Southern Sierra Change Adaptation Workshop - Final Report

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The Word Art on the title page was generated from participants' responses to the question, "What are your expectations for the workshop? What do you hope to learn or contribute?"

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Executive Summary

To engage conservationists across the southern Sierra Nevada in a discussion of how anthropogenic changes to the environment could affect land management, a group of collaborators composed of the Bureau of Land Management, California Landscape Conservation Cooperative, National Park Service, US Forest Service, and US Geological Survey hosted the Southern Sierra Change Adaptation Workshop on February 20th-22nd, 2013 in Visalia, California. This workshop brought nearly 170 land managers, conservation practitioners, and education partners together from across the region to dialog with each other and address the question: **"Given uncertain and rapidly changing conditions in the 21st century, how do we best achieve our shared conservation goals for the Southern Sierra Nevada Region?"**

After hearing keynote talks about agents of change, natural resource conditions, and human dimensions, participants tested a change adaptation framework through a series of exercises. They identified shared values, discussed resource vulnerabilities, assessed current objectives in light of these vulnerabilities, and brainstormed potential "climate-smart" revised objectives. Participants described management strategies for both the persistence of valued resources as well as ways to facilitate desired transformations when persistence is not possible. Speakers from government agencies, universities, and non-governmental organizations presented talks on vulnerability assessments, adaptation strategies, and more. Line officers or their representatives from several agencies also spoke on a panel about shared regional values, facilitating an open and informative discussion of the challenges ahead.

By the end of the workshop, participants had identified shared values within the Sierra Nevada, described vulnerabilities of six focal resources to climate change and other stressors, drafted potential revised objectives for these resources, and identified potential strategies and management tools to meet these objectives in the future (see box, next page). Results indicate that current management actions alone are not likely to accomplish current objectives, especially under rapidly changing conditions. In some cases, the current objectives were still deemed acceptable, but participants recommended changing how management is carried out. In other cases, current objectives were revised in light of changing conditions. The suggestions for on-the-ground management actions and for policy changes focused on resistance or resilience strategies. In contrast, research/monitoring and education actions generally focused more on facilitating transformation to novel conditions or planning for extreme events.

Participant Responses

Top values for the southern Sierra Nevada:
1) Hydrologic resources (e.g., water quality and quantity)
2) Human connections to the environment
3) Biodiversity

Top criteria used to establish values:
1) Public support
2) Cross-regional benefits
3) Vulnerability of value/ability to triage

Top stressors:
1) Fire (both lack of fire and undesired fire effects)
2) Pollution (air and land based)
3) Non-native species, recreational use, and climate change

Top strategies:
1) Managed fire
2) Education
3) Experimentation and monitoring

Constraints to Implementation:
1) Cost (i.e., sustained financial support)
2) Agency regulations and culture
3) Public concerns

Tools to Overcome Constraints:
1) Public support
2) Collaboration
3) Education

Emergent Themes:
- Protecting single species versus managing for the ecosystem.
- Focusing on at-risk areas/values versus investing in those likely to persist in spite of change.
- Some agencies can do certain strategies more easily than others.
- Some strategies accomplish multiple resource objectives (co-benefits).

Several themes emerged from the workshop. For example, should managers focus effort on conserving species versus ecosystems? Should managers protect locations/values that are most at-risk or those that are most likely to persist? Are these really trade-offs or can multiple objectives be accomplished over a regional landscape? Participants acknowledged that agencies have varying abilities to carry out different strategies and that some strategies benefit multiple resource objectives. By working regionally, we can take advantage of these differences and co-benefits.

This workshop represented the first of many steps in adapting to changing conditions in the southern Sierra. Overall, participants and members of the planning committee agreed that this was a good starting point, but that more effort, dialogue, and process development are needed to plan for and implement change adaptation strategies, especially from a regional perspective. In the post-workshop survey, many participants noted that the adaptation framework would be useful to their planning efforts, but it will require further development before integration. We expect to modify the approach using lessons learned described in this report.

Critical topics identified for future efforts include public engagement (how to understand and integrate human connections to the environment), technical aspects of adaptation actions (how to apply new strategies or change the way existing tools are applied), and methods for prioritization (how to decide where and when to act).

Workshop materials, including the report, will be hosted on the California Climate Commons website, which also will host an online forum to facilitate discussion (http://climate.calcommons.org/aux/sscaw/index.htm).

Acknowledgements

This workshop would not have been possible without the dedication of a multi-agency team. The following agencies contributed staff time and/or funding to make the workshop a reality: Bureau of Land Management – Bakersfield Office, California Fire Science Consortium, California Landscape Conservation Cooperative, Giant Sequoia National Monument, National Park Service – Climate Change Response Program, Sequoia and Kings Canyon National Parks, Sequoia National Forest, Sequoia Natural History Association, U.S. Fish and Wildlife Service Training Center, U.S. Forest Service Region 5, and the U.S. Geological Service Western Ecological Research Center – Sequoia-Kings Field Station.

The twelve-member program committee developed the workshop goals, created the agenda, invited speakers, developed exercises, and created the program workbook. The seven-member logistics committee handled the venue, participant registration, poster session, and other miscellaneous necessities at the workshop.

The invited speakers provided participants with baseline information for the exercises and goals of the workshop. Topics ranged from vulnerability assessments to change adaptation strategies to government perspectives on the issue. Invited speakers included:

- Susan Antenen (Conservation Biology Institute)
- Dr. John Battles (Center for Forestry and the Department of Environmental Science, Policy, and Management, at the University of California – Berkeley)
- Dr. Matt Brooks (USGS Western Ecological Research Center – Yosemite Field Station)
- John Exline (USFS – Sierra National Forest, Sequoia National Forest)
- Dr. Jo Ann Fites-Kaufman (USFS Region 5 Planning Team)
- Danielle LaRock (California Landscape Conservation Cooperative; USFWS Training Center)
- Dr. Sonja Lin (USFS Region 5 Planning Team)
- Dr. Mark Metcalfe (USFS Region 5 Planning Team)
- Dr. Koren Nydick (NPS – Sequoia and Kings Canyon National Parks)
- Dr. Hugh Safford (USFS Pacific Southwest Region)
- Debra Schlafmann (California Landscape Conservation Cooperative)
- Dr. Mark Schwartz (University of California – Berkeley)
- Michelle Selmon (California Department of Water Resources)
- Dr. Rodney Siegel (Institute for Bird Populations)
- Dr. Wayne Spencer (Conservation Biology Institute)
- Dr. Nate Stephenson (USGS Western Ecological Research Center - Sequoia-Kings Field Station)
- Charisse Sydoriak (NPS – Sequoia and Kings Canyon National Parks)
- Karen Taylor-Goodrich (NPS - Sequoia and Kings Canyon National Parks)
- Dr. Joshua Viers (University of California – Davis)
- Dr. Deb Whitall (USFS Region 5 Planning Team)
- Eric Winford (NPS – Sequoia and Kings Canyon National Parks)

Introduction

Climate change is one of the greatest land management challenges of the 21st century. Climate and other human-driven change, from introduced species to landscape fragmentation, will affect many aspects of life on the planet and will necessitate changes in the way land managers work. Preparing for and coping with the effects of change – change adaption – is an emerging field set on tackling this issue from both ecological and human dimensions. This is a brave new world for conservationists, who now need to address past and future stressors concurrently. From a land manager's perspective, it is crucial to know the resources most likely to be affected, how to prioritize management actions with limited funding and support, and available options to sustain these resources into the future.

The Southern Sierra Nevada Change Adaptation Workshop (SSCAW) was held to identify the shared conservation goals and values-at-risk, and to explore regional-scale strategies to conserve southern Sierra Nevada natural resources in the face of rapid change and an uncertain future. The workshop followed the 2008 Southern Sierra Science Symposium, which led to the Strategic Framework for Science in Support of Management in the Southern Sierra Nevada Ecoregion (US DOI et al. 2009).

The boundaries of land ownership are artificial – ecosystems, their services, and individual species do not follow these boundaries. Similarly, land management challenges often transcend agency boundaries, as separate agencies often grapple with similar constraints and stressors. Consequently, a regional-scale outlook is the more appropriate option to the traditional management approach favoring isolation. Both the US Department of the Interior (US DOI) and the US Department of Agriculture (USDA) have made regional cooperation a priority through creating and funding regional initiatives such as the Landscape Conservation Cooperative, the Climate Science Centers (US DOI 2009), and the "all lands" planning approach (USDA 2009). Public land managers and partners in the southern Sierra Nevada region are keenly aware that valued resources are at risk. Each entity has a compelling need to develop action plans that enable them to effectively respond to unprecedented and rapidly changing climatic, biogeophysical, and socio-economic conditions. This workshop served as an opportunity to collectively move forward in our change adaptation capabilities using the latest information and tools.

This workshop was geared towards land managers, planners, natural resource specialists, science partners, and conservation practitioners, with educators and members of the general public welcomed to attend as well. Nearly 170 participants attended SSCAW as representatives from the over 60 organizations (Table 1). For more information, visit: http://climate.calcommons.org/aux/sscaw/index.htm

List of all agencies and organizations participating in the workshop	
Federal Agencies	**State and local agencies**
Bureau of Land Management: -Bakersfield Office	Angiola Water District
California Landscape Conservation Cooperative	California Department of Fish and Wildlife
National Park Service: - Devils Postpile National Monument - Sequoia and Kings Canyon National Parks - Yosemite National Park	California Department of Water Resources
	California Energy Commission
	California Natural Resources Agency
NASA DEVELOP Program	California Tahoe Conservancy
United States Department of Agriculture-NRCS	Desert Mountain RC&D Council
United States Forest Service: - Giant Sequoia National Monument - Inyo National Forest - Sequoia National Forest - Sierra National Forest - Pacific Southwest Research Station - Pacific Southwest Region	Inyo-Mono Water Management Program
	Sierra Nevada Conservancy
	Non-governmental organizations
	Big Meadows Association
	California Fire Science Consortium
United States Geological Service, Western Ecological Research Center - Sequoia-Kings Canyon Field Station - Yosemite Field Station	California Forestry Association
	Conservation Biology Institute
	EcoAdapt
University and Education	Friends of the Inyo
California State University - Bakersfield	Giant Sequoia National Monument Association
Desert Research Institute	Huntington Manor Association
Joint Research for Regional Earth System Science and Engineering (collaboration of UCLA and NASA's Jet Propulsion Laboratory)	The Institute for Bird Populations
	National Forest Foundation
Lindsay Unified School District	Point Reyes Bird Observatory Conservation Science
Desert Research Institute, Western Regional Climate Center	Sequoia Riverlands Trust
University of California: - Berkeley - Davis - Los Angeles - Merced Santa Barbara	Sequoia Natural History Association
	Sierra Club
	Sierra Forest Legacy
	The Nature Conservancy
Lindsay Unified School District	Tulare Basin Watershed Initiative
Desert Research Institute, Western Regional Climate Center	Tulare Basin Wildlife Partners
University of Nevada – Reno	The Wilderness Society
Industry and Private Sector	**Tribal**
Provost & Pritchard Consulting Group	Wuksachi Band of Mono Indians
Sierra Forest Products	
Tierra Data	
Sierra Pacific Industries	

Table 1: List of all agencies and organizations participating in the workshop.

Workshop Goals and Structure

The overarching goal of this workshop was to help develop a change adaptation framework for use in the southern Sierra Nevada region in order to help facilitate making difficult conservation choices. The specific objectives of the workshop included: (1) Identify shared and unique values to be conserved, (2) Review resource condition and vulnerability assessments, (3) Explore potential response strategies and where they might be used, and (4) Assess constraints and opportunities of response strategies. This workshop helped us to identify a suite of shared resource conservation values for the southern Sierra Nevada region to inform collaborative and agency-specific change adaptation planning.

The SSCAW Framework started with key questions from the 2008 "*A Strategic Framework for Science in Support of Management in the Southern Sierra Nevada Ecoregion".* These questions were:

1) What is happening and what does it mean?

2) What is a range of plausible futures?

3) What can we do about it?

4) How can we make this information available and continue the conversation?

As planning progressed, the framework was adapted to include elements of Structured Decision Making (SDM), especially by explicitly including values in the framework. A central tenant of the workshop was to acknowledge that decision-making incorporates values as well as science (Hultman, 2002). Key conversations with the National Wildlife Federation (NWF), who were concurrently developing a change adaptation framework (i.e., climate smart conservation planning), provided insight and helped form the final framework (Figure 1). Starting by understanding what we value and where we value it, the framework directs us to identify current objectives and then assesses the vulnerability of values. The purpose of this step was to understand how vulnerability could be assessed and how the consideration of vulnerability may change our management objectives. Reassessing objectives is a key step, because current objectives may be unattainable given the pace and scale of global change. Creating strategies and prioritizing them returns the planner to the first step of the cycle.

