Automated Spatiotemporal Tracking of Priority Overstory Hardwood Stands in the Tahoe Basin

Joe Stewart and Jonathan Long

Derek Young

Objectives

- Use machine learning and high spatiotemporal resolution hyperspectral satellite imagery to map hardwood species canopy cover and track changes over time.
- Current distribution.
- Canopy cover.
- Changes in response to:
  - Fire
  - Pest/Pathogen
  - Vegetation Treatments

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Aspen as a Priority Species

- LTBMU forest plan has objective of "**restoring dominance of aspen in the canopy**" and includes a monitoring question, "**What is our progress towards maintaining and improving willow and aspen habitats within the Basin?**"
- TSAC Upland Ecosystem Science to Action Plan: **"Identify what modeling or forecasting capacity (and input data) would be needed to evaluate where and how an expanded and sustainable coverage of aspen could be achieved over time."**
- TRPA Threshold: **acres of aspen habitat** has long been tracked as part of EIP threshold reporting.

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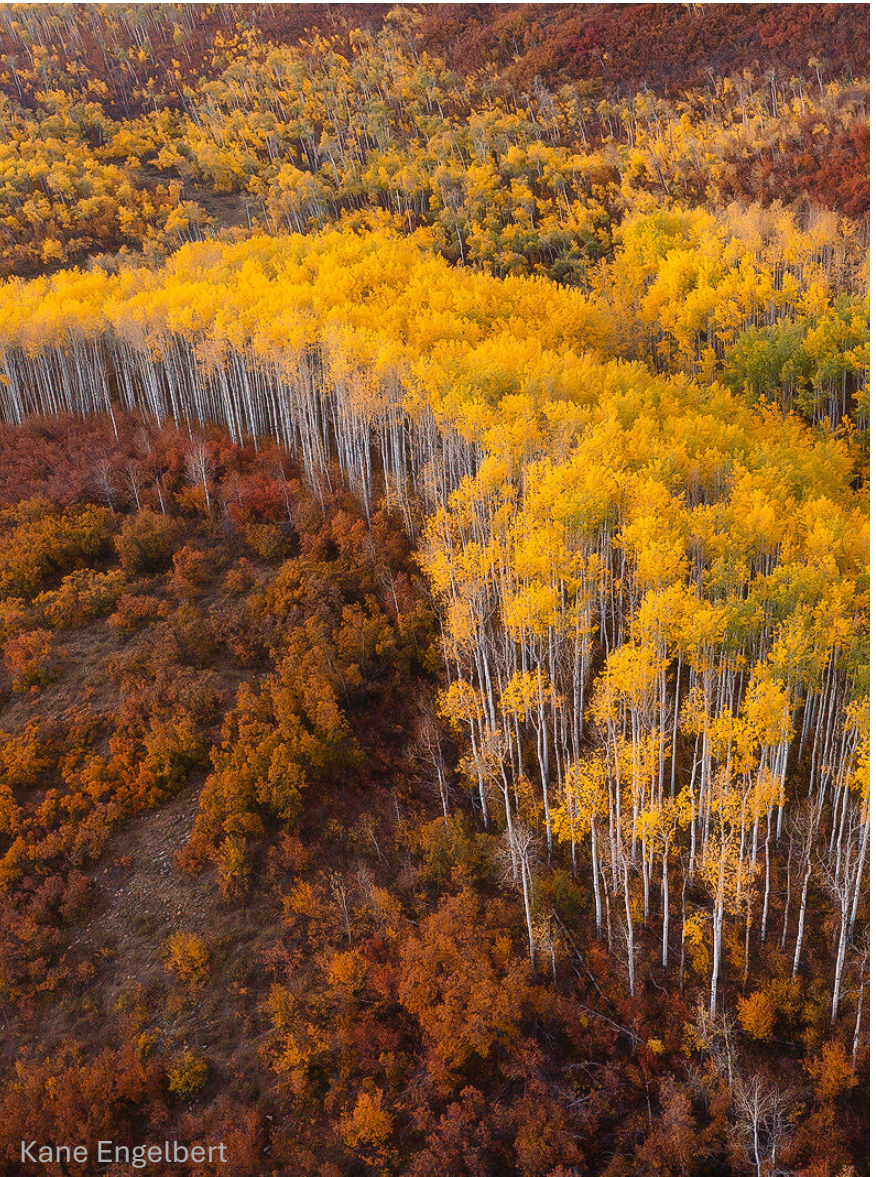
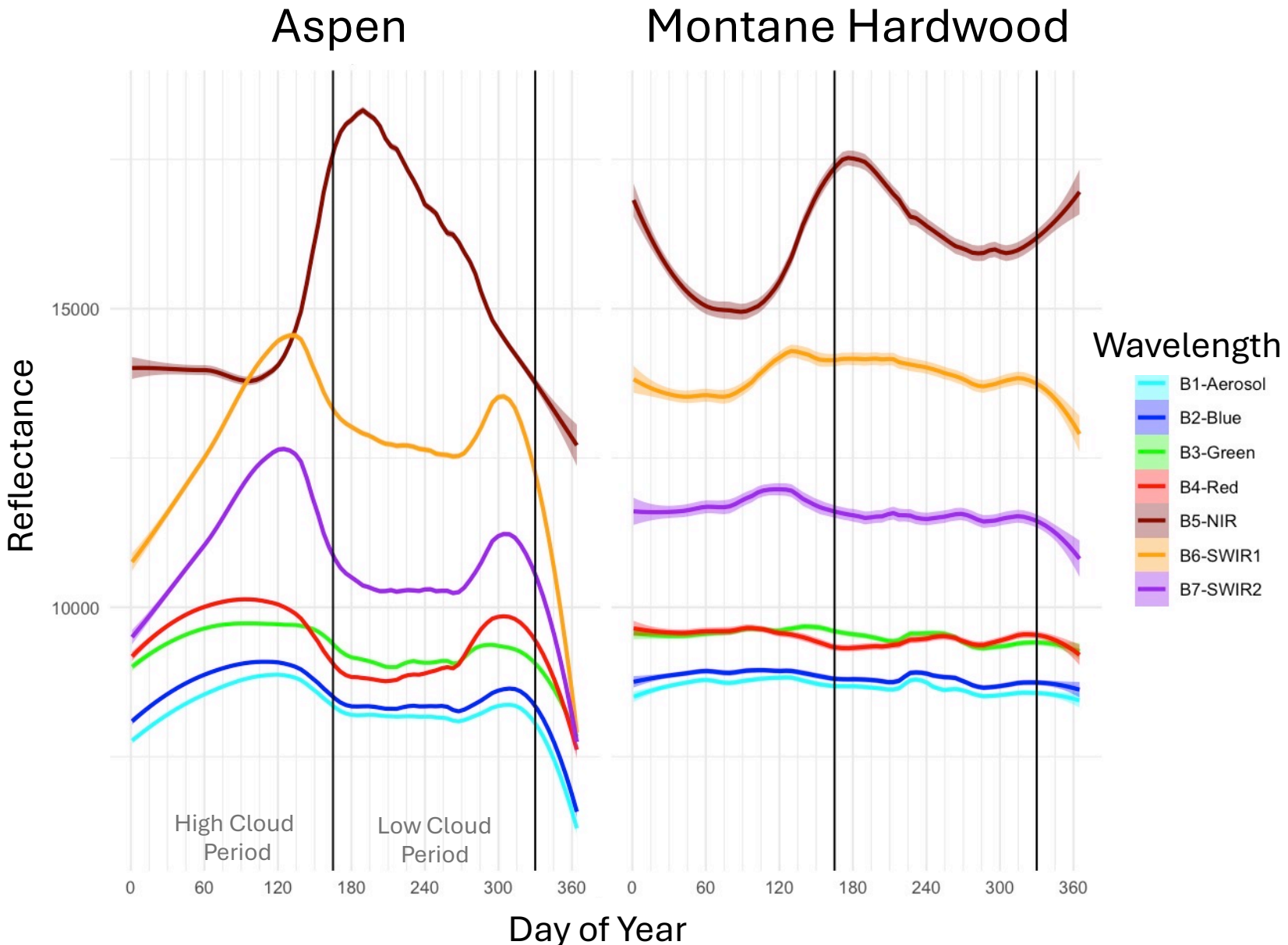
Unique Spectral Signatures





Remote Surveys

- Used google earth, street view, and drone imagery to estimate vegetation cover in Landsat-aligned plots (~ 30 m x 30 m).

