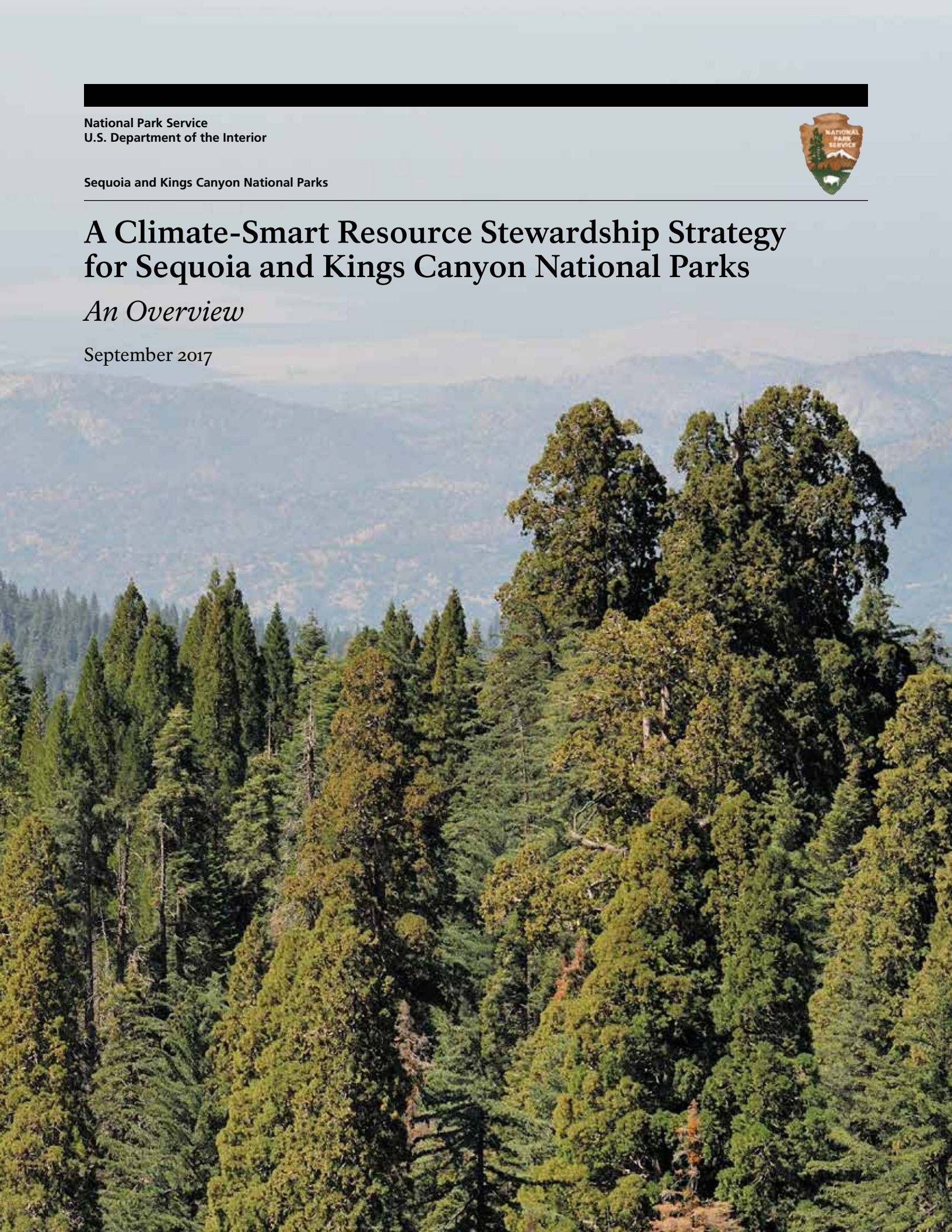
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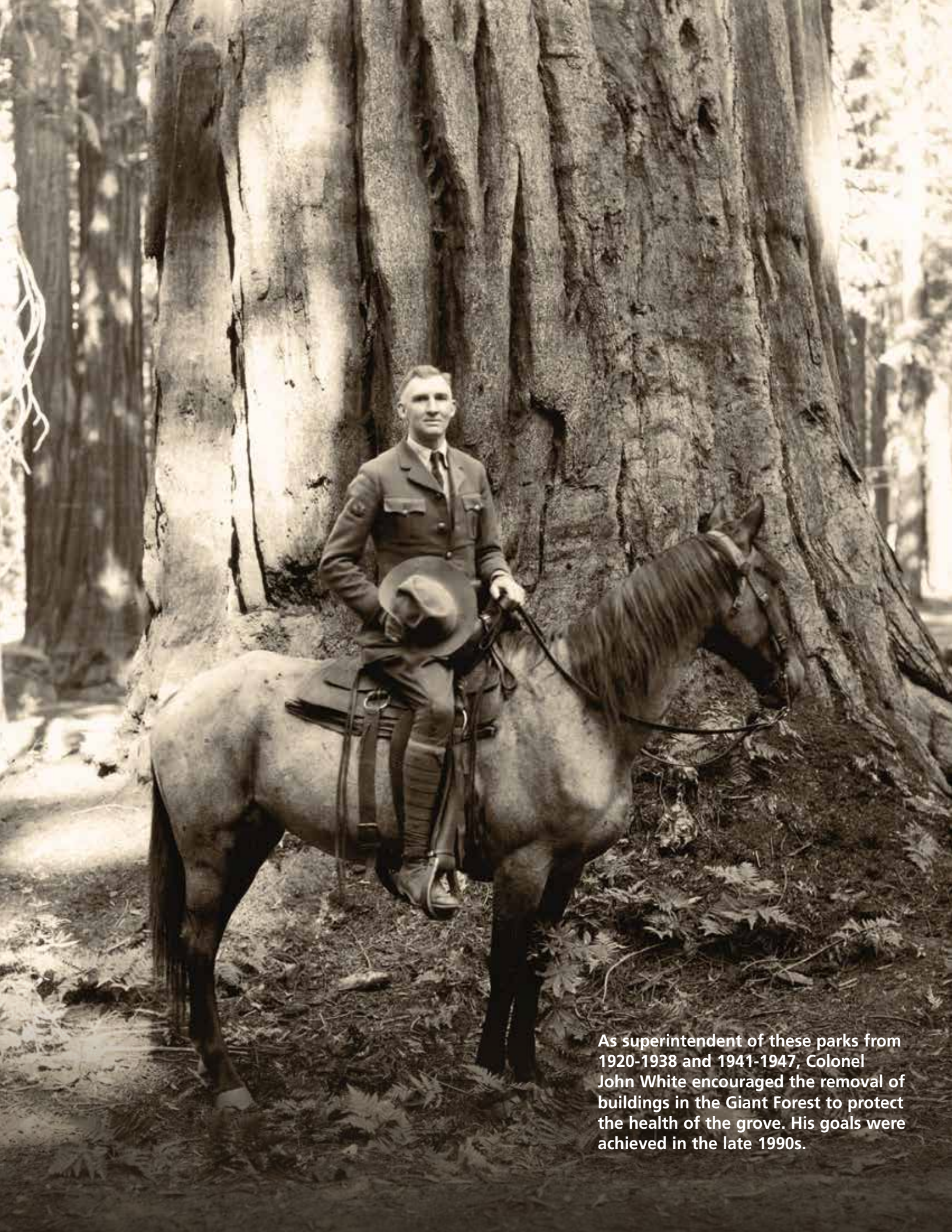
Sequoia and Kings Canyon National Parks

