

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

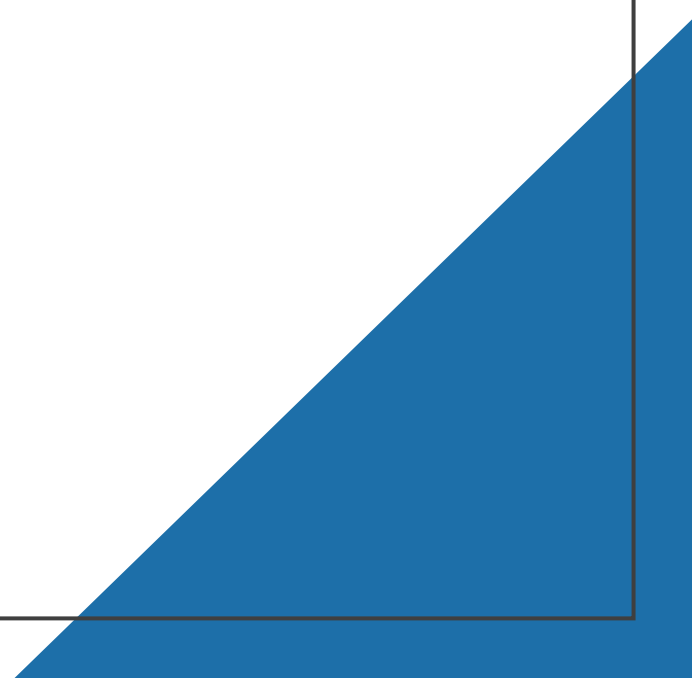
10:10 **Reports:** Key themes from small groups

10:25 **Final observations**

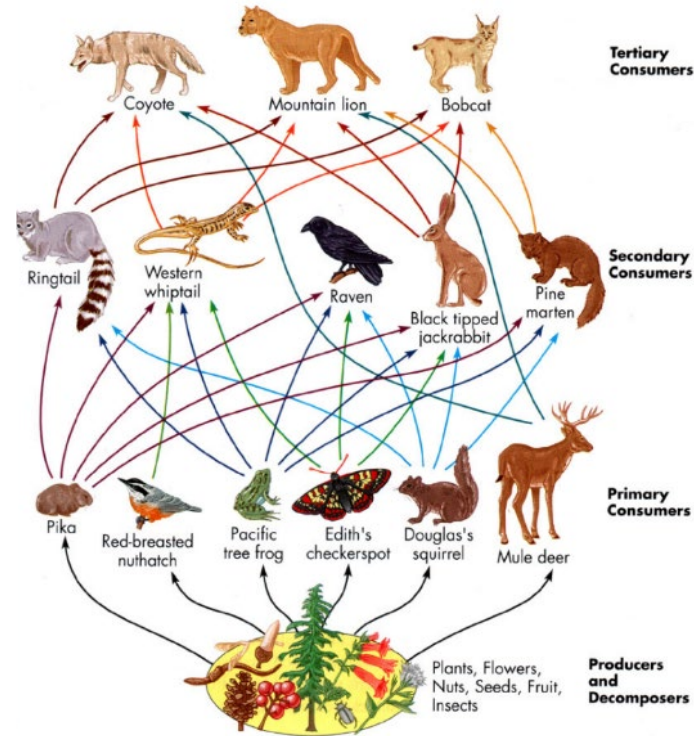
10:30 **Adjourn**

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

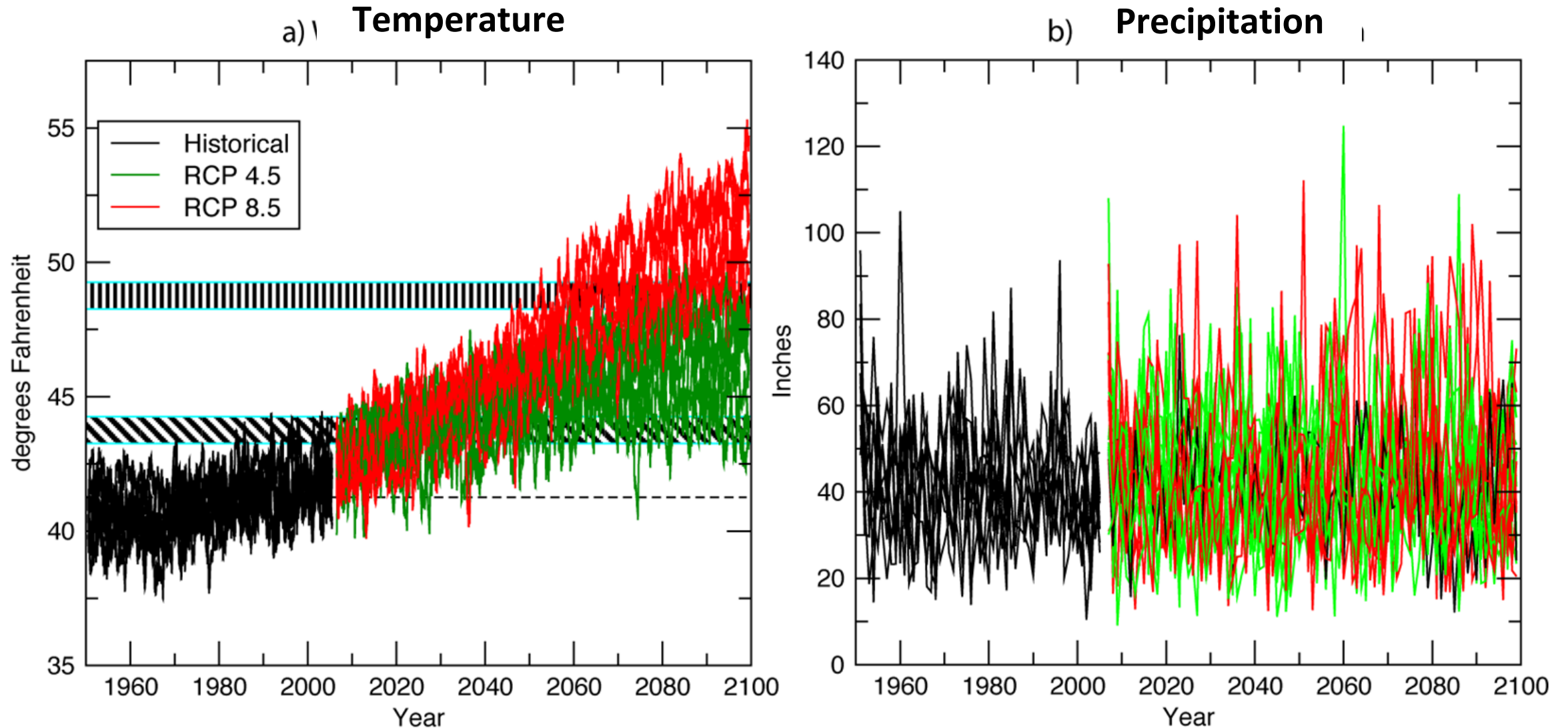
Invasives

Fire

Management



How is climate likely to change?



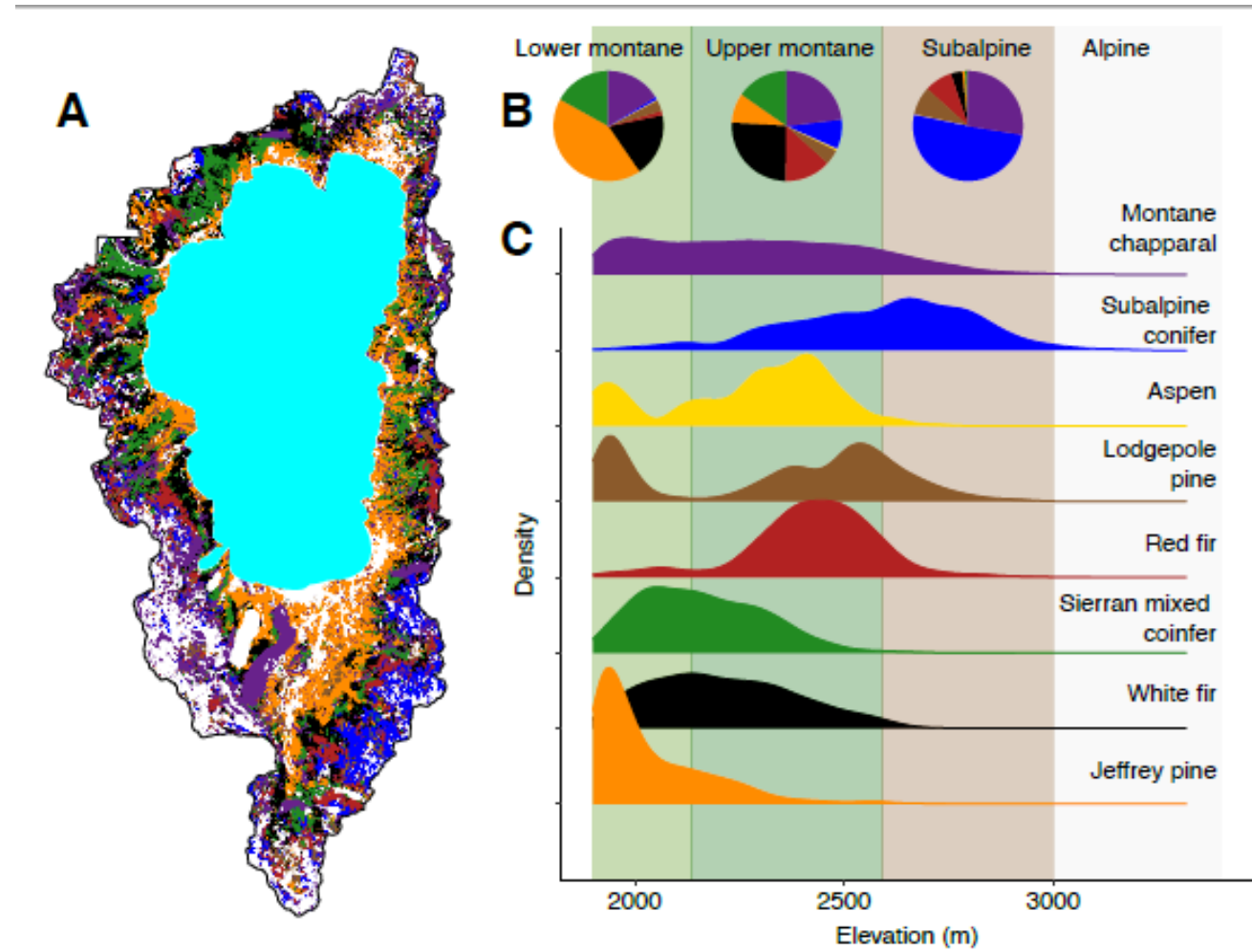
Where are we today?

