Climate Change Vulnerability & Adaptation for Focal Resources of the Sierra Nevada

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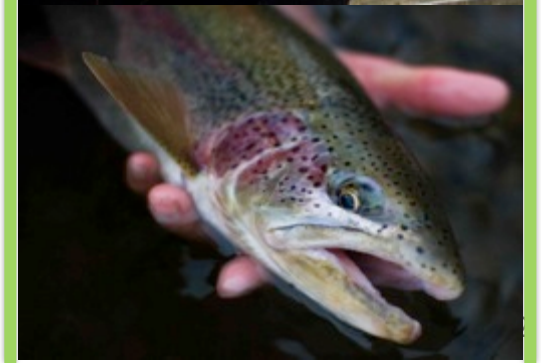
EcoAdapt™
Meeting the challenges of climate change

EcoAdapt

1. **State of Adaptation Program**
   finding out how people are fishing
2. **Climate Adaptation Knowledge Exchange**
   (CAKE; www.cakex.org)
   connecting fishermen
3. **Awareness to Action**
   teaching others to fish
4. **Adaptation Consultation**
   fishing for you

EcoAdapt™
Meeting the challenges of climate change

Photos: J. Armstrong

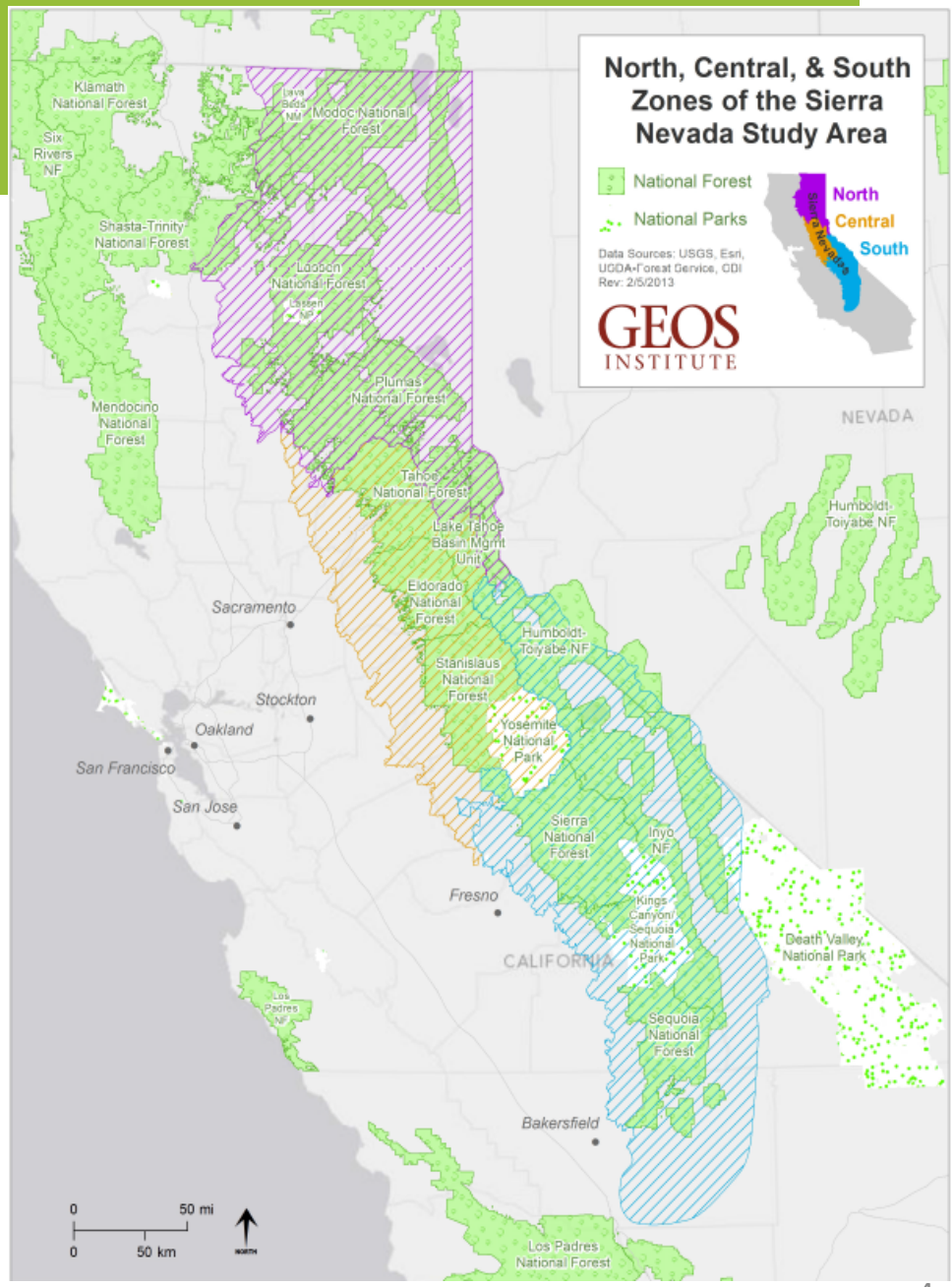


Outline

A. Project overview and process
B. Vulnerability assessment
C. Adaptation planning
D. Climate-informed mapping
E. Broader impacts and application

Project Overview

- **Audience:** land managers
- **Scope:** Sierra Nevada
- **Scale:** north, central, south ecoregions
- **Vulnerability of:**
  - Ecosystems
  - Species
  - Ecosystem services
- **Adaptation strategies for:**
  - Ecosystems
  - Species



Sierra Nevada Process

Pre-workshop	Vulnerability workshop	After workshop	Adaptation workshop
Step 1	Step 2	Step 3	Step 4
Identify Focal Resources; Gather Relevant Data and Info	Assess Components of Vulnerability	Synthesize Vulnerability Info	Apply Assessment Results in Adaptation Planning

Selecting Priority Resources

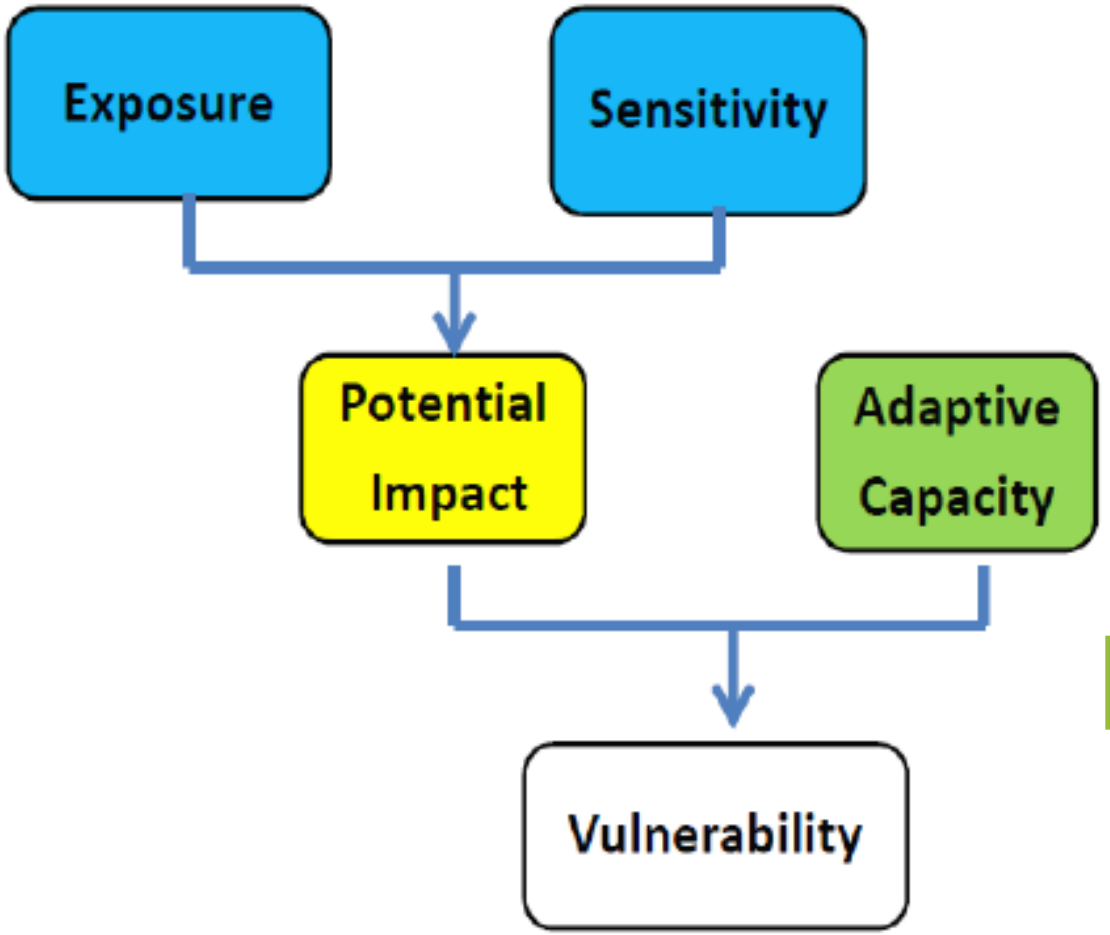
- Considered coarse versus fine filter approach in selecting a list
- Species (fine filter) were associated with ecosystems (coarse filter)
- Ultimately groups selected fine filter species given their expertise and whether the species was captured by coarse filter evaluation

Focal Resources: Final List

Coarse Filter (Ecosystem)	Fine Filter (Species)
Alpine/Subalpine	Bristlecone pine Whitebark pine Bighorn sheep
Yellow Pine/Mixed Conifer	Fisher
Wet Meadows	Willow flycatcher Aspen
Red Fir	Red fir Marten
Oak Woodlands	Blue oak Black oak
Chaparral	Wood rat Mountain quail
Sagebrush	Sage grouse
Aquatic	Sierra Nevada yellow-legged frog Mountain yellow-legged frog