A Climate-Smart Resource Stewardship Strategy for Sequoia and Kings Canyon National Parks

An Overview

September 2017





As superintendent of these parks from 1920-1938 and 1941-1947, Colonel John White encouraged the removal of buildings in the Giant Forest to protect the health of the grove. His goals were achieved in the late 1990s.

INTRODUCTION

The landscapes of Sequoia and Kings Canyon National Parks have a long history of stewardship. American Indians used traditional burning practices here for thousands of years. Captain Charles Young, superintendent in 1903, worked to stop livestock grazing in the parks. From the 1920s into the 1940s, Superintendent John White resisted over-developing park facilities. In more recent decades, with scientific studies supporting their actions, park managers have worked to restore nature in some of the areas where past human activity impacted resources. They took out buildings that encroached on giant sequoia trees, reintroduced fire to park ecosystems, repaired eroded wetlands, and removed non-native trout in naturally fishless lakes. People have cared for these special places in many ways for a long time. But there is still much work to be done.

Like earlier stewards, today's managers face many challenges while caring for Sequoia and Kings Canyon National Parks. The nature of these challenges is different, however. Of particular concern is accelerated global climate change. Its effects already are appearing in and around the parks. This is not surprising, as the huge elevational range in these parks creates an amazing variety of localized conditions and habitats, each of which react to shifts in climate. Based on how rapidly the climate changes, we may soon see even more impacts on plants, animals, waterways, and other park resources.

Current and forecasted climactic changes compel us to prepare for an uncertain future. From the foothills to the alpine peaks of the Sierra Nevada, climate change may result in shifting ecosystems and new combinations of species.

