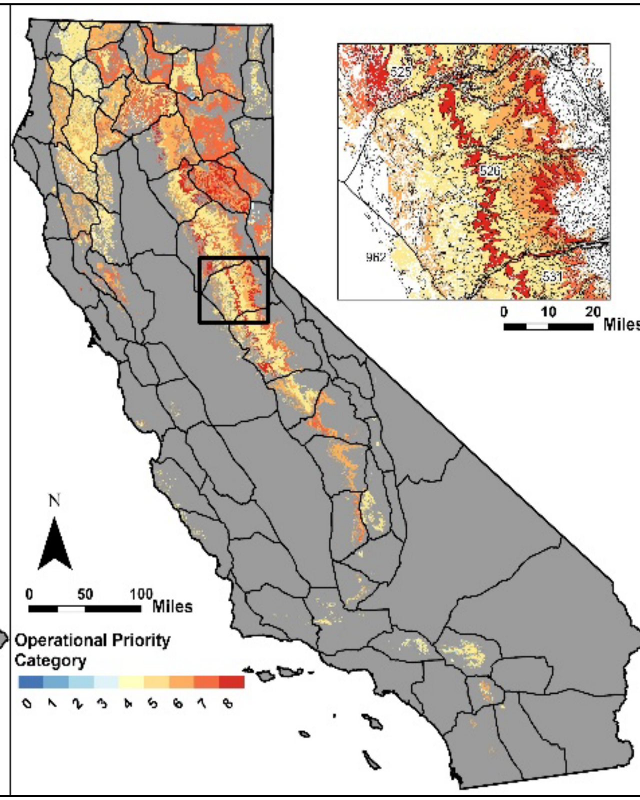

525
772
526
962
531
0 10 20 Miles
N
0 50 100 Miles
Operational Priority Category
0 1 2 3 4 5 6 7 8

