Science to Action:
Working Together to Build Resiliency at Lake Tahoe

Biodiversity

Conservation

Biodiversity Panel Agenda

8:45 **Introduce Panel and Topic**

8:50 **Panel Presentations**

9:30 **Questions for Clarification**

9:40 **Small Group Discussion:** Priority topics in Science and Management

10:10 **Reports:** Key themes from small groups

10:25 **Final observations**

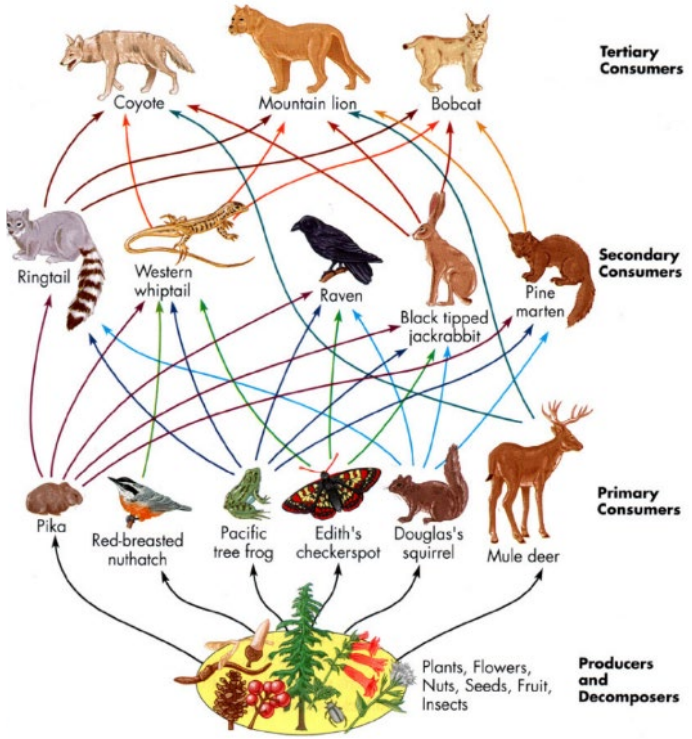
10:30 **Adjourn**

Presenters

Panelists

- Patricia Manley, US Forest Service Pacific Southwest Research Station
- Whitney Brennan, California Tahoe Conservancy
- Will Richardson, Tahoe Institute for Natural Sciences
- Mason Bindl, Tahoe Regional Planning Agency

Biodiversity: What do we need to worry about and what can we do about it?



Patricia Manley, PhD
US Forest Service
Pacific Southwest Research Station
Placerville, CA

https://www.fs.usda.gov/research/about/people/pmanley

Agents of Change acting on Biodiversity in the Lake Tahoe Basin

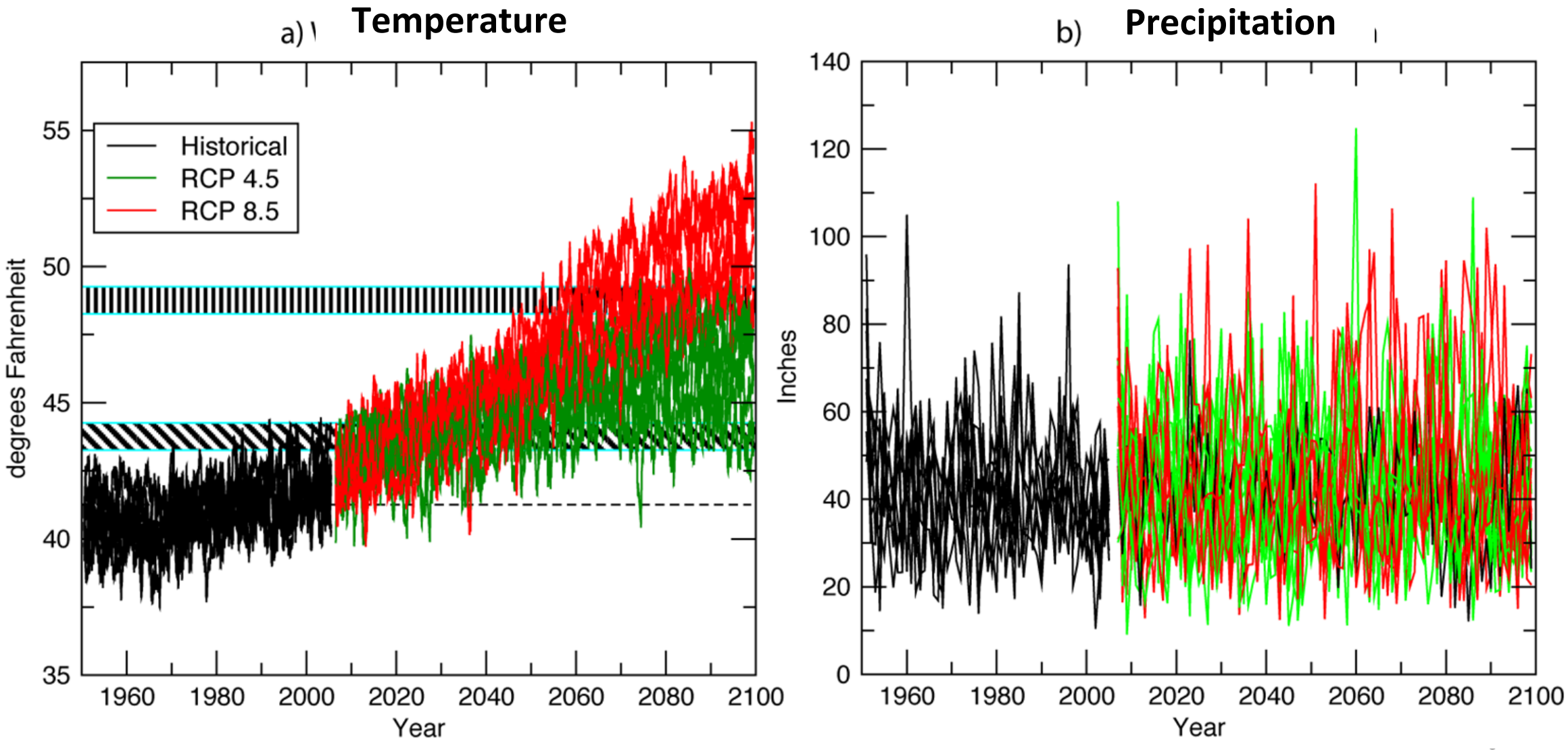
Climate

Invasives

Fire

Management

How is climate likely to change?

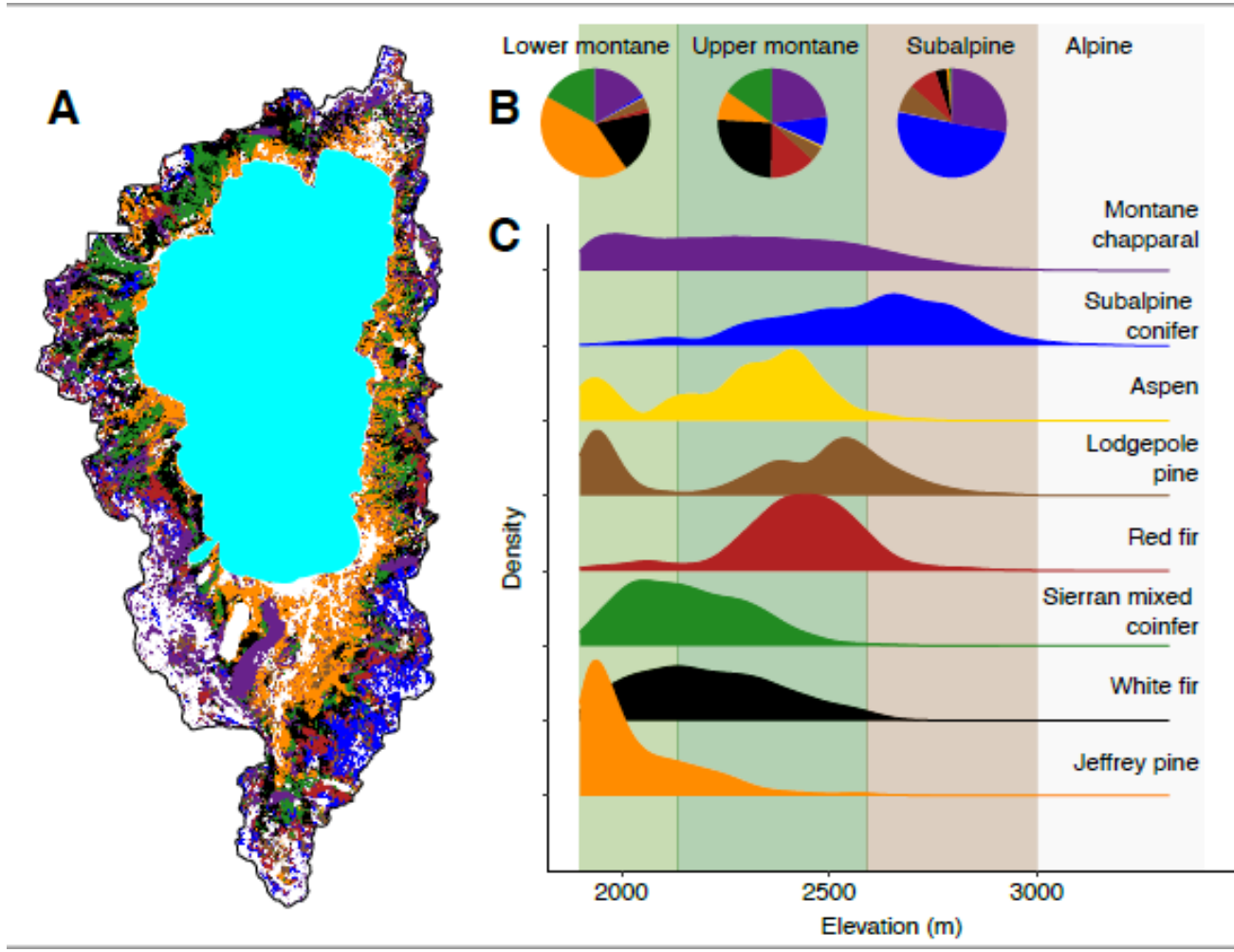


Dettinger and Rajagopal. 2023 Simulated hydrologic responses to climate change for the Lake Tahoe basin. Desert Research Institute. Pub. 41292

Where are we today?

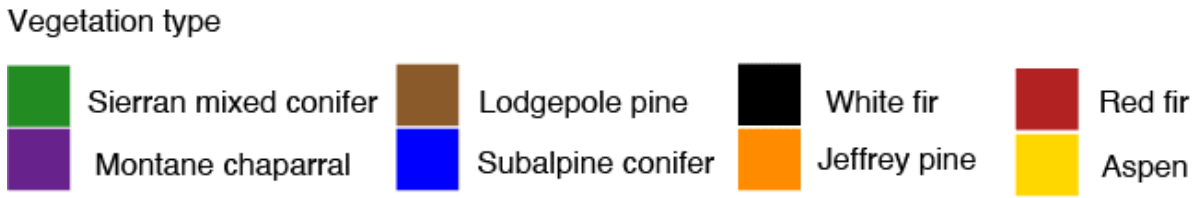
- Biophysical features
  - Elevational gradient
  - Bioregional transition

- Elements of biodiversity
  - Major forest types 8
  - Major aquatic types 8
  - Birds species 200
  - Mammal species 67
  - Reptile and amphibian sp 9
  - Tree species 13
  - Plant species 1262
  - Invertebrate guilds 730
  - Functional groups 118
  - Invasive species ?
  - Trophic integrity ??
  - Ecological integrity ???