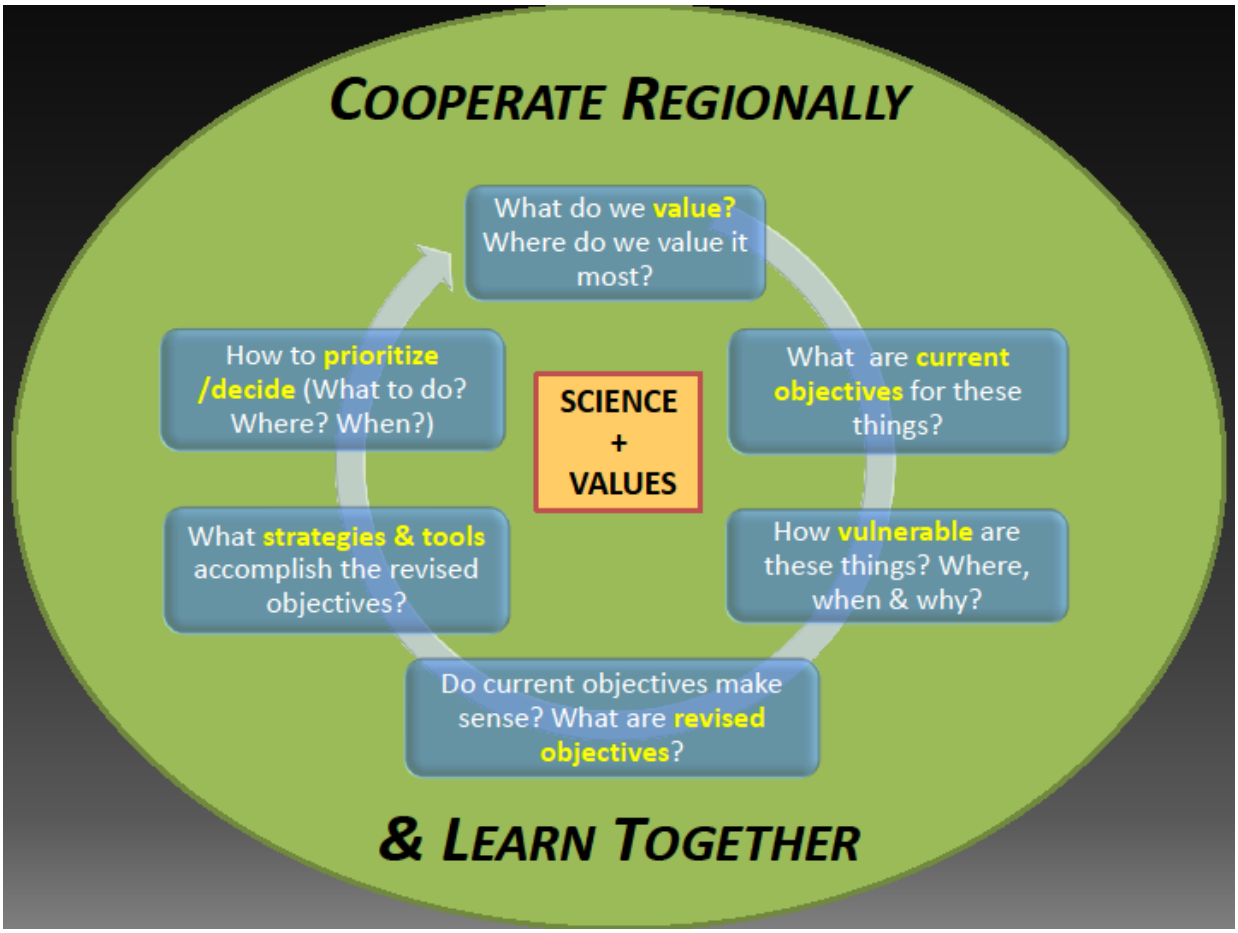


Figure 1: The Southern Sierra Change Adaptation Workshop framework

The NWF proposes a similar framework in their Quick Guide to Climate Smart Conservation (Figure 2) (Stein et al 2013). The two approaches share many similar traits, such as identifying objectives, assessing vulnerabilities, revising objectives, identifying possible actions, and prioritizing them. A key difference includes the focus on values in the SSCAW framework. Although the SSCAW planning committee recognized the importance of implementation and monitoring, the workshop focused on defining southern Sierra Nevada values, objectives, and potential strategies.

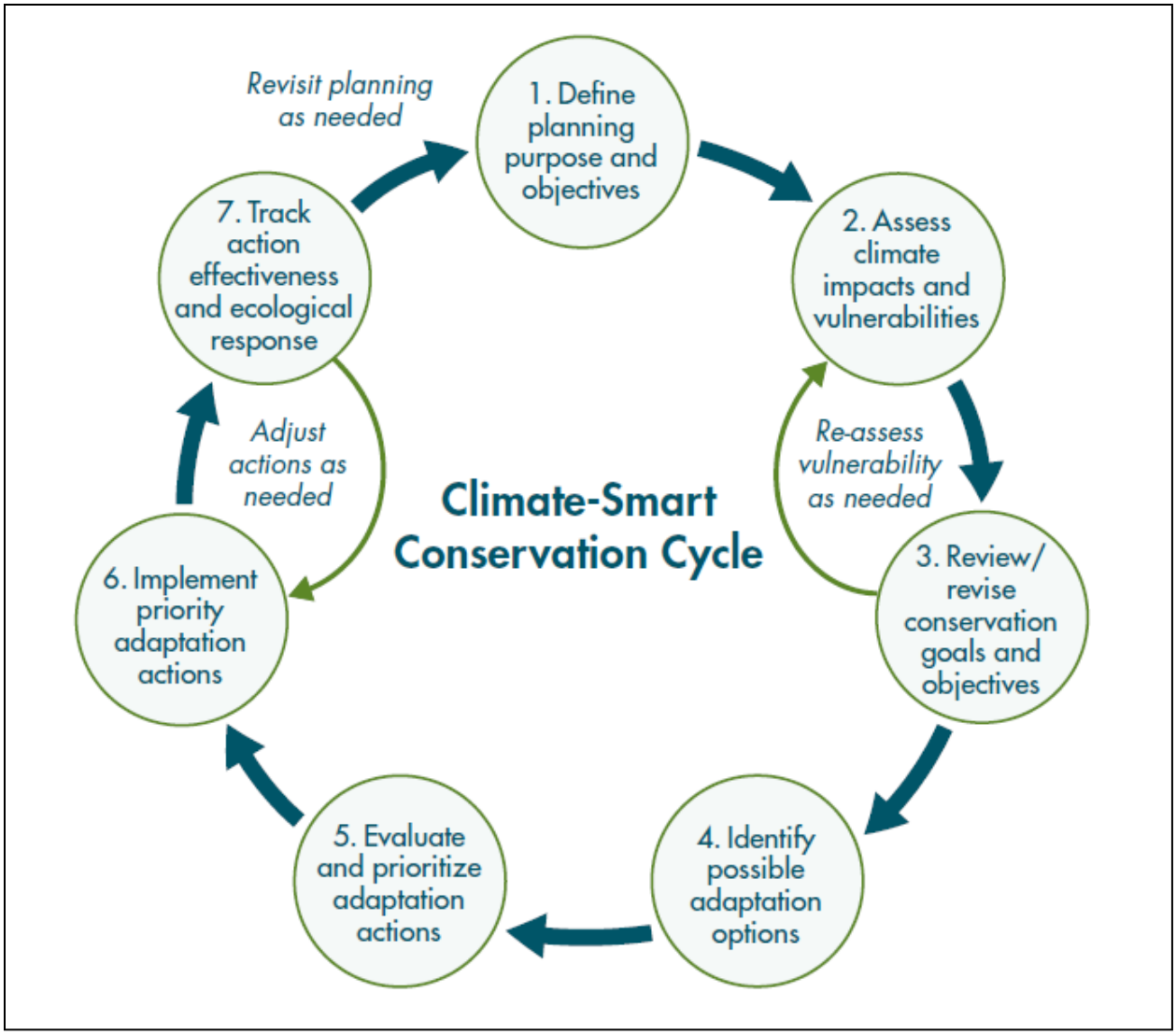


Figure 2: The NWF Climate Smart Conservation Cycle

With the framework in place, the planning committee created sessions designed to walk participants through the framework and achieve the objectives laid out earlier. The workshop was structured using a mixture of presentations from subject matter experts with facilitated dialog, discussions, and hands-on exercises. Emerging technology and decision-support tools were highlighted throughout the workshop to enlighten participants as to what tools are currently available to them. The workshop was separated into five sessions spread out over two-and-a-half days, with an evening poster and collaboration station session at the end of the first day. The sessions focused on the following questions:

- Session 1: What do we know?
- Session 2: What do we really care about?
- Session3: How can we determine the vulnerabilities of shared conservation values?
- Session 4: What can we really DO to prepare for rapid change and an uncertain future?
- Session 5: What's next?

The agenda is included in the Appendix. For more information on the individual sessions, the speakers, and the presentations, please visit http://climate.calcommons.org/aux/sscaw/index.htm.

Session 1 focused on answering the question "what do we know?" In this introduction, we attempted to prepare workshop participants to achieve the overarching goals of the workshop. We chose keynote speakers to address the current state of knowledge about climate change and other anthropogenic stressors, and the links between economic, social, and ecological values. We tried to establish a foundation for continuing dialogue and coordinated planning and introduced the concept of "climate-smart change adaptation principles". Based on years of experience in the Sierra Nevada, Dr. Nate Stephenson discussed the current knowledge of agents of change and Dr. John Battles highlighted current ecosystem conditions. The Regional Forest Service Planning Team, including Dr. Deb Whitall, Dr. Jo-ann Fites Kaufmann, Dr. Sonja Lin, and Dr. Mark Metcalfe, discussed the connections between ecological, social, and economic values – the "triple bottom line". Presenting the adaptation framework was Dr. Koren Nydick.

Session 2 engaged participants in regional scale conservation dialog about shared resource values and prioritized current values for possible coordinated conservation. A panel selected from federal land management agencies and state conservation organizations discussed regional values from the perspective of their agencies. They used a Change Adaptation Planning Template (CAPT) to highlight values that cross administrative boundaries or are regional in scale that merit coordinated conservation action. The CAPT served to highlight what each agency really cares about by spelling out their mission, goals, values, management objectives, and relative priority ranking (see Appendix).

With that insight, participants were assigned to tables (eight people to a table, with a total of 24 tables) so that each table could have a variety of perspectives. The assignment was to identify shared conservation values, both ecological and social, and pick the three that were their highest priority with limited funding, and report out to the group. Participants used the CAPT to record their list of values and their choices for the top three.

Session 3 aimed to answer the question "how can we determine the vulnerabilities of shared conservation values?" The goal of this session was to provide examples of how vulnerability may be determined for a defining feature or critical attribute (a value) by examining the three components of vulnerability (exposure, sensitivity, and adaptive capacity) using different kinds of tools. The intent was not to present a comprehensive or definitive statement about the vulnerability of each resource, but to explore how we collectively can use information on vulnerability for change adaptation planning. For this session, participants sat in groups based on pre-selected focal resources (Figure 3). The session started with an overview of vulnerability assessments by Danielle LaRock, followed by a series of case studies on various resources. The expertise of Dr. Joshua Viers, Dr. Matt Brooks, Dr. Mark Schwartz, Dr. Wayne Spencer, Dr. Rodney Siegel, and Susan Antenen introduced participants to the different resources and provided case studies of vulnerability assessments. Participants within groups then used a worksheet to identify current objectives for their selected resource and describe components of vulnerability for the resource. If current objectives were not possible in the face of these stressors, the last question asked what the new objectives could be (see Appendix).

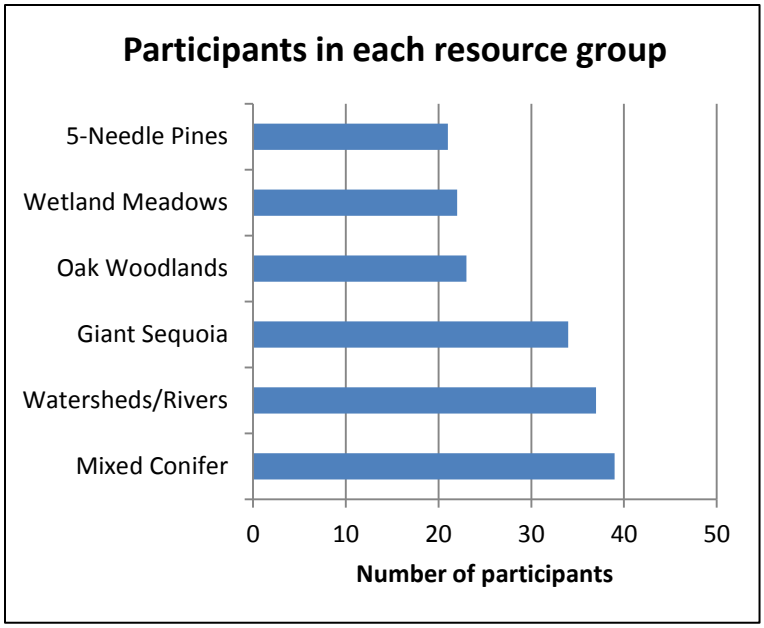
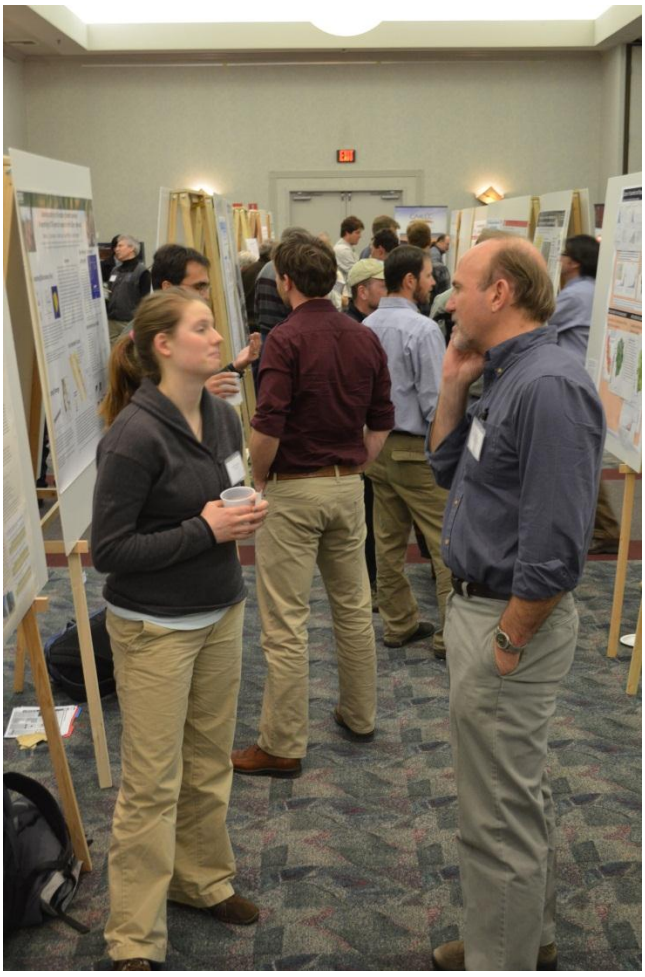


Figure 3: Number of participants within each pre-selected resource group

Session 4 tested an approach to evaluating whether current objectives for things we really care about are realistic, and to explore "revised objectives" and novel strategies that may help us adapt to rapid change and uncertain future conditions. While this was not done in depth to support an actual decision, the session enabled participants to experience how objectives, vulnerabilities, strategies, constraints, opportunities, trade-offs, and consequences may be integrated to inform the planning effort.

