COMPARATIVE RESILIENCE WORKSHOP SUMMARY
TAHOE-CENTRAL SIERRA INITIATIVE

Thursday, June 14 & 15, 2018
Institute of Forest Genetics
2480 Carson Rd, Placerville, CA 95667

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The TCSI Comparative Resilience Workshop was supported by Promoting Ecosystem Resilience and Fire Adapted Communities Together, a cooperative agreement between The Nature Conservancy, USDA Forest Service and agencies of the Department of the Interior — Bureau of Indian Affairs, Bureau of Land Management, National Park Service and U.S. Fish & Wildlife through a subaward to the Watershed Research and Training Center. For more information, contact Michelle Medley-Daniel at michelle@thewatershedcenter.com or (530) 628-4206.

Overview

The Tahoe-Central Sierra Initiative (TCSI), a part of the Sierra Nevada Watershed Improvement Program (WIP), brings together innovative approaches to increase the pace and scale of restoration across the Central Sierra Nevada and Lake Tahoe areas.

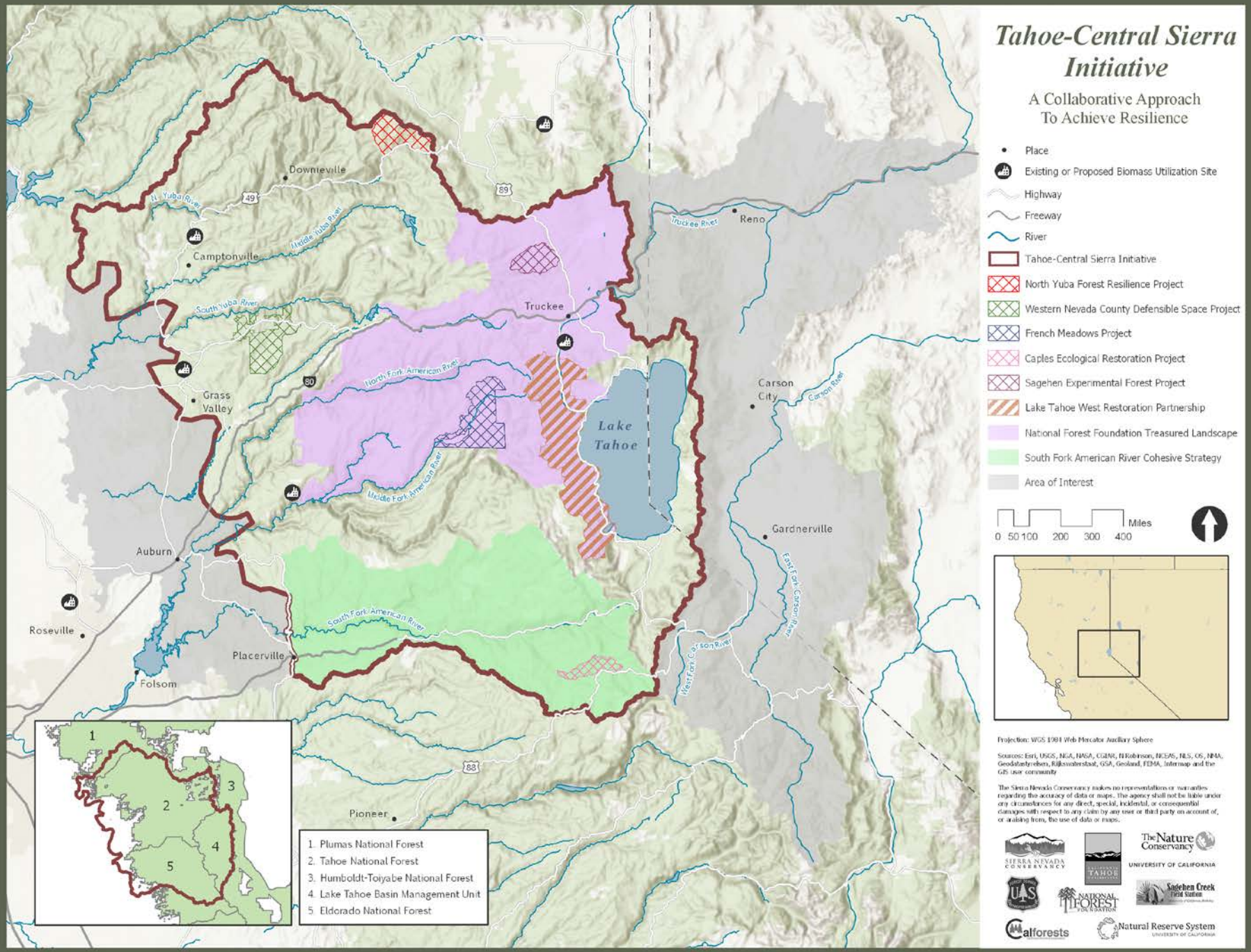
Encompassing 2.4 million acres, the Tahoe Central Sierra Initiative (TCSI) takes a novel approach to restoration by strategically linking forest landscape restoration collaboratives. Rather than duplicate or supplant these endeavors, TCSI focuses on the handful of cross-cutting issues that necessitate working at a very large scale, including operating biomass facilities to help treat forest fuels, protecting wide-ranging sensitive species, using prescribed and managed fire across multiple jurisdictions, and adapting to climate change. Building on the work of the collaboratives, TCSI has started identifying common outcomes that characterize resilient forest landscapes throughout the region. A subsequent action plan will help to guide and assess the restoration work that each agency and collaborative undertakes, and a corresponding data dashboard will help to compare and communicate their successes.

