Emergency Stabilization & Rehabilitation Plan

KNP Complex

Sequoia and Kings Canyon National Parks, CA

Submitted by: Clayton F. Jordan Date: 12/15/21

Clayton Jordan, Superintendent

November 5, 2021

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Unit Summary Information

Unit Name	Sequoia and Kings Canyon National Parks
Unit Identifier	SEKI
NPS Region	Pacific West

Fire Summary Information

Fire Name	KNP Complex
Fire Number	CA-KNP-000124
Fire Code	N9UH
Detection Date/Cause	9/10/2021 /Lightning
Date Contained	N/A
Acreage	Total Acres = 88,307 (as of 11/1/2021) Total Acres burned in SEKI = 78,675

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Introduction

This plan addresses Emergency Stabilization (ES, also called Burned Area Emergency Response BAER) and Burned Area Rehabilitation (BAR) of potential detrimental effects resulting from theKNP Complex that burned on Sequoia and Kings Canyon National Parks (SEKI). This plan hasbeen prepared in accordance with the Department of Interior policy and guidance, including:

35. *Office of Wildland Fire (OWF) Policy Memorandum 2016-01 (Post-Wildfire RecoveryProgram and Policy Changes)*;
36. *Interagency Standards for Fire and Fire Aviation Operations*
37. *NPS Reference Manual 18 (Chapter 18)*;
38. *NPS Wildland Fire & Aviation Management Business Rules, FY19*;
39. *Interagency Burned Area Emergency Response Guidebook (Version 4.0)*;
40. *Interagency Burned Area Rehabilitation Guidebook (Version 1.3)*

Sequoia and Kings Canyon National Parks

On September 25, 1890, President Benjamin Harrison signed legislation to protect 404,064 acres of the Sierra Nevada as Sequoia National Park. Created to protect the giant sequoia trees from logging, Sequoia National Park was the nation's second national park and the first createdto protect a living organism: *Sequoiadendron giganteum*. One week later, an adjacent area wasestablished as General Grant National Park; this park was enlarged and re-named Kings CanyonNational Park in 1940.

Under unified management since 1943, Sequoia Kings Canyon National Parks encompass 865,965 acres of foothills, canyons, mountain ridges, and alpine peaks, including Mount Whitney, the highest point in the contiguous United States at 14,505 feet. UNESCO designatedthe conjoined parks as the Sequoia-Kings Canyon Biosphere Reserve in 1976.

BAER Program

The primary objectives of the BAER program are to assess the need for and prescribe cost effective post-fire stabilization measures necessary to protect human life, property, and critical natural and cultural resources. The BAR program is intended to protect resources by repairing or improving burned landscapes unlikely to recover naturally to desired management conditions and to repair or replace fire-damaged minor assets. BAER and BAR are conducted in accordance with approved land management plans and policies, and all relevant federal, state and local laws and regulations.

BAER and BAR are intended to address imminent (<1 year) and short-term (<5 years) threats caused by wildfire, respectively; neither program is responsible for long-term management orrectifying deficiencies that existed prior to the fire. Department of the Interior and NPS BAER policy echoes federal wildland fire policy regarding protection priorities: human safety is first,

and property and critical natural and cultural resources are ranked based on the relative valuesto be protected, commensurate with emergency stabilization and rehabilitation costs.

The basis of the BAER and BAR assessment process is identifying, evaluating, and protecting, repairing or replacing values at risk (VARs)—human safety, properties, capital improvements and natural and cultural resources—located within and downstream of burned areas, and impacted by fire and/or vulnerable to post-fire conditions. When evaluating a given VAR, consideration is given to the significance of the value, probability of damaging events occurring,the magnitude of potential consequences, and the feasibility to mitigate. If warranted, treatments will be prescribed, implemented, maintained, and monitored as necessary to protect vulnerable VARs.

Assessments Process

A BAER Team with expertise in hydrology, forestry, cultural resources, infrastructure,recreation, botany, wildlife biology, GIS, and environmental regulatory

compliance assembled on October 20, 2021. The BAER Team held an initial briefing with the SEKI management team and various natural and cultural resources, facilities, environmental compliance, law enforcement, interpretive, and wilderness specialists on October 21, 2021. The briefing served as an overview of the BAER process and identification of important valuesat risk. On November 2, 2021 the BAER Team shared findings and recommendations with the SEKI management team and the multiple discipline staff specialists during a close out presentation.

Between October 20 and October 31, 2021, the BAER Team conducted field reconnaissance and compiled data from the on-site inspection of fire-impacted habitats, watersheds, culturalresources and other site-specific values and hazards on SEKI. Hydrologic models were used toestimate risks to structures and important habitat areas from run-off and sedimentation.

Satellite imagery was also used to develop maps of soil burn severity within the fire perimeter. Following field reconnaissance and further consultation with multi-disciplinary Park specialists, the BAER team identified the following values most at risk as a result of the KNP Complex. Note that not all issues result in recommendation for stabilization or rehabilitation treatments.

Topic/Issue	Watershed	
Background		
Increased watershed response in the form of rock fall, debris movement, erosion, sediment delivery and peak flow rates following the fire are anticipated. This will pose concern for public safety and infrastructure integrity. The following table, along with the Facilities VAR table will address these concerns.		
VAR	**Issue(s)/Concern(s)**	**Potential Response(s)**
Public Safety	Conditions of Road and Culverts	**ES-2**: BAER Crew-Storm Patrol: Road infrastructure tobe maintained.
Public Safety	Rockfall at Buckeye Flat Campground	**Non-Specification Recommendation**: Close campground over winter and assess rock fall situation inspring prior to opening.
Infrastructure Protection	Hydroelectric flume intake	**Non-Specification Recommendation**: Increasedmaintenance by SCE.
Resource Protection	Hillslope stability for Sequoias	**BAR-9**: Implement active sequoia restoration in 350acres of moderate to high burn intensity.
Resource Protection Monitoring	Replacement of fire damaged hydrologic monitoring equipment	**BAR-12**: Replace Hydrologic Scientific Equipment atHalstead Meadow and Elk Creek.

Topic/Issue	Forestry / Hazard Trees	
Background		
As a result of the KNP Complex at SEKI there are thousands of trees impacted by the fire. The fire has caused extensive tree mortality and there will be additional delayed mortality in the next few years. When dead trees are located near developed areas (parking lots, trailheads of high visitation, visitor centers, vista points, picnic areas, park roads and other park infrastructure) they are referred to as "hazard trees" and require mitigation. Based on the values at risk (visitors, structures, and vehicles) trees were assessed for hazard potential based on the 7-point system of hazard tree assessment used at SEKI. Trees were assessed along roads using a windshield survey method. Trees around infrastructure were assessed on foot where it was safe to do so. Those that were found to be hazards were marked and mapped.		
VAR	**Issue(s)/Concern(s)**	**Potential Response(s)**
Park Structures	Damage to property / structures	**ES-1:** Hazardous Tree Assessment & Mitigation, Marktrees for removal as needed.
Parking Areas	Stationary targets / vehicles	**ES-1**: Hazardous Tree Assessment & Mitigation, Mark trees for removal as needed Plan for follow up monitoringand mitigation for 3 years.
Generals Highway	Pullouts, parking areas, vista points, slow moving vehicles	**ES-1**: Hazardous Tree Assessment & Mitigation, Marktrees for removal as needed; plan for follow up monitoring and mitigation for 3 years.
Crescent Meadow / Moro Rock Roads	Pullouts, parking areas, slow moving vehicles	**ES-1**: Hazardous Tree Assessment & Mitigation, Marktrees for removal as needed; plan for follow up monitoring and mitigation for 3 years.
Mineral KingRoad	Pullouts, slow moving vehicles	**ES-1**: Hazardous Tree Assessment & Mitigation, Marktrees for removal as needed; plan for follow up monitoring and mitigation for 3 years.
Crystal Cave Road	Pullouts, slow moving vehicles, heavily traveled road	**ES-1**: Hazardous Tree Assessment & Mitigation, Marktrees for removal as needed; plan for follow up monitoring and mitigation for 3 years.