Final SZEB Rankings

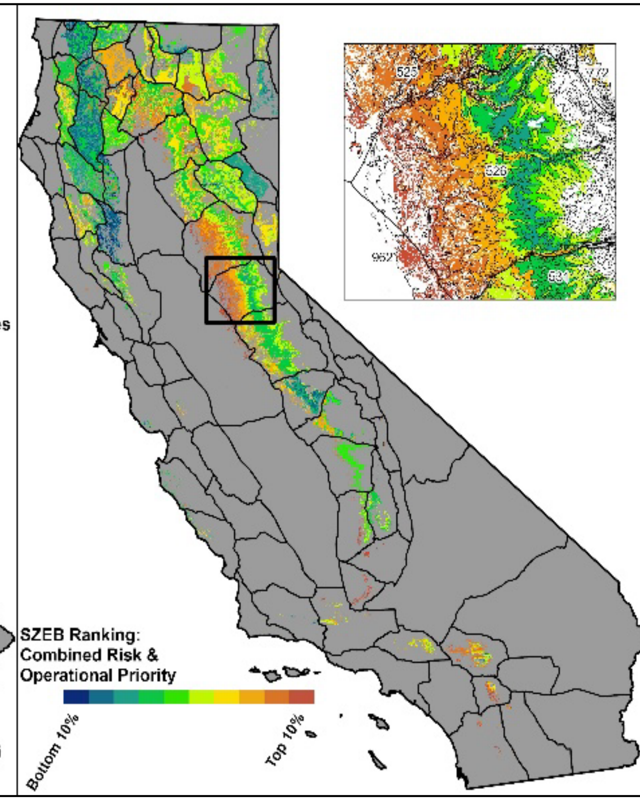
SZEB Combined Risk Category

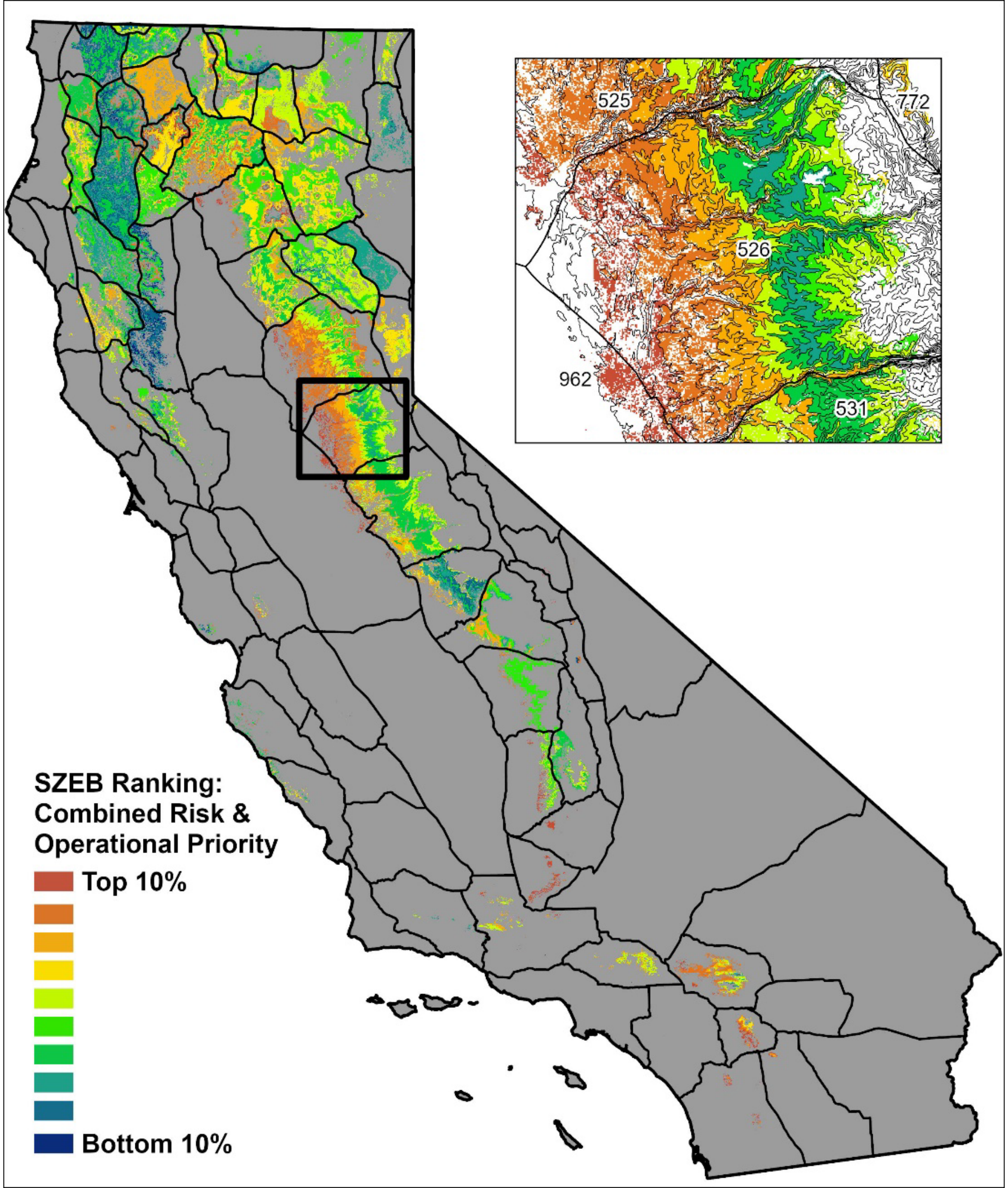


SZEB Operational Priority Category



SZEB Combined Risk & Ops Ranking

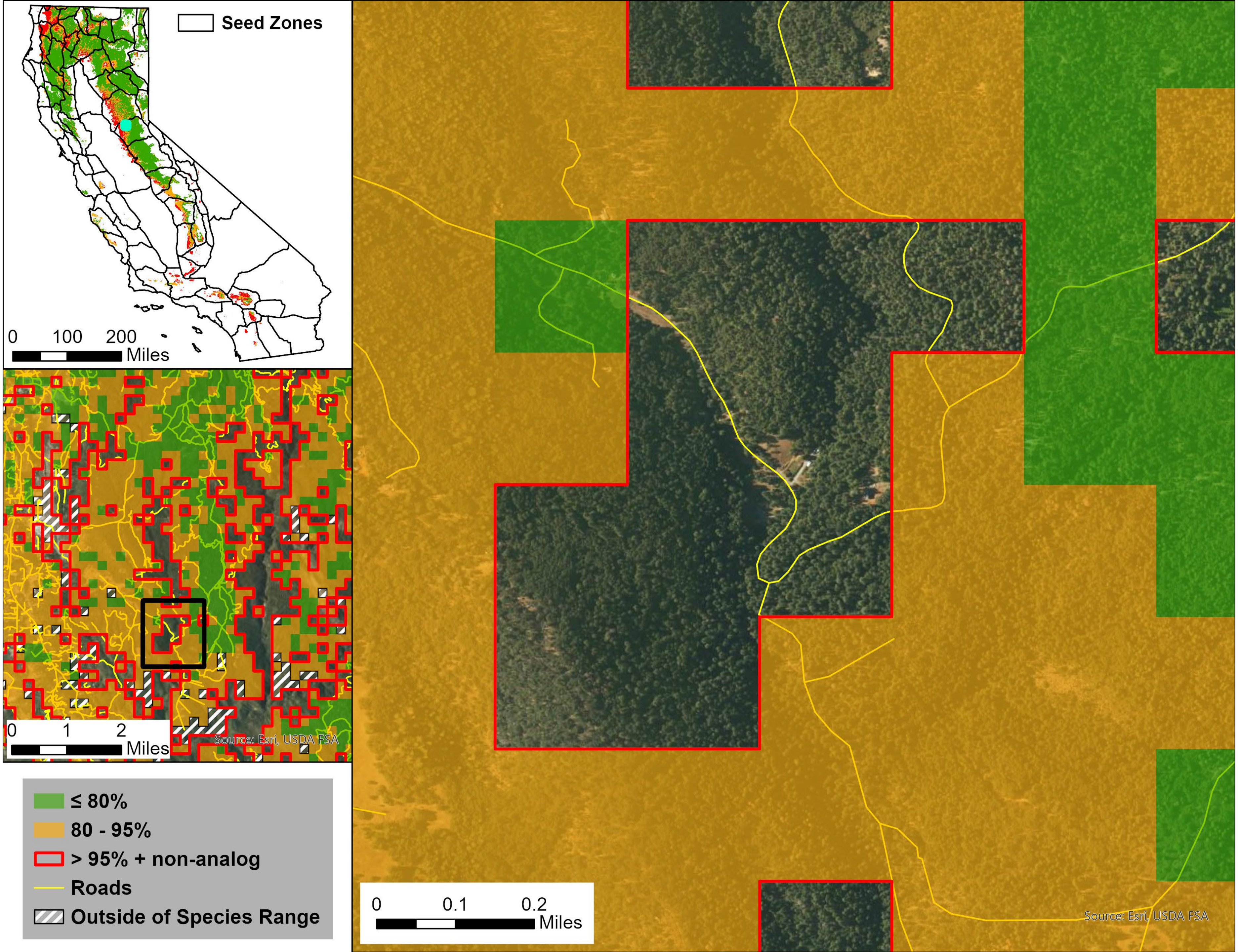




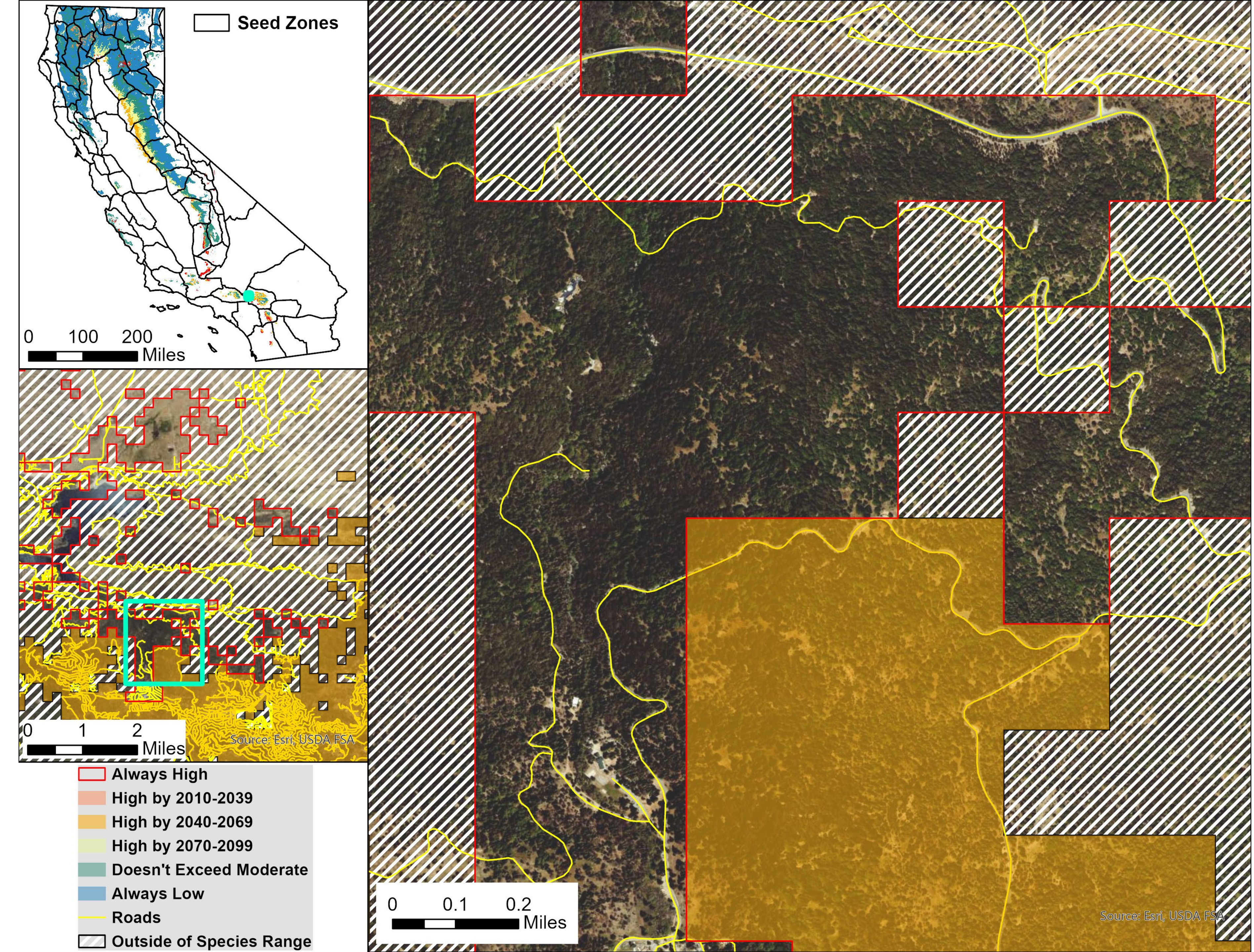
525
772
526
962
531
SZEB Ranking:
Combined Risk &
Operational Priority
Top 10%
Bottom 10%

SZEB	Climate Exposure Risk Category	High Intensity Fire Risk Category	Combined Risk Category	Current Landowner Demand Category	LAMRC-Projected Demand Category	Current (LAMRC 2020) Supply Category	Operational Priority Category	SZEB Rank