Ecosystem Services
Fire
Carbon storage
Recreation
Timber/Forest products

Vulnerability Assessment

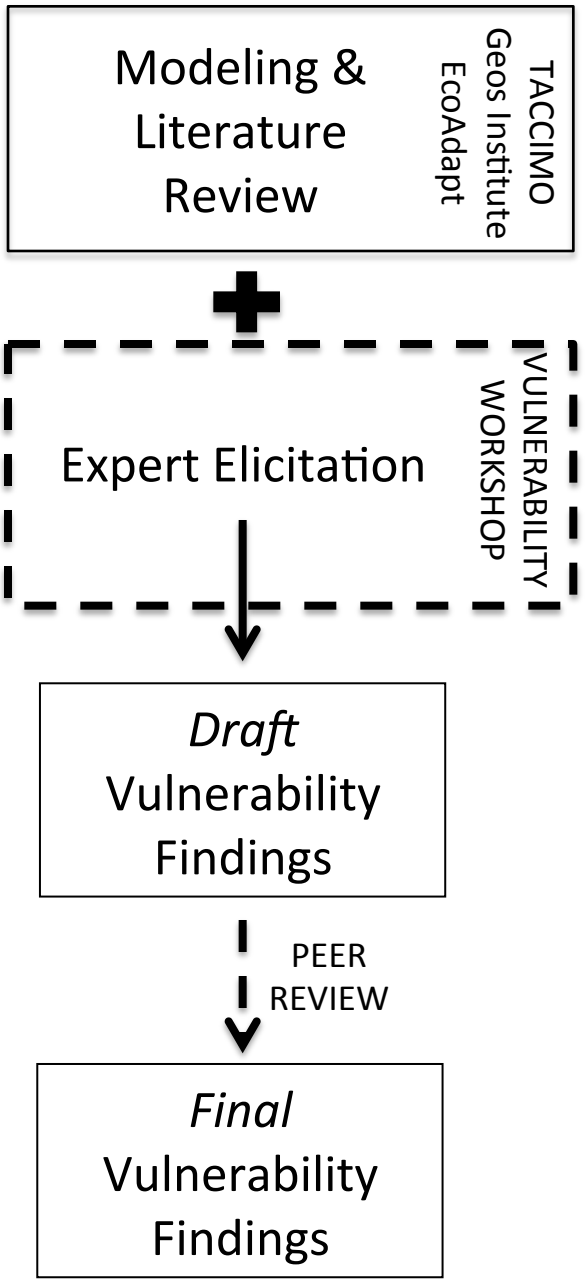


$$V = \frac{E*S}{AC}$$

Goal: Assess vulnerability of selected resources to climate and non-climate stressors using literature review, spatial climate info, and expert input

Vulnerability Assessment

- **Process Overview**
  1. Collect background info
  2. Conduct workshop
  3. Assemble & synthesize info
  4. Review & revise
- **Vulnerability findings**
  - Expert elicitation + Literature
  - Peer-reviewed by topic experts



Dashed lines indicate expert collaboration

What Happens at a Vulnerability Assessment Workshop?

Species Sensitivity Assessment

Please pay close attention to the gray boxes in each section. If time is limiting the project team can populate the non-gray fields although we may ask for participants to review answers later.

1. Taxonomy

Scientific Name: *Genus and species*	
Common Name: *All that apply*	
Realm *Put an X next to one or more:* Freshwater / Terrestrial	
Geography *For what geographic extent is this sensitivity information relevant? You may list its entire range in the Sierra Nevada, or regions, such as North, Central, South, or East.*	

2. Generalist/Specialist

Generalist: species that use multiple habitats, have multiple prey or forage species, or have multiple host plants (= less sensitive to climate change)
Specialist: species with very narrow habitat needs, single forage or prey species, or single host-plant species (= more sensitive)

Broadly, where does this species fall on the spectrum of generalist to specialist? *Please circle.*

Generalist | Neither/In-between | Specialist

Confidence in your assessment of the degree to which the species is a generalist or specialist? *Please circle.*

Low | Moderate | High

Please specify which factors make the species more of a specialist:
Please circle the relevant relationship(s) that apply. If none apply, do not circle any.

- Predator/prey relationship
- Foraging dependency
- Seed dispersal dependency
- Host plant dependency
- Phenology dependency
- Pollinator dependency
- Symbiont/Mutualist/Parasite
- Other dependencies (please describe)

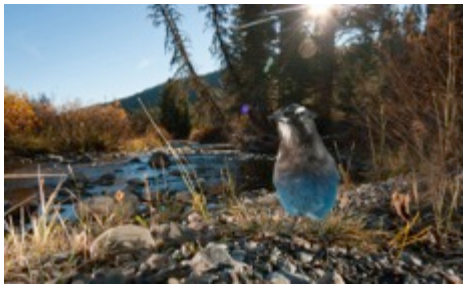
Comments and Citations: *Please further describe the relationships that make the species more of a specialist. List all relevant relationships and component species. For example, if the species being assessed is dependent on one host plant, please describe that relationship (e.g., food resource) and list the host plant.*

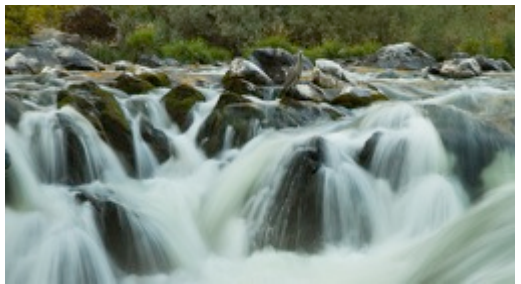
Worksheets for the Climate Adaptation Project for the Sierra Nevada; EcoAdapt (2013). Questions and guidance from *Scanning the Conservation Horizon* (2011) and the *Pacific Northwest Climate Change Vulnerability Assessment* (2010). 1

Vulnerability Assessment Findings: Wet Meadows

- **Sensitivities to climate and climate-driven changes (mod-high):**
  - Altered precipitation
  - Decreased snowpack
  - Altered hydrology
- **Sensitivities to non-climate stressors (high):**
  - Water diversions
  - Grazing
  - Recreational activities

Photos: J Armstrong

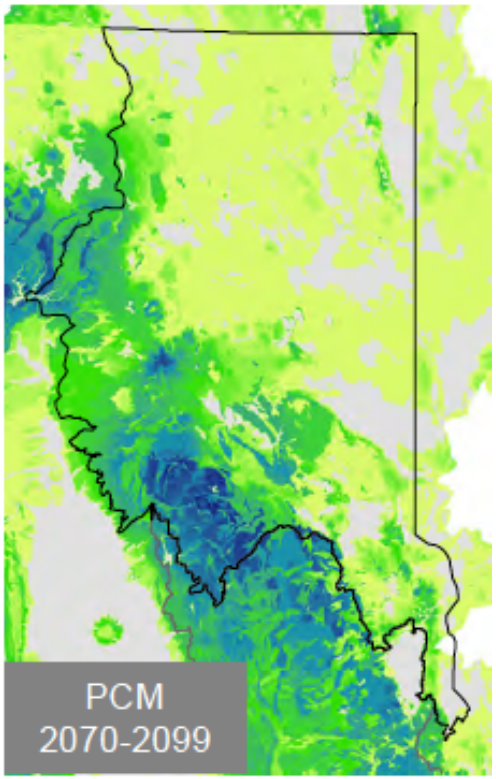


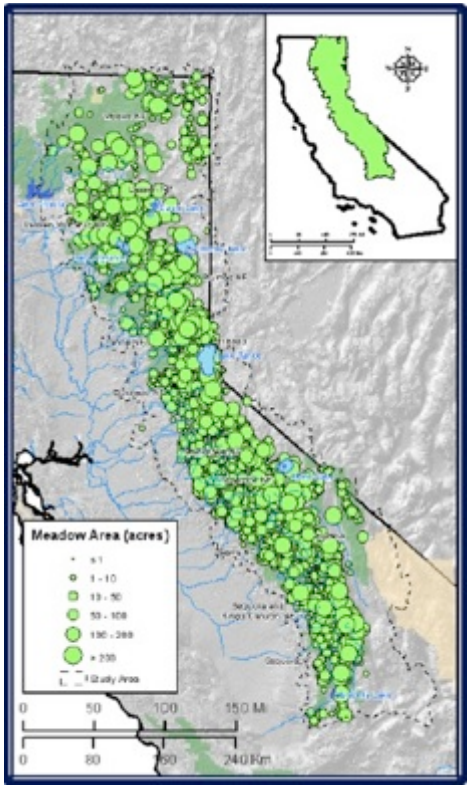


Vulnerability Assessment Findings: Wet Meadows

- **Future climate exposure:**
  - Changes in precipitation type, timing, and amount that affect hydrologic regimes and soil moisture