Topic/Issue	Vegetation	
Background		
READ, BAER, and SEKI staff identified vegetation concerns related to both direct fire effects as well as impacts of suppression activities implemented during the KNP Fires. Primary concerns include (1) spread of invasive plants into burned areas and newly disturbed sites, (2) effects of fire suppression activities on special status species, and (3) loss of mixed conifer forest that is critical Pacific fisher habitat, giant sequoia groves, and foothill shrubland communities because large areas of each community type burned with high intensity. Other concerns include suppression damage to vegetation planted to protect sensitive areas, direct fire damage to a type locality of an endemic plant species, large scale heavy equipment damage in chaparral communities, and fire damage to sandbags that are critical to a meadow restoration project.		
VAR	**Issue(s)/Concern(s)**	**Potential Response(s)**
Resource Protection / Revegetation	Fire-damaged sandbags put Halstead Meadow restorationat risk of new gullying	**ES-14:** Reinforce damaged sandbags with a row of new oneslaid immediately upstream (not on top). Retain damaged sandbags to allow surviving vegetation to colonize new bags
	Areas revegetated for resource protection but damaged by fire suppression activities	**BAR-6:** Collect propagules, propagate, and install replacement plants in conservation planting areas damagedby fire or those deliberately cut or burned at Giant Forest, Tunnel Rock, and Potwisha Campground.
Native Plant Communities	Ecological degradation byinvasive species	**ES-13 & BAR-5:** Invasive Plant Management: Survey and treat for new infestations of invasive species in sites disturbed by fire suppression activities as well as around known infestations that may have spread into nearby fire-disturbed areas.
	Loss of community structure and habitat function to severefire intensity, especially in mixed conifer habitat for Pacific fisher	**BAR-11:** Replant 500 acres of high severity mixed conifer inareas of maximum benefit to Pacific fisher. See Wildlife Assessment for details.
	Loss of giant sequoia trees to intense fire.	**BAR-9:** Implement active sequoia restoration in 350 acres of moderate to high burn intensity.
	Loss of community structureand diversity in large, bulldozed safety zones and control lines created in the foothill scrub zone	**BAR-7:** Protect safety zones and dozer lines from erosionover winter 2021-22, treat annual grasses and other invasive plants, collect seed and propagate natives for ecosystem recovery.
	Riparian impacts from temporary heavy equipment crossing built on Yucca Creek	**Non-Specification Recommendation:** Monitor this site (suppression repair should remove the structure and stabilize the bank) for streambank stability and riparianvegetation recovery.

Sensitive Plant Populations	Fire and slope erosion damageto type locality of *Eriogonum nudum* var. *murinum*	**BAR-8:** Propagate and out-plant 50 plugs of this species from seed collected in the type locality, to replace thoseburnt or buried during the fire.
Vegetation Monitoring Plots	Plot monumentation damaged; potential that plotsno longer are valid for monitoring goals	**Non-Specification Recommendation:** Inspect plots withinburn footprint, replace damaged plot stakes and tags, decommission plots and/or select new monitoring plots ifneeded.

Topic/Issue	**Facilities/Minor Infrastructure**	
Background		
Minor facilities within the KNP Complex fire perimeter include boundary fences, boundary markers, a shooting range, a communication site, a sewage spray field, and a solar array. Many of these facilities are constructed of wood and plastic-based materials. Fencing is particularly important in preventing cattle trespass from private and BLM lands. Boundary markers are important to inform hunters of the location of parks lands where hunting is illegal.		
VAR	**Issue(s)/Concern(s)**	**Potential Response(s)**
Boundary Fence	Fencing at the Yucca Creek area burned, fencing at Whitaker's Forest may be affected by falling trees, enabling cattle trespass intothe park.	**ES-2:** Replace burned wooden posts at Yucca Creek and restring the wire, repair fence at Whitaker where treesfall on it.
Shooting Range	A small storage building that is important to operations at the range burned.	**BAR-1:** Replace the storage building.
Milk Ranch CommunicationSite	Communication equipment at the site that is critical to park operations was burned in the fire and is non-functional	**ES-3:** Replace the communication equipment as part of a broader package of communications infrastructure needs inthe park.
Wuksachi Bridge	A part of the glulam bridge was burned by fire.	**BAR-2:** Repair bridge.
Boundary Signs	NPS boundary signs have beenlost to the fire.	**ES-2:** Signs require replacement in distinct locations to inform visitors and hunters when they cross onto NPS lands,where hunting is prohibited.

Topic/Issue	Roads	
Background		
The General's Highway and Mineral King Road were impacted directly by the KNP Complex and will sustain further damage due to post-fire events. Directional highway signs have burned, a bridge has burned, and asphalt road surfaces have been damaged by burning vegetation, heat, and falling trees. Road culverts will continue to fill with debris and sediment. Recommended actions include clearing storm debris from the road and placing fire hazard and closure signs to inform drivers of hazards.		
VAR	**Issue(s)/Concern(s)**	**Potential Response(s)**
General's Highway Culverts	Rolling debris and sediment can clog the inlet to culvertscausing them to fail during storm events	**ES-2**: Clean culverts after storms.
Mineral King Road Culverts	Stationary targets / vehicles	**ES-2**: Clean culverts after storms.
Road Statute signs	Signage to inform drivers of road conditions to enable safe driving (curves in road,safe driving speeds, etc.)	**ES-6**: Replace signs.
Road Hazard Signs	Signage to inform drivers of post-fire hazardous roadway conditions	**ES-6**: Install signs.
Storm Patrol	Rolling rocks, debris and falling trees will block the road causing a driving hazard	**ES-2**: Clear roads of debris.
Road Damage	Falling trees and burning trees have damaged segments of road surface. Burned geotextile fabric mayhave destabilized road foundation	**ES-4**: Repair road surface, contract geotextile analyses.

Topic/Issue	Trails	
Background		
Together, Sequoia and Kings Canyon National Parks receive almost 2 million visitors a year. Popular visitor attractions within the KNP Complex fire perimeter include giant sequoias and hiking trails. Over 68 miles of trails lie within the burn perimeter. Significant fire-related damage has occurred along these trails, including tread damage, accumulation of soil, rock, and woody debris, stump holes from rootwad burnout, damage to rock walls, burned wooden structures, and many trees across the trails. Repairs in FY22 and maintenance needs above normal annual maintenance in subsequent years will be required to open the trails.		
VAR	**Issue(s)/Concern(s)**	**Potential Response(s)**
Hiking Trails	Widespread damage to trails occurred within the burn perimeter. Trail clearing and stabilization to address safety concerns will require extensive work prior to allowing visitor access. Trail damage is severe inareas of moderate and high soil burn severity, although low severity burn areas along some trails (such as Crystal Cave) also resulted in extensive damage.	If possible, keep all trails closed to the public until Park staffcan clear the trails of debris (wood, soil, rocks) and re- establish the tread to a reasonably safe standard. Trails can be reopened on a case-by-case basis after necessary repair work is completed. **BAR-3: Trails Stabilization and Hazard Mitigation,** addresses the many needs to return the trails to a safe standard for visitors and provide for resource protectionalong the trails by preventing social trail development and limiting off-trail visitor use. **BAR-4: Outyear Trails Maintenance,** will provide fundingin Years 2 and 3 post-fire to address ongoing increased trail maintenance needs such as increased windfalls, increased drain cleaning/erosion control, and ongoing debris removal following storm events

Topic/Issue	Public Safety and Resource Protection	
Background		
The KNP Complex burned park infrastructure, vegetation, and soils resulting in threats to public safety and anincreased potential for impacts to natural and cultural resources from park visitation.		
VAR	**Issue(s)/Concern(s)**	**Potential Response(s)**
Public Safety	Damage to road, regulatory, and interpretive signs.	**ES-6**: Map and replace damaged signs.
Public Safety	Burned area hazards (falling rock, hazard trees, landslides, flash floods,etc.) that could significantly impact public safety.	**ES-6**: Install and track locations of burned area hazardsigns. Install and track locations of road closure gates, road closure signs, and temporary barriers as needed to control public access by the public. **ES-7**: Post-fire public outreach, interpretation, and education via online, printed, in-person, and interpretive display platforms and maps. Increasedagency presence to interact with the public.
Resource Protection	Potential for damage to newly exposed natural and cultural resources by the public due to socialtrail development and/or exploration/looting.	**ES-6**: Restricted public access as informed by burnedarea closure signs and maps. **ES-7**: Post-fire public outreach, interpretation, and education via online, printed, in-person, and interpretive display platforms and maps. Increased agency presence to monitor recently exposed areasand sensitive sites.