- Biophysical features

- Elevational gradient
- Bioregional transition

- Elements of biodiversity

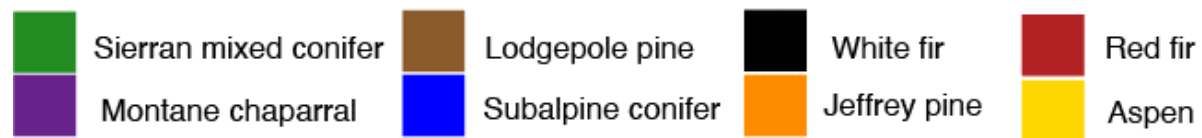
- Major forest types 8
- Major aquatic types 8
- Birds species 200
- Mammal species 67
- Reptile and amphibian sp 9
- Tree species 13
- Plant species 1262
- Invertebrate guilds 730
- Functional groups 118
- Invasive species ?
- Trophic integrity ??
- Ecological integrity ???



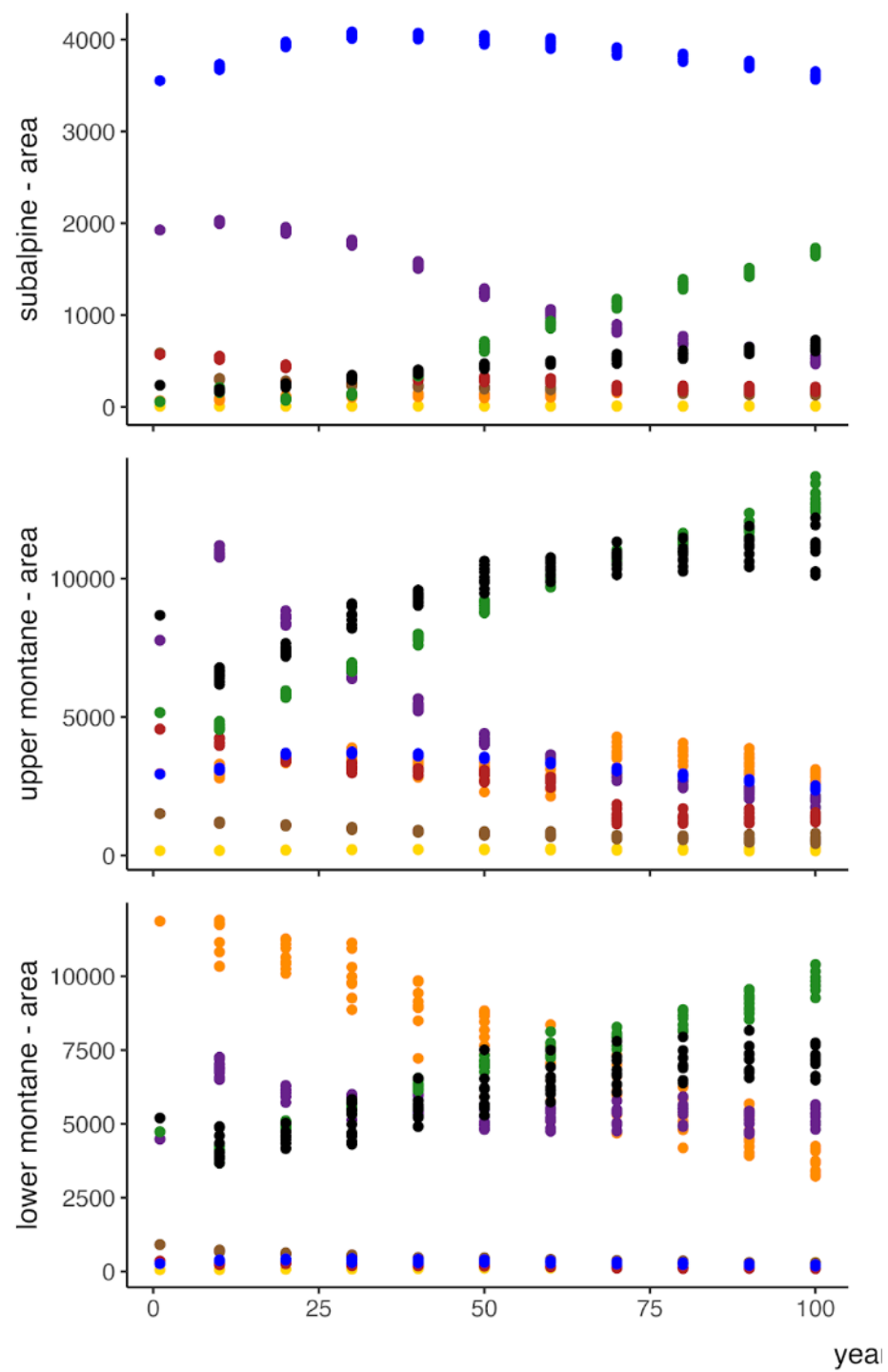
Courtesy of R. Wilcox, unpublished data,
California Academy of Sciences

Next Century of Vegetation Projections @ RCP 8.5

Vegetation type

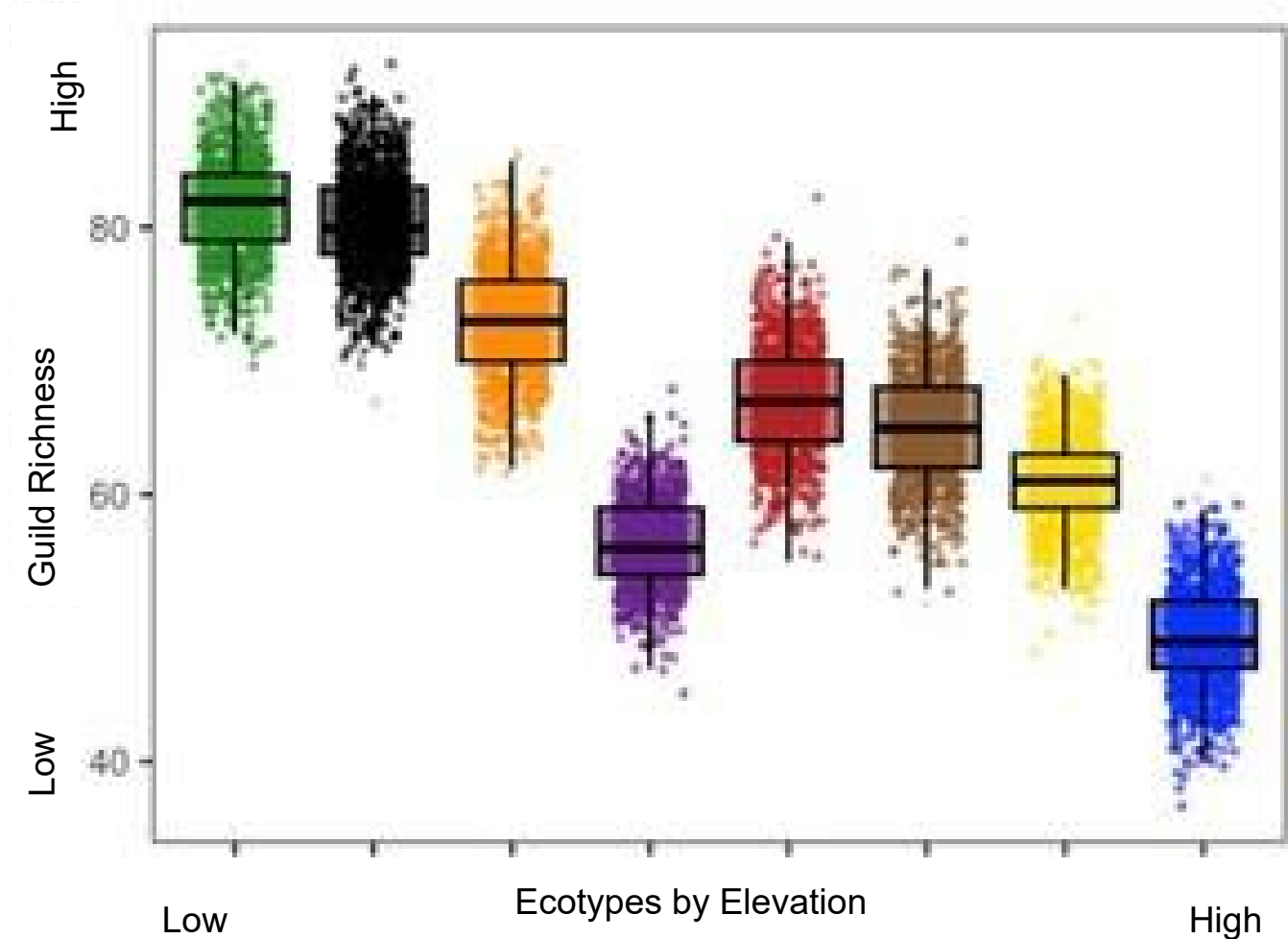


- Subalpine >8500 ft
 - SMC slight increase
 - MC decline
 - Least change overall
- Upper montane 7000-8500 ft
 - SMC and WF increase
 - RF and MC decline
- Lower montane < 7000 ft
 - SMC and WF increase
 - JP substantial decline