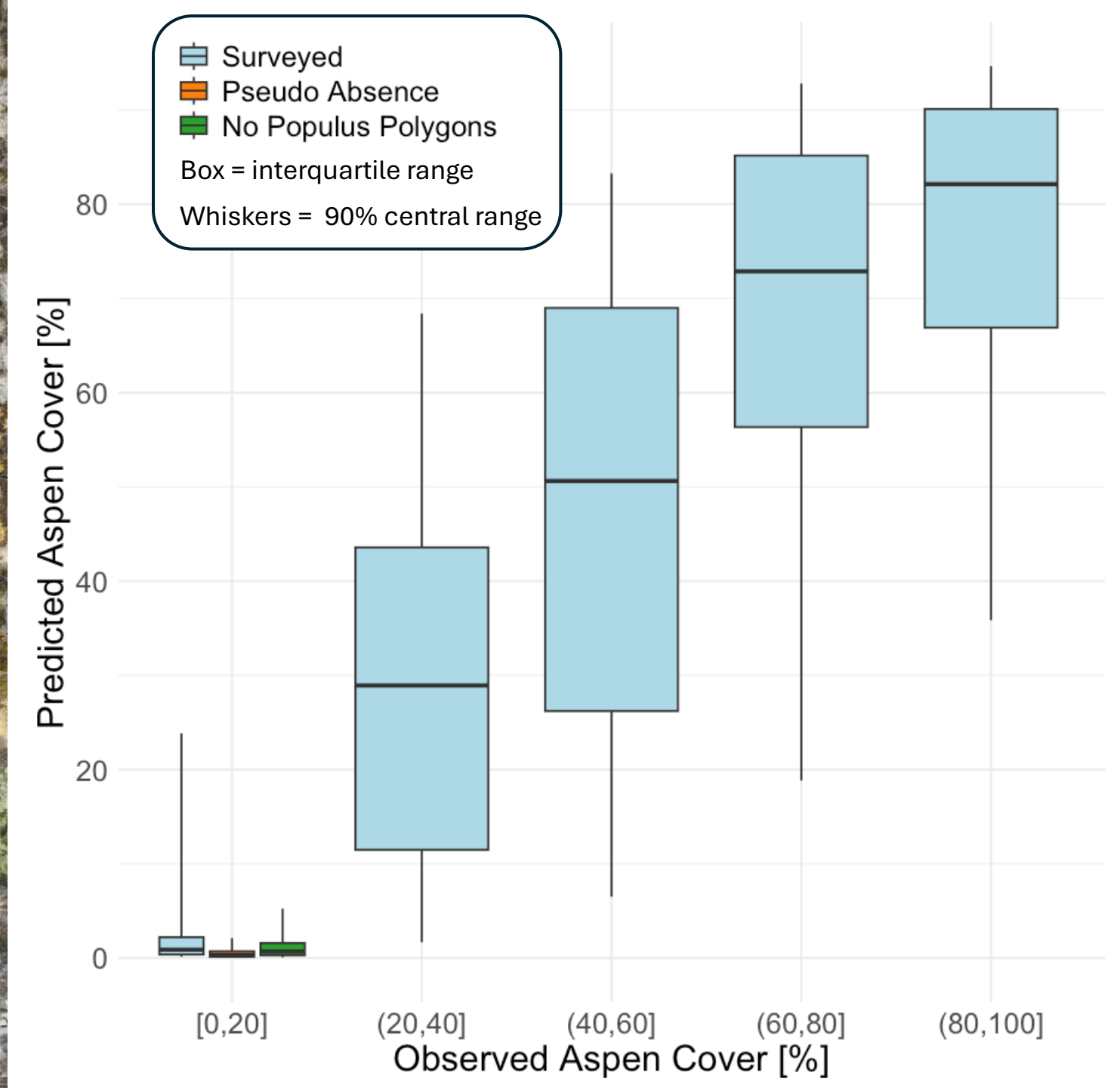
- Survey team: SIG, UC Davis, USFS
  - Expert aerial veg surveyors are extremely valuable. There's no substitute for years of experience.
  - New hires are great for efficient surveys of easier-to-interpret plots.