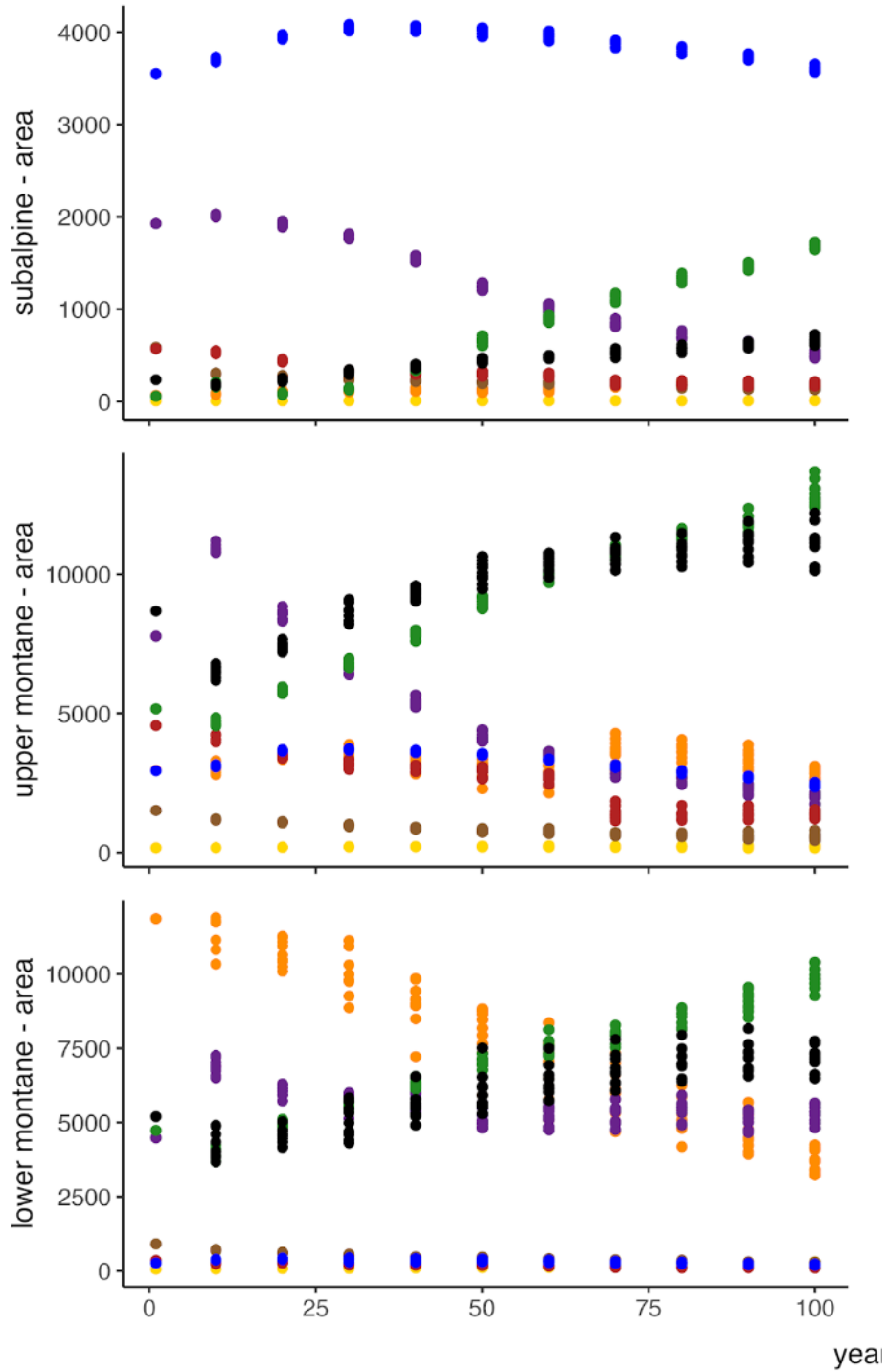


Courtesy of R. Wilcox, unpublished data, California Academy of Sciences

Next Century of Vegetation
Projections @ RCP 8.5



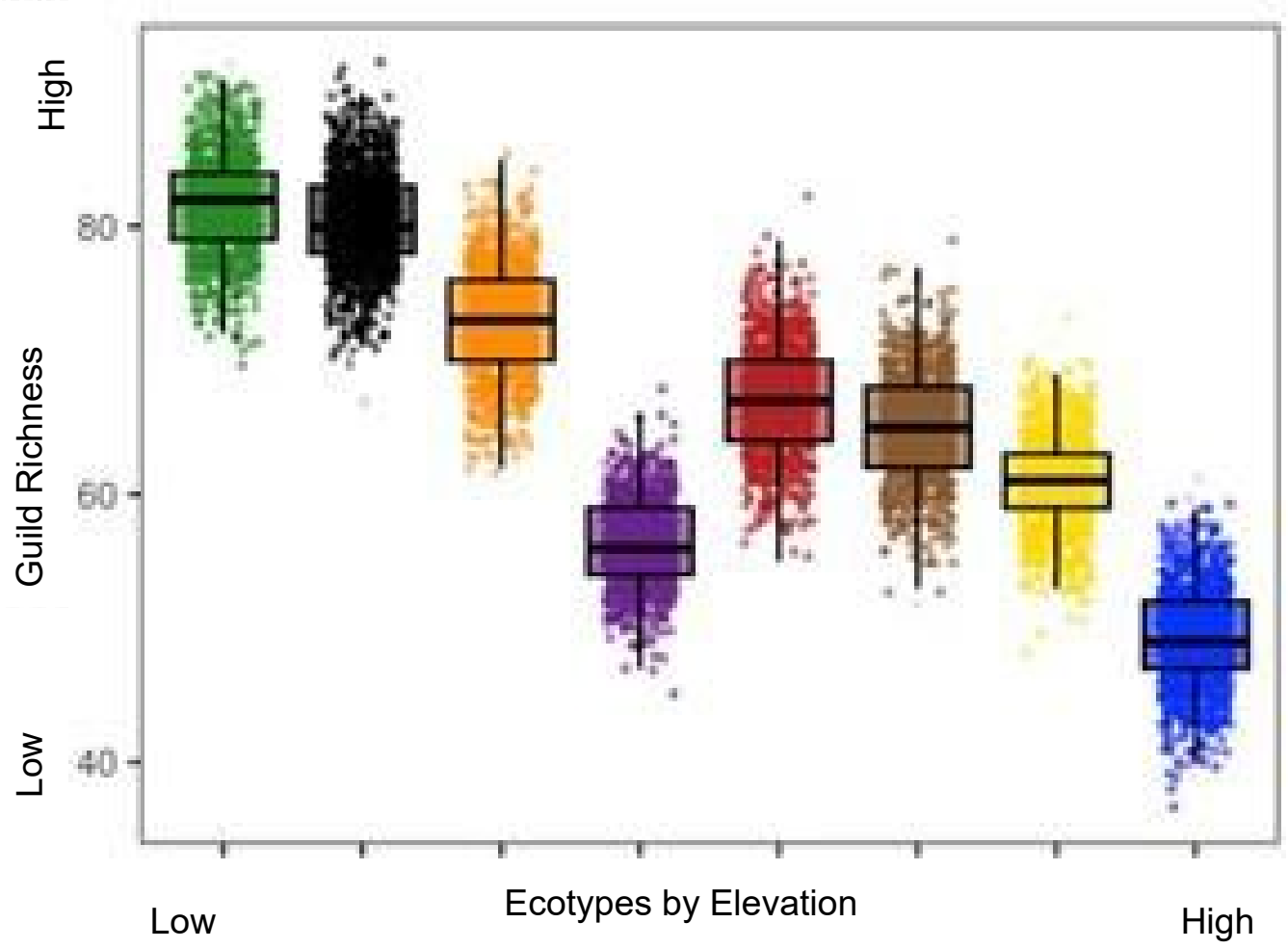
- Subalpine >8500 ft
  - SMC slight increase
  - MC decline
  - Least change overall
- Upper montane 7000-8500 ft
  - SMC and WF increase
  - RF and MC decline
- Lower montane < 7000 ft
  - SMC and WF increase
  - JP substantial decline



R. Wilcox, unpublished data, California Academy of Sciences

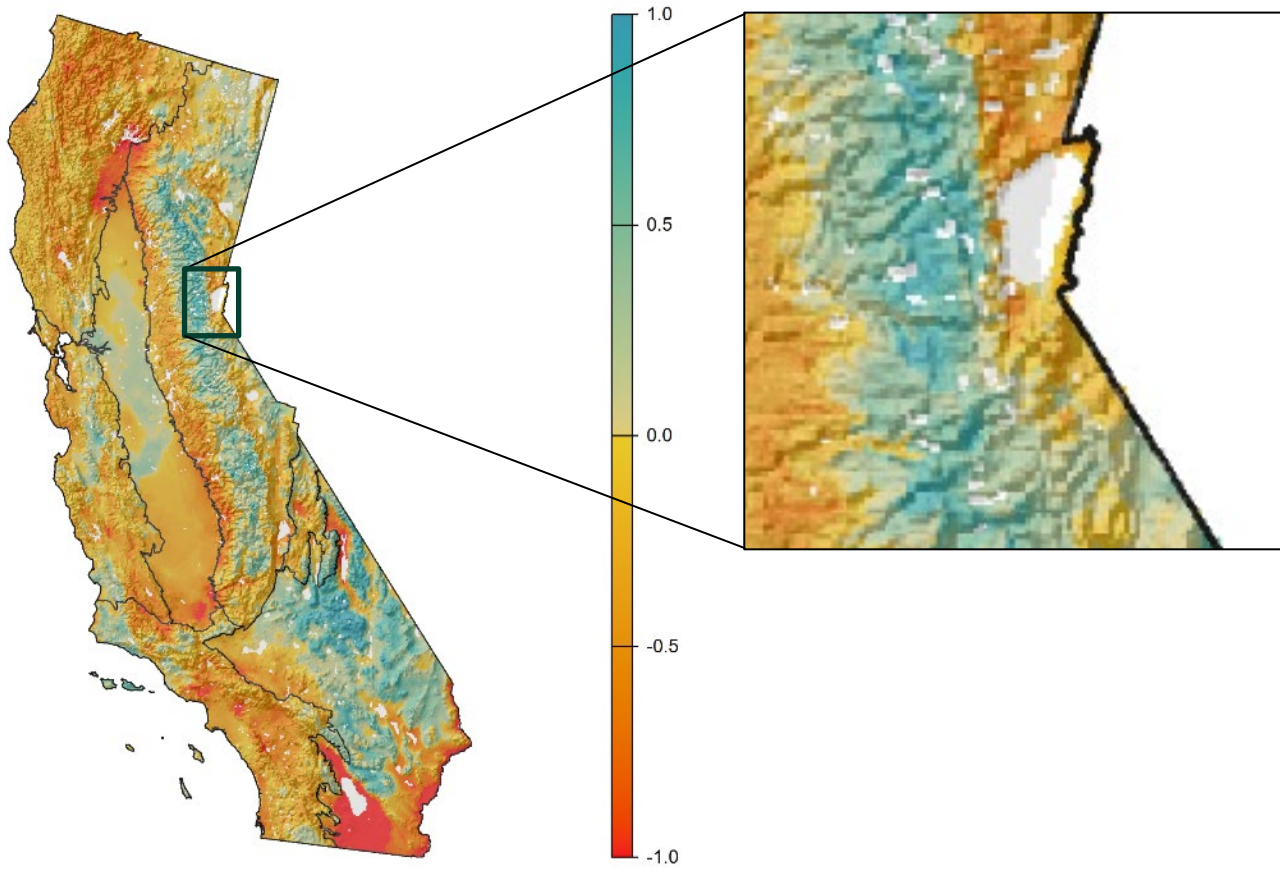
Anticipated Changes in Diversity

- Lower elevation ecotypes generally have higher diversity
- As those types move up in elevation, theoretically their associated species will follow
- Thus, based on CWHR, richness is projected to increase at higher elevations

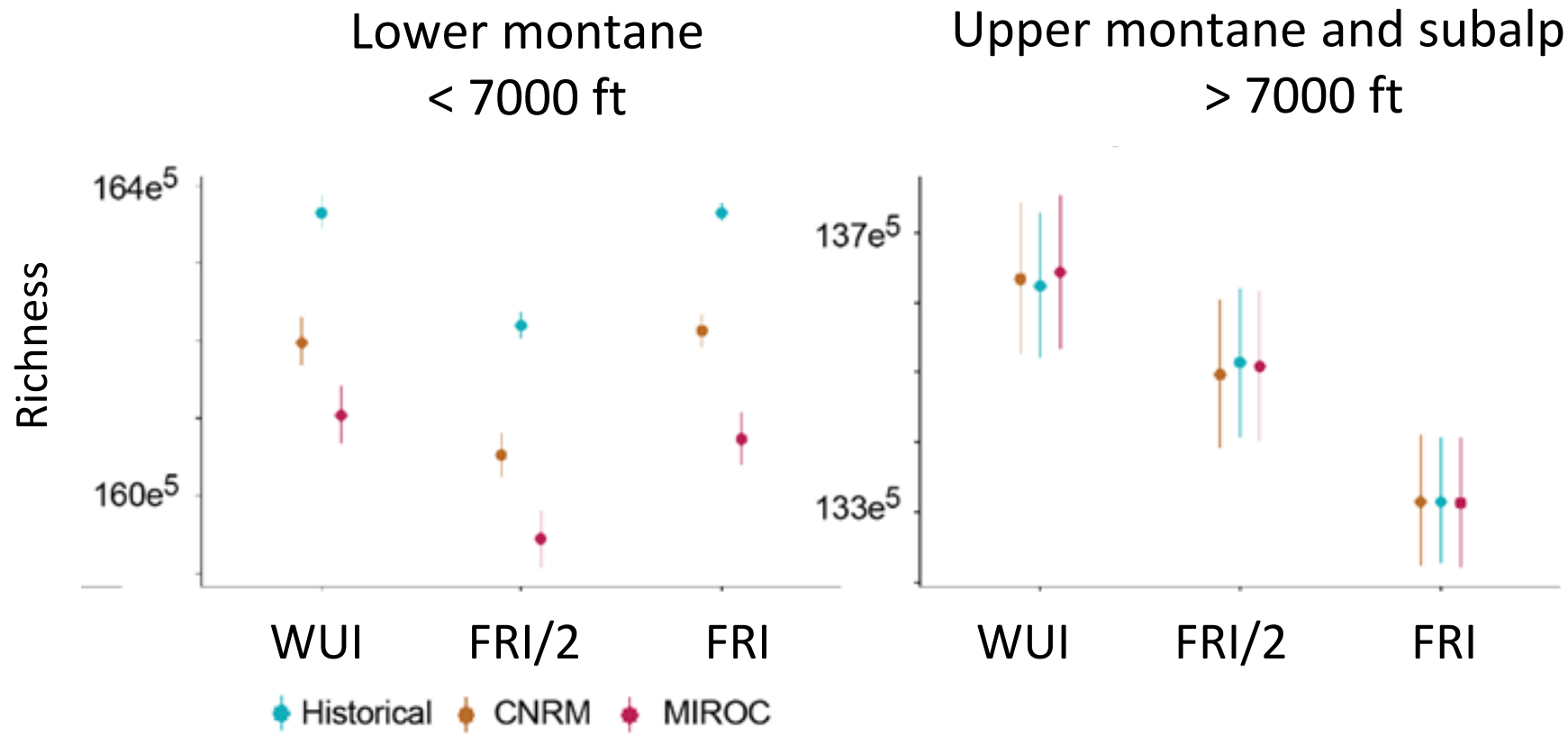


Climate Stability: Implications for Biodiversity

- However, climate analog modeling tells a little different story
- We anticipate declines in species richness
- Based on species richness at locations with climates today that match Tahoe's future climate