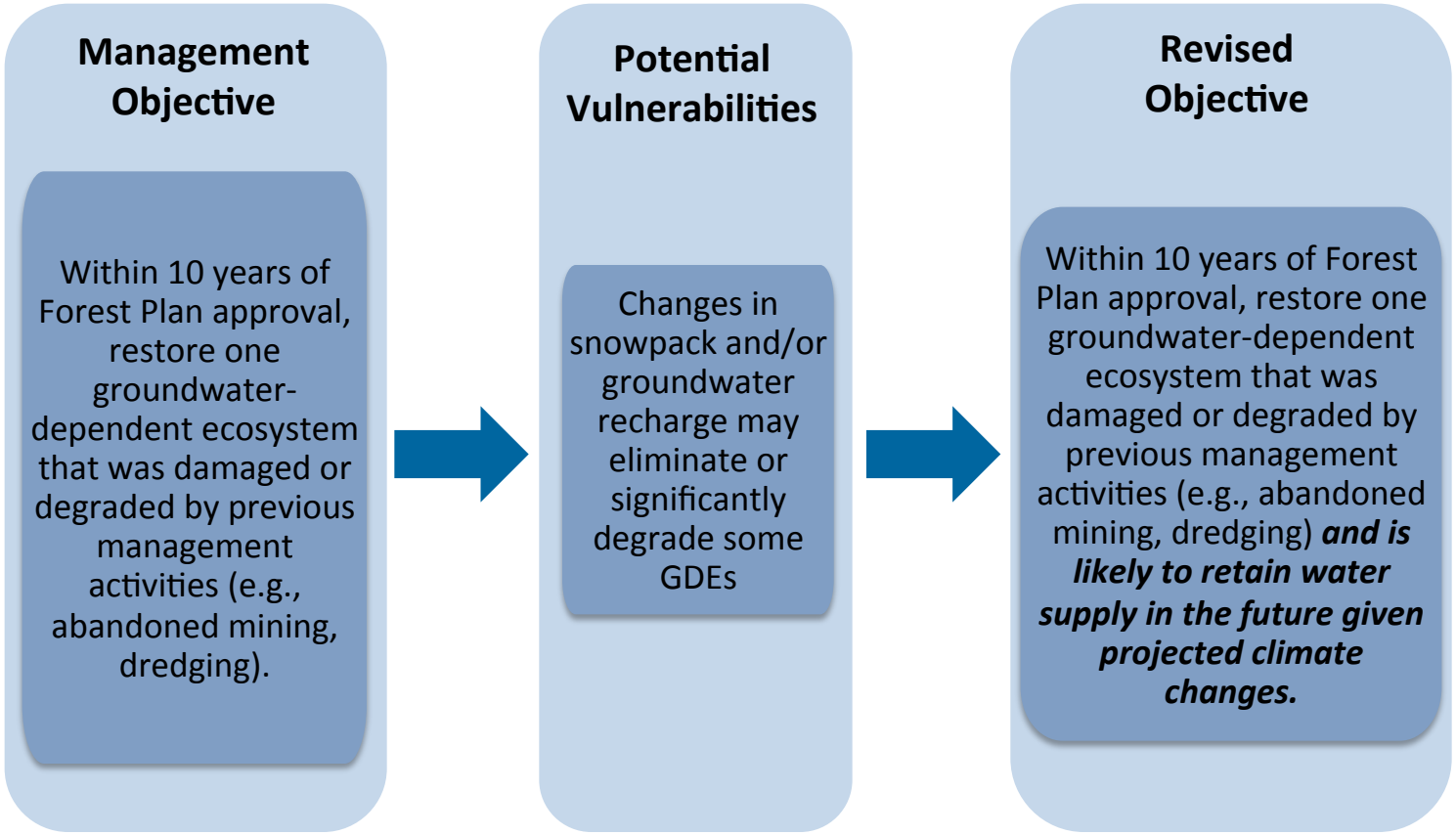
- **Adaptive capacity (mod-high):**
  (+) Component species diversity
  (-) Fragmented distribution
  (-) Currently degraded state



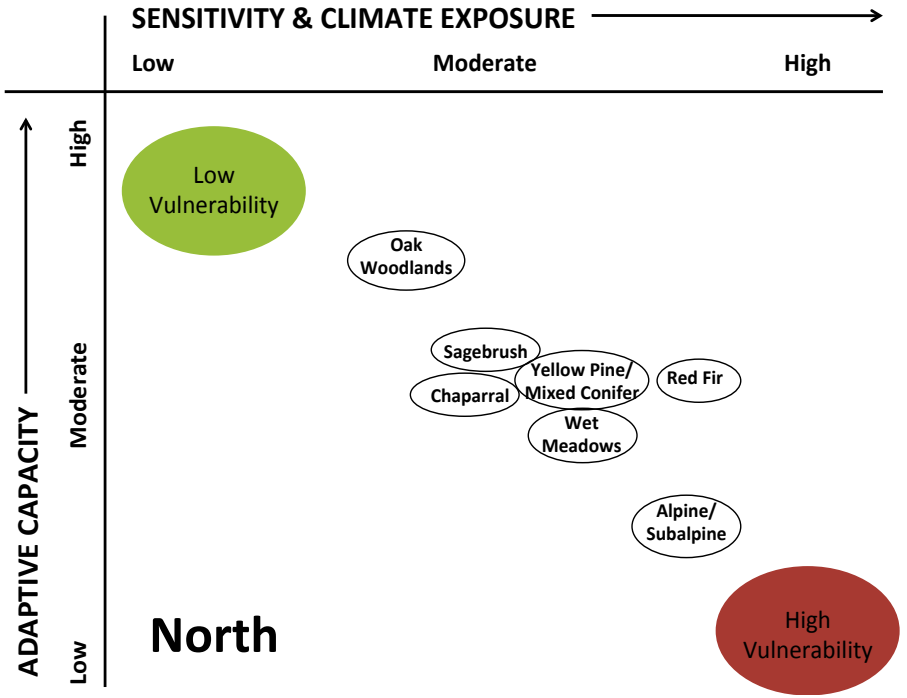


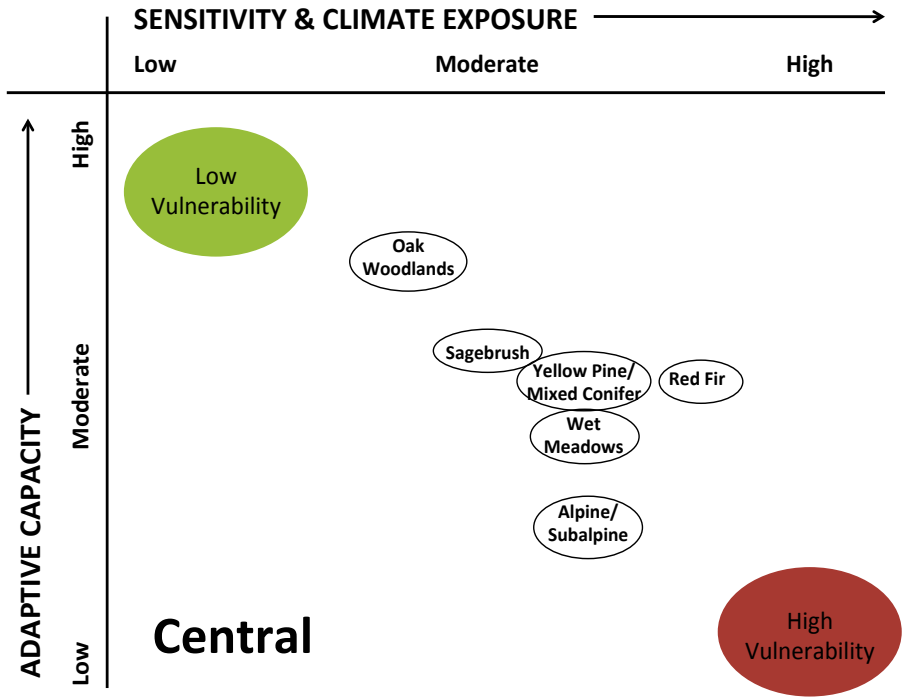
Applying Vulnerability Information in Management Decision-Making

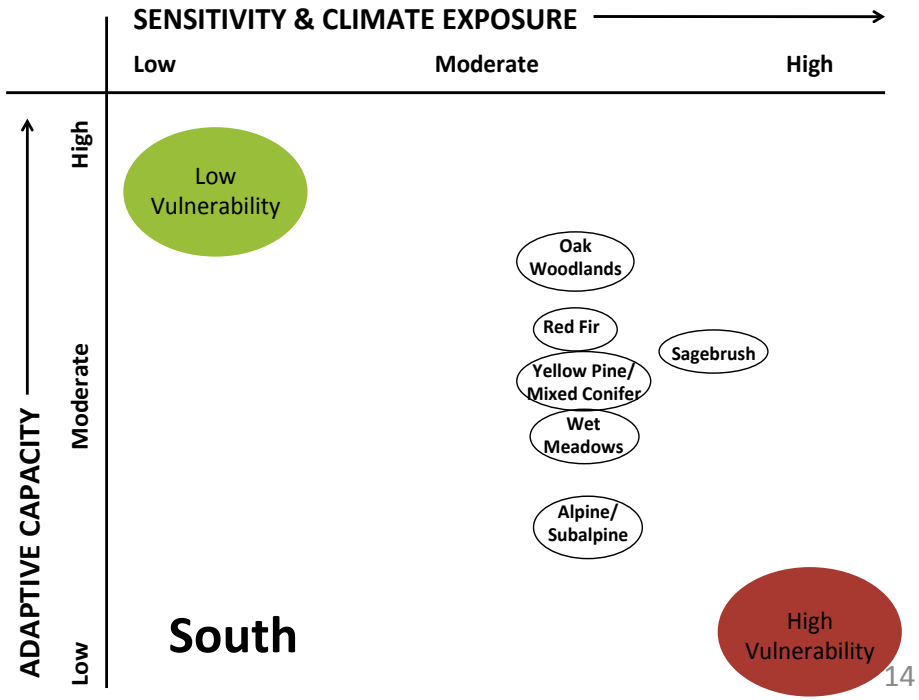
Example 1. Revising management objectives



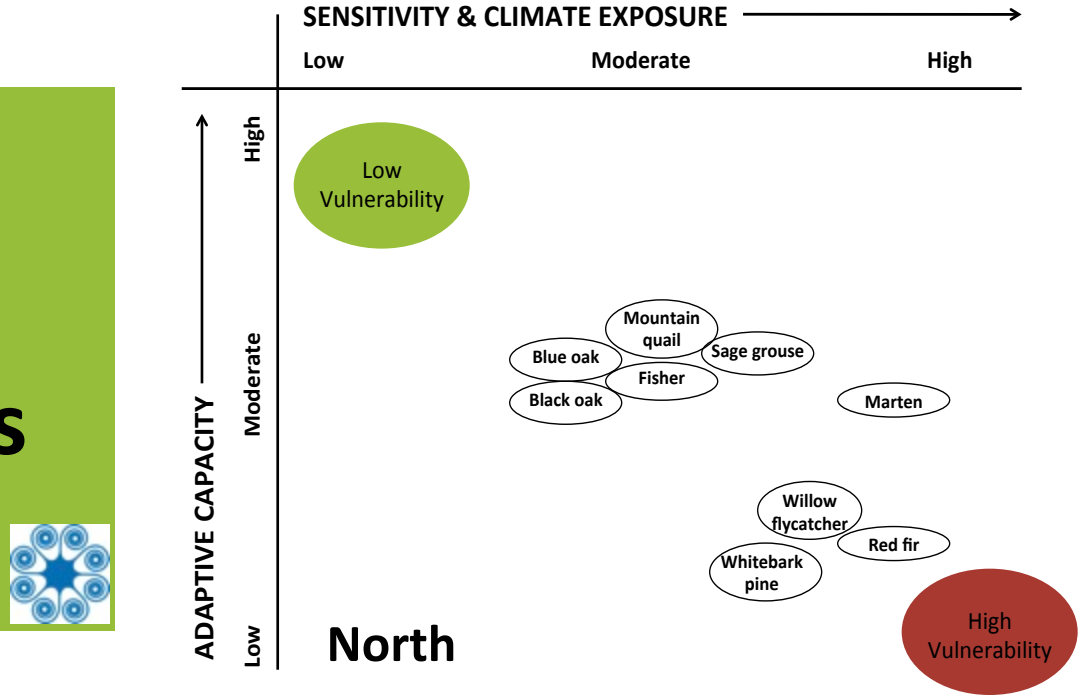
Vulnerability Assessment – Summarized Results for Ecosystems