Social conditions in and around national parks are changing as well. Demographics, economics, social expectations, and customs are shifting. Changing environmental and social conditions create challenges for national parks as they work to steward natural resources and provide unparalleled visitor experiences. Through this and other planning efforts, the National Park Service (NPS) is developing strategies in the face of these challenges.



ISAAC CHELLMAN

Overarching Goal and Principles that Guide Stewardship

The 2012 Revisiting Leopold report by the National Park System Advisory Board acknowledges these environmental and social uncertainties. It suggests that, "The overarching goal of NPS resource management should be to steward NPS resources for continuous change that is not yet fully understood." At Sequoia and Kings Canyon National Parks, we have embraced this goal and developed six principles to guide us:

1. **Conserve regional native biodiversity.** Focus on conserving the wide range of native species in the broader ecoregion, knowing that species may shift from their current locations.

2. **Conserve key structures and functions of ecosystems** even if they do not remain within their historic range of variability. Accommodating change at a slow pace may allow ecosystems to transition to new states without losing their significant structures and functions; rapid change can cause catastrophic simplification of ecosystems.

3. **Preserve the historical and cultural integrity of resources** while recognizing that climate change may not only alter their settings but also worsen deterioration of the resources themselves.

4. **Move audiences toward increased stewardship** by providing information and activities that people find transformative.

5. **Minimize potential negative impacts on natural and cultural resources from human infrastructure and activities** while considering the interactions of stressors (e.g., climate change and its influence on fires, flooding, erosion, vegetation, and wildlife).

6. **Cooperate across boundaries for ecoregional stewardship.** Apply the above principles in working on landscapes that cross jurisdictional lines.

The Purpose of a Resource Stewardship Strategy

To help guide management activities through the coming years, the park developed a Resource Stewardship Strategy (RSS). The RSS is a long-range strategic planning tool that is informed by current, accurate science. It will help us oversee the parks in a way that is more likely to be successful because it is climate smart – it takes climate change and its effects into account.

The purpose of the RSS is to:

- guide funding, planning, and resource-stewardship activities,
- track and evaluate progress in resource stewardship, and
- integrate new ways of thinking about resource stewardship, including management tools that take into account the realities of climate change.

The RSS is not a "plan" in that it does not prescribe any particular set of activities. Rather, it explores a wide range of potential activities that could be undertaken in the coming one to two decades to meet management goals. Prior to implementation of activities identified in the RSS, the proposed activities will be evaluated to determine the potential environmental impacts and appropriate level of analysis and documentation needed, in accordance with the National Environmental Policy Act, the National Historic Preservation Act, and other relevant laws and policies.



Sampling water quality at Spring Lake

NPS / Roxanne Kessler

PRIORITY RESOURCES AND THEIR STRESSORS

The RSS focuses on twelve priority resources in these two parks. These are natural and cultural resources or values that the NPS manages or monitors in order to:

- maintain park purpose and significance,
- address policy or legal mandates, or
- address scholarly and scientific research needs or findings.

Priority Resources of Sequoia and Kings Canyon National Parks



Cultural Resources

Archaeology, historic structures and landscapes, ethnography, museum collections and archives



Landscape integrity and biodiversity



Air Resources

Air quality, night skies, natural soundscapes



Water Resources



Cave and karst systems



Aquatic ecosystems and species



Wet meadows and fens



Foothill terrestrial ecosystems



Forests



Giant sequoias



Alpine terrestrial ecosystems



Terrestrial wildlife of concern

Factors that may significantly stress these resources include air pollution, unnatural fire regimes, climate change, invasive species, insects and disease, regional land use and habitat fragmentation, and human use. All of these stressors are likely to continue and may intensify.

Future Climate Conditions: Plausible Scenarios

So far, average temperatures in these parks have been rising, but we don't yet see a pattern that points to whether the local climate will be, on average, wetter or drier. This suggests three plausible scenarios that may result from a changing climate:

1) Much Warmer and Less Precipitation

2) Somewhat Warmer and Unchanged Amount of Precipitation

3) Much Warmer and More Precipitation

The RSS examines each priority resource to develop a hypothesis about how it would fare under each climate scenario. It summarizes each resource's current condition, concerns for its future, and its vulnerabilities to stressors. The RSS identifies climate-smart goals for each resource and presents a portfolio of management activities that would help maintain or improve its condition and lessen its vulnerability.

