Vulnerability Assessment and Adaptation Strategies for Focal Resources of the Sierra Nevada

An Overview of Project Components and Utility

Purpose of this Document

This document serves as a guide to the *Vulnerability Assessment and Adaptation Strategies for Focal Resources of the Sierra Nevada* project and its resulting products. It also briefly discusses the utility of the project's approach and products and how they may be transferrable.

Why Plan for Climate Change?

Climate change is already affecting Sierra Nevada ecosystems and communities. Changes are resulting in movement of species and modification of human activities, and are expected to continue for centuries or millennia to come. Failing to incorporate present and future change in the planning and management decisions we make today decreases the likelihood of long-term success from these actions. For example, forest management practices that are designed assuming only current forest assemblages, current fire regimes, current hydrological patterns and current pest species are unlikely to be successful into the future, just as current management based solely on conditions as they existed in the Sierra Nevada in the 1800s would be ineffective under today's conditions. In order to implement robust, durable management actions today that will sustain Sierra Nevada resources into the coming decades or centuries, it is imperative that climate change be considered explicitly in regional assessments and strategy development. The sooner strategies can be developed that incorporate consideration of future conditions, the sooner decisions can be made that will optimize rather than preclude opportunities for future success. Processes like the one described here can be used to help make this happen.

Project Overview

This project is intended to help guide and support a manager or planner in strategically integrating the challenges of climate change into their management of Sierra Nevada resources. The main products focus on understanding vulnerabilities to climate change and implementing adaptation actions. *Climate change vulnerability assessments*, in support of adaptation planning, help identify which resources are likely to be most affected by changing climate conditions, and also help establish why those resources are likely to be vulnerable[1]. *Adaptation strategies* are active approaches that help resources adjust to climate change (including climate

[1] Glick, P., B. Stein, and N. Edelson (Eds.). 2011. *Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment*. National Wildlife Federation, Washington, D.C.

variability and extremes) to moderate potential damages, to take advantage of opportunities, or to reconfigure without significant declines in crucial functions[2].

Objectives and scope

The project was comprised of four main objectives:

1. assess the vulnerabilities of a suite of Sierra Nevada focal resources to climate change;
2. use spatial analysis to inform the vulnerability assessment and facilitate adaptation planning;
3. identify priority management strategies for the Sierra Nevada; and
4. provide training, resources, and support for managers, planners, and others to conduct similar processes in their work.

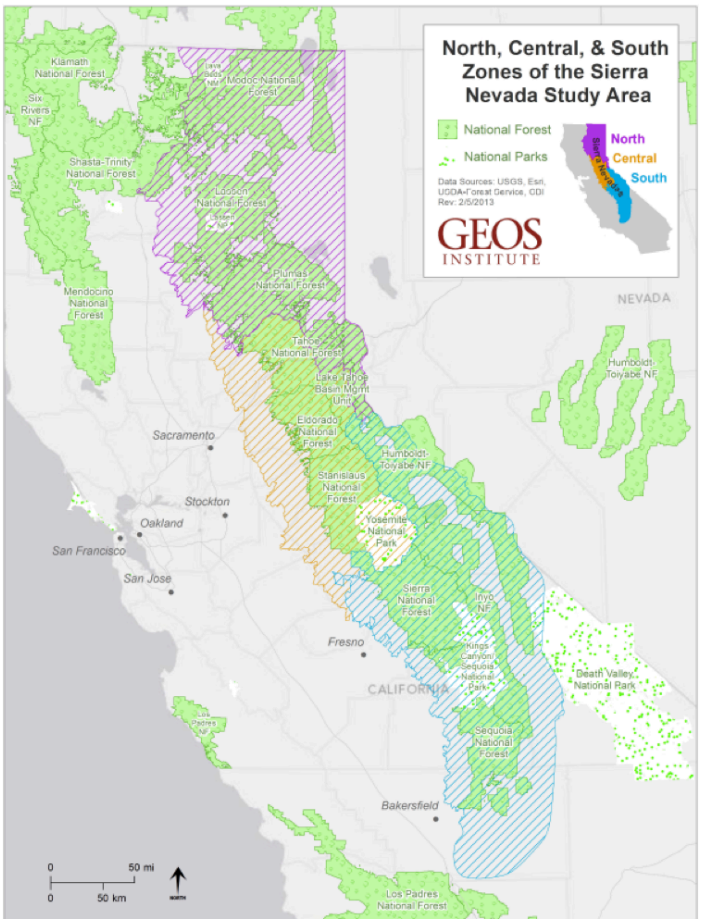

Figure 1. Sierra Nevada geographic sub-regions including national forests and parks[5].

