

Study of Climate Change Impacts on Cultural Landscapes in the Pacific West Region, National Park Service

Phase II: Preliminary Vulnerability Assessments

Cultural Landscape Research Group
Department of Landscape Architecture
University of Oregon, Eugene, OR
2017

This project was completed under Task Agreement P15AC01594, U.S. Department of the Interior, National Park Service, Pacific West Region. Additional support provided through The Office of the Vice-President for Research and Innovation, University of Oregon.

Recommended citation:
Melnick, Robert Z. and Nadja Quiroz. "Study of Climate Change Impacts on Cultural Landscapes in the Pacific West Region, National Park Service, Phase II: Preliminary Vulnerability Assessments." Cultural Landscape Research Group, University of Oregon, 2017.

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Robert Z. Melnick, FASLA
Nadja G. Quiroz

Cultural Landscape Research Group
Department of Landscape Architecture
University of Oregon, Eugene, OR

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Phase II responds to the growing need to understand the vulnerability and potential effects of projected climate trends and events on cultural landscapes.

Introduction

BACKGROUND

Phase II of the study of climate change impacts on cultural landscapes in the NPS Pacific West Region (PWR) are preliminary vulnerability assessments, and was conducted by the Cultural Landscape Research Group (CLRG), a unit of the Department of Landscape Architecture at the University of Oregon (UO), in collaboration with the National Park Service. CLRG utilized NPS and IPCC climate projections to assess the vulnerability ofthree cultural landscapes in the Pacific West Region (PWR) to projected climate change variables.

As with the previous work, Phase II responds to the growing need to understand the potential effects of projected climate trends and events on cultural landscapes. This work is based on the NPS Cultural Resources Climate Change Strategy (Rockman et al. 2016) and the "Climate Change and Cultural Landscapes: A Guide to Research, Planning, and Stewardship" (Melnick et al. 2017). This project supports the goals in Director's Policy Memo 14-02, "Climate Change and Stewardship of Cultural Resources" (see Appendix B). The NPS Strategy identifies vulnerability assessments as a key part of the process of developing climate change response strategies for cultural resources. Phase II of this project provides a preliminary model for completing vulnerability assessments specifically for cultural landscapes.

The Director's Policy Memo 14-02 establishes a set of goals, including the direction to "prioritize cultural resources funding and management actions on projects that integrate vulnerability and resource significance… [A]ll identified cultural resources should be evaluated in terms of their vulnerability and significance so that management decisions are directed to resources that are both significant and most at risk." (Memo 14-10). Assessing the vulnerability of cultural landscapes directly addresses this goal.

Following the Director's Policy Memo, the Office of Associate Director, Cultural Resources, Partnerships, and Science released the "Cultural Resources Climate Change Strategy" (CRCCS) (Rockman et al. 2016). "The purpose of this Strategy is to set out the broad scope of cultural resources in relation to climate change and identify major directions of action in cultural resources and climate change for the NPS" (p.1). The CRCCS builds on the NPS "Climate Change Response Strategy" (2010), including the four pillars of climate change response (science, adaptation, mitigation, and communication) described in that document, by focusing on cultural resources in detail. The current project builds on the CRCCS and on previous work on climate change and cultural landscapes (Melnick et al. 2016).

The CRCCS establishes a foundation from which to address specific concerns for all cultural resources, including cultural landscapes, through four

Figure 1.1: Death Valley Scotty Historic District in Death Valley National Park is one of three case study cultural landscapes analyzed in Phase II of this project (Malinay/UO CLRG, 2016).

BACKGROUND *(cont'd)*

broad goals (see below). While essential to NPS climate change response for cultural resources, not all CRCCS goals are equally applied in the current project, with specific attention to Goal Three.

CRCCS Goal One: Connect Impacts and Information. Set the broad scope of cultural resources and climate change response by connecting the concepts of impacts and information with the four pillars of climate change response: science, adaptation, mitigation, and communication.

CRCCS Goal Two: Understand the Scope. Coordinate science, management, and communication to identify and improve understanding of the effects of climate change on cultural resources.

CRCCS Goal Three: Integrate Practice. Incorporate climate change into ongoing cultural resources research, planning, and stewardship.

CRCCS Goal Four: Learn and Share. Collaborate with partners to grow and use the body of knowledge and practice for cultural resources and climate change.

The CRCCS provided two other important models for the Phase II project: The first is a table (Graphic 2, pp. 20-24) of the "broad range of climate impacts to cultural resources, subtle to dramatic and coastal to interior, so that they can be included in stewardship practices." This has been adapted for use in cultural landscapse and is included in this project (see Impacts Table, Appendix A).

The second model is the Cultural Resources-Climate Change Integration Flow Chart, (Graphic 3, p. 27), also included in this project (see Figure 1.4). The CLRG Decision Tree (Melnick et al. 2016) is used in this project but aligns closely with the CRCCS Graphic 3, as indicated and discussed below.

Project Scope: Phase I

Phase I consisted of collecting climate change projection data, previously identified climate-related impacts, and the best available GIS hazard data (as of 2015) for 164 cultural landscapes in the PWR. The following climate variables were included for these purposes: air temperature, precipitation, storm frequency and intensity, and sea level rise. Previously identified impacts to these cultural landscapes as well as their most recent CLI overall condition assessments were also collected. These impacts include: erosion, exposure to elements, microclimate, pest/disease, vegetation/invasive species, and disruption of species. GIS analysis was used to identify the current fire, flood, landslide, and drought hazards for each of the 164

cultural landscapes. The previously identified impacts, CLI overall condition assessments, and current GIS hazard data were consolidated into an historic exposure matrix (see Exposure Matrix, Appendix A). The Exposure Matrix translates qualitative historical and current exposure data into quantitative values that help determine the preliminary exposure of each character-defining feature withinthe 164 cultural landscapes.

Phase I also included conducting six case study cultural landscape condition assessments, using the CLI Professional Procedures condition assessment framework, to verify the existing condition of the following cultural landscape case studies: Buckner Homestead Historic District, North Cascades National Park (WA); Heart of the Monster, Nez Perce National Historical Park (ID); Eugene O'Neill National Historic Site (CA); Lyons' Ranches Rural Historic District, Redwood National Park (CA); Death Valley Scotty Historic District, Death Valley National Park (CA); and Pu'ukohola Heiau National Historic Park (HI).

CURRENT SCOPE

The primary goal of the current phase of the project, Phase II, is to identify the exposure and sensitivity of contributing cultural landscape characteristics and features to climate projections, resulting in a preliminary vulnerability assessment, a necessary step in planning for and implementing a range of adaptation options. In line with the CRCCS Goal Three, Phase II of this project provides a preliminary assessment of the vulnerability of contributing characteristics and features to climate change variables, with special attention to the impact on the physical condition and integrity of those features.

Although suggestions for new or refined adaptation options are not included in this report, current management strategies and practices could have the effect of offsetting stress, improving resilience/resistance, and managing change.

Phase II includes analysis of exposure and sensitivity of defining cultural landscape characteristics and features to arrive at a vulnerability assessment, providing a basis for establishing treatment priorities and making management decisions. As noted in the Next Steps section this phase does not include final vulnerability scoring of the characteristics and features but provides a basis for doing so in the future. The preliminary vulnerability assessment, in both quantitative and qualitative measures, is included in the Vulnerability Matrix below (see Appendix A). It also includes an option for assessing the potential impact of vulnerability on historic integrity.

The objectives of Phase II include preparing a preliminary vulnerability

Project Scope: Phase II *(cont'd)*

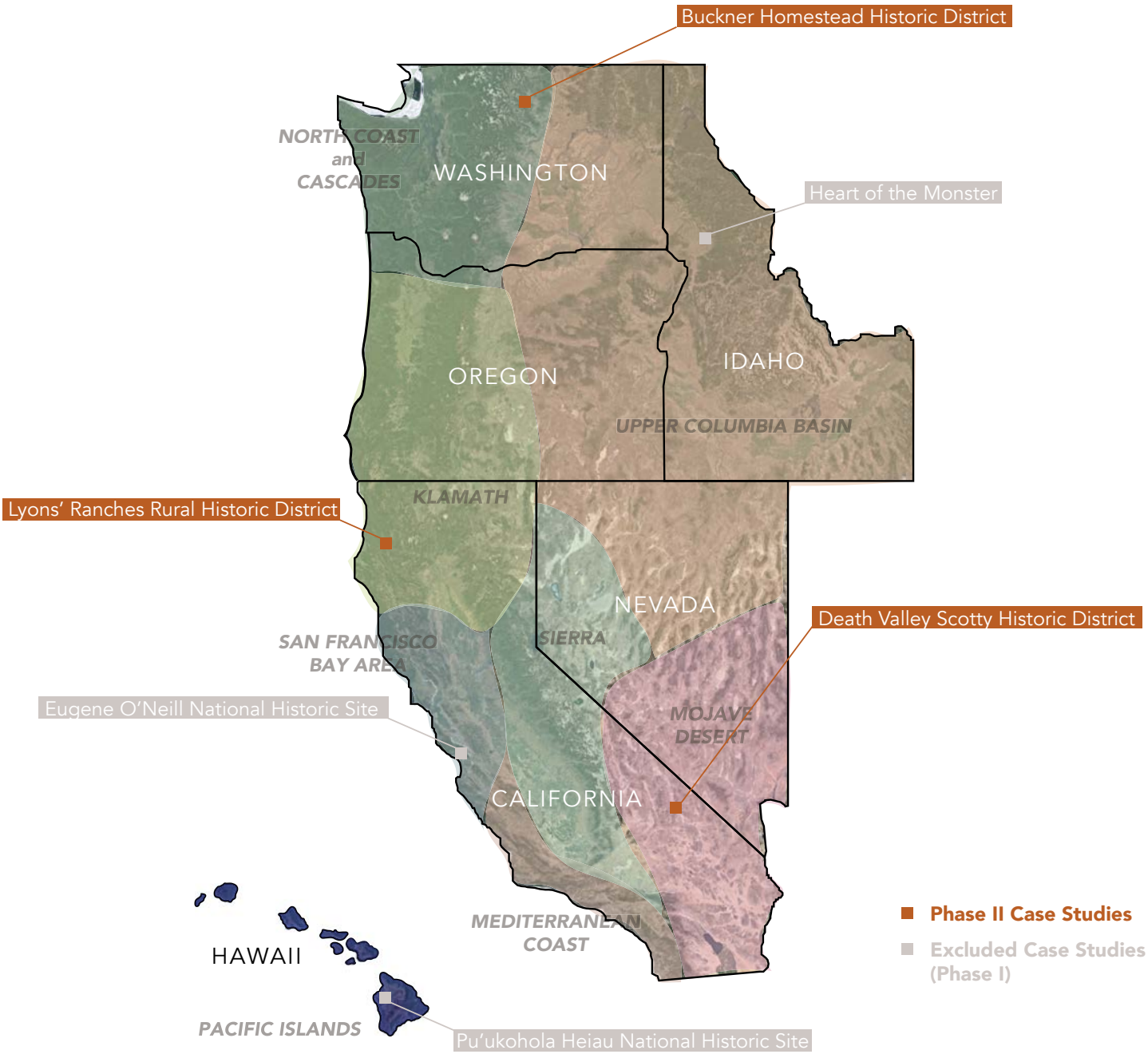
assessment for three case study cultural landscapes (see Figure 1.3), which includes assessing: 1) historical exposure, 2) projected exposure, and 3) sensitivity of each cultural landscape defining characteristic and feature to historical and projected exposures. This includes: analyzing historical and projected climate data for each of the three cultural landscapes and identifying the sensitivity of the character defining characteristics and features to collected historical and projected climate exposure data to arrive at a preliminary vulnerability assessment for each cultural landscape, including projected impact on resource integrity.

To achieve these Phase II objectives, the research team reviewed the NPS Cultural Resources Climate Change Strategy, consulted and reviewed other selected NPS and climate change related reports and literature for each site (see Bibliography, Appendix A) and conducted one webinar and one on-site workshop with NPS staff and NPS partners for each cultural landscape. NPS staff were consulted about their field observations, although for most staff length of time in the park was insufficient to draw long-term conclusions. Nonetheless, their observations were important indicators for further investigation.

Existing management capacities and practices for each cultural landscape are factored into the assessment of sensitivity. Adaptation options to be proposed in Phase III will take those capacities and practices into consideration. A goal of the entire project is to propose practical, realistic adaptation options that account for existing park capacities that will most effectively offset the sensitivities identified in Phase II, thus reducing vulnerability, and to identify changes with which existing management will be unable to cope.

The final cases studies selected for Phase II of the project are Buckner Homestead Historic District at North Cascades National Park, Lyons' Ranches Rural Historic District at Redwood National Park, and Death Valley Scotty Historic District at Death Valley National Park. These cultural landscapes were selected for vulnerability assessments based on their variation across cultural landscape type and ecological characteristics.

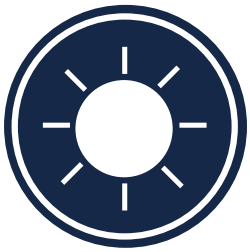
Figure 1.2: The three Phase II case studies (opposite) are located at North Cascades National Park, Redwood National Park, and Death Valley National Park.


Buckner Homestead Historic District
NORTH COAST and CASCADES
WASHINGTON
Heart of the Monster
OREGON
IDAHO
UPPER COLUMBIA BASIN
KLAMATH
Lyons' Ranches Rural Historic District
NEVADA
Death Valley Scotty Historic District
SAN FRANCISCO BAY AREA
SIERRA
Eugene O'Neill National Historic Site
MOJAVE DESERT
CALIFORNIA
MEDITERRANEAN COAST
HAWAII
PACIFIC ISLANDS
Pu'ukohola Heiau National Historic Site
Phase II Case Studies
Excluded Case Studies (Phase I)

Methods

ANALYSES

The historic climate variables, hazards data, and climate change projection data from Phase I of this project were the basis for developing a vulnerability assessment for each of the three case study landscapes. This included evaluating the exposure of the cultural landscapes' character defining features to historic and projected climate variables as well as their sensitivity to projected climate variables. Primary climate variables include temperature, precipitation, and storm frequency (right). Assessments included consideration of additional variables or hazards, such as fire, landslides, and flood events, that arise from the interactions of primary variables, were also included where appropriate.



TEMPERATURE

The research process for the vulnerability assessment included: collecting historical climate data for each cultural landscape; identifying the sensitivity of the contributing landscape features and characteristics to the historical and projected climate exposure data; and assessing the impacts to contributing landscape characteristics for each case study cultural landscape. Vulnerability assessments for cultural landscape features are included in each case study, below.



PRECIPITATION

Sources of quantitative and qualitative data climate data used in the study includes: the Exposure Matrix; historic records for case study cultural landscapes, when available; analytical reports from the NPS Climate Change Response Program; IPCC data (see Figure 1.4); observations and recording. These are identified in Appendix A. The contributing landscape characteristics and historical impacts were previously identified in the existing Cultural Landscape Inventories completed by the National Park Service as part of the baseline data the agency maintains to help inform planning and stewardship activities.



STORM FREQUENCY

DECISION TREE

The overall project is based upon a previously developed Climate Change and Cultural Landscapes

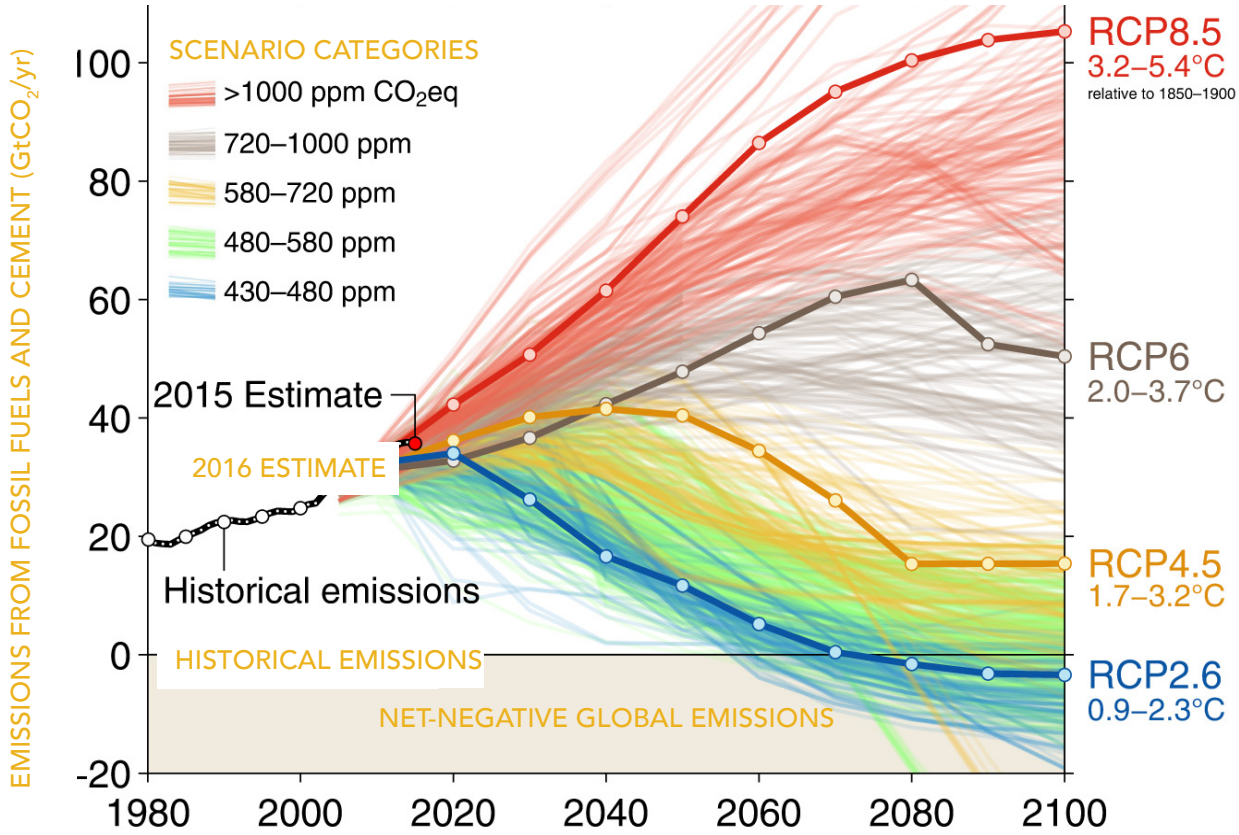
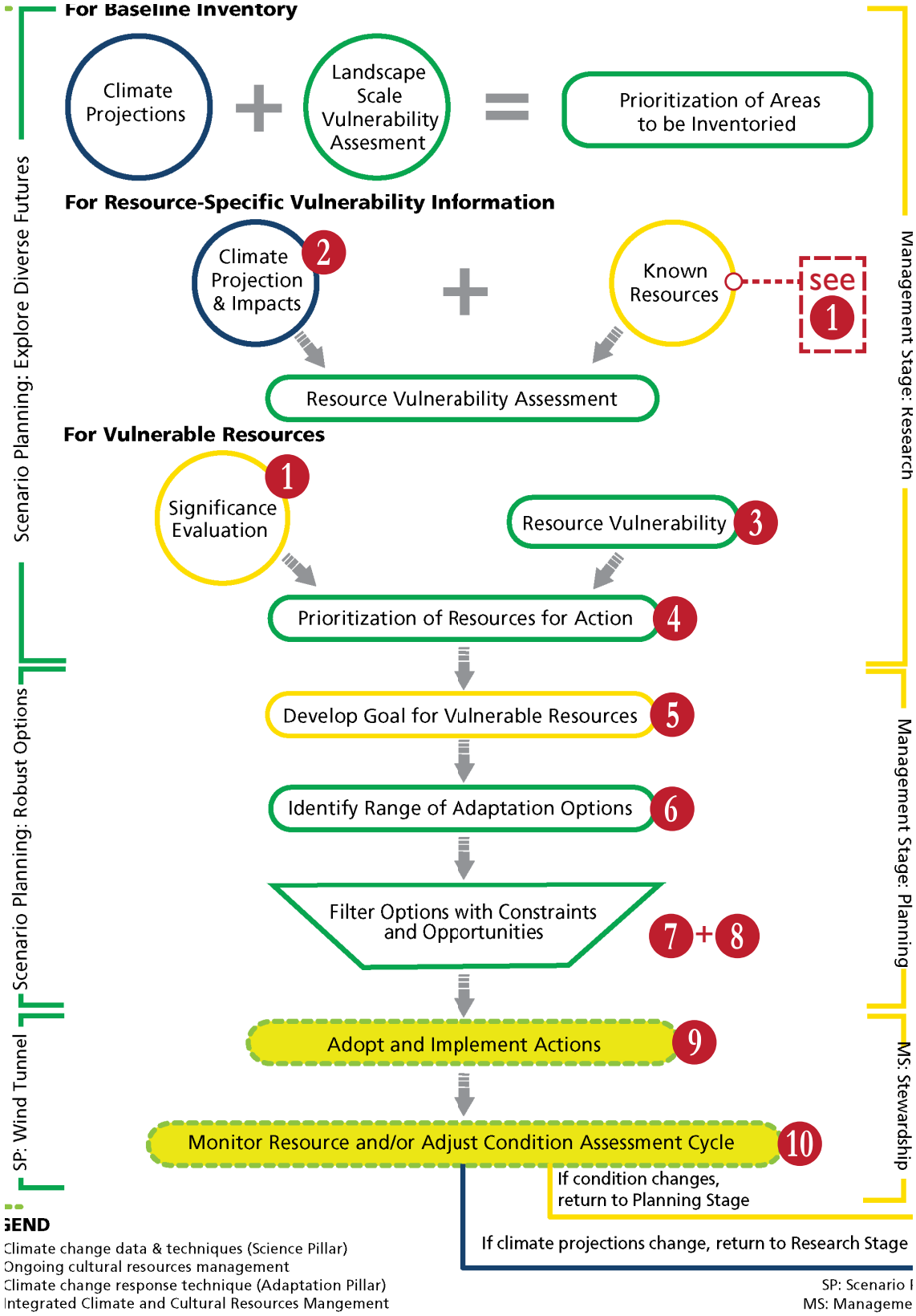


Figure 1.3: Observed emissions and projected emissions scenarios (CDIAC/GCP/IPCC/Fuss et al, 2014). For the purposes of this project, climatic analyses and cultural landscape assessments are based on the highest emissions scenario, *RCP8.5*.

decision tree (Melnick et al. 2017, see Figure 1.4), which models a core process for addressing the impacts of climate change on cultural landscapes. It is organized into three planning themes: research, planning, and stewardship, and as peris in line with standard NPS planning Management Policiespractices (2006), and are included in as outlinedby the NPS Cultural Resources Climate Change Strategy (CRCCS) (Rockman et al. 2016, see Figure 1.4). While the decision tree is presented in a linear mode, the field application is often cyclical and iterative. It requires that management and research teams assess the current state of information about a cultural landscape and available climate projections, and then adjust the core process to meet resource needs.

Phase II is based on the decision tree research theme, and includes gathering information about the historical and projected climate data and impacts on significant cultural landscape characteristics and features. This phase employs established NPS policies, procedures, and techniques to betterunderstand each cultural landscape and thoswho have shaped them. Together, these two sets of information (specific to the cultural landscape and to relevant climate variables) provide the basis for a vulnerability assessment that further informs management adaptation options. The goal, in line with the Director's Policy Memorandum 14-02: "Climate Change and Stewardship of Cultural Resources" is to protect the integrity of the cultural landscape, and to minimize adverse impacts to the landscape characteristics and features that convey significance.

This report includes both the CRCCS flow chart and the cultural landscapes/climate change decision tree. The CRCCS flow chart presents an approach to all cultural resources, while the decision tree is specific to cultural landscapes.


For Baseline Inventory
Climate Projections
Landscape Scale Vulnerability Assesment
Prioritization of Areas to be Inventoried
For Resource-Specific Vulnerability Information
Climate Projection & Impacts 2
Known Resources
see 1
Resource Vulnerability Assessment
For Vulnerable Resources
Significance Evaluation 1
Resource Vulnerability 3
Prioritization of Resources for Action 4
Develop Goal for Vulnerable Resources 5
Identify Range of Adaptation Options 6
Filter Options with Constraints and Opportunities 7 + 8
Adopt and Implement Actions 9
Monitor Resource and/or Adjust Condition Assessment Cycle 10
If condition changes, return to Planning Stage
If climate projections change, return to Research Stage
Scenario Planning: Explore Diverse Futures
Scenario Planning: Robust Options
SP: Wind Tunnel
Management Stage: Research
Management Stage: Planning
MS: Stewardship
GEND
Climate change data & techniques (Science Pillar)
Ongoing cultural resources management
Climate change response technique (Adaptation Pillar)
Integrated Climate and Cultural Resources Mangement
SP: Scenario
MS: Manageme

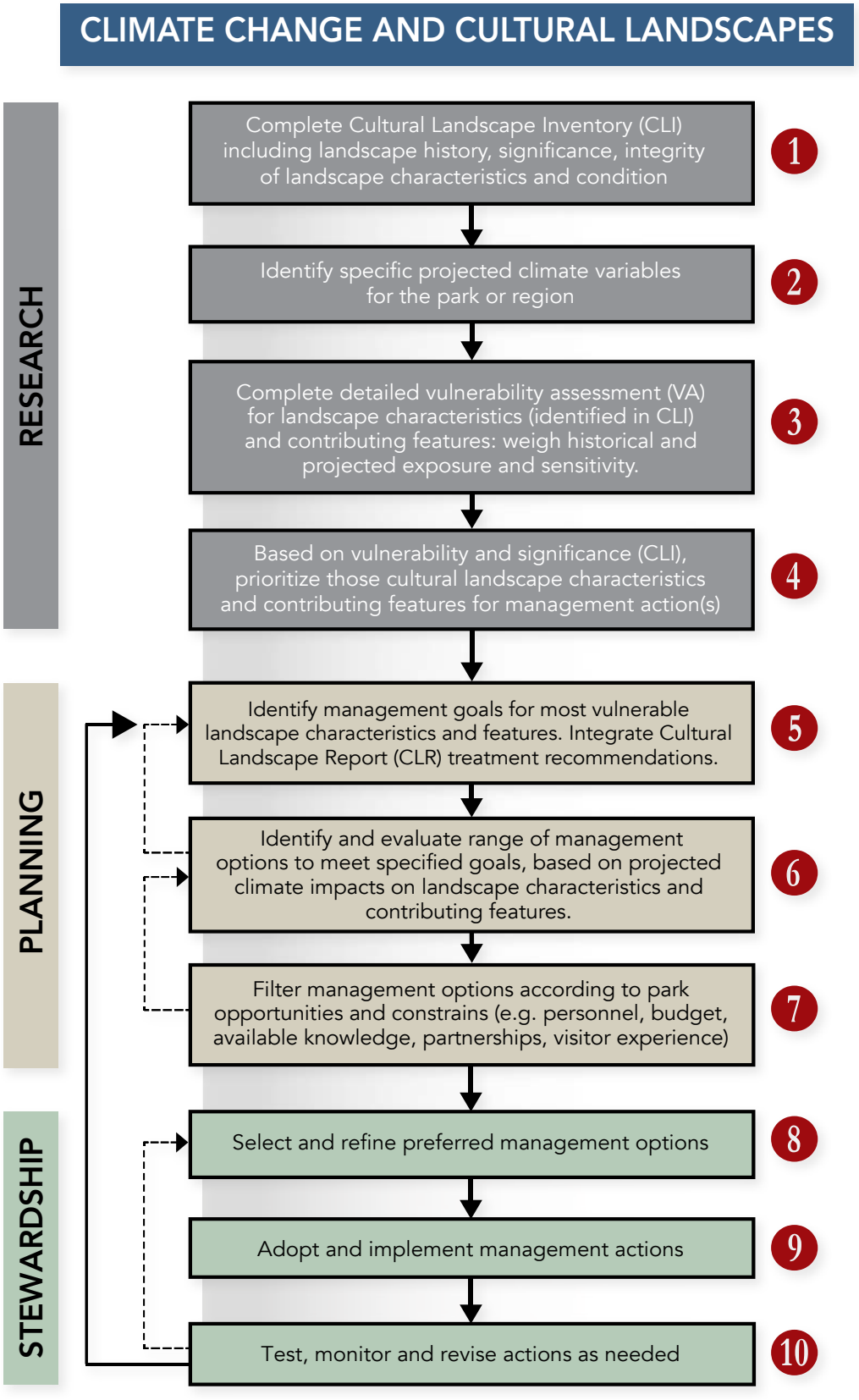


Figure 1.4: The NPS Cultural Resources Climate Change Strategy (CRCCS) [Rockman et al., 2016] outlines a process for integrating climate change across major stages of cultural resources management, opposite.