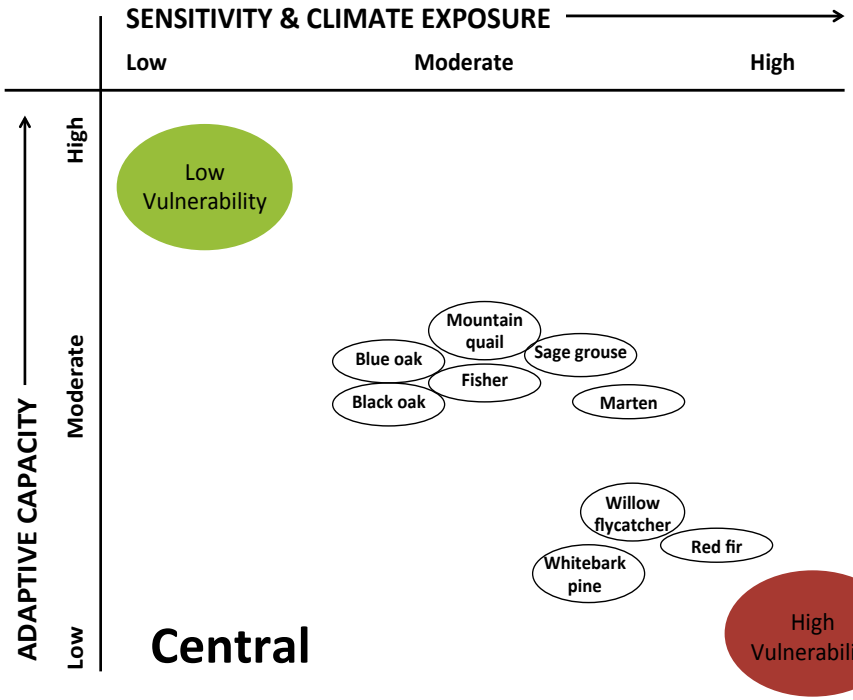


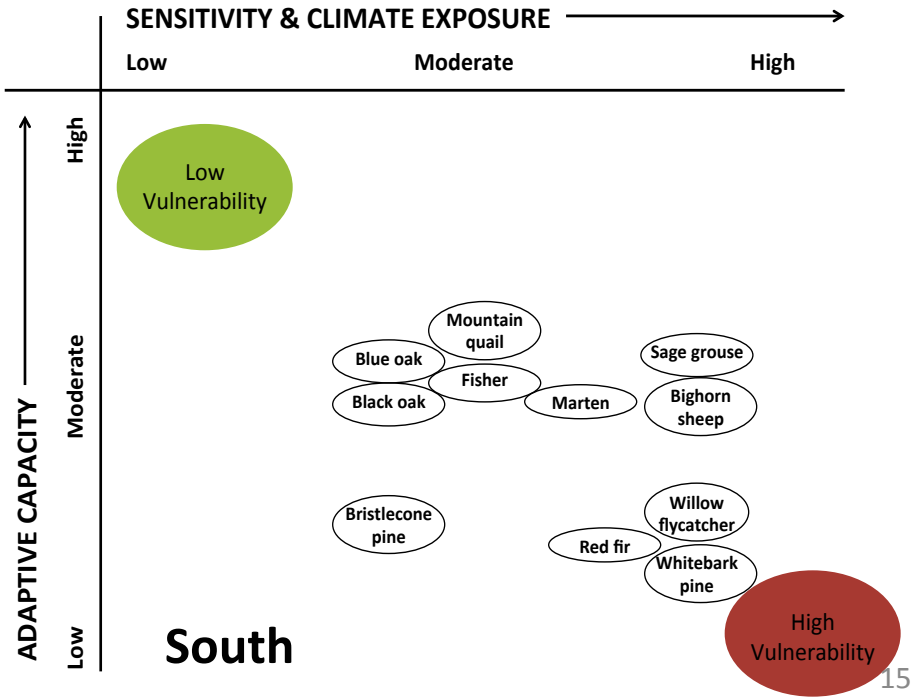




Vulnerability Assessment – Summarized Results for Species



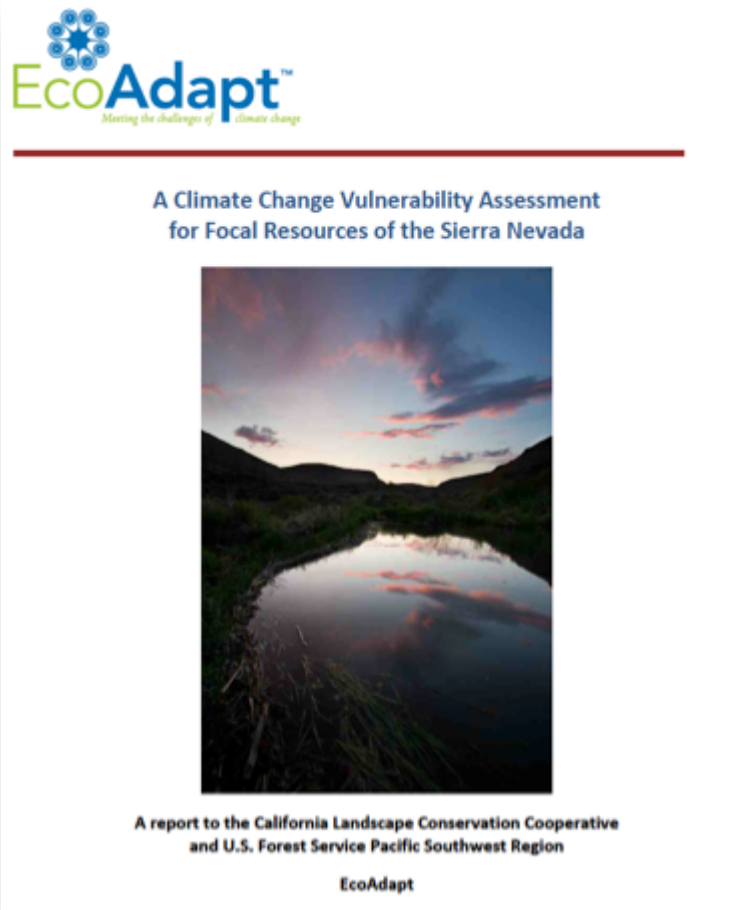




Vulnerability Assessment

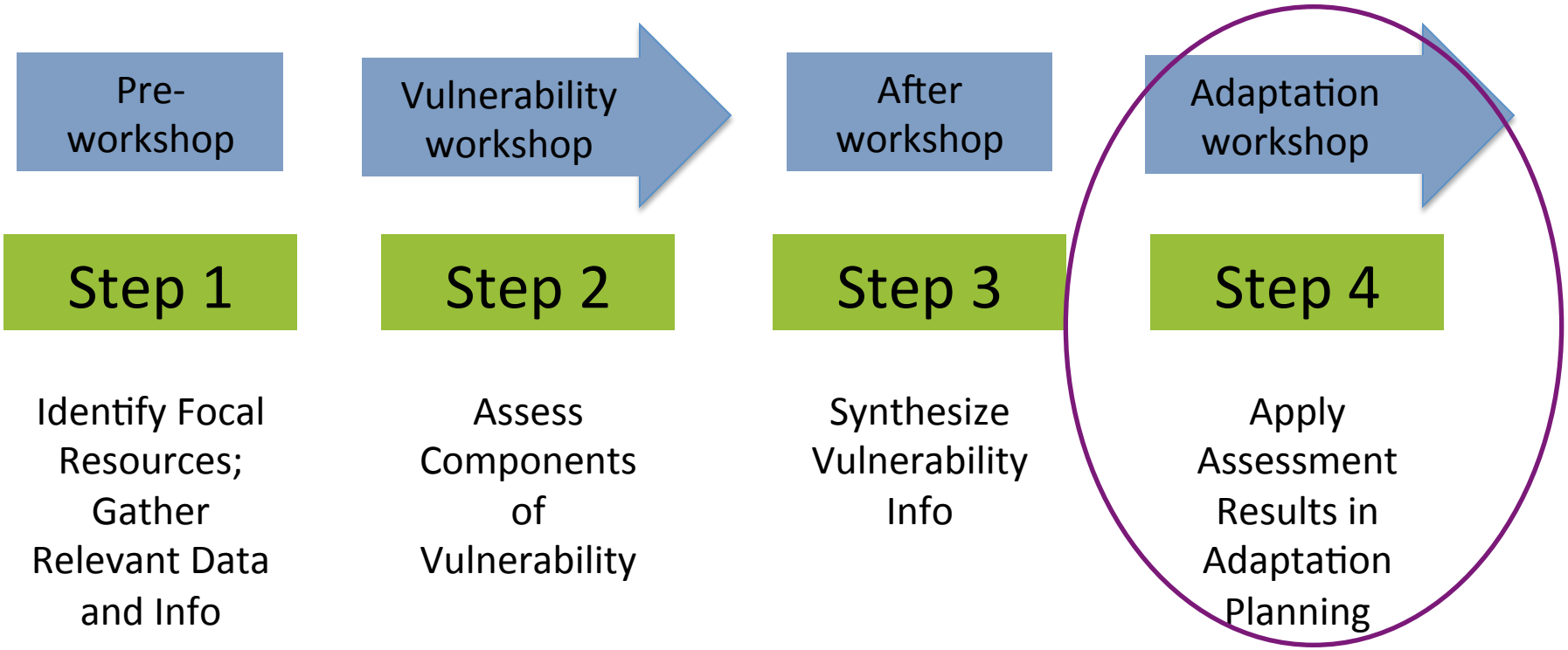
Products:

- Workshop support page
- Vulnerability assessment report
- Focal resource findings summarized as:
  - Full syntheses (~8-20 pgs)
  - Briefings (~3-5 pgs)



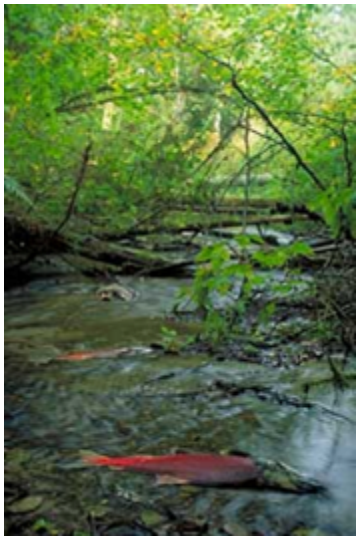
http://ecoadapt.org/programs/adaptation-consultations/calcc

Sierra Nevada Process



Applying Assessment Results in Adaptation Planning

- **Reduce Sensitivity**
  - *Example:* Actively plant drought-tolerant species in an area projected to get drier

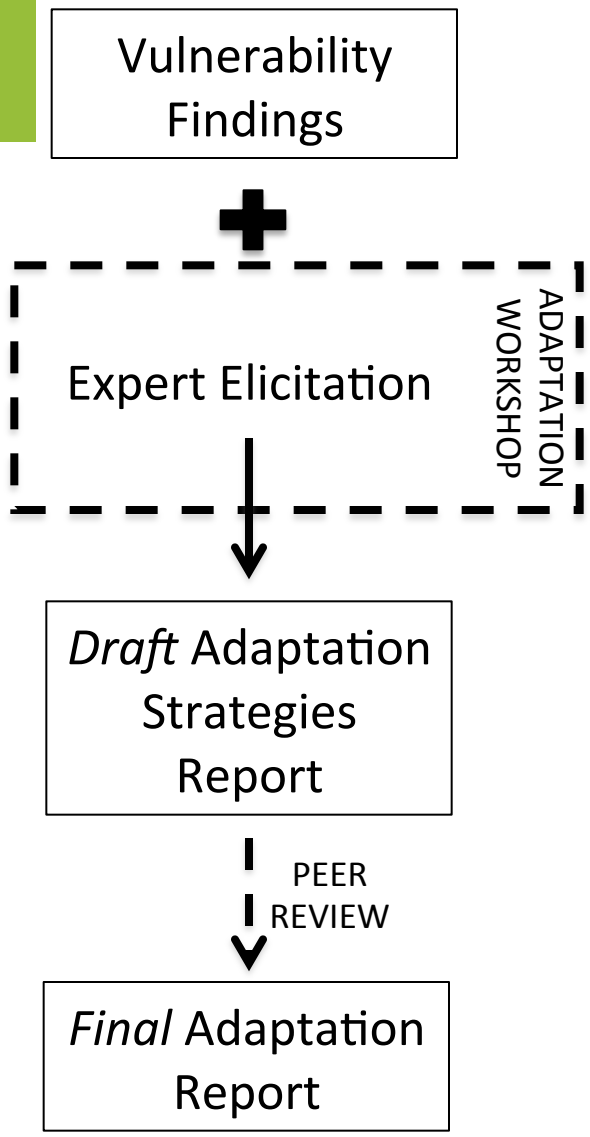


- **Reduce Exposure**
  - *Example:* Replant riparian vegetation to limit water temperature increases

- **Enhance Adaptive Capacity**
  - *Example:* Supporting connectivity across the landscape between different populations

Adaptation Strategies

- **Process**
  1. Assemble vulnerability info
  2. Conduct workshop
  3. Compile & synthesize info
  4. Review & revise
- **Adaptation strategies**
  - Expert elicitation + Literature
  - Draft report peer-reviewed



Dashed lines indicate stakeholder and/or expert collaboration

What Happens at an Adaptation Workshop?

Focal resources:

- Alpine/Subalpine
- Yellow Pine/Mixed Conifer
- Red Fir
- Wet Meadows and Fens
- Oak Woodlands
- Mountain yellow-legged frogs
- Sierra Nevada yellow-legged frogs
- Marten

Adaptation Strategies Example: Wet Meadows

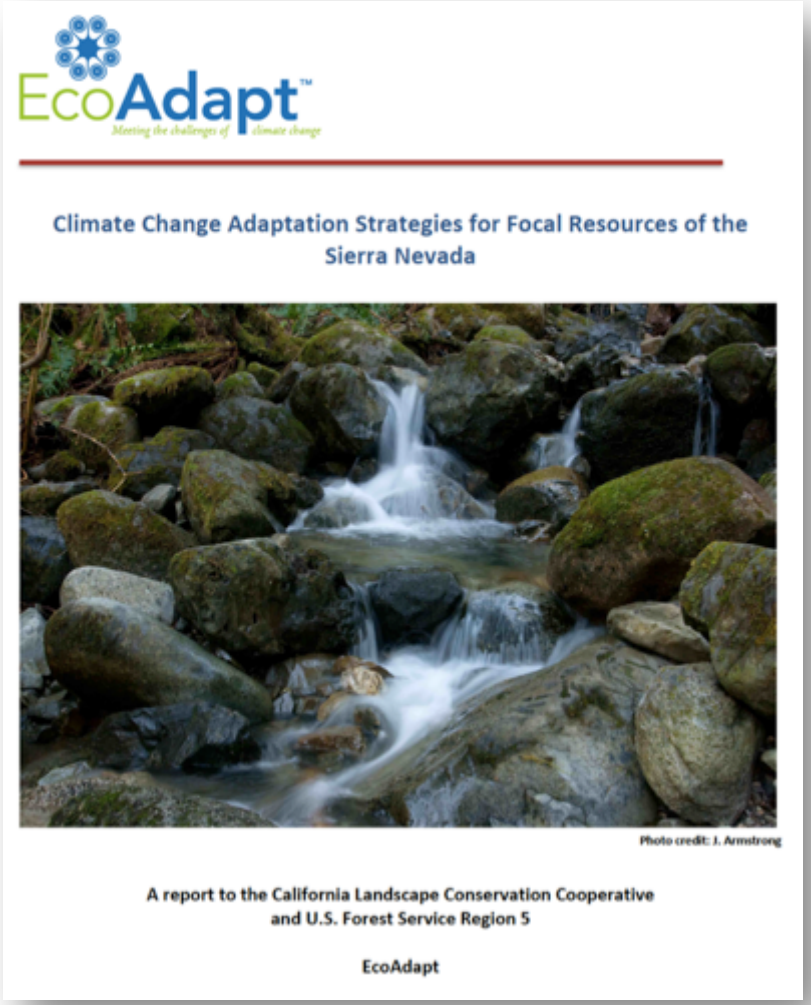
Adaptation approach	Strategic action	Rationale
Restore floodplain function to enhance ecosystem integrity and resilience under climate change, in particular, limiting impacts from projected changes including increased drought, reduced soil moisture, increased flooding, runoff and/or sedimentation, and decreased snowpack and groundwater recharge	• Plug and pond (redirects flow from incised channel to stable channel with broad floodplain) • Establish setbacks • Bank stabilization • Headcut stabilization (to stabilize upslope soils) • Restore soils and structure • Restore meanders • In-stream restoration	Knowledge, infrastructure and funding exist to continue to restore meadows in the next 10 years. However, the current pace and scale of restoration activities is insufficient. New approaches, additional funding, and greater stakeholder buy-in (e.g., Central Valley water users) are needed.
Reduce the negative impacts of grazing on achieving ecosystem objectives, as these impacts have the potential to amplify the effects of climate change	Grazing exclosures to minimize synergistic effects of grazing and climate impacts (e.g., decreased soil moisture, precipitation changes) on vegetation recruitment and growth as well as floodplain structure and soils	Cheap and beneficial.
Reduce negative impacts of recreation, roads, and trails to help wet meadows better cope with the effects of climate change	• Assess and consider removing roads in sensitive meadow areas in light of projected climate impacts • Enhance route designation plans in light of projected climate impacts	Need to change standards and consider changing amount of roads around meadows and timing of use.

Adaptation Strategies

Products:

- Workshop support page
- Final report

http://ecoadapt.org/programs/adaptation-consultations/calcc



Applying Adaptation Strategies in Management Decision-Making

Example 2. Alternative management strategies

Management Strategies

To maintain water quality, and to minimize the sediment that is generated and delivered to watercourses from active livestock grazing allotments, the grazing activity should:

- Locate new livestock handling and/or management facilities out of Resource Conservation Areas (RCAs);
- Locate salting efforts outside of RCAs; and
- Harden or relocate trailing stream crossings or approaches.