Topic/Issue	Cultural Resources	
Background		
Eight historic structures, five cultural landscapes & historic districts, 92 archaeological sites, 20 ethnographic resources, and 20 cubic feet of museum collections were directly affected or threatened by the KNP Complex. At least two historic structures were destroyed, and their remains pose a risk to visitor safety (e.g., collapse and hazardous debris). Two historic structures, four historic districts & cultural landscapes, 20 ethnographic resources, and 71 archaeological sites will need to be assessed in FY22. Threats and impacts to cultural resources within the fire perimeter include adjacent hazard trees, structural and site stability, erosion, and potential looting and vandalism. In addition, 20 cubic feet of nitrate film was likely damaged during evacuation for the KNP Complex, which creates an ongoing health, safety, and fire risk for the entire SEKI Museum Collections. Proposed emergency stabilization treatments by other BAER disciplines mayrequire Section 106 NHPA compliance and consultation. Non-specification recommendations include dismantling or stabilizing damaged structural features, continued historic structure wildfire fortification efforts, updating the CRIS database with post-fire condition assessments, and additional Section 110 NHPA archaeological surveys.		
VAR	**Issue(s)/Concern(s)**	**Potential Response(s)**
Historic Structures	Redwood Mountain Ranger Station was destroyed by fire on 10/4/21. Issues include debris and HAZMAT stabilization, feature stabilization, andexclusionary measures for public safety. Redwood Mountain Equipment Garage was not damaged by fire, but hazard trees are a concern.	**ES-1: Hazard Tree Assessment & Mitigation** Addresses the removal of hazard trees threateningthis building. Directionally fall hazard trees away from structures. No further assessments needed. **ES-9: Cultural Protection and Stabilization** Exclusionary measures to secure site from uncontrolled access for safety, looting, and vandalism.
	Barton's Log/Crose's Cabin was destroyed by fire on October 4, 2021.There is a concern for vandalism and looting.	**ES-9: Cultural Protection and Stabilization** addresseslooting and vandalism concerns by increasing park presence to monitor the site. The interpretive sign indicating to visitors the presence of a cabin site should be removed.
	Moro Rock Comfort Station was destroyed by fire on October 3, 2021. Issues include debris stabilization and exclusionary measures from the site for public safety.	**ES-9: Cultural Protection and Stabilization** Exclusionary measures to secure site from uncontrolled access for safety, looting, and vandalism.
	The Lilburn Research Cabin is withinthe fire perimeter and has not been assessed due to safety concerns.	**ES-10: Cultural Resource Assessments** Post-Fire assessment of Lilburn Research Cabin is needed.

	The Lost Grove Comfort Station was not damaged by fire, but hazard treesare a concern.	**ES-1: Hazard Tree Assessment & Mitigation** Addresses the removal of hazard trees threatening these buildings. Directionally fall hazard trees away

		from structures.
	Cabin Creek Ranger Station and Dormitory were not damaged by the fire.	No further assessments needed.
	Colony Mill Ranger Station is within the fire perimeter and has not been assessed due to safety concerns.	**ES-10: Cultural Resource Assessments** Post-Fireassessment of the Colony Mill Ranger Station is needed.
	Sequoia National Park Entrance Signwas not damaged by the fire, but hazard trees are a concern.	**ES-1: Hazard Tree Assessment & Mitigation** Addresses the removal of hazard trees threatening these buildings. Directionally fall hazard trees awayfrom this structure. No further assessments need.
Cultural **Landscapes & Historic Districts**	Generals Highway Historic District is within the KNP Complex fire perimeter and has not been assessed.	**ES-10: Cultural Resource Assessments** Post-Fire assessment of Generals Highway Historic District is needed.
	Mineral King Road Cultural Landscape District is within the KNP Complex fire perimeter and has not been assessed.	**ES-10: Cultural Resource Assessments** Post-fire assessment of Mineral King Road Cultural LandscapeDistrict is needed.
	The Giant Forest Village Historic District was impacted by the KNP Complex. The Beetle Rock Education buildings was not damagedby the fire, but hazard trees are a concern. The Giant Forest Ranger Residence was not damaged by the fire, but hazard trees are a concern.	**ES-1: Hazard Tree Assessment & Mitigation** Addresses the removal of hazard trees threatening these buildings. Directionally fall hazard trees awayfrom structures.
	Crystal Cave Historic District is withinthe KNP Complex fire perimeter andhas not been assessed.	**ES-10: Cultural Resource Assessments** Post-fire assessment of Crystal Cave Historic District is needed.
	Colony Mill Road is within the KNP Complex fire perimeter and has notbeen assessed.	**ES-10: Cultural Resource Assessments.** Post-fire assessment of Colony Mill Road is needed.
Archaeological Resources	Approx. 70 archaeological sites stillneed post-fire assessment to determine post-fire stabilization needs.	**ES-10: Cultural Resource Assessments** A contracted CRM firm will complete site assessments in FY22 andwill recommend emergency stabilization treatments.

	Burn sites have post-fire stability concerns including hazard trees, erosion, burned out stump holes androots, and exposed artifacts and features.	**ES-1: Hazard Tree Assessment & Mitigation.** One hazard tree at CA-TUL-2235H should be removed toprevent damage to a historic structural feature. Unassessed sites may have additional hazard treesthat require removal. **ES-10: Cultural Resource Assessments.** A contracted

		CRM firm will complete site assessments in FY22 andwill recommend emergency stabilization treatments. **ES-12: NHPA Compliance & Consultation.** SHPO/THPO consultation required for undertakings with potential for adverse effects on historic properties.
	Increased visitation, erosion, informal social trail development, looting and vandalism.	**ES-5: Increased Agency Presence.** VRP Ranger needed to deter unauthorized site visitation, looting,and vandalism. **ES-12: NHPA Compliance & Consultation.** CulturalLiaison needed to assess culturally significant archaeological sites and recommend emergency stabilization treatments.
Ethnographic Resources	Approx. 20 areas identified as culturally significant within the burn area are threatened by post-fire conditions including increased exposure and visitation, erosion, informal social trail development, andvandalism.	**ES-5: Increased Agency Presence.** VRP Ranger needed to deter unauthorized site visitation andvandalism. **ES-12: NHPA Compliance & Consultation.** CulturalLiaison needed to assess culturally significant ethnographic sites and recommend emergency stabilization treatments.
MuseumC ollections	The Museum collections were threated and compromised by the KNP Complex when the nitrate film collection was likely damaged creating an ongoing health, safety, and fire risk to the entire Museum collections.	**ES-11: Museum Collection Assessment.** Post-fire assessment and preliminary stabilization of nitratefilm collection is needed to stabilize risk to entire museum collections.

Topic/Issue	Wildlife

Background

The purpose of the Burned Area Emergency Response (BAER) Wildlife Assessment (Assessment) is to identify the post-fire threats to federally listed or proposed threatened or endangered wildlife species and their habitats from the KNP Complex and proposed emergency stabilization (ES) actions within Sequoia and Kings Canyon National Parks (SEKI). The Assessment also identifies the need for ES or BAR actions that may benecessary to prevent further post-fire condition degradation to listed species or their habitats.