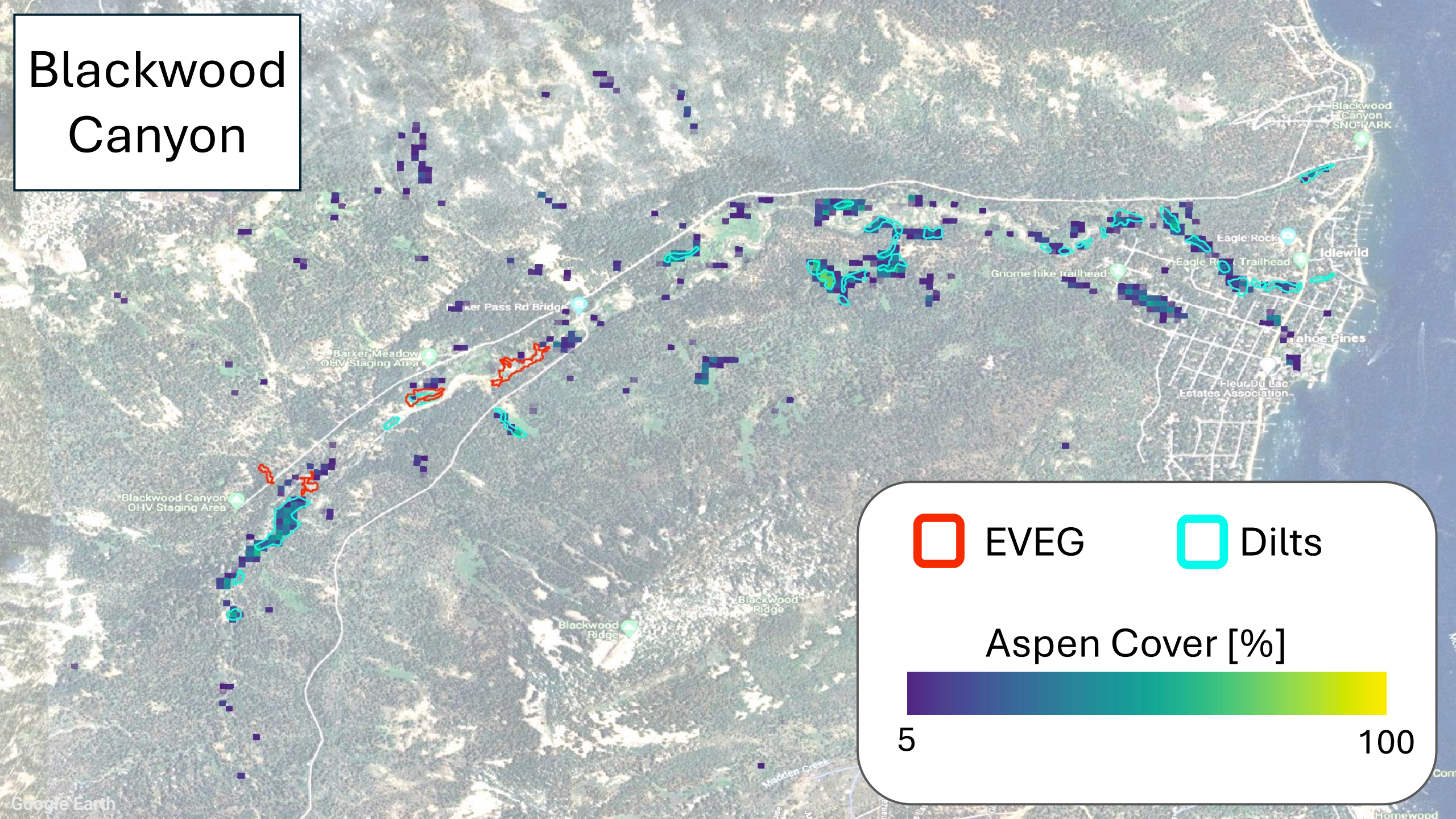
Google Earth

Google Street View

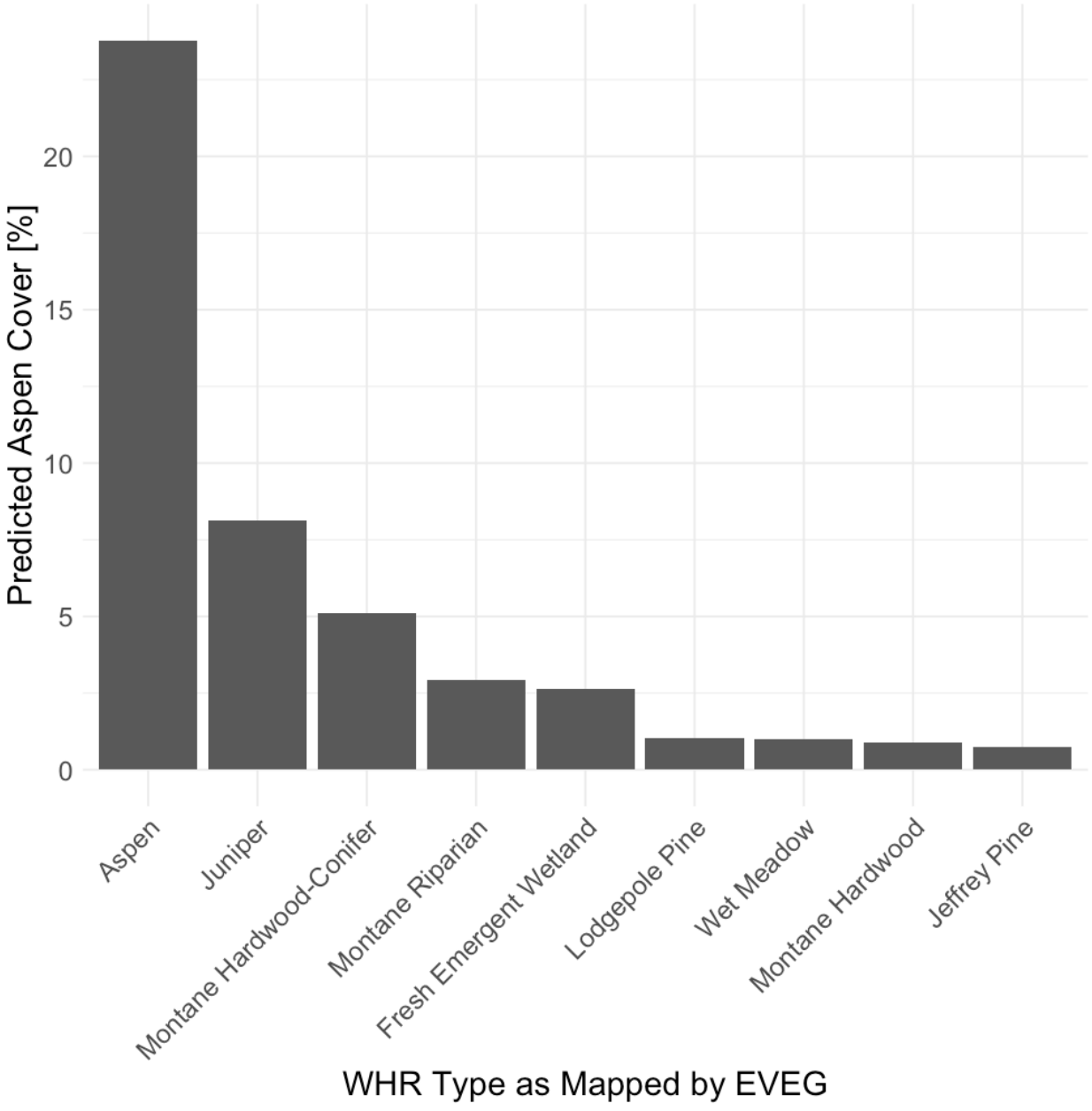
Out of Sample Model Accuracy

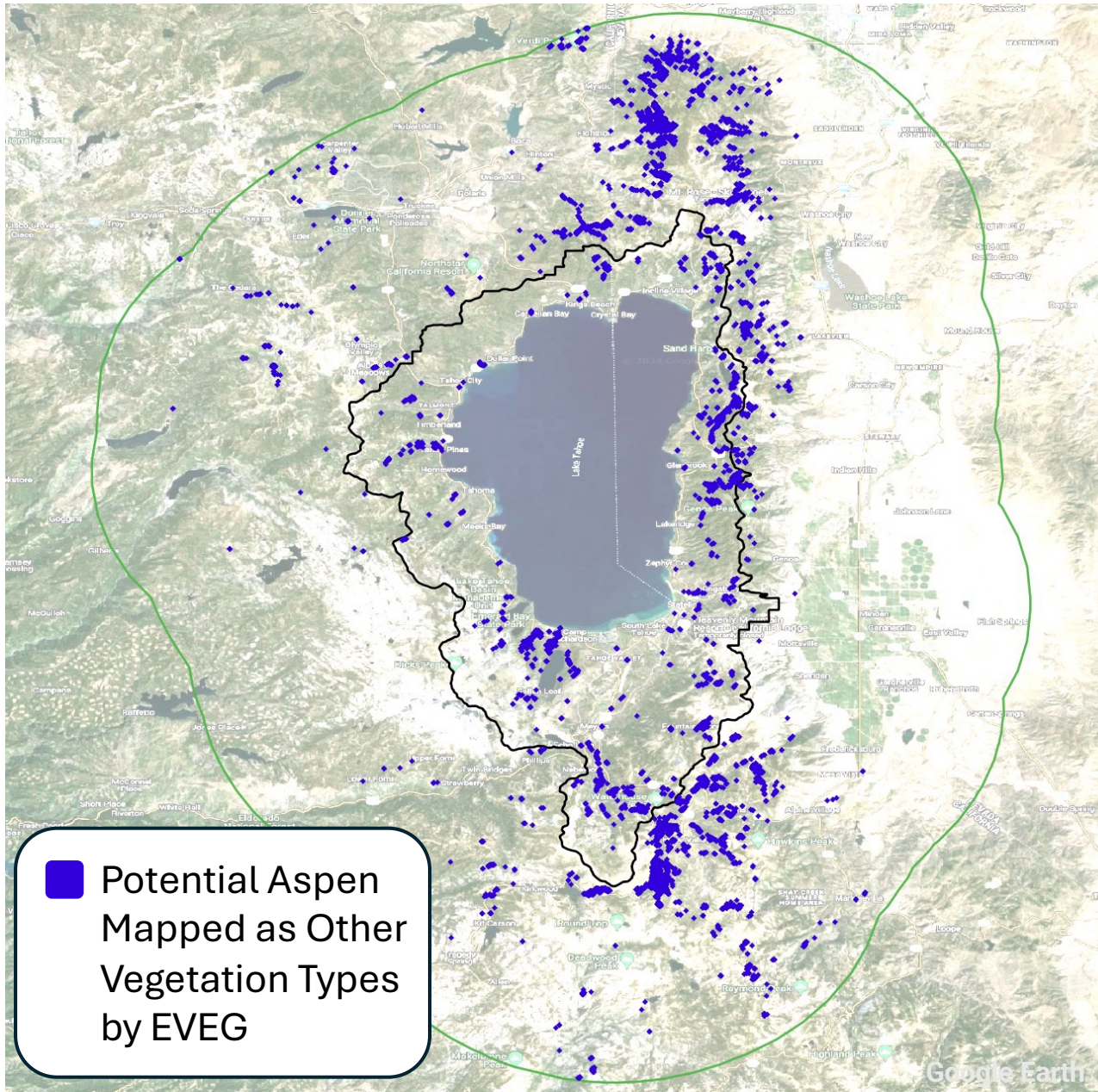
Model	Rsq	MAE	RMSE	Log Loss	Brier Score
Ensemble	0.8404	0.0156	0.0461	0.0327	0.0021
4.6 xgb	0.8095	0.0090	0.0503	0.0282	0.0025