540_3000 - 3500ft	High by 2010 (5)	High (3)	8	High (1)	Low (1)	None (4)	6	1
570_5500 - 6000ft	High by 2010 (5)	High (3)	8	Low (0)	Moderate (2)	None (4)	6	2
560_5000 - 5500ft	High by 2010 (5)	High (3)	8	Low (0)	Low (1)	None (4)	5	3
560_6000 - 6500ft	High by 2010 (5)	High (3)	8	Low (0)	Low (1)	None (4)	5	4
570_2500 - 3000ft	High by 2010 (5)	High (3)	8	Low (0)	Low (1)	None (4)	5	5
570_3000 - 3500ft	High by 2010 (5)	High (3)	8	Low (0)	Low (1)	None (4)	5	6
570_5000 - 5500ft	High by 2010 (5)	High (3)	8	Low (0)	Low (1)	None (4)	5	7
540_2000 - 2500ft	High by 2010 (5)	High (3)	8	High (1)	None (0)	None (4)	5	8
540_2500 - 3000ft	High by 2010 (5)	High (3)	8	High (1)	None (0)	None (4)	5	9
792_6000 - 6500ft	High by 2010 (5)	High (3)	8	Low (0)	None (0)	None (4)	4	10
560_5500 - 6000ft	High by 2010 (5)	High (3)	8	Low (0)	Low (1)	Moderate (2)	3	11
521_500 - 1000ft	High by 2010 (5)	Moderate (2)	7	High (1)	Moderate (2)	None (4)	7	12
516_6000 - 6500ft	High by 2039 (4)	High (3)	7	Low (0)	Moderate (2)	None (4)	6	13
521_5500 - 6000ft	High by 2039 (4)	High (3)	7	High (1)	Low (1)	None (4)	6	14
522_6500 - 7000ft	High by 2010 (5)	Moderate (2)	7	High (1)	Low (1)	None (4)	6	15
570_6000 - 6500ft	High by 2039 (4)	High (3)	7	Low (0)	Moderate (2)	None (4)	6	16
962_0 - 500ft	High by 2039 (4)	High (3)	7	High (1)	Low (1)	None (4)	6	17
997_4000 - 4500ft	High by 2010 (5)	Moderate (2)	7	High (1)	Low (1)	None (4)	6	18
560_4000 - 4500ft	High by 2010 (5)	Moderate (2)	7	Low (0)	Low (1)	None (4)	5	19
560_4500 - 5000ft	High by 2010 (5)	Moderate (2)	7	Low (0)	Low (1)	None (4)	5	20