The session started with presentations about possible change adaptation techniques for different resources from Dr. Hugh Safford, Dr. Koren Nydick, and Michelle Selman. Participants then were separated into their resource groups to continue the discussion from Session 3 on vulnerabilities, current and revised objectives, and strategies for meeting revised objectives by

using a worksheet (see Appendix). Management actions were separated out into strategy suites using the categories of resisting change, building resilience, facilitating transformation, and anticipating and planning for extreme events. Finally, participants discussed constraints, trade-offs, opportunities, and who may be in the best position to use the strategy.



Session 5, the conclusion, included a final discussion to identify three or more shared conservation values in the Southern Sierra that can serve as a focus for regional conservation planning. This was accomplished by revisiting the values identified during Session 2. Participants were asked, in the face of the knowledge they accrued during the workshop, if and why their choice of the top three regional values had changed. The second goal of this session was to find opportunities to "Manage for Desired Change When Uncertainty is the Only Certainty," which was introduced in a talk by Dr. Debra Schlafmann. A panel of managers from various federal agencies was asked questions both from the moderator and the audience.

The evening **Poster Session** that followed the first day included 42 posters and nine "collaboration stations." Poster topics covered woodland, forest, and alpine ecosystems, giant sequoia ecology, hydrological monitoring techniques, conservation tools and programs, invasive species management, paleoecological studies, and more. Collaboration stations were interactive venues to share new ideas and solicit input from other participants. They could include collaborative research proposals, conservation working groups, sharing of new management tools, and brainstorming solutions to climate-related themes. The posters are preserved online at http://climate.calcommons.org/aux/sscaw/index.htm.

Results from the Workshop

The results of the workshop are organized by workshop topic: values and criteria, vulnerabilities, revising objectives, and management strategies. The raw data from individual sessions are preserved in the appendix.

Values and Criteria (Sessions 2 and 5)

Participants were asked to identify their top three values for regional conservation and list the criteria for selecting those during sessions 2 and 5. In their workbooks, the groups (organized by tables) were given examples of how various agencies had identified their values using the CAPT. Shared regional values were brainstormed by each table. After the exercise, individual table responses were counted. Similar responses were grouped together (i.e, all values concerning biodiversity are placed in one "biodiversity" heading). Next, values were placed into the categories of Ecological, Social, Economic, and All-Encompassing to show broad trends (see Figure 4). The membership of some of the tables changed between Sessions 2 and 5 if the same participants did not attend both sessions. Therefore, all answers are given as a percent of the total for that session.

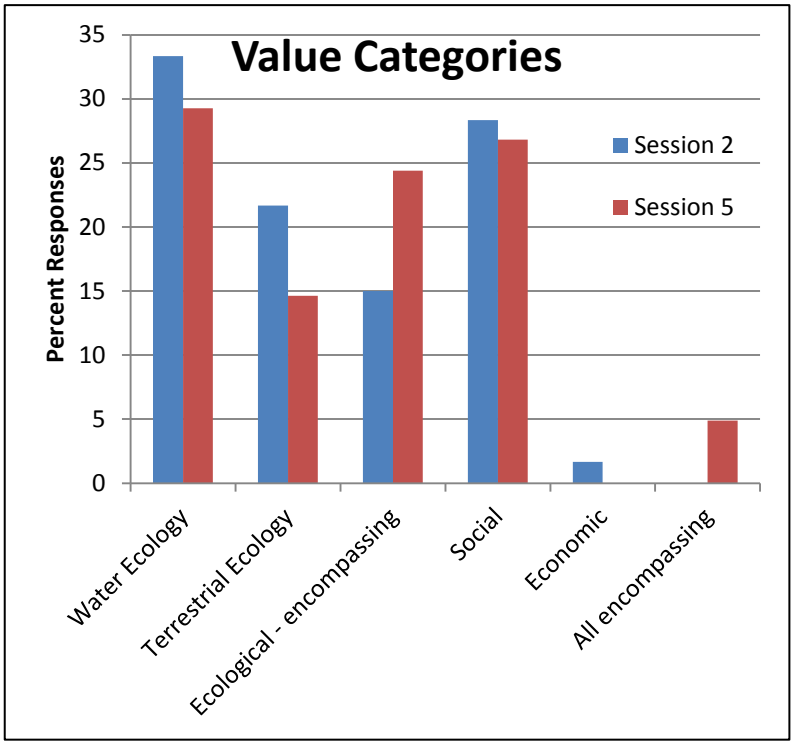


Figure 4: Prioritized socioeconomic and ecological value categories identified by participants in Sessions 2 and 5

The most often listed values were hydrologic processes, human connections to the environment, and biodiversity (see Figure 5). The listed values contain many participant responses that were more specific; for example, "human connections to the environment" is composed of answers such as public trust, recreation, and social connections to the environment (see the Appendix for raw participant responses). Overall, values did not notably change between Sessions 2 and 5. Many groups listed the same values as in Session 2 or broadened a value that they felt was too narrow.

Grouping related responses into broader categories exhibits a similar response distribution, with the Water Ecology category receiving the most responses, followed by Social, Ecological – All Encompassing, and Terrestrial Ecology receiving a similar percentage of responses, and a few responses falling into the Economic and All Encompassing categories. The category of Ecological - All Encompassing refers to values such as biodiversity and ecological integrity. Following the trend towards groups broadening their top three values in Session 5, more

responses were given towards Ecological – All Encompassing than Terrestrial Ecology in Session 5 (note the mirror image between these two categories in Figure 4).

While values did not change much between sessions 2 and 5, criteria did change somewhat (Figure 6). Groups maintained that public support/interest was a top criterion, but the number of responses using cross-regional benefits, monetary benefits, and potential for management action declined in Session 5. The top criteria for that session were the vulnerability of the value/ability to triage and values that were unique or critical to the southern Sierra Nevada.

Many tables did not provide detailed responses, so there is some chance of misinterpreting their listed value or criteria. Answers are given as a percent of the total number of responses because the number of tables and participants at tables changed somewhat between Sessions 2 and 5.

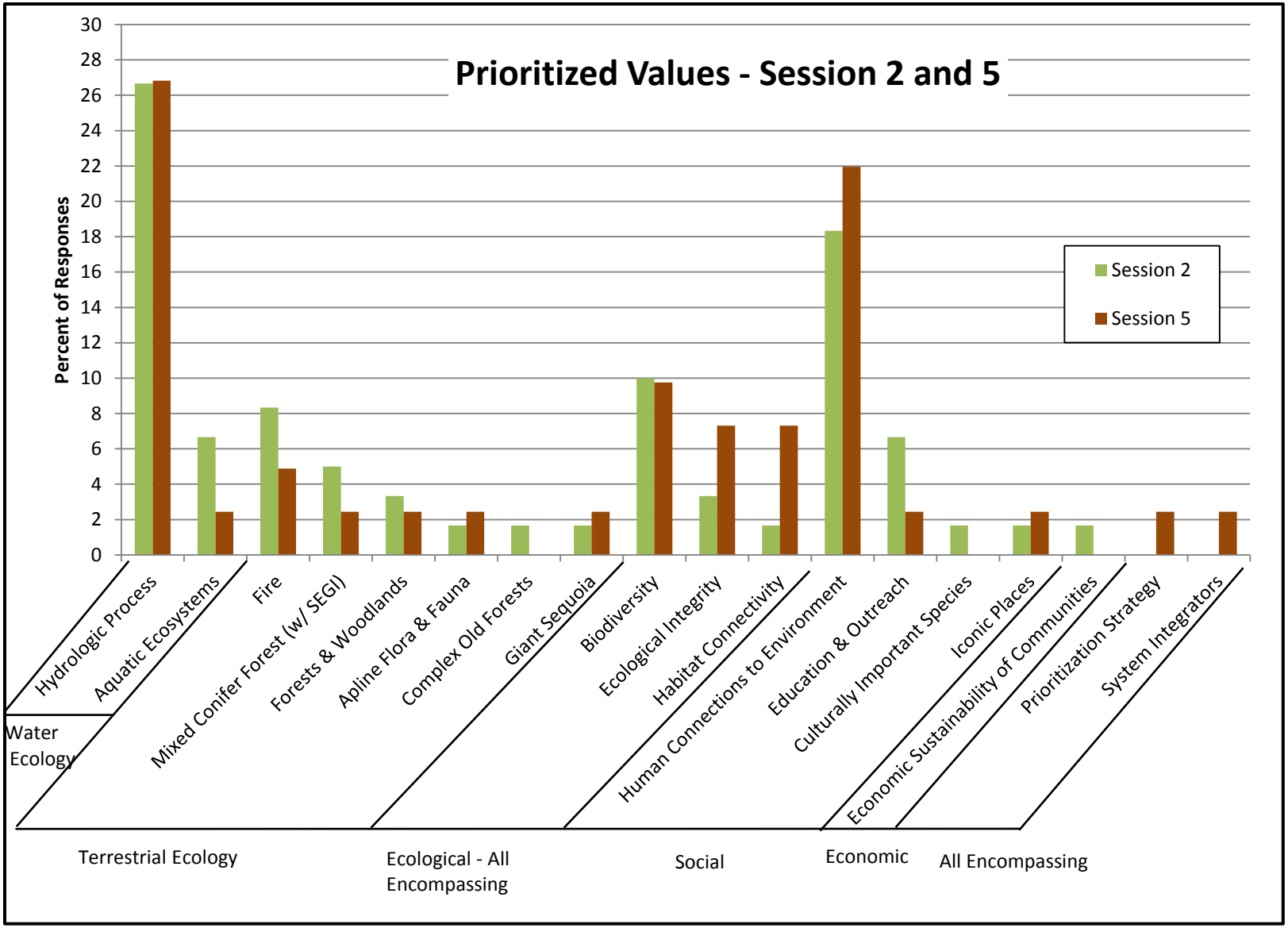


Figure 5: Prioritized Values for the Southern Sierra - Sessions 2 and 5. Values are grouped into categories: Water Ecology, Terrestrial Ecology, Ecological – All Encompassing, Social, Economic, and All Encompassing.

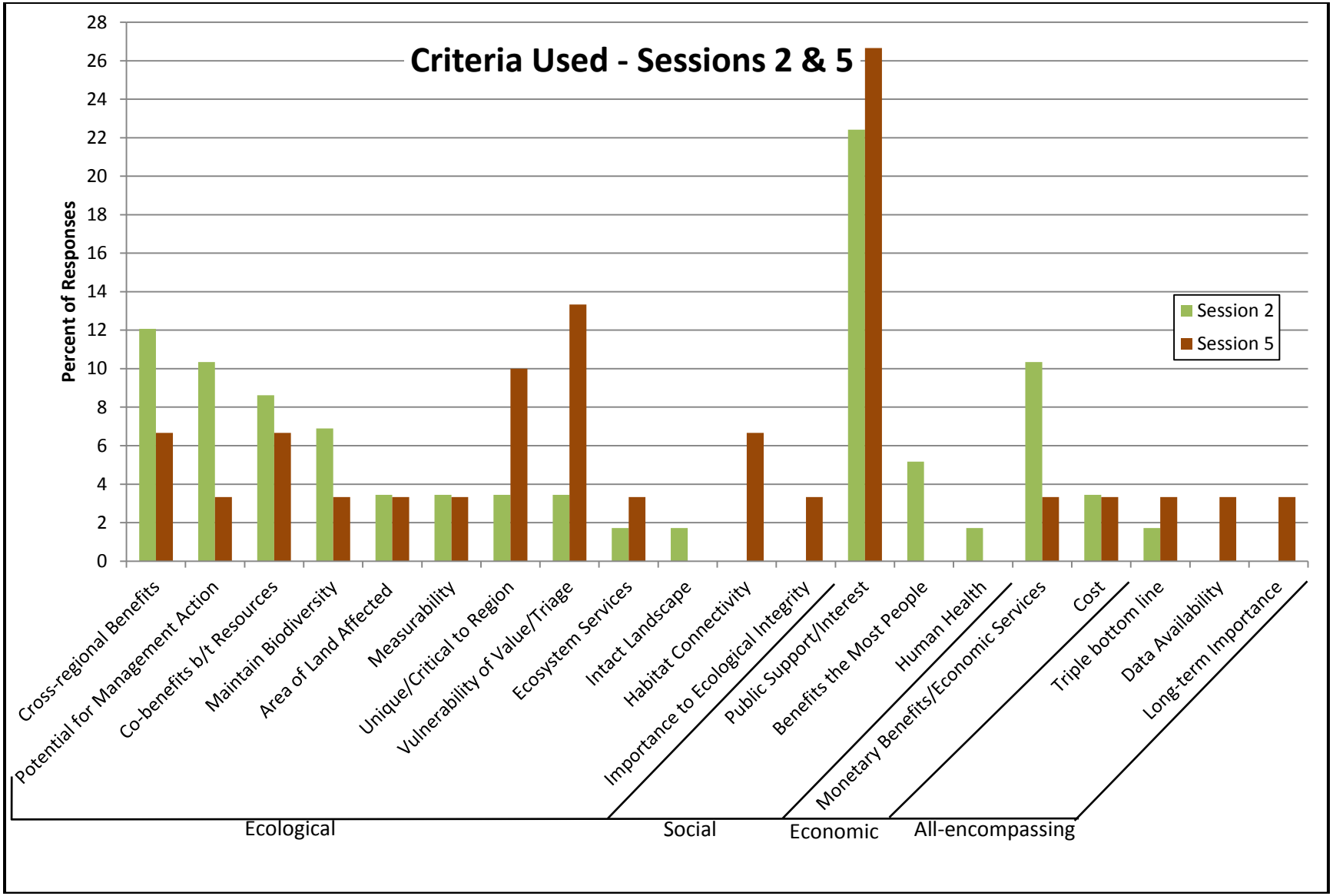


Figure 6: Criteria for choosing values in Sessions 2 and 5. Criteria were grouped into categories of Ecological, Social, Economic, and All-Encompassing rationale.