Elevation Matters:
Influence of Climate and Management Shift



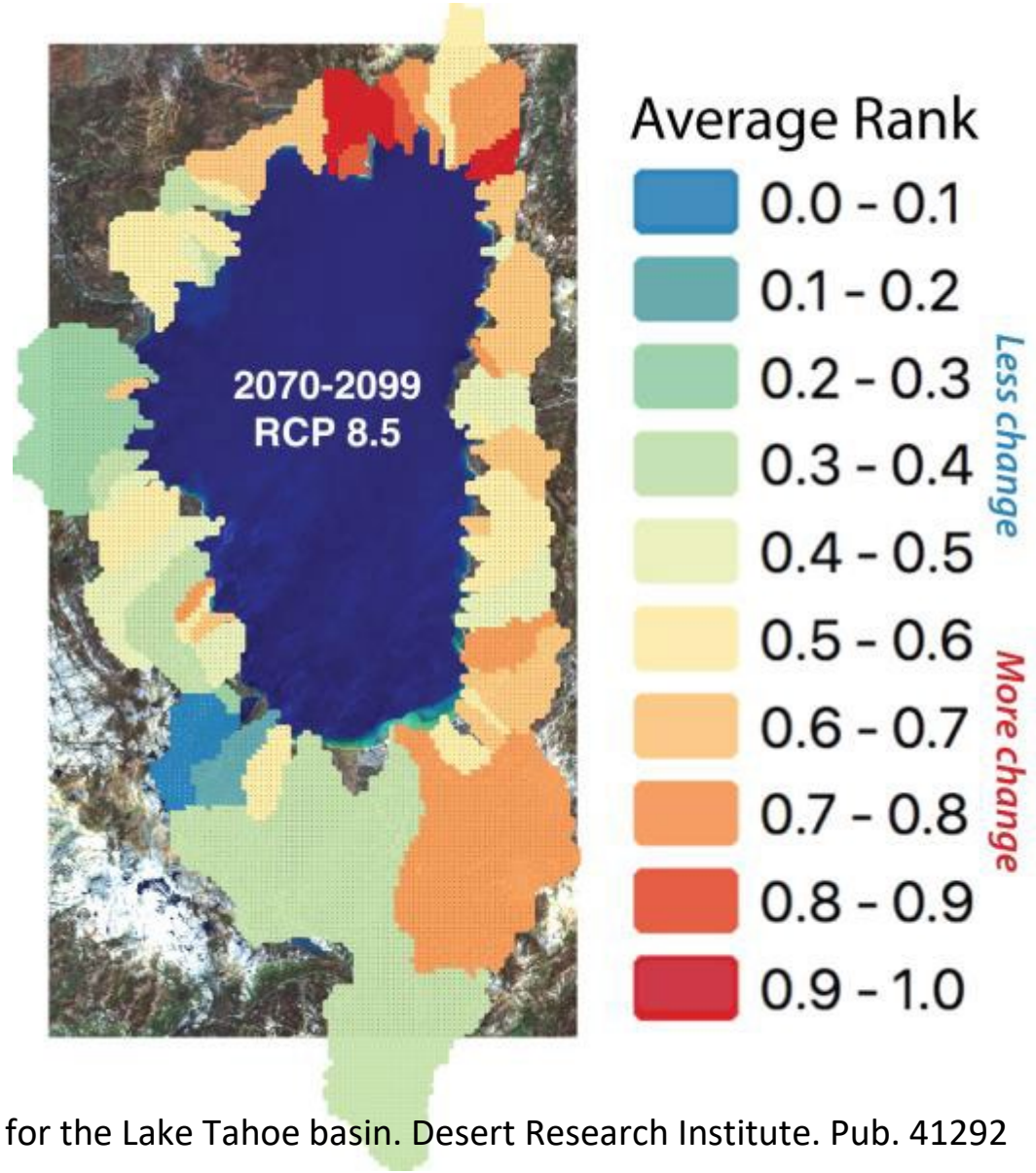
Zeller et al. In press. Managing for biodiversity: the effects of climate, management, and natural disturbance on wildlife species richness. Diversity and Distributions

Declines in the Number and Extent of Wetland Habitats

- Fate of aquatic ecosystems less clear but at high risk
- Lake Tahoe experiencing many changes
- Warmer stream temperatures and loss of habitat for cool water taxa at lower elevations
- Earlier drying and loss of smaller ponds and meadows

Climate Refugia Rankings by Watershed

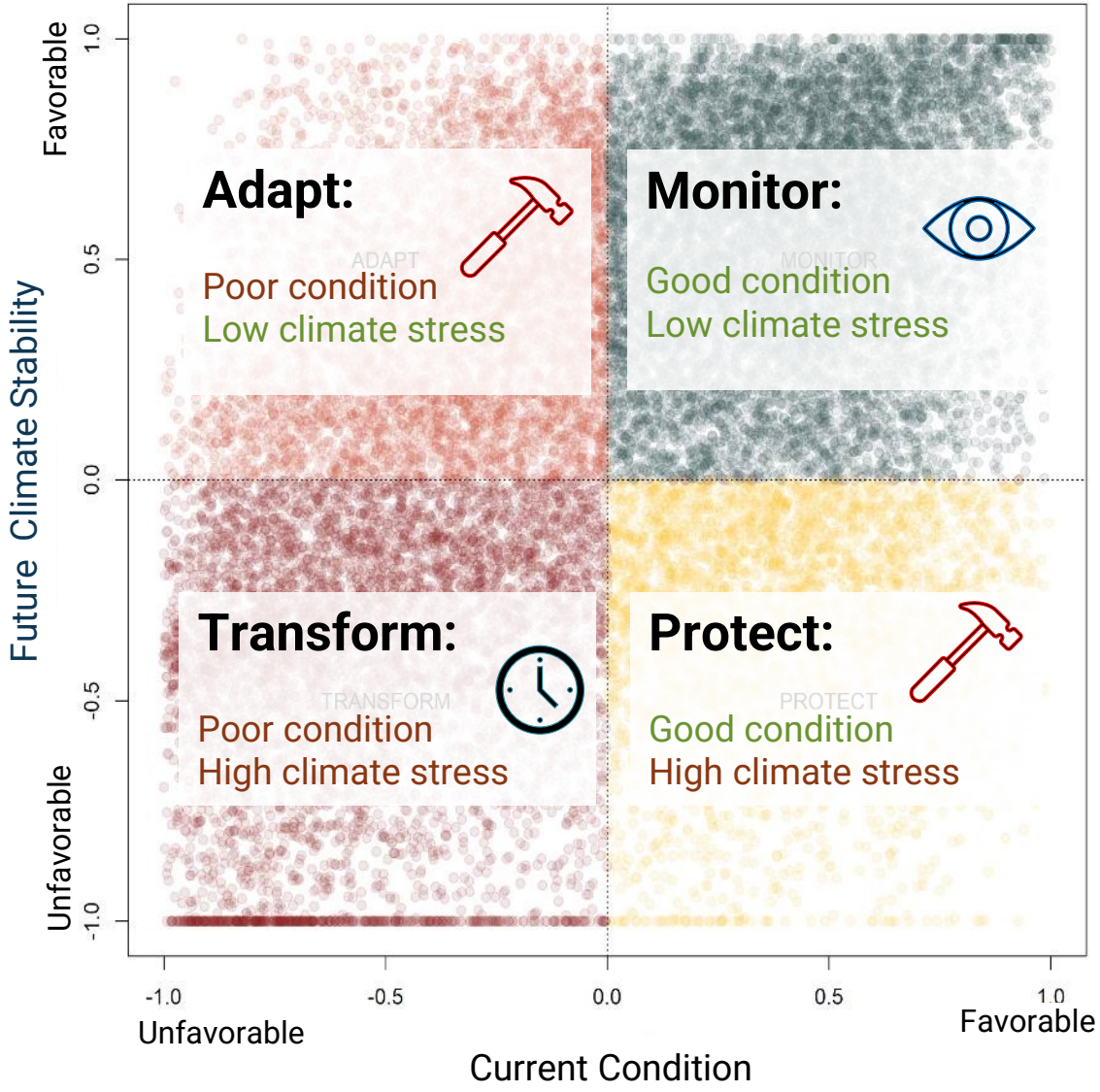
- Overall average of subbasin ranks of projected climate change impacts in the Tahoe basin by end of 21st Century under RCP8.5 emissions
- Composite of 9 different climate parameters and degree of change averaged across metrics and watersheds
- Even the best available modeling is limited in terms of being able to identify microrefugia that may buy time for some taxa and communities within and among watersheds



Dettinger and Rajagopal. 2023 Simulated hydrologic responses to climate change for the Lake Tahoe basin. Desert Research Institute. Pub. 41292

Principles of Large Landscape Management for Biodiversity and Resilience

1. Biodiversity “trade-offs” cannot be made across large areas without gambling with ecosystem resilience
2. Managing landscapes as mosaics - understanding where and how the landscape is best positioned to support various values over time - is an effective way to achieve multiple objectives
3. The longer we can conserve high biodiversity conditions - the better, particularly those that are irreplaceable within ~50 yrs
4. Locations anticipated to experience the greatest climate stress are also most vulnerable to state change from disturbance – fire or management



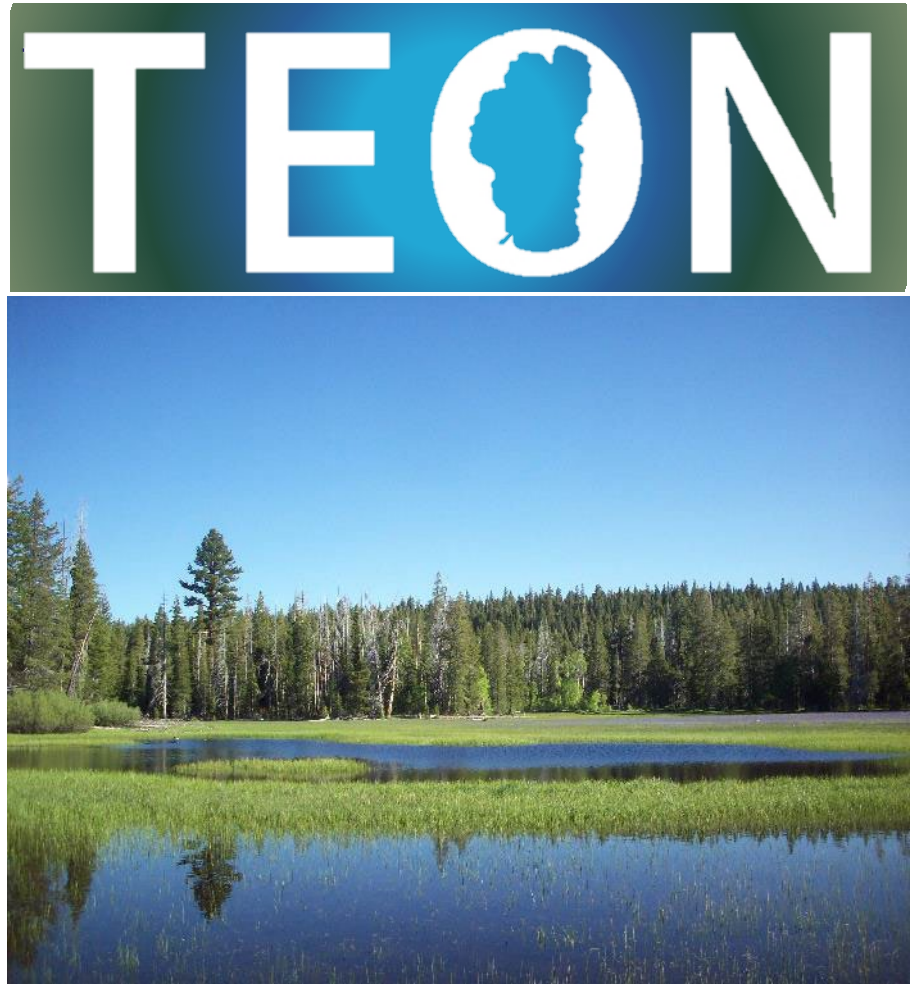
Uncertainty about…. nearly everything

- We lack a solid foundation for what will be most resilient and how or if it can be achieved ➔ “desired condition” is complicated
- A few things we do know..
  - Historical conditions no longer reliable as a singular frame of reference for resilience

  - We will gain and lose species, but less certain which ones, where, and what it will mean for ecosystem resilience
  - There will many things we won’t anticipate - positive and negative
  - We will need to intervene to conserve the biodiversity in the basin
  - We need effective and comprehensive monitoring more than ever