The TCSI hosted a Comparative Resilience Workshop in June 2018 which showcased how different landscape restoration efforts within TCSI have defined and measured social-ecological resilience. At the workshop ecologists at the forefront of resilience research provided foundational concepts for characterizing resilience. Planners and land managers experienced in assessing and managing for resilience shared their approaches to assessment and management. The TCSI Steering Committee members in attendance reinforced the need, urgency, and opportunity to expedite the adoption of a cohesive, scientific approach to landscape restoration.

The workshop built consensus around conditions that provide a common representation of resilience for the entire 2.4 million acres. The conditions describe patterns and processes that characterize resilience across a landscape as a whole over decades. The workshop and resulting products will support the TCSI's science framework and resource assessment, as well as provide the foundation for consistent communication and performance measurement.

The Workshop Planning Team was: Angie Avery, Nic Enstice, Dorian Fougeres, Pat Manley, Rodd Kelsey, Sarah Sawyer, Tania Carlone, Jason Vasques, Wayne Spencer, Patrick Wright, and Forest Schafer.

For more information on TCSI, visit restorethesierra.org/tahoesierra


Tahoe-Central Sierra Initiative
A Collaborative Approach To Achieve Resilience
Place
Existing or Proposed Biomass Utilization Site
Highway
Freeway
River
Tahoe-Central Sierra Initiative
North Yuba Forest Resilience Project
Western Nevada County Defensible Space Project
French Meadows Project
Caples Ecological Restoration Project
Sagehen Experimental Forest Project
Lake Tahoe West Restoration Partnership
National Forest Foundation Treasured Landscape
South Fork American River Cohesive Strategy
Area of Interest
0 50 100 200 300 400 Miles
Downieville
Camptonville
Grass Valley
Truckee
Reno
Carson City
Lake Tahoe
Gardnerville
Auburn
Roseville
Placerville
Folsom
Pioneer
North Yuba River
Middle Yuba River
South Yuba River
North Fork American River
Middle Fork American River
South Fork American River
Truckee River
Carson River
East Fork Carson River
West Fork Carson River
1. Plumas National Forest
2. Tahoe National Forest
3. Humboldt-Toiyabe National Forest
4. Lake Tahoe Basin Management Unit
5. Eldorado National Forest
Projection: WGS 1984 Web Mercator Auxiliary Sphere
Sources: Esri, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community
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Sierra Nevada Conservancy
The Nature Conservancy
University of California
National Forest Foundation
Sagehen Creek Field Station
Calforests
Natural Reserve System

Meeting Summary – Day One

1 Participants and Goals

1.1 Participant List

Name	Organization	Initiative
Becky Estes	US Forest Service R5	Caples
Becky Kirby	US Fish and Wildlife Service	
Ben Solvesky	Sierra Forest Legacy	SOFAR
Christina Restaino	Tahoe Regional Planning Agency	Lake Tahoe West
Dorian Fougères	California Tahoe Conservancy	Planning Team
Durrell Kapan	California Academy of Sciences	
Ed Smith	The Nature Conservancy	French Meadows
Evan Ritzinger	National Forest Foundation	
Forest Schafer	California Tahoe Conservancy	Planning Team
Helge Eng	CAL FIRE	TCSI Steering Committee
Hugh Safford	US Forest Service R5	
Jack Dumbacher	California Academy of Sciences	
Jason Vasques	California Tahoe Conservancy	Planning Team
Jeff Brown	UC Berkeley	Sagehen/TCSI Steering Committee
Jeff Marsolais	Lake Tahoe Basin Management Unit	TCSI Steering Committee

Name	Organization	Initiative
Jim Branham	Sierra Nevada Conservancy	TCSI Steering Committee
Jonathan Long	Pacific Southwest Research Station	TCSI Science Enterprise
Kelly Pavlica	Tahoe National Forest	
Kevin McGarigal	University of Massachusetts	North Yuba
Kristen Wilson	The Nature Conservancy	TCSI Science Enterprise
Leland Tarnay	US Forest Service R5	Sagehen
Lon Henderson	Tahoe National Forest	Western Nevada D-Space
Malcolm North	UC Davis	TCSI Science Enterprise
Mandy Vance	Sierra Nevada Conservancy	TCSI Steering Committee
Marilyn Tierney	Tahoe National Forest	North Yuba
Mason Bindl	Tahoe Regional Planning Agency	Lake Tahoe West
Nic Enstice	Sierra Nevada Conservancy	Planning Team
Pat Manley	Pacific Southwest Research Station	Workshop Planning Team
Patrick Wright	California Tahoe Conservancy	TCSI Steering Committee
Paul Cylinder	Conservation Biology Institute	Forest Resilience Initiative
Roger Bales	UC Merced	TCSI Science Enterprise
Sarah DiVittorio	National Forest Foundation	Lake Tahoe West
Sarah Sawyer	US Forest Service R5	Workshop Planning Team
Scott Stephens	UC Berkeley	TCSI Science Enterprise
Shana Gross	Lake Tahoe Basin Management Unit	Lake Tahoe West