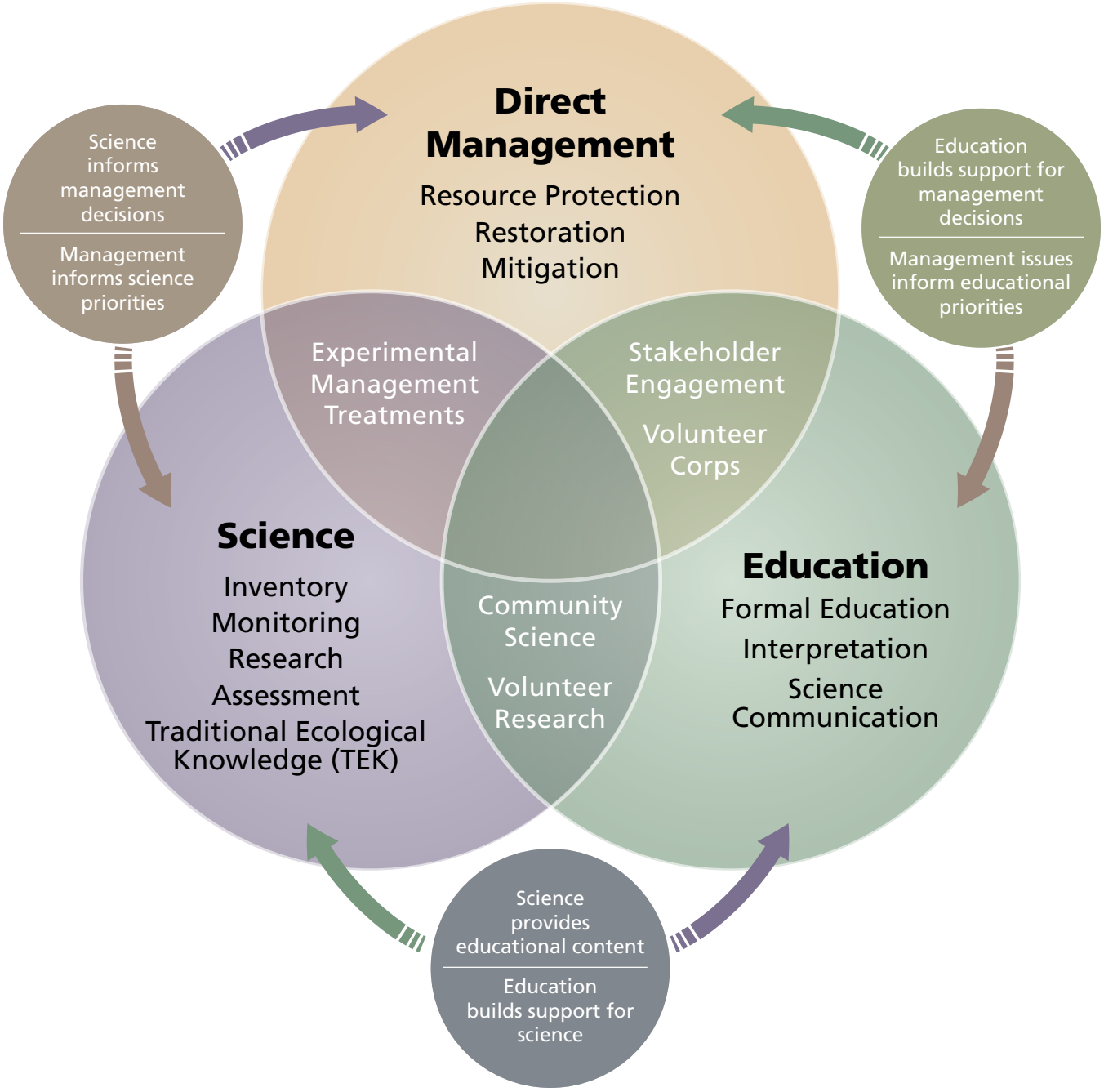


ALISON TAGGART-BARONE

The California drought (2012-2016) was very severe because of low precipitation combined with rising temperatures. Drought stressed trees, like these pines, were less able to resist bark beetles.

STEWARDSHIP STRATEGIES AND MANAGEMENT APPROACHES

Each of the many objectives and activities in the RSS has at its core at least one of three main strategies for stewarding resources through this changing time: direct management, science, and education. These strategies interconnect, overlap, and influence each other, providing a holistic and adaptable approach to resource stewardship.



Stewardship Strategies

Direct Management Strategy

This strategy consists of intervening directly in natural and cultural resources in order to achieve stewardship goals. Activities include preventing or reducing stressors; maintaining or restoring key structures or processes of ecosystems; maintaining or restoring cultural resources; mitigating impacts from stressors; and facilitating gradual (rather than sudden) ecosystem changes.