Tahoe Environmental Observatory Network

Designing a world-class environmental monitoring system for the Lake Tahoe Basin



Global Water Center
University of Nevada, Reno
Solutions for sustainability℠

USGS
science for a changing world

TAHOE REGIONAL PLANNING AGENCY

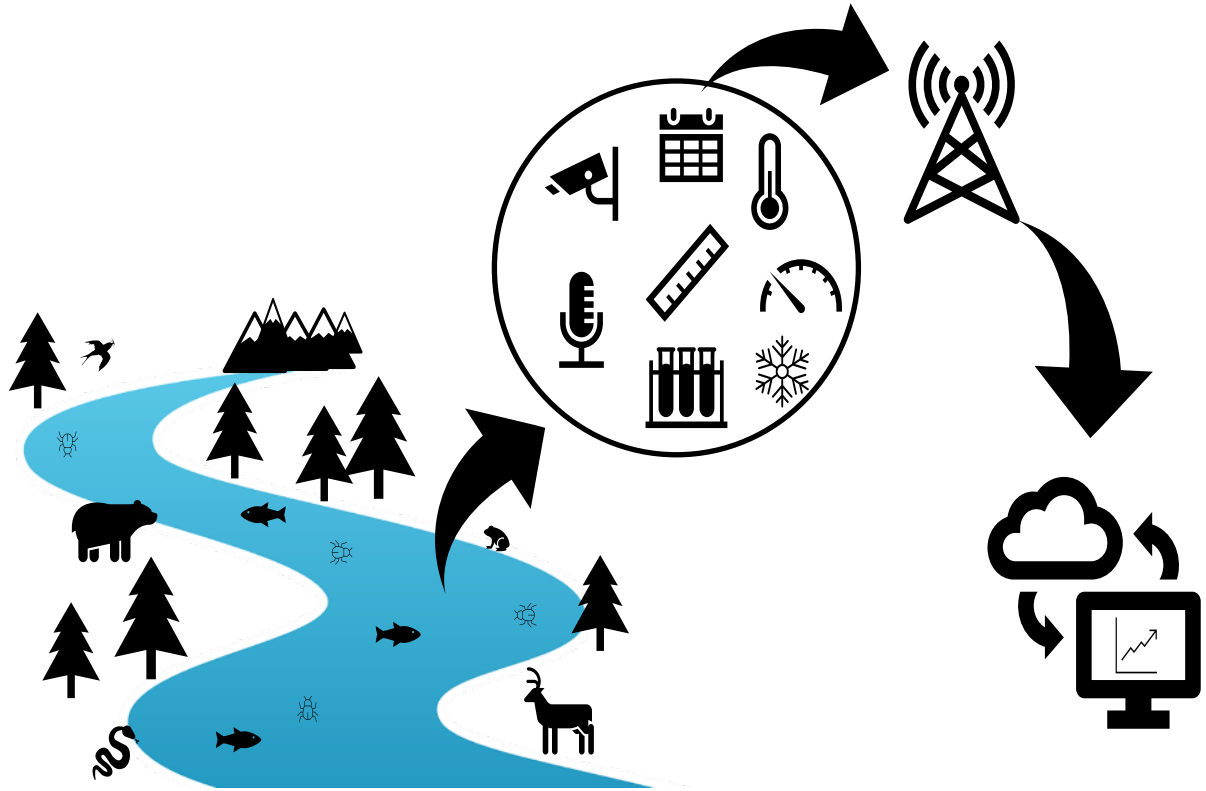
Nevada Division of STATE LANDS

CALIFORNIA TAHOE CONSERVANCY

CALIFORNIA STATE PARKS

California Water Boards

Objectives



- Enhance understanding of resilience of Tahoe basin to climate change and other disturbances
- Provide early warning signs of undesirable change
- Quantify how linkages among upland, wetland, and aquatic systems affect environmental quality, vulnerability and resilience
- Enhance community awareness and participation in monitoring

What we don't know but need to….

1. Where, how, and why do we put biodiversity as a top priority across the LTB?

Western pond turtle recently listed as federally threatened due to rapid population declines

- How do we want to classify and characterize different facets of biodiversity for the purposes of landscape design across the basin and over time?
- What are the rank values for biodiversity conservation across the basin based on current conditions?
- Where is climate most likely to support current and recruit future areas of high value biodiversity?
- What are some landscape design strategies that facilitate both near-term conservation and longer-term climate adaptation?
- Where are areas of low and high conflict between biodiversity conservation and other ecosystem values?

What we don't know but need to….

2. How can we effectively participate in the changes that are coming?

Pika are disappearing from the basin due to changing climate

- How can we support and implement basin-wide monitoring of biota and ecotypes that helps us detect, understand, and adapt to change?
- What species and communities are likely to require intervention beyond mainstream management practices in order to retain them in the basin?
- What species and communities are likely to become rare or potentially lost within the basin with or without management investments?
- How can we work more effectively with traditional Indigenous practices?
- How can we invest in continuous improvement of basin-specific data that takes advantage of broad-scale and locally derived sources?

Acknowledgements

Nicholas Povak, Pacific Southwest Research Station
Katherine Zeller, Rocky Mountain Research Station
Rebecca Wilcox, California Academy of Sciences

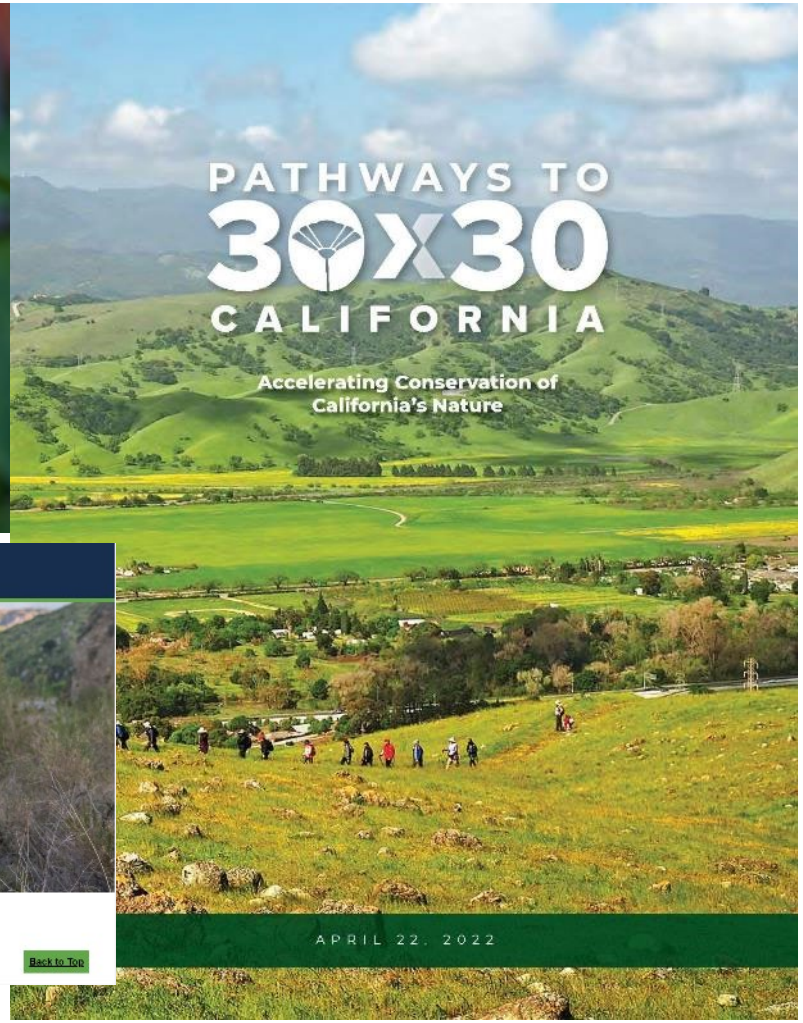
Biodiversity: What are the driving issues for the State and Managers in the Basin?

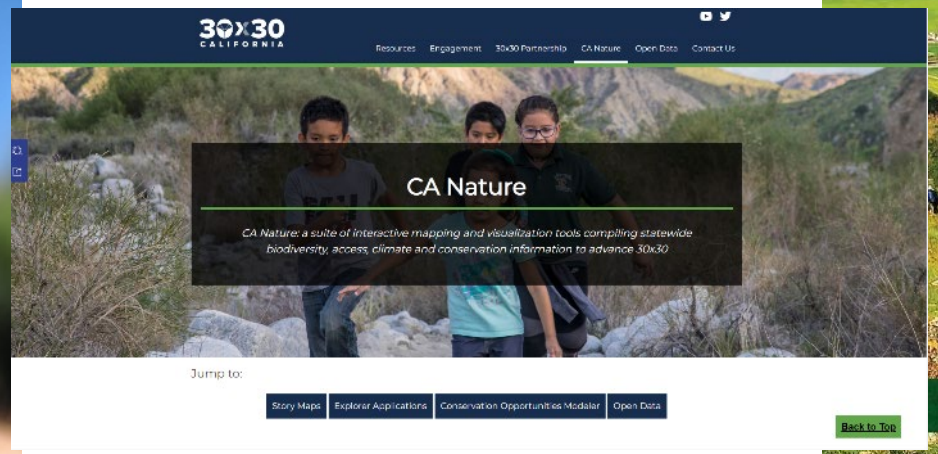
Management Perspective

Whitney Brennan, PhD
California Tahoe Conservancy

CALIFORNIA
TAHOE CONSERVANCY

Biodiversity in California

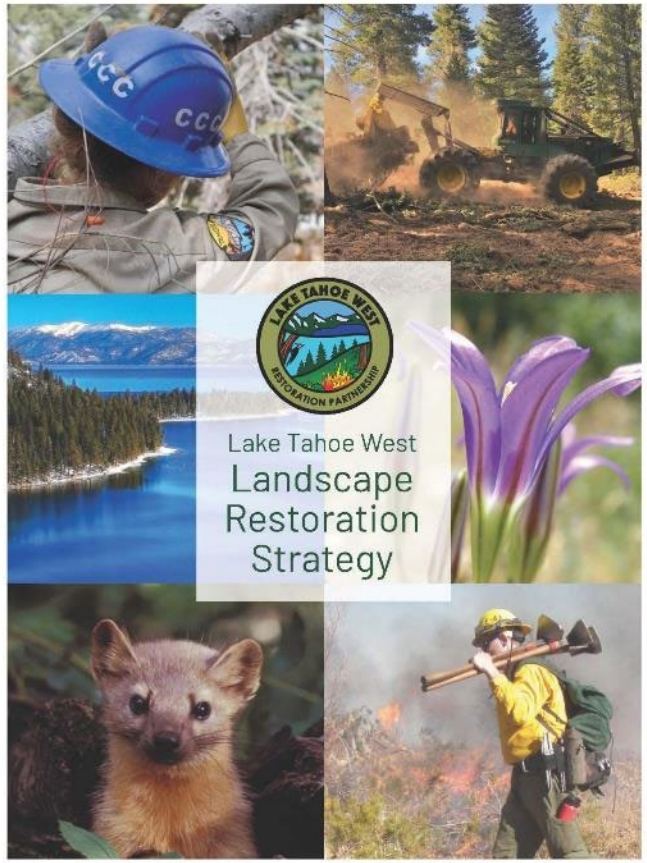




Biodiversity at the Tahoe Conservancy



Landscape Scale Considerations



Biodiversity: What else do we need to worry about?

Non-governmental Organization

Independent Science Perspective

Will Richardson, PhD
Tahoe Institute for Natural Science

tinsweb.org

Opportunities for Consideration

- Scales - both of the problems to be investigated, and the actions we can take

- Desired Conditions
  - historical conditions and maintenance of current conditions - out
  - need to ask ourselves some deeper philosophical questions that many of us haven't been: what ARE the desired conditions, why, on what basis, and can we actually aim for that target?

- Updating TRPA thresholds – now's a great time to take a good look at types of indicators/metrics/indices chosen – Golden Eagle?!?

Biodiversity is more than just species richness

- Types of indicators/metrics/indices chosen
  - Community metrics (species richness, diversity, abundance)
  - T/E, umbrellas, indicators, flagships (chosen wisely)
  - Guilds, functional groups, keystone species
  - Predators (top-down), plants and invertebrates (trophic foundation)

Choose Wisely

- All of these tools and recommendations are built on models, and the models are limited by the baseline data that we already have and especially those we collect moving forward

- Data collection is expensive

- Time even more so – the right baseline, pre-treatment, or pre-disturbance data are priceless

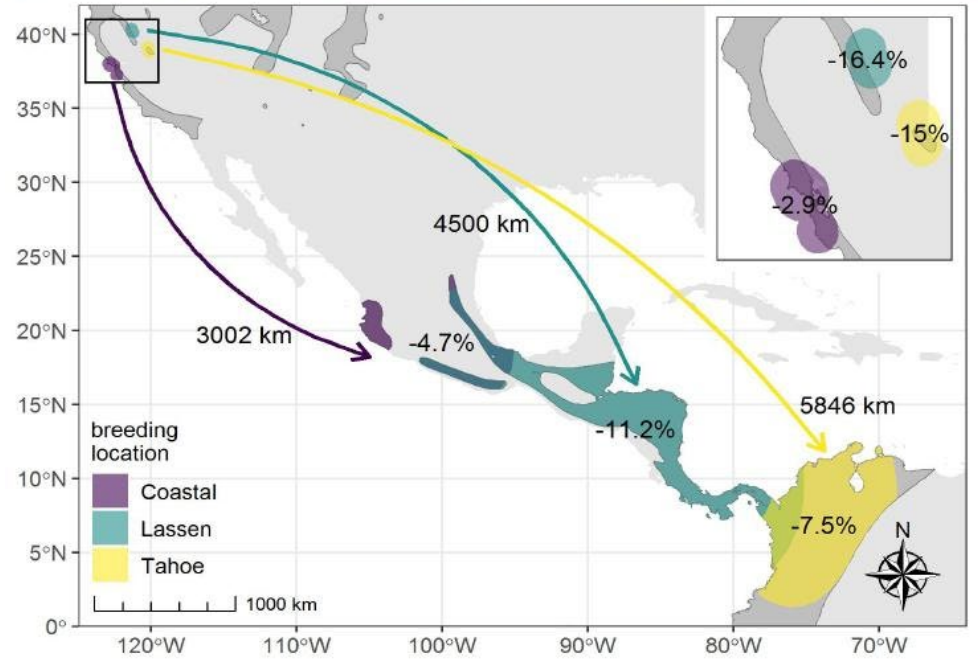
- We tend to monitor certain taxonomic groups that are cost-effective, conveniently species rich, conspicuous, responsive to change, inertia of having baseline data
  - Birds and small mammals

- Opportunity to include other groups that haven't been monitored well, but which have critical roles for ecosystem function:
  - Invertebrates
  - Montane rabbits