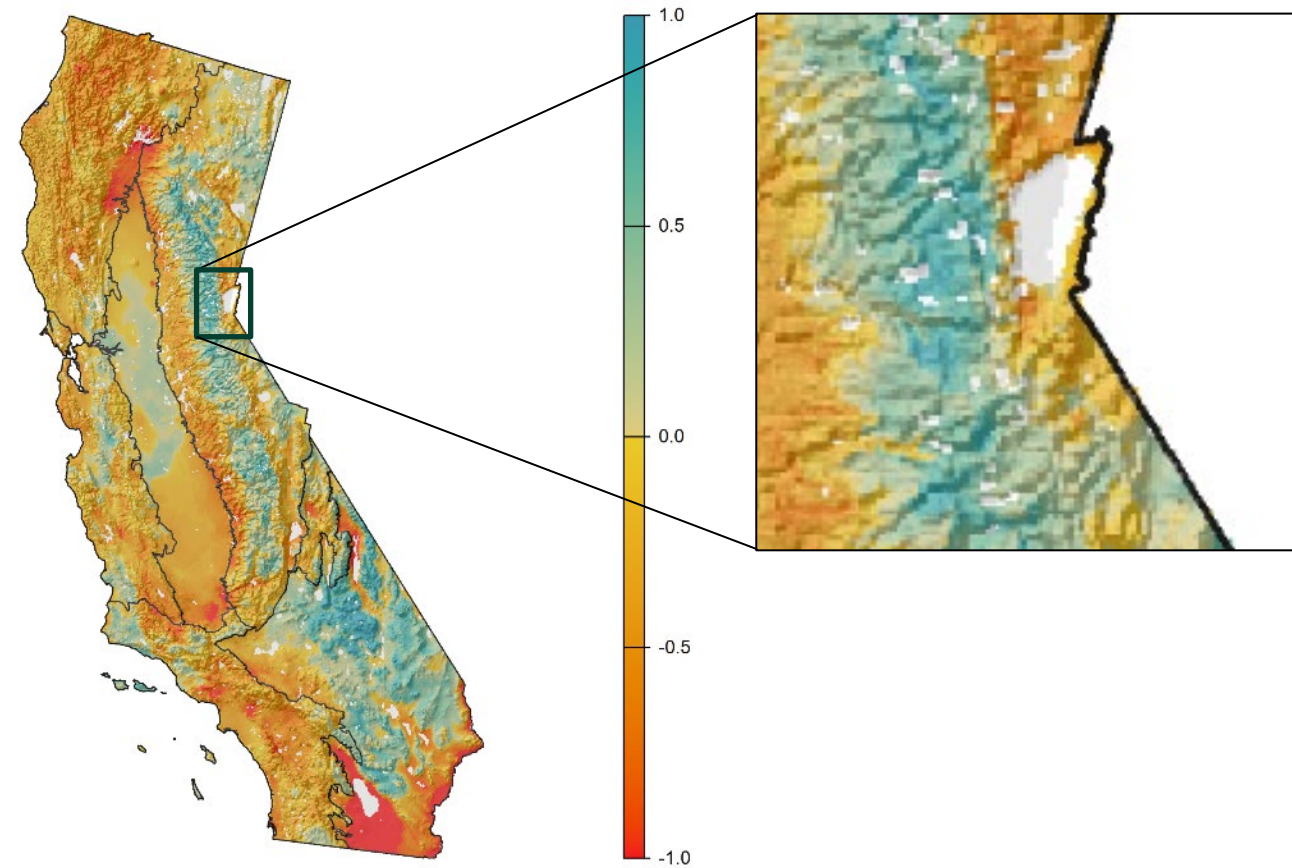
Anticipated Changes in Diversity

- 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

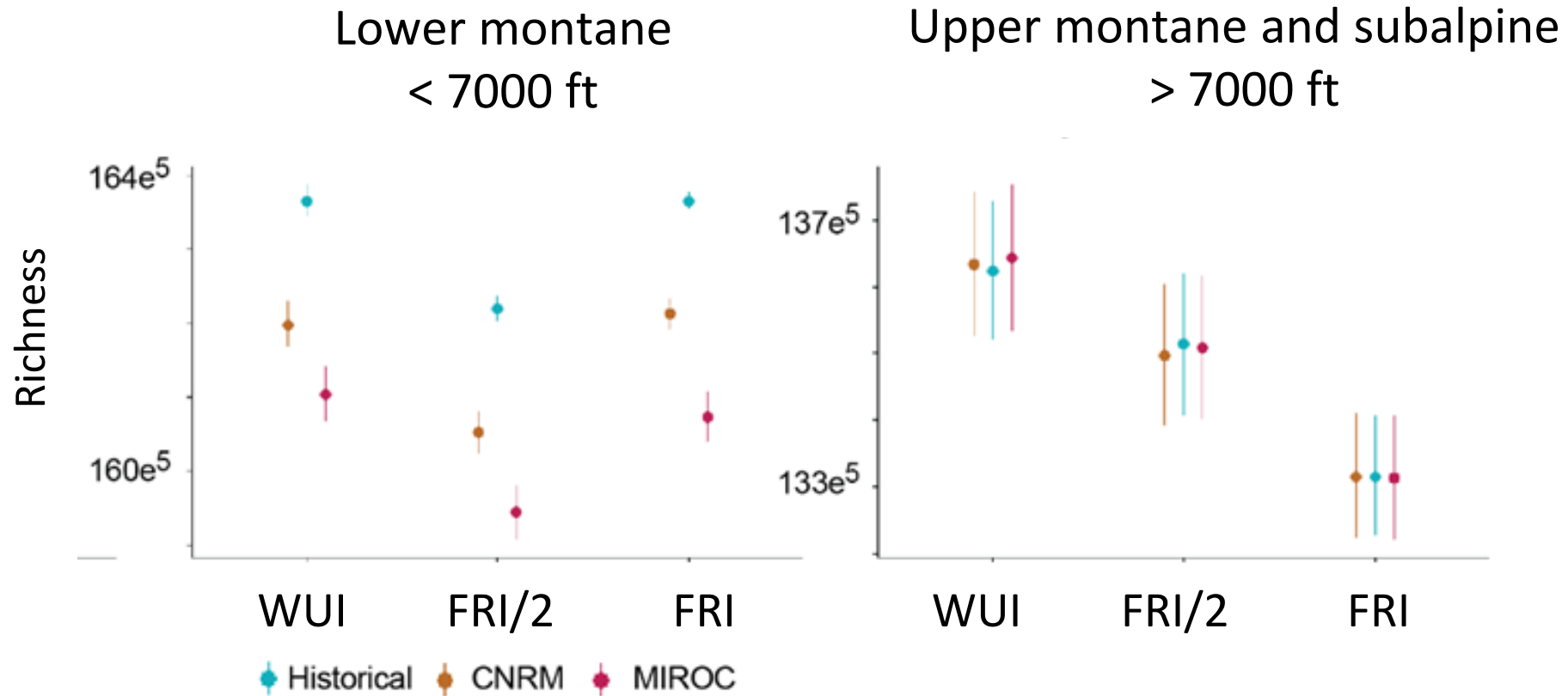


Climate Stability: Implications for Biodiversity

- 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



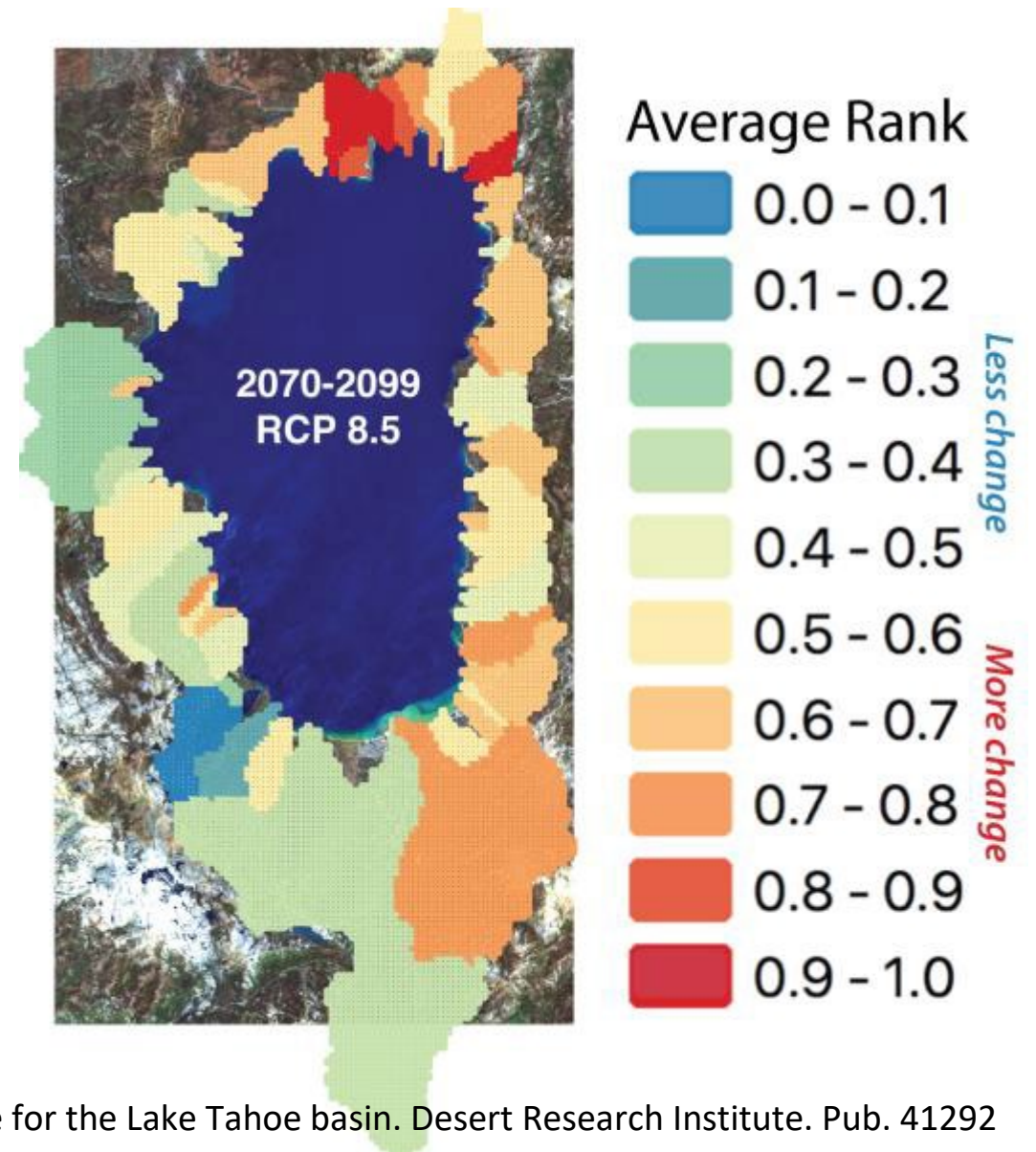
Declines in the Number and Extent of Wetland Habitats