Science is critical to inform what interventions may have a high probability of success, where and when to implement them, whether expected results are achieved, and how to modify or improve interventions. Experimenting with management actions is integral to both the management and science strategies, as innovation is necessary in the face of unprecedented global change. These experimental activities incorporate the scientific method and include monitoring and evaluating outcomes. Information needed to implement direct management actions also helps set priorities for scientific efforts.



NPS / ISAAC CHELLMAN

A park biologist uses a net to remove non-native fish to restore habitat for native species in an alpine lake.

Science Strategy

This strategy employs a peer-reviewed, interactive process based on the scientific method, and it aligns with the NPS Pacific West Region Science Strategy to promote and apply science to inform resource management decision-making. The strategy consists of resource inventories, monitoring, research, and assessments. Inventories reveal resource baselines. Monitoring tracks the status and trends of resources and stressors. Research and assessments help us understand ecosystem dynamics and relationships, evaluate resource conditions, describe vulnerabilities, and provide forecasts of plausible future conditions. Traditional Ecological Knowledge (TEK)—the knowledge acquired by indigenous people over long periods—augments these studies.

In addition to informing management decisions, science guides park educators regarding what to communicate to ensure public understanding. Scientific studies also provide hands-on educational opportunities for staff and public. In turn, education builds scientific literacy and support for the scientific process. Engaging community members and volunteers in research and monitoring is part of both the science and the education strategies.



LINCOLN ELSE

The park collaborates with university scientists to study the health of giant sequoias during and after extreme drought conditions.

Education Strategy

This strategy facilitates opportunities to learn about resources in the parks and ecoregion as well as about the challenges faced in managing these resources. In order to understand park decision-making, people need information. They need insight into the potential effects of climate change and other stressors, what activities may be warranted to protect valued resources, and ways these resources may, ultimately, be altered by a changing climate. Information sharing encourages public involvement and discourse. It can inform law and policy decisions that affect resources, such as potential regulations, or voluntary actions to reduce external stressors.

The education strategy includes activities that provide information on resource issues and relevant science in ways and formats that are accessible to non-technical, culturally diverse audiences. Important to this strategy are activities that facilitate meaningful, interactive opportunities for transformative experiences, such as engaging local communities and youth in hands-on management and science opportunities. The education strategy also incorporates cross-disciplinary connections, communication, and training for park staff.

Volunteer stewardship is important to all three strategies as it provides learning experiences; increases our information base through community science; and improves the condition of park resources through direct management.



NPS / MATTHEW CONNELLY

Volunteers plant elderberry bushes and other native plants at a former Native American village site in the park.

Management Approaches

The RSS recommends a management approach for each priority resource, taking into account interconnections among resources. These management approaches describe how the major strategies (direct management, science, and education) are applied to each priority resource via interdisciplinary management objectives and activities that will help to reduce vulnerabilities and improve resource conditions. The final product of the RSS is a portfolio of activities that collectively help us to achieve management goals for each resource. For each resource, activities are rated as higher, medium, or lower priority.

There is a wide variety of possible activities to manage each resource in this portfolio, depending on what the future brings. Changes in environmental and social conditions, funding, and other priorities will determine which actions we may be able to accomplish. The prioritized-portfolio approach allows us to implement activities strategically and to take advantage of opportunities as funding or other factors allow. In general, more effort will go to implementing higher-priority activities. Such effort includes writing proposals to obtain necessary funding and other support. Depending on the nature of the activity, support could come from NPS, other federal sources, state agencies, universities, or private organizations. Additionally, some activities would require supplementary law and policy compliance review in order to be implemented.

Over time, as both socio-economic and environmental conditions change, priorities and opportunities will shift. To ensure that the RSS remains relevant, park staff will review it annually. In ten years, conditions may have changed drastically enough to require a major revision of the RSS.



TONY CAPRIO

Fire is an important tool for directly managing vegetation in these parks. Managers use both natural and prescribed fire to improve and maintain the health of sequoia groves.

CONCLUSION

Effects of environmental and social change are now apparent in the national parks. As a result, parks must adapt traditional management approaches to take the rapid pace of change—and its effects—into account. The Resource Stewardship Strategy is a tool for just that. It prioritizes resources for management, assesses their vulnerabilities to stressors that may be aggravated by climate change or other factors, and guides decisions on how to best care for these valued resources in the face of an uncertain future.



PHILIP GROSS



McClure Meadow
NPS Photo

AN RSS EXAMPLE:
Wet Meadows And Fens

The following pages provide a summary of information presented in the RSS for one of the priority resources (wet meadows and fens). The example includes:

1) a description of the priority resource,

2) an assessment of the priority resource, and

3) the management approach and list of activities for the priority resource.