The Climate Change and Cultural Landscapes decision tree, abovve, expands on these stages in detail for cultural landscapes. Numbered symbols indicate connections between the stages in each chart.

VULNERABILITY MODEL AND DEFINITIONS

The IPCC defines 'vulnerability' to climate change as "the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change. The term 'vulnerability' may therefore refer to the vulnerable system itself, e.g., low-lying islands or coastal cities; the impact to this system, e.g., flooding of coastal cities and agricultural lands or forced migration; or the mechanism causing these impacts, e.g., disintegration of the West Antarctic ice sheet." [ADD REF}

For cultural landscapes, as a variation on the IPCC definition above, vulnerability is the degree to which the defining characteristics and features are susceptible to adverse impacts from known and projected climate variables. This project builds on the Cultural Resources Climate Change Change Strategy (Rockman et al. 2016) that states that vulnerability assessments "[connect] exposure to climate impacts with resource-specific sensitivities to determine impact risk at site-specific and regional scales." Vulnerability is understood as a propensity for a cultural resource to be adversely affected by climate variables. A vulnerability assessment combines cultural landscape information, historical and projected climate data, and feature or system sensitivity to identify the vulnerability of character-defining features. It is important to recognize that there is an inherent level of uncertainty in climate projections, as well as reasonable disagreements among the various climate models. Therefore, as noted below, future climate trends are treated as projections, not predictions. The identification of feature vulnerability also supports prioritization of future adaptation options. (For a detailed discussion of vulnerability in the parks see Gonzalez 2017).

Vulnerability assessments anticipate the broad impacts of climate change projections on the character-defining features of each case study cultural landscape by identifying, to the best extent possible, those character defining features that are most likely to be seriously impacted by climate variables. The vulnerability assessment model in this project includes five steps and data sets: 1) gathering historical climate data, gathering projected climate data, 2) analyzing the exposure of character-defining features to historical and projected climate variables, 3) analyzing the sensitivity of the character-defining features to historical and projected climate variables, 4) and assessing the exposure and sensitivity of the character-defining features for each cultural landscape.

The vulnerability assessment model for cultural resources is expressed in the following way:

(historical exposure + projected exposure) x sensitivity = vulnerability

The IPCC provides a broad definition of exposure, as "the presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected." For cultural landscapes, this project focuses that definition on specific characteristics, features, and climate variables, with "historical exposure" and "projected exposure" as subcategories of exposure.

historical exposure
historical rates and ranges of past climate events and trends in cultural landscape locations

Historical exposure is described by available data for past climate variables, typically from 1950 to 2010. Historic exposure data primarily includes temperature, precipitation, and sea level rise, where appropriate. For the three case studies in this report, sea level rise is not a factor. Historical exposure also includes associated hazards, such as erosion, flooding, drought, storm frequency and intensity. One of the major challenges with accounting for historical exposure is often the unevenness of available data. For the three landscapes in this study there are significant differences in available data for historical exposure, at both the geographic and temporal scales of recording and reporting. Historical exposure data can also be more reliable at a coarser grain, such as for a region or county, compared to the finer grain of a park or a specific cultural landscape. For all three landscapes, available historical exposure data was uneven. Historic alexposure data can also reveal historic rates of variation, which is important when describing projected climate variables. Park scale data can also be uneven, as occurs at Lyons' Ranches, in Redwood NP, where significant topographic variations are responsible for very different microclimates.

projected exposure
the best available climate science projections of anticipated changes in temperature, precipitation, sea level rise, and other projected secondary variables, such as storm event frequency, drought, and wildfires.

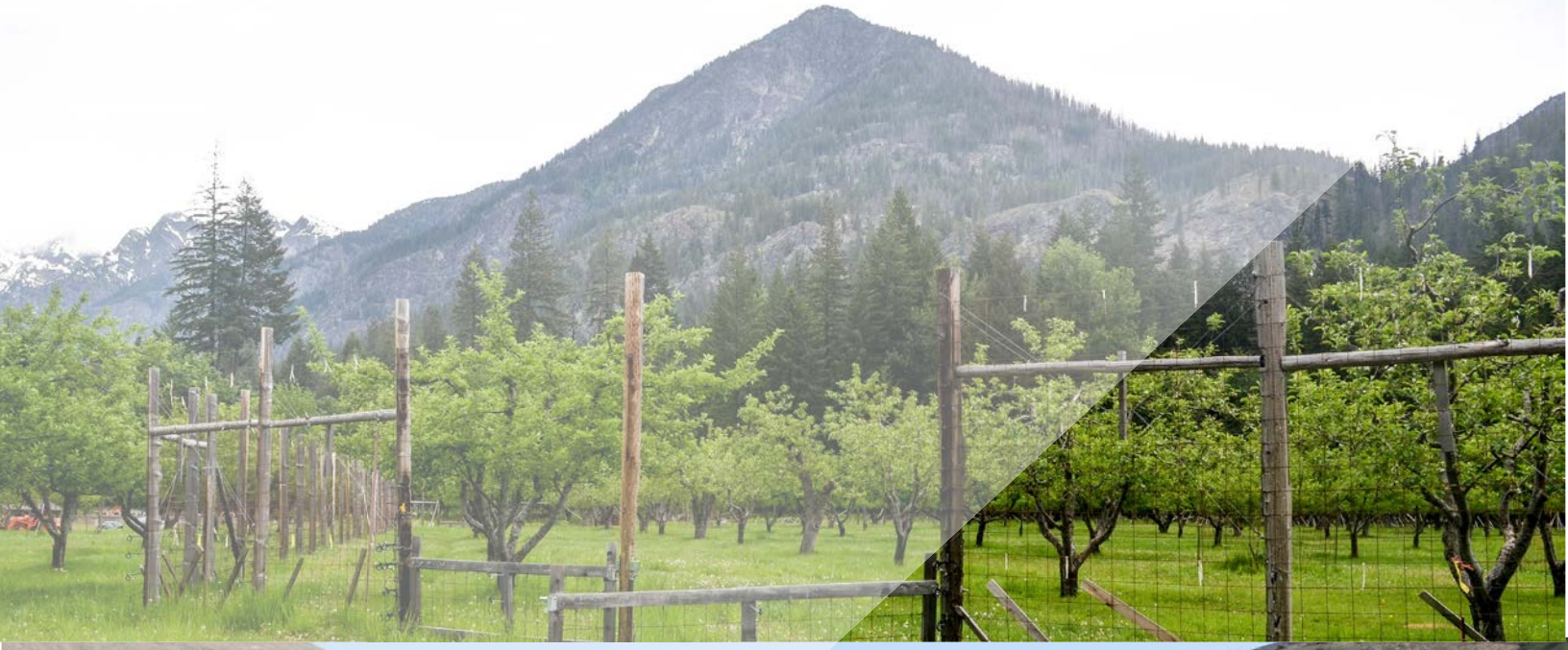
Projected exposure is based on data available through the NPS Climate Change Response Program, the most recent IPCC report, and other research reports. Often, these sources share data, especially from the IPCC. At its base, IPCC data is founded on the latest projections of high and low global emission levels, and the projected impact of those emissions on temperature, precipitation, and sea level rise, typically through 2100. These projections can then be applied to other factors, such as storm frequency and intensity, drought, temperature, and others. Sometimes IPCC emission

projections, when published and available, may already be out of date. For this reason, the latest projections of temperature, precipitation, and sea level rise tend to rely on the higher emissions projections.

As these are projections, not predictions, there will always be a level of uncertainty in available data and in its applicability. While details may not be certain, reliable trends in temperature, precipitation, and storm frequency are still discernable.

sensitivity
a measure of a cultural landscape's susceptibility to negative impacts which includes damage, deterioration, and/or loss of integrity, resulting from exposure to climate variables.

An assessment of sensitivity takes into account both natural and human factors which may affect the ability of the cultural landscape to cope with climate change-related impacts. These factors include existing ecological stresses and processes, intrinsic physical qualities of the resource, existing management capacities and practices, and ongoing traditional uses. Sensitivity is measured using the existing condition of the landscape's characteristics and features as a baseline. Existing condition incorporates both human and ecological interactions of the landscape characteristics and features. These ecological interactions include existing environmental stresses and processes, material resistance, and genetic resilience. Human interactions include existing preservation maintenance efforts and other management actions and ongoing traditional uses. Understanding sensitivity requires the recognition that different cultural landscape characteristics and features have different levels of sensitivity to the same climate change variables. Sensitivity is a measure of whether and/or how a characteristic or feature is likely to be negatively impacted by a specific climate variable. As with projected exposure, sensitivity includes a level of uncertainty since it can be difficult to anticipate the severity of impacts from exposure to individual or combined projected variables.







Case Studies

Buckner Homestead Historic District, Lake Chelan National Recreation Area, Managed by North Cascades National Park Service Complex, WA

Death Valley Scotty Historic District, Death Valley National Park, CA

Lyons Ranches Rural Historic District, Redwood National Park, CA

Note: a cultural landscape description and preliminary assessment for each case study is in the Phase I report.

Figure 1.6: Images from the three case study cultural landscapes: Buckner Homestead, Scotty's Castle, and Lyons Ranches (UO CLRG, 2016).



Figure NOCA 1.0: Buckner Homestead Historic District, North Cascades National Park, view northwest. (Malinay/UO CLRG, 2016)

BUCKNER HOMESTEAD HISTORIC DISTRICT
LAKE CHELAN NATIONAL RECREATION AREA
MANAGED BY NORTH CASCADES NATIONAL PARK SERVICE COMPLEX, WA

Chelan County, WA

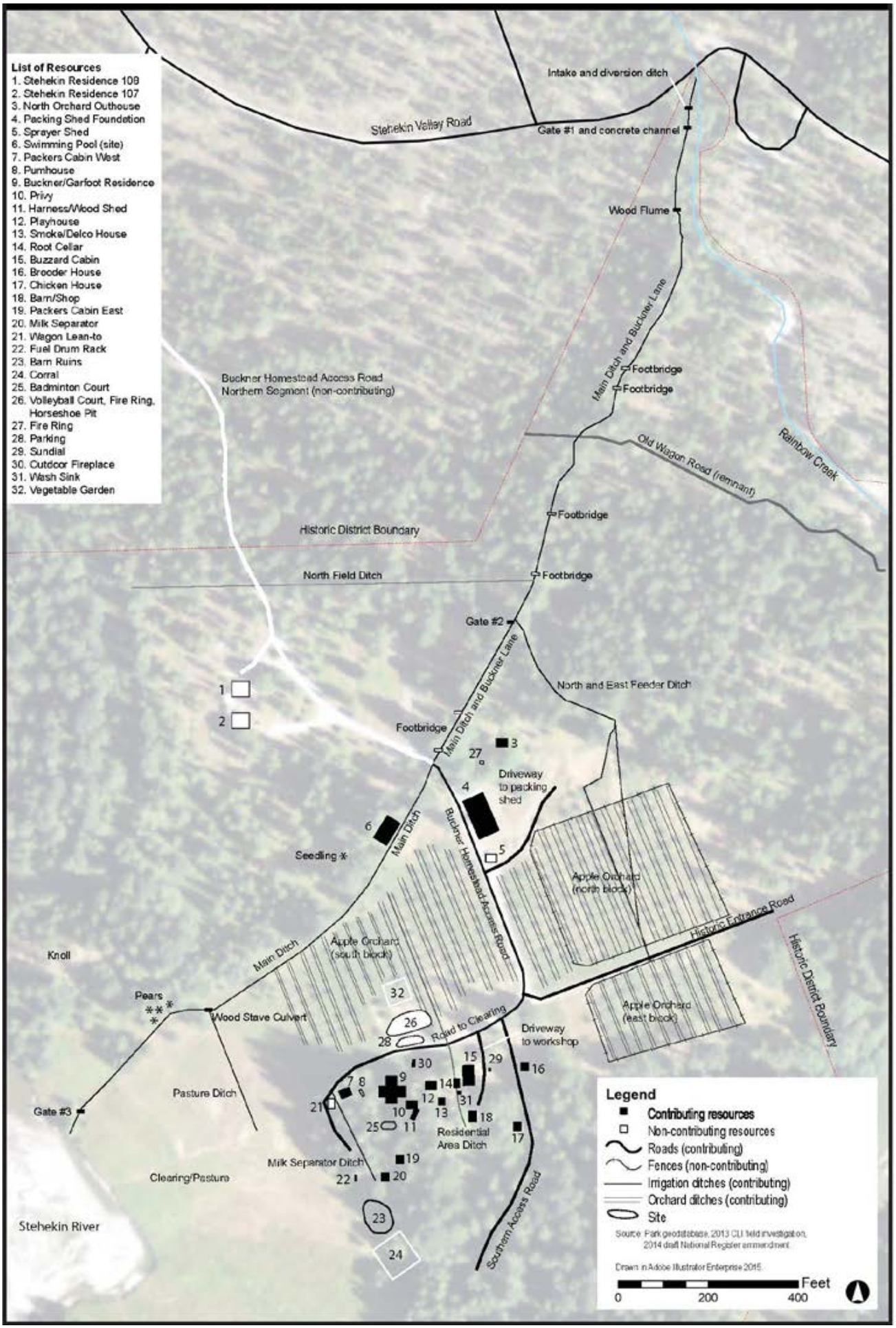
CULTURAL LANDSCAPE SUMMARY

- **Size:** 105.50 acres (42.69 hectares)
- **Cultural Landscape Type:** Historic Vernacular Landscape
- **Period of Significance:** 1889 - 1955

  The period of significance reflects the early establishment of nearby William Buzzard homestead, the Buckner family land purchase and improvements made after 1910, and the development of orchard cultivation.
- **National Register Significance:** Criterion A
  The Buckner Homestead Historic District is locally significant under Criterion A for its association with early settlement and agricultural development in the North Cascades.

CHARACTER DEFINING FEATURES

- **Archaeological Sites:** swimming pool, Old Wagon Rd. remnant, "Lower Buckner Can Dump", barn ruins, tractor/wagon shed ruins, fire ring remnants, badminton court
- **Buildings and Structures:** Buzzard cabin, privy, pickers cabin, chicken house, Buckner/Garfoot house, smoke/delco house, root cellar, milk separator, packing shed foundation, brooder house, playhouse, barn/shop, woodshed/harness shed, north orchard outhouse
- **Circulation:** Buckner Homestead access road, historic entrance road, road to clearing/pasture, sourther acces road, driveway to workshop, driveway to packing shed foundation parking, Buckner Lane
- **Constructed Water Features:** main ditch from Rainbow Creek, feeder ditches, orchard ditches, ancillary ditch to milk separator, ancillary ditch to residential area, ancillary ditch to pasture, north field ditch
- **Small Scale Features: sundial, fuel drum rack, outdoor fire place**
- **Spatial Organization**: main building cluster, orchard and clearing, roads: historic entrance, roads: to clearing/pasture, irrigation system (middle of district)"
- **Vegetation:** 3 apple orchard sections, fruit trees, ornamental trees within main cluster


List of Resources
1. Stehekin Residence 109
2. Stehekin Residence 107
3. North Orchard Outhouse
4. Packing Shed Foundation
5. Sprayer Shed
6. Swimming Pool (site)
7. Packers Cabin West
8. Pumhouse
9. Buckner/Garfoot Residence
10. Privy
11. Harness/Wood Shed
12. Playhouse
13. Smoke/Delco House
14. Root Cellar
15. Buzzard Cabin
16. Brooder House
17. Chicken House
18. Barn/Shop
19. Packers Cabin East
20. Milk Separator
21. Wagon Lean-to
22. Fuel Drum Rack
23. Barn Ruins
24. Corral
25. Badminton Court
26. Volleyball Court, Fire Ring, Horseshoe Pit
27. Fire Ring
28. Parking
29. Sundial
30. Outdoor Fireplace
31. Wash Sink
32. Vegetable Garden
Intake and diversion ditch
Stehekin Valley Road
Gate #1 and concrete channel
Wood Flume
Main Ditch and Buckner Lane
Footbridge
Footbridge
Buckner Homestead Access Road
Northern Segment (non-contributing)
Old Wagon Road (remnant)
Rainbow Creek
Historic District Boundary
Footbridge
North Field Ditch
Footbridge
Gate #2
North and East Feeder Ditch
Footbridge
Main Ditch and Buckner Lane
Driveway to packing shed
Main Ditch
Buckner Homestead Access Road
Seedling
Apple Orchard (north block)
Historic Entrance Road
Historic District Boundary
Knoll
Main Ditch
Apple Orchard (south block)
Pears
Wood Stave Culvert
Road to Clearing
Driveway to workshop
Apple Orchard (east block)
Pasture Ditch
Gate #3
Residential Area Ditch
Milk Separator Ditch
Clearing/Pasture
Southern Access Road
Stehekin River
Legend
Contributing resources
Non-contributing resources
Roads (contributing)
Fences (non-contributing)
Irrigation ditches (contributing)
Orchard ditches (contributing)
Site
Source: Park geodatabase, 2013 CLI field investigation, 2014 draft National Register amendment
Drawn in Adobe Illustrator Enterprise 2015
Feet
0
200
400

EXPOSURE

The most detailed climate data available for Buckner Homestead Historic District describes temperature and precipitation trends for the historically semi-arid Lake Chelan National Recreation Area. This includes the Stehekin Valley, one of the most arid regions within the North Coast and Cascades Network. For historical climate analysis, the following NPS sources were referenced: Climate change trends, vulnerabilities, and ecosystem carbon, Death Valley National Park, Climate Change Trends, North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area, Washington (Gonzalez 2015) (see Figure NOCA 1.6), Recent Climate Change Exposure of North Cascades National Park (Monahan and Fisichelli 2014), and the North Coast and Cascades Netowrk Weather and Climate Inventory Natural Resource Technical Report (2006). The most recent Buckner Homestead Historic District CLI (2016) was consulted for historical exposure and/or impacts. For current hazard risk assessments, the best available GIS data at the county level as of 2015 was used and incorporated into the Phase I assessment matrix (see Exposure Matrix, Appendix A). Projected climate data was sourced from Gonzalez's source above with supplemental data and figures from the USGS Climate Change Viewer from 2013 (see Figure NOCA 1.8).

HISTORICAL EXPOSURE

Throughout the North Cascade network, summers are dry and precipitation is concentrated in the fall and winter months (NPS/NCCN/NRTR 2006). Between 1950 and 2010, annual average temperatures have increased at a statistically significant rate of +2.7°C (+4.9°F) per century (see Figure NOCA 1.6). This rate of warming is the highest within park boundaries and is consistent with the 1-3°C warming trend observed for the entire Pacific Northwest over the last century (NPS/NCCN/NRTR 2006). Temperature variables calculated for shifting 10-year windows from 1901 to 2012 show that average temperatures for the driest quarter of the year and the lowest temperature of the coldest month have already exceeded the normal historical range for these times of year. Precipitation, however, has decreased at a non-significant rate of -20% per century between 1950 and 2010. This may be attributed to the multi-year dip in seasonal rainfall that occurred during the late 60s through 70s (see Figure NOCA 1.6). Overall, there is an established trend towards a warmer climate with minimal decreases in precipitation.

The most recent CLI contains information regarding impacts to archaeological sites, the small scale farming implements, the main irrigation ditch, portions of the apple orchard, and the clearing/pasture. The archaeological sites that have been historically impacted are the

Figure NOCA 1.1: Excerpted site map of Buckner Homestead Historic District from the most recent CLI.

CURRENT SITE CONDITIONS



Figure NOCA 1.2: Heavy erosion along the northern bank of the Stehekin River resulting from flash floods and increased amounts of woody debris; view east. (Kerr/UO CLRG, 2016)



Figure NOCA 1.3: A special grafting technique used to bridge vascular tissue in cases where heavy snowloading or bears have broken or removed major portions of the trunk. Note the debris-filled irrigation ditch in the foreground. (Kerr/UO CLRG, 2016)



Figure NOCA 1.4: The main irrigation inlet and ditch at Rainbow Creek with the Stehekin River in the background. Climate projections could result in more frequent winter flooding, damaging the inlet and potentially flooding parts of the district; view east (Malinay/UO CLRG, 2016).



Figure NOCA 1.5: Structural wear and aging as seen at Buzzard Cabin. Causes are most likely snow and/or rain related but are unknown; view west. (Kerr/UO CLRG, 2016)

HISTORICAL DATA

Lake Chelan National Recreation Area, WA

Temperature and Precipitation Trends

Historical data for Lake Chelan NRA show temperatures increasing at a rate of +2.7°C (+4.9° F) per century and precipitation decreasing at a rate of -20% per century between 1950 and 2010 (see Figure NOCA 1.6). Lake Chelan NRA has demonstrated statistically significant rates of warming-- greater than other regions of the park. Precipitation rates, on the other hand, have historically decreased but not at statistically significant rates. This historical precipitaiton trend contradicts the highest emissions scenario projection (see Figure NOCA 1.7).

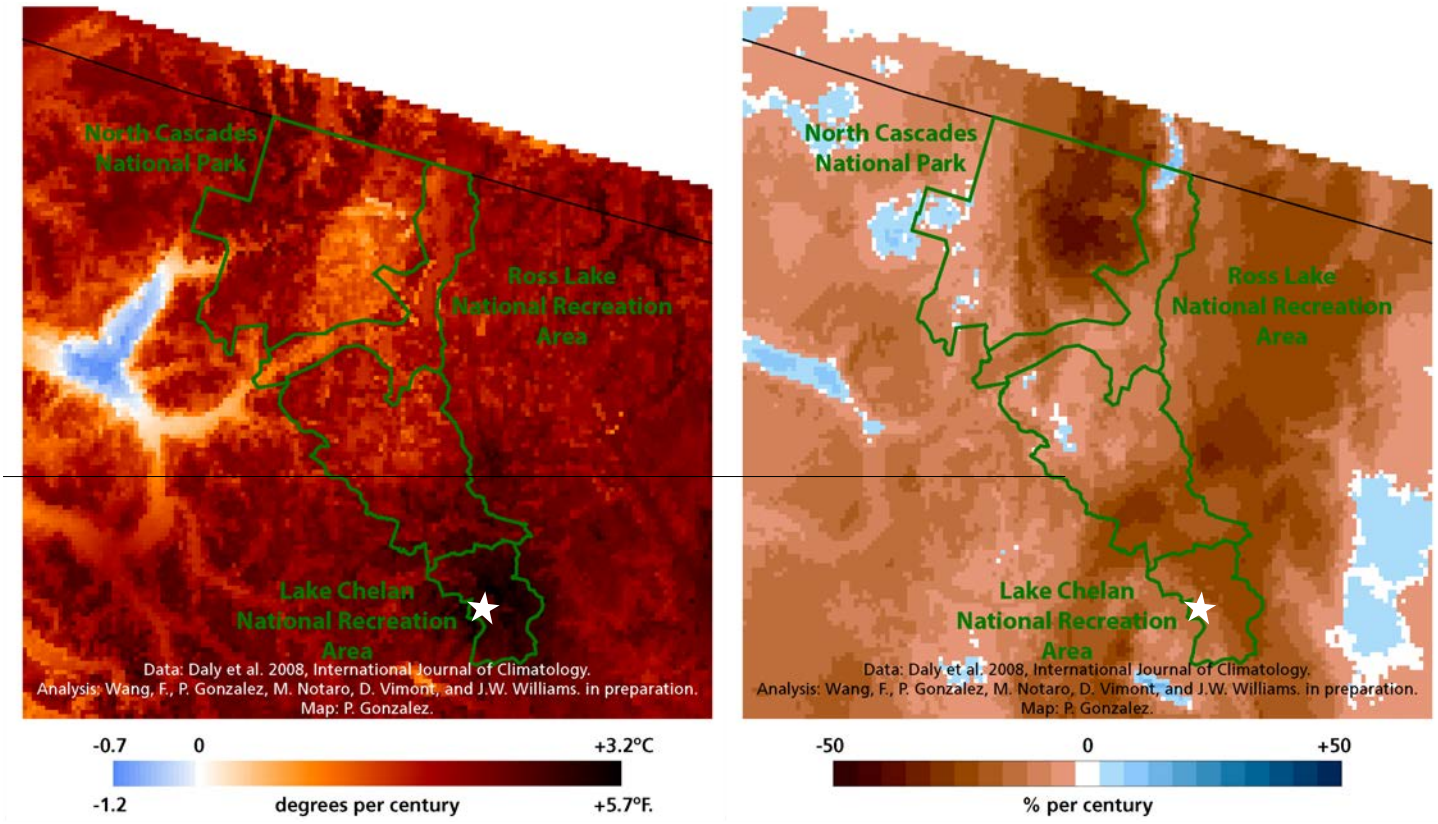


Figure NOCA 1.6: Historical trend in average annual temperature (above left) and total annual precipitation (above right) between 1950 and 2010.

Gonzales, Patrick, "Climate Change Trends, North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area, Washington," Natural Resource Stewardship and Science Report, National Park Service, 2015.

HISTORICAL EXPOSURE *(cont'd)*

swimming pool, which has been overgrown with vegetation, the can dump, which is eroding away, and the barn ruins, which are exposed to the elements. In the latter case, the exposure to elements consists of heavy snow loads, which were the cause of the barn's collapse. The farm implements are also indefinitely exposed to the elements. The main ditch, apple orchard, and clearing/pasture have been impacted by flood in the past. Presently, the orchards are not near the river bank but they historically occupied the pasture/clearing prior to a flood event that washed out a few apple trees. The area has since been cleared and remains as such to this day. According to park staff and field observations, the bank has been cutting closer into the clearing on the west side of the district (see Figure NOCA 1.2).

GIS Analysis

GIS data from 2015 were used to assess the current exposure of all contributing features to natural hazards such as fire, flood, landslide, and drought (see Exposure Matrix, Appendix A). Data reveal that all contributing features within Buckner Homestead Historic District (buildings and structures, circulation, constructed water features, spatial organization, and vegetation) are at a 30% risk of exposure to fire with a 0% risk of drought. This seems inconsistent with observational data from park staff that expressed a collective concern for drought both within the site and for the surrounding areas. This discrepancy could be attributed to a coarseness in the resolution of the GIS data or as a result of the site's location within the valley. There was no available GIS data for flood or landslide hazards at the county level.

These gaps in available GIS hazard data limit the capacity toquantify and analyze the interactions between historic and current exposure and the present condition of contributing features. As a result, the average scores for historical hazard exposure remain undetermined, while the average scores for current hazard exposure are possibly too low as a result of factoring in zero for drought hazards.