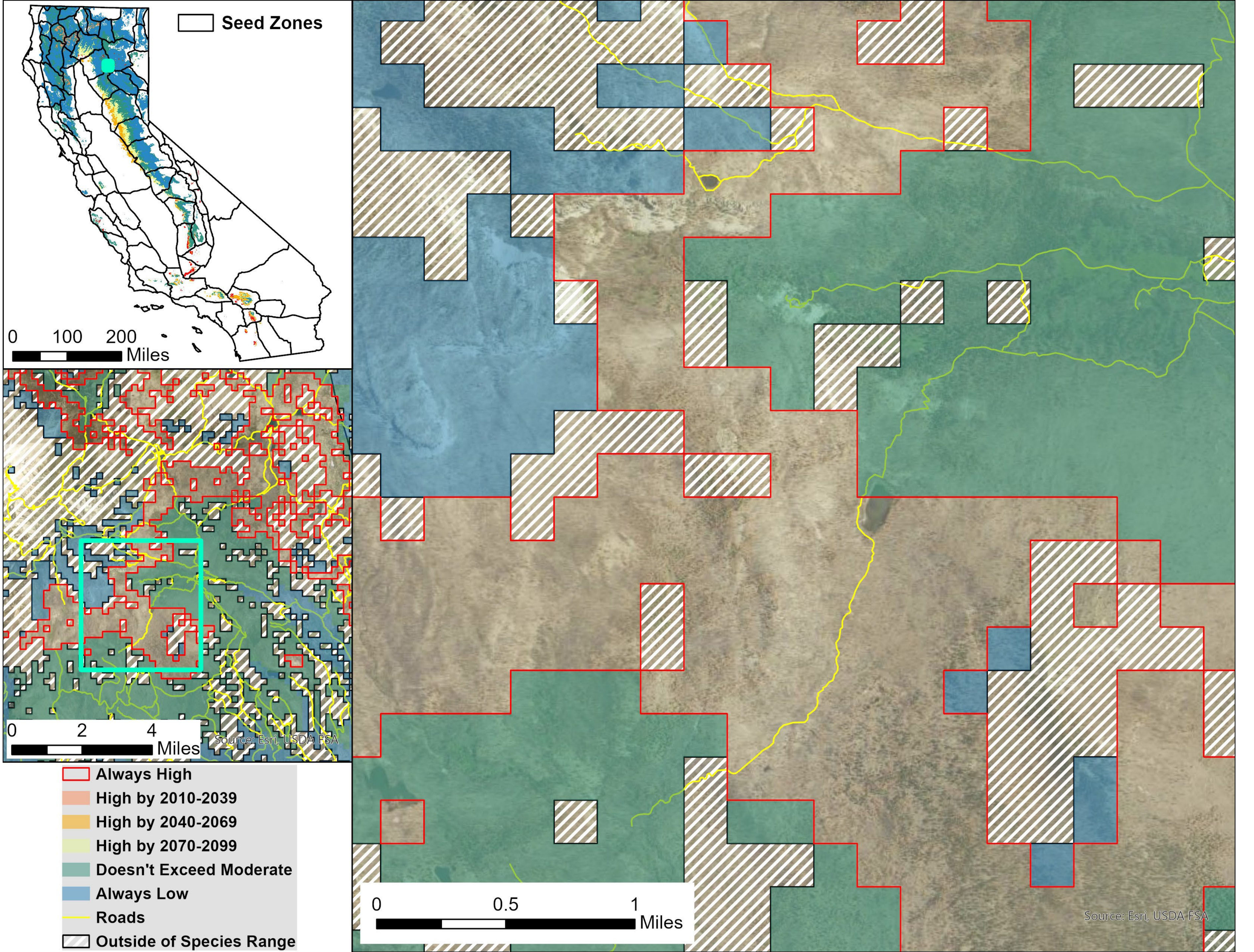
Pinus ponderosa

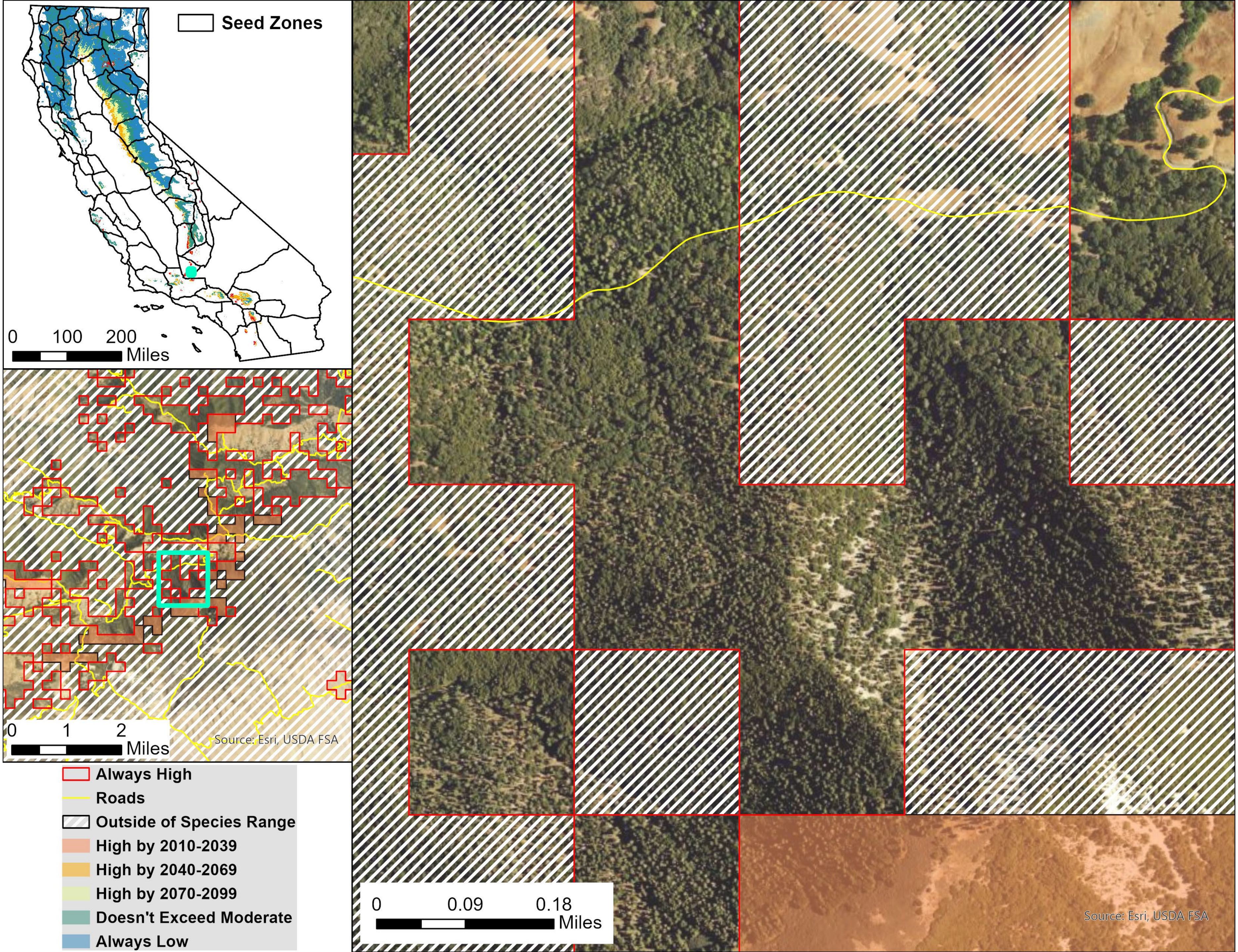


Seed Zones
0 100 200
Miles
0 1 2
Miles
Source: Esri, USDA FSA
≤ 80%
80 - 95%
> 95% + non-analog
Roads
Outside of Species Range
0 0.1 0.2
Miles
Source: Esri, USDA FSA



Seed Zones
0 100 200
Miles
0 1 2
Miles
Source: Esri, USDA FSA
Always High
High by 2010-2039
High by 2040-2069
High by 2070-2099
Doesn't Exceed Moderate
Always Low
Roads
Outside of Species Range
0 0.1 0.2
Miles
Source: Esri, USDA FSA