Overall Vulnerability

General Patterns

The Vulnerability Exercise grouped participants in tables based on pre-selected resources and asked them to list the critical components of vulnerability for each resource - exposure, sensitivity, and adaptive capacity (see Appendix). Focal resource groups were free to decide how they wanted to tackle that issue, and as a result the Mixed Conifer Group split into Mixed Conifer Forest, Pacific Fisher, and California Spotted Owl, increasing the group number for this exercise from 6 to 8.

To assess the groups' responses for exposure to stressors, we counted the number of tables within a resource group that mentioned that stressor. Because we did not ask participants to rank the stressors in order of greatest impact to the resource, we used the number of tables within a resource group that mentioned a stressor as a proxy for prioritization.

Definitions of the Components of Vulnerability:

Exposure – Measure of how much environmental change a species or system is likely to experience.

Sensitivity – Measure of whether and how a species or system will be affected by a particular change.

Adaptive Capacity – Ability to accommodate or cope with the impacts of change with minimal disruption.

Based on their responses, the most frequently mentioned stressor affecting focal resources in the southern Sierra Nevada is related to fire – both the lack of fire itself and the increased likelihood of catastrophic fire due to increased fuel loads and climate change (Figure 7). All of the focal resource groups listed fire as a stressor. The next most commonly mentioned stressor was pollution, listed by 75% of the resource groups, which includes both air and land-based pollution. Non-native species, recreational use, and general climate change followed, with half of all resource groups mentioning these stressors. Climate change in this instance refers to general trends in climate; other groups listed a specific impact from increased moisture stress, extreme events in the forms of floods, and changes in water flow. The categories used to group the stressors were applied after the workshop, so some mistakes could come from misinterpreting the groups' responses. Individual resource group responses are recorded in the Appendix.

Many responses fell into a "Miscellaneous Anthropogenic" category, which included anthropogenic stressors excluding land use and issues related to management. The second highest number of responses fell into the "Land Use" category, which included issues such as recreational use, grazing, and the effects of illegal marijuana grow sites. However, the single stressor affecting the most resources, fire, fell into the management category.

After listing stressors (exposure), the groups listed elements that make the resource more or less sensitive to experiencing impacts from this exposure. They also assessed the resource's adaptive capacity to cope with the impacts caused by exposure and sensitivity. Specific components of vulnerabilities mentioned within the resource group are discussed below, and are included in the Appendix in their raw form.

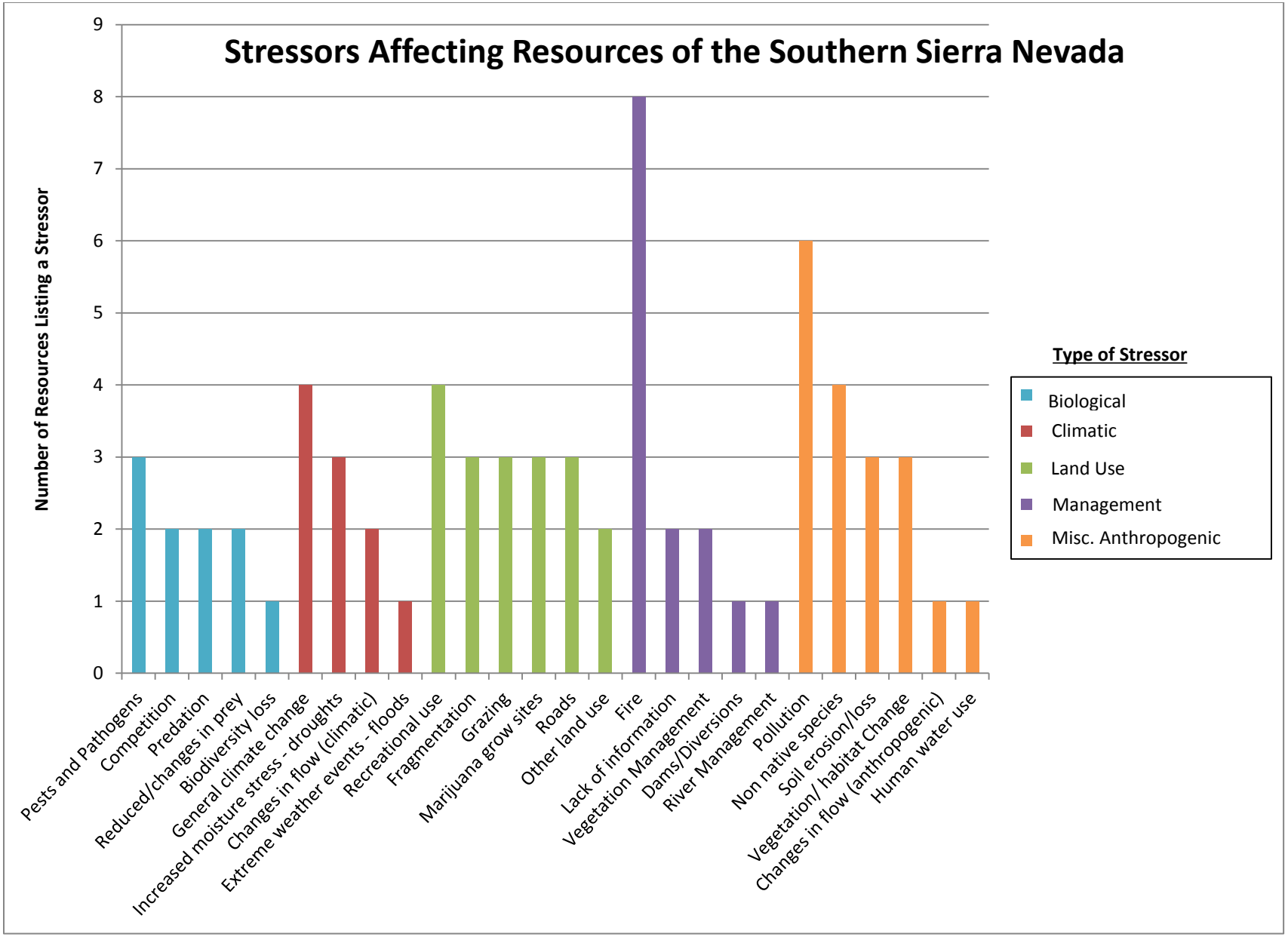


Figure 7: Stressors listed by participants in Session 3. Responses are lumped into similar stressors headings, then grouped by category and ranked by number of impacted resources. Types of stressors include biological, climatic, land use, management, and miscellaneous anthropogenic stressors.

Focal Resource Vulnerability

Watersheds and Rivers (4 workgroups)

Other land use, climatically-induced changes in flow, and fire were the most-often mentioned stressors in this resource group (see Table 2). "Other land use" is a very broad exposure category, based on generalized responses from participants. More specific land uses are also listed, but did not receive as many mentions. The most often mentioned sensitivities were geologic characteristics and stream characteristics, including sensitivity to changes in discharge. The sensitivity of ecosystem cycles to perturbation was also mentioned. Components of adaptive capacity include management opportunities – such as ability to restore habitats and alter flows – the ability of watersheds to recover from change, biodiversity, and more (see the Appendix).

Watersheds and Rivers			
Exposure to Stressor	**Sensitivity**	**Adaptive Capacity**	**Table Count**
Other land use Changes in flow (climatic) Fire	Geological Characteristics		3 (75%)
Dams and diversions Extreme weather events - floods Increased moisture stress - droughts Recreational use	Stream Characteristics	Management changes Inherent ability to recover from change	2 (50%)
Agriculture Fragmentation Grazing Human water use Lack of Information Marijuana grow sites Non-native species Pollution River management Roads Soil erosion/loss Vegetation/habitat change	Sensitivity of individual species Sensitivity of ecosystem cycles		1 (25%)

Table 2: Chart showing number of work groups that mentioned specific stressors for the Watersheds and Rivers focal resource. Please note that stressors, sensitivities, and adaptive capacities are not joined across rows – they are ordered by workgroup count.

Wetland Meadows (2 workgroups)

Many stressors were mentioned by both of the tables for this resource group, including changes in flow (both anthropogenic and climatic), fire, and non-native species (Table 3). Sensitivities included meadow structure – including type of meadow and elevational gradient - location of meadow, and sensitivity of rare species. Adaptive capacity included biodiversity of meadow

species and types, the ability to change management actions, and hydrologic function (see the Appendix).

Wetland Meadows			
Exposure to Stressor	**Sensitivity**	**Adaptive Capacity**	**Table Count**
Change in flow (Anthropogenic) Change in flow (Climatic) Fire Non-native species Other land use Pollution Recreational use Roads	Meadow structure	Biodiversity Change in management	2 (100%)
Biodiversity loss Fragmentation General climate change Grazing Soil erosion/loss Vegetation/habitat change	Location of meadow Rare species presence	Hydrologic function	1 (50%)

Table 3: Chart showing number of workgroups that mentioned specific stressors for the Wetland Meadows resource group. Please note that stressors, sensitivities, and adaptive capacities are not joined across rows – they are ordered by workgroup count.

Oak Woodlands (2 workgroups)

Most-mentioned stressors for this resource group include grazing, human encroachment (development), increased moisture stress, pests/pathogens, and predation (see Table 4). Sensitivity of oaks to these stressors includes their location (especially low elevations, boundary lands, and ridge tops) and the low current recruitment. However, oaks are well adapted to drought, and therefore may not be as negatively affected as other species under warming. Other adaptive capacities include the oak's high dispersal ability through animal vectors, the ability to change management practices, and (phenotypic) plasticity (see Appendix).

Oak Woodlands			
Stressor	**Sensitivity**	**Adaptive Capacity**	**Table Count**
Grazing Human encroachment Increased moisture stress - droughts Pests and pathogens Predation	Location		2 (100%)
Fire General climate change Lack of information Non-native species Pollution Recreational use	Low recruitment	Drought adaptations High Dispersal Management changes Plasticity	1 (50%)

Table 4: Chart showing number of workgroups that mentioned specific stressors for the Oak Woodlands resource group. Please note that stressors, sensitivities, and adaptive capacities are not joined across rows – they are ordered by workgroup count.

Giant Sequoia Groves (5 workgroups)

Fire and increased moisture stress were the most-mentioned stressors for this resource group (see Table 5). Some workgroups in the collective Giant Sequoia Group answered the sensitivity question as being sensitive to a stressor, but not indicating how. Sensitivity to fire and drought were most mentioned, with higher sensitivities for seedlings than mature trees. Two workgroups mentioned sensitivity to air pollution, with younger trees again being more susceptible. Other groups mentioned dispersal limitations (e.g. not being able to migrate above 7000 feet), shallow roots, and more. Management changes were the most-mentioned adaptive capacity – including mechanical thinning to reduce fuels and increase water availability for sequoia trees, prescribed fire, irrigation, assisted migration, and more. Other inherent adaptive capacities included good dispersal ability, longevity, and genetic diversity/adaptability (see Appendix).

Giant Sequoia Groves			
Stressor	**Sensitivity**	**Adaptive Capacity**	**Table Count**
Fire Increased moisture stress- droughts			5 (100%)
	To fire (mature trees and seedlings) To drought (mature trees and seedlings)		4(80%
		Management option – mechanical thinning Management change – prescribed fire	3 (60%)
Non-native species Pollution Recreational use	To air pollution To managed fire	Management change – irrigation Assisted migration Dispersal ability Longevity Genetic diversity	2 (40%)
General climate change Vegetative management	Dispersal limitations Not highly sensitive to severe fire Shallow roots Unknown sensitivity to non-native species	Other management options Adapted to fire High planted seedling survival Unknown for non-native species Water loss control	1 (20%)

Table 5: Chart showing number of workgroups that mentioned specific stressors for the Giant Sequoia Groves resource group. Please note that stressors, sensitivities, and adaptive capacities are not joined across rows – they are ordered by workgroup count.