VAR	Issue(s)/Concern(s)	Potential Response(s)
Pacific Fisher Proposed Critical Habitat	Proposed critical habitat for the federally listed Pacific fisher (SSN DPS) occurs within the fire perimeter.	**BAR-10:** Protection of Trees in Pacific fisher Habitat, to apply pheromone on large habitat trees for their protection from insect attack. **BAR-11:** Revegetation of Pacific Fisher Critical Habitat, to replantcritical habitat (mixed conifer forest) for long-term habitat recovery.
CA SpottedOwl – StateSpecies of Special Concern	CA spotted owl habitat occurswithin the fire perimeter.	**Non-Specification Recommendation:** Continue to monitor damage and any effects from changes to thepost-fire environment.
Increased Bear/Human Conflicts	Adverse impacts to black bear habitat and novel food sources resulting from the fire has increased bear/human conflicts within and adjacent to the park.	**Non-Specification Recommendation:** Continue to monitor damage and any effects from changes to the post-fire environment. Replace damaged food storagelockers, as needed, and assess fire impacts to bear management infrastructure.
Wildlife Monitoring Equipment	Wildlife monitoring equipment deployed within the fire perimeter was damaged or destroyed by the fire.	**Non-Specification Recommendation:** Replace damagedmonitoring equipment, as needed.
Aquatic Invasive Species	The use of lakes and ponds as water sources for fire suppression activities within thepark has increased the risk of aquatic invasive species introduction.	**Non-Specification Recommendation:** Continue tomonitor habitat for AIS introductions or spread.

Local Management Plans

Approved SEKI land and resource management plans and other documents guided the preparation of this plan. Management direction relevant to the Emergency Stabilization and Rehabilitation treatments proposed in this plan can be found in Appendix II and summarizedbelow:

41. A Climate Smart Resource Stewardship Strategy for Sequoia and Kings Canyon NationalParks, 2017
42. Foundation Document, Sequoia and Kings Canyon National Parks, 2016
43. Wilderness Stewardship Plan and Environmental Impact Statement, Sequoia and KingsCanyon National Parks, 2015

Compliance with environmental laws, regulations, policies, and local agency planning documents are required for all proposed BAER treatment actions at SEKI. All proposed treatments were reviewed and determined to be compliant with the National Environmental Policy Act under existing Categorical Exclusions, Environmental Assessments, and Environmental Impact Statements. Based on species occurrence data and analysis of the impacts of proposed post-fire mitigation measures to species and their habitats, treatments proposed in this plan may affect, but will not likely adversely affect listed species or adverselymodify critical habitat. This BAER plan is in compliance with the Endangered Species Act. All

activities with potential to affect cultural resources, including historic properties will be subjectto compliance with National Historic Preservation Act Section 106. Proposed activities not addressed in this plan may require additional NEPA analyses and other compliance documentation.

Plan Organization

This plan includes a narrative summary of the KNP Complex, followed by in-depth resourceor issue specific burned area assessments, and itemized specifications for BAER and BAR treatments and activities. Appendices are found at the end of the plan.

TABLE OF CONTENTS

UNIT SUMMARY INFORMATION 1
FIRE SUMMARY INFORMATION 1
ACCOUNT NUMBER(S) 1
BAER TEAM MEMBERS 1
EXECUTIVE SUMMARY 5
TABLE OF CONTENTS 21
FIRE NARRATIVE 22
BURNED AREA ASSESSMENTS 25
WATERSHED ASSESSMENT 26
FORESTRY/HAZARD ASSESSMENT 48
VEGETATION ASSESSMENT 58
FACILITIES/MINOR INFRASTRUCTURE ASSESSMENT 98
ROADS ASSESSMENT 103
TRAILS ASSESSMENT 108
PUBLIC SAFETY & RESOURCE PROTECTION ASSESSMENT 118
CULTURAL RESOURCES ASSESSMENT 128
WILDLIFE ASSESSMENT 156
SPECIFICATIONS 173
APPENDIX 265

1. Environmental Compliance
2. KNP BAER Restoration Recommendations
3. KNP Fire Progression Report
4. Maps

FIRE NARRATIVE

On Friday September 10, 2021, three fires were discovered in Sequoia National Park following asignificant lightning event. The Cabin Fire east of Stony Creek Campground in upper montane forest was contained at 1.25 acres on September 11, 2021. The Colony Fire was discovered on the northeast side of Colony Peak and estimated to be 4 acres burning in mixed conifer forest with a high density of drought killed trees. The Paradise Fire located south of Buckeye Campground was estimated at 0.25 acres burning midslope in dense oak woodland and chaparral.

A full suppression strategy was chosen for both fires based upon limited accessibility, high potential for fire spread, vulnerability of values at risk, and a national drawdown of wildland firefighting resources. Ground resources assigned to the Colony fire reported 6-foot flame lengths around the entire fire perimeter, no natural barriers to work from, and a high concentration of old snags. Water and retardant drops exhibited limited effectiveness in moderating fire behavior. Control objectives for the incident were to keep the Colony Fire on the ridgetop and west of the Crystal Cave Road. Due to the midslope location and lack of safe anchor points, safety zones, or road and trail access, no ground resources took action on the Paradise Fire. Instead, aircraft were directed to use water and retardant drops as part of an indirect strategy with the goal of keeping the Paradise Fire south of the Kaweah River and north

of Paradise Ridge. Resources for structure preparation and protection were ordered for theGiant Forest, Lodgepole, Ash Mountain, and Mineral King areas.

While temperatures remained moderate, fuel moistures throughout the surrounding area werecritically low. Most of the fire planning area had no recent fire history. Daytime smoke hinderedaviation. Throughout September, both fires burned actively at night under an inversion and resisted control efforts. Much of the fire's growth occurred due to backing and flanking, with short uphill runs. However, in some areas, terrain, fuels, and winds aligned to drive high intensity crown runs ranging from tens to hundreds of acres.

Over the following weeks, the Colony and Paradise fires merged and spread in all directions, eventually reaching a size of 88,307 acres at elevations ranging from 1,500 feet and 9,000 feetin the drainages of the North Fork, Marble Fork, Middle Fork, and East Fork of the Kaweah River. The fire footprint included private lands and portions of Sequoia and Kings Canyon National Parks, the Giant Sequoia National Monument and Sequoia National Forest, Bureau ofLand Management lands managed by the Bakersfield Field Office, and the University of California Whitaker's Forest.

Notable events and impacts included:

1. Closure of large portions of Sequoia and Kings Canyon National Parks to visitation.
2. Evacuation of Sequoia and Kings Canyon National Park Headquarters and residences in Ash Mountain, Mineral King, Lodgepole, and Grant Grove. Evacuations in Three Rivers, Silver City, Badger, and Heartland.
3. Fire impacts to the primary NPS thoroughfare through the park, the Generals Highway,and other roads including Crystal Cave, Crescent Meadow, Redwood Canyon, and Mineral King Roads.
4. Use of hand crews and bulldozers to build fire line in designated wilderness.
5. Destruction of NPS properties (including the Milk Ranch communications site, MoroRock Comfort Station, Redwood Mountain Ranger Station, and Redwood Canyon Research Cabin) and a private cabin at Oriole Lake. Damage to Southern California Edison 12 kV distribution line.
6. Fire in several giant sequoia groves, including Redwood Mountain, Lost, Skagway, PineRidge, Muir, Giant Forest, Suwanee, Castle Creek, Squirrel Creek, Oriole Lake, New Oriole Lake, Redwood Creek, and Atwell. Portions of some groves, including Suwanee and Redwood Mountain, burned intensely due to an alignment of winds and topography. Portions of other groves were intentionally ignited ahead of the arrival of the main fire to moderate intensity.
7. At its peak, the KNP Complex was staffed by more than 2,000 personnel. The incident was managed by six different teams over the course of the fire: SEKI Type 3 team, Type1 Southern Area

Blue Team, Type 1 Southwest Area Team 2, Type 1 California Incident Management Team 1, Type 1 California Incident Management Team 2, and Type 2 California Interagency Incident Management Team 12.

8. Two significant rain events aided containment, the latter an atmospheric river which occurred in late October.

By late October, little heat was left within the fire's perimeter. Mop up continued in a limited capacity to minimized large sequoia mortality, but suppression efforts shifted from increasing containment to suppression repair and evaluating emergency stabilization needs.