- 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



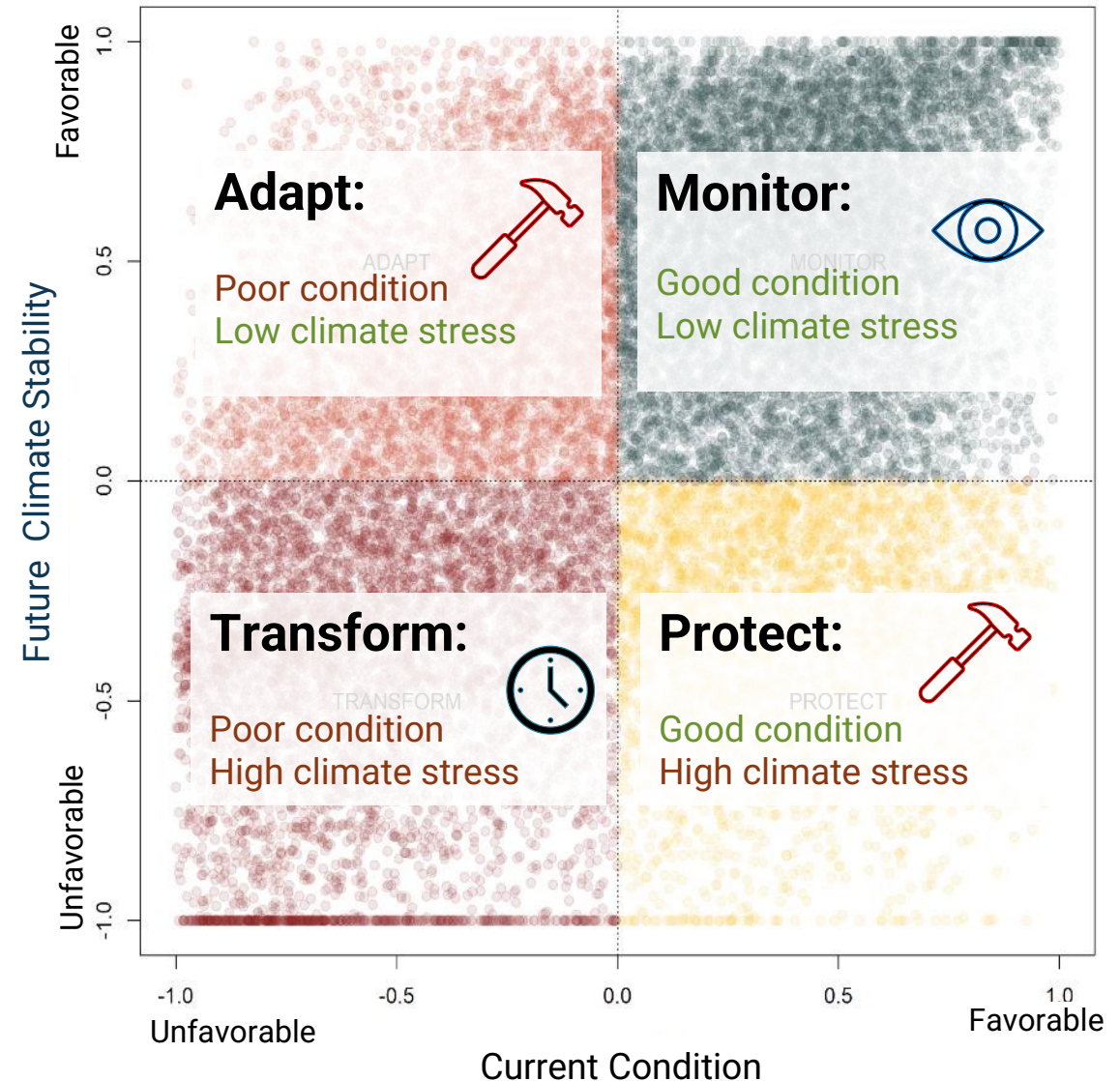
Climate Refugia Rankings by Watershed

- 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



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

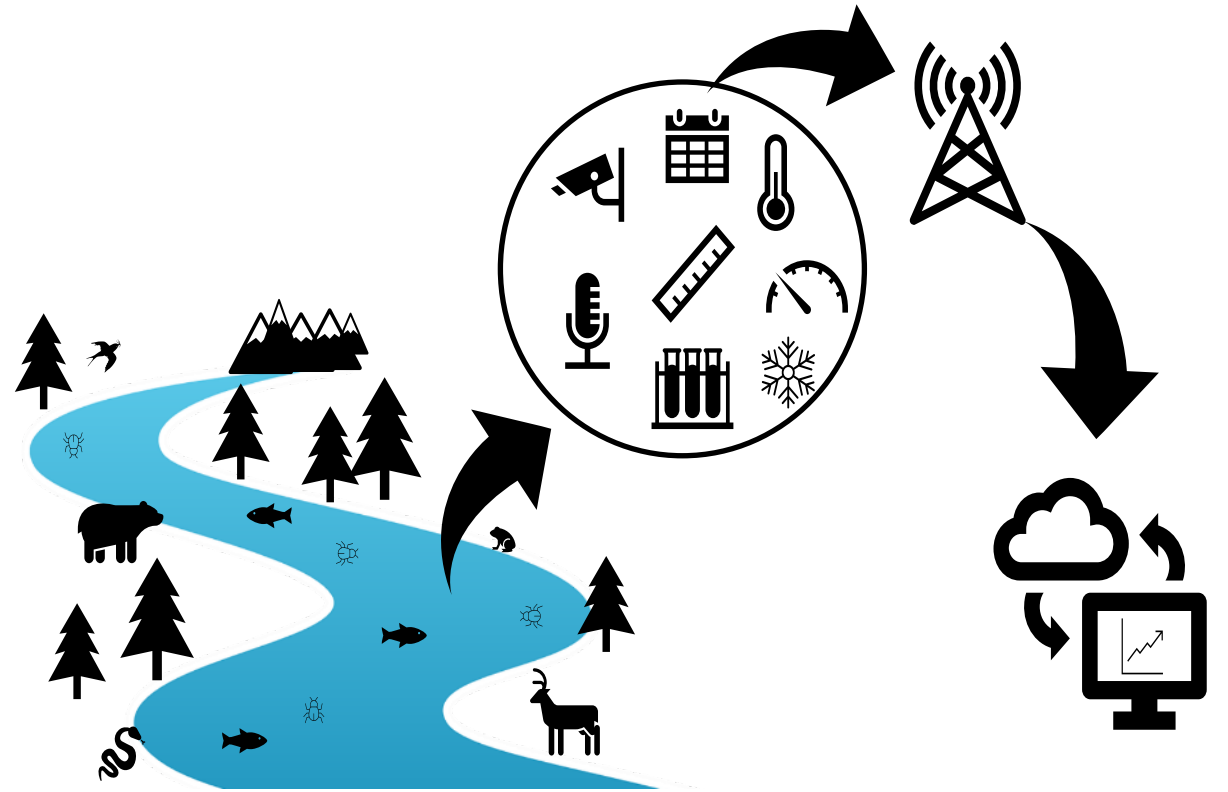
Designing a world-class environmental monitoring system for the Lake Tahoe Basin





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?



- 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?

Pika are disappearing from the basin due to changing climate

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?