Pacific Fisher (3 workgroups)

Out of the three workgroups who focused on the Pacific fisher, all mentioned fire, marijuana grow sites (mortality and reduced fitness caused by rodenticides poisoning), predation, and roads as stressors (see Table 6). Similar to the Giant Sequoia Group, some workgroups gave a ranking for sensitivity to certain stressors – for example, two-thirds of the workgroups stated that the fisher has a high sensitivity to fire, predation, roads, and rodenticides. Some workgroups also cited low genetic diversity and small population size/isolation as sensitivities increasing susceptibility to other stressors. Generally, the workgroups said the Pacific fisher has low to moderate adaptive capacity to many of the stressors mentioned, including roads, rodenticides, and severe fire. However, the Pacific fisher may have moderate- high adaptive capacity to predation, except small subsets of the population (see Appendix).

Pacific Fisher			
Stressor	**Sensitivity**	**Adaptive Capacity**	**Table Count**
Fire Marijuana grow sites Predation Roads			3 (100%)
Fragmentation Reduced/changes in prey Vegetative management	High sensitivity to fire High sensitivity to predation High sensitivity to roads High sensitivity to marijuana grow sites Low genetic diversity Small population	Low adaptive capacity to roads Moderate-high to predation	2 (67%)
		Low to marijuana grow sites Low to severe fire Moderate/uncertain to vegetative management Uncertain to small population size	1 (33%)

Table 6: Chart showing number of workgroups that mentioned specific stressors for the Pacific Fisher resource group. Please note that stressors, sensitivities, and adaptive capacities are not joined across rows – they are ordered by workgroup count.

California Spotted Owl (2 workgroups)

The most-mentioned stressors for the California Spotted Owl were competition and vegetation/habitat change (see Table 7). That fire was not ranked higher is possibly a consequence of the small number of workgroups for this resource, as fire affects the habitat structure of the mixed conifer forest, an important factor for California spotted owl survival. The only sensitivity mentioned, by both workgroups, is the specialized habitat requirements for this species. Adaptive capacities include their ability to use other habitats (i.e. through dispersal, selecting cooler or riparian environments), ability to change prey items, and ability for management options (see Appendix).

California Spotted Owl			
Stressor	**Sensitivity**	**Adaptive Capacity**	**Table Count**
Competition Vegetation/habitat change	Specialized habitat requirements		2 (100%)
Fire Marijuana grow sites Reduced/changes in prey		Ability to use other habitats Ability to change prey items Ability for management options	1 (50%)

Table 7: Chart showing number of workgroups that mentioned specific stressors for the California Spotted Owl resource group. Please note that stressors, sensitivities, and adaptive capacities are not joined across rows – they are ordered by workgroup count.

Mixed Conifer Forest (4 workgroups)

Fire was the most mentioned stressor for the Mixed Conifer Forest, with all workgroups mentioning it (see Table 8). Other important stressors, with 75% of the tables mentioning them, were increased moisture stress, pests and pathogens, and pollution. Three-quarters of the workgroups mentioned moderate-low sensitivity at low fire return interval departure (FRID; an index describing when the last fire occurred and if it is within the historic range of fire return interval time) to pests and pathogens, but a high sensitivity at high FRID, and a moderate sensitivity to precipitation change. A high sensitivity to fire with climate change was mentioned by half the workgroups. Conifer biodiversity, high dispersal ability, and adaptations to drought and fire were mentioned as adaptive capacities, with unknown adaptive capacity under the synergistic effects of multiple stressors acting in concert (see Appendix).

Mixed Conifer Forest			
Stressor	**Sensitivity**	**Adaptive Capacity**	**Table Count**
Fire			4 (100%)
Increased moisture stress - droughts Pests and pathogens Pollution	To Insects and Pathogens: Mod-low at low FRID; high at high FRID Moderate to precipitation change	Conifer biodiversity High dispersal	3 (75%)
	High to fire (w/ climate change)	Unknown under synergistic effects Moderate-low to air pollution	2 (50%)
Climate change	Homogenous forests	Adapted to drought and fire	1 (25%)

Table 8: Chart showing number of workgroups that mentioned specific stressors for the Mixed Conifer Forest resource group. Please note that stressors, sensitivities, and adaptive capacities are not joined across rows – they are ordered by workgroup count.

High Elevation Five Needle Pines (3 workgroups)

All workgroups for this resource mentioned pests and pathogens as a stressor (see Table 9). Other stressors mentioned included competition, fire, climate change, and pollution. The most often mentioned sensitivities were low potential for expansion, sensitivity to pests and pathogens, being poor competitors (due to their shade intolerance), and sensitivity to fire, with two-thirds of the workgroups mentioning these. Components of adaptive capacity included a broad tolerance to climate change and inherent adaptability to change (see the Appendix).

High Elevation Five Needle Pines			
Stressor	**Sensitivity**	**Adaptive Capacity**	**Table Count**
Pests and pathogens			3 (100%)
Competition Fire General climate change Pollution	Low potential for expansion/dispersal Higher to pests and pathogens Poor competitors High to fire (but low vulnerability)		2 (67%)
Soil erosion/loss	Higher to temperature change Loss of biodiversity Low for dispersal agent (Clark's nutcracker) Lower to climate change Slow growing species	Better competitors Broader tolerance to climate change Inherent resistance/adaptability Well mixed populations	1 (23%)

Table 9: Chart showing number of workgroups that mentioned specific stressors for the High Elevation Five Needle Pines resource group. Please note that stressors, sensitivities, and adaptive capacities are not joined across rows – they are ordered by workgroup count.

Revised Management Objectives

In light of the exposures, sensitivities, and adaptive capacities discussed above, we asked groups to evaluate whether current objectives should be revised or modified. The break-out groups for each resource in Session 4 also talked about this question as a single large group, so those answers will be discussed here as well. Although specific objectives could not be compared between resources, some overall themes did emerge, though in general, revised objectives remained similar to current objectives.

More than half the groups' responses reflected their judgment that some current objectives are satisfactory but the current approach used to achieve these objectives is not sufficient or attainable. For example, the Oak Woodlands group listed "preserve oak woodlands" as a current objective, but due to little management implementation, the objective was deemed not feasible. However, under different management practices this objective could be achieved. Therefore, although the objectives remained the same, the strategies listed in Exercise 4 used to accomplish the objectives would be different. Some groups also revised objectives to reflect managing with the ecosystem in mind instead of a specific species.

Other groups identified certain current objectives as no longer feasible if they included phrasing such as "maintain current species composition". These kinds of objectives may not be feasible under a changing climate because the species inhabiting a certain location now may not be suited for the same location in a warmer, wetter, and/or drier future. Instead, groups used words like "manage for", "maximize" and "improve". Similarly, a focus on individual species, such as maintaining threatened and endangered species, was revised to focus on ecosystem structure and function and maximizing habitat heterogeneity. This was done to "avoid focusing on the symptoms", and instead focus on ecosystem management.

Another emergent theme was prioritizing and accepting losses in other areas. This prioritization criterion may be used to decide where to protect resources with limited amounts of funding and human resources. For example, the Giant Sequoia Group suggested trying "to maintain grove locations only in the most suitable, mesic sites".

Other common themes describing the change from current to revised objectives include incorporating the public into management decisions and an increase in monitoring objectives. Two groups also took a more regional view in their revised objectives. For some no longer feasible current objectives, groups made them feasible by making it a regional conservation goal. For example, instead of "maintain communities", a revised objective could be "within the ecoregion, maintain representation of these communities". See the Appendix for complete participant responses.

Management Strategies

After briefly reviewing outcomes from Session 3's individual tables, the larger resource groups developed strategies by considering how to resist change, build resilience, facilitate transformation, or anticipate and plan for extreme events. Because a single management action could fall under more than one of these strategy types, certain actions, such as fire, are nearly ubiquitous across strategies. During the analysis of the responses, we combined each group's selected actions and categorized them into an education, management, policy, or science category (see Figure 8). The responses were not ranked in order of importance by the participants; the figures show only the number of times a response was given.

Management actions were the most frequently identified category, followed by policy, science, and education. It is interesting to note that while management and policy make up more of the responses for resist change and build resilience, science actions make up a greater proportion of the mentioned activities for facilitate transformation and anticipate and plan for extreme events (see the mirror image between policy and science responses in Figure 8). This likely reflects the need for better baseline knowledge to know how to facilitate transformation, and what the system could be transformed into, as well as determining how a resource may respond to an extreme event.

Education actions, although remaining at low levels throughout each strategy type, are fairly consistent across all strategies. This may indicate that education is relevant for all categories of action, but the focus of this workshop was on what land managers can do, and not explicitly on engaging the public, which probably influenced this response.

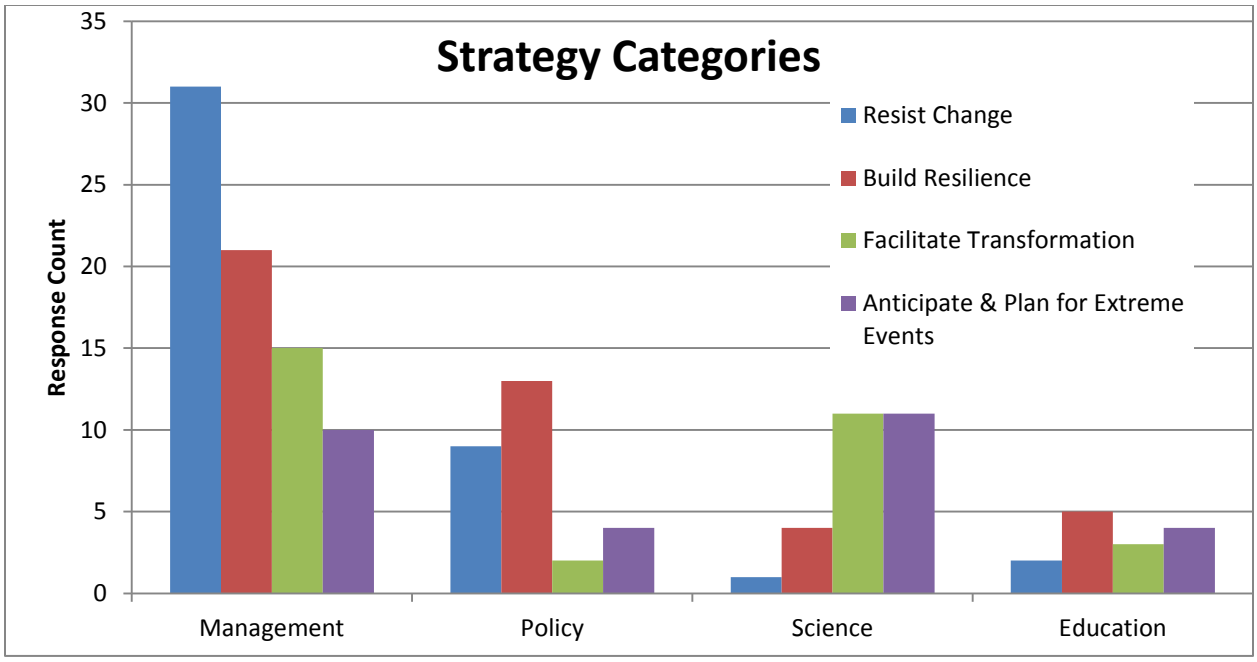


Figure 8: Count of adaptation strategies grouped by action type

Resist Change

Resisting change management actions will "buy time" for ecosystems that are experiencing state shifts. The most frequent responses were management actions. The most mentioned management actions were removing non-native invasive species, followed by fire management, and mechanical thinning; each option was mentioned by three resource groups (Table 10).

Building Resilience

Building resilience to climate change can translate into reducing other stressors to ensure the ecosystem is at its healthiest (and most resilient) state. Therefore, while the strategy of resist change had management actions such as "eradicate invasive species", building resilience included "prevent non-native species introduction". One possible vector for invasive plant introduction is the use of exotic and invasive plant seed in packstock feed, so the Wetland Meadows group also identified "supplemental feed controls" as a potential management action to minimize the potential for spread of invasive plants. The most common action listed for building resilience again fell into the category of management action, but was closely followed by policy actions to limit future anthropogenic disturbances of the resources. The most commonly mentioned action was fire, followed by education and limiting grazing (Table 11).

Facilitate Transformation

Management actions formed the majority of the responses for this strategy. Increasing genetic diversity and planting with genotypic variation were the most commonly mentioned actions under facilitate transformation, followed by research to determine sites suitable for vulnerable species and systems in the future (Table 12). There were a larger number of science actions than in the two managing for persistence strategy types. This category has a lower number of overall responses than the other strategy types. Because we do not know how climate change could alter

the landscape and how the ecosystems will react, it is hard to develop transformation management strategies and goals. Only through monitoring, research, and experimentation will land managers have a better idea of what to expect in a changing climate – with adaptable management practices implementation can begin now but can change when new information becomes apparent.

Anticipate and Plan for Extreme Events

Science strategies have the most frequent responses, with experimentation and monitoring being the most-mentioned strategy by all resource groups. Compliance work was the next most-mentioned management action, followed by learning from other examples and utilizing fire (Table 13).