Alternative Management Strategies

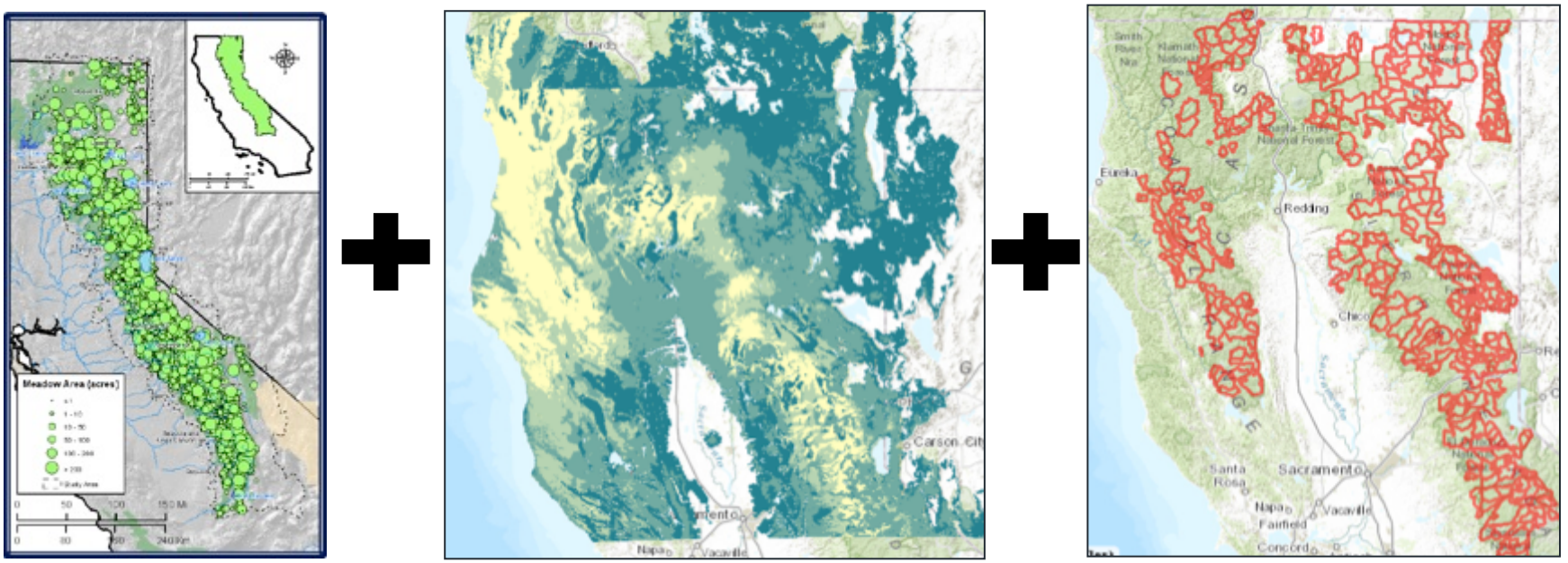
To maintain water quality, and to minimize the sediment that is generated and delivered to watercourses from active livestock grazing allotments, the grazing activity should:

- Locate new livestock handling and/or management facilities out of Resource Conservation Areas (RCAs), ***or areas projected to experience increased flood risk, landslides, or erosion due to climate change; and***
- ***Be restricted during seasons projected to experience increased precipitation (e.g., winter, spring).***

Climate-Informed Mapping

- Vulnerability assessment + stakeholder input

  → Used to create maps for a resource

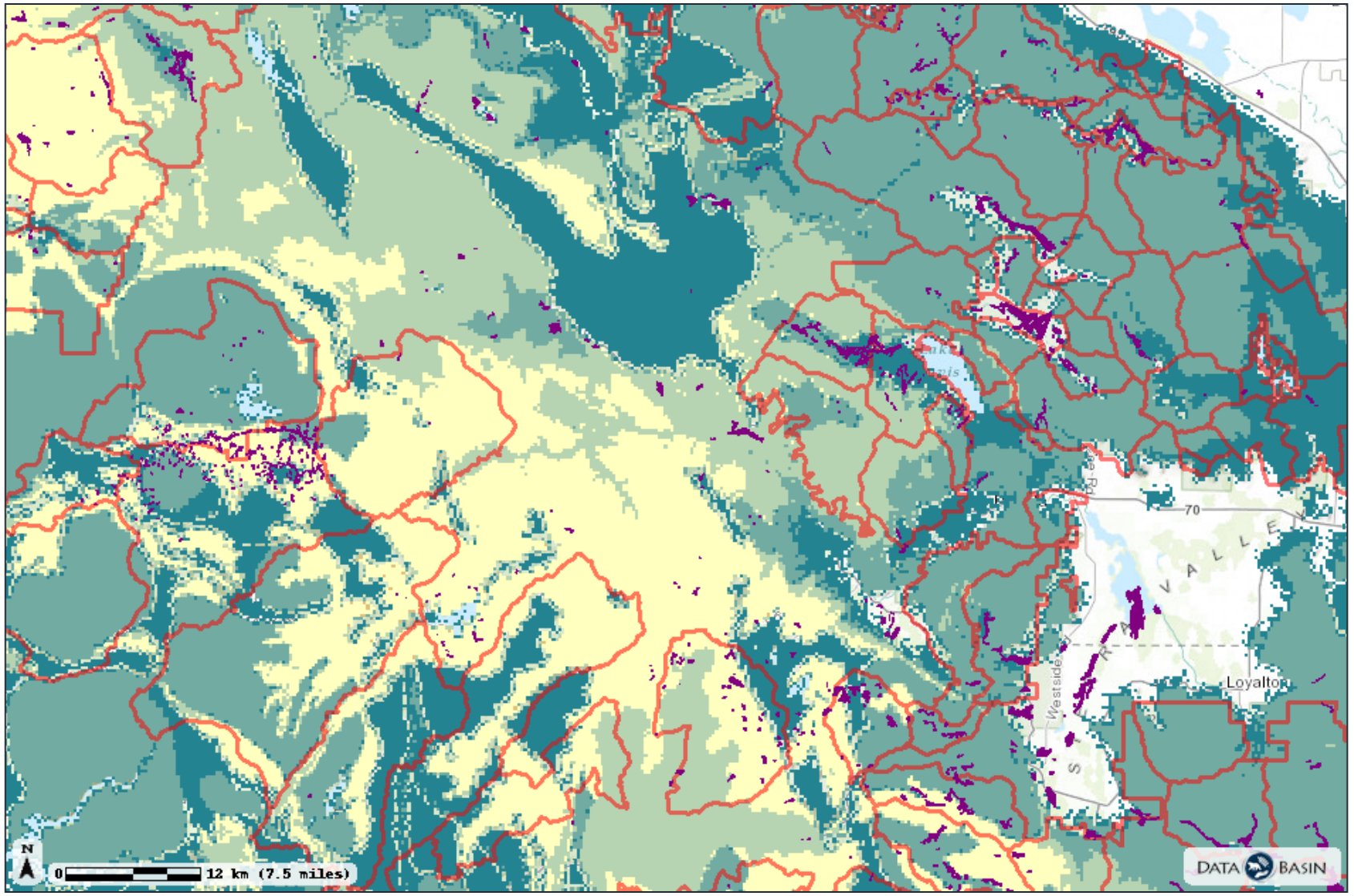


- Adaptation actions + maps

  → Used to identify what to implement, where

SIERRA NEVADA MEADOWS

RECHARGE + GRAZING



Livestock grazing allotments and resource use areas managed by the U.S. Forest Service in California, USA.

- Exclosure
- General Resource Area
- Range Allotment
- Wild horse / burro territory

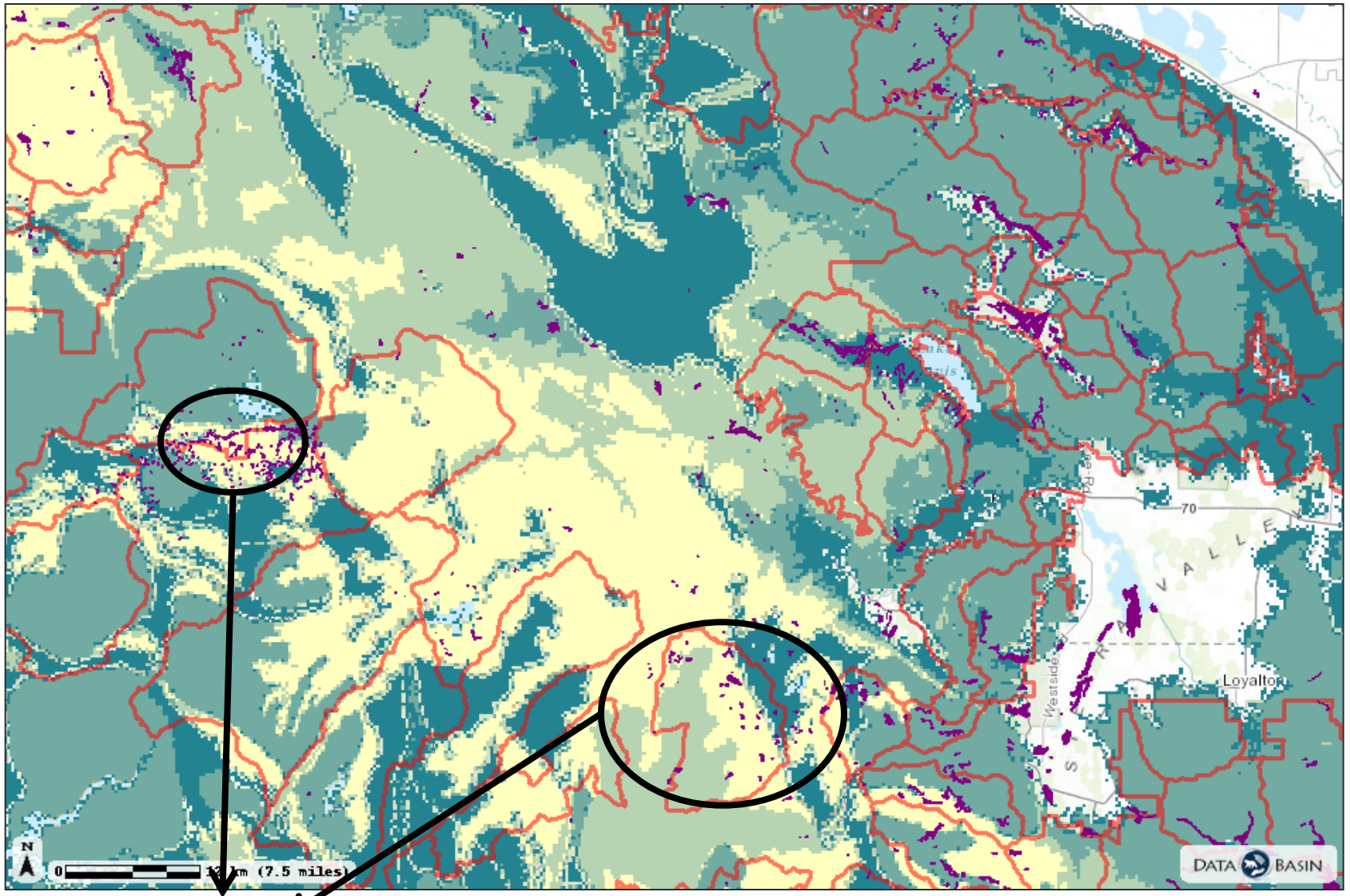
PCM A2 Recharge Change, Northern California, 2040-2069