Burned Area Assessments

RESOURCE ASSESSMENTS

1. **WATERSHED ASSESSMENT**
2. **FORESTRY/HAZARD TREE ASSESSMENT**
3. **VEGETATION ASSESSMENT**
4. **FACILITIES/MINOR INFRASTRUCTURE**
5. **ROADS ASSESSMENT**
6. **TRAILS ASSESSMENT**
7. **PUBLIC SAFETY & RESOURCE PROTECTION ASSESSMENT**
8. **CULTURAL ASSESSMENT**
9. **WILDLIFE ASSESSMENT**

WATERSHED ASSESSMENT

OBJECTIVES

9. Identify areas where life, property and critical natural and cultural resources are at riskof damage from debris movement, flooding, or erosion.

ISSUES

10. Post-fire watershed response impacts to Park roads and drainage networks.
11. Increased rock fall from slopes above the General's Highway and Buckeye Flat Campground.
12. Erosion in Giant Sequoia groves destabilizing trees and inhibiting recruitment.
13. Increased sediment delivery to caves.
14. Foot bridge over Cascade Creek on the trail to Crystal Cave
15. Elevated sediment concentrations in the upper-mid reaches of the Kaweah River Watersheds.
16. Risk of damage to hydro-electric intake and flume infrastructure from debris and rockfall.
17. Damage to restoration efforts at Halstead Meadow

BACKGROUND

Rocks within the KNP Complex are dominantly Cretaceous granites and granodiorites of the Sierra Nevada batholith that intruded masses of Mesozoic metasedimentary rocks such as schist, quartzite, and marble (Sisson and Moore, 2013). Many of the exposed marble outcrops contain cave and karst features that are among the tourist attractions of the area. Fine-texturedclayey soils dominate the metasedimentary terrains, while coarser textured granitic soils are found predominantly east of the metasedimentary contacts.

The dominant vegetation communities affected by the KNP Complex range with elevation fromoak and chaparral species in the foothills to mixed conifer to subalpine conifers at upper elevations. Giant sequoia stands feature prominently in open and closed canopy mixed conifer stands. Isolated pockets of sequoias occurring within drainages may have shallower root systems which may make them more susceptible to postfire lodging in

ensuing years. Other alterations in site conditions resulting from the fire, such as changes in hydrology or increased sedimentation from upslope, can increase the chances of tree mortality.

Further, as described in the *Vegetation Assessment*, sequoia regeneration is dependent on seedrain. Because sequoia seeds are typically not transported more than 100 m., patches of

high burn severity (i.e., marked by sequoia mortality) within groves that are farther than 200 m.

from living sequoia trees will have a single opportunity for establishment the first-year post-fire via seed from fire-killed trees. Erosion in these areas, which could lead to the loss of

the seed bank, is a management concern.

OBSERVATIONS

Soil Burn Severity

Burned Area Reflectance Classification (BARC) images were obtained from USGS to gauge burnpatterns and locations for evaluating evaluate soil burn severity (SBS). The BARC map is a classified image of pre- and post-fire canopy change (e.g. Hudak et al., 2004) observed by satellite.

In mapping soil burn severity, the team evaluated field-observable parameters such as the amount and condition of surface litter and duff remaining post-burn, soil aggregate stability, amount and condition of remaining fine and very fine roots, and degree of hydrophobicity, which is a measure of the length of time a water drop remains beaded on the soil surface (Doerr, 1998; Leelamanie et al., 2008). Ash and change in soil color indicate how long the fireremained at a given place (residence time). Slope steepness, aspect, elevation, and geology contribute to the soil characteristics and are important when determining areas of burn severity on the KNP Complex. Most of the soil burn severity calibration points were collected along major roadways.

Due to an initial disconnect between the BARC and collected SBS points, the BARC was stratifiedinto two zones to manage disconnect between vegetation (BARC) and soil thermal damage indicators. It was divided into coniferous and non-coniferous. Low elevations are comprised of oak and chaparral species and mixed conifer to subalpine conifers at upper elevations.

Locations with non-coniferous vegetation show a better correlation between soil burn severityand post burn vegetation consumption. However, in coniferous environments, soil burn severity was less accurately depicted by the BARC where there was less consumption of the canopy. Final SBS breaks were adjusted separately in these zones then re-stitched into a composite final.

Soil Burn Severity		
Class	**Acres**	**Percent**
Unburned	11,117	12.4%
Low	43,642	48.8%
Moderate	28,828	32.3%
High	5,769	6.5%
Total	89,356	

Park Roads

Infrastructure such as culverts and surface drainages were examined along major arterial roads.Culverts were mapped along Generals Highway, Mineral King Road, and North Fork Road,

noting condition and size. Numerous culverts along Generals Highway and Mineral King were observed to have an accumulation of sediment and debris, plugging culverts and limiting flow. However, hillslopes with moderate to high SBS contributed the most to sediment deposition onroadways. As a result, sheet flow from roadways was rerouted away from natural drainages causing further erosion downhill.

Generals Highway – lower watershed fire-impacted areas

The General's Highway between the park entrance and Buckeye Flat Campground was observedafter a rain event. Numerous small (up to approximately 2 feet in diameter) rocks were observed to have fallen on the road from burned hillslopes and roadcuts above the road.

Similar, and perhaps even larger, rock falls are likely to occur throughout the winter as erosion of sediment dislodges loose rocks. Rock falls are most likely to occur during or immediately after storm events but could happen at other times. Over multi-year timescales, additional rockfalls are likely to occur as larger storms impose greater stresses and as the root networks of burned vegetation that are presently stabilizing loose rocks decay.

Rock falls onto the Generals Highway from a roadcut between Ash Mountain and Hospital Rockfollowing a rain event.

		
Alder Creek at ~MP 1.3 near Park HQ has a 48" culvert set under deep road fill	Elk Creek near MP 4 has an 8x10 foot box culvert draining this stream.	The highway crosses the Marble Fork of the Kaweah River at MP 4 ona substantial bridge
		
Un-named stream near MP 6 has two 48" culverts	The hydroelectric intake infrastructure has and will continue to accumulate debris	There are several road crossings of an un-named drainage near HospitalRock and the highway switchbacks (including MP 7)

Generals Highway – upper watershed fire-impacted areas

The General's Highway between Hospital Rock and the Crystal Cave Road junction switchbacksup very steep slopes with relatively high potential for rock falls. Fortunately, most of these slopes have low or even unburned SBS, reducing the potential for substantial post-fire rock fallactivity. However, there are some patches of moderate and even high SBS above the General'sHighway, notably on the ridge projecting south of Moro Rock; rock falls originating from this area could travel through areas of low or unburned SBS to impact the road.

Unburned and low soil burn severity with patches of moderate and high soil burn severity abovethe General's Highway between Hospital Rock and Amphitheater Point.

This area of the General's Highway was visually observed following a rain event. Aside from very small rocks on the road, only one substantial rock fall was observed; a boulder approximately 4 feet in diameter detached from far above the road, tumbled down a drainageand landed just above the road. The boulder broke into several pieces, with one fragment punching a hole in the uphill lane and continuing down to the next road segment below the switchback.

Rock falls of this magnitude and smaller are likely to occur throughout the winter in conjunctionwith winter storms; the potential for rock falls during clear summer weather is less likely but still possible.

Boulder resulting from a post-fire rock fall from above the General's Highway above Amphitheater Point. A fragment of this boulder continued downward, damaging the asphalt in the uphill lane and traveling across a switchback to the next road segment below.

Mineral King Road

The Mineral King Road runs through the southern border of the KNP Complex. The road was evaluated for condition of culverts and susceptibility to sedimentation and debris flows. The slopes above and below the road varied from unburned to high SBS. Visual observations weremade after a rain event indicating rilling in slopes with moderate to high SBS, undercutting ondownspouts of culverts, sedimentation and blockage in culvert inlets, and sediment accumulation on roadways from loose high to moderate SBS hillslopes. Most notably, the highest contribution to sediment deposition on roadways was from high to moderate SBS hillslopes without preexisting culverts.

Sediment deposited on the Mineral King Road following a rain event within an area of locallymoderate to high soil burn severity.

Crystal Cave Road

Crystal Cave Road experienced low to high SBS. Due to the conditions of Crystal Cave Road, access was limited, and direct observations could not be made. However, due to the frequentuse of the trail, potential post fire impacts were examined via the USGS Debris Flow model.