4.6.1 maxent	0.7989	0.0230	0.0517	0.0408	0.0027



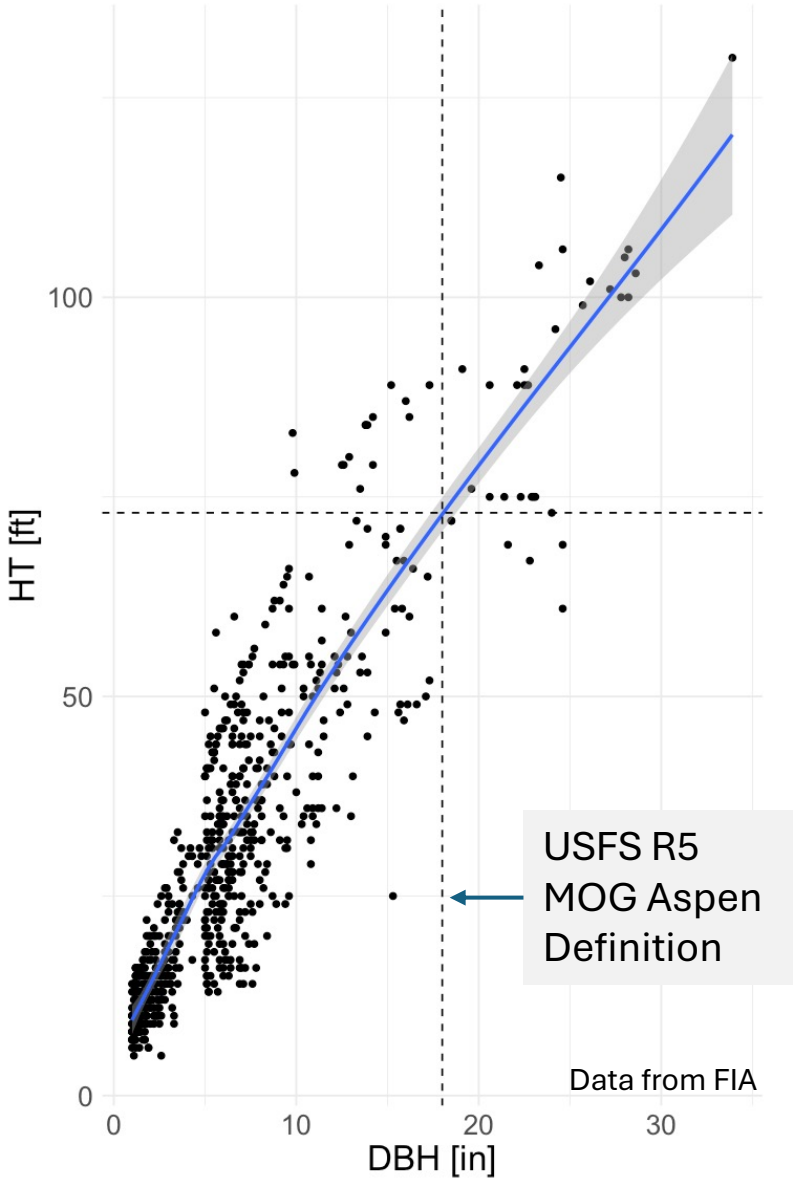

Blackwood Canyon
EVEG
Dilts
Aspen Cover [%]
5
100
Blackwood Canyon SNO-PARK
Eagle Rock
Idlewild
Gnome hike trailhead
Barker Meadow OHV Staging Area
Blackwood Canyon OHV Staging Area
Tahoe Pines
Fleur Du Lac Estates Association
Blackwood Ridge
Google Earth