Description of Wet Meadows and Fens

Wet meadows and fens extend over roughly 9,900 acres (1.5%) of Sequoia and Kings Canyon National Parks. Most of these 2,300 individual wetlands lie in the montane and subalpine zones between 5,000 and 9,000 feet (1,500-2,700 m) in elevation.

Wet meadows have surface or near-surface groundwater for most of the growing season. Fens have persistent surface or near-surface groundwater throughout the growing season, which promotes development of peat soil. Peat is often patchy within an area, so meadow/fen complexes are common. Wet meadows and fens support similar vegetation, but fens are usually characterized by a higher proportion of bryophytes (non-vascular plants such as Sphagnum moss) and wetland-dependent species.

These meadow habitats are extremely significant. Despite their limited extent, they support much of the Sierra Nevada's flora and fauna at local and regional scales. They sustain highly diverse plant communities. They provide essential habitat for a wide range of faunal species, including invertebrates, amphibians, birds, and mammals for at least part of their life cycles. The ecosystem services these wetlands provide include sediment storage, nutrient cycling, and delayed release of seasonal precipitation. Wet meadows and fens are critical to transferring nutrients between aquatic and terrestrial ecosystems.

For millennia, indigenous people living in the Sierra Nevada actively managed meadow systems and used associated plants and wildlife as sources of high-value food and material. In the historic era, meadows have provided forage for pack animals supporting both recreational and administrative trips in the park wilderness. Iconic mountain vistas afforded by these open habitats have also inspired conservation in the Sierra Nevada and beyond.

Assessment of Wet Meadows and Fens

Each priority resource has an assessment summary sheet with information about goals, conditions, vulnerability, and potential future impacts from climate change. These single-page assessments provide a summary of the information used by park staff as they identified, described, and prioritized management actions for each priority resource. More detailed information on each priority resource's assessment is available in the full RSS report and appendices.

The next section provides an example of how one of the priority resources, wet meadows and fens, is covered in the RSS.



NPS / LINDA MUTCH

As part of a program to monitor wet meadows and fens, National Park Service biologists examine a soil profile to determine wetland type.



Upper Halstead Meadow after restoration work to fill in and revegetate an erosion gully.
Photo by Jennifer Motley

Management Goals

These goals are long-term aspirations for the condition of the parks' priority resources. The goals embrace the overarching goal for resource stewardship, SEKI's guiding principles, and take into consideration resource vulnerabilities and what is feasible given plausible future scenarios. These goals were developed by reconsidering existing goals in light of the plausible futures.

Current Condition

A set of standardized symbols describes the status and trend over time (if known) of the priority resource along with a rating of confidence. Condition is based on a suite of indicators measured to track condition of the resource and success at achieving the management goals. Condition ratings were based on existing data or reports. If documented evidence was lacking, we indicated "unknown condition."

Symbols used to describe conditions for priority resources can be interpreted using the chart below.

Status	Trend	Confidence
Significant concern	Condition is improving	High
Moderate concern	Condition is unchanging	Medium
Good condition	Condition is deteriorating	Low

For example, in the Wet Meadows and Fens summary to the right, the first three symbols show the following conditions:

Total wetland area is in good condition, with a high degree of confidence in this assessment.

Non-native plants are causing moderate concern, though confidence is low for this assessment.

Restoring wetlands altered by human actions is a significant concern, but the condition is improving.

Vulnerability

This section summarizes key vulnerabilities to a suite of stressors and rates them according to the color chart below.

Highest	High	Moderate	Slight

Vulnerability refers to the extent to which a habitat, species, ecosystem process, or other resource is susceptible to harm from climate change and other stressors. A vulnerability assessment evaluates what things are most vulnerable, why they are vulnerable, and what characteristics of the resource or its environment make it vulnerable.

Climate Change Scenarios

This section summarizes some of the potential climate change impacts for the priority resource through the year 2040. The three scenarios suggest a range of plausible futures, but other outcomes are possible.

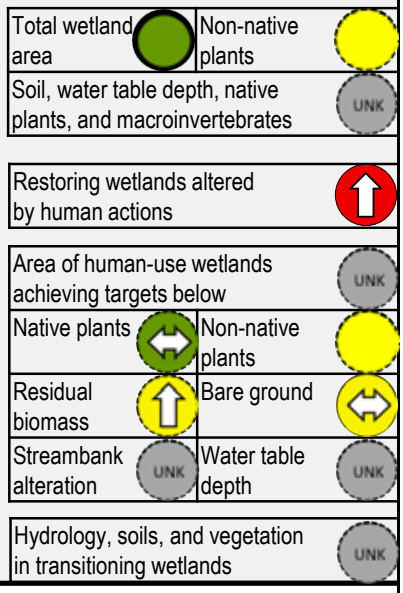
Wet Meadows and Fens

Management Goals

1. Maintain wetland characteristics of wet meadows and fens, as feasible, in the face of changing climatic conditions.
2. Restore wetland structure and function that have been altered by human actions, prioritizing areas where self-sustaining wetlands are likely to persist under changing climate.
3. Limit impacts from visitor and administrative activities to levels that don't degrade wetland structure or function over the long-term by themselves or in combination with climate change or other stressors.
4. Wet meadows and fens are managed to minimize disruption of critical ecological functions during transition to different ecosystem types where self-sustaining wetlands are not likely to persist under changing climate.