To achieve these objectives, the project itself was comprised of three principal components: (1) a vulnerability assessment workshop, (2) spatial analysis and comparative mapping, and (3) an adaptation planning workshop. The Vulnerability Assessment Workshop, held March 5-7, 2013, focused on assessing the vulnerabilities of focal resources (ecosystems, species, and ecosystem services) to climate change. Information from the vulnerability assessment workshop was used to identify key climate and non-climate spatial data layers for each focal resource, which were assembled on Data Basin[3]. The assemblage of dataset layers on Data Basin provide an online resource of spatial information that help inform vulnerability assessments and facilitate adaptation planning for focal resources of the Sierra Nevada.[4] The Adaptation Planning Workshop, held June 4-5, 2013, focused on identifying management strategies to help regionally important ecosystems

[2] IPCC. 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (Eds). Cambridge: Cambridge University Press.

[3] Data Basin is a science-based mapping and analysis platform created by the Conservation Biology Institute that supports learning, research, and environmental stewardship (http://databasin.org).

[4] Datasets and maps can be found on the Data Basin group page titled *EcoAdapt-CA LCC: Climate Adaptation Project for the Sierra Nevada* (http://databasin.org/groups/e6cfbd4218f54b32b695fad7af8cce31).

and species adapt to changing climate conditions and to lay the groundwork for adaptation action. Both the vulnerability assessment and adaptation planning workshops provided training and resources for managers and planners to conduct similar processes in their own work.

The geographic scope of this project includes the Sierra Nevada region of California, from foothills to crests, including ten national forests and two national parks (Figure 1).

Project process

The products from this project synthesize the best available and most relevant climate change science information, and report vulnerability information and adaptation strategies for focal resources. Local resource managers, stakeholders and other users, and regional and topical experts have collaborated through guiding committees, structured workshops, and review processes to generate and refine this information. The overall organization and process of the project is illustrated below.

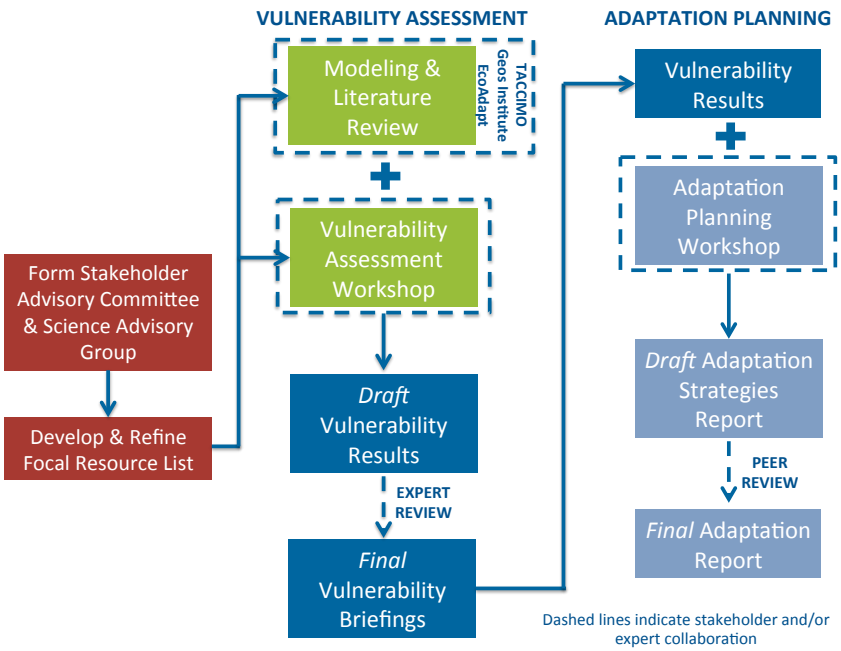

Figure 2. An overview of the process used in the Vulnerability Assessment and Adaptation Strategies for Focal Resources of the Sierra Nevada project.

Project committees: Two committees were formed at the beginning of the project: a Science Advisory Group and a Stakeholder Advisory Committee. The Science Advisory Group consisted of leading climate scientists, ecologists, hydrologists, and others for the Sierra Nevada region. Members of this group participated in the project through a number of avenues including review of the climate science synthesis produced by the Geos Institute (2013)[5], providing spatial data for the project, and/or reviewing vulnerability assessment summaries. The Stakeholder Advisory Committee consisted of resource managers, decision makers, scientists, conservationists, and others who helped guide the selection of focal resources, participated in workshops, and reviewed workshop results.