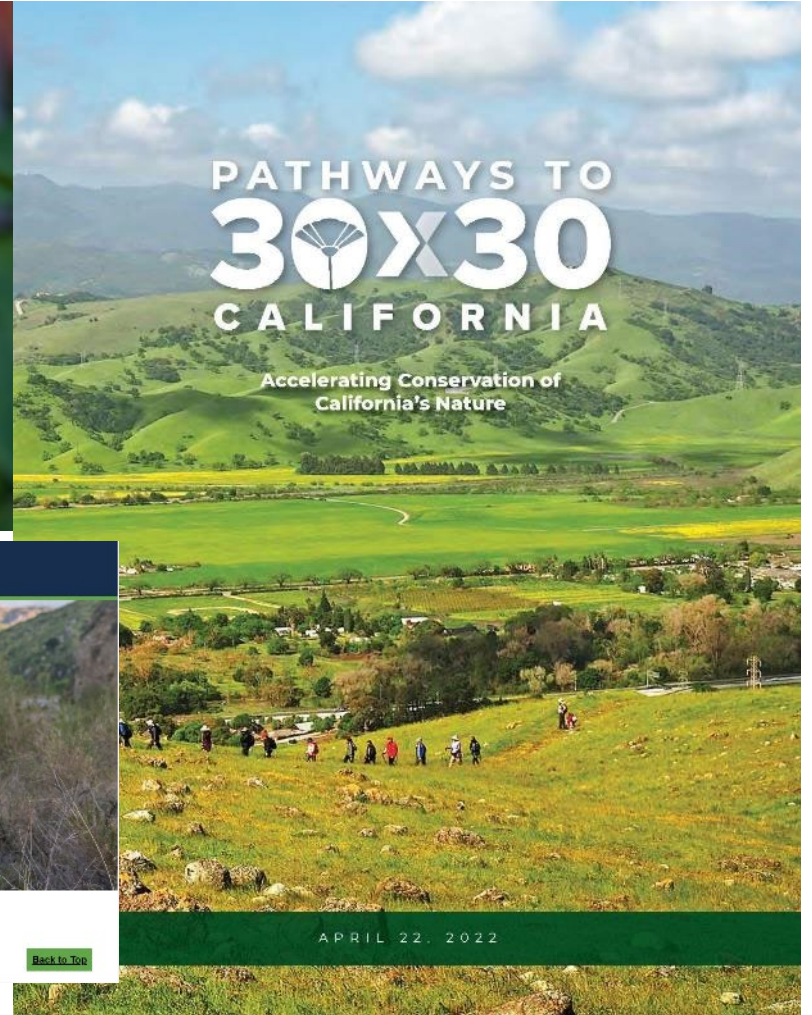
Management Perspective

Whitney Brennan, PhD
California Tahoe Conservancy



**CALIFORNIA
TAHOE CONSERVANCY**

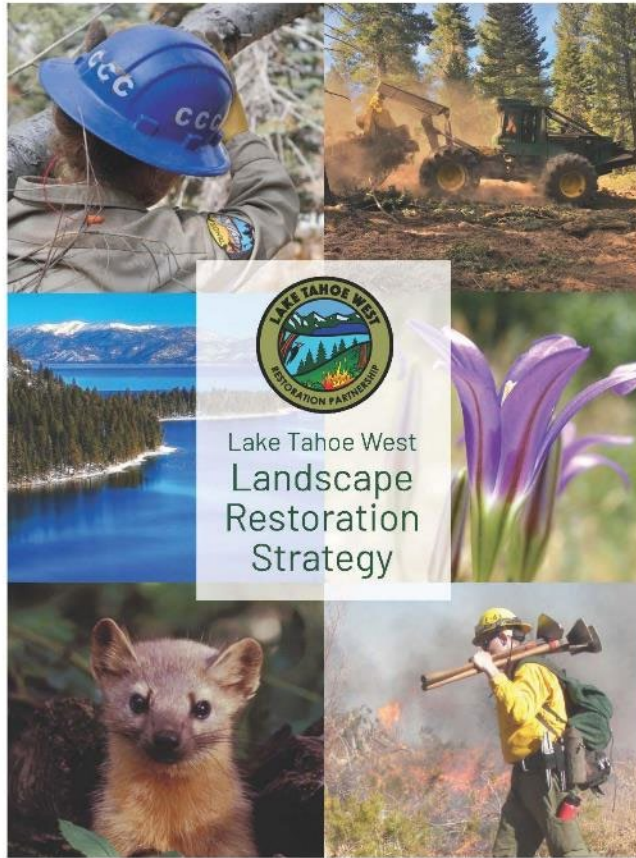
Biodiversity in California



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

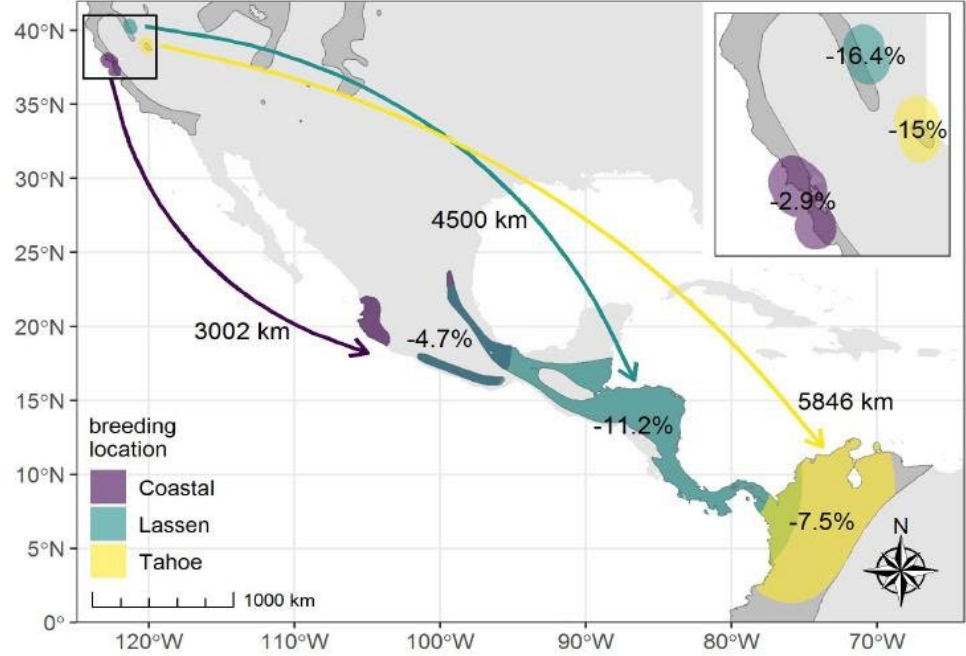


Species presence does not equal species health

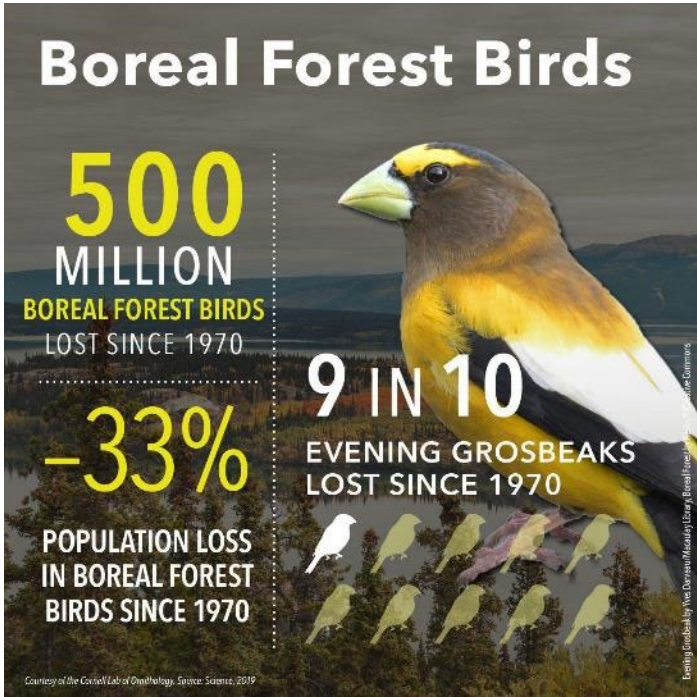
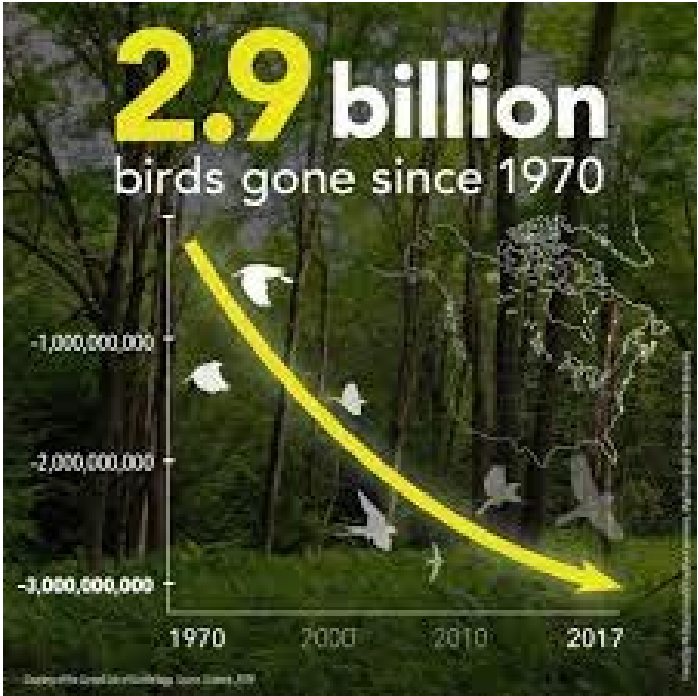
- Need to include abundance measures in our monitoring.
- It's no good to manage for species-rich sinks – how do we know?
- We also need to combine large-scale occupancy and community monitoring with fine-scale field studies that investigate productivity, survivorship, dispersal



Connectivity scales and complete life history considerations



Trends that reach far beyond our regional management scale

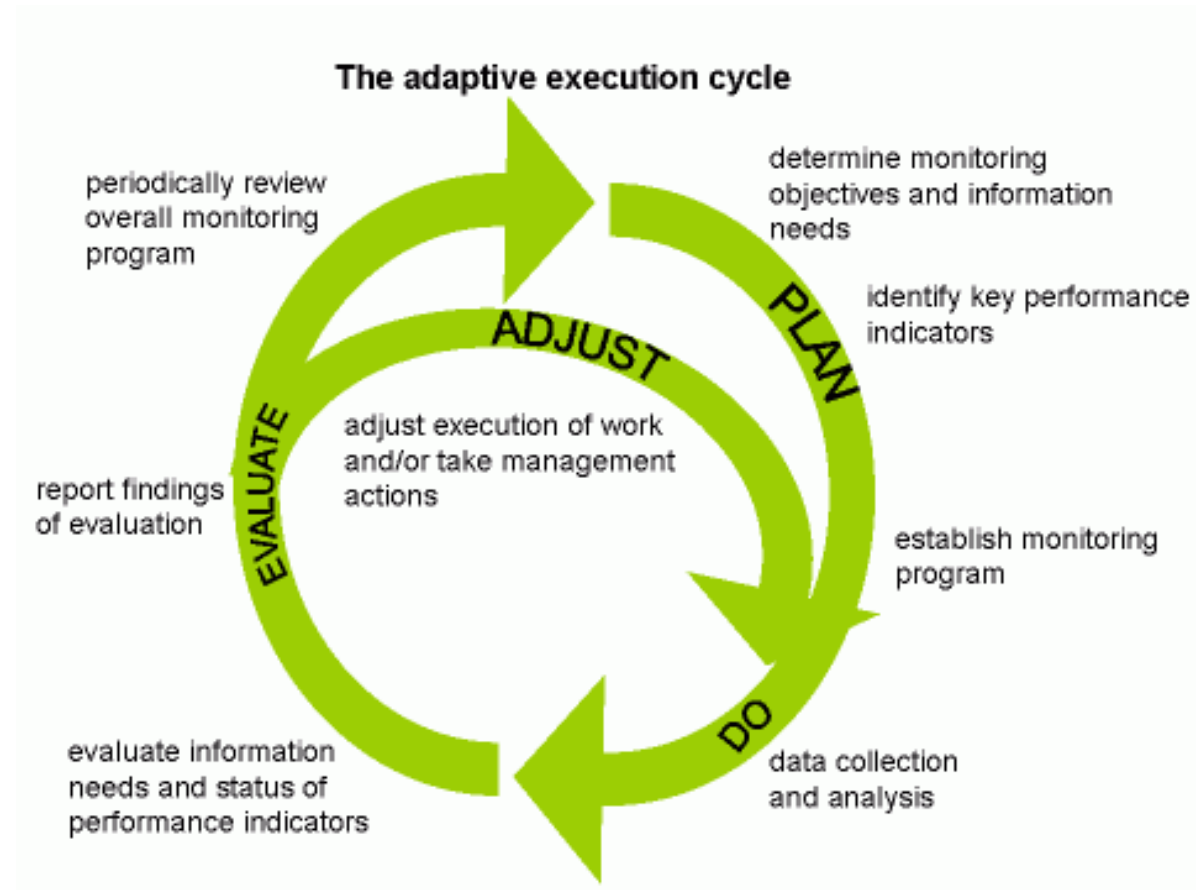


- When thinking about management actions, we do need to think in terms of scales, habitats, and variables that managers can do something about
- Wet meadow, riparian, and aspen may be underrepresented in some of our large-scale, forest-focused efforts
 - centers of biodiversity
 - provide other benefits: hydrologic impacts, natural firebreaks, cultural
- Focused management can have positive umbrella effects at various scales