Redwood Mountain Road

Redwood Mountain Road runs through the Redwood Mountain sequoia grove along the northern perimeter of the KNP Complex. While direct observations were not made due to weather impacting road conditions, conclusions were derived from SBS as well as watershed modeling. As a result, the road will likely experience sediment deposition as well as rilling on the downstream side of road from sheet flow runoff. Hillslopes with high to moderate soil burnseverity will likely experience the most impact.

Buckeye Campground

Buckeye Flat Campground is located approximately 7 miles east of the Ash Mountain Entrance, along the Middle Fork of the Kaweah River. The campground is accessed via a narrow, paved road extending 0.5 miles east of Hospital Rock. Several campsites on the northern margin of thecampground are located along the toe of a long hillslope leading up toward Moro Rock with moderate to high SBS. Many granitic “corestone” boulders are present on this hillslope and could be dislodged as finer sediment is eroded from around them. Depending on the size,

location, and runout paths of these boulders, it is possible that one or more of them couldreach Buckeye Campground, posing risk to campers.

Moderate to high soil burn severity on a hillslope north of the Middle Fork Kaweah River andeast of the General's Highway below Moro Rock. Erosion of hillslope sediments could cause granitic boulders on the slope to tumble towards Buckeye Flat Campground, located in the unburned trees adjacent to the river at the toe of the slope.

Giant Sequoia Groves

Numerous sequoia groves were impacted by the KNP Complex and experienced a range from low to high soil burn severity. Groves located below hillslopes with moderate to high SBS are likely to experience greater erosion around roots and impact to the seed bank.

Caves

Sequoia and Kings Canyon National Parks have exceptional cave resources. Many caves are located within the KNP Complex, including several exceeding one mile in length, as well as karstfeatures such as sinkholes and springs. Most of the caves are undeveloped, but Crystal Cave is developed with trails and lights and is seasonally open for guided tours.

Six caves are located in areas of high SBS and twelve are in areas of moderate SBS. Although some sedimentation may occur as a result of fire directly above the caves, greater impacts areexpected for those caves that contain streams entering from burned watersheds.

Lilburn Cave

Lilburn Cave, located in lower Redwood Canyon, is the longest cave in SEKI and the second longest in California. Most of the area above the cave has moderate to high SBS. Although sediment is unlikely to enter the cave directly through the two gated entrances, surface wateris fed to the cave through a series of karstic sinkholes. Redwood Creek sinks underground and

flows through the cave, which is how the extensive network of cave passages formed. At present the inlet sink where Redwood Creek enters Lilburn Cave is diffuse, I.e., the creek sinks into gravel over a length of channel rather than into an open cave entrance. The resulting sieving effect will likely help to prevent substantial coarse debris from entering the cave duringstorm-triggered events. However, finer sediment and high-water flows are expected to impact the cave during storm events, threatening cave resources and posing human risk.

View looking north up Redwood Canyon from a position approximately above Lilburn Cave showing moderate to high soil burn severity above the cave and on the hillslopes adjacent to it.Sediment from burned slopes could enter Lilburn Cave via Redwood Creek, which flows throughthe cave, or through tributaries that enter the cave through sinkholes.

Crystal Cave

Crystal Cave is one of the longer caves in SEKI and is developed with trails and lights for seasonal guided access by park visitors. The cave is located upstream of the confluence of Cascade and Yucca Creeks. Yucca Creek sinks and flows through the cave, emerging as a springbelow the main entrance and quickly joining Cascade Creek. Hillslopes directly above the cave are unburned, but patches of low, moderate, and high SBS exist immediately upslope of the cave and within the Cascade and Yucca Creek watersheds. Elevated water and sediment discharges on Cascade Creek are unlikely to impact the cave, but similar discharges on Yucca Creek may have an impact. Similar to Lilburn Cave, the inlet sink where Yucca Creek enters Crystal Cave is diffuse, with only a portion of the creek entering the cave during high flows (the remainder flows along the surface channel of Yucca Creek). The diffuse sink point will likely helpto limit the amount of flood water and coarse debris entering the cave during storm events.

Nevertheless, elevated water discharges and sediment deposition may occur within the caveduring storms, potentially impacting the trail and other infrastructure.

View to the northeast showing the confluence of Yucca Creek (left) and Cascade Creek (right). Crystal Cave occupies the light gray marble band in the center of the photo. A portion of YuccaCreek sinks into this marble and flows through the cave, perpendicular to the ridge separating the watersheds, and emerges below the main cave entrance to join Cascade Creek.

Hurricane Crawl Cave

Hurricane Crawl Cave is located along Yucca Creek downstream of Crystal Cave. It is the best decorated cave in SEKI and is highly sensitive in that regard. A small stream flows through thecave, but the watershed for this stream is mostly unburned and we expect few fire-related impacts.

Crystal Cave Trail Foot Bridge

Due to the condition of Crystal Cave road, direct observations of the foot bridge over CascadeCreek were not made. Low to moderate SBS were observed in the upstream drainage. The bridge is estimated to have a cross sectional area of approximately 90 square feet, which is likely adequate to accommodate most reasonable flows from the Cascade Creek watershed.

Sedimentation to the Kaweah River

Hillslopes that contribute to the Kaweah River and its tributaries experienced low to high soilburn severity. Slopes with high to moderate SBS had the greatest response to sediment deposition. The mainstem of the Kaweah experienced an increase in ash and sediment loads after the storm event.

Hydroelectric Intakes and Flumes

Numerous hydroelectric intakes and flumes located along the Kaweah River will be impacted byincreased sediment loads and debris from upstream hillslopes. The intake above Potwisha Campground was observed to have an accumulation of sediment and debris.

WATERSHED MODELING

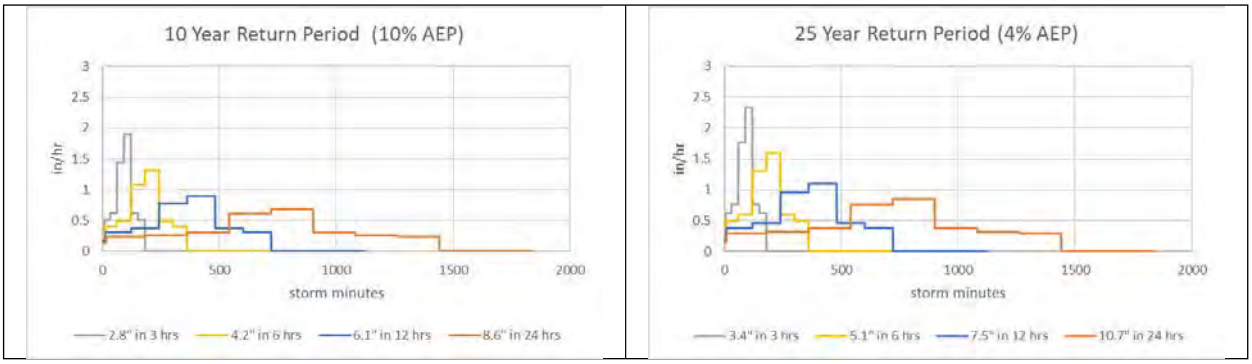
AGWA/KINEROS2

The AGWA/KINEROS2 modeling framework (https://www.tucson.ars.ag.gov/agwa/) uses readily available geospatial datasets to provide model inputs for rapid assessment model runs. This tool uses a Digital Elevation Model (USGS-DEM) to break a watershed into modeling elements, which are then intersected with soil (SSURGO/STATSGO) and land cover (MLRC- NLCD) geospatial layers to derive requisite model input parameters (Goodrich et al, 2005). Onceparameters are assigned, the KINEROS2 runoff and erosion model determines storm runoff response for both an unburned and a burned condition to get a sense of the anticipated change. This modeling scheme is designed to provide rapid estimates of runoff rates relative to landscape change. It cannot provide reliable estimates of runoff or erosion without careful calibration. It is also subject to the assumptions and limitations of its component hydrologic models (Goodrich et al, 2005). The degree of change in storm response expectations is the 'result' of this effort.