[5] Geos Institute. 2013. *Future Climate, Wildfire, Hydrology, and Vegetation Projections for the Sierra Nevada, California: A climate change synthesis report in support of the Vulnerability Assessment/Adaptation Strategy process.* Ashland, OR.

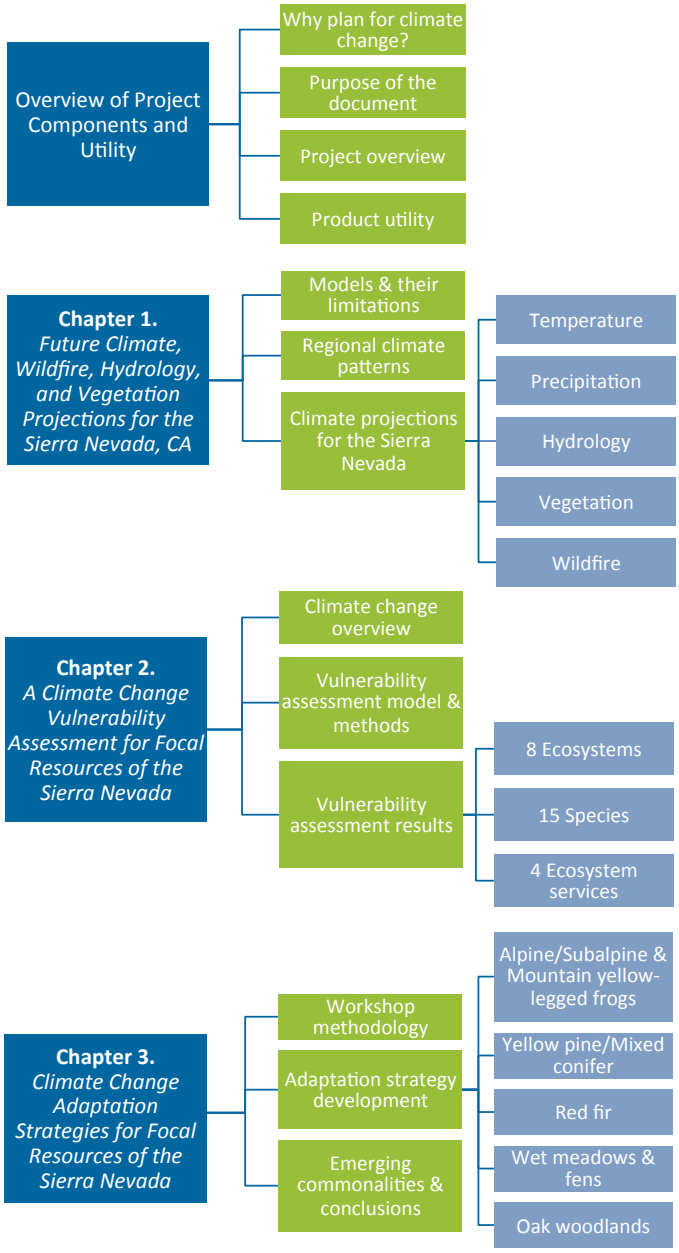

Figure 3. Overview of project components and where to find information on projected trends in future climate, vulnerability assessment methods and findings, and adaptation strategies for focal resources of the Sierra Nevada.

Vulnerability assessment: Background information on focal resources and climate trends for the Sierra Nevada region were compiled prior to, and presented at, the Vulnerability Assessment Workshop. Climate trends information was assembled into the climate science synthesis document produced by the Geos Institute (2013)[5], while climate exposure information for focal resources was provided by the Template for Assessing Climate Change Impacts and Management Options (TACCIMO)[6]. EcoAdapt provided background information packets on sensitivity and adaptive capacity for focal resources. During the Vulnerability Assessment Workshop, participants evaluated climate change vulnerability of twenty-seven focal resources (eight ecosystems, fifteen species, four ecosystem services) by considering exposure to climate change, sensitivity to climate and non-climate stressors, and adaptive capacity. Workshop participant assessments, rankings, and comments were assembled into two main products: resource vulnerability briefings and resource vulnerability syntheses. *Vulnerability briefings* provide referenced, peer-reviewed summaries for each focal resource, highlighting key sensitivity, adaptive capacity, and exposure factors. The intended audience is resource managers and planners who want an overview of vulnerability to climate change for a particular resource. *Vulnerability syntheses* compile participant rankings and comments, peer-review references including information from the background resource summaries, and topic expert reviews for each resource into longer documents (~8-20 pages each). The purpose of creating these longer syntheses was to make transparent all of the information collected from the process for each resource. The intended

[6] http://www.taccimo.sgcp.ncsu.edu/

audience is scientists and others who want a more comprehensive understanding of the process and findings. The vulnerability assessment findings from this process are intended to be a living resource that new information can be added to as it becomes available.