PROJECTED EXPOSURE

Average temperatures at Lake Chelan NRA are projected to increase +4.9°C (+8.8°F) between 2000 and 2100, continuing the statistically significant trend of rising temperatures of the last half of the 20th century (see Figure NOCA 1.7). Summers and winters are projected to exhibit the greatest rates of increase (see Figure NOCA 1.8). Warmer winters could continue the trend of decreased snow pack, a pattern that is strongest in milder climates, like the Cascades, despite recorded increases in winter

PROJECTED EXPOSURE *(cont'd)*

precipitation (Mote et al. 2005). Higher temperatures during the growing season can exacerbate water stress for native and planted vegetation—especially Douglas-fir— which are most sensitive to high temperatures at low to mid elevations during the drier months (Case and Peterson 2005). Increased water stress can also lead to a greater risk of pest and disease infestations, like the locally present Douglas-fir beetle or mountain pine beetle, which are more likely to undergo range expansion into higher elevation forests (Littell et al. 2010). Although park staff have observed past beetle outbreaks to dwindle, increased outbreaks in forests with lower soil moisture can create favorable conditions for wildfir. According to field observations and park staff, greater amounts ofwoody debris resulting from greater tree death can potentially contribute to heavier bank erosion during winter storm events (Southerland 2003). Additionally, according to the on-site orchardist, the risk of powdery mildew (which is an on-going issue in the orchards) increases with drought stress and can cause the leaves to dry up and fall during the growing season.

Warmer winters could mean less snow damage on structures and the orchard Impact analysis reveals that heavy snow loading was the source of damage to the Buzzard Cabin roof. This is also the cause for severe limb breakage and bark damage to orchard trees during the winter months, exposing trees to pests and disease. Indirect effects of a decreased snow load could alsomean less damage from elk, which strip the living layer of cambium from the apple trees during winter months. However, the increased Elk presence in the Stehekin Valley is not well understood. Precipitation in the form of rain instead of snow could also lead to greater compaction of orchard soils and potentially increase the exposure of roots to frost, as well as increase the rates of structural rot.

Despite the historical trend of decreasing precipitation, the highest emissions scenario models for Lake Chelan NRA show an average projected increase in precipitation of 9% between 2000 and 2100 (see Figure NOCA 1.7) However, the projected distribution of annual precipitation is uneven, with winters potentially becoming wetter and summers potentially becoming drier (see Figure NOCA 1.9). With warmer winters, the projected increase in seasonal precipitation could lead to a decrease in snow pack and an increase in winter rains. Additionally, twenty-year storm events are projected to occur four times more frequently, or every five years, which could increase the number of rain-on-snow events and subsequent flooding (see Figure NOCA 2.0), a trend that has been reinforced by observational park data in recent years. Heavier winter rains with less snowpack would mean decreased water availability in Rainbow Creek and within the water table into the late summer months. According to the park geologist, Jon Riedel, spring flows are expected to

PROJECTIONS DATA

Chelan County, WA

Emissions Scenarios Summary

Under the highest emissions scenario, *RCP8.5*, the climate models for Lake Chelan National Recreation Area project a 9% increase in precipitation and a 4.9° C (8.8° F) increase in temperature between 2000 and 2100 (see Figure NOCA 1.7). All four scenarios exhibit a trend of increased precipitation and temperatures although the models for highest emissions demonstrate the least amount of certainty.

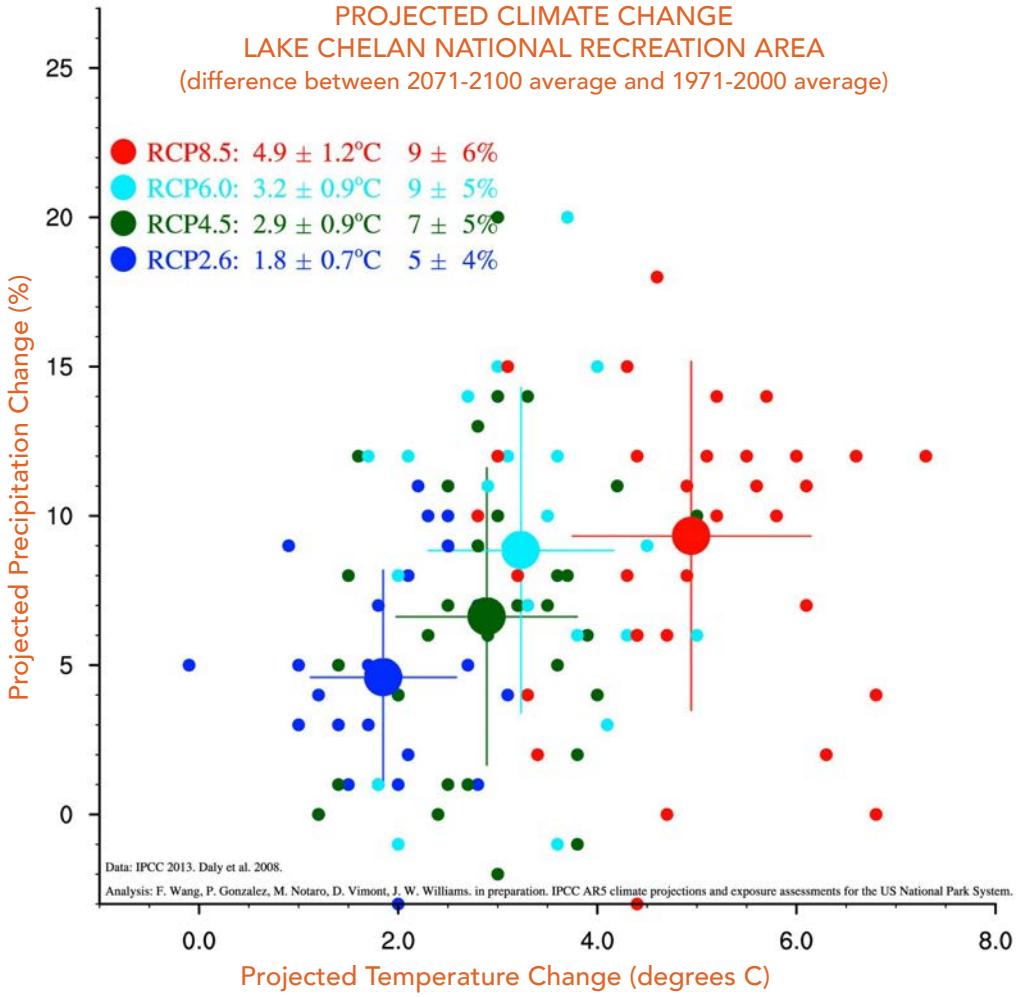


Figure NOCA 1.7: Projections of future climate for the area within park boundaries. Each small dot is the output of a single climate model. The large color dots are the average values for the four IPCC emissions scenarios. The lines are the standard deviations of each average value.

Gonzales, Patrick, "Climate Change Trends, North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area, Washington," Natural Resource Stewardship and Science Report, National Park Service, 2015.

PROJECTIONS DATA

Chelan County, WA

Maximum Air Temperature

Under the highest emissions scenario, *RCP 8.5*, average seasonal temperatures are projected to increase by 4.9° C (8.8° F) per century by the year 2100 with summers and winters showing the greatest rates of increase (see Figure NOCA 1.8).

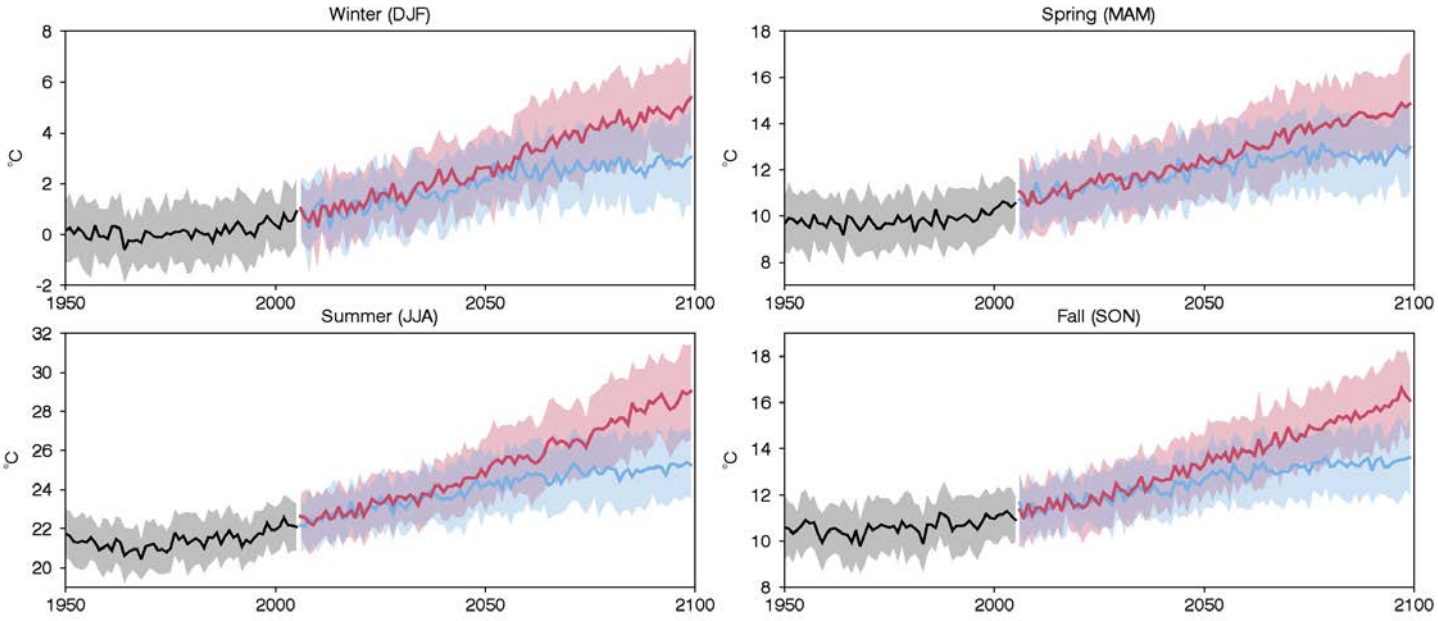


Figure NOCA 1.8: Seasonal average time series of maximum 2-m air temperature for historical (black), *RCP4.5*, and *RCP8.5*. The historical period ends in 2005 and the future periods begin in 2006. The average of 30 CMIP5 models is indicated by the solid lines and their standard deviations are indicated by the respective shaded envelopes.

Alder, J. R. and S. W. Hostetler, "USGS National Climate Change Viewer," *USGS*, 2013.

PROJECTIONS DATA

Chelan County, WA

Precipitation

Under the highest emissions projections, *RCP 8.5*, average precipitation is projected to increase by 9%/century by the year 2100 relative to 1950 (see Figure NOCA 1.9). However, the distribution of annual precipitation is uneven with winters potentially becoming wetter and summers potentially becoming drier. Additionally, 20-year storm events are projected to occur four times more frequently (see Figure NOCA 2.0).

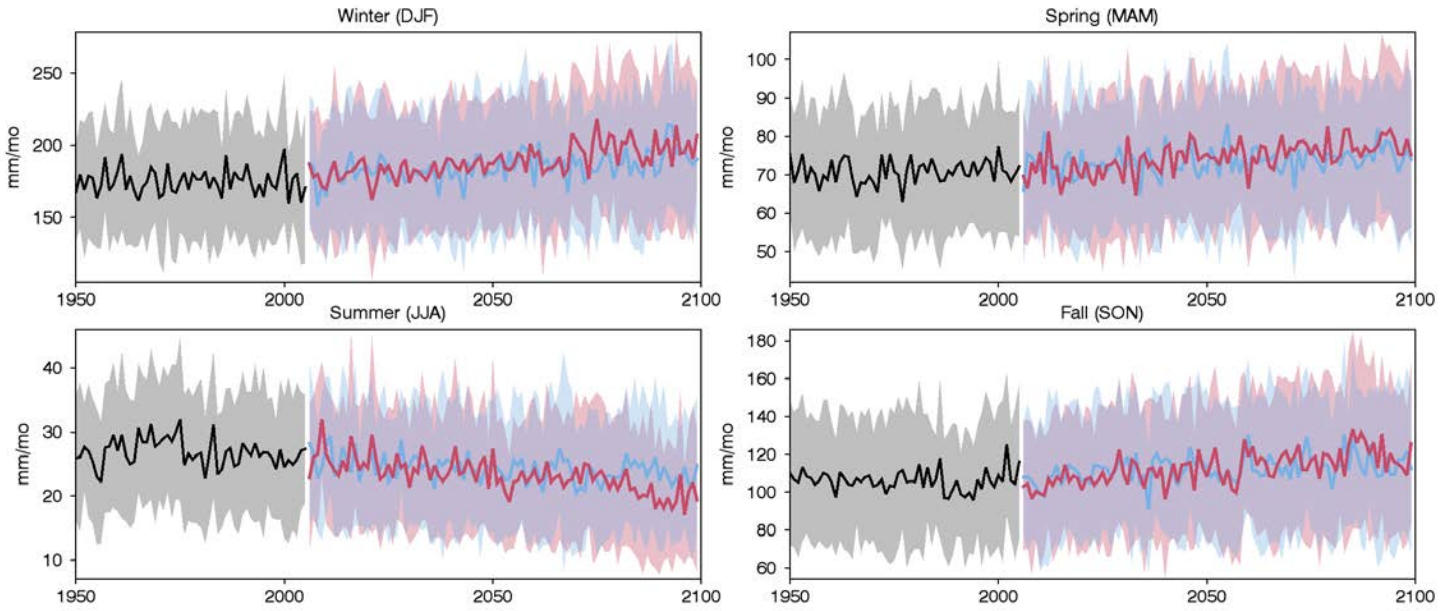


Figure NOCA 1.9: Seasonal average time series of precipitation for historical (black), *RCP4.5*, and *RCP8.5*. The historical period ends in 2005 and the future periods begin in 2006. The average of 30 CMIP5 models is indicated by the solid lines and their standard deviations are indicated by the respective shaded envelopes.

Alder, J. R. and S. W. Hostetler, "USGS National Climate Change Viewer," *USGS*, 2013.

Storm Frequency

STORM FREQUENCY PROJECTION DATA

CASE STUDY SITE	IPCC STORM FREQUENCY MULTIPLIER	20-YEAR STORM OCCURRENCE (YEARS)
NOCA	4	5.0

Figure NOCA 2.0: Projected changes in 20-year storm frequency for NOCA from the IPCC AR5 (2013). IPCC storm multiplier indicates the projected increase in frequency of 20-year storms. Occurrence indicates how that increase translates in the number of years.

PROJECTED EXPOSURE *(cont'd)*

peak earlier, too, which could result in less available water for irrigating the orchards when supplemental water is most needed. Flooding poses a continued risk to site stability, in light of apparent increases in severe event frequency since 1995 and the site's position relative to the 100 year FEMA floodplain below McGregor Meadows. This can also lead to a loss of vegetation along the river, resulting in continued erosion during heavy storm events. Decreased snowpack and subsequent lower summer stream flows could indirectly exacerbate the drought-related impacts described above (Mote et al. 2005). As snowpack decreases over time, the risk of winter floods may decrease over time, according to Riedel.

The combination of projected climate variables could lead to longer growing seasons in lower elevations, potentially favoring the continued encroachment of invasive species. Another associated risk are the three different varieties of tree rot that park staff have observed killing groups of native maple trees. Longer summers followed by warmer, wetter winters are less effective at keeping pests at bay, and can also increase the risk of wildfires. The unprecedented severity of the 2014 and 2015 Washington state fire seasons underline a concern for this hazard, reflected locally in the Okanogan Complex and Carleton Complex fire events. Subsequent years of alternating heavy winter flooding and summer drought could further exacerbate the effects of the previously discussed risks in unpredictable ways.

SENSITIVITY

Existing Ecological Processes

The analysis of existing ecological processes is based on NPS reports, other literature and documentation, and staff and research team field observations. Buckner Homestead is sensitive to temperature and precipitation variations. Individual features are sensitive to specific impacts. The overall assessment of sensitivity is included in the vulnerability matrix, below.

Although the retreat of glaciers in this region results in less snow pack and a 2-6% decrease in the amount of summer streamflow for much of the Stehekin Valley, Rainbow Creek is most at risk of a loss of snowpack which feeds groundwater reserves and the bulk of late summer streamflow (Riedel and Larrabee 2012). Glacial retreat also decreases the area exposed to late summer melt, reducing late summer water flow (Pelto 1992). Glacial retreat can impact the following cultural landscape characteristics through either/or increased flooding and decreased late summer water flow: natural systems and features (especially Stehekin

River flow, bank erosion, and degradation of pasture; seasonal flooding and seasonal reduced water flow in Rainbow Creek); spatial organization (orchard grid and irrigation system, especially main ditch); orchards (seasonal drought).

In the North Cascades region, vegetation at all scales is sensitive to temperature and precipitation variations, resulting in reduced tree vigor and increased tree susceptibility to insects and pathogens; increased potential for large and extensive insect and pathogen outbreaks; more fire (larger aerial extent, higher intensity, and increased frequency) and more area in recently burned or early successional stages. (Raymond et al. 2014) Following wildfire there is also the sensitivity to increased spread of invasive cheat grass (*Bromus tectorum)* (Agbalog 2010).

Temperature and precipitation sensitivities apply to: natural systems and features (surrounding forest, orchards); spatial organization (orchards and orchard grid); buildings (adjacent vegetation); orchards (apple varieties); ornamental vegetation; and archeological sites (grasses and shrubs).

Additionally, orchards, as a primary contributing characteristic and as individual features, are sensitive to: flooding from Stehekin River and Rainbow Creek; aphid infestation; powdery mildew on young trees, especially Jonathans; and bark loss.

In addition, cultural landscape characteristics and features are sensitive to the following impacts and hazards:

Natural Systems and Features: changes in river banks and course potentially affecting pasture and archeological site; increased intensity of floods during rain and snow events; invasive understory vegetation; high increase in invasive species due to disturbance from lightning strike fires.

Spatial Organization: irrigation system, especially the mainline ditch, affected by roots and erosion; main building cluster canopy, screening buildings from other areas; orchard grid, highly maintained trees have more vigorous growth.

Circulation: pasture access road flooding

Buildings: fire, snow load, mold/moss, rot due to poor drainage

Orchards: bark loss from elk herbivory (higher sensitivity in Common Delicious); frost damage due to exposed roots during winter; fire danger, soil compaction and loss of permeability from dry grasses in the orchard in summer; nutrition problems; compacted soils from wetter winters

SENSITIVITY (cont'd)

Ornamental Vegetation: no major issues, other than listed above.

Small Scale Features: no major issues

Archeological sites: less forest spread due to hotter, drier periods.

Existing Management Practices

The park is currently managing the resources based on ongoing response to current climate as well as numerous other factors. The park also recognizes the exposure and sensitivity of contributing cultural landscape features to projected climate variables beyond the historic range of variation.

Existing park management practices include extensive and cyclical use of historic orchard pruning,propagation, and grafting techniques in the apple orchards. These practices are based on research in historic techniques, completed by the NPS orchardist. The orchard irrigation ditches are maintained and repaired as needed, including the use of a weed whacker and propane burner to clear orchard irrigation ditch vegetation. Staff is careful to ensure that this practice does not alter the gradient of the ditches, which could negatively affect the flow of water.

As a part of the effort to maintain historic irrigation features and techniques, the water flow volume and rate from Rainbow Creek, through the main ditch to the orchard irrigation ditches, is carefully monitored. However, the main ditch is being eroded around the Rainbow Creek inlet (see Figure NOCA 1.3) which could become a concern with increased winter flooding. Encroaching trees in the main irrigation ditch are removed as necessary. Monitoring and precipitation levels are used to increase the orchard's watering regimen to offset reduced precipitation and a lower water table when necessary.

The orchards are mowed when dry (before irrigation) and then spot-mowed as needed. There is the potential to scalp berms and disturb invasive seeds during mowing. The park uses wide mower tires to reduce orchard soil compaction.

To offset the potential impact of wildfires, the park has established a fuel reduction buffer zone of 25 feet from the orchards' edge. The access road buffer is also maintained for fire safety.

The park maintains an active monitoring program of cultural landscape resources, including the Stehekin River bank's erosion; ground water levels; Douglas-fir beetle, lodge pole mountain beetle, budworm, bores,

and root rot infestation; snow load impactsto contributing historic structures; and wildfire.

The traditional use of the orchards is maintained, however the other historic resources of Buckner Homestead, including the houses, sheds, and barn, are not used in traditional ways. Although not conclusive, the absence of constant human presence and especially domestic dogs in this landscape, as there was during the period of significance, may have impacted the presence of bear and elk. Constructed fences and other barriers are used to limit orchard access for bear and elk.

Historic resources are maintained and managed using NPS historic preservation tools and techniques.

VULNERABILITY SUMMARY

Based on the historical and projected exposure and sensitivity analysis, Buckner Homestead Historic District is vulnerable to temperature and precipitation variations, that can lead to a significant decrease in snowpack and additional hazards including increased winter flooding, decreased late summer stream flows, increased erosion rates, and more frequent wildfires. These vulnerabilities and hazards will have direct impact on many of the cultural landscape contributing features, including: natural systems and features (surrounding forest, orchards, Rainbow Creek); spatial organization (orchards and orchard grid); buildings; orchards (dependent on variety); ornamental vegetation; and archeological sites (due to encroaching grasses and shrubs).

The vulnerability assessment matrix applies the vulnerability equation [*(historic exposure + projected exposure) x sensitivity = vulnerability*] to each Buckner Homestead cultural landscape feature. This results in the following overall vulnerability summary (low, medium, high, or very high) for each feature, providing the basis for setting management priorities (see Preliminary Vulnerability Matrix, Appendix A).

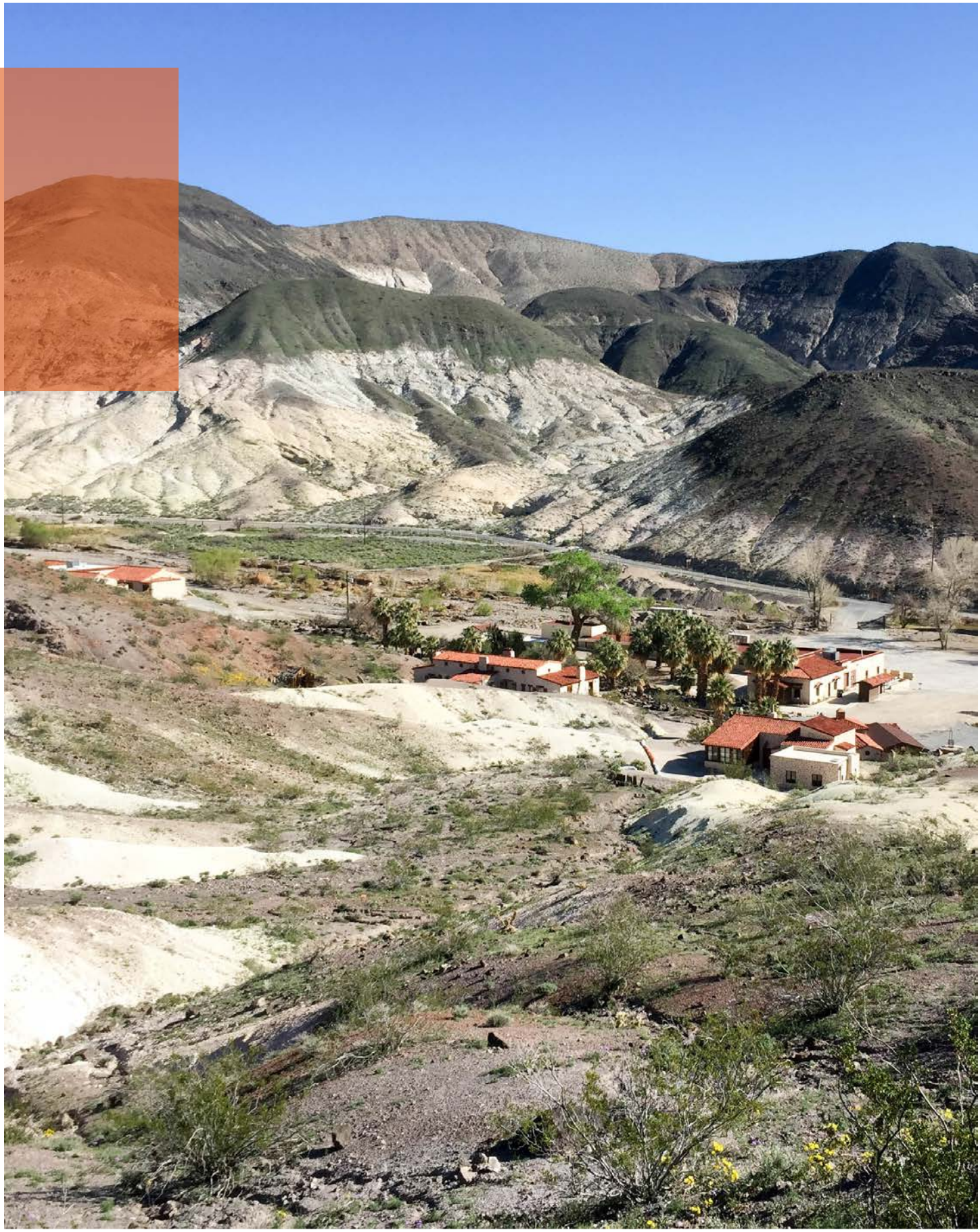


Figure DEVA 1.0: Death Valley Scotty Historic District, view southeast. (Kerr/UO CLRG, 2016)

DEATH VALLEY SCOTTY HISTORIC DISTRICT
DEATH VALLEY NATIONAL PARK, CA

Inyo County, CA

CULTURAL LANDSCAPE SUMMARY

- **Size:** 300 acres (121 hectares)
- **Cultural Landscape Type:** Designed
- **Period of Significance:** 1907 - 1954
  The period of time serves as a reminder of the excesses of mining promotion during the early 20th century, the frontier romanticism connected with it, and the conspicuous consumption practiced by the wealthy during the 1920s.
- **National Register Significance:** B
  Scotty's Castle is significant at the regional level under Criterion B for its association with one of the best known and most colorful figures produced by the American mining frontier — Walter Scott (a.k.a. Death Valley Scotty).
- **National Register Significance:** C
  Scotty's Castle is significant under Criterion C for its unusual and extravagant use of Spanish-styled architecture built in a remote desert location, and for the use of experimental building techniques and materials by its owner, Albert Johnson.