Name	Organization	Initiative
Shengli Huang	US Forest Service R5	
Steve Baumgartner	Department of Fish and Wildlife	AB 1492
Steve Holdeman	Stanislaus National Forest	
Sue Britting	Sierra Forest Legacy	Lake Tahoe West
Tania Carlone	Consensus Building Institute	Facilitator
Tim Sheehan	Conservation Biology Institute	Forest Resilience Initiative
Traci Allen	Eldorado National Forest	
Van Butsic	UC Berkeley	AB 1492
Wayne Spencer	Conservation Biology Institute	Workshop Planning Team

1.2 Workshop Goals

The goals of the workshop were to:

1. Share the analytical and modeling approaches to resilience.
2. Identify desired landscape outcomes for the TCSI landscape, including linking technical considerations to management and communications.
3. Identify consistent methods and metrics for assessing resilience.

1.3 Opening Remarks

Jim Branham (Executive Officer, Sierra Nevada Conservancy)
Patrick Wright (Executive Director, California Tahoe Conservancy)

Mr. Branham and Mr. Wright delivered opening remarks, which provided background on TCSI, and highlighted the need, urgency, and opportunity to expedite the adoption of a cohesive, scientific approach to landscape restoration. Key Points:

- The overall goal of TCSI is to move the landscape toward a state of resilience.

- TCSI is bringing together multiple restoration initiatives and collaboratives to identify how their work fits together, and how we can communicate about the value of restoration work.
- The workshop is a starting point for TCSI to test new approaches in a critical landscape that provides water, recreation, and health benefits to millions of people.
- We need performance measures that better translate to resilience. This will help us to track progress and support communications efforts. These measures must rely on science and research, and would be the foundation for a resilience dashboard that would track resilience across the Sierra.
- The need to restore resilience is urgent. If we don't act soon, ecosystems and communities may move past the point of recovery. There is also enormous opportunity to expedite restoration because of the alignment of policy and funding in California and nation-wide.

2 Desired Landscape Outcomes

Dorian Fougères (Chief of Natural Resources, California Tahoe Conservancy)

Mr. Fougères provided an overview of the Desired Landscape Outcomes concept, and set expectations for workshop deliverables. Key Points:

- The TCSI needs a clear, easy to understand method of tracking and communicating about resilience to help guide public policy decision making and to increase forest health funding.
- The deliverables this group is working toward will help policy and communications experts to speak with a single voice about resilience in the Sierra Nevada.
- The opportunity to succeed at working toward a common vision of resilience is now, due to current political attention and available funding.

2.1 Workshop Concepts and Terminology

Mr. Fougères provided a common set of definitions and terminology, to provide a common basis for communication about resilience at the workshop.

Landscape

One may define a landscape technically or colloquially. The workshop conveners respect the autonomy of the different groups to define their own landscape. Purely as a point of reference, some ways to distinguish landscape may include:

- Place-based identity – a landscape consists of an area that stakeholders identify with and feel has a sensible boundary
- Nested ecological hierarchy – somewhere between a watershed (any one of a range of hydrologic unit sizes), biome, and ecoregion (e.g., 22 USFWS Landscape Conservation Cooperatives cover all of North America)
- Management scale – somewhere between a project (e.g., 2,000 to 10,000 acres) and forest (e.g., 1+ million acres) or multiple forests (e.g., Four Forests Restoration Initiative CFLRP 2.4M acres)

Desired (and Acceptable) Landscape Outcome (DLO)

As emphasized by the word **"landscape"** itself, a DLO describes (quantitatively and/or qualitatively) a process that shapes, and/or the resulting pattern that characterizes, a landscape as a whole over decades.

- In this regard, one could consider a DLO epiphenomenal, insofar as one has to look at the portions of a landscape altogether to see it – the proverbial forest created from the trees.

- The emphasis that the concept puts on processes corresponds with both a large spatial extent and evolution over many years.

The term **"outcome"** draws attention to human involvement and intervention in ecological processes. The concept of a DLO requires a strong sense of humility that comes from viewing the landscape as an intertwined social-ecological system (SES), which is itself a complex adaptive system (CAS).

- Complex adaptive systems are inherently dynamic, non-linear, emergent, and uncertain, and have the capacity to self-organize and adapt based on past experience.
- Social-ecological systems are inherently integrative, understanding the presence and activities of people as part of rather than separate from the landscape. Science, policy and management cannot treat people and ecology as silos.

The concept of a DLO borrows from, but is not limited to, scholarship on social-ecological resilience. Applying the concept first requires identifying what system state is **"desired",** e.g., mixed conifer forest as manifest at the landscape-scale. In this regard, it makes human values explicit, rather than assumed. It also draws attention but is not limited to ecological disturbance processes.

- Crucially, rather than expecting one can control the system, building resilience seeks to avoid having the system shift into a non-desired state.
- Within the boundaries of this desired state, the conditions of the system at any given time may vary widely.