Many Apparent Errors in Previous Veg Maps



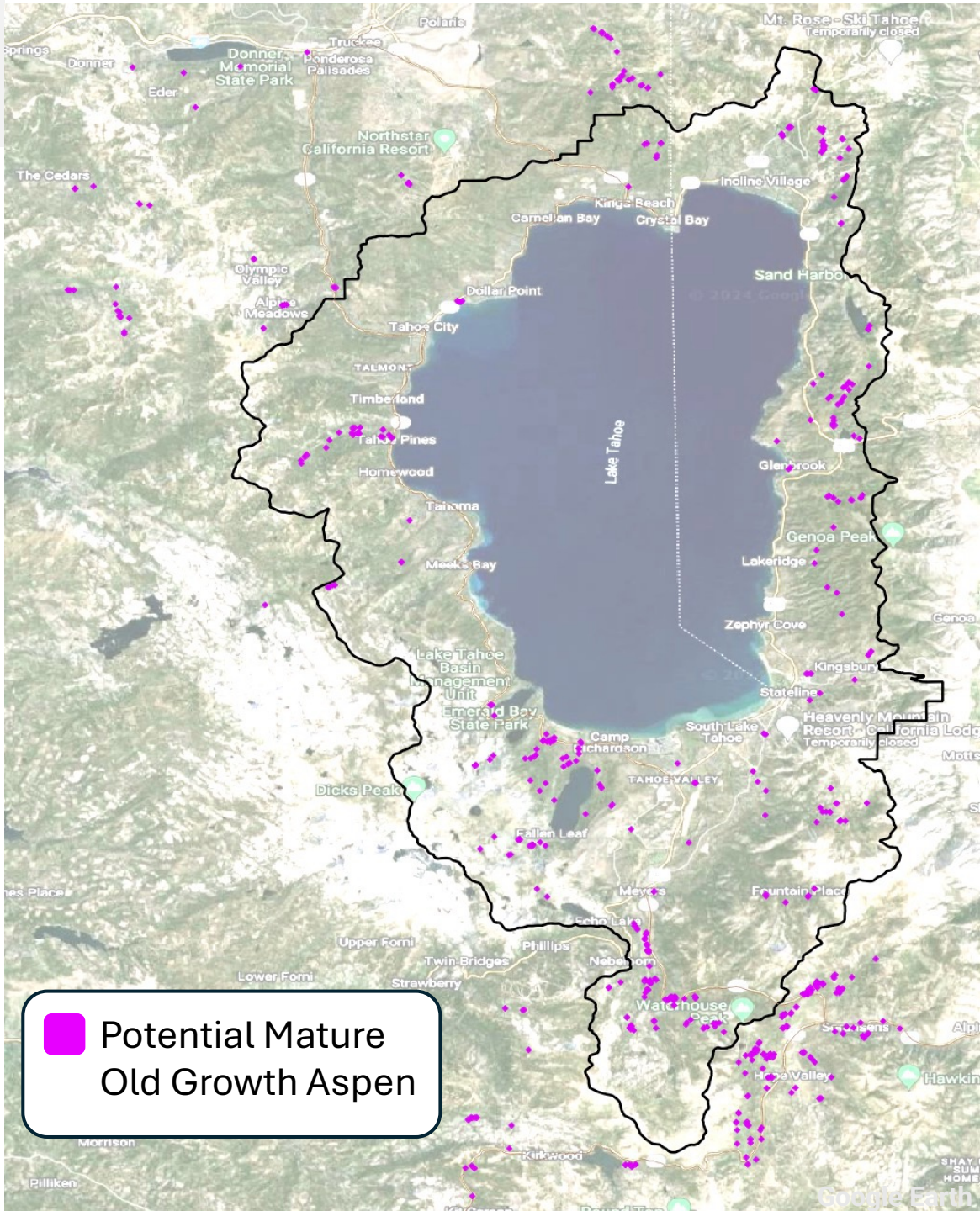


Mature Old Growth Aspen



Aspen Cover ≥ 50%
+
Canopy Height ≥ 73 ft
≈
Potential Mature
Old Growth Aspen

Canopy HT estimates from SALO



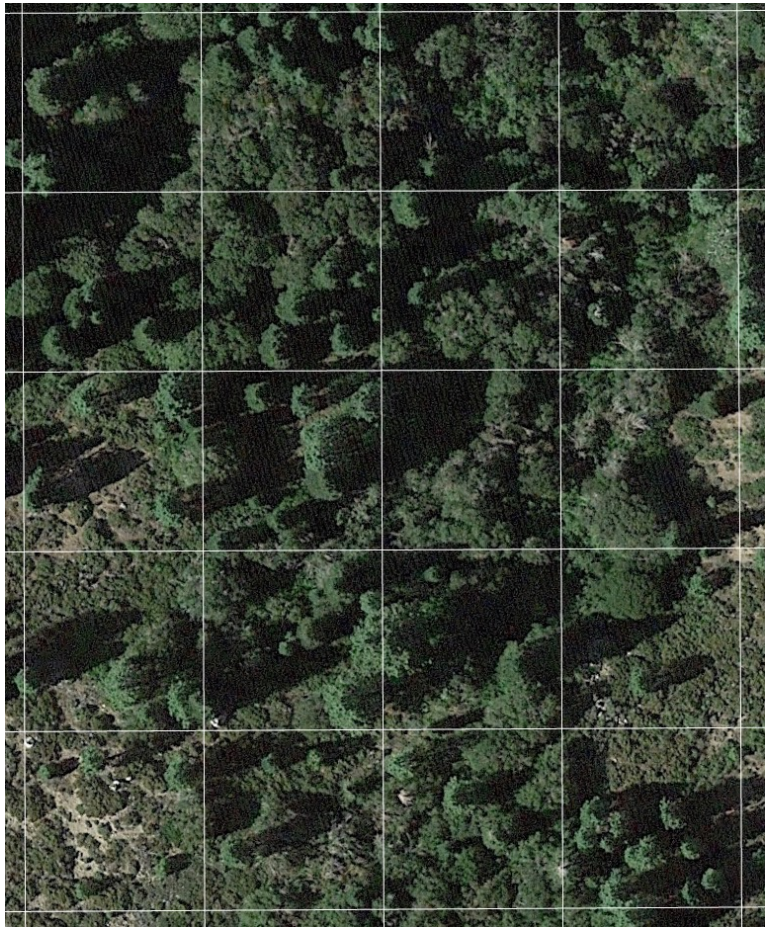
Aspen Die Off & Recovery: High Severity Fire