Adaptation planning: Findings from the vulnerability assessment were provided to participants of the Adaptation Planning Workshop. During this workshop, participants collaboratively identified management and conservation goals and objectives for focal resources, developed adaptation strategies to reduce vulnerabilities of resources and increase positive long-term outcomes for regional management goals, evaluated the feasibility of implementing a given adaptation strategy, and began identifying implementation needs. Adaptation strategies for focal resources were assembled into a final report that comprises those strategies and actions generated by participants as well as additional actions from the literature.

Where to find project results

Each section of the project focuses on one component of the overall process and includes summaries of key findings, methodologies, detailed results, and supporting information. A good place to start would be to read each section's initial summary and then refer to other sections as needed. The figure below highlights the structure of the document and its major subsections.

Chapter 1 describes current understanding of the changes in climate the Sierra Nevada is predicted to experience and potential influences on major physical and ecological processes such as wildfire, hydrology, and vegetation cover[5]. It provides a summary of past and projected climate trends for three sub-regions of the Sierra Nevada: north, central, and south. **Chapter 2** describes the vulnerability assessment model, including how focal resources were selected, and summarizes the results that were obtained when the model was applied to focal resources of the Sierra Nevada (ecosystems, species populations, ecosystem services). It also presents vulnerability assessment findings for twenty-seven focal resources – eight ecosystems, fifteen species, and four ecosystem services. **Chapter 3** describes the Adaptation Planning Workshop methodology, discusses adaptation strategies for five ecosystems and three species, and provides a framework for applying the adaptation strategies.

In total, twenty-seven focal resources of the Sierra Nevada were considered as part of this project. Available vulnerability assessment products for each of the focal resources are listed in Table 1. Due to limited availability of subject experts, we were unable to develop adaptation strategies for all twenty-seven resources although vulnerability information does exist for each. Vulnerability assessment syntheses and briefings are available in **Chapter 2** or as separate, downloadable reports on the California Climate Commons (http://climate.calcommons.org). Adaptation strategies for alpine/subalpine, oak woodland, red fir, wet meadow and fen, and yellow pine/mixed conifer ecosystems as well as marten, Sierra Nevada and mountain yellow-legged frogs are available in **Chapter 3**.

Table 1. Vulnerability assessment products for focal resources of the Sierra Nevada.

	Focal Resource	Vulnerability Assessment – *synthesis*	Vulnerability Assessment – *briefing*
ECOSYSTEMS	Alpine/Subalpine	✔	✔
	Aquatic	✔	✔
	Chaparral	✔	✔
	Oak woodland	✔	✔
	Red fir	✔	✔
	Sagebrush	✔	✔
	Wet meadows and fens	✔	✔
	Yellow pine/Mixed conifer	✔	✔
SPECIES	Aspen		✔
	Bighorn sheep	✔	✔
	Black oak	✔	✔
	Blue oak	✔	✔
	Bristlecone pine	✔	✔
	Fisher	✔	✔
	Marten	✔	✔
	Mountain quail	✔	✔
	Mountain yellow-legged frog	✔	✔
	Red fir	✔	✔
	Sage grouse	✔	✔
	Sierra Nevada yellow-legged frog	✔	✔
	Whitebark pine	✔	✔
	Willow flycatcher	✔	✔
	Wood rat	✔	✔
SERVICES	Carbon storage	✔	
	Fire	✔	
	Recreation	✔	
	Timber/Forest products	✔	

As described above under *Objectives and scope*, key climate and non-climate spatial data layers for each focal resource were assembled on Data Basin. The assemblage of data layers on Data Basin are intended to support climate-smart planning for the Sierra Nevada[4]. Available datasets and further descriptions on spatial analysis and mapping can be found in **Chapter 3**.

Product Utility in On-the-Ground Adaptation Planning

This project will be successful if its outputs spur and help support modification of existing management activities and integration of climate change challenges into planning along with appropriate monitoring of local change and adaptation action effectiveness.