Distinguishing between a desired and an "**acceptable**" outcome maintains humility and provides flexibility when applying the DLO concept in the field. Practitioners may use a discrete range to characterize a DLO, and identify corresponding management interventions (which may include no action). However, the dynamism and agency inherent in the landscape may result in an outcome outside this range. So long as this outcome remains within the desired system state, albeit outside the range of the DLO, one could still consider this outcome acceptable.

Desired Condition

Practitioners can describe and utilize the concept of a desired condition in sophisticated ways that equate with a DLO. The purpose of coining "desired landscape outcome," however, serves to emphasize the preceding ideas, and distinguish the concept from simplistic uses of desired condition. In many management contexts, for example, establishing a desired condition involves identifying a "target" for management intervention to achieve, and focuses on site-specific conditions at a given future point in time. We propose not using the term "desired condition" for this workshop.

Indicator and Metric

An "indicator" refers to a characteristic used to describe something. (Stated in active voice, the characteristic indicates that something exists, or degree to which it exists.)

- An indicator can consist of a process, or a condition.
- However, given the difficulty of directly measuring many processes, for our discussions we propose (1) using the term "indicator" to refer to a site-specific condition at a given moment, and (2) that using multiple indicators taken together (especially when measured over time) can approximate a process. This includes, in our case, a process that constitutes a DLO.

Measuring an indicator implies identifying an appropriate unit of measurement (a "metric"), and then creating or utilizing a corresponding data set.

- In practice, the data available for different landscapes varies greatly.
- The ability to combine multiple indicators to approximate a DLO allows different landscapes to draw on the data available to them, yet still speak to the same DLO, and compare themselves.
- In some cases, an indicator and metric may be identical (e.g., trees per acre). And in some cases, a complex indicators may combine multiple metrics and data sets.

Summary Example

- DLO: a fire regime that maintains vegetative heterogeneity
- Indicator: mean condition class; fire severity
- Metric: condition class category; post-fire appearance of soil, litter, or vegetation

2.2 Select Resilience Terminology

Resilience: The capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks. Source: Walker, B.H., C.S. Holling, S.R. Carpenter, and A. Kinzig. 2004. Resilience, adaptability, and transformability in social-ecological systems. Ecology and Society 9(2): 5.

- Applicable not only to ecological systems but to social-ecological systems.

Adaptability: The capacity of a social-ecological system to learn, combine experience and knowledge, adjust its responses to changing external drivers and internal processes, and continue developing within the current stability domain or basin of attraction. Source: Berkes, F., J. Colding, and C. Folke, eds. 2003.

Navigating Social-Ecological Systems: Building Resilience for Complexity and Change. Cambridge University Press.

Transformability: The capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable. Walker et al, *ibid.*

Engineering resilience: A system's speed of return to equilibrium following a shock. Source: Pimm, 1984. The complexity and stability of ecosystems. Nature 307: 321-326.

- Note this assumes that existence of a system equilibrium, in contrast to the system dynamism assumed in the first definition of "resilience" above. Engineering resilience seeks to maintain or return to the same conditions in the same system.
- Note the similarity with persistence (see below).

From Fisichelli et al 2015, "Is 'Resilience' Maladaptive? Towards an Accurate Lexicon for Climate Change Adaptation." Environmental Management. DOI 10.1007/s00267-015-0650-6

- **Persistence:** An approach to climate change adaptation that focuses on the persistence of current conditions.
    - Note that the conditions would not change, nor the system.
- **Autonomous change:** An approach to climate change adaptation in which a resource responds to change with no management response intended to drive the system toward a specific state.
    - Note that conditions as well as the system could change.
- **Directed change**: An approach to climate change adaptation where management responses intend to drive the system toward a specific desired new future state.
    - *Note that conditions could change, while the system would remain the same.*

3 TCSI Science Enterprise Status and Overview

Pat Manley (Research Program Manager, Pacific Southwest Research Station)

Ms. Manley provided an overview of the objectives, status, and overall process for the TCSI Science Enterprise. Key Points:

- The TCSI aims to accelerate large-landscape forest restoration across the Sierra Nevada by demonstrating a collaborative, private and public effort to restore forest resilience across a 2.4 million acre landscape in the Central Sierra. A cornerstone of TCSI will be a science enterprise designed to provide the foundation needed for strategically implementing restoration at this large landscape scale.
- Implementing landscape-scale forest restoration requires robust information about where restoration is needed most, what kinds of active management are possible, and the relative costs and benefits of alternative restoration pathways (e.g., reduced fire risk, biodiversity, carbon, timber supply).
- The science team for TCSI will fulfill this need by providing the science, planning and foundational data required by developing the following products:
    - Framework for Resilience: an evidence-based framework for defining and measuring forest resilience in the Sierra Nevada that provides a benchmark for planning restoration;
    - Resource Assessment: a complete assessment of current conditions, stressors and resilience across the landscape that can be used to evaluate different restoration scenarios and prioritize restoration investments; and
    - Blueprint for Success: a landscape restoration plan for improving the ecological and social resilience of the TCSI landscape that will provide a landscape-scale foundation for project level planning and implementation over the coming decades.
- Our ultimate goal for this landscape is to improve forest resilience to fire, drought, disease, and climate change, to protect biodiversity, and to reduce threats to human well-being. In addition, we intend through this effort to create a model that can be exported to advance restoration throughout the Sierra Nevada and the western United States.