CHARACTER DEFINING FEATURES

- **Buildings and Structures:** annex, hacienda guest house, power house and pavilion, chimes tower, Scotty's cabin, gas house, stable, motel unit/ garage, entrance gate, lower grapevine ranch fe, wash house, upper tie storage area, tunnels, swimming pool, solar heater, Scotty's grave, cook house, gravel separator, powder storage, Scotty's Castle Annex, retaining walls
- **Circulation:** entrance road, Scotty's Castle building road, Tie Canyon access roads, water catchment, tile courtyard, stone walkways, concrete driveway, watercourse
- **Constructed Water Feature:** watercourse
- **Topography:** level terraces
- **Vegetation:** picnic area (cottonwood, willow, mesquite, palms), cottonwood corner (cottonwood, willow, mesquite, palms), building complex: palms, cholla cacti, and compatible Joshua tree and creosote bush

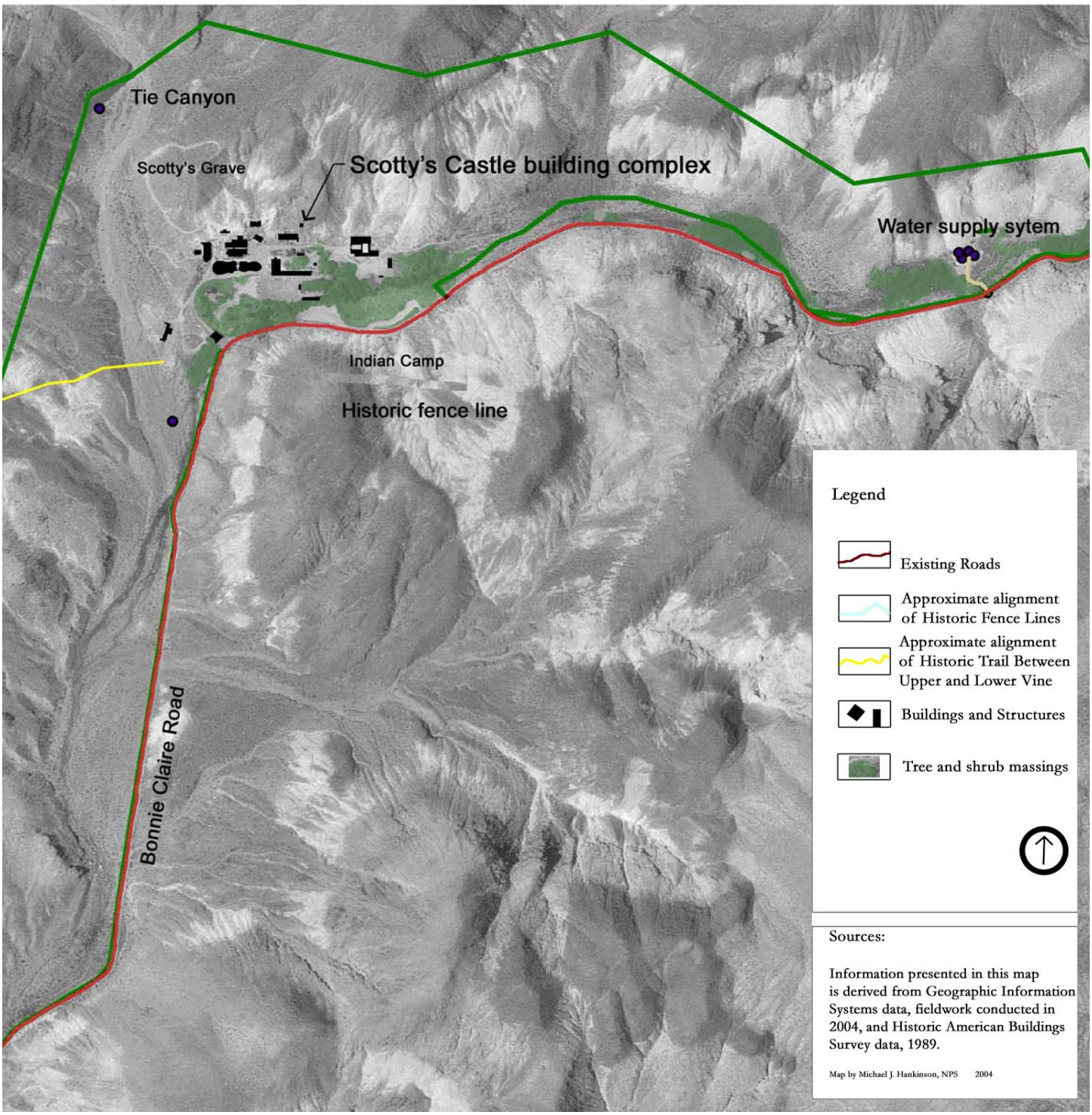


Figure DEVA 1.1: Excerpted site map of Death Valley Scotty Historic District from the most recent CLI.

EXPOSURE

The most detailed climate data available for the Death Valley Scotty's Historic District describes temperature and precipitation trends for the area contained within the national park boundaries as well as at park headquarters. For historical climate analysis, the following NPS sources were referenced: Climate change trends, vulnerabilities, and ecosystem carbon, Death Valley National Park, California (Gonzalez 2016) (see Figure DEVA 1.6); Recent Climate Change Exposure of Death Valley National Park (Monahan and Fisichelli 2014); and The Climate of Death Valley, California (Roof and Callagan 2003). The most recent Death Valley Scotty Historic District CLI was consulted for historical exposure and/or impacts. For current hazard risk assessments, the best available GIS data at the county level as of 2015 was used. This corresponds with Phase I of the project in which the initial quantitative analysis of exposure was conducted (see Appendix A: Exposure Matrix). Projected climate data was sourced from Gonzalez's source above with supplemental data and figures from the USGS Climate Change Viewer from 2013 (see Figure DEVA 1.8).

HISTORICAL EXPOSURE

Death Valley is one of the most extreme environments in the world (Roof and Callagan 2003) and it has historically been getting warmer. Average annual temperatures within park boundaries increased at a statistically significant rate of 1.3 ± 0.5°C (2.3 ± 0.9°F) per century between 1950 and 2010 while temperatures at park headquarters increased 2.1 ± 0.3°C (3.78 ± 0.5°F) per century between 1912 and 2015. The rates of historical temperature increase have been highest at higher elevations within the Saline Range and northwest section of the park. The lowest rates of historical temperature increase have occurred in the hottest part of the park— the valley floor (see Figure DEVA 1.6). Total annual precipitation within park boundaries increased slightly between 1950 and 2010, but the trend is not statistically significant. However, precipitationat park headquarters has increased at a statistically significant rate of 59 ± 21% per century between 1912 and 2015. Most annual precipitation is delivered during localized, singular storm events, so records at park headquarters do not necessarily reflect similar changes at Grapevine Canyon (Roof and Callagan 2003). The highest rates of historical precipitation increases have occurred on the valley floor (see Figure DEVA 1.6). Overall, there appears to be a warming trend that is noticeable throughout the year resulting in temperatures and even precipitation conditions that have already exceeded the historic range of variability within recent years (Monahan and Fisichelli 2014).

Despite the sporadic nature of storm events within Death Valley,

CURRENT SITE CONDITIONS



Figure DEVA 1.2: The stables sustained impacts from heavy debris flows during the 2015 flood. Debris has piled up against the walls just left of the photo. Note the sandbags intended to redirect future flows; view southeast. (Quiroz/UO CLRG, 2017)



Figure DEVA 1.3: A row of white sandbags (indicated) is intended to direct future storm flows away from the stables (midground). Note the heavily eroded slope in the foreground; view west. (Kerr/UO CLRG, 2016)



Figure DEVA 1.4: A view of the picnic area looking north/northeast towards Scotty's Castle from the entrance gate. Note the new vegetation and heavy erosion of the stream channel (bottom). (Quiroz/UO CLRG, 2017)



Figure DEVA 1.5: The district as seen from Scotty's grave; view southest. Note the exposed, loose canyon soils to the north of the district. The Hacienda's bottom floor (indicated) has flooded twice in the past. (Kerr/UO CLRG, 2016)

HISTORICAL DATA

Death Valley National Park, CA

Temperature and Precipitation Trends

Based upon available climate data, average annual temperatures within park boundaries increased at a statistically significant rate of 1.3 ± 0.5°C per century between 1950 and 2010 with an increase in total annual precipitation (though not at a statistically significant rate). Temperatures at park headquarters increased 2.1° ± 0.3°C per century between 1912 and 2015 while precipitation increased at the statistically significant rate of 59 ± 21% per century (see Figure DEVA 1.6).

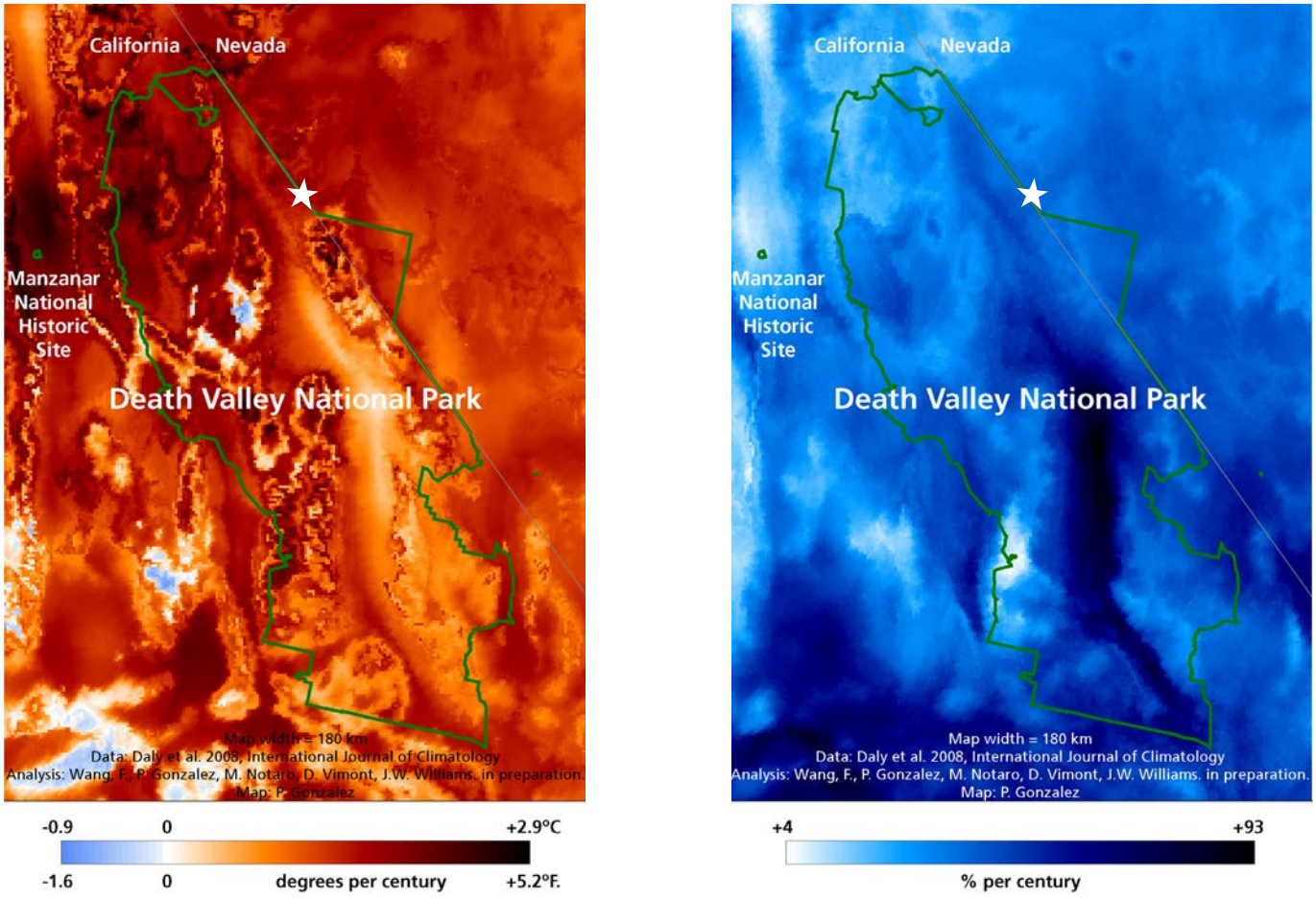


Figure DEVA 1.6: Historical trend in average annual temperature (above left) and total annual precipitation (above right) between 1950 and 2010.

Gonzales, Patrick, "Climate Change Trends, Vulnerabilities, and Ecosystem Carbon, Death Valley National Park, California," Natural Resource Stewardship and Science Report, National Park Service, 2016.

HISTORICAL EXPOSURE (cont'd)

there appears to be a pattern of temperature increase within the park boundaries. The total elevation change within Death Valley NP is approximately 11,329 ft with the highest point being Telescope Peak at 11,049 feet and the lowest being Badwater Basin at -282 feet (Burchfiel and Stewart 1966). Grapevine Canyon sits at just under 3,000 ft in elevation which is approximately 26.48% of the total elevation change of the park (Google Earth 2013). Based on the available data discussed above, the highest rates of temperature increase have occurred at the highest elevations while the highest rates of precipitation increase have occurred at the lowest elevations. This might suggest that temperatures within Grapevine Canyon have increased at a rate less than the park's average while the rate of increase for historical precipitation has likely been greater than the park's average. Observation data from park staff confirms that, in general, Scotty's Castle is about 10°F cooler than park headquarters, just north of Furnace Creek. We cannot assert that this pattern holds true across scales based on available data, however, it does highlight a potential relationship between precipitation and temperature trends within the park. Despite the discrepancy between rates of temperature and precipitation change, historical data suggest an overall warming trend for the entire park with significant precipitation increases at lower elevations.

In addition to temperature and precipitation variables, park records reveal that 21 out of 39 contributing buildings and features have been historically exposed to either water/wind erosion, and/or inundation and flooding (see Exposure Matrix, Appendix A). Of these, the horse stable, entrance gate, and lower grapevine ranch have been historically exposed to all three identified hazards. Buildings and structures that have been exposed to two of the three hazards are the power house pavilion, chimes tower, Scotty's cabin, gas house, motel unit/garage, wash house, and Upper Tie storage area. Three of seven circulation features have been exposed to water/wind erosion, all of which are major access roads. The main entrance road has also been exposed to inundation/flooding, making it the most at-risk circulation feature. Additionally, the main water course, which is a constructed water feature, has been historically exposed to plant species disruption. In total, water/wind erosion has historically impacted 17 features, exposure to the elements has impacted 12 features, inundation/flooding has impacted 11 features, and species disruption has impacted 1 feature.

The observed impacts of the 2015 flood support these historical data. Although not all exposed features were impacted, those that were have a documented history of exposure. The features impacted the most by 2015 inundation/flooding were the hacienda and the motel unit/garage, which

HISTORICAL EXPOSURE (cont'd)

have been exposed to the elements and flooding in the past. Although the entrance gate is one of the most exposed features, an assessment by the NPS Vanishing Treasures Program, conducted after the 2015 flood, concluded that the feature is still structurally sound and that the present cracks are a result of seismic activity rather than flood-driven foundational undermining. Other impacted features were the hacienda, the chicken yard, Cottonwood corner, the vegetation in the picnic area, and the main entrance road. The hacienda is located at the mouth of a canyon arroyo and, as a result, experiences basement flooding regularly during rain events. Much of the vegetation in the spring bed has been altered while native vegetation has vigorously colonized the stream bed since the flood.

As for planted vegetation, it is unclear whether the historic cottonwoods are declining or responding to the disturbance. More time is needed to determine if the observed limb loss and abundant root clonal suckering are symptoms of seasonal water stress and flood-related shallow root scarification (Rood et al. 2010) or signs of a lower water table caused by flood channel incision (Scott et al. 2000). Finally, the main entrance road was impacted the heaviest by the 2015 flash flood. Entire portions of the road fell away or were completely undermined by flood waters. As of this writing, the road remains closed.

GIS Analysis

GIS analysis was used to assess the current exposure of contributing features to the following natural hazards: fire, flood, landslide, and drought. The entire cultural landscape is at a 30% risk of exposure to fire. According to the same GIS data, there is a 0% risk of current exposure to flood and landslides, with no drought information available. It's not clear why the GIS data lacked flood information within Grapevine Canyon. It could be surmised that flash flood data were not captured within the flood category, but again, this is only speculation.This gap between historical and observational data reveals that the flood and overall hazard values are most likely too low for Scotty's Castle (see Exposure Matrix, Appendix A).

PROJECTED EXPOSURE

Different climate models for precipitation within Death Valley National Park do not agree, although the averages from each emissions scenario show a warming trend. This could be attributed to the major differences observed between rates of precipitation increase at low and high elevations, resulting in varying averages for the entire area within park boundaries. Projections under the highest emissions scenario show an increase in temperature of +4.9 ± 1.0°C (+8.8 ± 1.8°F) as compared to

PROJECTIONS DATA

Death Valley National Park, CA

Emissions Scenarios Summary

Climate models for precipitation do not agree, however, projections under the highest emissions scenario display an increase of 4.9 ± 1°C by 2100 (see Figure DEVA 1.7).

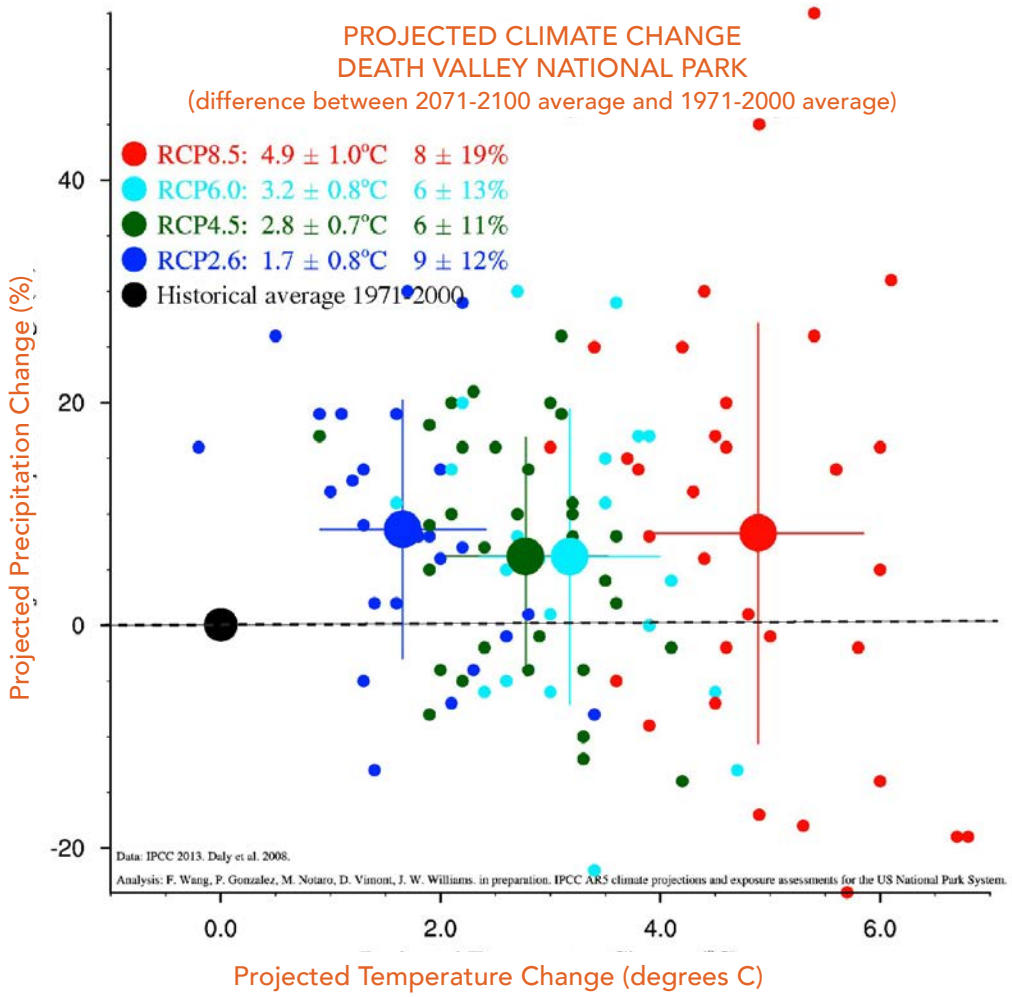


Figure DEVA 1.7: Projections of future climate for the area within park boundaries. Each small dot is the output of a single climate model. The large color dots are the average values for the four IPCC emissions scenarios. The lines are the standard deviations of each average value.

Gonzales, Patrick, "Climate Change Trends, Vulnerabilities, and Ecosystem Carbon, Death Valley National Park, California," Natural Resource Stewardship and Science Report, National Park Service, 2016.

PROJECTIONS DATA

Inyo County, CA

Maximum Air Temperature

Under the highest emissions projection, *RCP 8.5*, temperatures are projected to increase 5.3° C (9.5° F) by the year 2100 (28.7° C/83.6° F) relative to 1950 (see Figure DEVA 1.8).

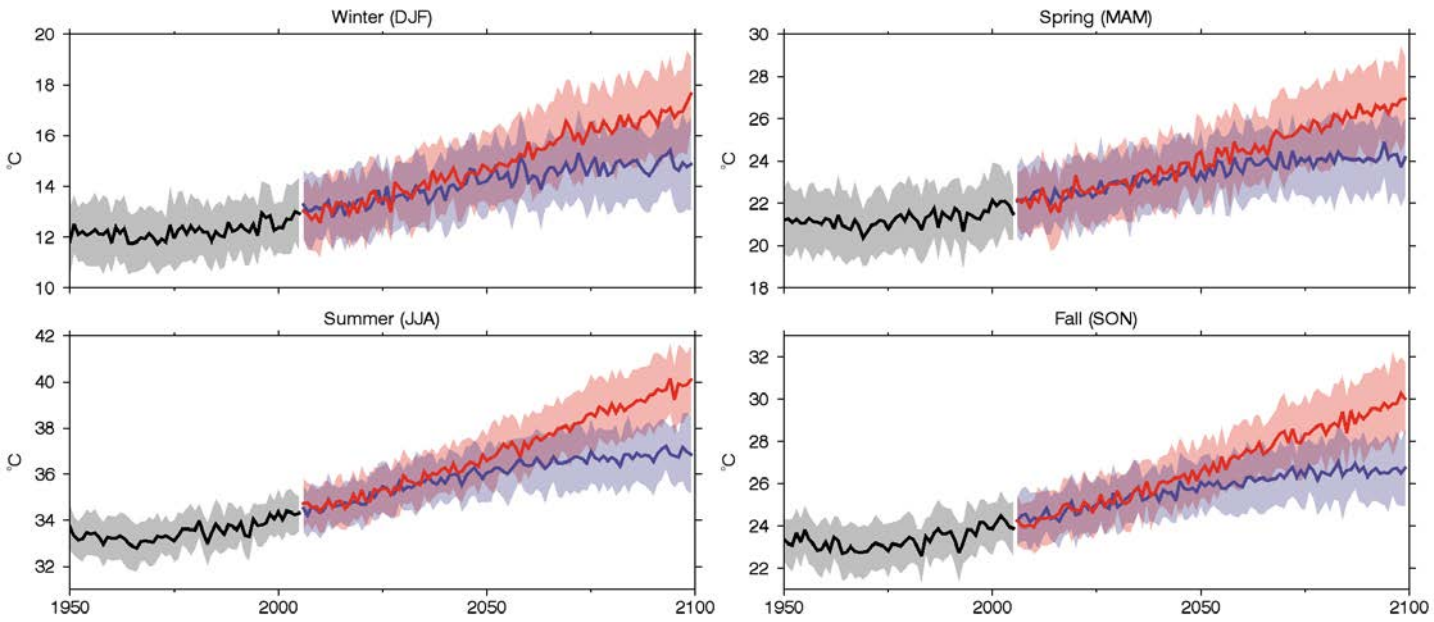


Figure DEVA 1.8: Seasonal average time series of maximum 2-m air temperature for historical (black), *RCP4.5*, and *RCP8.5*. The historical period ends in 2005 and the future periods begin in 2006. The average of 30 CMIP5 models is indicated by the solid lines and their standard deviations are indicated by the respective shaded envelopes.

Alder, J. R. and S. W. Hostetler, "USGS National Climate Change Viewer," *USGS*, 2013.

PROJECTIONS DATA

Inyo County, CA

Precipitation

Regardless of emissions scenario, uncertainty around precipitation projections show a range of a 0.0 mm/day to a 0.2 mm/day increase by 2100. The modern value is 0.5mm/day (see Figure DEVA 1.9). Projections under the highest emissions scenario also display an increase in 20-year storms to once every 5-10 years (see Figure DEVA 2.0).

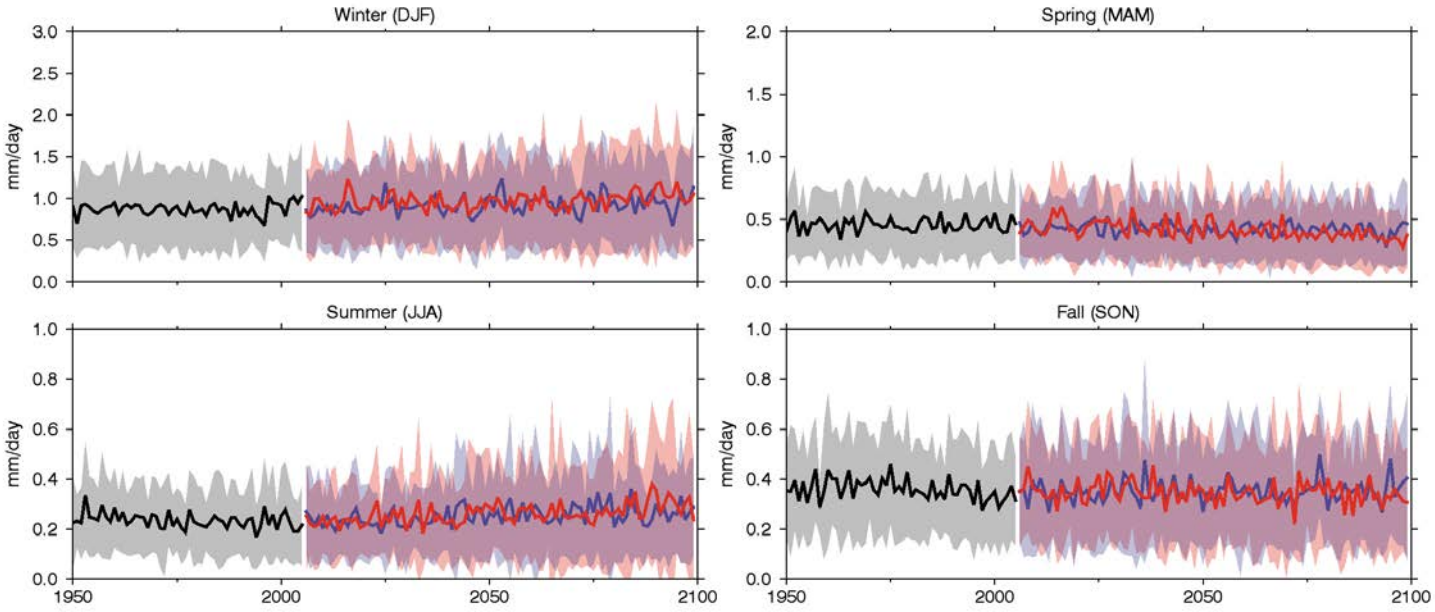


Figure DEVA 1.9: Seasonal average time series of precipitation for historical (black), *RCP4.5*, and *RCP8.5*. The historical period ends in 2005 and the future periods begin in 2006. The average of 30 CMIP5 models is indicated by the solid lines and their standard deviations are indicated by the respective shaded envelopes.

Alder, J. R. and S. W. Hostetler, "USGS National Climate Change Viewer," *USGS*, 2013.

Storm Frequency

STORM FREQUENCY PROJECTION DATA

CASE STUDY SITE	IPCC STORM FREQUENCY MULTIPLIER	20-YEAR STORM OCCURRENCE (YEARS)
DEVA	2	10.0

Figure DEVA 2.0: Projected changes in 20-year storm frequency for DEVA from the IPCC AR5 (2013). IPCC storm multiplier indicates the projected increase in frequency of 20-year storms. Occurrence indicates how that increase translates in the number of years.