Category	Management Action	Watersheds & Rivers	Wetland Meadows	Blue Oak Woodlands	Giant Sequoia Groves	Mixed Conifer Forest	High Elevation 5 Needle Pines
Education	Adopt-a-Tree program						
	Education						
	Working with the public						
Management	Eradicate non-natives						
	Managed fire						
	Managed thinning						
	Irrigate						
	Capture barred owls						
	Create artificial nesting/ resting habitat						
	Herbivory exclosure/enclosures						
	Forest structuring/ management						
	Install fuel breaks						
	Manage hydrology						
	Manage vegetation along waterways						
	Plant in current groves						
	Plant native grasses						
	Protect seedlings						
	Reduce herbivores						
	Reintroduce porcupines						
	Remediate illegal marijuana farms						
	Remove lodgepole from whitebark stands						
	Remove trails						
	Spray pesticides on beetle outbreaks						
	Stabilize stream banks						
Policy	Discharge manipulation						
	Limit firewood cutting						
	Limit human development						
	Protect dead/down wood						
	Regulate squirrel hunting						
	Require mitigations when oaks are removed						
	Shorten licensing period under FERC						
	Support NRCS efforts						
	Work with CalFire to protect oaks during fire						
Science	Find/protect refugia						

Table 10: Strategies listed by participants under the Resist Change strategy type.

Category	Management Action	Watersheds & Rivers	Wetland Meadows	Blue Oak Woodlands	Giant Sequoia Groves	Mixed Conifer Forest	High Elevation 5 Needle Pines
Education	Education						
	Work with private land owners						
Management	Managed fire						
	Mechanical thinning						
	Avoid harvest in nesting sites						
	Avoid harvesting large dbh trees						
	Close/remediate unnecessary roads						
	Install wildlife crossing structures						
	Maintain connectivity						
	Native seeding						
	Plant genetically diverse seeds						
	Prevent non-native species						
	Re-establish natural hydrology						
	Reintroduce predators of herbivores						
	Sustainable landscaping						
Policy	Limit grazing						
	Limit erosion						
	Limit recreation/OHV						
	Limit water diversion						
	Oak ordinances						
	Protect areas with native grasses						
	Protect suitable fisher/CSO habitat (limit mechanical disturbance)						
	Reduce air pollution						
	Reduce tourism/development						
	Supplemental feed controls						
Science	Develop white pine blister-rust resistant genotypes						
	Establish experimental oak reserves						
	Map recruitment areas						
	Research to improve recruitment						

Table 11: Strategies listed by participants under the Build Resilience strategy type.

Category	Management Action	Watersheds & Rivers	Wetland Meadows	Blue Oak Woodlands	Giant Sequoia Groves	Mixed Conifer Forest	High Elevation 5 Needle Pines
Education	Accept type conversion						
	Education						
	Work with private land owners						
Management	Planting with genotypic variation						
	Assisted migration						
	Create seed banks						
	Capture-release programs for wildlife						
	Experiment w/ traditional mgmt practices						
	Managed fire						
	Foster black oak expansion						
	Plant conifers upslope						
	Reduce barriers to species movement						
	Sustainable landscaping						
Policy	Protect migration corridors						
Science	Increase genetic diversity						
	Research into possible expansion sites						
	ID most likely to succeed and high risk areas						
	Designate blue oak research areas						

Table 12: Strategies listed by participants under the Facilitate Transformation strategy type.

Category	Management Action	Watersheds & Rivers	Wetland Meadows	Blue Oak Woodlands	Giant Sequoia Groves	Mixed Conifer Forest	High Elevation 5 Needle Pines
Education	Learn from other examples						
	Education						
	Work with private owners						
Management	Managed fire						
	Augment hydrology						
	Captive breeding program for fisher and CSO						
	Construct buffers						
	Early warning system						
	Eradicate pine beetles						
	Nursery of WPBR-immune sugar pines						
	Prepare for large-scale severe fire / veg die-off						
	Prepare for sudden oak decline outbreaks						
Policy	Compliance work						
	Inter-agency cooperation						
Science	Experimentation & Monitoring						
	Investigate resistance of sugar pine to WPBR						
	Modern data structuring						
	Planting plan						
	Rebuild abandoned monitoring infrastructure						
	Seed/genetic banking						

Table 13: Strategies listed by participants under the Anticipate and Plan for Extreme Events strategy type.

Shared Management Actions and Co-benefits

Although we asked groups to list co-benefits across management actions, due to time constraints, most groups focused on answering other questions. The Wetland Meadows group was able to answer the question and stated that flood control provided by functioning wetlands will benefit many ecosystems in allowing for a slower and more sustained release throughout the dry summer season. Healthy wetlands also have the capacity to store more carbon than many other ecosystem types due to their deep soils, and therefore have the ability to affect the global carbon cycle if they are disturbed.

Another example of co-benefits was apparent by how many resource groups mentioned prescribed fire and/or mechanical thinning in their presentations. These management tools, while reducing the likelihood of severe/catastrophic fire, creating better conditions for germination of certain conifers, reducing competition for moisture among the remaining mature trees, and allowing for a more natural age and size distribution, was also seen to benefit watersheds by allowing for more water to run into streams and not be released to the atmosphere by evapotranspiration. With projections of continued warming, earlier snowmelt, and reduced snowpack, returning more flow to aquatic systems may help counteract the impacts of climate change. This, in turn, has the potential to benefit many other ecosystems downstream of the treatment area, including wetlands, other meadow types, mixed conifer forests, oak woodlands, other foothill habitats, and life in the central valley of California (including humans).

In addition to co-benefits, there is overlap between which resource groups could use certain management actions (see Table 14). Managed fire, education, and experimentation and monitoring were the most cited actions. Depending on where these actions are put into practice, they could have the potential to benefit other resources, and it is important to remember there are many other natural resources to the southern Sierra Nevada not on this list, such as the Pacific fisher. For example, doing a managed burn in a mixed conifer forest could also benefit giant sequoia groves, wetland meadows, and wildlife that depends on structures created by wildfire, such as the Pacific fisher and California spotted owl, depending on the location.

Management Action	Count	Watersheds and Rivers	Wetland Meadows	Blue Oak Woodlands	Giant Sequoia Groves	Mixed Conifer Forest	High Elevation Five Needle Pines
Managed fire	6	■	■	■	■	■	■
Education	5	■	■	■	■		■
Experimentation & monitoring	5	■		■	■	■	■
Limit grazing	4	■	■	■	■		
Mechanical thinning	4	■			■	■	■
Assisted migration	3			■	■	■	
Compliance work	3			■	■	■	
Eradicate non-native species	3		■	■	■		
Increase genetic diversity	3			■	■	■	
Planting with genotypic variation	3				■	■	■
Research into potential expansion sites	3			■	■		■
Create seed banks	2				■	■	
Identify most likely to success & high risk areas	2		■	■			
Irrigate	2				■	■	
Learn from other examples	2			■	■		
Protect migration corridors	2			■		■	

Table 14: Management actions identified by more than one resource group. These actions include any strategy theme (resist change, build resilience, facilitate transformation, and anticipate and plan for extreme events).

Constraints and Opportunities

What are constraints and trade-offs to implementation (including other objectives that present conflicts)?

The other part of the Strategies Exercise asked participants about constraints to implementation. These constraints can include limitations for conducting management activities or detrimental impacts of one management activity to another objective. The main concern of all six resource groups was money – all groups listed the cost of management activities with a limited budget in some fashion (see Figure 9). The second most commonly mentioned constraints dealt with agency regulations/culture and public concern – including public acceptance and apathy. Competing laws and regulations within and between agencies may hinder management efforts. Other constraints include lack of knowledge and access to locations.

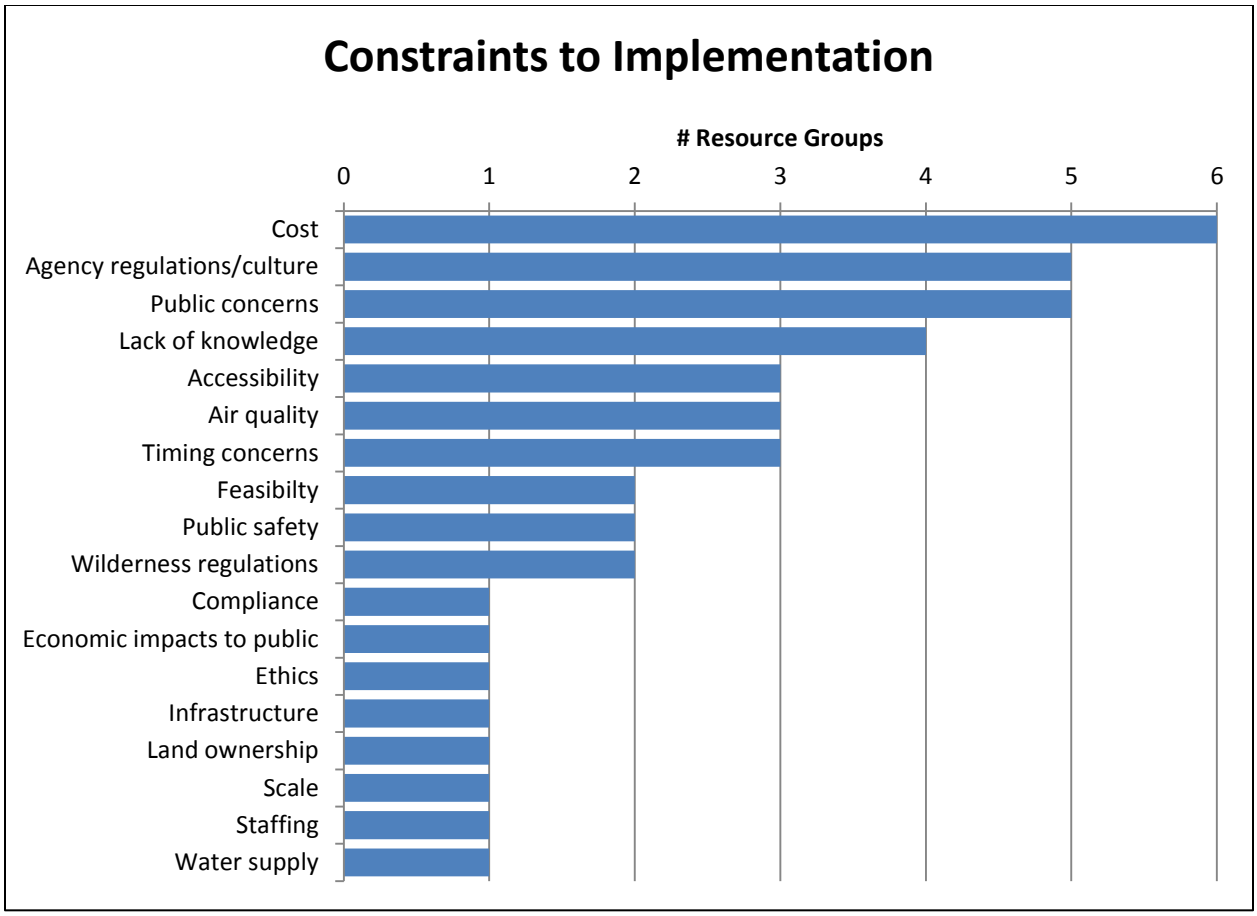


Figure 9: Participant responses for constraints to implementation.

What thematic strategies and management tools are most likely to enable us to meet objectives?

Strategies mentioned to overcome constraints were gaining public support, collaboration, and education (see Figure 10). Some groups also noted that the first step is acknowledging that management limitations exist (see Appendix).

Figure 10: Participant responses for strategies to help land managers in the southern Sierra Nevada meet objectives

Who has the capacity to use different management tools? Where will these tools be most successful? What factors will enable us to meet objectives in certain places?

Group responses to this question largely depended on the resource (see the Appendix for responses). Generally, different agencies were listed as being able to do different activities depending on agency rules and regulations. Therefore, by working together across a landscape, even if one agency cannot undertake a specific management technique, agencies in lands surrounding them may be able to. For example, the Blue Oak Woodlands group stated that the BLM has fewer limitations on acquiring new land than other agencies, but that all agencies have the potential to conduct more research on effective management techniques and monitoring, especially to determine potential refugia sites. Wilderness regulations also disallow certain management actions.

Factors enabling the agencies of the southern Sierra Nevada to meet objectives include many of the factors listed in Figure 10. The strongest responses were for public participation and collaboration. Experimentation in different potential management types was also encouraged by one group, and many groups listed experiments and monitoring in their strategy responses (see Tables 10-13). Interestingly, the same group that suggested experimentation also suggested that tools be applied only where they are accepted and ecologically relevant. Thus, there appeared to

be a tension between the tenants of experimentation and managing for change and the desire to only apply tested strategies and do no harm. One group also urged agencies to manage with the expectation of change and not stasis, as only when we accept this will managing for climate change come more easily. Another important factor influencing our ability to meet objectives is whether or not a species gets listed as endangered or threatened, as this will change how agencies are lawfully able to manage the species.

What would success look like? What are indicators of success? How can we work together to overcome constraints? What gaps in monitoring and research are most important to fill? How do we work together to fill these gaps?