Douglas Shinneman, USGS

2021 High Severity Fire

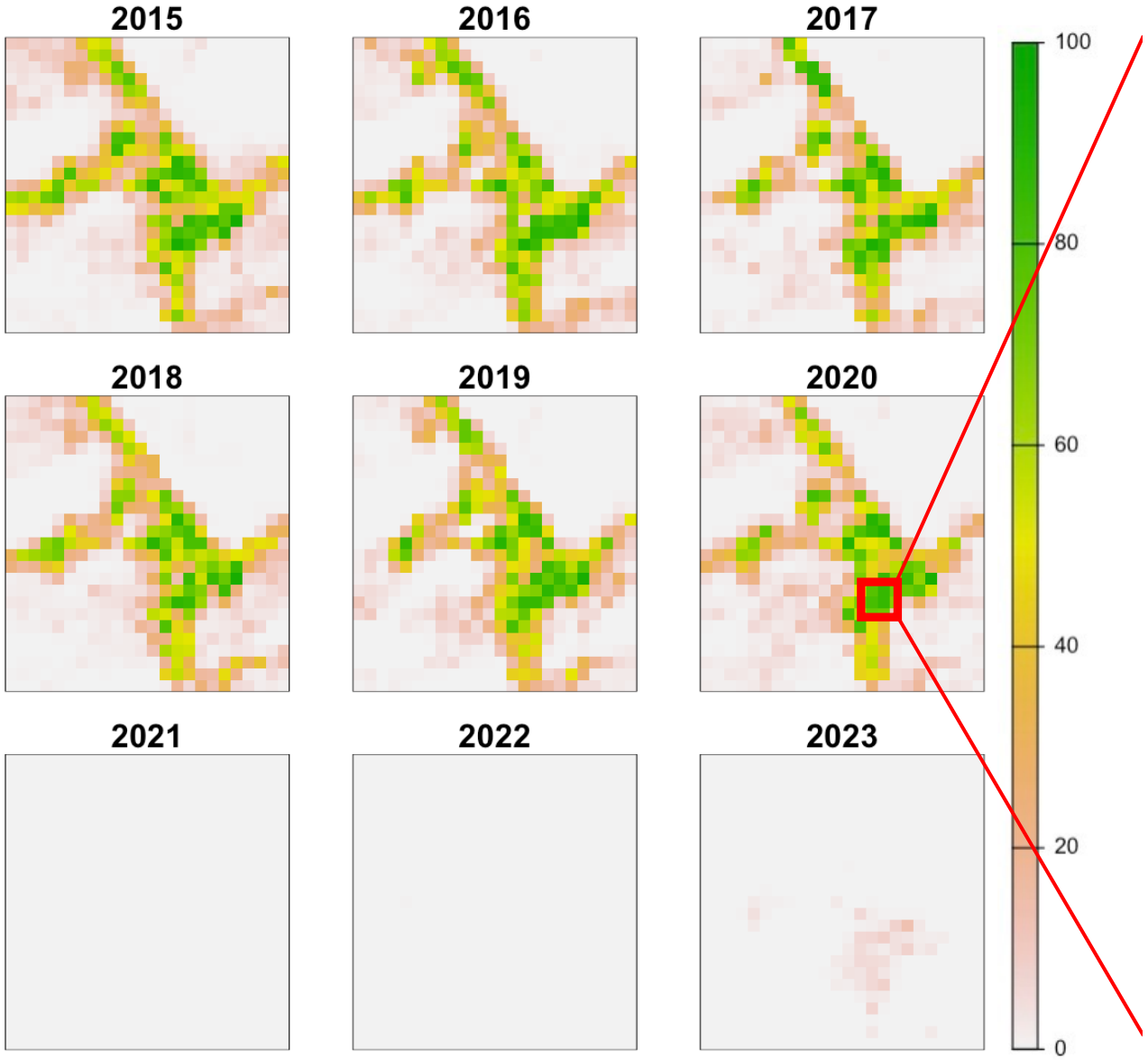
April 2015

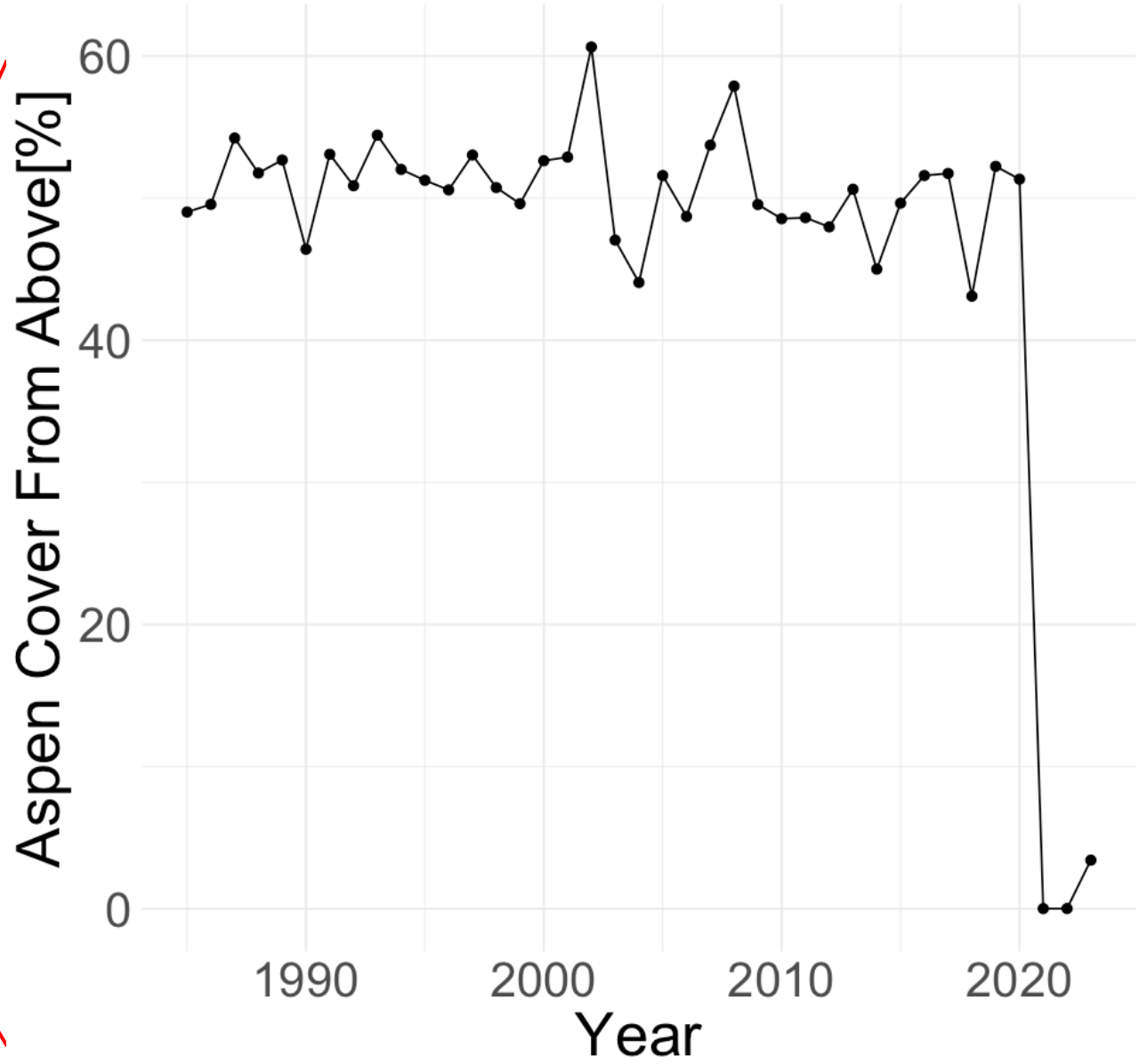
Aug 2019



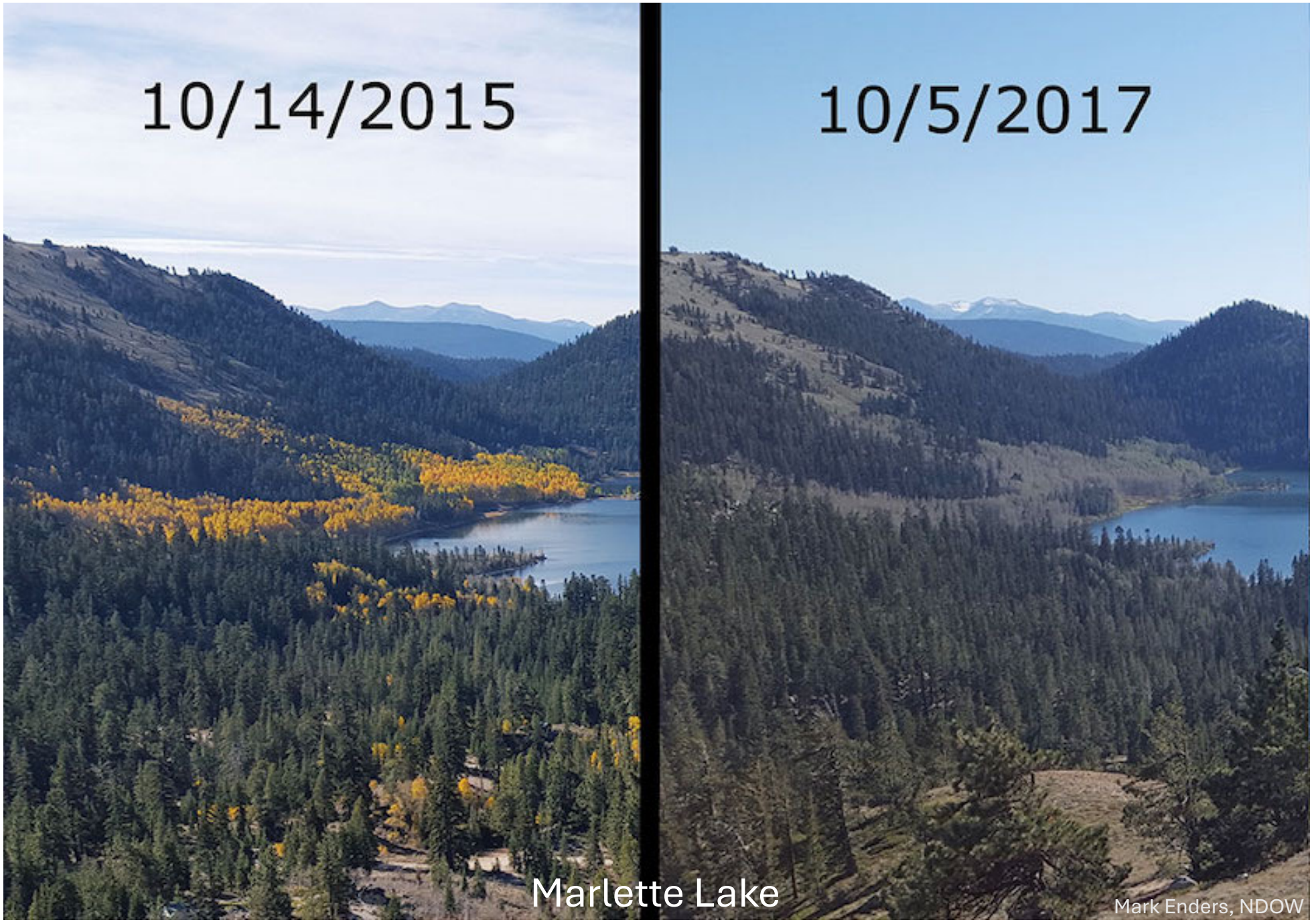
June 2023

2021 High Severity Fire





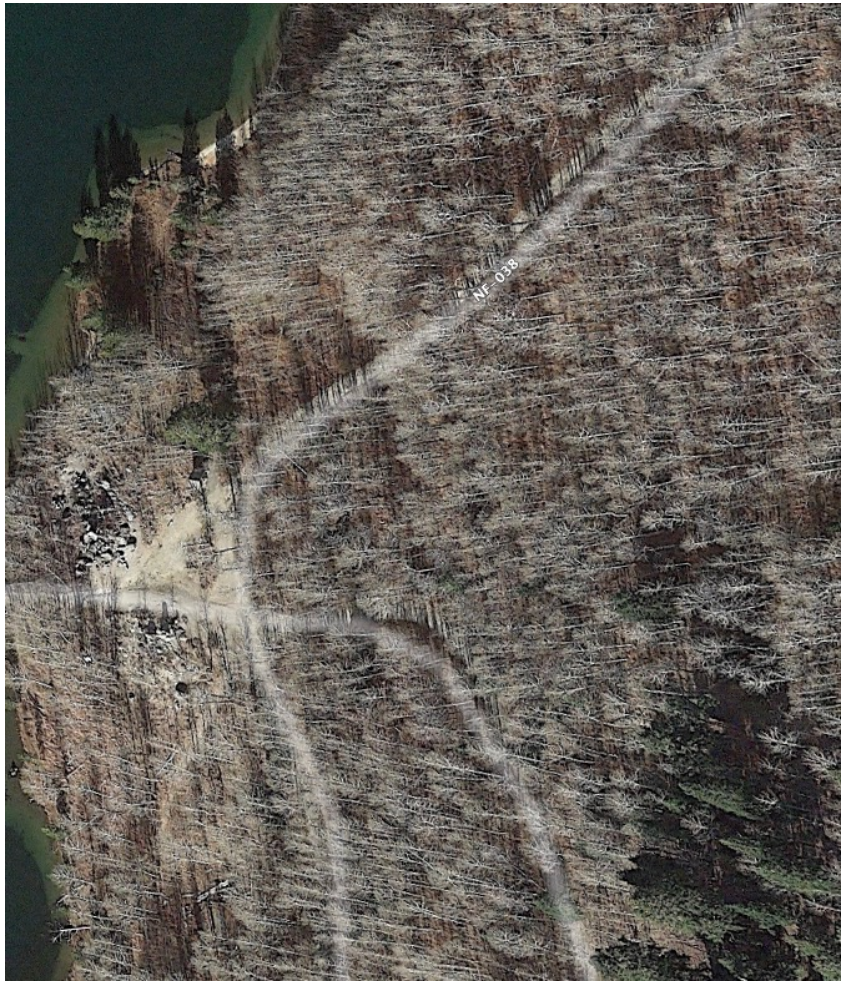
Aspen Die Off & Recovery: White Satin Moth