Project outputs will occur in two phases. The first phase includes these three comprehensive chapters (Figure 3), **Chapter 1**: *Future Climate Wildfire, Hydrology, and Vegetation Projections for the Sierra Nevada,* **Chapter 2**: *A Climate Change Vulnerability Assessment for Focal Resources of the Sierra Nevada*, and **Chapter 3**: *Climate Change Adaptation Strategies for Focal Resources of the Sierra Nevada.* Phase two will consist of a series of targeted short guides to adaptation planning for selected focal resources and audiences.

We suggest the following approaches to get started with the first-phase outputs generated by this project.

If you are new to climate change and are looking for an introduction to climate change and adaptation planning in the Sierra Nevada:

- Start with Section 2 of **Chapter 2**, *A Climate Change Vulnerability Assessment for Focal Resources of the Sierra Nevada,* followed by **Chapter 1**, *Future Climate Wildfire, Hydrology, and Vegetation Projections for the Sierra Nevada*, and then read the executive summaries of **Chapters 2** and **3**

If you are working to integrate climate change into existing management activities:

- Start with **Chapter 3**, *Climate Change Adaptation Strategies for Focal Resources of the Sierra Nevada*

If you are looking for specific climate change vulnerability information for focal resources in the Sierra Nevada:

- Start with **Chapter 2**, *A Climate Change Vulnerability Assessment for Focal Resources of the Sierra Nevada*

If you are looking for specific adaptation actions for focal resources in the Sierra Nevada:

- Start with **Chapter 3**, *Climate Change Adaptation Strategies for Focal Resources of the Sierra Nevada*

If you are interested in the vulnerability assessment process and methods used…

- Start with Section 3 of **Chapter 2**, *A Climate Change Vulnerability Assessment for Focal Resources of the Sierra Nevada*

If you are looking for spatial data to support your climate change adaptation planning:

- Start with Section 2 of **Chapter 3**, *Climate Change Adaptation Strategies for Focal Resources of the Sierra Nevada*, as well as the EcoAdapt-CA LCC Data Basin group page: http://databasin.org/groups/e6cfbd4218f54b32b695fad7af8cce31, for access to spatial climate and non-climate datasets and maps

However you decide to approach these documents, you are encouraged to have a good understanding of the background information, data, modeling, and methods used and their limitations before relying on these results in any management decision or planning process. The

results of this project are a new toolset among many that can be used in managing natural resources. This project relied heavily on input from the stakeholder advisory committee, science advisory group, and other workshop participants. An expert elicitation, or scientific consensus approach, helped inform conclusions by characterizing uncertainty and filling data gaps where traditional scientific research was not feasible or data were not yet available. This approach can be limited by inconsistencies in local knowledge and unfamiliarity with complex relationships. Future climate condition and ecosystem response projections rely on modeling. These models vary in their level of detail and assumptions, making output and future scenarios variable[7]. Therefore, results derived are considered qualitative and relative only within the context of the focal resources considered.

Vulnerability Assessment Utility – Approach and Use in Other Regions

As mentioned previously, climate change vulnerability assessments help identify *which* resources are likely to be most affected by changing climate conditions, and also help establish *why* those resources are likely to be vulnerable. In general, there are more quantitative (e.g., NatureServe Vulnerability Index) assessments and more qualitative (e.g., this project) assessments, each of which has their own utility. Quantitative vulnerability assessments calculate an overall score or level of vulnerability for a particular resource, and can be used to compare vulnerability rankings among a suite of resources as well as show patterns in sensitivity and vulnerability factors across multiple resources. These assessments can depend on the availability of information on a wide range of vulnerability factors, which may be unknown for a number of resources and result in a less reliable vulnerability score. However, these assessments can provide a useful template for collecting a wide range of information needed to understand a resource's vulnerability. Qualitative vulnerability assessments can be more flexible than quantitative assessments, with a broader scope and more general information about a resource. The strength of these assessments is their simplicity, capacity to make general evaluations of vulnerabilities across a wide range of resources, and inclusion of a wide range of information needed to better understand resource vulnerability and develop adaptation strategies. However, scores associated with these assessments are dependent on the user's interpretation and knowledge, and may only be comparable within and among resources assessed by the same project.

However you decide to approach conducting a vulnerability assessment, the methods described in **Chapter 2** can provide a useful starting point for understanding the kinds of information needed to assess vulnerability for a particular resource. Further, the resource vulnerability assessment findings (also described in **Chapter 2**) can be used as a starting point for the same resources in other regions.

[7] See Chapter 1 for climate and ecosystem model parameters and limitations.

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