This was a "bonus" question, so not all resource groups were able to answer this in the time allotted. However, in terms of success, groups answered with the following responses:

- Delayed loss of high functioning ecosystems across a range of types and environments
- More of the key species for that ecosystem
- Healthy population structures
- Public support
- Biodiversity
- Self-sustaining populations
- Persistence
- Improved ecosystem benefits across ecosystems from managing just one – wetland meadows (flood control; slower/sustained release of water through summer season; carbon sequestration)

Monitoring was also discussed as a strategy; see Tables 10-13 and the Appendix. Research gaps mentioned here included:

- Identify hydrologic vulnerability to facilitate priority setting on a regional scale (Wetland Meadows)
- Genetic research (Wetland Meadows; Blue Oak Woodlands)
- Factors that limit recruitment (Blue Oak Woodlands)
- Growth response (High Elevation Five Needle Pine)
- Demographics (High Elevation Five Needle Pine)
- Rust resistance/exposure level for Sierra Nevada (High Elevation Five Needle Pine)
- Effects of altered fire regime (High Elevation Five Needle Pine)
- Beetle life history (High Elevation Five Needle Pine)
- Native pathogens and insects (High Elevation Five Needle Pine)
- Co-migration/range expansion of species, competitors, and pathogens (High Elevation Five Needle Pine)

To help fill these monitoring gaps, groups listed leveraging existing partnerships and rebuilding abandoned monitoring infrastructure.

Prioritization Strategy

A prioritization strategy will be crucial in assessing which locations and resources to manage for with limited funding, and the Wetland Meadows breakout group in Session 4 provided a list of criteria for selecting high priority refugia sites:

- High likelihood of persistence
- High likelihood of success with restoration methods
- Accessibility/cost
- High public value
- Threatened and endangered species (habitat and richness)
- Maximizing species diversity
- Focus on high elevations? Follow the water?

Overall, emergent themes from this session were in the form of more questions and were not necessarily answered throughout the SSCAW process. Issues resource groups struggled with included:

1) protecting single species (threatened and endangered) versus maximizing biodiversity and managing for the ecosystem;

2) focusing on vulnerable/at risk areas versus investing in areas most likely to persist under climate change ; and

3) acknowledging that some entities can do certain strategies more easily than others, especially due to agency mandates and culture.

Emergent Themes from the Strategies Session:

- Protecting single species versus managing for the ecosystem
- Focusing on vulnerable/at risk areas versus investing in areas likely to persist in spite of change.
- Acknowledging that some agencies can do certain strategies more easily than others.

These topics should be further discussed in depth at future southern Sierra Nevada regional cooperatives.

Feedback and Response

Testing a new process, using new language to discuss complicated terms, and asking people from various agencies with different goals to agree on resource values can be a difficult process. Yet in two surveys given after the workshop, a majority of participants and members of the program committee felt that the broad goals of *working collaboratively to develop a new process of dealing with regional conservation in the face of change and identifying potential goals and strategies* were met. Most participants described a benefit of meeting and working with other resource professionals. Respondents felt that this workshop was a crucial first step forward to be built upon. The mere fact that 100 out of 169 attendees responded to the post-workshop survey is evidence of strong engagement.

Many of the respondents said they would utilize this framework or a similar one in their next planning effort, but it could use more work (Figure 11). Several others suggested they were interested but wanted to see it applied first. More effort is needed to fine-tune and improve the framework and the process used before applying it. As in all planning efforts, monitoring, learning, and improving upon the process are important steps. We present the following information in order to assist our own efforts as well as to inform others. The following section is organized by overall workshop goals and structure, and then by workshop session goal. The feedback comes from a participant survey and the response comes from a survey of the program committee and the authors of this report.

Overall Goal and Workshop Structure

Goal: Dialog about and possibly identify shared conservation values, and explore regional scale strategies to conserve Southern Sierra natural and cultural resource values in the face of rapid changes and an uncertain future.

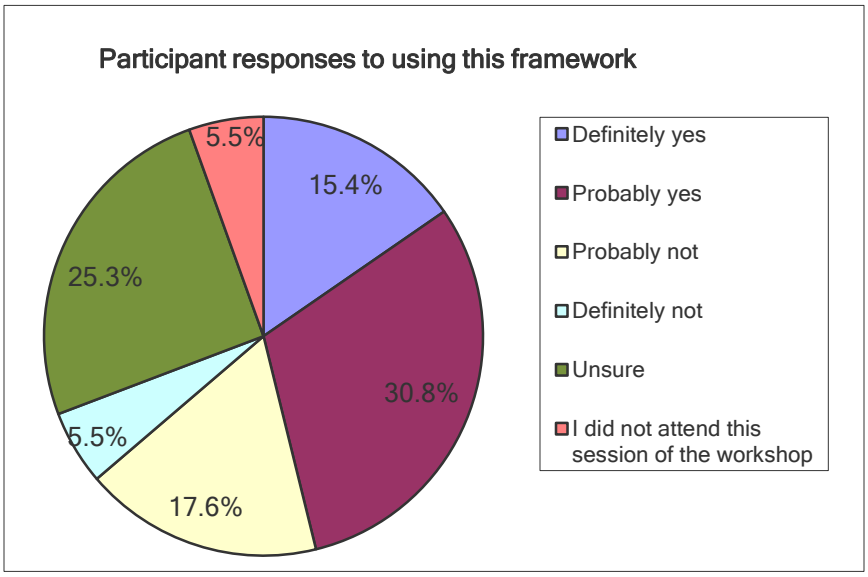


Figure 11: Participant responses to the question of "Can you envision using this framework structure and process?"

Participant Feedback

More than 60 percent of participants felt that the overall goal was accomplished either very well or well (ranked a 1 or a 2 out of 5). The framework was helpful for most respondents, but several mentioned that it could use more work before put into practice. The main issues cited by respondents were that the definitions of terms (the vocabulary) were too confusing and the exercises were too complicated for such a short workshop.

Program Committee Response
Many in the program committee felt that limitation of time was an overriding issue with the workshop. By necessity, some topic areas had to be shortened to make room for other parts of the exercise. Some suggestions were to simplify the exercises, reduce the time for Session 2 (What Do We Care About?) and give the extra time to Session 4 (Strategies, Constraints, and Management Tools).

A critical topic identified by the committee was facilitation. Early on, the committee acknowledged that funds were not adequate to pay for professional facilitation. Several levels of facilitation were integral to this workshop, however. Each session had one or two overall facilitators. The exercises required 32 group facilitators plus note-takers. Session facilitators were responsible for finding exercise facilitators and sought out good discussion leaders who would commit time and effort to the task. For session 4 breakout sessions, facilitators were selected based on an additional criterion of subject matter expertise. An overall suggestion was to increase the level of involvement and preparation of the exercise facilitators ahead of time. While these facilitators were involved and prepared to some extent for some of the sessions (i.e., opportunity to comment on session planning documents, invitation to conference calls, etc.), asking for earlier feedback on the session was recommended. Additionally, more involvement of education and interpretation experts in workshop preparation is advised to improve the exercises and the delivery of instructions.

The aspect of the Change Adaptation Planning Framework (CAPT) that was not given as much attention as we should have during the workshop was **developing a prioritization strategy**. This aspect of climate adaptation planning should be given a more prominent role in future planning efforts.

Session 1 – What Do We Know?
Goal: Answer the question, "What do we know?" and prepare workshop participants to participate in change adaptation dialog.

Participant Feedback
Respondents were generally satisfied with Session 1 saying the information presented was both useful for the workshop and served as a concise update to current knowledge about climate change, stressors, and values. When asked if this session fulfilled its goal to prepare participants to participate in a change adaption dialog, about 70% of respondents who attended this session gave it a 1 or 2 out of 5 (with 1 being best).

Program Committee Response
The committee felt that Session 1 was executed extremely well, and had no responses on how to improve it.

Session 2 – What Do We Care About?
Goal: Identify and prioritize current conservation values that warrant coordinated change adaptation planning for possible management action.

Participant Feedback
Half of the respondents gave this session a score of 1 or 2 out of 5, and many respondents had suggestions for improvements that we summarize here. The generation of broad encompassing

values in Sessions 2 and 5 (for example, hydrology or biodiversity) left some respondents satisfied in being able to integrate as many resources as possible into these general categories, while others felt that identifying a narrow set of values (for example, summer low flows or native wetland plants) would have been more useful to make management decisions. Many respondents felt the vocabulary chosen for this session could have been simpler, or could have been common to all agencies and participating groups. The worksheet provided for this session (the Change Adaptation Planning Template, or CAPT) had a mixed review and many of the respondents did not find it helpful.

Program Committee Response

During the workshop we were able to identify broadly shared values for conservation: hydrologic processes, human connections to the environment, and biodiversity (see Figure 5). These values could be the basis to create communication and education programs. However, some within the program committee were hoping for more specificity in order to support place-based coordinated action planning, prioritization, decision-making, and implementation.

In hindsight, a few suggestions were made to narrow the task and restructure the exercise substantially.

- Allow participants to select more than three top values. If participants could list more values, they may have been able to narrow their values, but more than three could be also unwieldy and may not have helped participants prioritize;
- Break down the exercise into three steps: 1) identify shared Southern Sierra conservation values; 2) identify which aspects or attributes of these values, warrant coordinated response (due to high social value or vulnerability, for example); and 3) narrow further to those attributes that we have the capacity to act on now or in the next 10 to 20 years.
- Ask participants to list their values and then rank them as high, medium, or low.
- Give participants a hypothetical $100 budget to spend on a list of values. These funds could be distributed to a few or across many values and could be used for multiple purposes (on-the-ground management, research, education, etc.). Then ask participants to identify values that were likely to receive co-benefits from spending funds on another value (for example, $20 spent on wetland protection and restoration provides $5 of benefit to water quality). In this manner, a set of narrower values could be linked to broader co-benefits.
- Ask participants to describe multiple objectives for their top values and then prioritize the objectives (however, it is likely that more time would have been required).
- Rank strategies or objectives rather than values. Having participants chose strategies or objectives (or even more specifically where to implement them) over values may have avoided the reluctance of many of the participants in choosing more specific values, as a single management activity can have co-benefits among many resources.

The CAPT likely could have been simplified, especially in regards to the vocabulary and wording used (for example, “fundamentals”, defining features” and “critical attributes”) and the size of the worksheet. One suggestion was to use “values” (as in resource values, social values, etc.) and “attributes of values” to help participants focus in on particular elements that they care about.

Session 3 – Vulnerability

Goals: 1) Provide examples of how vulnerability may be determined for a defining feature or critical attribute (value) by examining the 3 components of vulnerability.

2) Begin assessing whether current management objectives are feasible in light of these sensitivities, and if not, how objectives could be revised.

Participant Feedback

Nearly half of participants believed this session achieved its goal. Some participants expressed the desire to be able to choose the 'focal resources' planned for the workshop and did not agree with some of the pre-selected choices. Other participants felt the vocabulary used in vulnerability (exposure, sensitivity, adaptive capacity) was confusing.

Program Committee Response

We were able to examine the condition and vulnerability of selected values (presentations are shared on the website). For this task we pre-selected six resources for which condition and or vulnerability assessment information was available. The program committee believed these six topics to be of high interest/concern and for which we had adequate scientific information to discuss objectives, condition, vulnerability, and management strategies. The number of topics was limited by logistical constraints on the number of facilitators, meeting space for break-out groups, and time available for groups to report their findings.

Substantial pre-work was necessary to compile and summarize the available data in a useful format – the information briefs. One downside is that the pre-selected resource topics were not necessarily those of greatest concern or interest to all participants. However, information syntheses do not exist in an easily digestible format for the top three shared conservation values identified by workshop participants. This means that significant additional work would be necessary to compile the state-of-knowledge summaries for the shared values identified during the workshop. While participants were allowed to decide which resource group to join, it may have been better to conduct a pre-workshop survey ahead of time to help us select the resource topics.

While the goal of the session was not to conduct comprehensive vulnerability assessments for the six resources, it was suggested that participants could rank stressors, determine how sensitive the resource is to these stressors, and discuss whether stressors are systemic or local. A related suggestion was that it would have been more useful to link the components of vulnerability across for each stressor – naming a stressor exposure, and then describing why a resource is sensitive to it, and any traits the resource has to adapt to or resist the stressor.

Other suggestions for this session (or another part of the workshop) were to make the connections between values and management objectives clearer (for example, what are the objectives for a shared conservation value like biodiversity?), to ask participants why they made changes between current and revised objectives, and to ask participants to focus on revised objectives specific to coping with the impacts of climate change.

Another vocabulary issue that emerged here was the use of the term "retrofitted" objectives. We view using the term "retrofitted" as an error and that "revised" is a more appropriate term. Retrofitted refers to adding a component to something that did not have this component when it was originally created. Revised, however, refers to reconsidering and altering something in light of further evidence. As we were reconsidering our objectives in the face of new knowledge and environmental conditions, "revised" is the correct terminology to use. We therefore changed this terminology throughout the writing of this report.

Session 4 – Strategies, Constraints and Management Tools

Goal: Test a shared learning approach to evaluate whether current objectives for things we really care about are realistic and to explore revised objectives as well as strategies and tools that may help us adapt to rapid change and uncertain future conditions.

Participant Feedback

Out of all the sessions, this was described as the most useful, most difficult, most time-consuming, and most in need of additional working time. Some participants were confused when asked to reconsider vulnerability, objectives, and revised objectives since they had already began discussing this during Session 3. Others expressed confusion about the strawman worksheets (see Appendix) that contained examples of responses, and thought that the committee was providing them with "the answers". They recommended limiting the use of strawman examples at future workshops or providing clearer instructions.

Program Committee Response

We were able to explore response strategies through the use of a template that enabled participants to be exposed to the broad categories of possible response strategies. The groups felt that they learned from this exercise and many expressed interest in spending more time on the

exercise. The overlap between sessions 3 and 4 was intentional. The purpose was to use session 3 to provide an initial foray into the assessment of vulnerability and re-evaluation of objectives in a small group. Session 4 could then be used to more fully develop these concepts in a larger group and then connect them to potential management strategies. Some of the planning committee members suggested trying to prioritize strategies, but in the time allowed, others thought this additional task unrealistic.