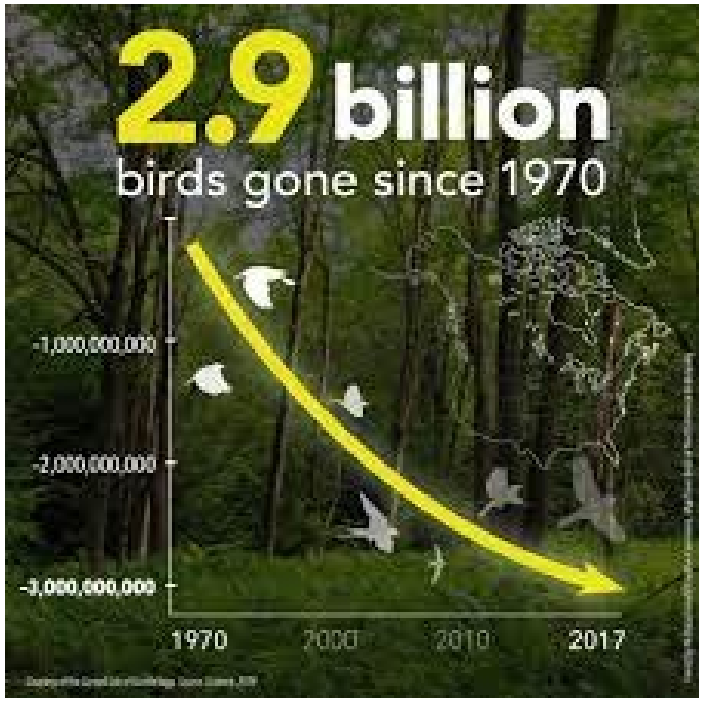
Species presence does not equal species health

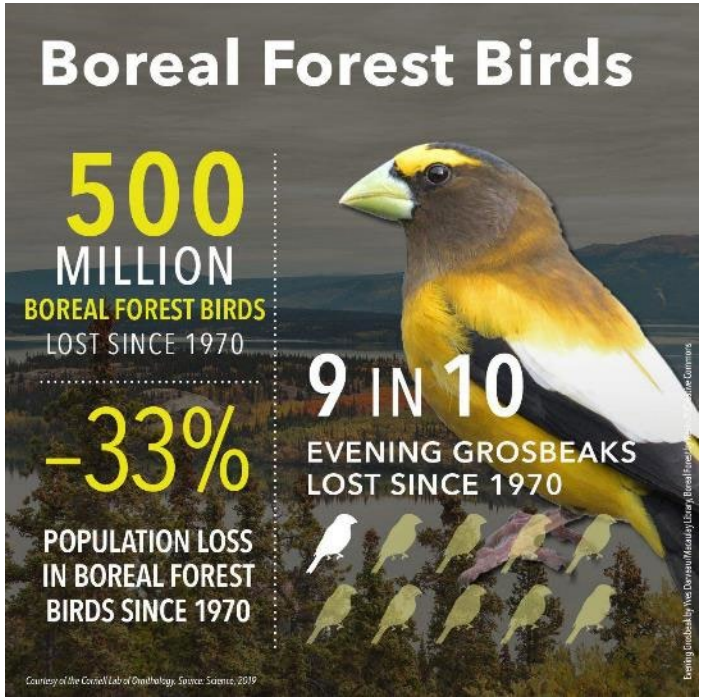
- Need to include abundance measures in our monitoring.
- It's no good to manage for species-rich sinks – how do we know?
- We also need to combine large-scale occupancy and community monitoring with fine-scale field studies that investigate productivity, survivorship, dispersal

Connectivity scales and complete life history considerations



Trends that reach far beyond our regional management scale





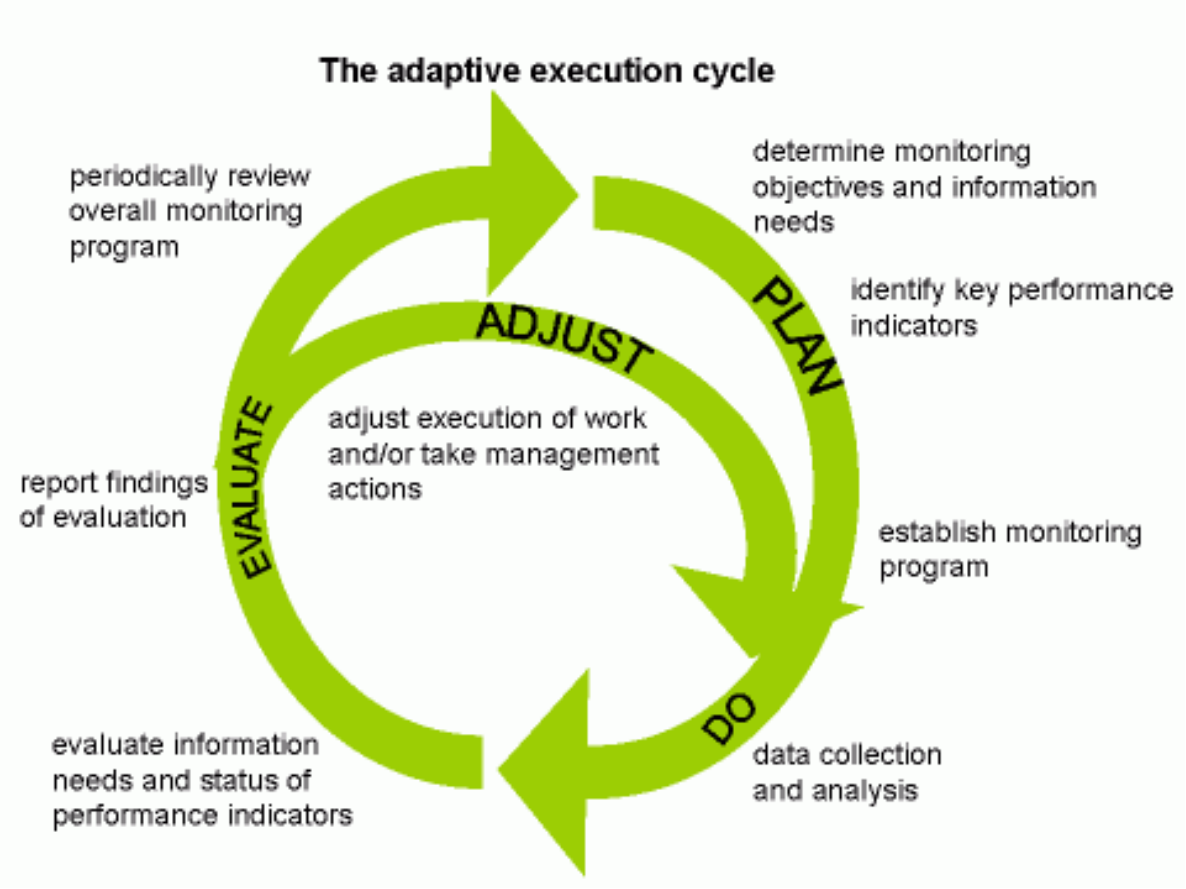
- When thinking about management actions, we do need to think in terms of scales, habitats, and variables that managers can do something about

- Wet meadow, riparian, and aspen may be underrepresented in some of our large-scale, forest-focused efforts
  - centers of biodiversity
  - provide other benefits: hydrologic impacts, natural firebreaks, cultural

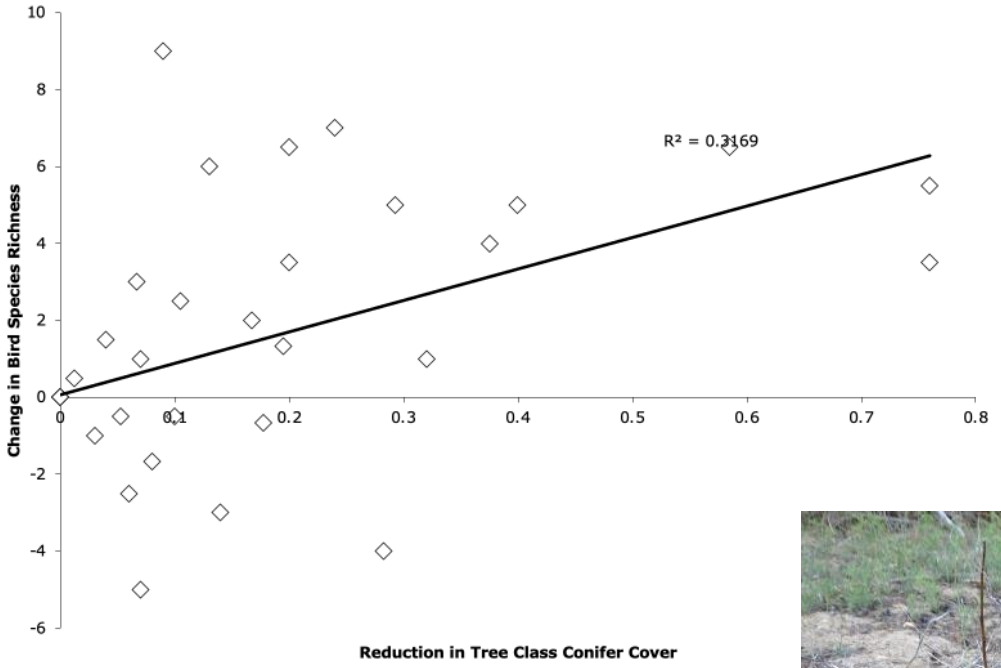
- Focused management can have positive umbrella effects at various scales

Monitoring and Adaptive Management

- Monitoring is critical to process for a tight feedback loop to inform both the models and land managers, esp. as we ramp up management practices



Monitoring and Adaptive Management



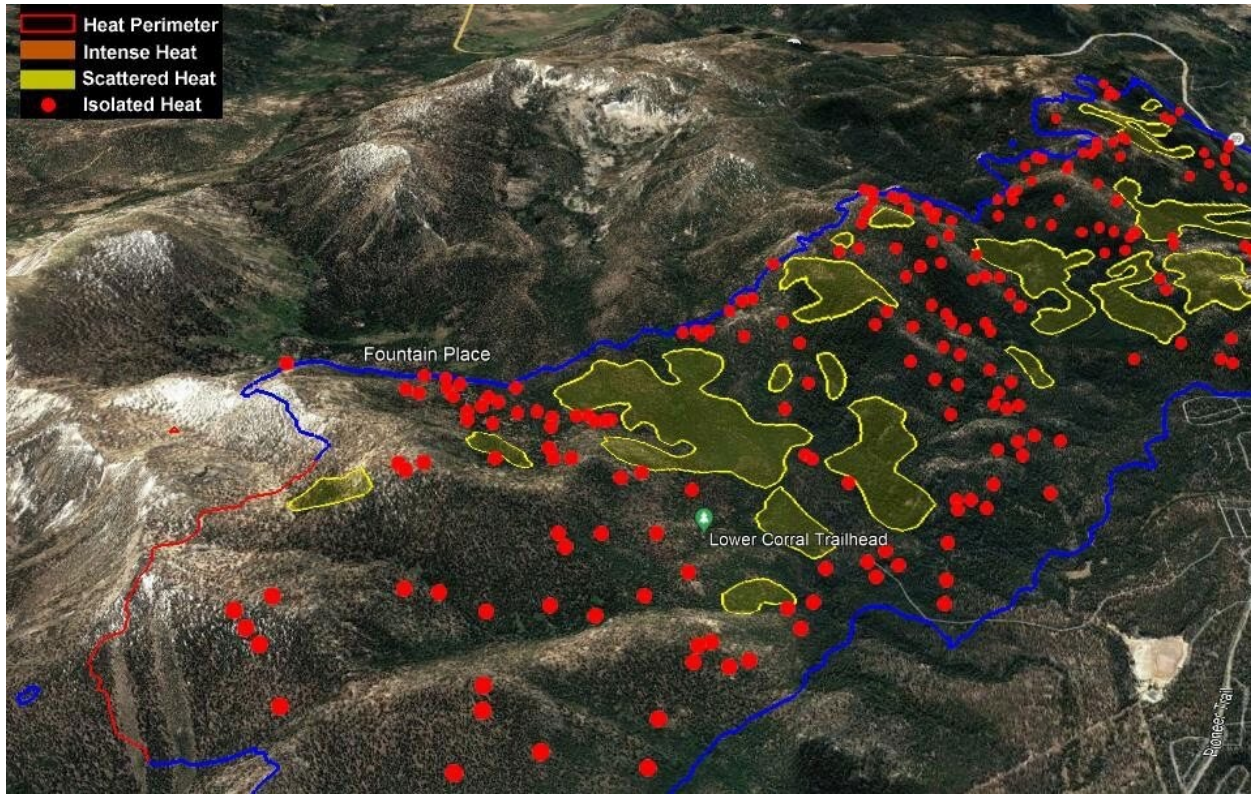
Power, sample size issues + stochasticity

Table 1. Aspen avian point count stations sampled and treatment status per treatment cluster per year (2002-2021).