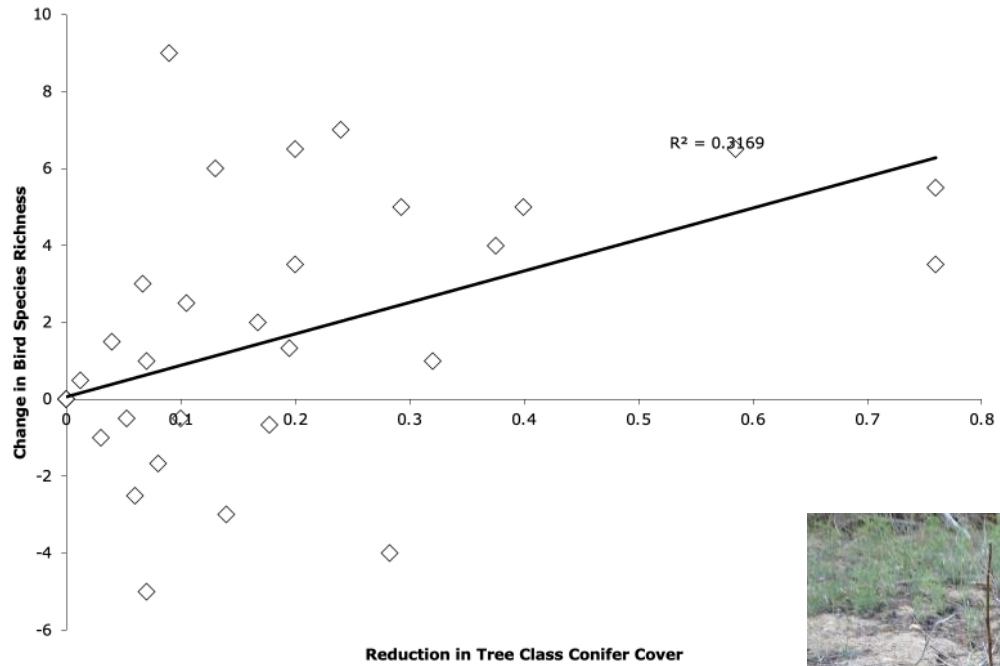


Monitoring and Adaptive Management

- 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



Reduction in Tree Class Conifer Cover



Power, sample size issues + stochasticity

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

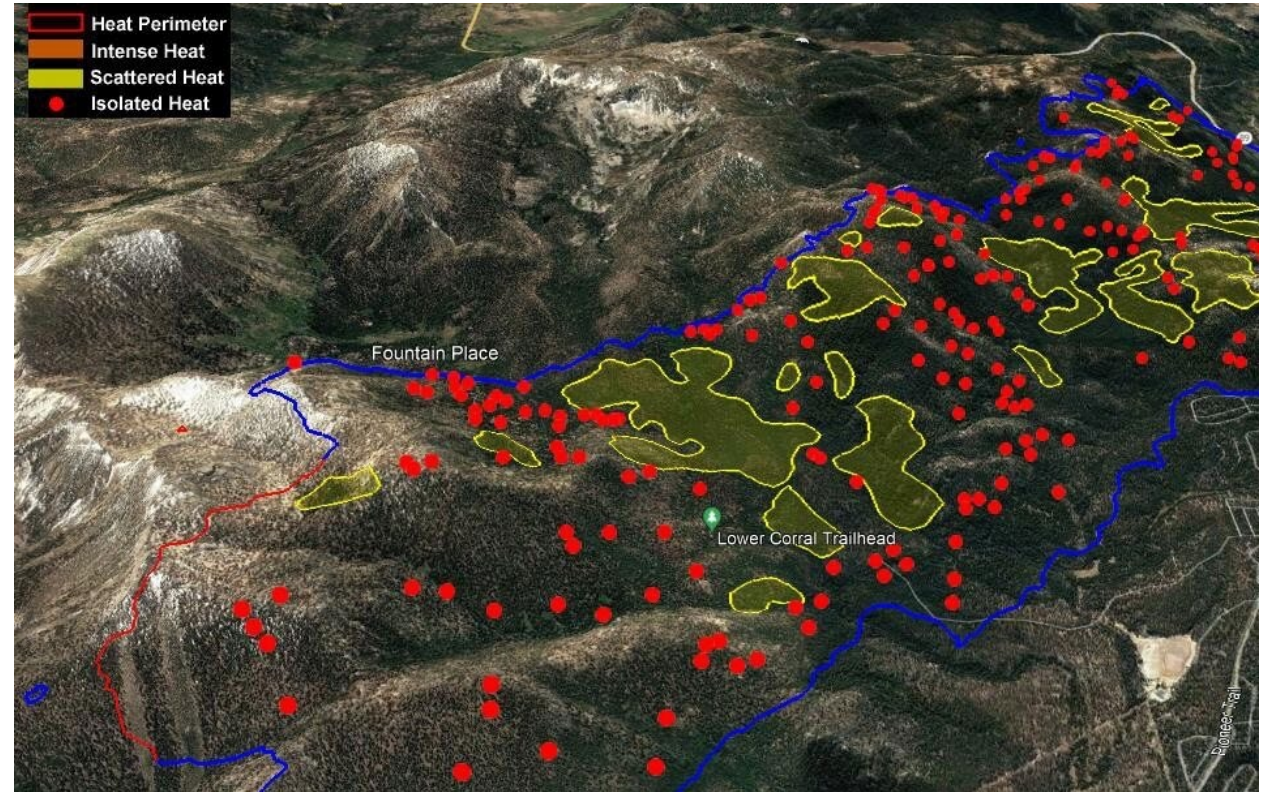
Years	2002-2004	2008 ^b	2009	2010	2012	2016	2018-2020	2021
Treatment Status	Pre-	Pre-	Pre- Post-	Pre- Post-	Pre- Post-	Pre- Post-		Pre- Post-
Cluster (<i>n</i>)								
Big Meadow (9)	9							
Blackwood Canyon (6)			6	6	2 4	6		6
Christmas Valley (7)			7	7				
Christmas Valley, Upper (4)				4	4	4		4
Cold 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	
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 🐻	5	1 6
Tunnel Creek (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

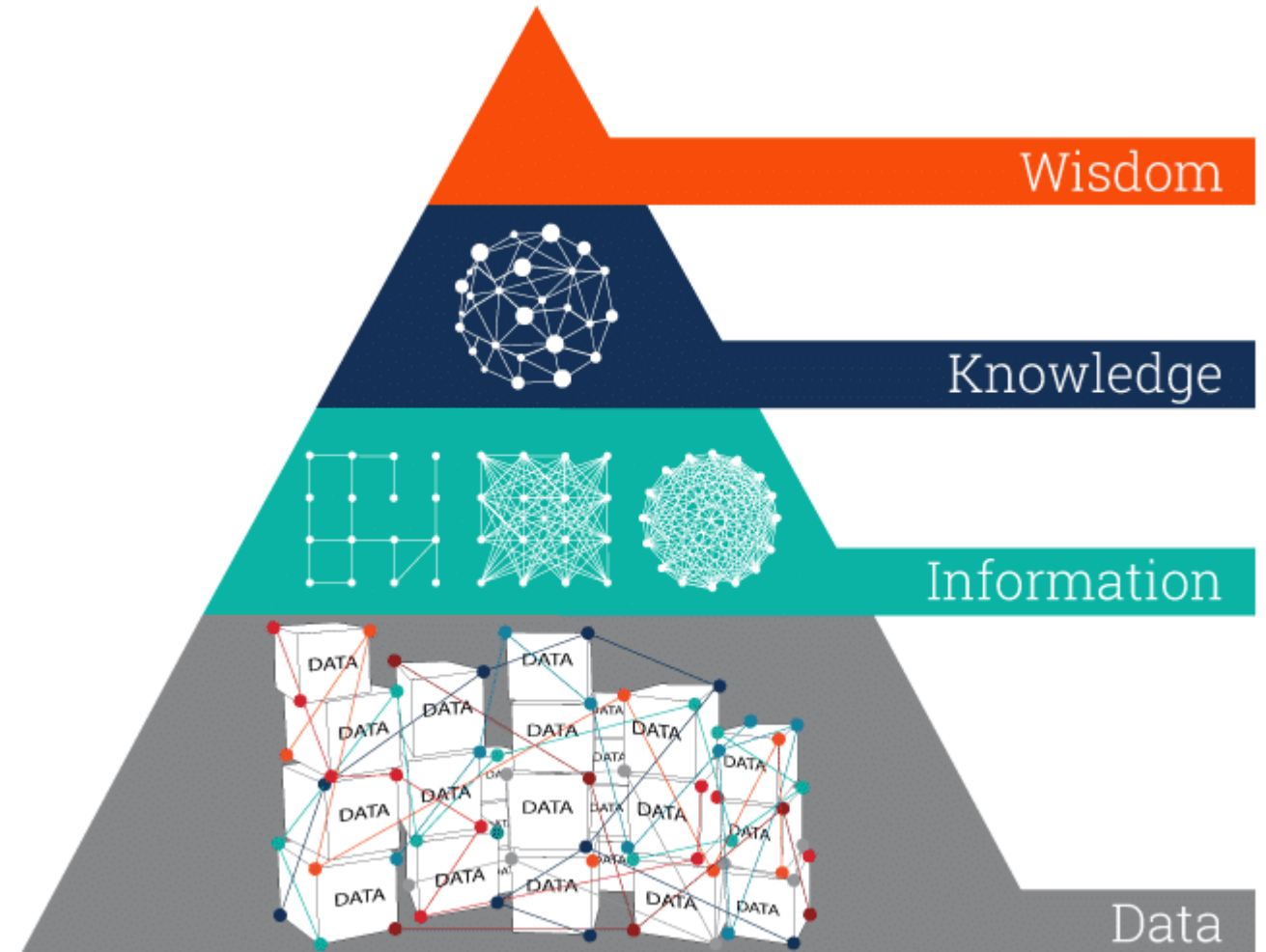
Mason Bindl

Tahoe Regional Planning Agency

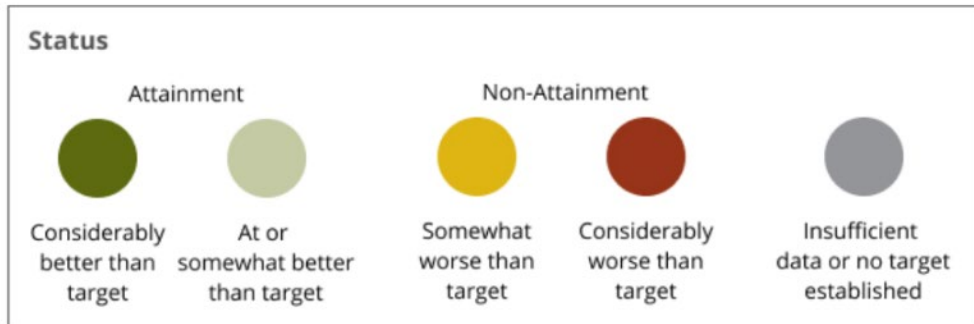


Science Data to Information for Managers

- 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

TAHOE YELLOW CRESS

MONITORING PROGRAM

Tahoe Yellow Cress (TYC, *Rorippa subumbellata*) is a small native plant that grows on the shoreline of Lake Tahoe, primarily on sandy beaches and dunes at the ever-changing margin of the lake. Impacts from recreation and development have caused TYC to become endangered in both states since 1982. In 1999, a multi-agency and private interest group task force was formed to promote the recovery and conservation of TYC. The conservation strategy provides an adaptive management plan to address the impacts to TYC and its habitat on public and private lands. The TYC Stewardship Program recognizes the critical importance of TYC.