4 Framing Resilience

Representatives from the resilience initiatives contained or overlapping with the TCSI landscape provided 10 minute presentations on their approach to assessing and restoring resilience. Workshop participants were asked to consider what common themes or cross-cutting issues were revealed through the presentations, as well as the successes and limitations of various approaches to resilience.

Complete presentations from each initiative are available online.

4.1 Lake Tahoe West Restoration Partnership

Shana Gross (Central Sierra Province Associate Ecologist, Lake Tahoe Basin Management Unit)

Ms. Gross presented an overview of the Lake Tahoe West Restoration Partnership. The Partnership's goal is to restore the resilience of the west shore's forests, watershed, recreational opportunities, and communities to threats such as wildfire, persistent drought, changing climatic conditions, and a potential bark beetle epidemic.

The partnership conducted a 5 step resilience assessment:

1. Identified landscape values and services desired to be resilient to major disturbances.
2. Identified indicators of resilience.
3. Specified a range of resilient conditions for each indicator.
4. Analyzed geospatial data for each indicator to determine current resilience.
5. Combined multiple indicators into composite indicators to identify landscape resilience to each disturbance and resilience of each value/service.

The full presentation is available online.

4.2 Caples Ecological Restoration Project

Becky Estes (Central Sierra Province Evologist, U.S. Forest Service Region 5)

Ms. Estes presented an overview of the Caples Ecological Restoration Project. The project is located within the South Fork American River Watershed. The project goals are to:

- Improve watershed and forest health
- Reduce hazardous fuel accumulation

- Restore meadows
- Improve conditions for aspen and oak
- Improve public safety

Higher resolution datasets, such as LiDAR, were not available for the project area. Project managers instead utilized an extensive network of monitoring plots in conjunction with Fire Return Interval Departure and Canopy Cover datasets. The level of resilience was determined based upon departure from the Natural Range of Variation (NRV).

The full presentation is available online.

4.3 South Fork of the American River Cohesive Strategy

Ben Solvesky (Conservation Biologist, Sierra Forest Legacy)

Mr. Solvesky presented an overview of the South Fork of the American River Cohesive Strategy project (SOFAR). The projects goals are tiered to the National Cohesive Wildland Fire Management Strategy and its goals of restoring and maintaining fire-resilient landscapes, creating fire adapted communities, and providing for safe and effective wildfire response.

The SOFAR Collaborative Group developed a process for creating a landscape vision consisting of:

1. Defining resilience and desired conditions.
2. Identifying values at risk.
3. Developing resilience indicators.
4. Assessing current conditions.
5. Prioritizing areas for treatment.
6. Implementing projects.

The collaborative encountered challenges in assessing current conditions due to the lack of capacity and technical expertise. Because the work was proceeding slowly, the collaborative elected to no longer make the indicators and current conditions a priority. Instead, based on several stakeholder meetings, the group defined two community-based focus areas to plan and develop projects where values at risk and wildfire potential were high. They also defined a large landscape area away from communities where progress toward landscape resilience was attainable and the potential to manage wildfires for resource benefits was also high.

The full presentation is available online.

4.4 French Meadows Project

Ed Smith (Forest Ecologist, The Nature Conservancy of California)

Mr. Smith presented an overview of the French Meadows Project. The goals of the project are to:

- Reduce risk of high-intensity wildfire.
- Improve forest health, wildlife habitat and their resilience.
- Protect water quality, improve water security.
- Improve science connecting management and hydrology.
- Innovate approach to project management and fundraising.

To assesses resilience the project team measured potential fire behavior at the watershed scale, including flame length, rate of spread, crown fraction burned, crown fire activity (CFA), and burn probability. They are also considering the impacts of restoration work and wildfire on watershed function, including expected increases in available soil moisture, improvement in tree water status, and impacts on streamflow.

The full presentation is available online.

4.5 Sagehen Experimental Forest Project

Jeff Brown (Director, UC Berkeley Sagehen Field Station)

Mr. Brown presented an overview of the Sagehen Experimental Forest Project. The project initiated to test the viability of implementing Strategically Placed Landscape Area Treatments (SPLATs). Ultimately, a more collaborative approach was utilized to build consensus around resilience with a diverse group of stakeholders. The goals of the project are to:

- Reach broad consensus
- Improve forest health
- Improve wildlife habitat
- Maintain or improve water quality
- Reduce to chance of a catastrophic wildfire
- Return low intensity fire to the landscape where practical

The collaborative group utilized principles from PSW-GTR-220 and PSW-GTR-237 to strategically place treatment units throughout the project area. Project managers have nearly completed implementation of initial treatments.

The full presentation is available online.