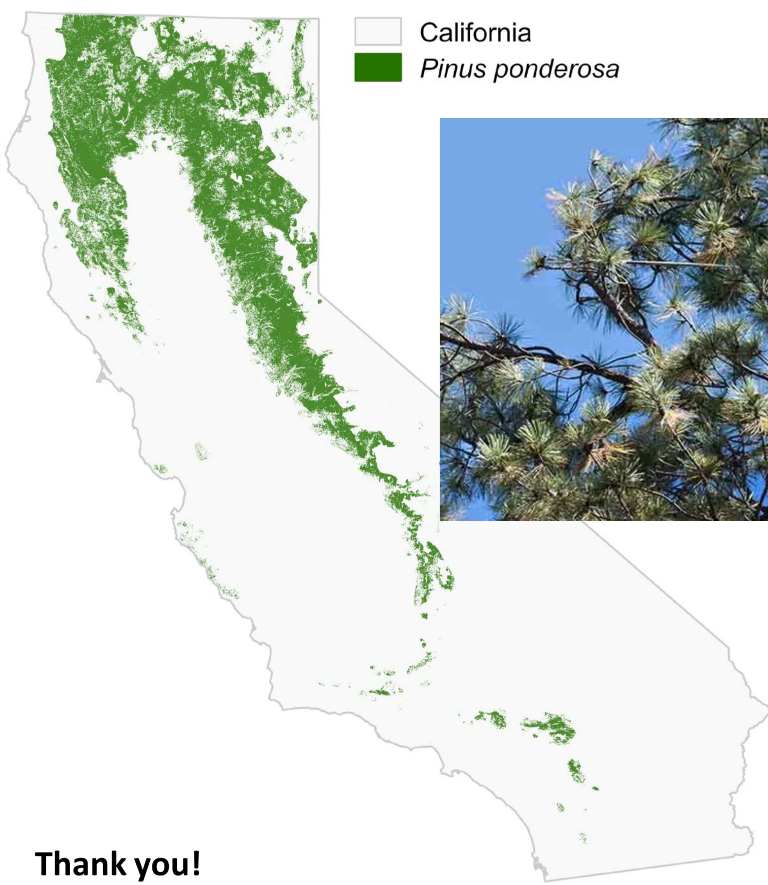

Seed Zones
0
100
200
Miles
0
2
4
Miles
Source: Esri, USDA FSA
Always High
High by 2010-2039
High by 2040-2069
High by 2070-2099
Doesn't Exceed Moderate
Always Low
Roads
Outside of Species Range
0
0.5
1
Miles
Source: Esri, USDA FSA


Seed Zones
0 100 200
Miles
0 1 2
Miles
Source: Esri, USDA FSA
Always High
Roads
Outside of Species Range
High by 2010-2039
High by 2040-2069
High by 2070-2099
Doesn't Exceed Moderate
Always Low
0 0.09 0.18
Miles
Source: Esri, USDA FSA