Design Storms

*Several design storms were run through the AGWA/KINEROS2 framework. These storms represent events with different durations and return periods or Annual Exceedance Probabilities(AEP). The AEP represents the odds of the storm happening in any given year. (*https://hdsc.nws.noaa.gov/hdsc/pfds/)

Duration (hours)	10 year return period (10% AEP)	25 year return period (4% AEP)
3	2.8"	3.4"
6	4.2"	5.1"
12	6.1"	7.5"
24	8.6"	10.7"

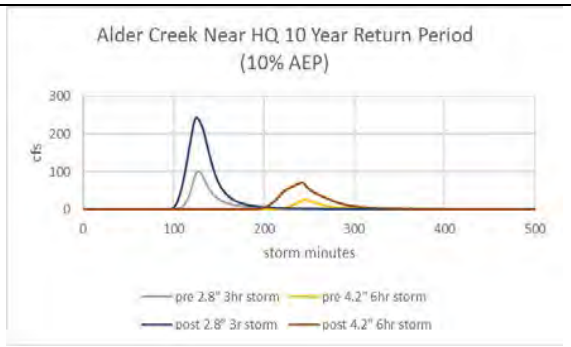


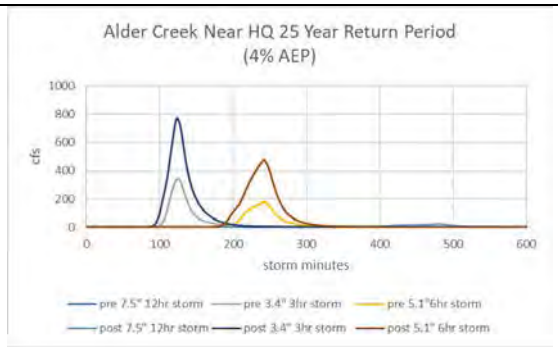
The 10% AEP design storm was selected to represent a typical storm of concern for post-fire flooding concerns and the 4% AEP design storm was selected to provide model results for a lesslikely, but more damaging storm.

The AGWA/KINEROS2 model framework was used to show changes in watershed response for select lower watershed road-stream crossings and the hydroelectric flume intake near Potwisha

campground. Additionally, cartographic representations are provided a spatial sense of where changes to peak runoff and sediment delivery is anticipated to occur (full size maps included in appendix). This is intended to provide information to address concerns for aquatic species, caveresources and the foot bridge near Crystal Cave.

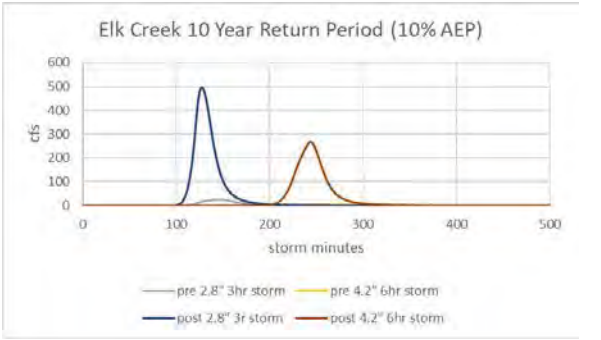
<u>Generals Highway:</u>
Alder Creek

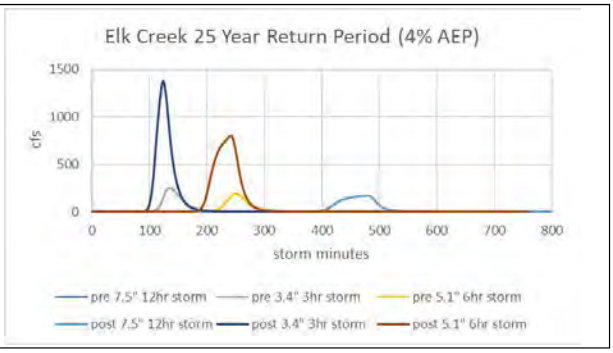




Design Storm	pre-fire (cfs)	post-fire (cfs)	Percent Change	Magnitude Change
10 year 3 hour	101	244	141	2.4
10 year 6 hour	25	73	186	2.9
25 year 3 hour	345	769	123	2.2
25 year 6 hour	178	475	166	2.7
25 year 12 hour	0.05	23	large	large

Elk Creek

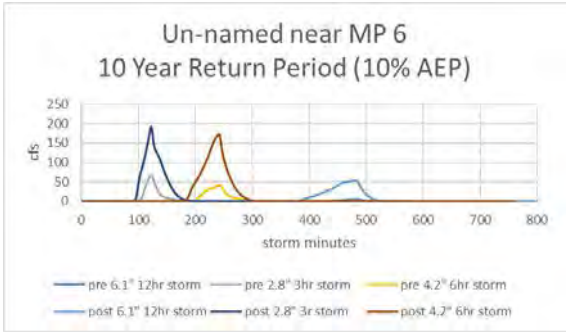


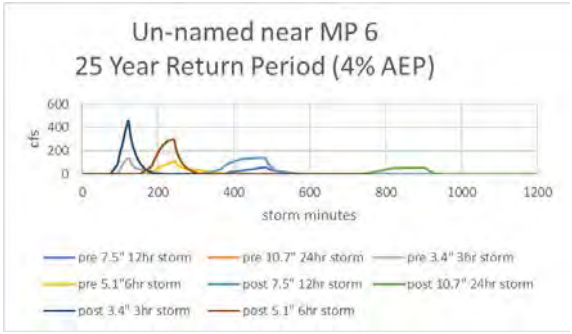


Design Storm	pre-fire (cfs)	post-fire (cfs)	Percent Change	Magnitude Change

10 year 3 hour	26	498	1849	19.5
10 year 6 hour	3	269	8641	87.4
25 year 3 hour	252	1374	446	5.5
25 year 6 hour	190	803	323	4.2
25 year 12 hour	0.00022	168	large	large

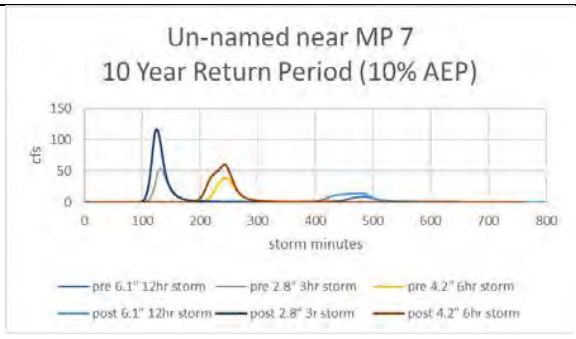
Un-named stream near MP 6

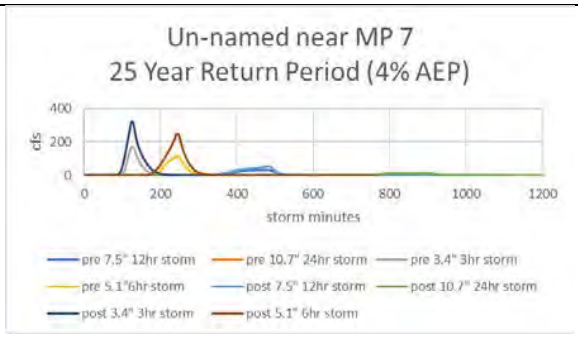




Design Storm	pre-fire (cfs)	post-fire (cfs)	Percent Change	Magnitude Change
10 year 3 hour	68	192	183	2.8
10 year 6 hour	42	172	310	4.1
10 year 12 hour	6	54	882	9.8
25 year 3 hour	140	458	227	3.3
25 year 6 hour	114	300	162	2.6
25 year 12 hour	59	142	141	2.4
25 year 24 hour	2	53	2535	26.3