PROJECTED EXPOSURE *(cont'd)*

1971 with an increase of 5 to 25 more days per year with a maximum temperature of >95°F (see Figure DEVA 1.7).

Projections data for the county suggests that under the highest emissions scenario, temperatures are projected to increase 5.3°C (9.5°F) by the year 2100 (28.7°C/83.6°F) relative to 1950 (see Figure DEVA 1.8). Increased temperatures can increase water stress on native vegetation as a result of increased evapotranspiration rates, especially during summer when temperatures are projected to increase the fastest. Death Valley NP has already experienced a ~4% decrease in carbon storage (vegetation) between 2001 and 2010. Some of these losses have occurred around Telescope Peak, the highest point in the park, where historic rates of temperature increase are one of the highest (Gonzalez 2016). Increased temperatures could lead to a loss in vegetation along these slopes which would result in decreased sediment stability and an increased risk of erosion and inundation during storm events. Hotter temperatures could also lead to decreased snowpack in the mountainous areas which recharge Death Valley's seeps, springs, and wetlands (Gonzalez 2016). This may have little effect on the spring at Scotty's Castle, however, since its supply is not dependent on snowmelt or other current recharge rates as it is connected to a remnant supply from the last glacial maximum (Bedinger and Harrill 2012). However, unpredictable shifts in the streambed as a result of major floods could render the spring unavailable for use at Scotty's Castle, both within the building and for cottonwood corner

Different emissions scenarios reveal uncertainty around precipitation. Projections for Inyo County show a range of a 0.0 mm per day to a 0.2 mm per day increase by 2100 (see Figure DEVA 1.9). Summers show a slightly increasing trend while the fall shows the most uncertainty. Projections under the highest emissions scenario also display an increase in 20-year storms to once every 5-10 years (see Figure DEVA 2.0). An increase in storm events can result in a greater risk of flash floods, debris flows, and mass wasting (heavy erosion) which can lead to serious damage of features that are on or adjacent to the canyon walls or riparian corridor, such as the spring houses, stables, and motel unit. A higher occurrence of flood events could also continue to undermine circulation and the spring's underground course, which is likely to fall deeper as flood waters incise the corridor further (Scott et al. 2000). The scouring capacity of flash floods can be exacerbated by higher rates of native vegetation mortality along steep slopes where soils are already vulnerable to erosion.

Despite the disagreement surrounding precipitation projections, the increased likelihood of heavier storm events has been observed in recent years and is supported by historical exposure data. With most of Death

Valley's precipitation delivered via punctuated events, the increased likelihood of flash floods coupled with added debris, and decreased canyon stability could result in faster, more extreme flood events. It's unclear how hotter summers and average temperatures could directly impact built features or influence wind erosion, which is a significant hazard at Scotty's Castle.

SENSITIVITY

Existing Ecological Processes

The analysis of existing ecological processes is based on NPS reports, other literature and documentation, and field observations from staff and the research team.

Death Valley Scotty Historic District is sensitive to three major existing ecological processes: flood events outside the historic range of variation, increased erosion rates, and changes in groundwater levels. Individual features are sensitive to specific impacts. The overall assessment of sensitivity is included in the vulnerability matrix, below.

The historic flood event of 2015 exceeded the historic range of variation for floods. The impacts on the Death Valley Scotty Historic District were the result of a discrete event rather than a trend. While it is not possible to predict how often similar storm events will occur, or at what intensity, IPCC data projects that the 20-year storm cycle will increase to an average of once every 10 years (IPCC ARS 2013). Depending on the storm intensity, many of the cultural landscape features will be sensitive to the acceleration of the storm cycle, including: buildings and structures, circulation, constructed water features, vegetation, topography, archeological sites, and natural systems and features.

It is projected that groundwater levels will drop up to 2 meters, exacerbating conditions of limited water supply in the region and park (Fisk 2011). While there is no similar study for the historic district or Grapevine Canyon, it can be projected that the district will face a similar situation. Frequent flooding may also cause the spring's course to continually change by surfacing in some places and falling deeper in others as the underground bed shifts with material movement. Several cultural landscape features will be sensitive to this change, especially vegetation in the lower topographic levels of the canyon and site, and water flow in constructed water courses.

In addition to sensitivity to storm events and lowered groundwater levels, cultural landscape characteristics and features are sensitive to the following impacts and hazards:

SENSITIVITY *(cont'd)*

Circulation: increased erosion

Buildings: increased flooding and/or debris damage to buildings adjacent to northern canyon

Spatial organization: potential decline of Cottonwoods at picnic area; migration of planted palms

Constructed water features: invasive/non-historic plants

Vegetation: vegetation on hillsides and within riparian zone susceptible to repeat flood damage

Topography: Tie Canyon heavily impacted by the flood; Grapevine Canyon channel was changed by flood; heavy erosion

Archeological Sites: Indian Camp site impacted by flood.

Buildings: alluvial material eroding down hills into north side of buildings; spring house sensitive due to location; potential for future flood to undercut gatehouse soils.

Natural Systems and Features: 9,000 square foot aquifer with no monitoring system at Grapevine Canyon. (See comments above regarding projected change in groundwater levels for the park).

Existing Management Practices

The park recognizes the sensitivity of contributing cultural landscape features to projected climate variables beyond the historic range of variation, and has undertaken preservation management efforts, other maintenance actions, and, in some cases, traditional uses. Many of these are site scale efforts and actions, in continuing response to the impacts of the 2015 major storm event.

A number of efforts have been directed towards mitigating the impacts of regular storm events, especially runoff and historically minor floods, within the historic range of variation. There is extensive use of sandbags to divert runoff from hillside north of the historic district. The park has constructed stone-filled wire gabion berms on the east side of the historic district (east of the pump house), to divert future flood waters. As of August 2017, there is a proposed project to design and construct new flood protection structures, including dikes, berms and paved ditches, primarily on the east side of the historic district, to divert flood waters from historic resources and visitor use areas.

The current cooling system will be converted to a closed system, without the need for spring water, resulting in 60,000 gallons of water discharged from the spring into the wash, unlike in the recent past. This may make more water available to the historic Cottonwoods, and also increase the growth of riparian vegetation. The park plans to monitor vegetation growth on a regular basis.

In addition to the decreased groundwater levels discussed above, the historic district is also sensitive to the groundwater pumping outside the park to satisfy urban water demands in the Las Vegas Area, mining operations, irrigation, and development of a high-level radioactive waste dump (Yucca Mountain, Nevada) (Pringle 2001).

The traditional use of the historic district, as a popular visitor destination, has been suspended until site repair from the 2015 flood is completed. Historic resources are being restored and maintained using NPS historic preservation tools and techniques.

VULNERABILITY SUMMARY

Based on the historical and projected exposure, and sensitivity analysis, Death Valley Scotty Historic District is vulnerable to projected increased temperatures, more intense and more frequent storm events and flash floods, and increased fire exposure, with uncertainty regarding precipitation projections. These vulnerabilities and hazards, primarily flood events outside the historic range of variation, will have direct impact on many of the cultural landscape contributing features, including: buildings and structures, circulation, constructed water features, vegetation, topography, archeological sites, and natural systems and features.

The vulnerability assessment matrix applies the vulnerability equation [***(historic exposure + projected exposure) x sensitivity = vulnerability***] to each Death Valley Scotty Historic District cultural landscape feature. This results in the following overall vulnerability summary (low, medium, high, or very high) for each feature, providing the basis for setting management priorities (see Vulnerability Assessment Matrix, Appendix B).



Figure REDW 1.0: Lyons Ranches, in the Bald Hills of Redwood National Park, is set within the prairies and oakwoods of the Redwood Creek watershed. (Kerr/UO CLRG, 2016)

LYONS RANCHES RURAL HISTORIC DISTRICT
REDWOOD NATIONAL PARK, CA

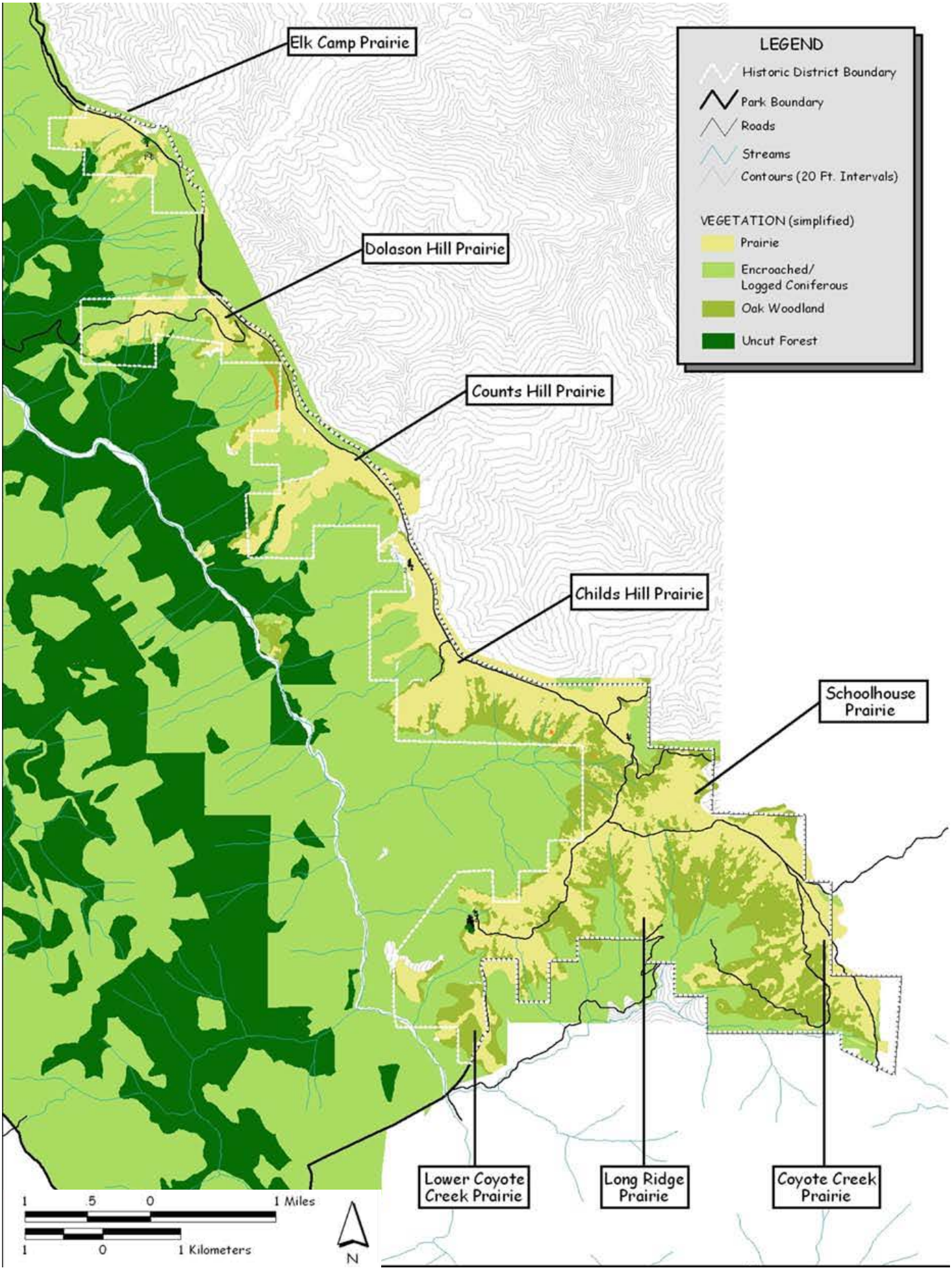
Humboldt County, CA

CULTURAL LANDSCAPE SUMMARY

- **Size:** 5,660 acres (2,290 hectares)
- **Cultural Landscape Type:** Historic Vernacular Landscape
- **Period of Significance:** 1868 - 1959
  The District's period of significance under Criteria A and C begins in 1868, the time by which Jonathan Lyons had settled on land in the District, and continues through 1959. The end date of 1959 represents the end of the period for which sheep ranching was a major economic presence in the Bald Hills.
- **National Register Significance:** Criterion A
  The District is significant under Criterion A at the local level for its association with the history and development of the Bald Hills as a sheep ranching community and for its association with settler and Native American economic cooperation.
- **National Register Significance:** Criterion C
  The District is significant under Criterion C at the local level as an example of a large-scale sheep ranching landscape in the Bald Hills and for its incorporation of traditional Native American skills in construction.

CHARACTER DEFINING FEATURES

- **Archaeological Sites:** collapsed barn, Elk Camp outhouse ruin, Dooleyville barn ruin, Home Place cemetery, Childs Hill prairie, Schoolhouse site
- **Buildings and Structures:** Coyote Creek: line cabin, outhouse, sheep shed; Dooleyville line cabin, Elk Camp: garage, retaining wall, sheep shed; Home Place: barn, bunkhouse, shed; Lane House; Long Ridge: herder's trailer and sheep shed; stock ponds; well
- **Circulation:** Bald Hills School Road, Coyote Creek Road, Coyote Peak Road, Coyote Peak Spur,
- Elk Camp Road, Home Place Cemetery Trail, Long Ridge Road, Lyons Road, Main Stem Road, Maneze Road, Ranch Road, Rock Fork Road, Schoolhouse Pasture Road, T. Bear Road, Upper, Lyons Road
- **Cluster Arrangements:** Coyote, Elk Camp, Home Place, Long Ridge
- **Small Scale Features:** concrete troughs, Coyote pipelines, ranch fencing, spring boxes
- **Spatial Organization:** prairies, development adjacent to prairies, roads connecting prairies and developed areas, grazing fences
- **Topography:** road prisms, stock tanks, ditches, **structure/staging sites**
- **Vegetation: Elk Camp, Childs Hill Prairie, Schoolhouse site, Manez Road, Home Place**


Elk Camp Prairie
Dolason Hill Prairie
Counts Hill Prairie
Childs Hill Prairie
Schoolhouse Prairie
Lower Coyote Creek Prairie
Long Ridge Prairie
Coyote Creek Prairie
LEGEND
Historic District Boundary
Park Boundary
Roads
Streams
Contours (20 Ft. Intervals)
VEGETATION (simplified)
Prairie
Encroached/ Logged Coniferous
Oak Woodland
Uncut Forest
1 5 0 1 Miles
1 0 1 Kilometers
N

EXPOSURE

The best available data were used to analyze Lyons Ranches' historical and projected exposure to climate variables at the park scale. For historical climate analysis, the following NPS sources were referenced: Climate change trends, vulnerabilities, and ecosystem carbon, Redwood National Park, California (Gonzalez 2015) (see Figure REDW 1.6); Recent Climate Change Exposure of Redwood National Park (Monahan and Fisichelli 2014); Fire history of coast redwood forests in Lower Prairie Creek, Redwood National Park (Kane and Engber 2015); and Ecology of the Bald Hills and Little Bald Hills of Redwood National Park: An assessment of vegetation change (Varner et al. 2012). The most recent Lyons Ranches Historic District CLI (2004) does not include historical exposure data to climate-related hazards. Available Schoolhouse Peak station logs and/or fire weather data sheets spanning the years 1948-2001 (excluding 1961-1974 and 1990-1992) were also referenced. These records provide multiple weather variables collected daily throughout the interannual fire seasons (July-October) but were excluded from historical exposure analysis due to informational gaps resulting from illegibility, unfamiliar and unexplained coding systems, and/ or data inconsistencies between years. There is a need for statistical analysis to translate the available data into interpretable figures. Current exposure analysis for the vulnerability matrix was drawn from 2015 GIS data at the county level and supplemented by sources mentioned above. Projected climate analysis included data and figures from Gonzalez's aforementioned source with supplemental data and figures from the USGS Climate Change Viewer from 2013 (see Figure REDW 1.8).

HISTORICAL EXPOSURE

The Bald Hills region of Redwood National Park is defined by Oregon oak (Quercus garryana) woodlands and diverse herbaceous grasslands, which sets it apart from the rest of the park's coniferous landscape (Sugihara and Reed 1987). It's believed that this open habitat has been defined by a frequent fire regime that has declined since 1850 despite burning, planting, and grazing practices that continued through the site's ranching period. This has led to the gradual encroachment of Douglas-firs, resulting in darker, damper, wind-resistant forests that demonstrate decreased flammability during controlled burns (Varner et al. 2012).

Historical climate data for Redwood National Park reveals that average annual temperatures and total annual precipitation within park boundaries have decreased since 1950 but not at statistically significant rates. Fall months (September-November) however, have exhibited a statistically significant decrease in precipitation at a rate of -57 ± 26% per century (see

Figure REDW 1.1: Excerpted site map of Buckner Homestead Historic District from the most recent CLI.

HISTORICAL EXPOSURE (cont'd)

Figure REDW 1.6). Overall, recent climatic conditions within the park have fallen within the historical range of variability (Monahan and Fisichelli 2014).

Spring months (March-May) have shown the greatest increase in temperature at a rate of 1.1 ± 0.7°C (2 ± 1.6°F) per century. Drier fall months are more closely associated with an increase in the risk of wildfires since annual precipitation negatively correlates with the frequency of fire returns. Changes in temperature, on the other hand, have less of a correlation with wildfire frequency. This is supported by the fact that most historical fires occurred in late summer and early fall months for adjacent redwood public lands (Engber et al. 2015). Landscape flammability could potentially be compounded by repeat years of summer drought but the long-term trend of precipitation changes remains unclear.

The most recent CLI (2004) contains no information regarding exposure to natural hazards and/or events (see Exposure Matrix, Appendix A). As a result, the average score for CLI impacts remains undetermined even though there is an established history of fire and earthflows. Even with the lack of historical hazard data from the CLI, findings suggest that observed decreases in precipitation could lead to an increased risk of wildfires for the Bald Hills.

GIS Analysis

According to available GIS data for Humboldt County (2015), Lyons Ranches Rural Historic District contains 44 contributing features that are currently at risk of either fire or landslide (see Exposure Matrix, Appendix A). According to park staff, there is no history of landslides at Lyons Ranches, however, the presence of creep and earthflows (which are slower geologic processes) dominate hillslopes of the Redwood Creek basin (Swanston et al. 1980). Currently exposed features belong to the following characteristics: buildings and structures, circulation, cluster arrangements, natural systems and features, small scale features, spatial organization, topography, and vegetation. This includes all buildings and structures at Coyote Creek, Dolason, Dooleyville, Elk Camp, Home Place, and Long Ridge, with the exception of the well. The stock ponds are also listed under buildings and structures. These features are at 50% risk of earthflow or creep, which can be exacerbated by heavy rains. Although some shallow earthflows can be slowed down by extreme drought, heavy rains may also speed up the rate of movement of deeper earthflows as water can permeate further via cracks, increasing the chance of unprecedented response rates (Bennett and Roering et al. 2016). Further analysis of the soil depth at Lyons Ranches is needed to determine the site's susceptibility to precipitation-linked changes in earthflow dynamics.

HISTORICAL DATA

Redwood National Park, CA

Temperature and Precipitation Trends

Based upon available climate data, average annual temperatures within the park have increased since 1950, but the rate has not been statistically significant. Spring (March-May) temperatures have shown the greatest increase at 1.1 ± 0.7° C (2 ± 1.6° F) per century. Total annual precipitation has decreased since 1950, but the rate has not been statistically significant. Autumn (September-November) precipitation has decreased at a statistically significant rate of -57 ± 26% per century (see Figure REDW 1.6).

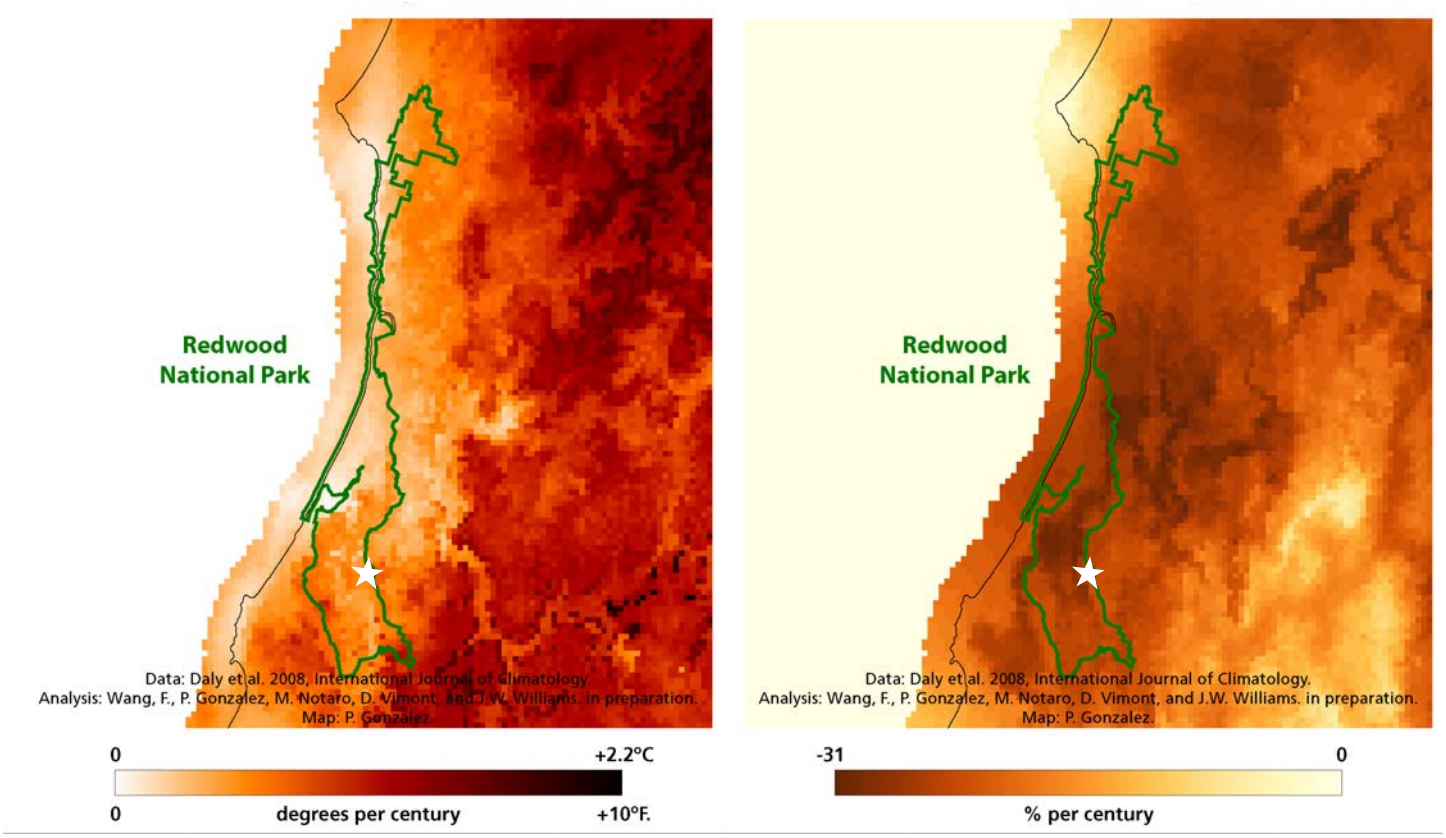


Figure REDW 1.6: Historical trend in average annual temperature (above left) and total annual precipitation (above right) between 1950 and 2010.

Gonzalez, Patrick, "Climate Change Trends, Vulnerabilities, and Ecosystem Carbon, Redwood National Park, California," Natural Resource Stewardship and Science Report, National Park Service, 2015.

CURRENT SITE CONDITIONS



Figure REDW 1.2: Bald Hill Road runs along the ridge and is cut into slopes, potentially making them more sensitive to heavy rains. Note encroaching Douglas-firs to the left; view south. (Kerr/UO CLRG, 2016)



Figure REDW 1.3: Home Place barn is exposed to potential increases in storm frequency and resulting damage. Note the Douglas-fir sapling in the foreground; view northwest. (Kerr/UO CLRG, 2017)



Figure REDW 1.4: Schoolhouse Prairie historic fruit tree in decline; view south. (Kerr/UO CLRG, 2016)



Figure REDW 1.5: Concrete trough at School House prairie. Note the encroaching vegetation along the prairie's edge (top of photo) and declining fruit trees (upper right corner); view southwest. . (Kerr/UO CLRG, 2016)

HISTORICAL EXPOSURE (*cont'd*)

Although not usually catastrophic, earthflows and creep do cause a significant amount of structural damage over time.

Additionally, these built features, except for the Elk Camp retaining walls, have at least a 60% risk of fire. The Long Ridge herder's trailer and sheep shed fall under this category while the remainder of the contributing buildings and structures (11 total) have a 100% risk of fire. Eight circulation features (Bald Hills School Road, Coyote Creek Road, Coyote Peak Road and spur, Elk Camp Road, Home place Cemetery Trail, Long Ridge Road, and Lyons Road) also share a 100% risk of fire and 50% risk of landslide. While it's unclear what the implications of fire are for these circulation features, earthflows and creep pose an understandable threat to the stability of roadways. All remaining features within topography, small scale features (troughs pipelines, and fencing), natural systems and features (ephemeral seeps, streams, and springs), vegetation, spatial organization, and cluster arrangements are at 100% risk of fire and 50% risk of landslides, except for the coyote pipelines which have a 60% risk of fire. The reduction of fire risk in the latter is unclear. The only features that do not fall into these risk categories are five remaining roads, two spring boxes, staging sites, and the natural systems and features that do not correlate with a specific size or location, such as grasslands and the identified Mediterranean climate. Such a continuously high risk of fire is consistent with the area's history of wildfiresIt's important to acknowledge that ranching operations, which began in 1858, likely kept conifer encroachment at bay and maybe even expanded the prairie's edges.

Since then, conditions created by conifer encroachment have likely decreased the amount of grassy fuels, which aid the spread of wildfires (Varner et al. 2012). Dating of the fire events that contribute to available GIS data is unclear although, according to park staff, GIS fire data within the Bald Hills is based on prescribed fires that park staff have been implementing for management purposes (with the exception of the Xoannatukk fire in 2003) (Redwood National Park: Fire Regime 1998-2011). It can be concluded, however, that the prominence of fire within Bald Hills will most likely continue, especially if precipitation decreases, since as mentioned above, is more closely associated with a higher frequency of fires than high temperatures.

In summary, the bulk of the features that make up Lyons Ranches are currently at serious risk of wildfires and medium risk of damage from earthflows and/or creep, with few exceptions. Condition assessments of the cultural landscape rated all features as "fair", which is an intermediary score, and thus increases the overall average hazard score to a 37.5%

for the contributing features that are at 100% risk of fire and 50% risk of landslides.

PROJECTED EXPOSURE

As with historical precipitation trends, future climate models for Redwood National Park disagree on projections for average annual precipitation. Under the highest emissions scenario, precipitation output projections vary widely but the most recent IPCC model (RCP 8.5) shows an annual total precipitation increase of +4% by 2100. Annual average temperatures are projected to increase at a rate of +3.8°C (+6.8°F) per century by 2100 with up to five more days per year with a maximum temperature of >35°C (95°F) (see Figure REDW 1.7).

It is unclear, however, whether projected increases for precipitation for the park are applicable to the Bald Hills. Much of the park's precipitation is delivered via coastal fog, and although a notable study shows that this trend is decreasing, such findings are still considered inconclusive by park staff (Johnstone and Dawson 2010). Additionally, projections disagree. According to Figure REDW 1.7, projected relative increases could be due to the significant dip in precipitation that occurred during the 1970s, the fall-then-rise of which may have obscured any larger trend. This discrepancy could also be attributed to the major variation of interannual seasonal rainfall in addition to the differences in precipitation amounts recorded as fog at varying elevations. Over the last century, however, there has been an observed decrease in summer fog within Redwood National Park but further analysis is needed to determine more accurate estimates as the reliability of methods varies. Furthermore, how much precipitation reaches the Bald Hills as fog is also unclear (Johnstone 2010).