Current Condition

- Wetland characteristics are in good overall condition based on current total area of wet meadows and fens in the parks. Abundance of non-native plants in wet meadows and fens is a moderate concern. Condition and trend of other indicators (soils, water table depth, native plants, and macroinvertebrates) are unknown, but a long-term monitoring program recently began to measure them.
- Restoring wetlands altered by human actions is a significant concern because there are areas known to be damaged (e.g., Cahoon Meadow), but restoration needs have not been systematically identified and mapped. Recent restoration has been successful (e.g., Halstead Meadow), however, so the trend is improving.
- Wetlands with visitor or administrative human use are in good condition for native plants, but are a moderate concern for non-native plants, residual plant biomass, and bare ground. Streambank alteration and water table depth are not measured (unknown condition), but few locations have known concerns. Monitoring is not adequate to estimate total area of human-use wetlands that achieve targets for these indicators.
- Transitioning wetlands condition is unknown. Wetlands likely to persist versus transition have not been identified. This type of monitoring has not begun.



Vulnerability

Key vulnerabilities: Loss of wetland area due to warming and drying of habitat - and interactions with other stressors, which may speed erosion (including gully formation), lowering of water table, and loss of wetland soils.

	Air Pollution	Warming/ Drying	Altered Fire Regime	More extreme weather	Loss of snowpack	Fragment-ation and land use	Increased visitation	Non-native plants	Non-native animals	Insects and disease	Multiple Stressor Interactions
Wet meadows and fens	Nutrient & contam-inant deposition	Shrinkage, total loss of wetland	Watershed effects, tree migration	Runoff, gully formation	Decreased summer water	Historic livestock grazing, pack stock use	Trampling, new roads and trails	Increased/ new invasion	Increased/ new invasion	Yosemite toad sensitive to chytrid fungus?	Drying X other stressors

Climate Change Scenarios: Potential Impacts thru 2040

Scenario 1: Much Warmer/Drier	Scenario 2: Warmer/Similar Precipitation	Scenario 3: Much Warmer/Wetter
Drier wetlands dry out more and shift to upland plant species with more bare ground. Obligate wetland plants decline. Erosion and gully-formation channelize flow and dry wetlands. Drying peat decomposes and causes organic soil loss. There is more invasion by non-native plants , more burrowing rodents, and more establishment of upland woody species into meadows. Large wetlands become smaller. Small wetlands disappear. Habitat for wetland dependent species declines. Fire frequency increases in wetlands.	Changes are similar to Scenario #1, but less in magnitude and extent. The most vulnerable wetlands are negatively affected (for example, 3-5%).	Wetlands already degraded with incised channels become further degraded with more extensive and deeper gully systems. Restoration of these degraded sites is more difficult. Growing season lengthens for wetland plants, productivity increases, and species composition shifts. Wetlands in good condition are more resistant to extreme rainfall events and gain biomass. At highest elevations, existing wetlands expand due to more snowpack and warmer temperatures.

Management Approach for Wet Meadows and Fens

Each priority resource also has a management approach that was guided by the assessment information. The management approach is the big-picture, integrated overview of the types of activities that the RSS recommends to achieve management goals for the resource. Following the management approach is a chart listing the management objectives and activities. Activities were rated as comparatively higher, intermediate, or lower priority within each priority resource.

Climate change and potential drying are key vulnerabilities for wet meadows and fens. Because responses to these threats are likely to vary dramatically by location, mapping these wetlands by vulnerability is a high priority.

Management objectives for specific wetlands may include managing for persistence, facilitating gradual ecological transitions, or taking a hands-off approach. The objective for individual wetlands will be determined by a combination of factors: assessment of its vulnerability, values, and current conditions (including human-caused degradation), plus the feasibility of taking certain actions. Therefore, it also is important to conduct values assessments and to inventory existing impacts in order to be able to prioritize meadows for restoration or other management actions.

Research is needed to test methods of adding or retaining moisture in wet meadows and fens as possible tools to reduce the effects of climate change. Monitoring these wetlands is critical to evaluate whether management goals are being achieved and if not, why. Targeted monitoring of meadows will continue, enabling the park to adapt its management of these resources as needed to respond to changes.