Years	2002-2004	2008 [b]	2009		2010		2012		2016		2018-2020	2021	
Treatment Status	Pre-	Pre-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-		Pre-	Post-
Cluster (*n*)													
Big Meadow (9)	9												
Blackwood Canyon (6)			6		6		2	4		6			6
Christmas Valley (7)			7		7								
Christmas Valley, Upper (4)					4			4		4			4
Cold Creek (9)			9										
Fountain Place (6)	6		6						6		6	6	
Glenbrook Creek (11)	11										11		
Logan House Creek (8)	8	8	8						8		8	8	
Marlette (10)	10	10									10		
North Canyon (21)	21	21									21		
Page Meadows (12)	12												
Secret Harbor Creek (10)		10					6	4	6	4	10	6	4
Tallac/Taylor Creeks (7)			5	2	5	2	1	6	1	6		1	6
Tunnel Creek (5)	5	5									5		
Ward Creek (11)			11		5	6	5	6	5	6	11	1	10
Total (annual total)	82	54	52	2 (54)	27	8 (35)	14	24 (38)	26	26 (52)	82	22	30 (52)

Weather, invasives, fires, outbreaks of pests – there are sure to be surprises

Weather, invasives, fires, outbreaks of pests – there are sure to be surprises



Biodiversity: Science Modeling and Monitoring

Data Management and Application Perspective

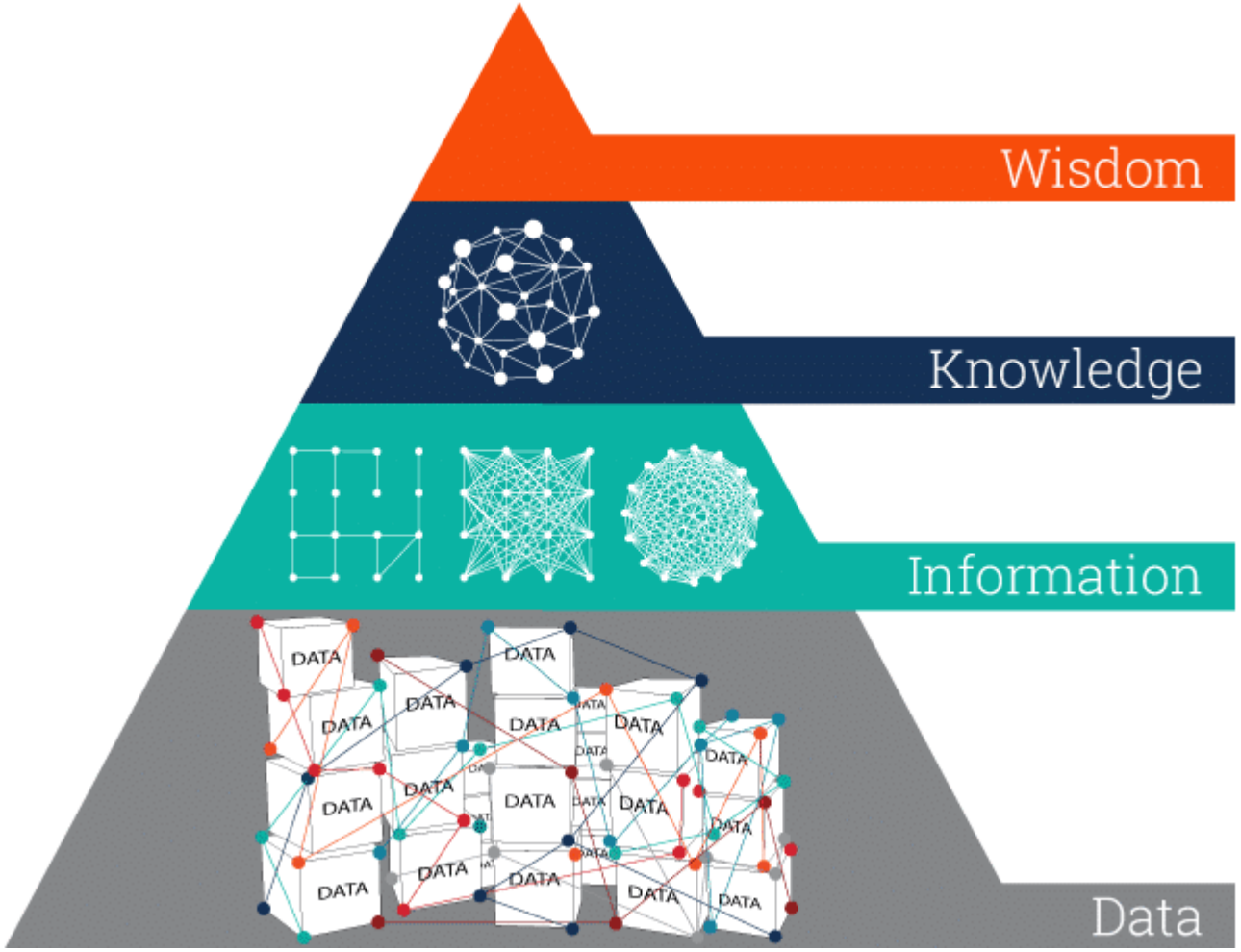
How do we keep up with the science?

Translating science modeling and monitoring into actionable information for managers

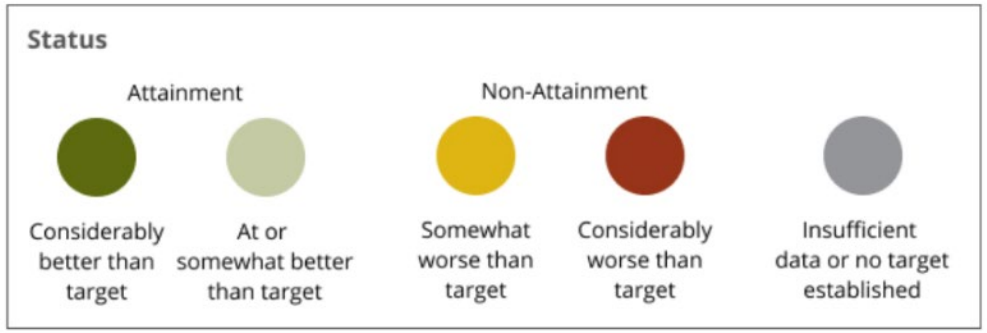
Mason Bindl
Tahoe Regional Planning Agency

Science Data to Information for Managers

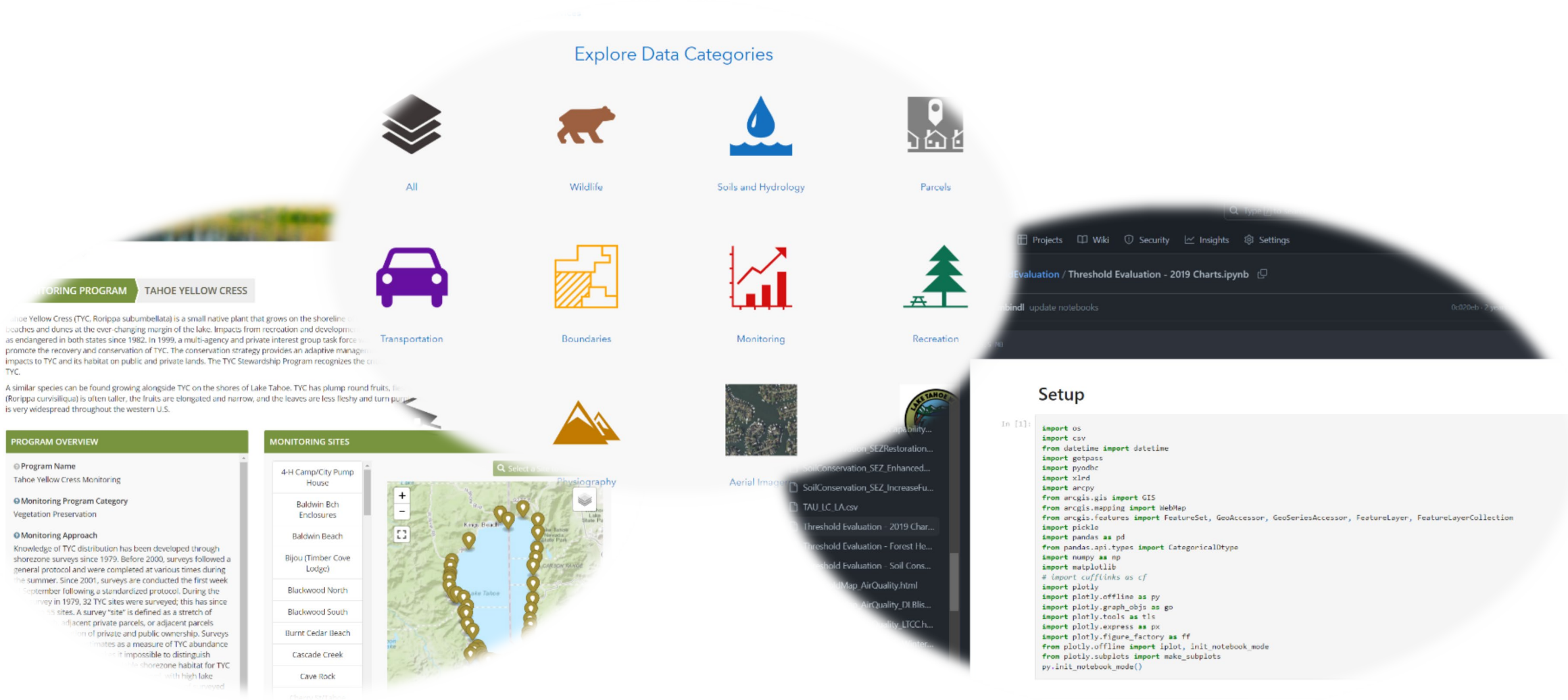
- Measuring what matters
- Frame the problem for scientists
- Feedback loop
- Modeling and monitoring data that informs decisions
- Timeliness of the info