Marlette Lake - White Satin Moth

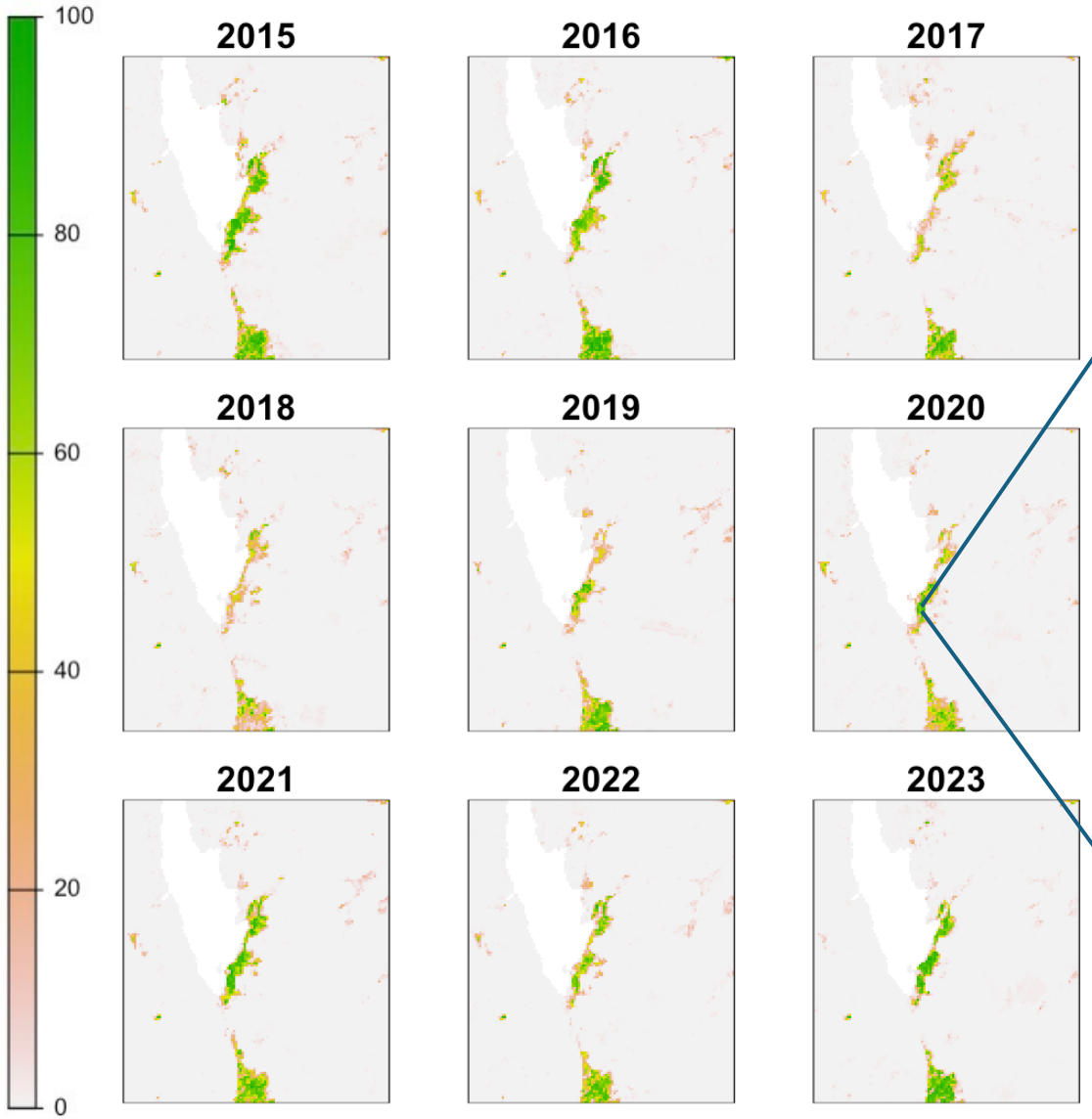
June 2016

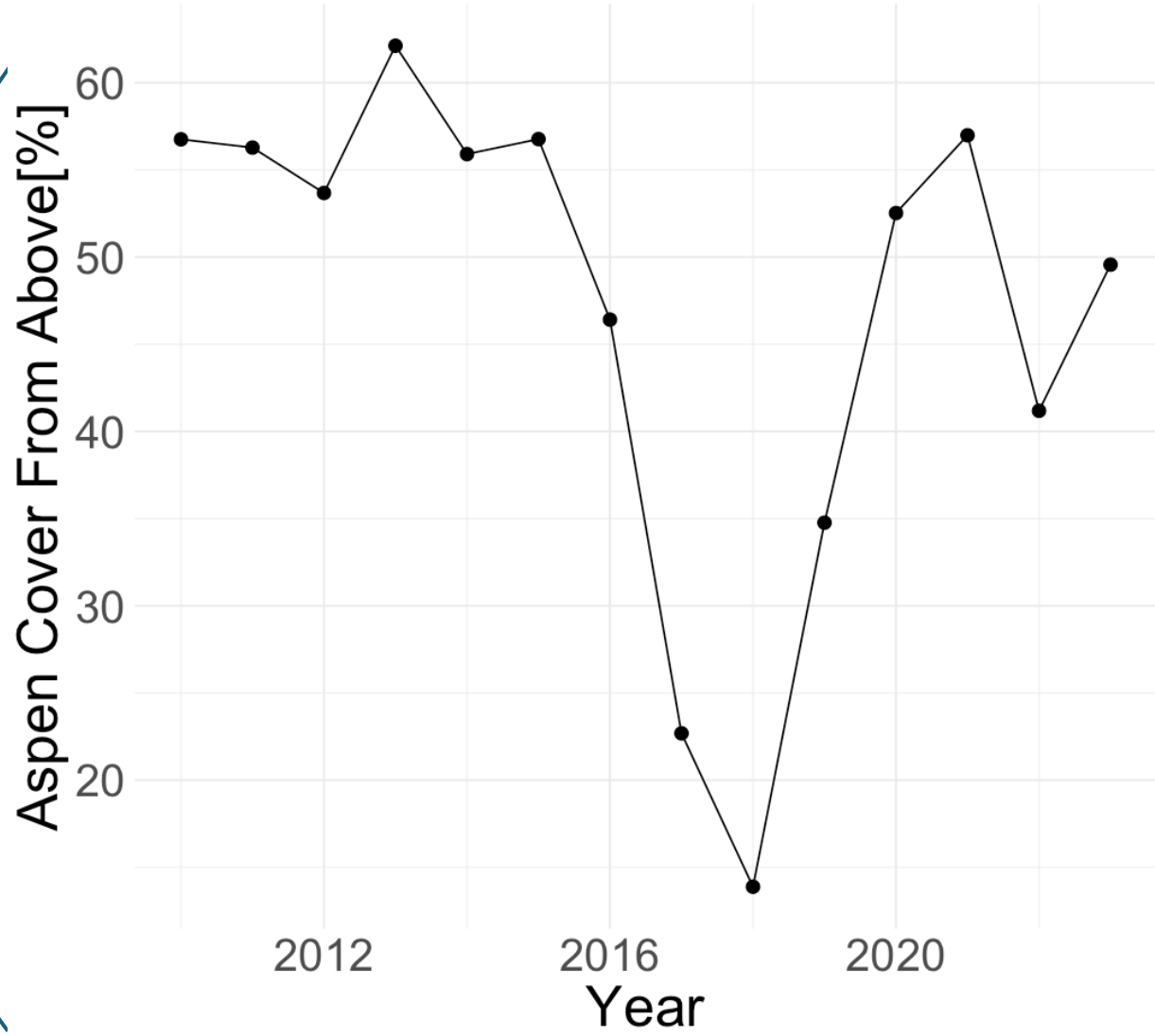
Nov. 2018



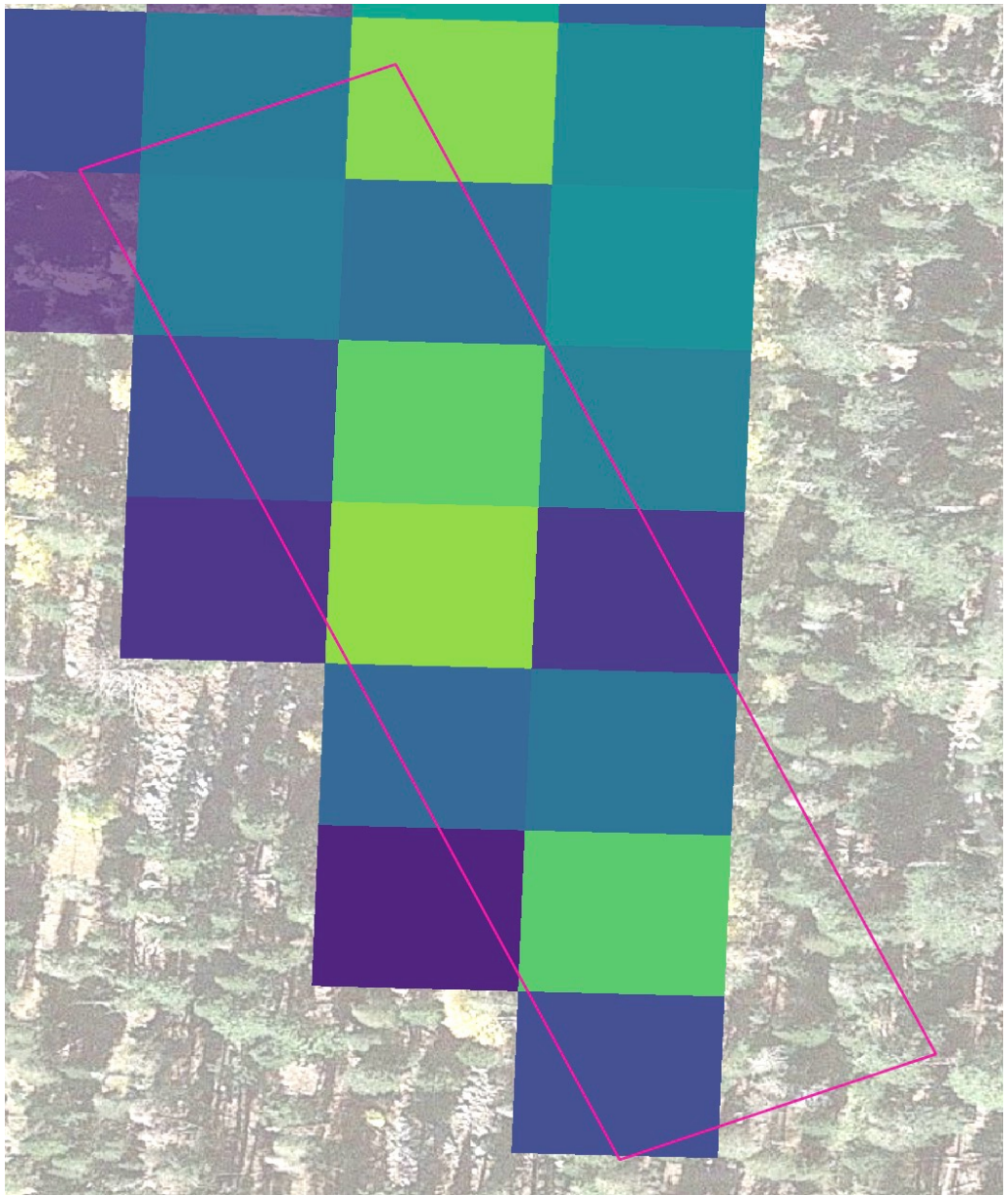
Aug. 2023

Marlette Lake - White Satin Moth

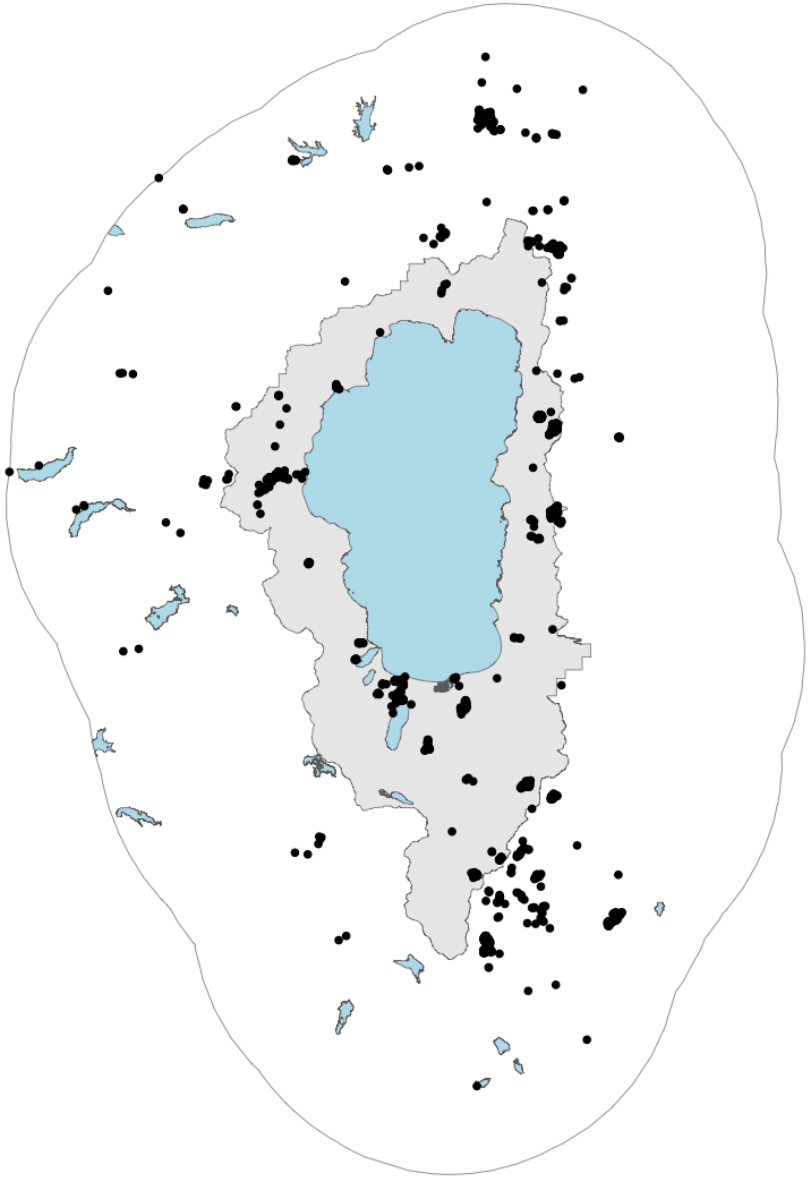


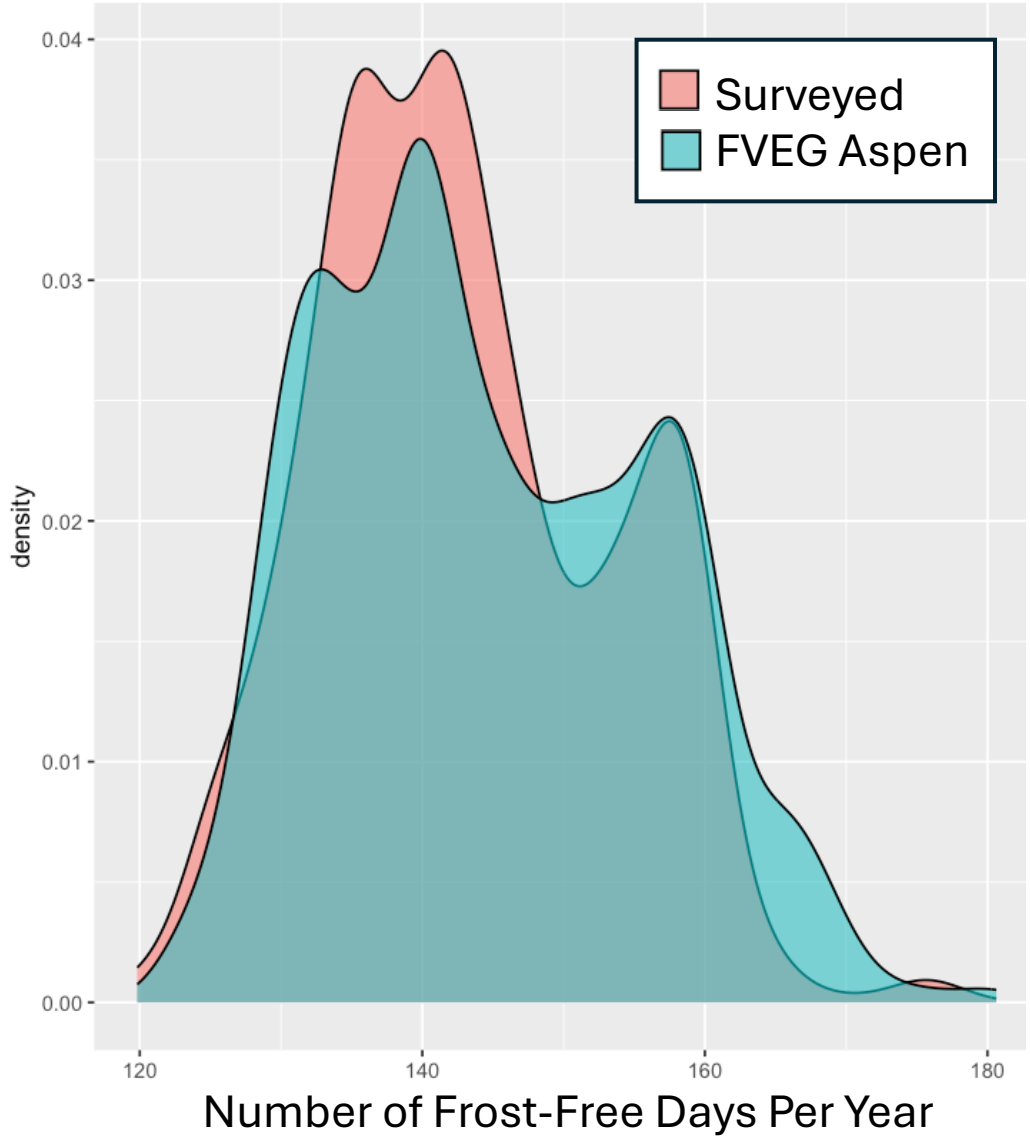


Vegetation Treatments to Promote Aspen



Surveys Stratified Across Broader Lake Tahoe Area





Survey Data

Surveys Focused on Aspen

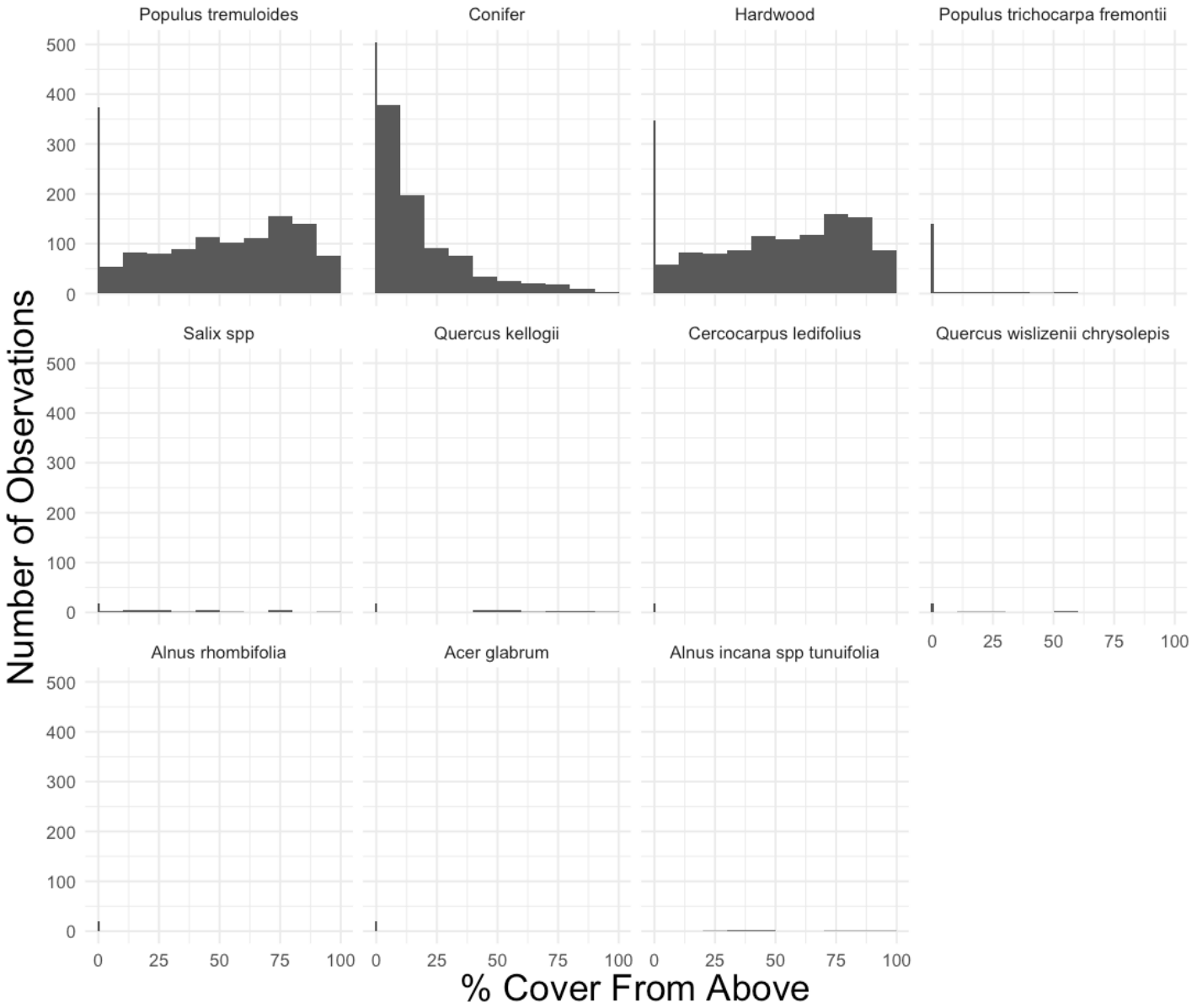
- 94% of hardwood tree cover recorded in surveys was classified as aspen
- 1,004 surveys with aspen present
- 375 surveys with no aspen

Number of Surveys:

- 1,405 surveys of 900-m^2 plots
  - USFS: 188
  - SIG: 927
  - UC Davis: 290
- 80 Larger No-Populus-Polygons
  - USFS – 77 polygons
  - SIG – 3 polygons

Sample Biases:

- Limited by where and when image quality allows confident vegetation identification.
- Young and low-growing trees are more challenging to identify.



Training Data

- Up to ≈ 3,000,000 rows
  - 1,395 surveys
  - ≈ 40,000 plots within “no-Populus polygons”
  - ≈ 40,000 pseudoabsence plots
  - Up to 39 year-year periods

- Up to 209 columns
  - 13 spectral bands
    - 6 bands from Landsat 4-7, 7 bands from Landsat 8-9
  - Up to 16 phenological periods

Takeaways

Model estimates of aspen distribution are remarkably accurate.

- In areas of disagreement with previous veg maps, our product appears to be correct in the large majority of cases.

Model estimates of percent aspen cover are moderately accurate.

- More data collection, data cleaning, and model tuning needed to improve models.

Model estimates of change in aspen cover over time show promise.

- The model appears to track some known instances of large-scale die offs and recovery.
- High-temporal-resolution predictions are noisy, especially in areas further from training data.
- More data collection, data cleaning, and model tuning needed to improve models.

Derek Young

Thank You

USFS
- Laura Young-Hart

UC Davis:
- Derek Young – Drone Flights
- Jen O'Brien – Aerial Surveys

SIG – Aerial Surveyors:
- Nick Miley
- Travis Freed

TSAC
Tahoe Science Advisory Council

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