A similar species can be found growing alongside TYC on the shores of Lake Tahoe. TYC has plump round fruits, but the other (*Rorippa curvisiliqua*) is often taller, the fruits are elongated and narrow, and the leaves are less fleshy and turn purple in the fall. This species is very widespread throughout the western U.S.

MONITORING SITES

- 4-H Camp/City Pump House
- Baldwin Bch Enclosures
- Baldwin Beach
- Bijou (Timber Cove Lodge)
- Blackwood North
- Blackwood South
- Burnt Cedar Beach
- Cascade Creek
- Cave Rock

Setup

```
In [1]: import os
import csv
from datetime import datetime
import getpass
import pyodbc
import xlrd
import arcpy
from arcgis.gis import GIS
from arcgis.mapping import WebMap
from arcgis.features import FeatureSet, GeoAccessor, GeoSeriesAccessor, FeatureLayer, FeatureLayerCollection
import pickle
import pandas as pd
from pandas.api.types import CategoricalDtype
import numpy as np
import matplotlib
# import cufflinks as cf
import plotly
import plotly.offline as py
import plotly.graph_objs as go
import plotly.tools as tls
import plotly.express as px
import plotly.figure_factory as ff
from plotly.offline import iplob, init_notebook_mode
from plotly.subplots import make_subplots
py.init_notebook_mode()
```

Transparent

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

The screenshot shows a web dashboard for the Tahoe Yellow Cress monitoring program. At the top, there is a navigation bar with 'Monitoring Dashboard' and a 'Data Center' link. Below the navigation, there is a section for 'Monitoring Programs' with a dropdown arrow. The main content area is titled 'MONITORING PROGRAM' and 'TAHOE YELLOW CRESS'. A paragraph of text describes the Yellow Cress (TYC, *Rorippa subumbellata*) as a small native plant that grows on the shoreline of Lake Tahoe and nowhere else in the world. It mentions that impacts from recreation and development first led to conservation concerns in the 1970s and that the plant is listed as endangered in both states since 1982. In 1999, a multi-agency and private interest group task force was formed to develop and implement a conservation strategy for the recovery and conservation of TYC. The conservation strategy provides an adaptive management framework and options for avoiding, minimizing, or restoring TYC and its habitat on public and private lands. The TYC Stewardship Program recognizes the critical role of private landowners in ensuring the recovery of TYC.

Below the text, there are two main sections: 'PROGRAM OVERVIEW' and 'MONITORING SITES'. The 'PROGRAM OVERVIEW' section includes the following information:

- Program Name:** Yellow Cress Monitoring
- Monitoring Program Category:** Conservation Preservation
- Monitoring Approach:** The distribution of TYC has been developed through one survey since 1979. Before 2000, surveys followed a different protocol and were completed at various times during the summer. Since 2001, surveys are conducted the first week of the summer following a standardized protocol. During the survey in 1979, 32 TYC sites were surveyed; this has since increased to 55 sites. A survey "site" is defined as a stretch of beach, adjacent private parcels, or adjacent parcels of a combination of private and public ownership. Surveys use a stem count estimates as a measure of TYC abundance because clonal growth makes it impossible to distinguish individuals. The amount of available shorezone habitat for TYC varies widely with changes in lake level, with high lake levels leaving little habitat. On average, over 70% of surveyed sites are occupied when the lake is below 6,225 ft. in elevation, but less than 40% are occupied when the lake level is above 6,225 ft.

The 'MONITORING SITES' section includes a list of monitoring sites and a map of Lake Tahoe showing the locations of these sites. The list of sites includes:

- 4-H Camp/City Pump House
- Baldwin Bch Enclosures
- Baldwin Beach
- Bijou (Timber Cove Lodge)
- Blackwood North
- Blackwood South
- Burnt Cedar Beach
- Cascade Creek
- Cave Rock
- Cherry St/Tahoe Swiss Village

The map shows Lake Tahoe with several monitoring sites marked with yellow pins. The map includes a search bar, zoom in (+) and zoom out (-) buttons, and a full screen button. The number 43 is visible in the bottom right corner of the map area.

Accessible

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

The screenshot displays the Tahoe Open Data portal interface. At the top left, the logo for the Tahoe Regional Planning Agency (TRPA) is visible, along with the text "Tahoe Open Data". In the top right corner, there is a search icon and a "Sign In" link. The main content area is titled "Spotted Owl PAC" and includes a green "Authoritative" badge. Below this, the TRPA logo and name "TRPA GIS Tahoe Regional Planning Agency" are shown. A "Summary" section states: "Tahoe wildlife data available for public use and download". Two buttons are present: a blue "View Full Details" button and a white "Download" button. The "Details" section lists the following information: Dataset: Feature Layer; Info Updated: March 25, 2022; Data Updated: March 25, 2022; Published Date: February 6, 2018; Records: 22 (with a link to "View data table"); Public: Anyone can see this content; License: CC BY-NC 4.0 License (with a link to "View license details"). At the bottom left, a blue bar contains the text "I want to use this" and a right-pointing arrow. The right side of the page features a large map of the Tahoe region with various geographical features and roads. A "Records: 22" box is overlaid on the top left of the map. The map includes a search bar, a "Sign In" link, and a vertical toolbar with icons for information, navigation, and other map functions.

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="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"

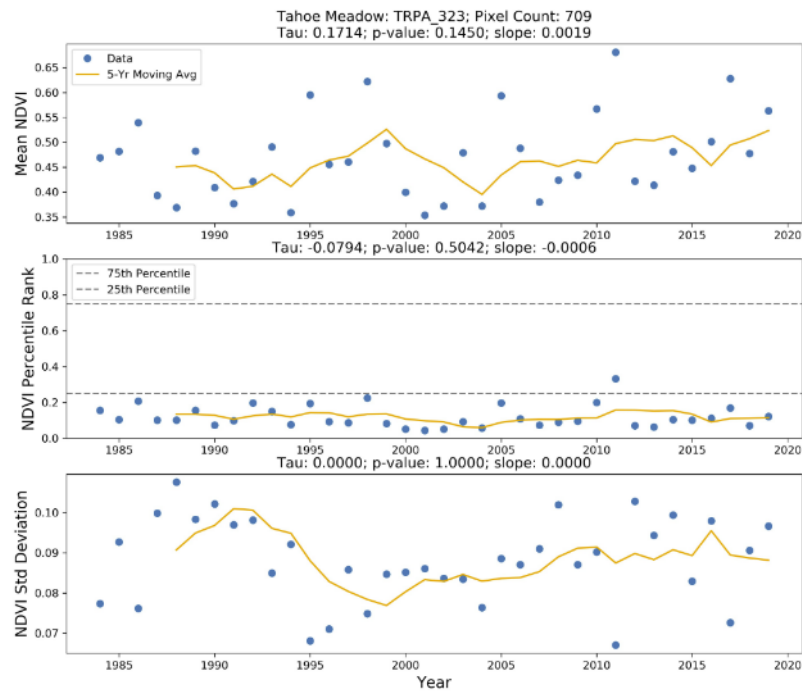
# input zones
zones = "ExtractByMask_ClimateClasses_ReferenceSites_ACCEL_30m_SierraNevada"

# 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



Lake Tahoe Basin Stream Environment Zone (SEZ) Baseline Condition Assessment

Tahoe Regional Planning Agency

Funded through a United States Environmental Protection Agency Wetland Development Grant

FINAL (December 2020)