Next steps-

Adoption of the approach
Digitizing another 15-20 tree species' ranges
Combining w/ UC Merced's Tree Masting Model, UCD's Climate Adaptive Seed Tool (CAST)
Seeking to include other seed inventories
Using the base maps for:

- better yearly tracking of scouting efforts
- tracking changes in condition across species' ranges



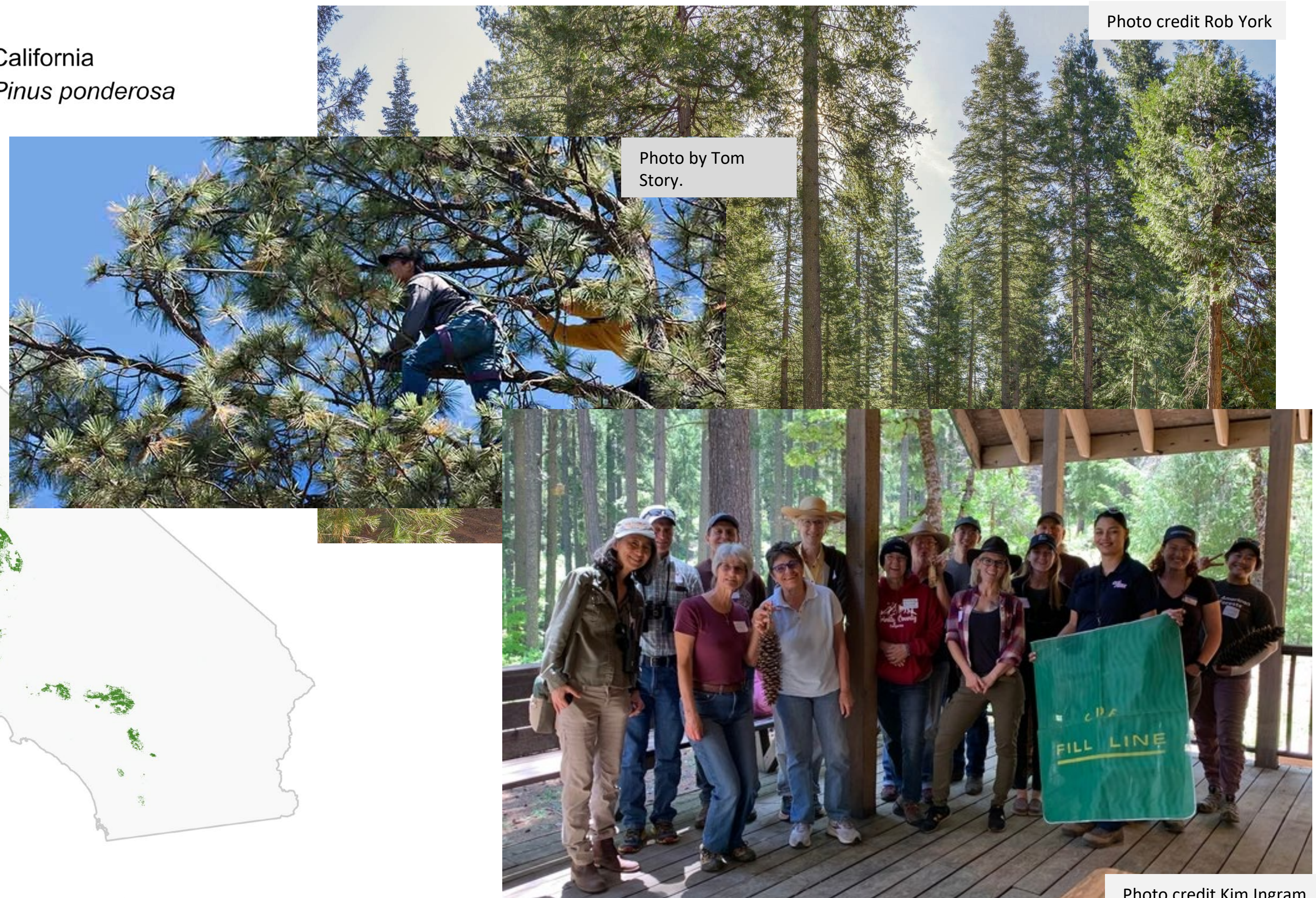


Photo credit Rob York

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Photo credit Kim Ingram

Thank you!
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