In general, higher elevations, lower relative latitudes, and less influence of fog correlate with drier conditions, higher incidence of lightning strikes, and more frequent fires as compared with surrounding redwood-dominatedareas (Kane and Engber 2015). Seasonal projections show consistently warmer temperatures throughout the year for the county, which could reduce the amount of fog that reaches the Bald Hills and potentially prolong seasonal drought conditions and/or extend the fire season. Increased water stress could make native black oaks more susceptible to Sudden Oak Death. Coniferous stands, especially Douglas-fir on exposed slopes, could also be impacted by hotter summers, leading tanincrease in mortality rates. Extended fire season conditions could be exacerbated by a trend towards slightly drier fall months and wetter winter months, suggesting that rains will start later but occur more frequently and/or intensely in winter (see Figure REDW 1.9). This coincides with the projected increase in historical 20-year storm events to occur once every 6-7 years (see Fig-

PROJECTIONS DATA

Redwood National Park, CA

Emissions Scenarios Summary

Various climate models disagree on projections for average annual precipitation, with half showing an increase and half showing a decrease. However, increasing emissions scenarios show a consistent increase in temperatures with the highest scenario projecting up to 5 more days per year with a maximum temperature of >35°C (95°F) (see Figure REDW 1.7).

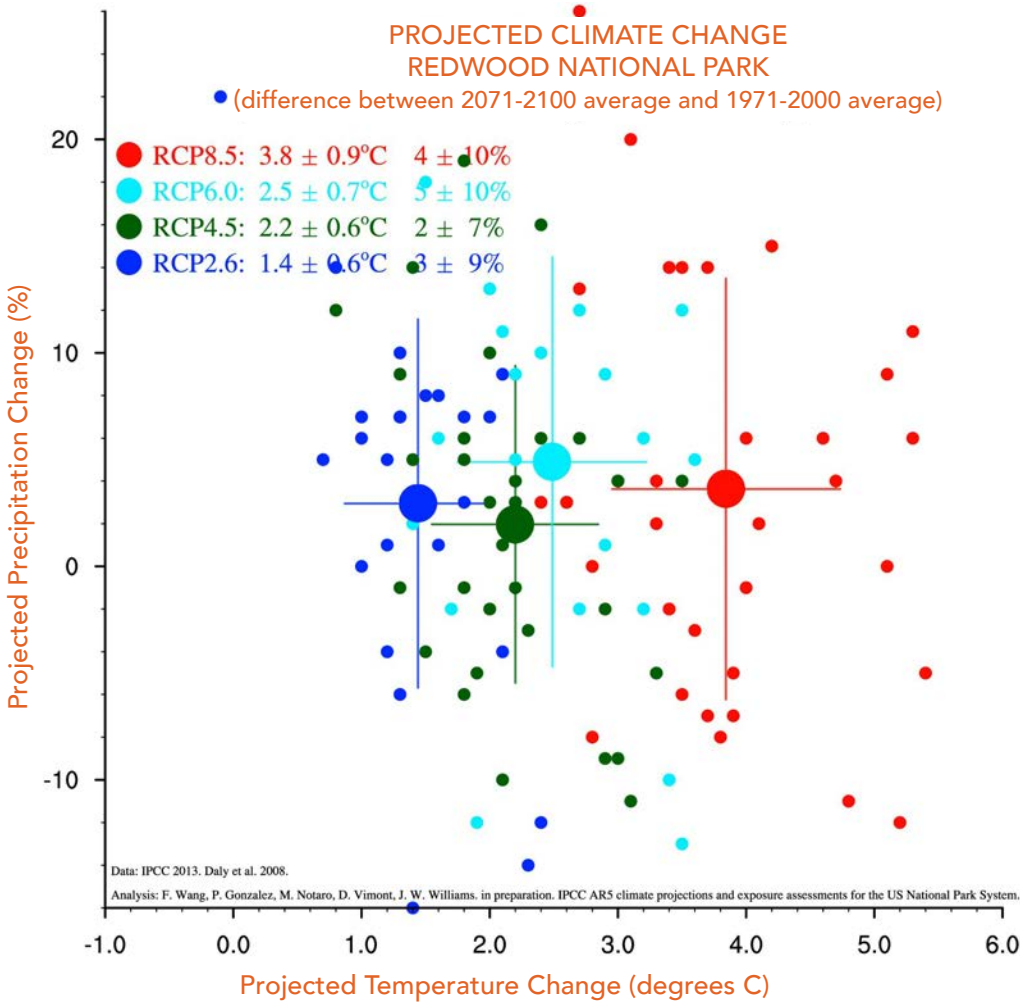


Figure REDW 1.7: Projections of future climate for the area within park boundaries. Each small dot is the output of a single climate model. The large color dots are the average values for the four IPCC emissions scenarios. The lines are the standard deviations of each average value.

Gonzalez, Patrick, "Climate Change Trends, Vulnerabilities, and Ecosystem Carbon, Redwood National Park, California," Natural Resource Stewardship and Science Report, National Park Service, 2015.

PROJECTIONS DATA

Humboldt County, CA

Maximum Air Temperature

Under the highest emissions projections, *RCP 8.5*, average maximum temperatures are projected to increase by 3.3°C (6.0°F) by the year 2100 relative to 1950 (see Figure REDW1.8). These projections show consistently warmer temperatures throughout the year with faster rates of increase in the summer and fall seasons.

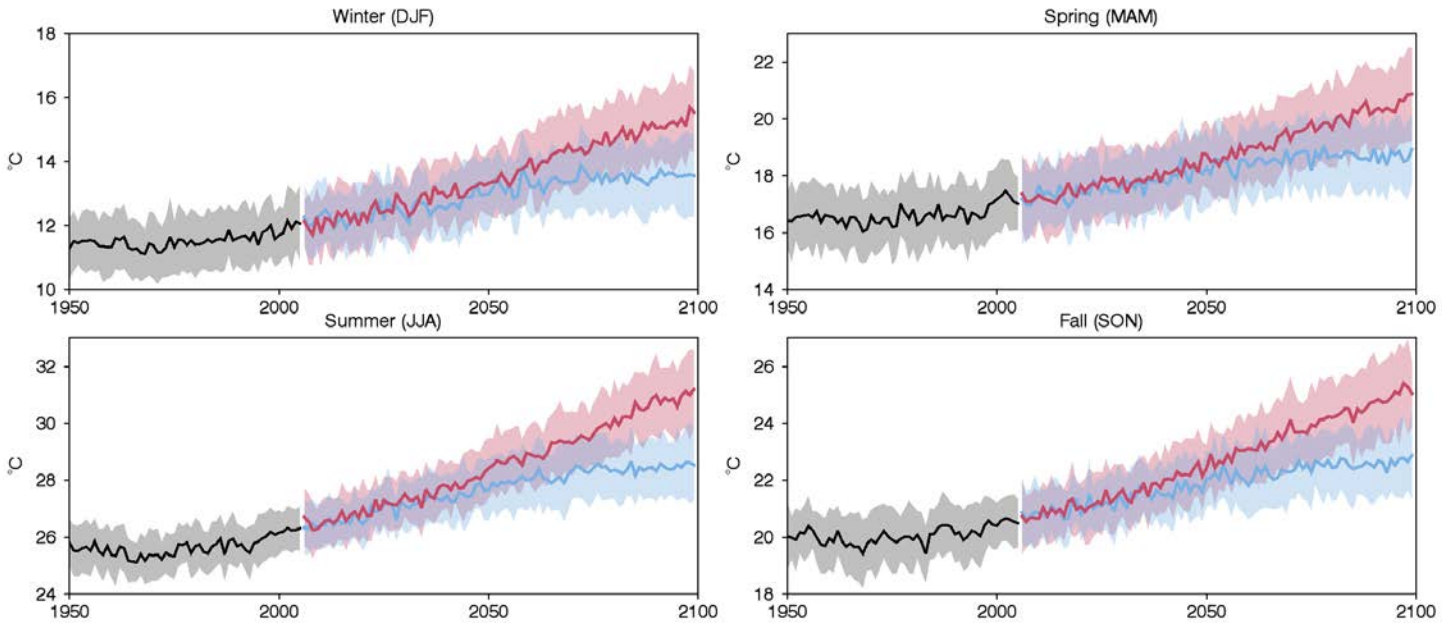


Figure REDW 1.8: Seasonal average time series of maximum 2-m air temperature for historical (black), *RCP4.5*, and *RCP8.5*. The historical period ends in 2005 and the future periods begin in 2006. The average of 30 CMIP5 models is indicated by the solid lines and their standard deviations are indicated by the respective shaded envelopes.

Alder, J. R. and S. W. Hostetler, "USGS National Climate Change Viewer," *USGS*, 2013.

PROJECTIONS DATA

Humboldt County, CA

Precipitation

For projected average annual precipitation, both high and low emissions scenarios show a slight increase in winter precipitation and a slight decrease in fall and spring precipitation by the year 2100 (see Figure REDW 1.9). Although the climate models do not agree on annual averages, seasonal projections suggest a trend towards a greater concentration of precipitation during the winter months. Additionally, there is a projected increase of 20-year storm events to once every 6-7 years (see Figure REDW 2.0).

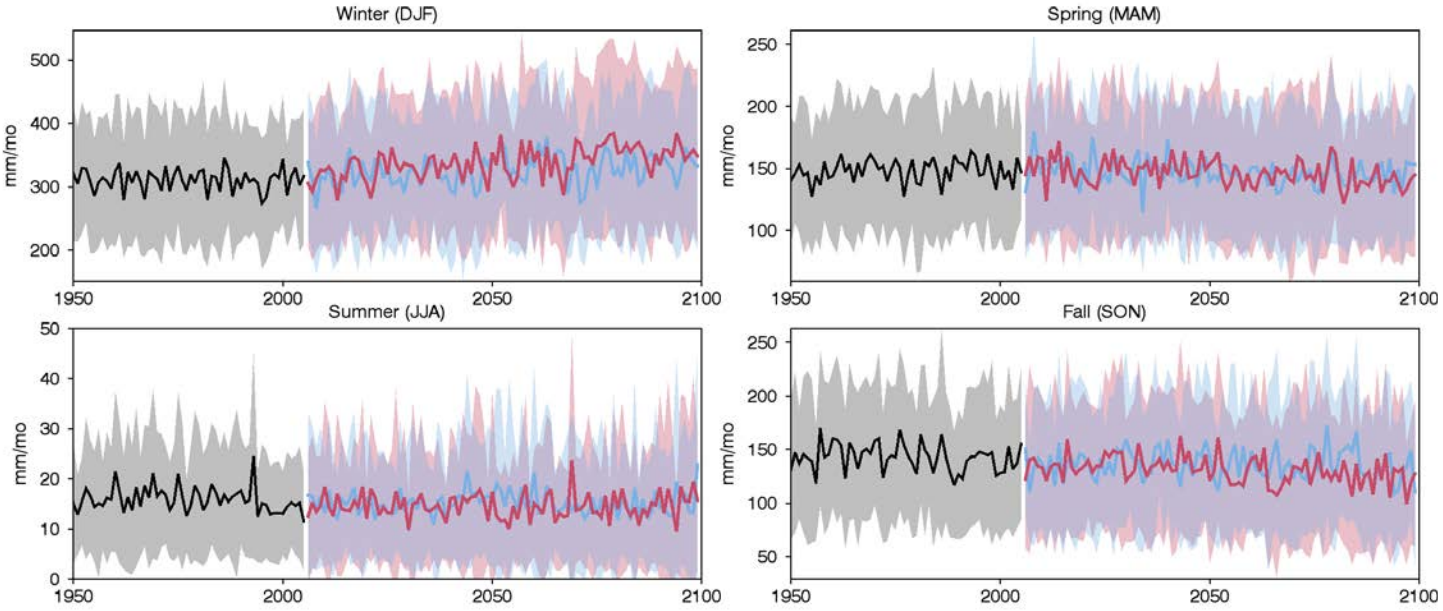


Figure REDW 1.9: Seasonal average time series of precipitation for historical (black), *RCP4.5*, and *RCP8.5*. The historical period ends in 2005 and the future periods begin in 2006. The average of 30 CMIP5 models is indicated by the solid lines and their standard deviations are indicated by the respective shaded envelopes.

Alder, J. R. and S. W. Hostetler, "USGS National Climate Change Viewer," *USGS*, 2013.

Storm Frequency

STORM FREQUENCY PROJECTION DATA

CASE STUDY SITE	IPCC STORM FREQUENCY MULTIPLIER	20-YEAR STORM OCCURRENCE (YEARS)
REDW	3	6.7

Figure REDW 2.0: Projected changes in 20-year storm frequency for REDW from the IPCC AR5 (2013). IPCC storm multiplier indicates the projected increase in frequency of 20-year storms. Occurrence indicates how that increase translates in the number of years.

PROJECTED EXPOSURE (*cont'd*)

ure REDW 2.0). Heavy rains on already saturated soils during the winter months could increase the response rates of earthflows, which is supported by current GIS data. Sudden landslides are more likely to occur on the steep slopes that abut Lyons Ranches, making them less of a direct concern to the site, however, heavy winter rains that follow consistently drier summers can create conditions in which earthflows could unpredictably slip and cause landslides (Swanston et al. 1980, Handwerger et al. 2016.

The complex interplay of climate variables within the Bald Hills land systems requires further analysis. Even with increased favorable conditions for fire, the rate of conifer encroachment into the Bald Hills may contradict climate-related speculations since it creates conditions that dampen landscape flammability. However, increased temperatures may slow encroachment on southern-facing, steeper slopes while it could potentially continue on low-elevation, northwest-facing slopes. Furthermore, the spatial extent of historic prairie areas remains unclear and highlights the difficulty of assessing climate impacts against a known historical baseline. Greater understanding of coastal range climate patterns that are specific to the Bald Hills is still needed.

SENSITIVITY

Existing Ecological Processes

The analysis of existing ecological processes is based on NPS reports, other literature and documentation, and staff and research team field observations. Lyons Ranches Historic District is sensitive to three major existing ecological processes: conifer encroachment, and temperature and precipitation variations. Individual features are sensitive to specific impacts. The overall assessment of sensitivity is included in the vulnerability matrix, below.

Conifer encroachment is documented in California oak woodlands (Cocking et al. 2015), and, based on long term field observation, is applicable to the Lyons Ranches Rural Historic District. Without containment, the long-term implication from research is that conifers, predominantly Douglas-fir, will continue to overtake the woodland and prairies in a series of phases (establishment, piercing, overtopping, decadent) with eventual irreversible conversion from prairie to woodland, changing the landscape's overall pattern of spatial organization, thus affecting the ability to convey the integrity and significance of this cultural landscape.

SENSITIVITY (cont'd)

Heavy erosion could damage foundations flood seasonal streams and stock ponds, and alter the overall character of the landscape. More frequent storms could lead to an increased risk of wind damage to wooden structures and buildings that are not protected by tree cover, despite the lack of available historical data for such events.

Although not in the immediate vicinity of Lyons Ranches, a study of the Little Bald Hills concluded that "encroachment began 1850 and was not related to differences in topography across the landscape. Trees greater than 30 cm in diameter have increased from a mean stem density of 1.6 trees per ha in 1890 to a mean stem density of 13.8 trees per ha in 2009. Concomitant with the increase in tree density and average tree size was the contraction of the grass-dominated areas of the savanna, which represented 50% of Little Bald Hills in 1942, but less than 10% in 2009. If current encroachment rates continue, our models suggest that less than 5% of Little Bald Hills will be grassland in 50 years." (Sahara et al. 2015). This has implications for Lyons' Ranches Rural Historic district, as all eight historic prairies are sensitive to this interaction. See below for park prescribed fire burning response.

Temperature and precipitation variables are discussed at length in the HISTORICAL EXPOSURE and PROJECTED EXPOSURE sections above. In addition to sensitivity to Douglas-fir encroachment, and temperature and precipitation variables, cultural landscape characteristics and features are sensitive to the following impacts and hazards:

Natural Systems and Features: potential landslides/mass wasting around exposed soils; Gold-spotted borer (black oaks [*Quercus kelloggii*]); lower prairies are more vulnerable to fire; sudden oak death in Redwood Creek watershed; an increase in invasive plants could affect prairie character; intense storms could cause downed trees and topple legacy oaks; damage to orchards from bears.

Archeological sites: damage from growth of shrubs and trees.

Stock ponds: loss of edge definition; vegetation encroachment; soil accretion and sedimentation deposits; dead trees; utilization as water source by elk and cows.

Buildings: loss of durability of old growth redwood material with continued drought; powder-post beetle; loss due to high intensity storms; susceptible to increased rot in a warmer wetter projection.

Vegetation: consistent encroachment by species such as blackberry,

foxglove, scotch broom, Vinca, especially at Home Place; annual non-native grasses susceptible to
fire and impact on prairie character.

Orchard: age of trees and limited maintenance regime; condition based on water availability; exposure to bears; fire impact

Seeps and Springs: loss of available water due to absorption by encroaching vegetation; increased erosion with heavy storms

Roads: erosion under a warmer/wetter projection; erosion from greater rain events, limiting access; hillside erosion from culvert outfall concentrations; risk of mass wasting (landslides)

Watershed: Dewatering is occurring to irrigate crops outside of the park, and could affect the historic district; fertilizer and pesticides from outside the park could affect the watershed.

Existing Management Practices

The park is currently managing the resources based on ongoing response to current climate conditions as well as numerous other factors, and has undertaken preservation management efforts, other maintenance actions, and, in some cases, traditional uses.

There is an active program of prescribed burning of prairies and encroaching evergreen trees on a regular yearly and seasonal cycle. It was recognized in the early 1990s that California oat grass (Danthonia californica) was a particularly invasive and damaging species in the Bald Hills. Spring and fall burning was recommended (Auguello 1994).

The park burning program includes both 'hot' burns in the early seasons, with hand lines, and 'colder' burns during moist conditions. The hand lines allow for more intense burning and are generally more successful at controlling encroaching Douglas-firs. The colder burns are less successful at inhibiting Douglas-fir encroachment but are employed during seasons when use of hand lines is not available. Staff report that the season for prescribed burns has increased in recent years. Invasive vegetation (e.g., blackberries, scotch broom, Vinca, etc) is monitored and regularly removed from historic orchards.

The condition of historic structures is regularly monitored, including houses, barns, sheds, and outbuildings, with special attention to rot, deteriorating building materials, and fire fuel that grows too close to structures.

The park also maintains a monitoring program for wildland fires, and, to a

SENSITIVITY (cont'd)

lesser extent, for farm pond size and edge condition.

The historic district is impacted by practices in the watershed within which the district sits. In the watershed, crop irrigation occurs outside the park, potentially reducing water availability in the historic district.

Traditional native American uses of the prairies are practiced and supported by the park. The traditional sheep herding practices ceased approximately 40 years ago. Historic resources are maintained and managed using NPS historic preservation tools and techniques.

VULNERABILITY SUMMARY

Based on the historical and projected exposure and sensitivity analysis, Lyons'
Ranches Historic District is vulnerable to increased annual temperatures, increased fire, conifer encroachment on the prairies, and hotter summers, with uncertainty regarding precipitation projections. These vulnerabilities and hazards will have direct impact on many of the cultural landscape contributing features, including: natural systems and features (especially the prairies); circulation (roads); buildings and structures; and orchards.

The vulnerability assessment matrix applies the vulnerability equation [(historic exposure + projected exposure) x sensitivity = vulnerability] to each Lyons Ranches cultural landscape feature. This results in the following overall vulnerability summary (low, medium, high, or very high) for each feature, providing the basis for setting management priorities (see Vulnerability Assessment Matrix, Appendix A).

Next Steps

This report is a preliminary vulnerability assessment of the impact of climate change on cultural landscapes in the NPS Pacific West Region. The complete vulnerability assessment will be based on the work presented in this report.

In the final report, a final vulnerability assessment rubric will be developed using the information gathered during this preliminary assessment. The matrix and impact tables data will be used to update the scoring for the rubric.

The final report should include impacts on the capacity of the cultural landscape features to convey significance and integrity, as well as prioritize cultural landscape characteristics and contributing features for management actions. Prioritization is included in the CLRG Decision Tree (Step 4), but not included in Phase II of this project.

As with any work of this nature, questions arise and limitations need to be recognized. Park staff are often on-the-ground experts for the natural history of each site and can provide insights into latest and widely accepted studies that corroborate observational data. Likewise, through their professional knowledge and experience, staff will have a good understanding of disputed literature or studies. It is recommended that they be consulted throughout the complete vulnerability assessment process.

The exposure matrix is based on current data. In some cases there are discrepancies between available GIS data and historical record and/or observational data, which may create a gap in understanding historic impacts and existing condition. This may lead to inaccurate climate projections or landscape condition values. This data should be updated as often as possible.

When available, local climate data should be used in conjunction with larger-scale data from NPS studies, NOAA, IPCC, etc.

Appendix A

EXPOSURE MATRIX (PHASE I)

The following are excerpts from the Phase I Pacific West region vulnerability matrix for each of the three Phase II case studies. They have been renamed "Exposure Matrices" in order to avoid confusion between the initial quantitative matrices and the Phase II vulnerability assessment matrix, which incorporates qualitative information that was collected during Phase II webinares, workshops, and field visits.

Exposure Matrix				*33, Fair=0.66,*	**Current Exposure**					**Historical Exposure**										**Projected Exposure**						
CLI ID information					**GIS hazard data (either blank, or 0-1)**					**CLI Impact (either blank=0 or 1+)**																
Park Alpha Code	*Cultural Landscape Inventory Name	Landscape Characteristic	Feature Name	Condition (0.33-1)	Fire Hazard (blank, 0-1)	Flood Hazard (blank, 0-1)	Landslide Hazard (blank, 0-1)	Drought Hazard (blank, 0-1)	Average Hazard Score	Water / Wind Erosion	Coastal or Shoreline Erosion / Inundation / Flooding	Drought	Fire	Exposure to Elements	Micro-climate	Pest / Disease	Vegetation / Invasive Plants	Disruption of Species	Average Impact Score	Condition x (Hazard + Impact)	Projection of change in average annual temperat	Projection of change in average annual precipitati	Projection of sea-level rise in meters	Projection of frequency of 20-Year	Intensity	Confidence	**Projected Exposure (Intensity x Confidence)**
NOCA	Buckner Homestead Historic District	Archeological Sites	Swimming Pool	0.66					0								1		0.111111	7.33%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Archeological Sites	Old Wagon Road Remnant	0.66					0										0	0.00%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Archeological Sites	"Lower Buckner Can Dump" (in stand of trees)	0.66					0		1								0.111111	7.33%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Archeological Sites	Barn Ruins (near pasture)	0.66					0					1					0.111111	7.33%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Archeological Sites	Tractor/Wagon Shed Ruins (near corral)	0.66					0										0	0.00%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Archeological Sites	Fire Ring Remnants (N of root cellar)	0.66					0										0	0.00%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Archeological Sites	Badminton Court	0.66					0										0	0.00%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Buzzard Cabin	0.66	0.3		0		0.075										0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Privy	0.66	0.3		0		0.075										0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Pickers cabin (E and W)	0.66	0.3		0		0.075										0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Chicken House	0.66	0.3		0		0.075										0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Buckner/Garfoot House	0.66	0.3		0		0.075										0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Smoke/Delco House	0.66	0.3		0		0.075										0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Root Cellar	0.66	0.3		0		0.075										0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64

NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Milk Separator	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Packing shed foundation	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Brooder House	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Playhouse	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Barn/Shop.	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Woodshed/Harness Shed	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: North orchard outhouse.	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Circulation	Buckner Homestead Access Road (Historic section begins where road crosses the main irrigation ditch)	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Circulation	Historic Entrance Road	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Circulation	Road to Clearing / Pasture	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Circulation	Southern Access Road	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Circulation	Driveway to Work Shop	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Circulation	Driveway to Packing shed foundation parking	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Circulation	Buckner Lane	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: Main ditch from Rainbow Creek (intake, log/earth cribbing and diversion ditch, concrete channel, concrete gates (1-3), wood flume, canvas dikes, and a wood stave culvert.	0.66	0.3	0	0.075	1	0.111111	12.28%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: Feeder ditches	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: Orchard ditches	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: Ancillary ditch to milk separator	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: Ancillary ditch to residential area	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: Ancillary ditch to pasture	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: North field ditch	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Small Scale Feature	Sundial	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Small Scale Feature	Fuel drum rack (wood)	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Small Scale Feature	Outdoor fireplace (between Buzzard Cabin and House)	0.66	0.3	0	0.075		0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
			Historic farm equipment and tool shed implements (includes														

NOCA	Buckner Homestead Historic District	Small Scale Feature	tractors, plows, hand tools, and orcharding equipment; see CLI for list)	0.66			0		1	0.111111	7.33%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Spatial Organization	Main building cluster (middle of district)	0.66	0.3	0	0.075			0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Spatial Organization	Orchard and large clearing (to W, N and E of building cluster; second growth forest to S. Divided into three sections by road system)	0.66	0.3	0	0.075			0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Spatial Organization	Roads: Historic Entrance Roach, branches from the southern end of Homestead Access Road.	0.66	0.3	0	0.075			0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Spatial Organization	Roads: Road to Clearing/Pasture, extends from terminus of Buckner Homestead Access Road	0.66	0.3	0	0.075			0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Spatial Organization	Irrigation System: Series of ditches that draw water from Rainbow Creek.	0.66	0.3	0	0.075			0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Vegetation	Apple orchard: 10 acres, 34 rows divided into 3 sections	0.66	0.3	0	0.075	1		0.111111	12.28%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Vegetation	Fruit trees: located N of main ditch and S orchard block (4 pear, 1 plum, unidentified seedlings	0.66	0.3	0	0.075			0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Vegetation	Ornamental Trees / Shrubs around Buckner/Garfoot House and Buzzard Cabin (maples, subalpine fir, snowball shrub, and cluster or lilacs)	0.66	0.3	0	0.075			0	4.95%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Vegetation	Clearing / Pasture (1930s-40s)	0.66			0	1	1	0.222222	14.67%	5.1	9.7	n/a	5	3	0.88	2.64
NOCA	Buckner Homestead Historic District	Vegetation	Non-historic vegetable garden located N of Buckner/Garfoot House within the S orchard block (small square-shape plot enclosed by a wooden picket fence)	0.66			0			0	0.00%	5.1	9.7	n/a	5	3	0.88	2.64