The strawman worksheets (see the Appendix) that contained examples of responses were created as a jumping off point for participants, to be added to, deleted, and/or changed. They were created as an aid because of the limited time participants had for the exercise. While the survey showed that some people were confused by these examples, other evidence suggested that some participants found them very useful. If this kind of tool is used again, its purpose should be made clearer to participants.

At least one member of the program committee felt the groups focused mostly on resistance and resilience strategies (i.e., managing for persistence) and did not explore novel response strategies for facilitating change. Other committee members felt the groups did begin to explore new approaches (including new tools as well as new ways of using existing tools). Some advice was to add a final phase to the exercise which forces the group to reconsider their management objectives and strategic action options. One suggestion was to tell groups that 50% of that resource had disappeared in 50 years because of climate change in spite of the actions they had taken using a resilience/resistance based strategic plan. One aspect of decision-making that may have changed based on this information is the way that resources and specific locations are prioritized for management actions. Therefore, another suggestion was to redraft the questions we asked on the worksheet to explicitly include prioritization, for example: "What criteria would you use to select places to implement these actions? Why?"

Ideas for next steps included having more technical subject matter experts present to help further the discussion of novel strategies. This could be the focus of another workshop.

Session 5 – Conclusions and Next Steps

Goal 1: Agree on 3-10 shared conservation values in the Southern Sierra that can realistically be accomplished through regional conservation planning and implementation.

Goal 2: Find opportunities to "manage for desired change when uncertainty is the only certainty."

Participant Feedback

Just under half the respondents that attended this final session thought the session was successful in reaching the first goal. For the second goal, 29 percent of respondents thought it was successful. Participants generally chose broad values in this session to reflect their desire to protect as many resources as possible.

Program Committee Response

The planners of the workshop had hypothesized that the process of learning and discussing resource vulnerabilities, strategies, constraints and opportunities might alter what people value. However, many workgroups chose the same values or broadened them, limiting the value that

they provided managers. For some in the program committee, seeing similar values only confirmed the idea that a few broad values crossed boundaries and presented opportunities to work collaboratively on conservation planning. While the values identified in sessions 2 and 5 did not change very much, we did note an increase in the groups that used vulnerability as a criteria for selecting values for conservation.

Other Elements of the Workshop

The poster session and collaboration stations were generally well-received and provided an opportunity to showcase up-and-coming work. Most participants responded that the posters and collaboration stations were generally informational and the knowledge learned here influenced their thinking during the workshop. However, the collaboration stations – intended to be places where individuals could exchange ideas – were perceived to be overwhelmed by the posters and it was suggested that a dedicated time or separate space for working on collaboration stations be provided.

The materials gathered for the workshop (especially the resource briefs) served as important sources of information for participants. Almost all respondents thought the pre workshop emails, information posted online, and resource information briefs were very useful or somewhat useful in preparing them for the workshop, but wished they had more lead time to review them before the event. Most (62%) of respondents thought the program and workbook were very worthwhile, and all but 1% of the remaining thought they were helpful. Some participants reported using this information in other planning exercises held after the workshop.

Some of the non-governmental participants felt that their organizations often are overlooked in regional conservation planning. Generally, these organizations have fewer regulations and restrictions in doing certain management activities, and are a great partner for conservation efforts that government agencies cannot implement due to various constraints. It is important to remember these groups when planning and implementing actions in the southern Sierra Nevada.

Next Steps

The achievements and lessons learned from this workshop demonstrated the value of shared dialog within the Southern Sierra Nevada region. To facilitate ongoing collaboration, we plan to establish an online forum, increase public outreach and engagement, and consider a subsequent workshop focused on a specific resource. Each of these potential initiatives is discussed below.

Following the publication of this document, an online forum will be established on the workshop website (http://climate.calcommons.org/aux/sscaw/index.htm). The program committee agreed with the 40% of surveyed participants who expressed a desire for additional communication. The forum is envisioned as a means to further discuss change adaptation between and within agencies, subject matter experts, and other partners.

Another step will be to engage the public including policy makers in a change adaptation dialog. About 70% of surveyed participants listed electronic media as the best way to do this, including the internet and social media. Approximately 65% of surveyed participants recommended public programs at public land venues, and an additional 65% recommended programs for organizations in local communities (such as college campus or Rotary). Other recommendations included hosting small workshops, focus groups, outreach booths at local events, or webinars. The intent

of these activities is to educate and inform the public, and to also get feedback and buy-in from the public.

Another step will be conduct a pilot regional collaboration project. This will focus on a particular resource and apply the change adaptation framework at a regional level. With constraints on travel, this may be difficult to achieve, but online meeting resources could be utilized to discuss and choose an appropriate resource. The approach for this next step may be different than this workshop, with a smaller number of subject-matter experts asking specific questions about the vulnerability of a resource and how to prioritize strategies. Monitoring and research will take a large role in the next steps of this process.

Conclusion

Nothing is permanent but change – Heraclitus

*"…give us…[**the adaptive capacity**] to accept … the things that cannot be… [**sustained**], the courage to…[**manage**] the things that should be changed, and the wisdom [**using the best available science**] to distinguish the one from the other."* – Modification of the original Serenity Prayer by Reinhold Niebuhr.

During two and a half days in February 2013, nearly 170 resource professionals and other interested individuals gathered to discuss climate change and how to respond to it. The questions before the group were what to do about change, and how to make decisions about the things we value. This workshop was a step towards the goal of working regionally to make thoughtful, reasoned decisions about how to manage resources. The first step in making those decisions is understanding what is valued regionally. Based on the workshop results, we can surmise that participants value water and its ecological communities, human connections to the environment, and biodiversity. The overriding criteria used for choosing these values were public support and interest in a resource. While the broad swath of values discussed at the workshop may seem unwieldy, it shows common interest – which can be the basis for action.

The second step in the framework discovers current objectives, and then the group proceeded to assess vulnerability. The elements of vulnerability – exposure, sensitivity, and adaptive capacity – will vary for each resource. The response of many resource groups to list fire and air pollution as stressors simply shows that those stressors affect a broad swath of resources. It does not rank those stressors higher than any other stressor, but, if actions could be taken to increase the use of managed fire on the landscape – and reduce the impact of severe fire – or to reduce air pollution, the impact would likely benefit multiple resources.

Revising objectives after evaluating vulnerability showed benefits in recognizing that objectives may not be feasible due to changing and uncertain conditions. Dr. Nate Stephenson described this well during his presentation (Session 1 – please see http://climate.calcommons.org/aux/sscaw/index.htm), when he described an objective as a constantly moving target as the climate changes conditions for meeting that objective. The dialog we had during the workshop was not conclusive but it opened the door to a wider discussion around what could be realistic objectives for land management agencies. Themes emerged, like having regionally-based objectives for maintaining regional native biodiversity. Another was to recognize the potential for losing species and using that to help prioritize actions.

Designing strategies showed the cross-cutting issues of land management. Some strategies may provide win-win, no-regret solutions. Other strategies may require taking on more near-term risk to reduce potentially much greater longer-term risks. Management actions were the preferred response in resist change and build resilience strategies, while science became more common to the strategies of facilitate transformation and anticipate extreme events. Managed fire, education, and experimentation and monitoring were the top mentioned strategies across resource groups. Looking at the constraints associated with these actions allowed groups to understand the cross-cutting impact of lowered budgets and regulations. Identifying the opportunities of public support and collaboration showed the importance of working together to overcome those

constraints. Many participants in the workshop stressed the need for greater public support in dealing with land management in the face of change.

As one participant said, these are still just terms and ideas, and a concrete workable example will need to be developed. The framework used for the workshop (Figure 12) would be a useful tool in developing a workable regional change adaptation process. A regional approach using this framework has many benefits, including opening dialog among agencies and organizations, helping them critically think about these issues, and providing logical tools for moving forward. Obstacles to utilizing the framework include federal regulations that are difficult to change and inclined to promote the status quo, data issues, (including limited data sharing between agencies, data management, and data collection), the political atmosphere, and lack of funding. Although these obstacles may be difficult to work around, the alternative of not attempting to answer the questions posed in the workshop would be much more devastating.

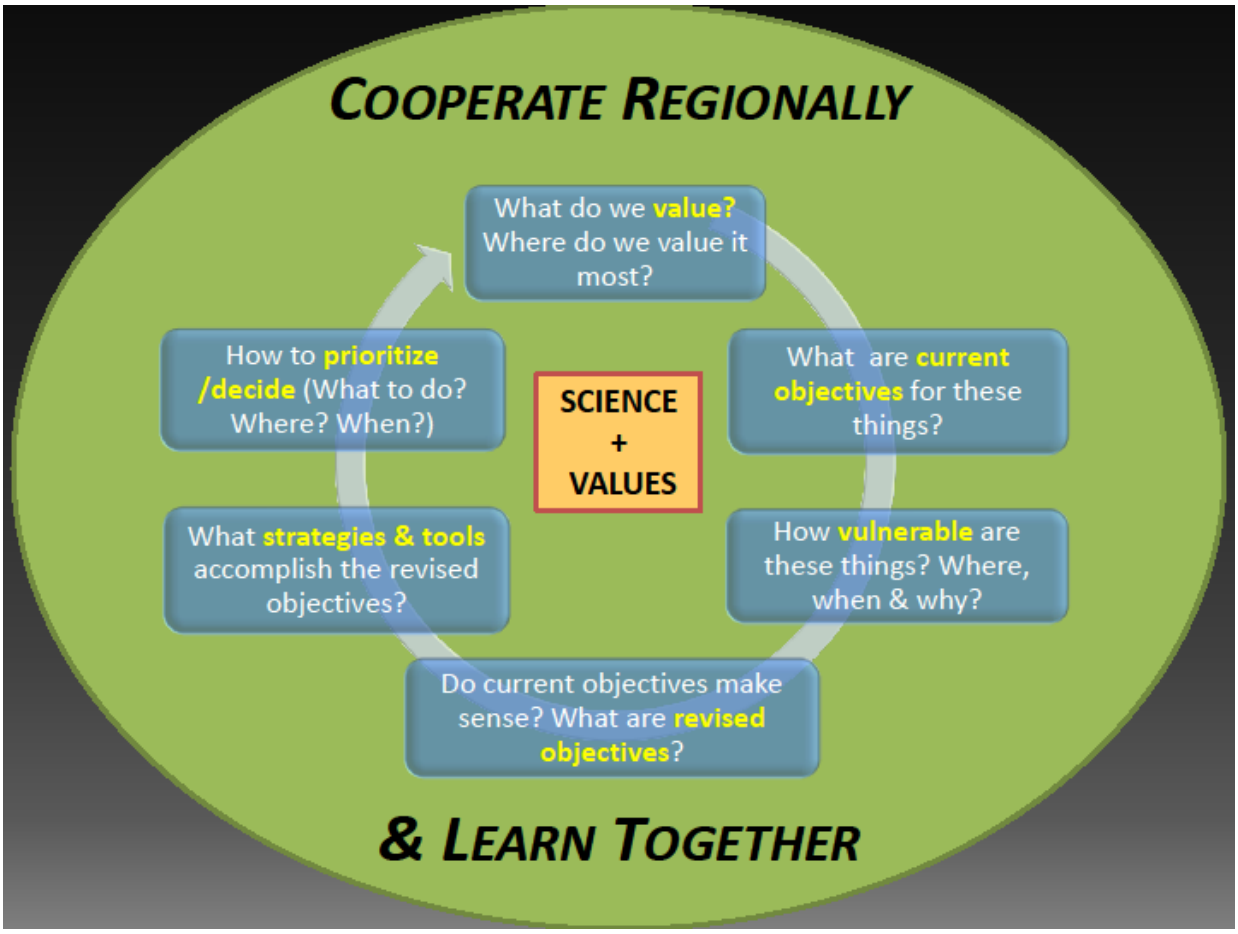


Figure 12 – The Southern Sierra Change Adaptation Workshop framework

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Resources for Further Studies

California Climate Commons <http://climate.calcommons.org/>

National Park Service Climate Change Response Strategy <http://www.nps.gov/climatechange/docs/NPS_CCRS.pdf>

National Wildlife Federation Climate Adaptation Reports <http://www.nwf.org/What-We-Do/Energy-and-Climate/Climate-Smart-Conservation/Adaptation-Reports.aspx#quickguide>

The Nature Conservancy Climate Adaptation Case Studies <http://www.nature.org/ourinitiatives/regions/northamerica/areas/greatlakes/explore/climate-adaptation-case-studies.xml>

The Nature Conservancy – Climate Change: Our Priorities <http://www.nature.org/ourinitiatives/urgentissues/global-warming-climate-change/how-we-work/supporting-strong-adaptation-strategies.xml>

Previous Southern Sierra Climate Adaptation Workshop Website <http://www.cafiresci.org/s-sierra-adaptation-workshop>

USDA Forest Service Climate Change Resource Center < http://www.fs.fed.us/ccrc >

Region 5 Climate Change Initiative <http://www.usda.gov/oce/climate_change/effects.htm>

Southern Sierra Partnership <http://conserveonline.org/workspaces/climateadaptation/documents/southern-sierra-partnership-ca-0

Southern Sierra Cooperative <http://www.nps.gov/seki/naturescience/sscc.htm >

US Fish and Wildlife Service and National Oceanic and Atmospheric Administration National Fish, Wildlife & Plants Climate Adaptation Strategy <http://www.wildlifeadaptationstrategy.gov/ >

USFS Our Forest Place < http://ourforestplace.ning.com/>

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