- -3,499 to -2,500
- -2,499 to -1,500
- -1,499 to -500
- -499 to -250
- -249 to 0
- 1 - 250

- Sierra Nevada Meadows, California

SIERRA NEVADA MEADOWS

RECHARGE + GRAZING

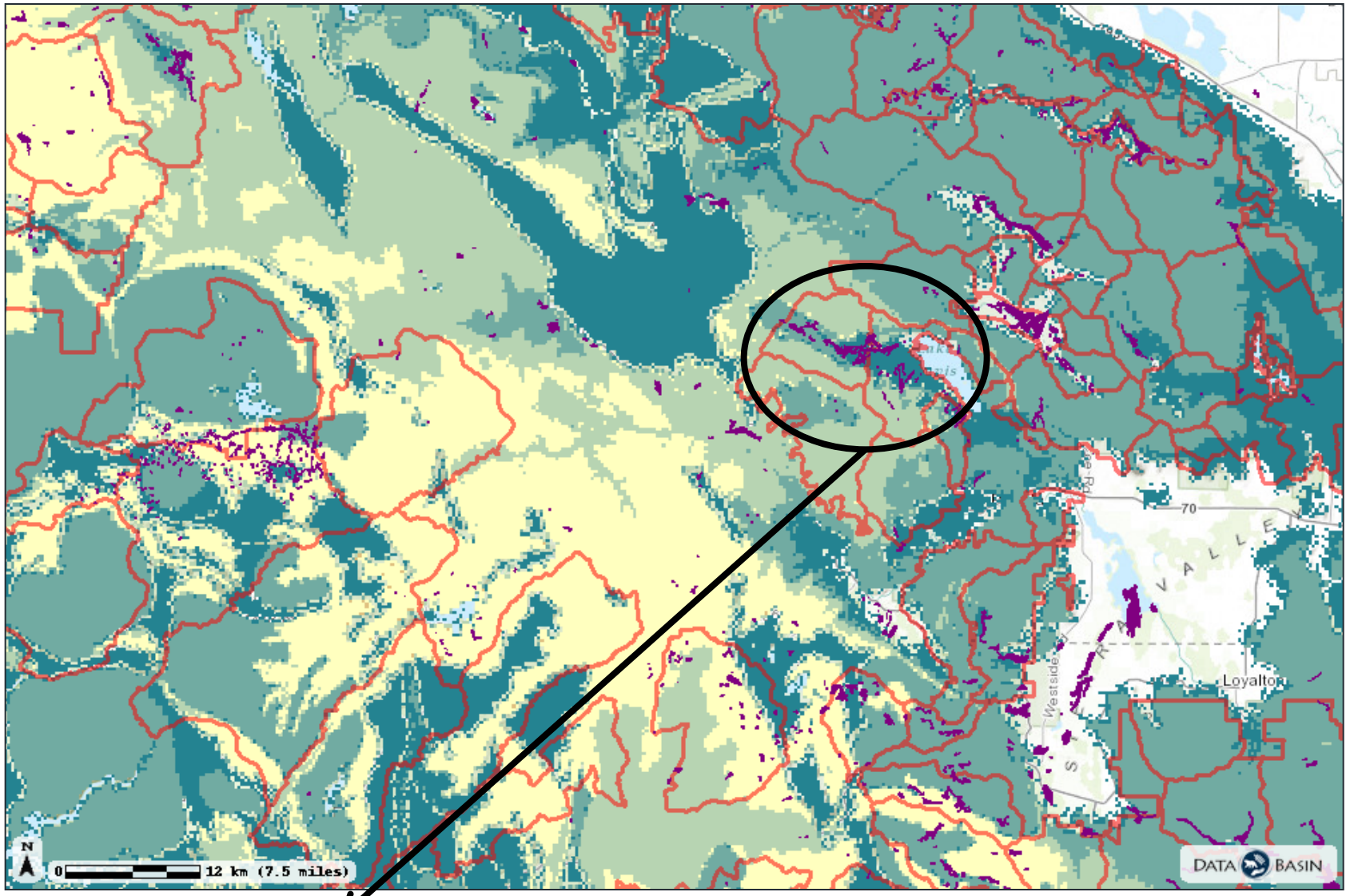


Adaptation Actions:

- Install grazing exclosures
- Establish seasonal restrictions on grazing
- Establish monitoring plans to determine if recharge is declining
- Targeted restoration activities, particularly if high biological value meadows

SIERRA NEVADA MEADOWS

RECHARGE + GRAZING

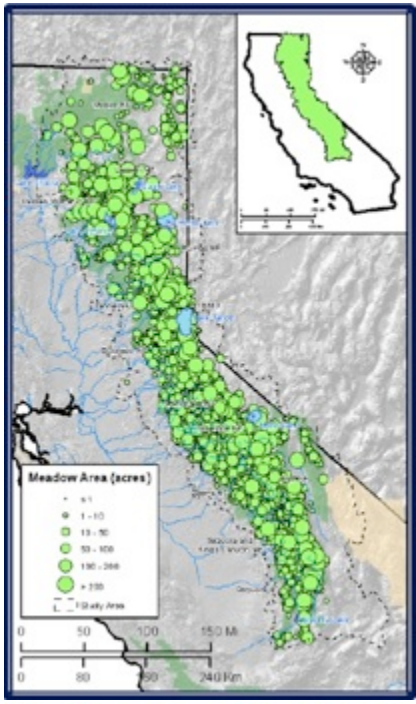


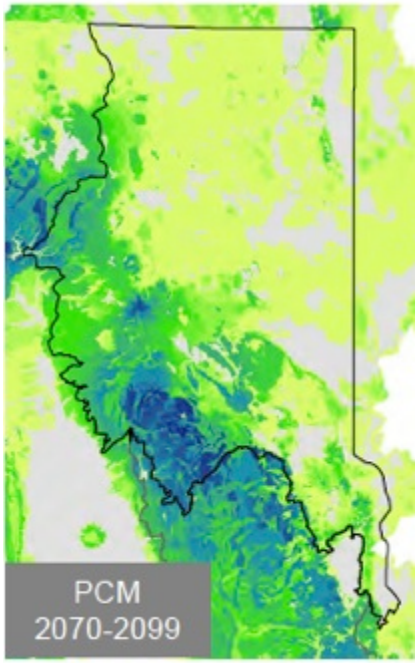
Adaptation Actions:

- Manage to reduce grazing impacts (maintain fencing, provide off-channel water and minerals
- Close allotments or restrict grazing intensity in areas with high biological value

Climate-Informed Maps

- Assembled on Data Basin
  - EcoAdapt-CA LCC: Climate Adaptation Project for the Sierra Nevada*
- Maps can help identify:
  - Where and why resources are vulnerable
  - Magnitude of change they are likely to experience
  - What adaptation strategies may be appropriate given impacts

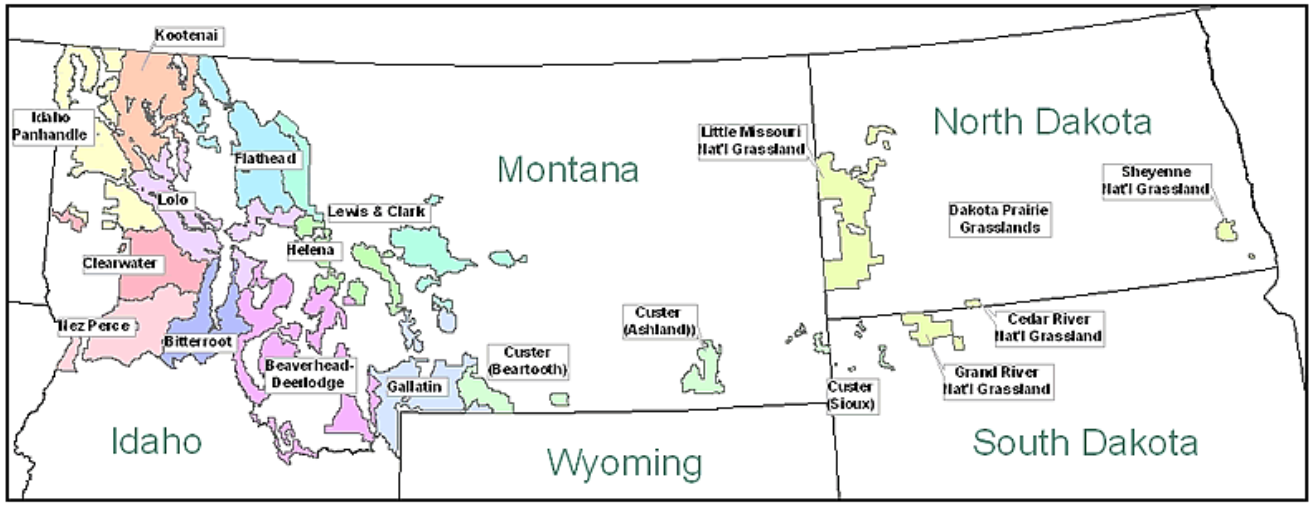




* http://databasin.org/groups/e6cfbd4218f54b32b695fad7af8cce31

Broader Impacts & Application

- USFS Climate Change Scorecard
- USFS Bioregional Assessment (Forest Plan Revision)
- Info for early adopter forests
- USFS Region 1 (Idaho/Montana/Dakotas), Tongass NF
- And others!