Establishing Status and Trend

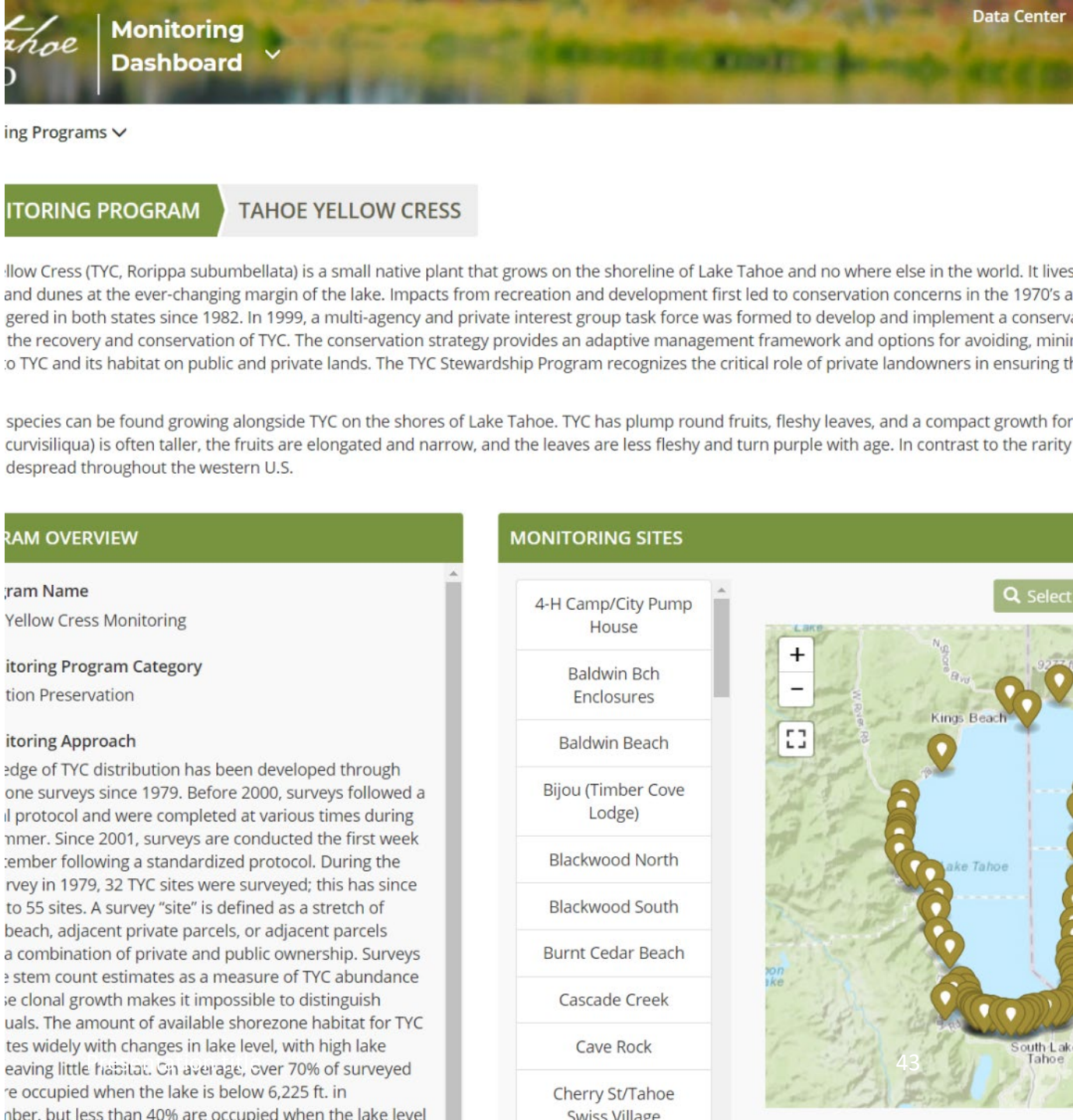


Transparent, Accessible, Reproducible



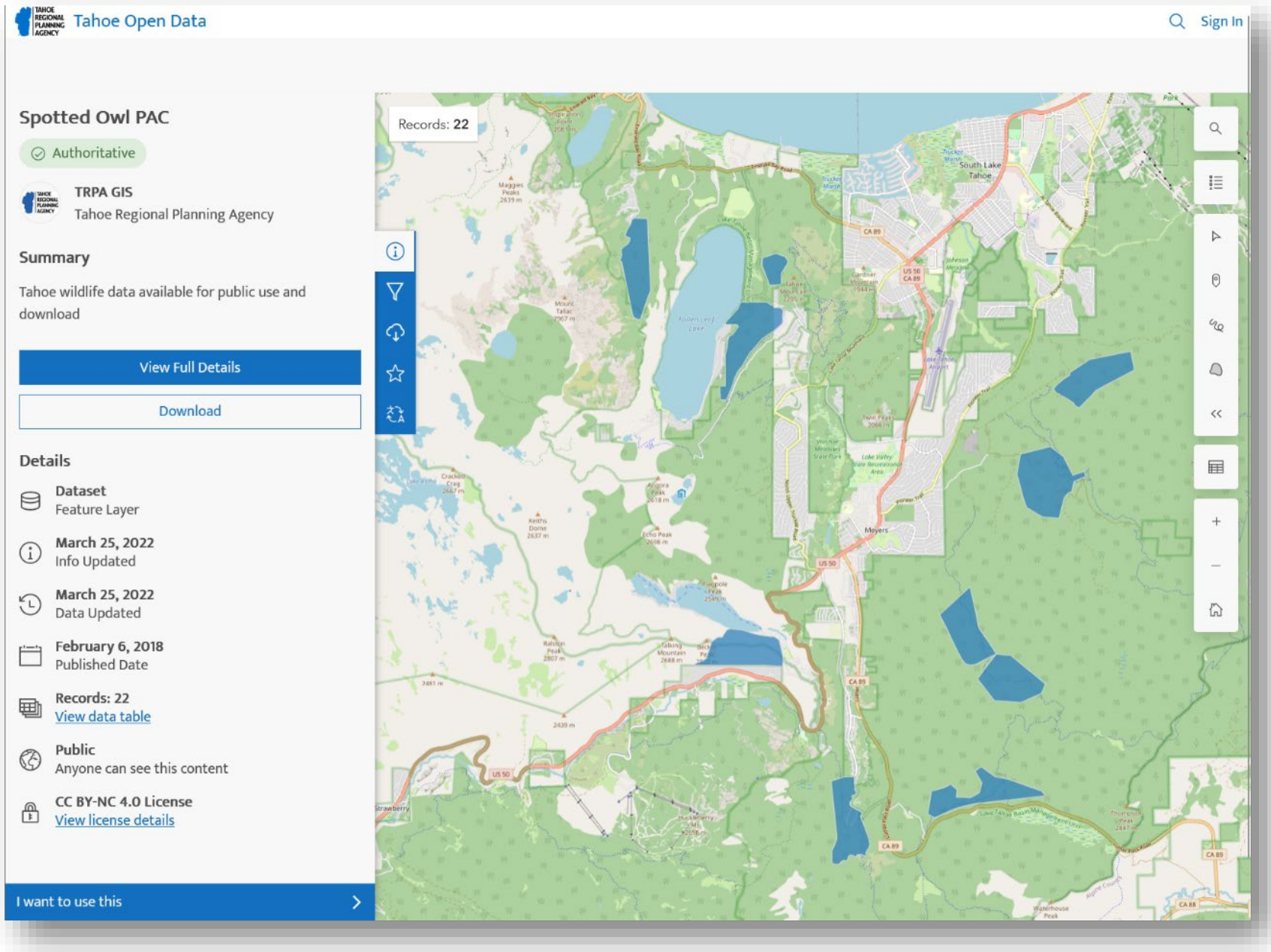
Transparent

- Summarizing and visualizing data to communicate key results
- Distilling complex analysis into a user-friendly format
- Methods available



Accessible

- Well organized/easy to find
- Multiple formats available
- Automated updates
- Comprehensive metadata
- We will host your Data!



Reproducibility

- Clear concise methodology
- New input/timely results
- Jupyter Notebooks!
- Version control on GitHub

Large Tree Density

Methods

- Extracted climate classes by contemporary reference sites to use as the zonal input to calculate 10th and 90th percentile of number of Trees Per Acre >30in DBH
- Extract by mask Tahoe Climate Classes and Tahoe number of Trees Per Acre >30in DBH values
- Classify new rasters of 10th and 90th percentile for Tahoe by climate class
- Compare current Tahoe number of Trees Per Acre >30in DBH pixel values to 10th and 90th percentile climate class/reference site values and classify whether the pixel is below target (<10th percentile), at target (between 10th and 90th percentile, or above target (>90th percentile)

In [3]:

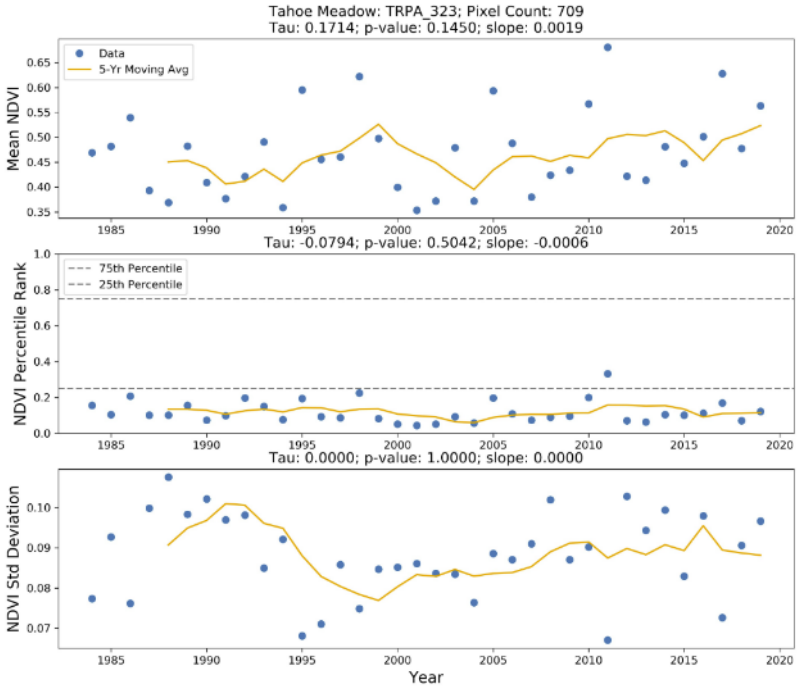
```
# save integer version of large tree density and extract by mask to Tahoe
Int(
    in_raster_or_constant="F:\GIS\PROJECTS\ForestHealth_Intiative\ThresholdUpdate\Data\Download\ACCEL\DensityLargeTree
    out_raster="LargeTreeDensity_TPA30inUp_ACCEL_30m_SierraNevada"
)
# extract by mask to Tahoe extent
out_raster = ExtractByMask(
    in_raster="LargeTreeDensity_TPA30inUp_ACCEL_30m_SierraNevada",
    in_mask_data=r"F:\GIS\DB_CONNECT\Vector.sde\sde.SDE.Jurisdictions\sde.SDE.TRPA_bdy",
    extraction_area="INSIDE",
    analysis_extent='-214749.813147473 -338358.008101731 228897.27559438 457005.517540967 PROJCS["NAD_1983_California_
)
# save.
out_raster.save("LargeTreeDensity_TPA30inUp_ACCEL_30m_Tahoe")
```

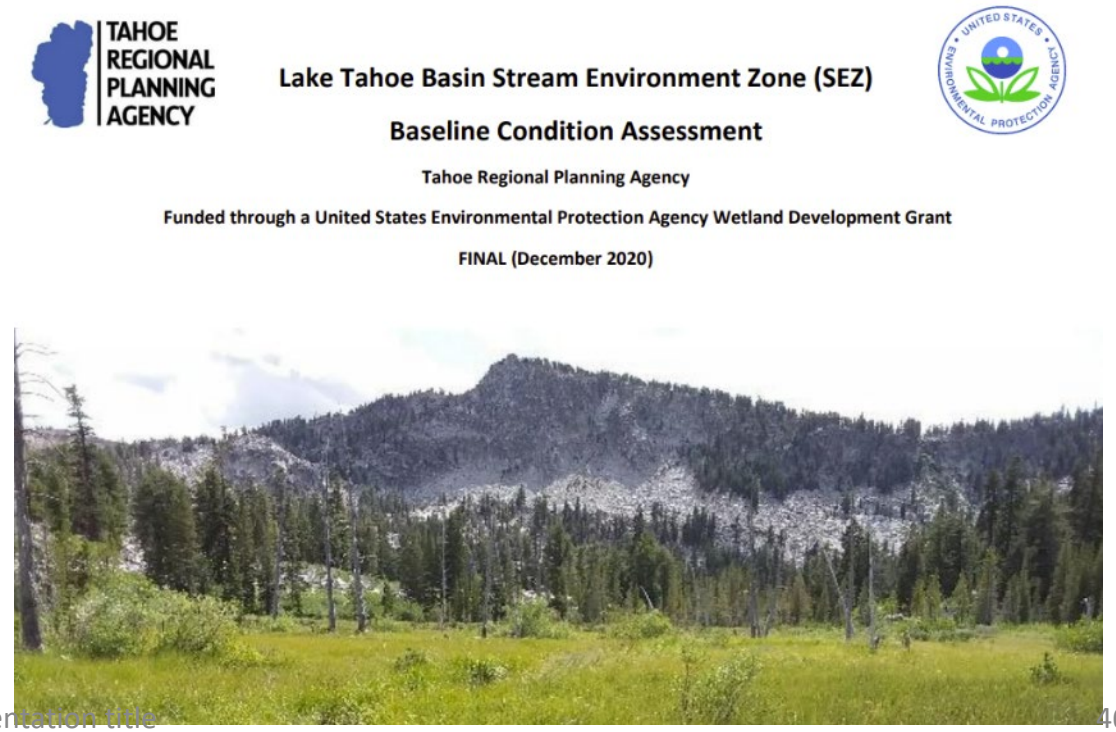
In [63]:

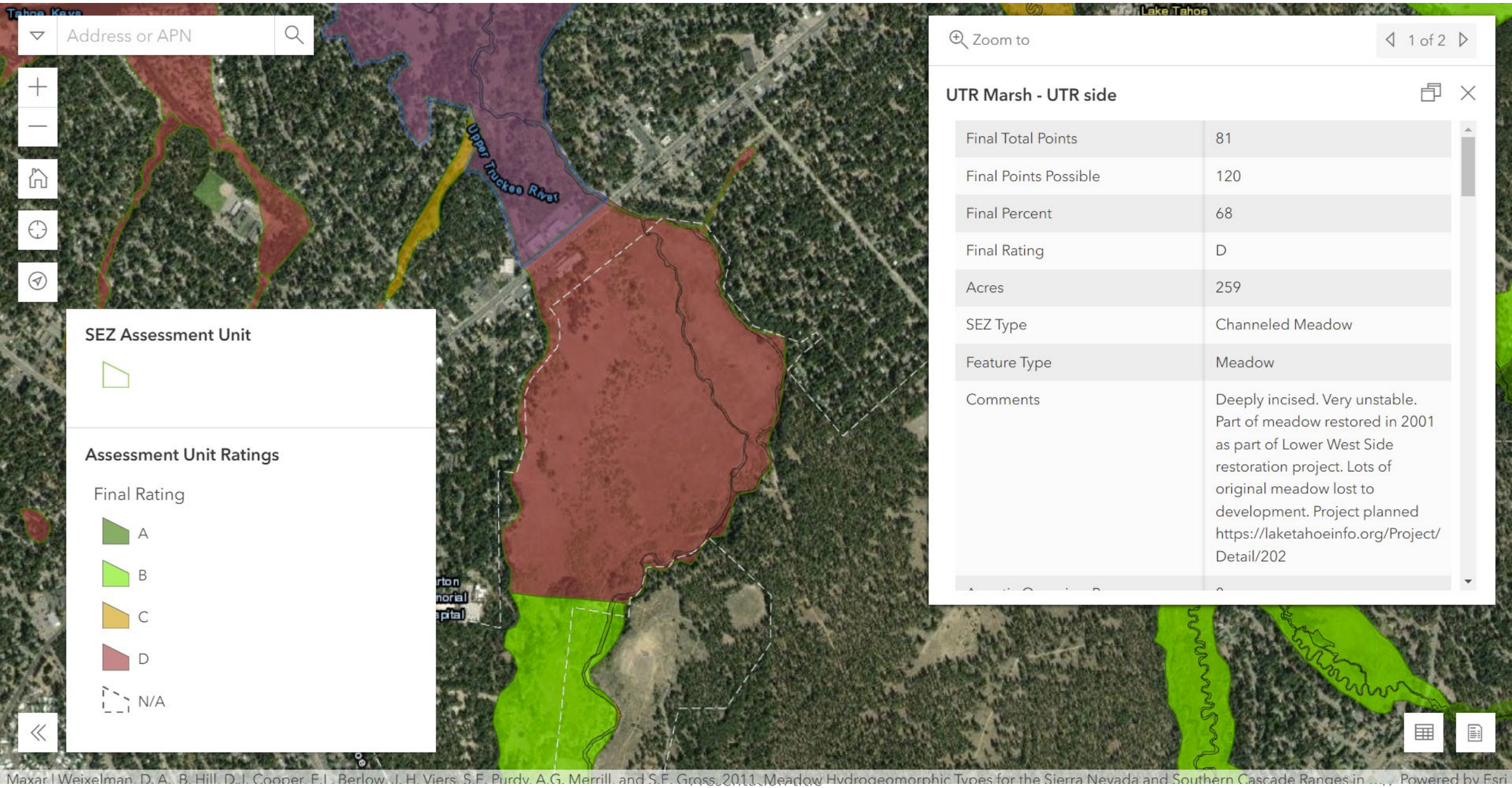
```
# input Tahoe ACCEL Climate Class Raster
climateClass = "ClimateClass_Tahoe"

# input zones
zones        = "ExtractByMask_ClimateClasses_ReferenceSites_ACCEL_30m_SierraNevada"

# output zonal stats table
zonalStats   = "ZonalStats_ReferenceSiteClimateClass_LargeTreeDensity_Percentile"

# out field names
field10th    = 'LargeTreeDensity10thPercentile'
field20th    = 'LargeTreeDensity20thPercentile'
field80th    = 'LargeTreeDensity80thPercentile'
field90th    = 'LargeTreeDensity90thPercentile'
```