Exposure Matrix

CLI ID information				Good=0.33, Fair=0.66,	Current Exposure					Historical Exposure										Projected Exposure						
					GIS hazard data (either blank, or 0-1)					CLI Impact (either blank=0 or 1+)																
Park Alpha Code	*Cultural Landscape Inventory Name	Landscape Characteristic	Feature Name	Condition (0.33-1)	Fire Hazard (blank, 0-1)	Flood Hazard (blank, 0-1)	Landslide Hazard (blank, 0-1)	Drought Hazard (blank, 0-1)	Average Hazard Score	Water / Wind Erosion	Coastal or Shoreline Erosion / Inundation / Flooding	Drought	Fire	Exposure to Elements	Micro-climate	Pest / Disease	Vegetation / Invasive Plants	Disruption of Species	Average Impact Score	Condition x (Hazard + Impact)	Projection of change in average annual	Projection of change in average annual precipitation	Projection of sea-level rise in meters	Projection of frequency of 20-Year Storm	Intensity	Confidence	**Projected Exposure (Intensity x Confidence)**
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Annex	0.66	0.3	0	0	0.075					1					0.111111	12.28%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Hacienda Guest House	0.66	0.3	0	0	0.075					1					0.111111	12.28%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Power House and Pavilion	0.66	0.3	0	0	0.075	1				1					0.222222	19.62%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Chimes Tower	0.66	0.3	0	0	0.075	1				1					0.222222	19.62%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Cabin	0.66	0.3	0	0	0.075	1				1					0.222222	19.62%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Gas House	0.66	0.3	0	0	0.075		1			1					0.222222	19.62%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Stable	0.66	0.3	0	0	0.075	1	1			1					0.333333	26.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Motel Unit/Garage	0.66	0.3	0	0	0.075		1			1					0.222222	19.62%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Entrance Gate	0.66	0.3	0	0	0.075	1	1			1					0.333333	26.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle/Lower Grapevine Ranch Fe	0.66	0.3	0	0	0.075	1	1			1					0.333333	26.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Wash House	0.66	0.3	0	0	0.075		1			1					0.222222	19.62%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Upper Tie Storage Area	0.66	0.3	0	0	0.075	1	1								0.222222	19.62%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and	Scotty's Castle																							

DEVA	Scotty's Castle	Buildings and Structures	Tunnels	0.66	0.3	0	0	0.075		1			0.111111	12.28%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Swimming Pool	0.66	0.3	0	0	0.075					0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Solar Heater	0.66	0.3	0	0	0.075					0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Scotty's Grave	0.66	0.3	0	0	0.075			1		0.111111	12.28%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Cook House	0.66	0.3	0	0	0.075					0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Gravel Separator	0.66	0.3	0	0	0.075	1				0.111111	12.28%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Powder Storage	0.66	0.3	0	0	0.075	1				0.111111	12.28%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Retaining walls	0.66	0.3	0	0	0.075	1				0.111111	12.28%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle Annex	0.66	0.3	0	0	0.075	1				0.111111	12.28%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Hacienda Guest House	0.66	0.3	0	0	0.075					0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Power House and Pavilion	0.66	0.3	0	0	0.075					0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Chimes Tower	0.66	0.3	0	0	0.075					0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Cabin	0.66	0.3	0	0	0.075					0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Stable	0.66	0.3	0	0	0.075					0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Motel Unit/Garage	0.66	0.3	0	0	0.075					0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Entrance Gate	0.66	0.3	0	0	0.075					0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Wash House	0.66	0.3	0	0	0.075					0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11

DEVA	Scotty's Castle	Buildings and Structures	Scotty's Castle/Lower Grapevine Ranch Fe	0.66	0.3	0	0	0.075			0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Upper Tie Storage Area	0.66	0.3	0	0	0.075			0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Tunnels	0.66	0.3	0	0	0.075			0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Swimming Pool	0.66	0.3	0	0	0.075			0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Solar Heater	0.66	0.3	0	0	0.075			0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Scotty's Grave	0.66	0.3	0	0	0.075			0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Cook House	0.66	0.3	0	0	0.075			0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Gravel Separator	0.66	0.3	0	0	0.075	1		0.111111	12.28%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Powder Storage	0.66	0.3	0	0	0.075	1		0.111111	12.28%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Buildings and Structures	Retaining walls	0.66	0.3	0	0	0.075	1		0.111111	12.28%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Circulation	Primary RoadÑEntrance Road	0.66	0.3	0	0	0.075	1	1	0.222222	19.62%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Circulation	Secondary RoadÑScotty's Castle building	0.66	0.3	0	0	0.075			0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Circulation	Secondary RoadÑTie Canyon access roads	0.66	0.3	0	0	0.075	1		0.111111	12.28%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Circulation	Secondary RoadÑSpring/Water catchment ac	0.66	0.3	0	0	0.075	1		0.111111	12.28%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Circulation	Tile courtyard at Scotty's Castle	0.66	0.3	0	0	0.075			0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11

DEVA	Scotty's Castle	Circulation	Stone walkways at Cook House and Guest H	0.66	0.3	0	0	0.6	0.225				0	14.85%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Circulation	Concrete driveway at Scotty's Castle Mot	0.66	0.3	0	0		0.075				0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Constructed Water Features	Watercourse	0.66	0.3	0	0	0.6	0.225			1	0.111111	22.18%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Natural Systems and Features	Hot dry summers	0.66					0				0	0.00%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Natural Systems and Features	Cold winters	0.66					0				0	0.00%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Natural Systems and Features	Cottonwoods and willows	0.66	0.3	0	0	0.6	0.225				0	14.85%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Natural Systems and Features	Site located above floodplain	0.66					0				0	0.00%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Natural Systems and Features	Bonnie Clare road follows a naturally gentle grade along Grapevine Canyon and sits above floodplain	0.66	0.3	0	0		0.075				0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Natural Systems and Features	Natural springs conveyed through pipes that historically generated electricity as well as fed the watercourse	0.66	0.3	0	0	0.6	0.225				0	14.85%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Natural Systems and Features	Water conveyed up canyon to support tree and shrub plantings	0.66					0				0	0.00%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Natural Systems and Features	Underground pipe conveyed water from springs into lake	0.66					0				0	0.00%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Topography	Extensive cut and fill between 1925 - 1931 which created level terraces for buildings and roads	0.66	0.3	0	0		0.075				0	4.95%	5.3	25	n/a	10	4.67	0.88	4.11

DEVA	Scotty's Castle	Topography	and roads	0.66	0.3	0	0	0.6	0.225		0	14.85%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Topography	The watercourse, picnic area, swimming pool and cottonwood corner also retain their original topography	0.66	0.3	0	0	0.6	0.225		0	14.85%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Vegetation	Picnic area: cottonwood, willow, mequite, and palms	0.66	0.3	0	0	0.6	0.225	1	0.111111	22.18%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Vegetation	Cottonwood corner: cottonwood, willow, mesquite and palms	0.66	0.3	0	0	0.6	0.225	1	0.111111	22.18%	5.3	25	n/a	10	4.67	0.88	4.11
DEVA	Scotty's Castle	Vegetation	Building complex: Palms, washington fan falms (Joshua tree and creosote bush are compatible with original planting scheme), cholla cacti	0.66	0.3	0	0	0.6	0.225		0	14.85%	5.3	25	n/a	10	4.67	0.88	4.11

Vulnerability Assessment Matrix

				*33, Fair=0.66,	Current Exposure					Historical Exposure										Projected Exposure						
CLI ID information					GIS hazard data (either blank, or 0-1)					CLI Impact (either blank=0 or 1+)																
Park Alpha Code	*Cultural Landscape Inventory Name	Landscape Characteristic	Feature Name	Condition (0.33-1)	Fire Hazard (blank, 0-1)	Flood Hazard (blank, 0-1)	Landslide Hazard (blank, 0-1)	Drought Hazard (blank, 0-1)	Average Hazard Score	Water / Wind Erosion	Coastal or Shoreline Erosion / Inundation / Flooding	Drought	Fire	Exposure to Elements	Micro-climate	Pest / Disease	Vegetation / Invasive Plants	Disruption of Species	Average Impact Score	Condition x (Hazard + Impact)	Projection of change in average annual temperat	Projection of change in average annual precipitati	Projection of sea-level rise in meters	Projection of frequency of 20-Year Storm	Intensity	Confidence	**Projected Exposure (Intensity x Confidence)**
REDW	Lyons Ranches Historic District	Archeological Sites	CA-HUM-445H (collapsed barn)	0.66					0										0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Archeological Sites	CA-HUM-710H (Elk Camp Outhouse Ruin)	0.66					0										0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Archeological Sites	CA-JUM-529H (Dooleyville Barn Ruin)	0.66					0										0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Archeological Sites	Home Place Cemetery	0.66					0										0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Archeological Sites	REDW 2001-01 (Childs Hill Prairie)	0.66					0										0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Archeological Sites	REDW 2002-01 (Schoolhouse Site)	0.66					0										0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Coyote Creek Line Cabin	0.66	1	0.5			0.375										0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Coyote Creek Outhouse	0.66	1	0.5			0.375										0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Coyote Creek Sheep Shed	0.66	1	0.5			0.375										0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Dolason Sheep Shed	0.66	1	0.5			0.375										0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Dooleyville Line Cabin	0.66	1	0.5			0.375										0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Elk Camp Garage	0.66	1	0.5			0.375										0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Elk Camp Retaining Wall	0.66	0	0.5			0.125										0	8.25%	4.1	2	n/a	6.7	3.23	0.63	2.03
	Lyons Ranches	Buildings And																									

REDW	Historic District	Structures	Elk Camp Sheep Shed	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Home Place Barn	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Home Place Bunkhouse	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Home Place Shed	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Lane House	0.66	0	0.5	0.125		0	8.25%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Long Ridge Herder's Trailer	0.66	0.6	0.5	0.275		0	18.15%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Long Ridge Sheep Shed	0.66	0.6	0.5	0.275		0	18.15%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Stock Ponds	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Buildings And Structures	Well	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	Bald Hills School Road	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	Coyote Creek Road	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	Coyote Peak Road	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	Coyote Peak Spur	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	Elk Camp Road	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	Home Place Cemetery Trail	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	Long Ridge Road	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	Lyons Road	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	Main Stem Road	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03

REDW	Lyons Ranches Historic District	Circulation	Maneze Road	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	Ranch Road	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	Rock Fork Road	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	Schoolhouse Pasture Road	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	T. Bear Road	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Circulation	Upper Lyons Road	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Cluster Arrangement	Coyote Cluster	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Cluster Arrangement	Elk Camp Cluster	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Cluster Arrangement	Home Place Cluster	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Cluster Arrangement	Long Ridge Cluster	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Natural Systems And Features	Mediterranean with cool rainy winters, hot summers	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Natural Systems And Features	Areas of large slow moving landlslides at praries	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Natural Systems And Features	Clay soils with impaired drainage	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Natural Systems And Features	Soils have high vulnerability to surface erosion	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Natural Systems And Features	Ephemeral streams in winter	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03

REDW	Lyons Ranches Historic District	Natural Systems And Features	Seeps, springs important for summer irrigation	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Natural Systems And Features	Grassland	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Natural Systems And Features	Oak woodland	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Natural Systems And Features	Douglas firs invading prarie and oak woodland	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Small Scale Features	Concrete Troughs (10)	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Small Scale Features	Coyote Pipelines	0.66	0.6	0.5	0.275		0	18.15%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Small Scale Features	Ranch Fencing	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Small Scale Features	Spring Boxes (2)	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Spatial Organization	Praries	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Spatial Organization	Development adjacent to praries	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Spatial Organization	Roads connecting praries and developed areas	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Spatial Organization	Fences demarcating grazing lands	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Topography	Road prisms	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Topography	Stock tanks	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Topography	Ditches	0.66	1	0.5	0.375		0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Topography	Structure/staging sites	0.66			0		0	0.00%	4.1	2	n/a	6.7	3.23	0.63	2.03

REDW	Lyons Ranches Historic District	Vegetation	Elk Camp	0.66	1	0.5	0.375				0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Vegetation	Childs Hill Prarie	0.66	1	0.5	0.375				0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Vegetation	Schoolhouse site	0.66	1	0.5	0.375				0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Vegetation	Manez Road	0.66	1	0.5	0.375				0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03
REDW	Lyons Ranches Historic District	Vegetation	Home Place	0.66	1	0.5	0.375				0	24.75%	4.1	2	n/a	6.7	3.23	0.63	2.03

PRELIMINARY VULNERABILITY MATRIX

Park Code	Cultural Landscape (CL)	Landscape Characteristic	Contributing Landscape Feature	HISTORICAL EXPOSURE *Phase I* (percentage up to 50%; condition x [GIS hazard + historical impact])	PROJECTED EXPOSURE *Phase I* (quantitative ranking: 0-5; based on finest resolution data available for entire landscape)	SENSITIVITY (numerical rating: 1=low, 2=medium, 3=high; based on feature's qualities and location within CL)	VULNERABILITY (historical exposure + projected exposure) x sensitivity	OVERALL VULNERABILITY RATING (qualitative conversion: 2.28-4.95= low, 4.96-7.62 = medium, 7.63-10.30 = high, 10.31-12.99= very high)	PROJECTED IMPACT ON INTEGRITY (high, med, low)
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Annex	12.28%	4.11	1	4.23	low	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Hacienda Guest House	12.28%	4.11	2	8.46	high	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Power House and Pavilion		4.11	2	#VALUE!	high	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Chimes Tower	19.62%	4.11	1	4.31	low	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Cabin	19.62%	4.11	2	8.61	high	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Gas House	19.62%	4.11	1	4.31	low	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Stable	26.95%	4.11	2	8.76	high	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Motel Unit/Garage	19.62%	4.11	2	8.61	high	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Entrance Gate	26.95%	4.11	1	4.38	low	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle/Lower Grapevine Ranch Fe	26.95%	4.11	1	4.38	low	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Wash House	19.62%	4.11	1	4.31	low	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Upper Tie Storage Area	19.62%	4.11	1	4.31	low	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Tunnels	12.28%	4.11	2	8.46	high	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Swimming Pool	4.95%	4.11	1	4.16	low	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Solar Heater	4.95%	4.11	1	4.16	low	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Scotty's Grave	12.28%	4.11	1	4.23	low	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Cook House	4.95%	4.11	2	8.32	high	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Gravel Separator	12.28%	4.11	2	8.46	high	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Powder Storage	12.28%	4.11	1	4.23	low	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Retaining walls	12.28%	4.11	2	8.46	high	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle Annex	12.28%	4.11	1	4.23	low	
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Hacienda Guest House	4.95%	4.11	1	4.16	low	

DEVA	Death Valley Scotty Historic District	Buildings and Structures	Power House and Pavilion	4.95%	4.11	1	4.16	low
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Chimes Tower	4.95%	4.11	1	4.16	low
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Cabin	4.95%	4.11	2	8.32	high
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Stable	4.95%	4.11	2	8.32	high
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Motel Unit/Garage	4.95%	4.11	2	8.32	high
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Entrance Gate	4.95%	4.11	1	4.16	low
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Wash House	4.95%	4.11	2	8.32	high
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Castle/Lower Grapevine Ranch Fe	4.95%	4.11	2	8.32	high
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Upper Tie Storage Area	4.95%	4.11	2	8.32	high
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Tunnels	4.95%	4.11	2	8.32	high
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Swimming Pool	4.95%	4.11	2	8.32	high
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Solar Heater	4.95%	4.11	1	4.16	low
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Scotty's Grave	4.95%	4.11	1	4.16	low
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Cook House	4.95%	4.11	1	4.16	low
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Gravel Separator	12.28%	4.11	2	8.46	high
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Powder Storage	12.28%	4.11	2	8.46	high
DEVA	Death Valley Scotty Historic District	Buildings and Structures	Retaining walls	12.28%	4.11	2	8.46	high
DEVA	Death Valley Scotty Historic District	Circulation	Primary Road / Entrance Road	19.62%	4.11	3	12.92	very high
DEVA	Death Valley Scotty Historic District	Circulation	Secondary RoadÑScotty's Castle building	4.95%	4.11	1	4.16	low
DEVA	Death Valley Scotty Historic District	Circulation	Secondary RoadÑTie Canyon access roads	12.28%	4.11	1	4.23	low
DEVA	Death Valley Scotty Historic District	Circulation	Secondary RoadÑSpring/Water catchment ac	12.28%	4.11	2	8.46	high
DEVA	Death Valley Scotty Historic District	Circulation	Tile courtyard at Scotty's Castle	4.95%	4.11	2	8.32	high
DEVA	Death Valley Scotty Historic District	Circulation	Stone walkways at Cook House and Guest H	14.85%	4.11	1	4.26	low
DEVA	Death Valley Scotty Historic District	Circulation	Concrete driveway at Scotty's Castle Mot	4.95%	4.11	1	4.16	low
DEVA	Death Valley Scotty Historic District	Constructed Water Features	Watercourse	22.18%	4.11	2	8.66	high
DEVA	Death Valley Scotty Historic District	Natural Systems and Features	Hot dry summers	0.00%	4.11		0.00	
DEVA	Death Valley Scotty Historic District	Natural Systems and Features	Cold winters	0.00%	4.11		0.00	
DEVA	Death Valley Scotty Historic District	Natural Systems and Features	Cottonwoods and willows	14.85%	4.11		0.00	
DEVA	Death Valley Scotty Historic District	Natural Systems and Features	Site located above floodplain	0.00%	4.11		0.00	

DEVA	Death Valley Scotty Historic District	Natural Systems and Features	Bonnie Clare road follows a naturally gentle grade along Grapevine Canyon and sits above floodplain	4.95%	4.11	3	12.48	very high	
DEVA	Death Valley Scotty Historic District	Natural Systems and Features	Natural springs conveyed through pipes that historically generated electricity as well as fed the watercourse	14.85%	4.11	3	12.77	very high	
DEVA	Death Valley Scotty Historic District	Natural Systems and Features	Water conveyed up canyon to support tree and shrub plantings	0.00%	4.11	3	12.33	very high	
DEVA	Death Valley Scotty Historic District	Natural Systems and Features	Underground pipe conveyed water from springs into lake	0.00%	4.11	3	12.33	very high	
DEVA	Death Valley Scotty Historic District	Topography	Extensive cut and fill between 1925 - 1931 which created level terraces for buildings and roads	4.95%	4.11	2	8.32	high	
DEVA	Death Valley Scotty Historic District	Topography	The watercourse, picnic area, swimming pool and cottonwood corner also retain their original topography	14.85%	4.11	3	12.77	very high	
DEVA	Death Valley Scotty Historic District	Vegetation	Picnic area: cottonwood, willow, mequite, and palms	22.18%	4.11	3	12.99	very high	
DEVA	Death Valley Scotty Historic District	Vegetation	Cottonwood corner: cottonwood, willow, mesquite and palms	22.18%	4.11	3	12.99	very high	
DEVA	Death Valley Scotty Historic District	Vegetation	Building complex: Palms, washington fan falms (Joshua tree and creosote bush are compatible with original planting scheme), cholla cacti	14.85%	4.11	3	12.77	very high	
NOCA	Buckner Homestead Historic District	Archeological Sites	Swimming Pool	7.33%	2.64	1	2.71	low	
NOCA	Buckner Homestead Historic District	Archeological Sites	Old Wagon Road Remnant	0.00%	2.64		0.00		
NOCA	Buckner Homestead Historic District	Archeological Sites	"Lower Buckner Can Dump" (in stand of trees)	7.33%	2.64	2	5.43	medium	
NOCA	Buckner Homestead Historic District	Archeological Sites	Barn Ruins (near pasture)	7.33%	2.64	2	5.43	medium	
NOCA	Buckner Homestead Historic District	Archeological Sites	Tractor/Wagon Shed Ruins (near corral)	0.00%	2.64		0.00		
NOCA	Buckner Homestead Historic District	Archeological Sites	Fire Ring Remnants (N of root cellar)	0.00%	2.64		0.00		
NOCA	Buckner Homestead Historic District	Archeological Sites	Badminton Court	0.00%	2.64		0.00		
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Buzzard Cabin	4.95%	2.64	2	5.38	medium	
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Privy	4.95%	2.64	2	5.38	medium	
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Pickers cabin (E and W)	4.95%	2.64	2	5.38	medium	
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Chicken House	4.95%	2.64	2	5.38	medium	
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Buckner/Garfoot House	4.95%	2.64	2	5.38	medium	
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Smoke/Delco House	4.95%	2.64	2	5.38	medium	
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Root Cellar	4.95%	2.64	2	5.38	medium	
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Milk Separator	4.95%	2.64	2	5.38	medium	
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Packing shed foundation	4.95%	2.64	2	5.38	medium	
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Brooder House	4.95%	2.64	2	5.38	medium	
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Playhouse	4.95%	2.64	2	5.38	medium	
	Buckner Homestead	Buildings and							

NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Barn/Shop.	4.95%	2.64	2	5.38	medium
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: Woodshed/Harness Shed	4.95%	2.64	2	5.38	medium
NOCA	Buckner Homestead Historic District	Buildings and Structures	Main building cluster: North orchard outhouse.	4.95%	2.64	2	5.38	medium
NOCA	Buckner Homestead Historic District	Circulation	Buckner Homestead Access Road (Historic section begins where road crosses the main irrigation ditch)	4.95%	2.64	2	5.38	medium
NOCA	Buckner Homestead Historic District	Circulation	Historic Entrance Road	4.95%	2.64	1	2.69	low
NOCA	Buckner Homestead Historic District	Circulation	Road to Clearing / Pasture	4.95%	2.64	1	2.69	low
NOCA	Buckner Homestead Historic District	Circulation	Southern Access Road	4.95%	2.64	1	2.69	low
NOCA	Buckner Homestead Historic District	Circulation	Driveway to Work Shop	4.95%	2.64	1	2.69	low
NOCA	Buckner Homestead Historic District	Circulation	Driveway to Packing shed foundation parking	4.95%	2.64	1	2.69	low
NOCA	Buckner Homestead Historic District	Circulation	Buckner Lane	4.95%	2.64	1	2.69	low
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: Main ditch from Rainbow Creek (intake, log/earth cribbing and diversion ditch, concrete channel, concrete gates (1-3), wood flume, canvas dikes, and a wood stave culvert.	12.28%	2.64	3	8.29	high
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: Feeder ditches	4.95%	2.64	3	8.07	high
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: Orchard ditches	4.95%	2.64	3	8.07	high
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: Ancillary ditch to milk separator	4.95%	2.64	3	8.07	high
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: Ancillary ditch to residential area	4.95%	2.64	3	8.07	high
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: Ancillary ditch to pasture	4.95%	2.64	3	8.07	high
NOCA	Buckner Homestead Historic District	Constructed Water Feature	Irrigation System: North field ditch	4.95%	2.64	3	8.07	high
NOCA	Buckner Homestead Historic District	Small Scale Feature	Sundial	4.95%	2.64	1	2.69	low
NOCA	Buckner Homestead Historic District	Small Scale Feature	Fuel drum rack (wood)	4.95%	2.64	1	2.69	low
NOCA	Buckner Homestead Historic District	Small Scale Feature	Outdoor fireplace (between Buzzard Cabin and House)	4.95%	2.64	1	2.69	low
NOCA	Buckner Homestead Historic District	Small Scale Feature	Historic farm equipment and tool shed implements (includes tractors, plows, hand tools, and orcharding equipment; see CLI for list)	7.33%	2.64	1	2.71	low
NOCA	Buckner Homestead Historic District	Spatial Organization	Main building cluster (middle of district)	4.95%	2.64	2	5.38	medium
NOCA	Buckner Homestead Historic District	Spatial Organization	Orchard and large clearing (to W, N and E of building cluster; second growth forest to S. Divided into three sections by road system)	4.95%	2.64	3	8.07	high
NOCA	Buckner Homestead Historic District	Spatial Organization	Roads: Historic Entrance Roach, branches from the southern end of Homestead Access Road.	4.95%	2.64	2	5.38	medium
NOCA	Buckner Homestead Historic District	Spatial Organization	Roads: Road to Clearing/Pasture, extends from terminus of Buckner Homestead Access Road	4.95%	2.64	2	5.38	medium

NOCA	Buckner Homestead Historic District	Spatial Organization	Irrigation System: Series of ditches that draw water from Rainbow Creek.	4.95%	2.64	3	8.07	high	
NOCA	Buckner Homestead Historic District	Vegetation	Apple orchard: 10 acres, 34 rows divided into 3 sections	12.28%	2.64	3	8.29	high	
NOCA	Buckner Homestead Historic District	Vegetation	Fruit trees: located N of main ditch and S orchard block (4 pear, 1 plum, unidentified seedlings	4.95%	2.64	3	8.07	high	
NOCA	Buckner Homestead Historic District	Vegetation	Ornamental Trees / Shrubs around Buckner/Garfoot House and Buzzard Cabin (maples, subalpine fir, snowball shrub, and cluster or lilacs)	4.95%	2.64	3	8.07	high	
NOCA	Buckner Homestead Historic District	Vegetation	Clearing / Pasture (1930s-40s)	14.67%	2.64	2	5.57	medium	
NOCA	Buckner Homestead Historic District	Vegetation	Non-historic vegetable garden located N of Buckner/Garfoot House within the S orchard block (small square-shape plot enclosed by a wooden picket fence)	0.00%	2.64		0.00		
REDW	Lyons Ranches Historic District	Archeological Sites	CA-HUM-445H (collapsed barn)	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Archeological Sites	CA-HUM-710H (Elk Camp Outhouse Ruin)	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Archeological Sites	CA-JUM-529H (Dooleyville Barn Ruin)	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Archeological Sites	Home Place Cemetery	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Archeological Sites	REDW 2001-01 (Childs Hill Prairie)	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Archeological Sites	REDW 2002-01 (Schoolhouse Site)	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Buildings And Structures	Coyote Creek Line Cabin	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Coyote Creek Outhouse	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Coyote Creek Sheep Shed	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Dolason Sheep Shed	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Dooleyville Line Cabin	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Elk Camp Garage	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Elk Camp Retaining Wall	8.25%	2.03	1	2.12	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Elk Camp Sheep Shed	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Home Place Barn	24.75%	2.03	2	4.56	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Home Place Bunkhouse	24.75%	2.03	2	4.56	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Home Place Shed	24.75%	2.03	2	4.56	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Lane House	8.25%	2.03	1	2.12	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Long Ridge Herder's Trailer	18.15%	2.03	1	2.22	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Long Ridge Sheep Shed	18.15%	2.03	1	2.22	low	
REDW	Lyons Ranches Historic District	Buildings And Structures	Stock Ponds	24.75%	2.03	3	6.85	medium	

REDW	Lyons Ranches Historic District	Buildings And Structures	Well	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Circulation	Bald Hills School Road	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Circulation	Coyote Creek Road	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Circulation	Coyote Peak Road	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Circulation	Coyote Peak Spur	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Circulation	Elk Camp Road	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Circulation	Home Place Cemetery Trail	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Circulation	Long Ridge Road	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Circulation	Lyons Road	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Circulation	Main Stem Road	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Circulation	Maneze Road	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Circulation	Ranch Road	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Circulation	Rock Fork Road	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Circulation	Schoolhouse Pasture Road	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Circulation	T. Bear Road	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Circulation	Upper Lyons Road	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Cluster Arrangement	Coyote Cluster	24.75%	2.03	2	4.56	low	
REDW	Lyons Ranches Historic District	Cluster Arrangement	Elk Camp Cluster	24.75%	2.03	2	4.56	low	
REDW	Lyons Ranches Historic District	Cluster Arrangement	Home Place Cluster	24.75%	2.03	2	4.56	low	
REDW	Lyons Ranches Historic District	Cluster Arrangement	Long Ridge Cluster	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Natural Systems And Features	Mediterranean with cool rainy winters, hot summers	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Natural Systems And Features	Areas of large slow moving landlslides at praries	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Natural Systems And Features	Clay soils with impaired drainage	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Natural Systems And Features	Soils have high vulnerability to surface erosion	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Natural Systems And Features	Ephemeral streams in winter	24.75%	2.03	2	4.56	low	
REDW	Lyons Ranches Historic District	Natural Systems And Features	Seeps, springs important for summer irrigation	24.75%	2.03	2	4.56	low	
REDW	Lyons Ranches Historic District	Natural Systems And Features	Grassland	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Natural Systems And Features	Oak woodland	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Natural Systems And Features	Douglas firs invading prarie and oak woodland	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Small Scale Features	Concrete Troughs (10)	24.75%	2.03	1	2.28	low	
	Lyons Ranches	Small Scale							

REDW	Lyons Ranches Historic District	Small Scale Features	Coyote Pipelines	18.15%	2.03	1	2.22	low	
REDW	Lyons Ranches Historic District	Small Scale Features	Ranch Fencing	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Small Scale Features	Spring Boxes (2)	0.00%	2.03	1	2.03	low	
REDW	Lyons Ranches Historic District	Spatial Organization	Praries	24.75%	2.03	3	6.85	medium	
REDW	Lyons Ranches Historic District	Spatial Organization	Development adjacent to praries	24.75%	2.03	2	4.56	low	
REDW	Lyons Ranches Historic District	Spatial Organization	Roads connecting praries and developed areas	24.75%	2.03	2	4.56	low	
REDW	Lyons Ranches Historic District	Spatial Organization	Fences demarcating grazing lands	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Topography	Road prisms	24.75%	2.03	1	2.28	low	
REDW	Lyons Ranches Historic District	Topography	Stock tanks	24.75%	2.03	2	4.56	low	
REDW	Lyons Ranches Historic District	Topography	Ditches	24.75%	2.03	2	4.56	low	
REDW	Lyons Ranches Historic District	Topography	Structure/staging sites	0.00%	2.03		0.00		
REDW	Lyons Ranches Historic District	Vegetation	Elk Camp	24.75%	2.03	3	6.85	medium	
REDW	Lyons Ranches Historic District	Vegetation	Childs Hill Prarie	24.75%	2.03	3	6.85	medium	
REDW	Lyons Ranches Historic District	Vegetation	Schoolhouse site	24.75%	2.03	3	6.85	medium	
REDW	Lyons Ranches Historic District	Vegetation	Manez Road	24.75%	2.03	3	6.85	medium	
REDW	Lyons Ranches Historic District	Vegetation	Home Place	24.75%	2.03	3	6.85	medium	

IMPACTS TABLE

The Cultural Landscapes Impacts Table is based on the Impacts Table in the Cultural Resources Climate Change Strategy (CRCCS) (Rockman, et.al., 2016, pp.20-24.) The table organization and the column and row categories are taken directly from CRCCS. The general text under 'Cultural Landscapes' is also from CRCCS. The specific text for the three case studies was developed for Phase II of this project from the cultural landscapes vulnerability assessment and was not included in CRCCS.