4.6 North Yuba Forest Resilience Project

Kevin McGarigal (Director, University of Massachusetts Landscape Ecology Lab)

Mr. McGarigal presented an overview of the North Yuba Forest Resilience Project. The project's goals are to:

- Synthesize empirical and expert knowledge on disturbance and succession processes characteristic of the pre-Euro-American settlement period in the northern Sierra Nevada ecoregion, which contains the upper Yuba River watershed.
- Quantify the historical range of variability (HRV) in landscape structure (i.e., vegetation land cover composition and configuration) in the upper Yuba River watershed by using the RMLands landscape disturbance-succession model.
- Quantify current departure of the upper Yuba River watershed landscape structure from its HRV.
- Quantify range of variability in landscape structure in the upper Yuba River watershed under several alternative management scenarios and compare them to the current landscape and HRV.
- Synthesize simulation modeling results and summarize the implications for land management.

The project team used historical range of variability as the basis for evaluating the resiliency of the current and potential future landscapes. Fire return interval and other disturbance regime measures were not considered measures of resilience in the study because the team treated the disturbance regime as the driver of vegetation change. The team considered the vegetation composition and configuration as the landscape response to disturbance, and treated the corresponding measures as resilience indicators.

The full presentation is available online.

4.7 Western Nevada County Community Defense Project

Lon Henderson (District Ranger, Yuba River Ranger District, Tahoe National Forest)

Mr. Henderson presented an overview of the Western Nevada County Community Defense Project. The goal of the project is to initiate treatments in specific locations where the effects of the activities would reduce potential wildfire behavior; allow firefighters to make safer tactical decisions; and assist in the defense of the communities.

The project team utilized historical range of variability and fire return interval departure to assess resilience. The Yuba River Ranger District is currently implementing the project, and is focused on connecting treatment in the wildland-urban interface across multiple ownerships.

The full presentation is available online.

4.8 AB 1492 (2012) Ecological Performance Measures Working Group

Steve Baumgartner (Senior Environmental Scientist, CA Dept. of Fish and Wildlife)

Mr. Baumgartner presented an overview of the Ecological Performance Measures Working Group. California's AB 1492 became law in 2012 and directs the state to develop ecological performance measures (EPMs) for the state's forest practice regulatory program. The duties assigned to the working group are:

1. Develop a stakeholder outreach and communication plan for gathering input on potential approaches to identifying and quantifying EPMs.
2. Develop a brief background paper on approaches to EPMs. The intent of the paper is to provide a starting point for discussions with stakeholders.
3. Develop an initial draft set of EPMs.
4. Develop a final working set of EPMs, an implementation plan, and an adaptive management approach.

The full presentation is available online.

4.9 Conservation Biology Institute Forest Resilience Initiative

Wayne Spencer (Chief Scientist, Conservation Biology Institute)

Mr. Spencer provided an overview of the Conservation Biology Institute's Forest Resilience Initiative. The initiative is seeking to better define goals and targets for habitat resilience, and to utilize them to prioritize and track success of forest restoration projects.

Species such as fishers and spotted owls are associated with dense forests, which conflicts with traditional vegetation management concepts of resilience. However, the presence of suitable habitat does not confer that the habitat is resilient. Although managers can set goals and targets for suitable habitat availability, researchers must define habitat resilience before it can be mapped and monitored.

The initiative is using the Environmental Evaluation Modeling System (EEMS) to develop resilience indices. Currently existing vegetation data is not systematically and reliably updated, which challenges efforts for monitoring. FastEMap is updated regularly with Landsat imagery and may provide a solution.

The full presentation is available online.

4.10 PSW Remote Sensing Lab F3 and DRAST Models

Shengli Huang (Senior Remote Sensing Analyst, U.S. Forest Service Region 5 Remote Sensing Lab)

Mr. Huang presented an overview and demonstration of the F3 and DRAST modeling systems. F3 uses data from Forest Inventory and Analysis (FIA) and FastEMap. It adds spatial capabilities to the Forest Vegetation Simulator model to enable modeling of individual tree dynamics geographically and temporally.

DRAST quantifies spatial and temporal post-fire recovery using field inventory, tree growth simulations, and remote sensing. It estimates total biomass lost and recovered following disturbance events.

The full presentation is available online.

5 The TCSI Framework for Resilience

Malcolm North (Research Forest Ecologist, UC Davis)
Scott Stephens (Professor, UC Berkeley)

Mr. North and Mr. Stephens provided an overview of the TCSI Framework for Resilience. The project has two objectives:

1. To provide a conceptual model of what structures Sierra Nevada forested landscapes, what constitutes resilience, why resilience is an appropriate objective for management and how to manage those landscapes for increased resilience.
2. Using LiDAR, apply the conceptual model to identify and scale metrics that strongly influence forest conditions in a) a reference landscape and b) compare against a managed part of the TCSI landscape to identify areas needing treatment.

Although previous efforts such as PSW-GTR-220 and PSW-GTR-237 are useful, the scale must increase to meaningfully plan for restoring resilience across large landscapes.

At the landscape level, resilience might be forest conditions that are sufficiently congruent with the bottom up drivers (such as topography) to flex (adapt) to projected increases in the intensity and spatial scale of top-down stressors (such as climate, drought, and new fire regimes). Currently the intensity and frequency of top-down stressors, interacting with homogenized, fire-suppressed forests, overwhelms the fine-scale heterogeneity that historically was self-reinforcing.