Tahoe SEZ Assessment

- Tahoe Stream Environment Zone Monitoring
  - Remote Sensing + In-situ monitoring



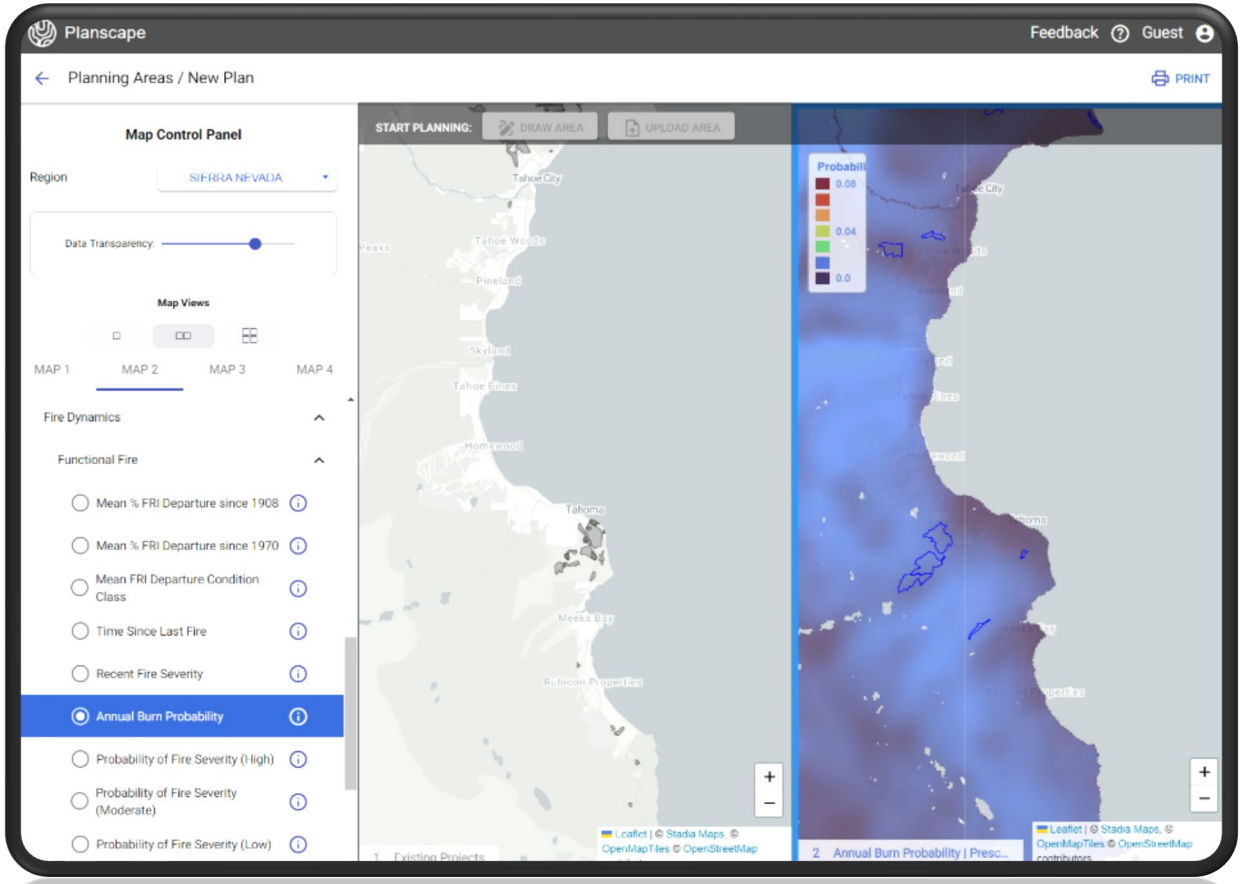


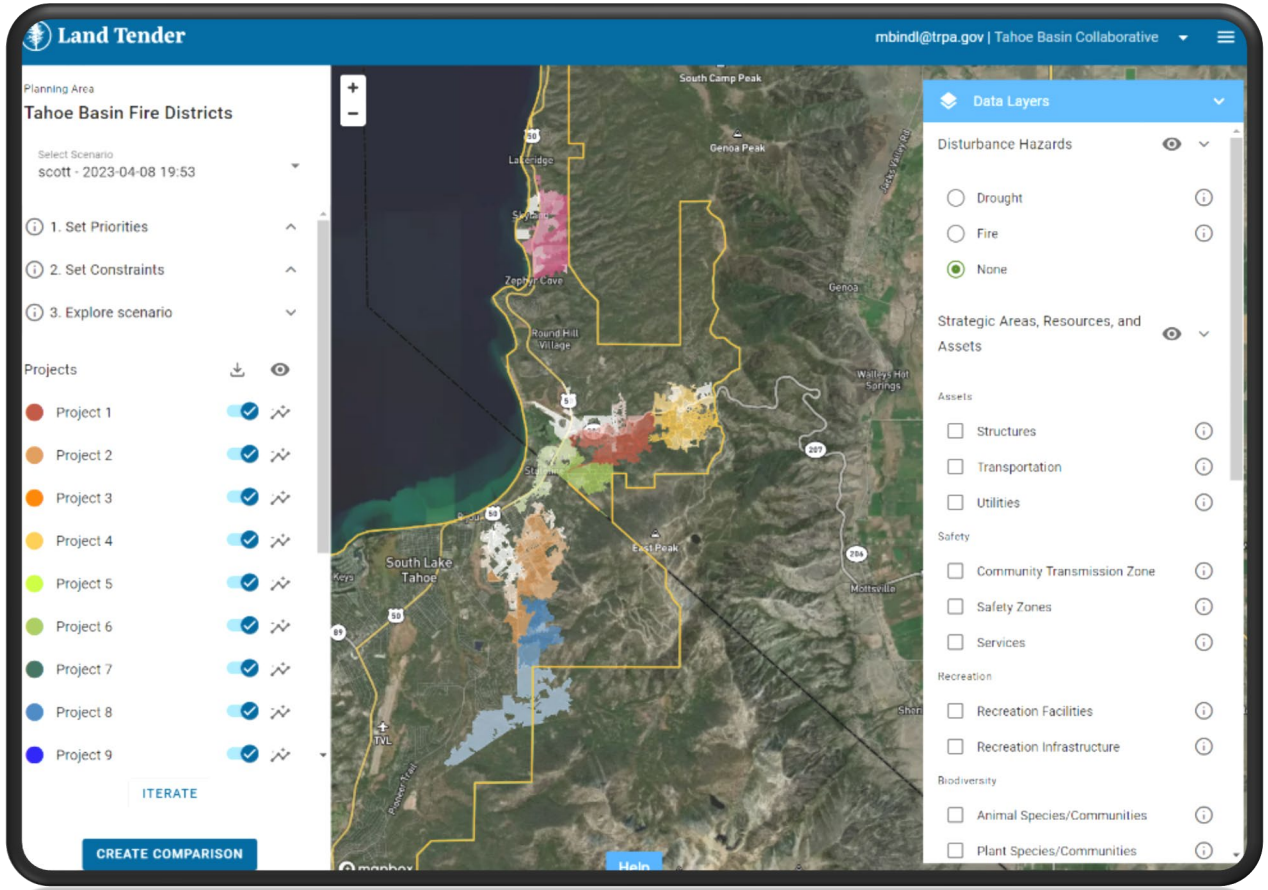

Address or APN
Upper Truckee River
Lake Tahoe
SEZ Assessment Unit
Assessment Unit Ratings
Final Rating
A
B
C
D
N/A
Zoom to
1 of 2
UTR Marsh - UTR side
Final Total Points 81
Final Points Possible 120
Final Percent 68
Final Rating D
Acres 259
SEZ Type Channeled Meadow
Feature Type Meadow
Comments Deeply incised. Very unstable. Part of meadow restored in 2001 as part of Lower West Side restoration project. Lots of original meadow lost to development. Project planned https://laketahoeinfo.org/Project/Detail/202
Maxar | Weixelman, D.A., B. Hill, D.J. Cooper, E.L. Berlow, J.H. Viers, S.E. Purdy, A.G. Merrill, and S.E. Gross, 2011, Meadow Hydrogeomorphic Types for the Sierra Nevada and Southern Cascade Ranges in ..., Powered by Esri

Data to Information - Project Example - Lake Tahoe West

- Landscape Resilience Assessment informed Strategy and Proposed Action
- Biodiversity indicators evaluated
- Composite index to evaluate Resilience
- LANDIS modeling to validate alternatives
- Monitoring plan to track status and trend

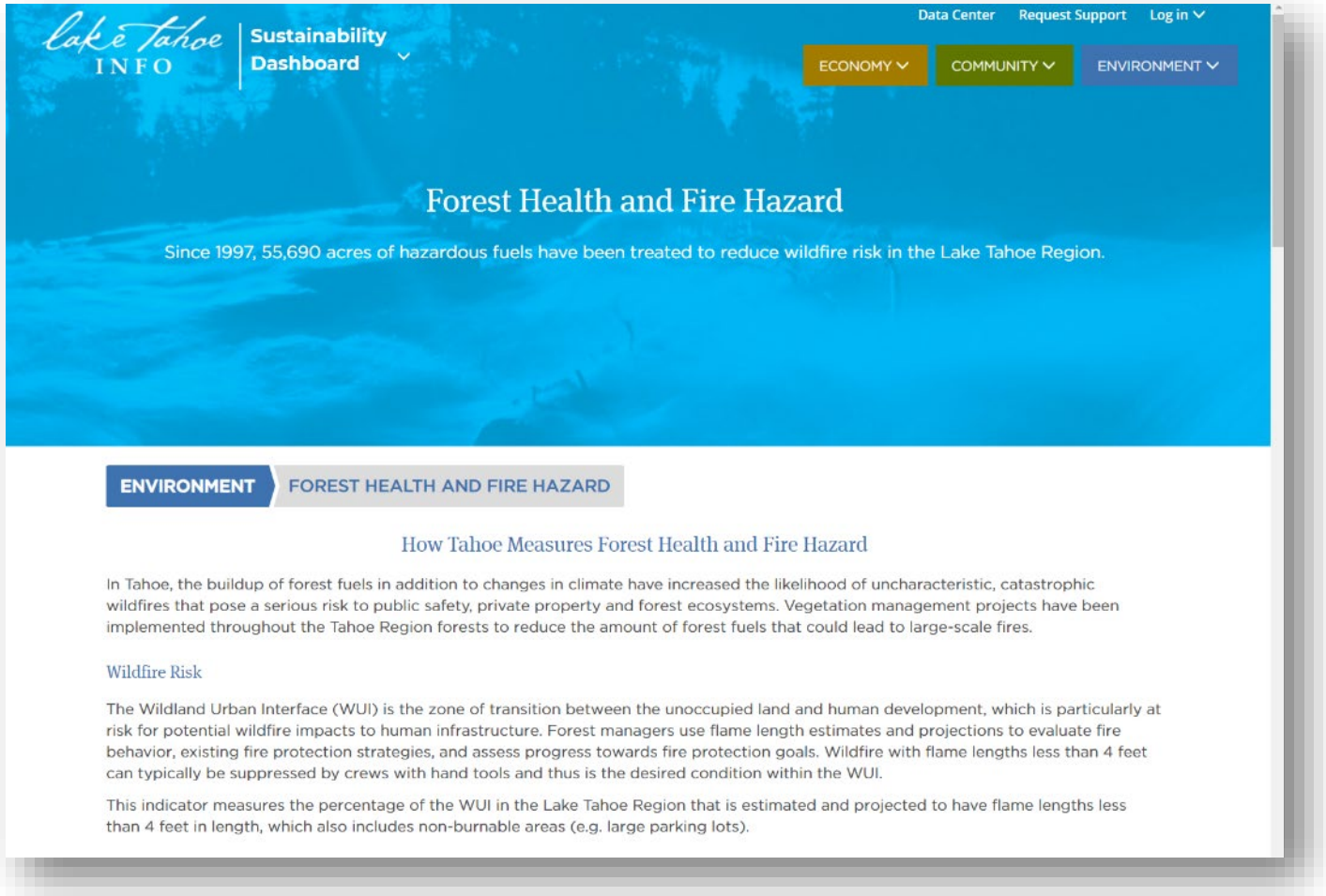
Decision Support Tools to Speed up Collaboration





Coming Soon…

- Updated Climate Resilience Dashboard on LTinfo
- Updated metrics for Threshold Evaluation
  - Forest Health Standards update
  - Open to updating other Thresholds soon…
- More Science and Monitoring data on LTinfo and Tahoe Open Data!



References

- Tahoe Open Data
- TRPA GitHub
- LTinfo Threshold Dashboard
- LTinfo Monitoring Dashboard
- Landtender & Vibrant Planet
- Planscape & Sierra Nevada Resource Toolkit

Contact

- mbindl@trpa.gov
- GIS@trpa.gov

TAHOE REGIONAL PLANNING AGENCY

Small Group Questions

- Did anything stand out as new, surprising, or as an “a-ha moment”?
- What are the most pressing current issues for this topic?
- What are opportunities to advance science delivery?

Reports from Small Group Discussion

- Did anything stand out as new, surprising, or as an “a-ha moment?”
- What are the most pressing current issues for this topic?
- What are opportunities to advance science delivery?

THANK YOU!

Please join us Friday to synthesize key themes and discuss how the Science Council can advance science delivery for healthy Tahoe systems!