Address or APN








SEZ Assessment Unit



Assessment Unit Ratings

Final Rating

-  A
-  B
-  C
-  D
-  N/A

Zoom to

1 of 2

UTR Marsh - UTR side

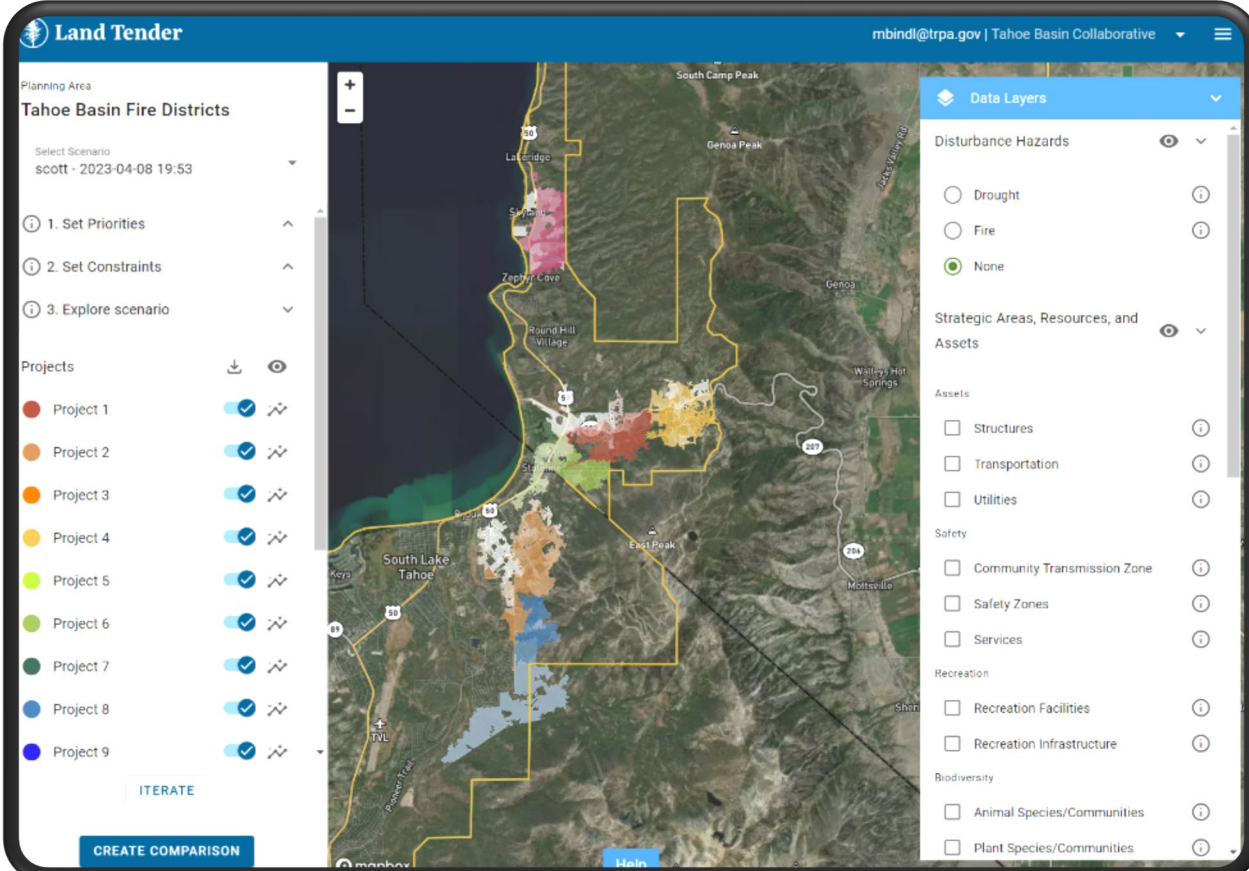
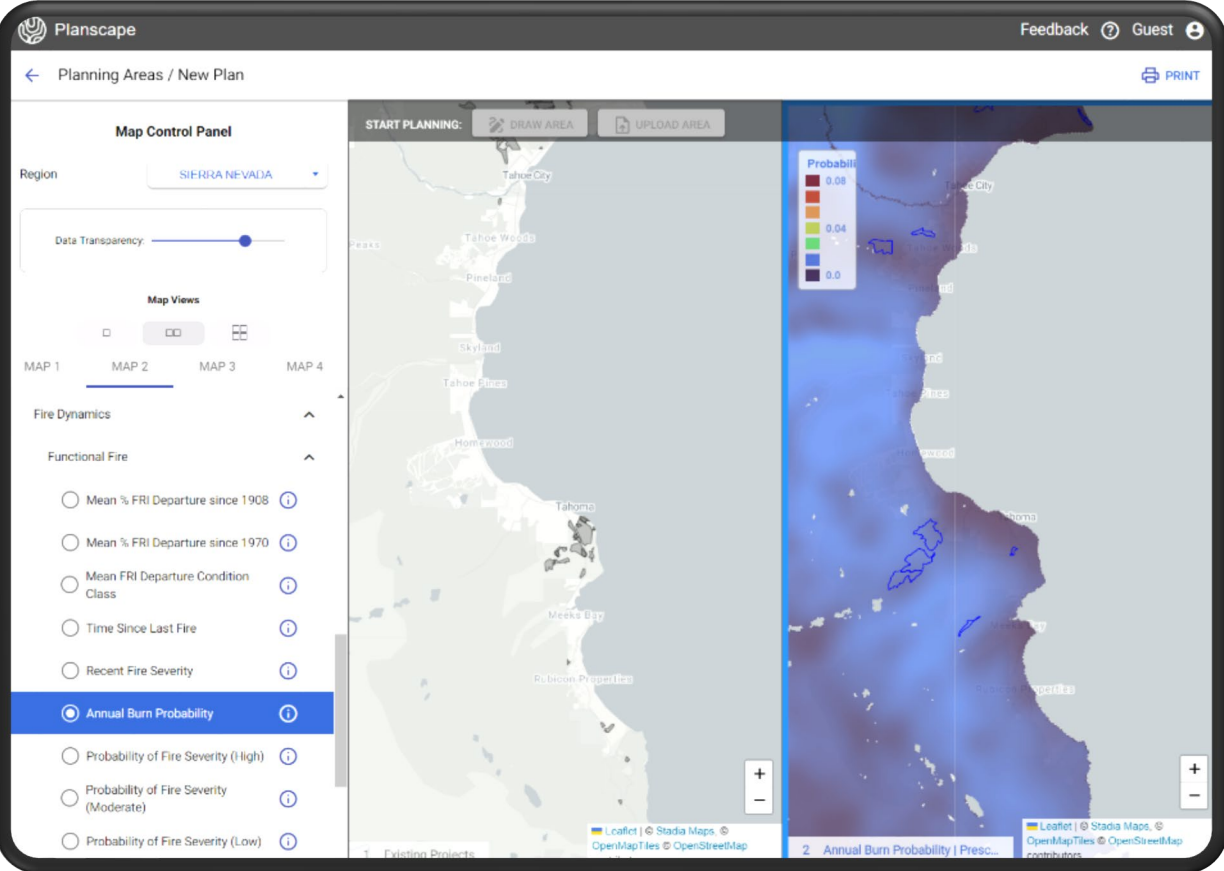
Final Total Points	81
Final Points Possible	120
Final Percent	68
Final Rating	D
Acres	259
SEZ Type	Channeled Meadow
Feature Type	Meadow
Comments	Deeply incised. Very unstable. Part of meadow restored in 2001 as part of Lower West Side restoration project. Lots of original meadow lost to development. Project planned https://laketahoeinfo.org/Project/Detail/202

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

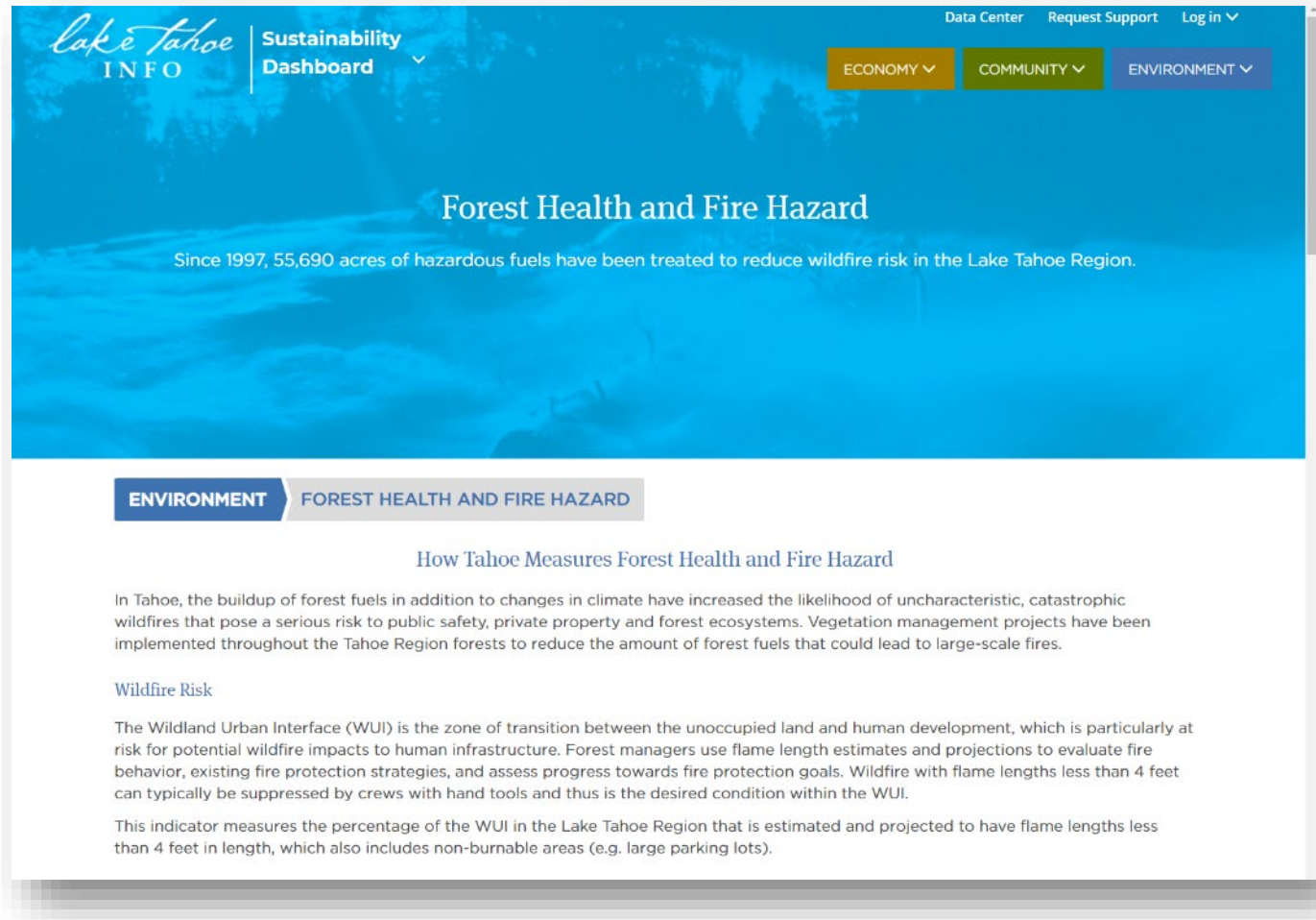


Decision Support Tools to Speed up Collaboration



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

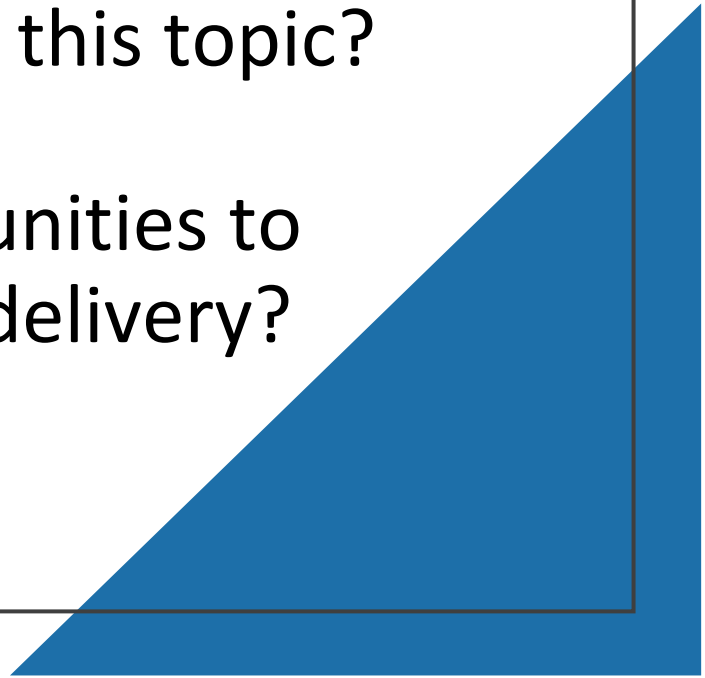


Small Group Questions

- 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!