Success of the approach relies on constraining the analysis to dry western forests that historically had a frequent, low-intensity fire regime. In such a system, a resilient forest will "lifeboat" a wide variety of ecosystem values and attributes.

Potential issues with the approach include lack of extensive reference landscapes, lake of continuous LiDAR datasets, and poor to non-existent soils data.

The full presentation is available online.

6 Desired Landscape Outcomes Group Work and Discussion

6.1 Group Discussion

Following the presentations, participants were asked to identify common themes and cross-cutting issues revealed through the presentations. Additionally, the group proposed the most important elements that must be considered in developing a set of Desired Landscape Outcomes for TCSI.

1. Common themes:
    - NRV, HRV and FRID frequently used to assess resilience
    - Goals to reintroduce fire as a disturbance and reduce fire behavior.
    - Metrics relating to structural heterogeneity.
    - Old forest species as indicators of ecological function
    - Working at larger scales than before
    - Collaborative design to build consensus
    - Less emphasis on wildlife specifically and more on forest structure (could also be categorized below as an issue)
    - Proximity to humans perpetuates and reinforces disturbance impacts. Spectrum WUI – wilderness

2. Cross-cutting issues:
    - Data limitations, both in terms of access and consistency across the landscape
    - Tensions between human impact and ecological health
    - Dismal treatment economics

- Limited agency time, resources, and capacity
- Climate change
- Need to involve the timber industry
- Getting through NEPA/CEQA planning

3. Important elements for Desired Landscape Outcomes:
    - Bridge multiple scales, i.e. fine scale and landscape scale
    - Definition must be able to be assessed with spatial data
    - Incorporate reference conditions and/or NRV/HRV
    - Define how DLOs will be utilized
    - Address maintenance of treatments.
    - Closely integrate human interactions
    - Consider treatment economics
    - Acknowledge that humans are part of the definition of resilience in certain parts of landscape
    - Allow for comprehensive monitoring
    - Allow for the incorporation of work from multiple initiatives into TCSI.
    - Have different definitions/ranges of resilience for human dominated vs. wildland areas

6.2 Small Group Work

Participants formed six groups to provide direction and suggestions to the working group tasked with developing a draft set of desired landscape outcomes on day two.

Group One

Group One considered the communications aspects of DLOs. Key points:

- Need to communicate about the adaptive capacity of Sierra Nevada forests, and the wide range of natural conditions that are present across the landscape.
- Regarding how to get the public onboard:
    - Focus on diversity and sustainability
    - Focus on wildfire risk and severity reduction
    - Focus less on the project by project communciations, and more about the master plan for resilience.
- Consider a greater emphasis on visuals, such as videos, maps, and infographics.

- Need to consider how to treat the hardest parts of the landscape, as those areas might be the most important.

Group Two

Group Two considered the scale of DLOs, and their connections to economics and monitoring. Key points:

- Need to think about framing cumulative landscape effects in a positive way, i.e. high severity fire that may be considered unacceptable at a small scale me be acceptable at a larger scale.
- Be explicit about the costs and benefits of landscape scale approach. Treatment costs have increased and may not economically pay off immediate, but benefits accrue over the long term.
- Need to address maintenance in the context of economics, e.g. larger trees are more valuable than biomass and understory trees.
- One size fits all indicators are not useful, and a wide variety of indicators should be able to be applied to the DLOs depending on landscape context.
- Monitoring and research are critical for defining and redefining success, so consider how adaptive management approaches fit in.

Group Three

Group Three developed a proposal for an example DLO relating to fire:

- When fire burns, it burns in an ecologically and socioeconomically appropriate way, e.g., it burns within the natural range of variation given the landscape context; it perpetuates landscape heterogeneity; and it doesn't threaten human safety or infrastructure.

Group Four

Group Four considered the various categories of values and possible subcategories and indicators which connect to them:

- Soils and Water
    - Avoid significant water quality impacts
- Fire Regime
    - Less than 5000 tons PM10/day
    - Discontinuous fuels and low flame lengths, especially on sun-facing slopes.
    - Individuals, clumps, and openings (ICO)

    - Wildland Urban Interface conditions.
- Mortality, Regeneration, and Succession
- Ecological Communities
    - Sustained fish and wildlife populations
- Communities
    - Health and safety
    - Cultural landscapes
    - Forest industry
    - Recreation
- Air Quality

Group Five

Group Five considered communications, policy, industry, and biodiversity connections to consider in developing DLOs:

- Communications:
    - Why we need to get to scale
    - Role of forest management
    - Land management is imperfect
        - Uncertainty/accidents can occur
    - Connection between healthy wildlife and habitat variability
    - Safety for communities
    - Forest restoration needs industry to support it.

- Policy
    - Integrated management across ownerships through landowner incentives and partnerships.
    - People are a part of the maintenance of the landscape, through behavior change, increased investment, and environmental stewardship.
    - Funding sources, administration, and regulatory structure support needed restoration.

- Industry
    - Restoration industry: Right sized, right location, right capacity. Both timber and biomass.
    - Jobs, education, and skills match restoration need.

- Biodiversity
    - Energy flow dynamics, and ecosystem bioengineering that address wildlife biodiversity.
    - Monitoring conducted for keystone species, predator prey dynamics.