The impact of visitor and administrative activities is not a major stressor overall, but local impacts can be severe. Therefore, stewardship activities include monitoring conditions, limiting impacts, and restoring ecosystems that are currently open to visitor and administrative use or have been degraded historically.

Outreach to visitors and park staff helps to prevent meadow degradation and builds understanding of management decisions.



NPS / ATHENA DEMETRY

Replacing existing roadway with an elevated bridge (above) and filling in a gully caused by erosion restored the natural flow of water to Halstead Meadow. Water now flows slowly across the meadow's surface instead of rushing through the gully.

This table gives brief descriptions of high, medium, and lower priority stewardship activities for wet meadows and fens, along with the management objectives that each activity would help achieve.

Management Objectives	Activity #	Priority	Activities (Short Descriptions)
Assess resource vulnerability and value across the landscape and enable selection of appropriate management goals.	WM01	High	Map climate change vulnerability for wet meadows and fens.
	WM02	High	Map conservation value of meadows and fens.
	WM03	High	Identify goals for individual meadows based on their value and vulnerability.
Experiment with potential adaptation actions to reduce vulnerability.	WM04	Medium	Test methods to retain moisture in wet meadows and fens for climate change adaptation.
Protect native biodiversity by preventing and controlling non-native species.	WM05	High	Survey and control non-native plants in wet meadows and fens.
Limit or reduce the impacts of past and ongoing administrative and recreational use for improvement of resource conditions and long-term sustainability.	WM06	High	Monitor pack stock grazing locations and amount in wet meadows and fens.
	WM07	High	Monitor wet meadows and fens impacted by visitors or administrative activities as described in Wilderness Stewardship Plan.
	WM08	Low	Add hydrologic monitoring of wet meadows and fens impacted by visitors or administrative activities.
	WM09	High	Develop and periodically revise grazing guidelines and monitoring targets for wet meadows and fens impacted by visitors or administrative activities.
	WM10	Medium	Conduct outreach to stock users to reduce impacts.
	WM11	High	Complete a disturbed lands inventory and prioritization strategy for wet meadows and fens.
	WM12	High	Restore priority wet meadows and fens (design, implement, monitor, and evaluate).

Management Objectives	Activity #	Priority	Activities (Short Descriptions)
Facilitate gradual ecological transitions to allow desired ecosystem functions such as hydrologic regulation and native species habitat.	WM13	Low	Identify desirable alternative states and define targets in areas that will not persist as wet meadows and fens in a changing climate.
	WM14	Low	Implement guided transformation where self-sustaining wet meadows and fens are not likely to persist under changing climate.
	WM15	Medium	Prevent fires in large, dried out peat/organic soil bodies to slow release of soil carbon and enable gradual ecosystem transition.
	WM16	Low	Identify locations where wet meadows and fens don't exist now but might be able to in the future.
Monitor status and trends in species, ecosystems, and ecological processes to detect change in resource condition in response to stressors or management action.	WM17	Medium	Define hydrologic indicators and targets for maintaining/restoring wet meadows and fens.
	WM18	High	Continue monitoring of wet meadow and fen soil, vegetation, hydrology, and macroinvertebrates.
	WM19	Low	Test soil carbon flux as a measure of wet meadow and fen structure and function and to quantify carbon sequestration.
	WM20	Medium	Periodically (~10 yr) re-map wet meadows and fens to assess change (area, distribution).
Enable use of data in all formats in recognition of the vital role of data management.	WM21	Low	Scan and curate wet meadow and fen archives to make accessible to managers and researchers.
	WM22	Low	Write environmental history of wet meadow and fen research and management, including Soil and Moisture Conservation Crews to understand their effects on current conditions and inform future management.
Target communication with diverse audiences to increase stewardship.	WM23	Medium	Enhance education about benefits of wetland management in the face of a changing climate.
Collaborate with partners to manage priority resources at larger landscape scales.	WM24	Medium	Participate in regional meadow and wetland conservation groups.
	WM25	Medium	Identify opportunities to standardize wet meadow and fen data collection and conduct collaborative regional research.

This overview provides a summary of the Resource Stewardship Strategy for Sequoia and Kings Canyon National Parks, with example results for one priority resource. For more information, including assessments and management approaches of all twelve priority resources, see the full report.

go.nps.gov/sekiRSS

The National Park Service preserves unimpaired the natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration of this and future generations.



Photo by Tharwah Rabah

Cover photo by Randy Morse, Golden State Images

Back cover photo by Kirke Wrench