Acknowledgements

Funders:

- Yale Mapping Framework

Partners

Assessing Sensitivity

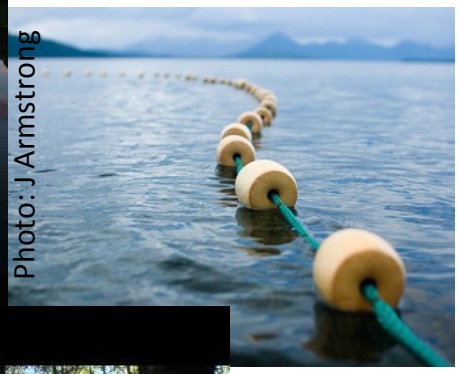
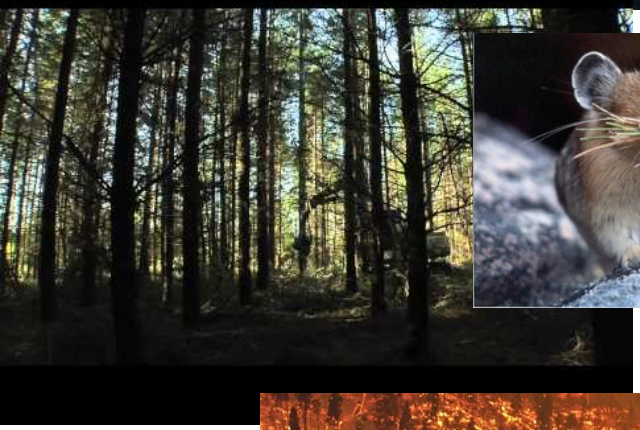


Photo: J Armstrong

Measure of whether and how a species or habitat is likely to be affected by a given change in climate.



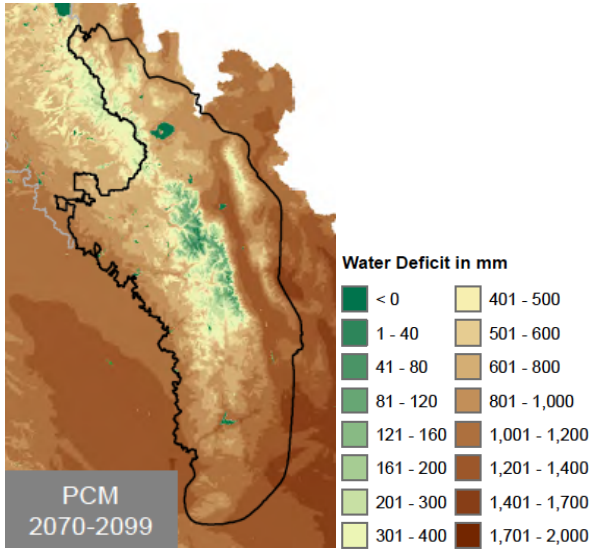
Factors affecting sensitivity of habitats or species:

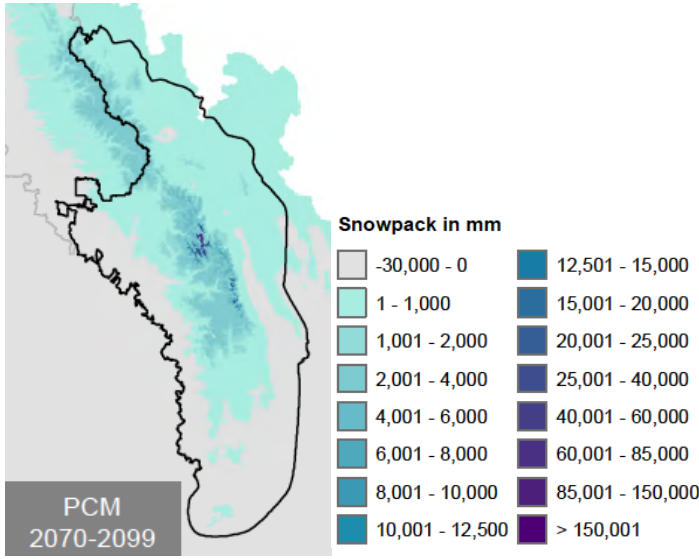
- Climate factors
- Disturbance regimes
- Non-climate stressors
- Dependencies
- Life history

Assessing Exposure

Measure of how much of a change in climate or other environmental factor a species or habitat is likely to experience.

Climate Variable	Projected Future Trends (2080)
Annual Temperature	+2.7 to +3.4˚C
Precipitation	↓ summer/fall ↑ winter
Snowpack	-64% to -87%
Climatic Moisture Deficit	+19% to +44%
Wildfire – area burned	+35% to +169%





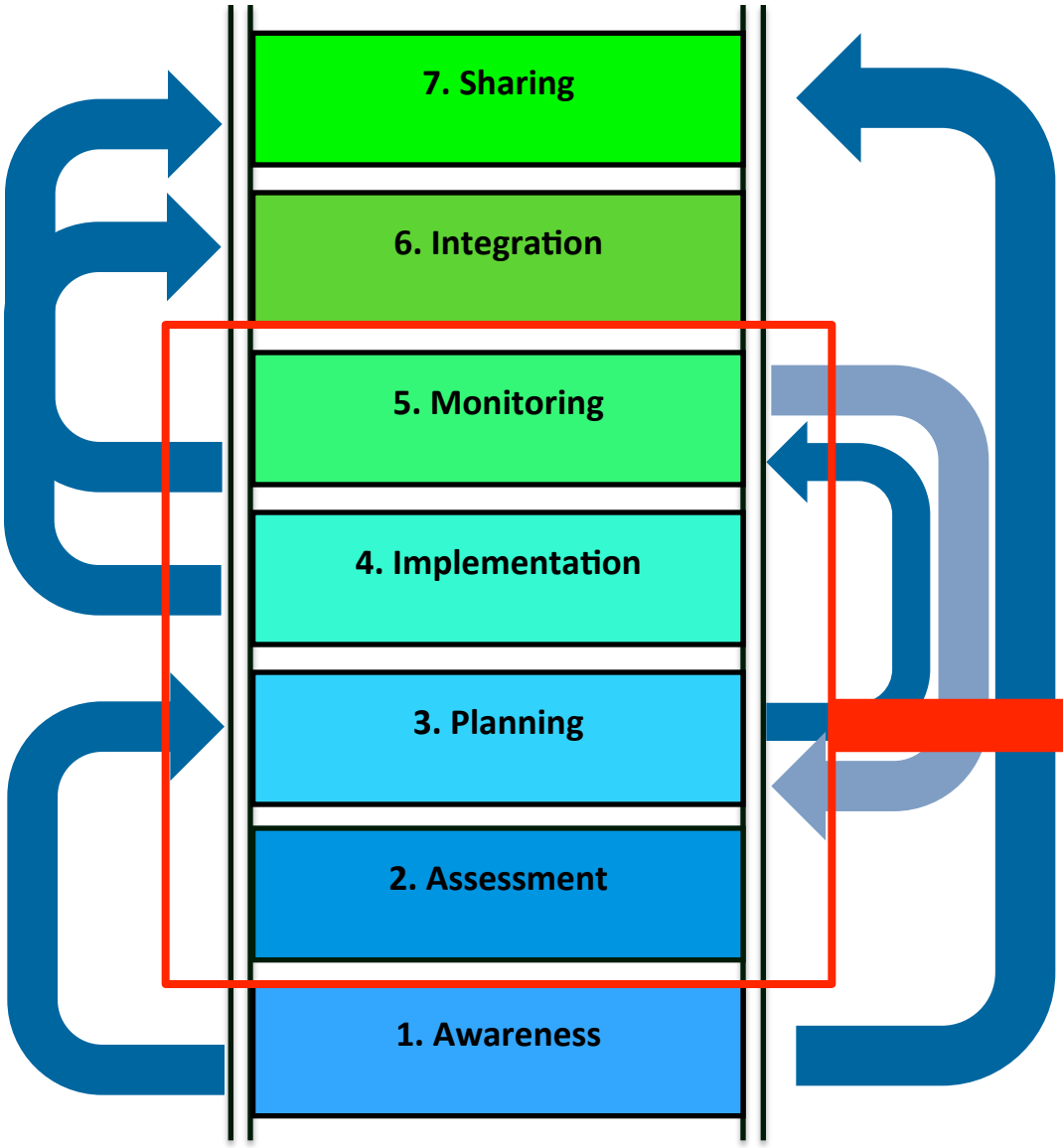
Assessing Adaptive Capacity

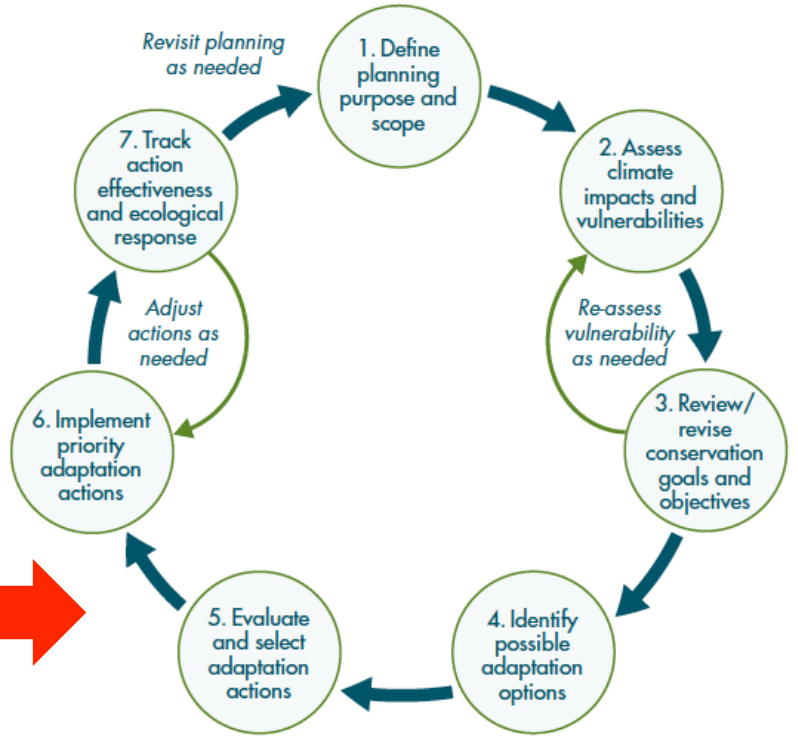
Ability to accommodate or cope with climate change impacts with minimal disruption.

Factors affecting adaptive capacity of habitats or species:

- Extent, status, dispersal ability
- Dispersal barriers/landscape permeability
- Life history or habitat diversity
- Management potential

Adaptation Ladder of Engagement





Climate-Smart Conservation Cycle
A General Framework for Adaptation Planning and Implementation