Group Six

Group Six provided conceptual direction regarding the connection between DLOs and indicators. Key points:

- Consider whether the DLOs must be quantifiable, or whether indicators connected to DLOs provide the quantification ability.
- The indicators that are used to quantify DLOs need to be flexible and adaptable to particular areas. Some indicators will be more or less applicable in some context.
- DLOs must be specific enough to provide programmatic direction, but not so specific as to be prescriptive or limit applicability.

Meeting Summary – Day Two

A small working group synthesized direction from day one participants and developed a draft proposal of Desired Landscape Outcomes for TCSI. The TCSI Steering Committee will consider the draft and provide direction for refinement.

6.3 Day Two Participants

Name	Organization
Becky Estes	US Forest Service R5
Dave Fournier	Tahoe National Forest
Forest Schafer	California Tahoe Conservancy
Kristen Wilson	The Nature Conservancy
Nic Enstice	Sierra Nevada Conservancy
Pat Manley	Pacific Southwest Research Station
Sarah Sawyer	US Forest Service R5
Shana Gross	Lake Tahoe Basin Management Unit
Steve Brink	California Forestry Association
Sue Britting	Sierra Forest Legacy
Tania Carlone	Consensus Building Institute
Van Butsic	UC Berkeley
Wayne Spencer	Conservation Biology Institute

6.4 First Draft Desired Landscape Outcomes Proposal

Background

A group of representatives from collaboratives working to restore resilience in the Tahoe-Central Sierra Initiative (TCSI) landscape developed proposed Desired Landscape Outcomes (DLOs). The TCSI hosted a Comparative Resilience Workshop in June 2018 to initiate DLO development. At the workshop ecologists at the forefront of resilience research provided foundational concepts for developing DLOs. Planners and land managers experienced in assessing and managing for resilience shared their approaches to linking management actions to resilience. The TCSI Steering Committee members in attendance reinforced the need, urgency, and opportunity to expedite the adoption of a cohesive, scientific approach to landscape restoration.

Defining Desired Landscape Outcomes

A DLO describes patterns and processes that characterize resilience across a landscape as a whole over decades. Resilience refers to the capacity of a system to respond to disturbance without shifting to a different state. The DLOs incorporate the presence and activities of people as part of the landscape, make human values explicit, and integrate social and ecological systems. Achieving the DLOs will build the resilience of the TCSI landscape to climate change, disturbance, extreme events, and management impacts.

Historically, topography, disturbance regimes, and other drivers of vegetation generated and sustained the fine-scale heterogeneity and range of conditions present in the TCSI landscape. The landscape had high resilience to disturbances like fire and drought, and the ability to respond and adapt to changing climate. The past 170 years of settlement by the United States transformed the landscape and increased the intensity and scale of disturbances.

Today the landscape has low resilience and adaptive capacity, and climate change will continue to amplify disturbances. In particular, wildfire suppression and extensive logging during the late 1800's reduced fine-scale forest heterogeneity in the Sierra Nevada and created a more homogeneous forest. Today, the same types of disturbances that enhanced forest heterogeneity and resilience in the past – fire, drought, insect and disease – are now more likely to threaten the ecological and social benefits that forests provide.

Applying Desired Landscape Outcomes

These DLOs connect the science, research, and management efforts in the TCSI landscape with the policy, investment, and communications needs of TCSI. This will especially benefit the future work of the TCSI Science Enterprise, Communications Committee, and Core Team. The group designed the DLOs to meet five primary criteria:

1) Rely on the best available science
2) Allow for quantifiable measurement
3) Respond to management
4) Translate complex processes into straightforward, compelling messages
5) Allow for consistent yet flexible application throughout the greater TCSI landscape

TCSI will use the DLOs to measure and compare progress among the TCSI initiatives and other forest restoration efforts in the Central Sierra through a resilience dashboard. The DLOs will guide the TCSI's efforts to prioritize actions and set landscape-scale goals. This includes helping to guide the development of smaller scale projects and research inquiries that would otherwise exist in isolation.

TCSI Desired Landscape Outcomes Proposal (First Draft)

Vegetation	Vegetative conditions, including composition and structure, are congruent with topography and desired disturbance dynamics through time. Heterogeneity is accentuated at ecologically appropriate scales, resulting in vegetation mosaics across the landscape.
Fire	When fire burns, it burns in an ecologically beneficial and socially acceptable way, it perpetuates landscape heterogeneity, and rarely threatens human safety or infrastructure.
Communities	Society lives safely with wildfire, and is accepting of both natural ecological dynamics and management for restoration and hazard reduction. Beneficial fire is encouraged. Non-planned human-caused ignitions are rare, and unwanted fires are suppressed.
Wildlife	The diverse and interacting network of native species and ecological communities is present across the landscape in a sufficiently abundant and distributed manner to support and sustain their full suite of ecological and cultural roles.
Water	Water reliability, quantity, quality, and connectivity are buffered against precipitation variability and disturbance by the integrity of the watershed.
Economy	Restoration, management and recreation activities support a diverse economy. Forest products are harvested sustainably and utilized at their highest and best use, promoting community workforce development and sustainable capacity for restoration and hazard reduction activities.