As explained in the CRCCS, the Impacts Table is intended "as a guide for identified impacts and motivation for continued research, monitoring and understanding of all effects of climate change…The table is organized according to the major trends of climate change: Temperature Change, Precipitation Change, Sea Level Rise, Combined Stressors, and Increased Greenhouse Gas (GHG) Emissions. Left hand columns in the table list the major observable phenomena of these climate trends, in other words – how these changing trends are being and will be experienced. These observable phenomena are how cultural resources are and will be exposed to climate change. The impacts listed within the table are examples of the sensitivities of cultural resources to climatic changes. Taken together, exposure and sensitivity are the primary components of cultural resources climate change vulnerability." (CRCCS, p.19)

Increased GHG Emissions

	Impact on Cultural Resources			
	Cultural Landscapes	**Buckner Homestead**	**Death Valley Scotty**	**Lyons Ranches**
Ocean Acidification	Coastal soil erosion/ infertility[v] Loss or deterioration of culturally significant landscape features[v]	*N/A*	*N/A*	*N/A*

IMPACTS TABLE (*cont'd*)

Temperature Change

	Impact on Cultural Resources			
	Cultural Landscapes	**Buckner Homestead**	**Death Valley Scotty**	**Lyons Ranches**
Increased Global Temperature	Decline/disappearance of some vegetation species, other species favored[c] Heat stress on culturally significant vegetation[a] Increased stress (e.g. desiccation, warping, cracking, etc.) on constructed landscape features[c]	*increased heat/water stress in forests and orchards; decreased snowpack; water stress for native and planted vegetation (espcially Douglas fir); reduced tree vigor/increased susceptibility to pests and disease*	*increased heat/water stress to natural and cultural vegetation on slopes and within complex; potential losses of natural vegetation*	*encroaching conifers threaten integrity and definition of savanna/prairies; increased temperatures may slow conifer encroachment*
Increase Freeze/ThawCycles	Decline/disappearance of some vegetation species due to recurrent freezing[a] More rapid deterioration of constructed materials of landscape features (e.g. corrosion, decay, desiccation)[b]	*insufficient data, possible impact on blooming season*	*N/A*	*N/A*
Permafrost Melt	Decline/disappearance of some vegetation species[c] More rapid decay, dessication of constructed materials of landscape features[c]	*N/A*	*N/A*	*N/A*
Higher Relative Humidity	Decline/disappearance of critical vegetation species, other species favored[c] Increased desiccation, warping, and cracking of constructed landscape features[c]	*increased mold/moss growth on structures and vegetation (e.g., apple trees); potential to accelerate deterioration*	*N/A*	*conflicting projections data- possible increase in mold/moss on structures and vegetation; potential to accelerate deterioration*
Increased Wind	Damage or loss of culturally significant plants[c] Change in historic/ culturally significant vegetationpatterns[a] Increase in need for protective structures that shelter landscapes[c]	*insufficient data: possible damage to orchard trees and other vegetation, with potential need for screening, bracing, and/or protective barriers*	*increased erosion into and around built features and structures*	*increased deterioration of structures in open prairies/savannas; faster spreading wildfires*

IMPACTS TABLE (*cont'd*)

Temperature Change (cont'd)

	Impact on Cultural Resources			
	Cultural Landscapes	**Buckner Homestead**	**Death Valley Scotty**	**Lyons Ranches**
Increased Wildfire	Loss or damage of associated structures[23] Change in vegetation density andcomposition[4] Bedrock and border spalls[23] Increased susceptibility to erosion and flooding[23] Loss of soil fertility due to highheat[23] Damageto structure and/ or associated cultural landscape from fire retardants[12]	*loss or damage to homestead structures; loss of orchard trees*	*increased susceptibility to flash floods and heavy erosion of canyon edges and stream bed; loss or damage of Scotty's Castle structures*	*potential to sustain prairie/savanna density and composition; decrease rate of conifer encroachment; increased risk of loss or damage to structures; increased susceptibility to creep and/or earthflows*
Changes in Seasonality and Phenology	Loss of synchronicity betweenspecies[14] Altered landscapes dueto shifts in blooming times[14] Loss of pollinators reduces plant fertility in historic agriculturallandscapes[4]	*insufficient data- possible impact on apple blooming season*	*insufficient data*	*insufficient data*
Species Shift	Changes in historic/ culturally significant vegetation patterns[4] Emigration and/or local extinction of culturally significantspecies[5] Changes in landscape appearance from altered growth patterns of lichen[14]	*potential increase in invasive species due to disturbance from lightning strike fires.*	*shift and migration in palm trees and/or cottonwoods*	*potential loss of remaining fruit trees*
Invasive Species/Pests	Potential loss of significant plants due to introduction of newpests[5] Potential biological selection pressure for incompatible vegetation or other biotic species[5] Changes in viewsheds (e.g. battlefieldparks)[14]	*increased colonization and/or spread of invasive plants, pests, and/or disease*	*N/A*	*loss of definition of prairie boundaries and pathways due to encroachment; increased colonization and/or spread of invasive plants; increased fire susceptibility due to annual grasses*

IMPACTS TABLE (*cont'd*)

Precipitation Change

	Impact on Cultural Resources			
	Cultural Landscapes	**Buckner Homestead**	**Death Valley Scotty**	**Lyons Ranches**
Less Precipitation/Drought	Water stress may inhibit growth of some species[4] Decline/disappearance of some vegetation species; other species favored[4] Soil infertility due to decreased microbial activity[4] Limited water supply inhibits established maintenance practices[17] Increased soil erosion[4] Challenges to current irrigation practices[4]	*potentially competing uses of Rainbow Creek water supply (salmon restoration); loss of durability of old growth redwood material; decreased seasonally-available water for irrigation system; increased need for fertilization/supplementation; increased risk of powdery mildew and/or other pests/diseases*	*decreased native vegetation; increased susceptibility of canyon edges to heavy erosion*	*projections disagree- possible decline/loss of cultural vegetation; potential slowing of conifer encroachment and/or reestablishment of oak savannas; greater risk of wildfire;*
More Precipitation and/or Heavier Precipitation	·Increased tree fall due to waterlogging[17] ·Limited ability to plant in waterlogged soil[4] ·Loss of historical integrity with improved drainage systems[17] ·Decline/disappearance of some vegetation species[4] ·Decreased soil fertility fromerosion, waterlogging, leaching[4] ·Loss of landscape features[5] ·Increased susceptibility to destructive fungi[18] ·Erosion of earthworks[24] ·Disruption ordelay of traditional maintenance practices (e.g. burning)[24]	*increased risk of root rot, aphids, powdery mildew, and other moisture-related pests/disease in orchards; increased structure rot; increased forest root rot, especially of maples; increased tree fall and potential damage to structures; with warmer winters: decrease in snow pack, greater risk of floods, heavier bank erosion*	*increased risk of severe flash floods and/or heavy erosion events; potential loss of terraces; damage/loss of remnant retaining walls, Scotty's Grave, and/or Scotty's Cabin; potential shift or loss of cottonwoods due to spring channel shifts; potential inundation of structures abutting canyon edge*	*projections disagree- possible increased tree fall and damage to structures; heavier erosion of irrigation ditches/seeps; heavier encroachement of invasives in prairies; increased moss/mold growth, especially in shaded structures*
Increase of Flooding Events	Wash out or damage to roads, trails, and landscape features throughout parks[4] Decline/disappearance of important vegetation species, other species favored[4] Loss of landscape features[5]	*damage to Rainbow Creek irrigation inlet and potential flooding of system; heavier erosion of Stehekin River bank; pasture access road flooding; potential pooling and damage of roads; increased presence of rush skeleton weed; increase in frequency of rain-on-snow events and subsequent flooding (short-term prior to loss of snow pack); main irrigation ditch erosion*	*heavy erosion and/or alteration of wash/stream channel and spring course; persistent damage to earth berms east of complex; persistent/permanent damage to Bonnie Clare Rd.; heavy erosion/alteration of canyon system and arroyos; increased damage and/or permanent alteration of motel unit, picnic area, and channel vegetation; damage to structures nearest wash (motel unit and stables)*	*N/A*

IMPACTS TABLE (*cont'd*)

Sea Level Rise

	Cultural Landscapes	Buckner Homestead	Death Valley Scotty	Lyons' Ranches
Inundation and Increased flooding events	Variable damage/ loss of organic and inorganic materials and landscape features[28] Decline/ disappearance of some vegetation species, other species favored[4] Soil erosion[4] Soil infertility due to waterlogged, anaerobic conditions[4]	*N/A*	*N/A*	*N/A*
Increased Frequency and/or Severity of Storm Surges	Immediate alteration/ destruction of historic landscape[44] Decline/ disappearance of some vegetation species, other species favored[4] Soil infertility from soil erosion, loss of topsoil[4] Loss of landscape features[4]	*N/A*	*N/A*	*N/A*
Increased Coastal Erosion	Decline/ disappearance of some vegetation species, other species favored[4] Soil infertility from loss oftopsoil[4] Loss or compromise of associated structures[23]	*N/A*	*N/A*	*N/A*
Higher Water Table	Decline disappearance of important vegetation species, other species favored[4] Soil infertility due to waterlogged, anaerobic conditions[4]	*loss of snowpack, threatening groundwater level;*	*drop up to 2 meters, exacerbating conditions of limited water supply in the region and park;*	*N/A*

IMPACTS TABLE (*cont'd*)

Combined Stressors

	Impact on Cultural Resources			
	Cultural Landscapes	**Buckner Homestead**	**Death Valley Scotty**	**Lyons' Ranches**
Salt Water Intrusion	Decline/disappearance of important vegetation species[c] Soil infertility[c]	*N/A*	*N/A*	*N/A*
Extreme Weather Events	Immediate alteration/ destruction of historic landscape[m], particularly trees[cr] Decline/disappearance of some vegetation species, other species favored[i], particularly colonizing species in disturbed areas[cr] Reduction in or loss of access due to washing out or damage to roads, trails, and landscape features[c] (See also: Temperature Change: Increased Wind; Precipitation: Heavier Downpours; Sea Level Rise: Increased Storm Surge)	*increased risk of flooding; damage to irrigation system, particularly main ditch; increased erosion of Stehekin River bank; increased pooling in low areas; increased damage to roads; increased risk of tree fall and damage to structures; increased risk of limb loss/breakage of orchard trees*	*increased occurrence of localized storm events; higher frequency of severe flash floods; severe erosion of canyon edges/arroyos with potentially permanent loss of native vegetation (with increased temperatures); increased frequency of damage to roads and circulation; potential for shift in underground spring channel*	*increased occurrence of winter storms; heavier winds in open areas with potential impacts on barns and outhouses; increased rate of earthflows and/or creep with potential for sudden failures adjacent to sites*
Pollution	Dissolution of stone due to increases in acid rain, particulate matter, and ground- level ozone[m] Decline/disappearance of some vegetation species inc. favored[i] Soil infertility due totoxicity and depletion ofnutrients[c] Loss of landscape features, especially plantings,buildings[c]	*insufficient data*	*insufficient data*	*insufficient data*
Development	Increased abundance of invasive species along roadways[c] Degraded integrity of historic viewsheds[c] Loss of undeveloped buffer areas around cultural landscapes[c] Loss of culturally significant plants from soil compaction, limited root zones, temperature stress from heat island effect, high urban soil contaminant levels[m] Loss of adjacent natural habitat for native species[m]	*N/A*	*N/A*	*N/A*

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Appendix B

NPS DIRECTOR'S POLICY MEMORANDUM 14-02:
Climate Change and Stewardship of Cultural Resources

Date: Februrary 10, 2014
To: All Employees
From: Director /s/ Jonathan B. Jarvis
Subject: Climate Change and Stewardship of Cultural Resources

This policy memorandum provides guidance and direction regarding the stewardship of cultural resources in relation to climate change. It follows my March 6, 2012, memorandum, Applying National Park Service Management Policies in the Context of Climate Change, which addressed the implications of climate change on the guiding principles of National Park Service (NPS) resource management. Additional guidance, in the form of a Cultural Resource Climate Change Strategy, will be forthcoming.

Background

Since my first climate change memorandum was issued in 2012, the risks posed by climate change to parks and communities across the Nation have become even more apparent. Climate science projections anticipate that the rate and intensity of climate change effects will continue to increase for the foreseeable future. Climate change poses an especially acute problem for managing cultural resources because they are unique and irreplaceable — once lost, they are lost forever. If moved or altered, they lose aspects of their significance and meaning. Every year, we lose irreplaceable parts of our collective cultural heritage, sometimes before we even know they exist. Therefore, the decisions we make and the priorities we set today will determine the effectiveness of NPS stewardship of cultural resources in the coming decades.

The NPS leads the Nation in the care and management of our country's cultural resources through the national park system and our programs. On behalf of the Secretary of the Interior, we manage preservation programs that extend to nearly every American community. The National Register of Historic Places and National Historic Landmark Programs, the Federal Historic Preservation Tax Incentives Program, Technical Preservation Services, National Heritage Areas, National Scenic and National Historic Trails, certification of local governments, and our partnerships — including collaborations through the Landscape Conservation Cooperatives, and with tribal governments, States, universities, and other Federal agencies — form a framework for historic preservation inside parks and around the country. Our leadership role in cultural resources now requires engaging this framework to set priorities, to share techniques for protecting significant resources, and to help guide our collective actions with respect to

climate change.

NPS cultural resource management must keep in mind that (1) cultural resources are primary sources of data regarding human interactions with environmental change; and (2) changing climates affect the preservation and maintenance of cultural resources. The NPS will integrate these concepts into information and data gathering and analysis within each of the four components of the NPS Climate Change Response Strategy (2010): science, adaptation, mitigation, and communication. The Cultural Resource Climate Change Strategy currently being prepared will provide further guidance.

Several recent documents set out approaches for the NPS to address current and future effects of climate change: Climate Change Response Strategy (2010), A Call to Action (Action Item 21: Revisit Leopold 2011), Revisiting Leopold: Resource Stewardship in the National Parks (2012), Green Parks Plan (2012), Climate Change Action Plan (2012), and the forthcoming Cultural Resources Challenge. The guidance included in this policy memorandum should be integrated, as applicable, into all actions stemming from those documents.

Based upon discussions across the Service, I address three essential questions with respect to NPS cultural resources and climate change: (1) what is climate change adaptation for cultural resources; (2) how should we make decisions related to cultural resources in light of climate change; and (3) how do we communicate regarding climate change science and impacts.

1. Climate Change Adaption for Cultural Resources

The focus for cultural resources adaptation in an era of climate change must be on our research and management practices. Following the Intergovernmental Panel on Climate Change and as incorporated into the NPS Climate Change Response Strategy, adaptation is "an adjustment in natural or human systems that moderates harm or exploits beneficial opportunities in response to change." Because cultural resources have strong ties to place, risk the loss of integrity if moved or altered, and are in large part non-living, their capacity to move or change as environments around them change is limited. Therefore, we must take a flexible approach in our management actions. Our long-standing policies and the regulations we help administer require that management decisions consider the specific characteristics and significance of each cultural resource. Climate change does not alter these requirements, but it does challenge us to manage these resources in the best possible manner given uncertainty and some-

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times rapidly changing conditions.

Specific foci for adaptive research and management activities will include:
A. Integration of Natural and Cultural Resources: Modeling of climate change impacts and the collecting of environmental monitoring data should, wherever feasible, integrate the data needs of both cultural and natural resource managers. Cultural resources exist within or include parts of the natural world. A given climate variable can affect natural and cultural resources quite differently — heat stresses pikas differently than historic wooden buildings. However, both are stressed and the tracking of that trend provides critical information to both cultural and natural resource managers. Such information should be integrated into standardized reporting for both cultural and natural resources, such as State of the Parks reports. In turn, cultural resources also have tremendous potential to provide critical information for climate science, such as data about past climates at local scales and the history of human impacts on the environment. We must work with our partners to tap this information more fully and use it effectively in establishing baselines, assessing change, undertaking planning efforts, and setting management goals.

B. Innovation for Emergent Threats: Effective adaptive management requires that our decision processes be nimble and flexible. Because climate change-related impacts to cultural resources can occur rapidly, often with less warning than our budgeting cycle is designed to accommodate, I encourage managers to use appropriate discretion and innovation in their actions and decision processes, including reallocating funds, where appropriate, to address emergent threats.

C. Incorporation of Cultural Resources into Sustainability Actions: Cultural resources should be important components of efforts to mitigate the effects of climate change nationwide by improving energy efficiency and reducing greenhouse gas emissions. The adaptive reuse of historic buildings and installation of energy-saving design elements, for example, can be more climate friendly than new construction. As the recently revised Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings make clear, rehabilitation to meet current needs often can be done while maintaining historic integrity in accordance with The Secretary of the Interior's Standards for the Treatment of Historic Properties. Within the NPS, cultural resources are integral to full implementation of the NPS Green Parks Plan. I encourage managers to incorporate historic structures and cultural landscapes into their carbon reduction strategies and planning.

D. Evaluation of Siting of Museum Facilities and Collections: In light of the risks posed by climate change, we must revisit past decisions about

museum facilities and collections. As part of a broader effort to update how we site and use facilities, I direct the Associate Director for Cultural Resources, Partnerships, and Science to undertake a vulnerability study of our museum facilities and collections, and develop a plan for improving stewardship of them.

2. Cultural Resources Decision-making in an Era of Climate Change

Cultural resources have long been subject to environmental forces. The risks of climate change for cultural resources lie in the alteration and recombination of these forces, which together are increasing the types and intensity of impacts on cultural resources. My memorandum of March 6, 2012, addressed the impairment prohibition of the NPS mission and charged the NPS with continuing to work to preserve resources unimpaired from in-park activities. It directed us to engage fully in cooperative conservation and civic engagement to mitigate the impacts arising from external forces. For cultural resources, this work must include the following:

A. Refocus Inventory Responsibilities: As per our responsibilities under section 110 of the National Historic Preservation Act (16 USC 470h-2), NPS policy is to identify resources, evaluate their significance and eligibility for the National Register of Historic Places, and assess any threats of impairment. Accordingly, parks should focus their resource inventory work on lands not yet investigated in those areas most vulnerable to observed and projected climate change impacts and other threats. These areas may include wilderness.

B. Integrate Resource Vulnerability and Significance: We will prioritize cultural resource funding and management actions on projects that integrate vulnerability and resource significance. The current Service-wide Comprehensive Call already prioritizes such work. As such, all identified cultural resources should be evaluated in terms of their vulnerability and significance so that management decisions are directed to resources that are both significant and most at risk.

C. Understand the Range of Climate Change Effects: Cultural resources are vulnerable to dramatic and well-publicized effects of climate change, such as sea level rise or storm surge. Evidence from across the Service is beginning to indicate they are also vulnerable to inland and other more subtle effects of climate change, such as the impacts of more freeze/thaw cycles on stone walls or more rapid wetting and drying cycles on adobe buildings. We must improve our understanding of these additional impacts, address them in our stewardship practices, and be able to

communicate them to the public.

D. Consult Broadly: Consultation to inform the assessment of resource significance must engage a broad array of stakeholders. This will ensure that our actions are based upon thorough, up-to-date understandings of how and why our resources are valued by many diverse groups, including Native Americans and other traditionally associated people, visitors, and the scientific community. It is critical that we engage with all stakeholders to identify their important stories and strengthen our understanding of cultural resources and their values. The National Register of Historic Places eligibility criteria provide a sound framework for assessing significance. In addition, we may discover during consultation that the contemporary significance of our parks and resources transcends the enabling legislation for individual parks. Consultation to glean and understand the contemporary significance of cultural resources to the American people will help keep the national park system and the NPS relevant for generations to come.

E. Value Information from the Past: National Register criteria challenge us to identify and manage not only our known and honored heritage, but also to understand how cultural resources can address questions about the past. Such questions must now include how our modern climate situation has come about and how human societies have responded to climatic and environmental variability in the past. What do resilient and sustainable societies look like? The resources in our parks, including the ones we have not yet identified, have a vital role to play in answering these questions for our multiple publics. Incorporating these questions into our significance evaluations is another critical piece in maintaining NPS relevance into the future.

F. Recognize Loss: We will ensure that our management options recognize the potential for loss. Responsible stewardship requires making choices that promote resilience and taking sustainable management actions. Funding temporary repairs for resources that cannot, because of their location or fragility, be saved for the long term, demands careful thought. Managers should consider choices such as documenting some resources and allowing them to fall into ruin rather than rebuilding after major storms. Such decisions for loss cannot be made lightly nor without appropriate consultation and compliance. They must incorporate interdisciplinary research and should be coordinated on a consistent and Service-wide basis. As with many aspects of climate change adaptation, as yet there are no specific guidelines for these decisions. Guidance and tools to support them are being built in the Cultural Resource Climate

Change Strategy, other documents in preparation, and through the continued collaboration and best practices of our parks, regions, and national programs. History will judge us for the choices we make, and we will take comfort in knowing that sometimes the hard choices are also the ones that are best for our resources, our parks, and our Nation.

3. Communicating about Climate Change Science and Impacts

The NPS has taken significant strides in communicating about climate change through interpretive and educational programs in our parks and through our Service-wide programs. Cultural resources and the stories they anchor are one of the most powerful means we have to share experiences and connect changes in parks to trends across the Nation and worldwide. Impacts to cultural resources provide tangible examples of the effects of climate change at the human scale. Cultural resources offer lessons in past human successes, and failures, in adapting to environmental changes, and provide insight into the origins of the modern climatic situation. There is much to learn and share from traditional ecological knowledge and the weather- and disaster- related memories, practices, and architecture of traditional communities.

Every place has a climate story, many have more than one. Some are told in various ways by the people who have lived and worked on the land for generations. Building on the communication goals of the NPS Climate Change Response Strategy, each park and program should engage its staff, including facilities and maintenance staff, rangers, resource managers, scientists, and superintendent, and its surrounding communities to begin to identify and share their climate stories. It is important to do this — even when doing so is uncomfortable — so that they can spark discussion and inform choices. We must be committed to talking about climate change Service-wide, in our internal and external communications, including acknowledging the uncertainty we face as we make management decisions that will have long-term consequences for cultural resources. We will leverage the additional message about climate change into ongoing stories and programs where appropriate.

Looking Forward

Climate change is one of the great challenges of the 21st century. It is remaking our world and substantially influencing how we set priorities and make management decisions. The process of adaptation will not return us to the way things have been done before, but it will assist us in making choices in the face of uncertainty and change. Cultural resources remind us of who we are and where we have come from. They offer clues on past climate variability and speak to the many different ways humans have adapted to changing environments over time, in our parks and across the

country. We need their information and their inspiration.

We must be well-informed and creative in our approach to resource management given the effects of climate change. The paths climate change will take remain uncertain so we must be open to the unexpected, search out new and useful ideas, and share the innovations we develop. This cannot be a NPS-only effort, but instead will require a collaborative approach in order to be successful. This effort will include our international partners, as we learn from their work and perspectives, and share our own. While we cannot afford to wait for absolute certainty about where and when impacts will occur, we must act based on the best available sound science even as we continue to incorporate new information as it becomes available. I challenge all of us to continue to strengthen our work with our many partners to recognize and respond to the effects of climate change on cultural resources. As stewards of America's greatest national treasures, we must draw on our strengths and join with our partners to meet this challenge over the long term.

[End of Policy Memorandum]

Acknowledgements

NPS PACIFIC WEST REGIONAL OFFICE
Vida Germano, Cultural Landscape Program Coordinator
David Louter, PhD., Chief of Cultural Resources
Christopher E. Johnson, Historian
Shannon Sawyer, Historical Landscape Architect
Julian Huertas, Cultural Resources Intern

NPS NATURAL RESOURCE STEWARDSHIP AND SCIENCE
Patrick Gonzalez, Principal Climate Change Scientist

NPS, OFFICE OF THE ASSOCIATE DIRECTOR, CULTURAL RESOURCES, PARTNERSHIPS, AND SCIENCE
Marcy Rockman, Climate Change Adaptation Coordinator for Cultural Resources

NPS PARK CULTURAL LANDSCAPES PROGRAM
Susan Dolan, Program Manager

NORTH CASCADES NATIONAL PARK, WA
Jack Oelfke, Chief of Natural and Cultural Resources
Kim Kwarsick, Archeologist, 106 Coordinator
Vicki Gempko, Stehekin National Resources Program Manger
Laurie Thompson, Orchardist
Mignonne Bivin, Plant Ecologist
Michael Koenen, Fire Management

REDWOOD NATIONAL PARK, CA
Karin Grantham, Joint Chief Resource Management and Science
Kevin McArdle, Cultural Resource Specialist / Historical Landscape Architect
Michael Peterson, Archeologist
Stassia Samuels, Plant Ecologist
Eamon Engber, Fire Ecologist
John McClelland, Fuels/Prescribed Fire Technician

DEATH VALLEY NATIONAL PARK, CA
Mike Reynolds, Superintendent
Mary-Blair Davenport, Cultural Resources
Josh Hoines, Chief of Resources
Blair Davenport, Cultural Resource Manager
Amanda Landon, Compliance Archeologist
Lou Rogers, Civil Engineer
Nicole Arendt, Facilities Management Specialist
Linda Slater, Chief of Interpretation