Hospital Rock/Switchbacks/MP 7

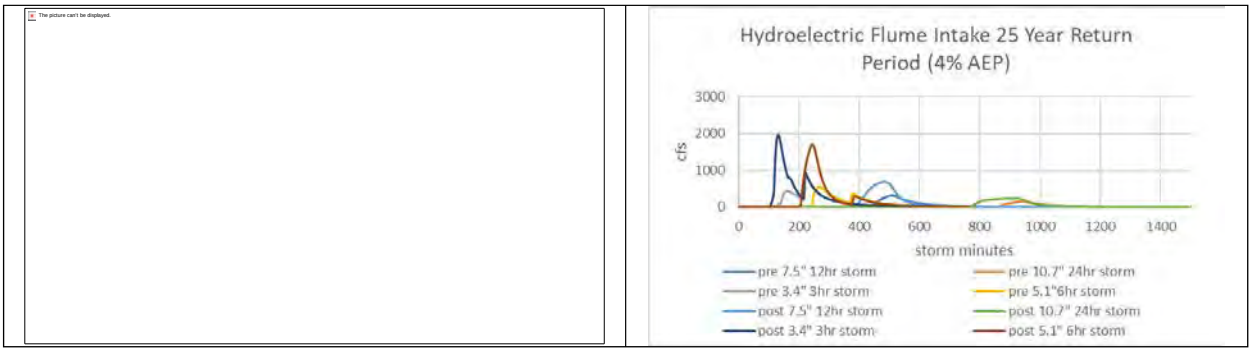




Design Storm	pre-fire (cfs)	post-fire (cfs)	Percent Change	Magnitude Change
10 year 3 hour	54	117	118	2.2
10 year 6 hour	39	60	54	1.5

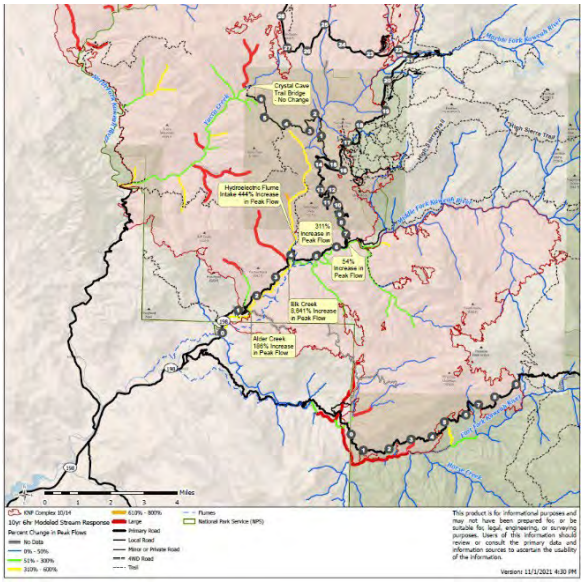
10 year 12 hour	9	14	56	1.6
25 year 3 hour	172	323	87	1.9
25 year 6 hour	117	250	114	2.1
25 year 12 hour	34	54	59	1.6
25 year 24 hour	11	15	39	1.4

Hydroelectric Intake Near Potwisha Campground



Design Storm	pre-fire (cfs)	post-fire (cfs)	Percent Change	Magnitude Change
10 year 3 hour	65	559	765	8.6
10 year 6 hour	103	559	444	5.4
10 year 12 hour	46	213	365	4.6
10 year 24 hour	0.7	66	large	large
25 year 3 hour	852	1971	131	2.3
25 year 6 hour	550	1704	209	3.1
25 year 12 hour	322	687	114	2.1
25 year 24 hour	141	235	67	1.7

Spatial Peak-flow



AGWA model showing reaches with the greatest change in peak flows.

USGS Debris Flow Estimation (DFE)

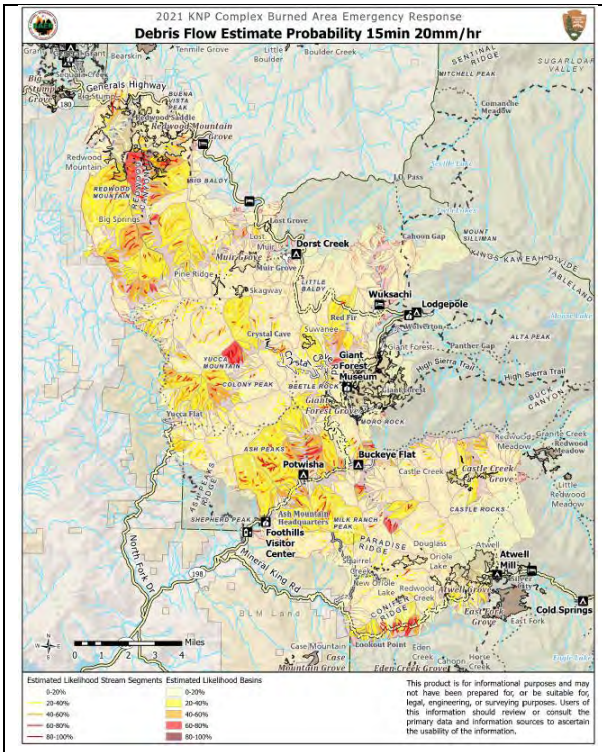
The US Geological Survey (USGS) debris flow risk determination is a valuable part of post-fire vulnerability assessment (Staley et al., 2016). The USGS model combines moderate and high soilburn severity acres and uses them as a key predictor of debris flow probability and volumetric magnitude.
(https://landslides.usgs.gov/hazards/postfire_debrisflow/)

The USGS DFE models estimate a low to moderate level of debris-flow hazard for most of the area burned by the KNP Complex. Most stream reaches and drainage basins have less than 40% likelihood of debris-flow occurrence at the modeled rainfall intensity. However, stream segments and basins with a high (60-80% likelihood) to very high (80-100% likelihood) level of debris-flow hazard occur in some sections of the burn area. These high hazard areas occur in many drainages above Redwood Canyon and Redwood Creek and in some areas above the North and Marble Forks of the Kaweah River, Yucca Creek, and in the vicinity of Buckeye Flat. Most of the burn area requires rainfall rates greater than 32 mm/h to exceed a 50% likelihood of debris-flow occurrence. High hazard areas require more modest rainfall rates between 12 and 24 mm/h to exceed a 50% likelihood of debris flow occurrence. Most watersheds are estimated to produce volumes between 10,000-100,000 m3, resulting in a moderate combineddebris-flow hazard for most of the burn area. The year 1 and 2 model-estimated rainfall thresholds (segment-scale) and corresponding recurrence intervals appear in the table below.

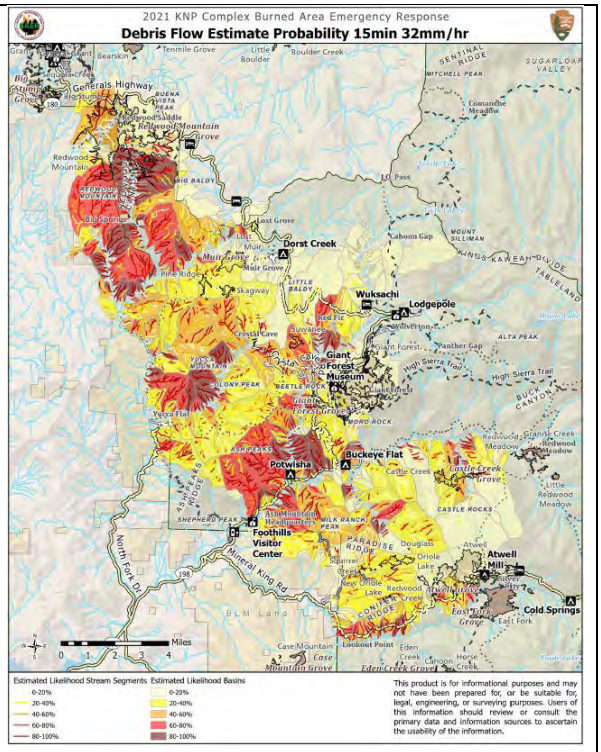
Year 1		
Rainfall Thresholds		Probability of Occurrence
15 minutes at 37 mm/hr	0.35” in 15 minutes	83%
30 minutes at 29 mm/hr	0.60” in 30 minutes	58%
60 minutes at 25 mm/hr	1.00” in 60 minutes	22%

Year 2		
Rainfall Thresholds		Probability of Occurrence
15 minutes at 44 mm/hr	0.5” in 15 minutes	37%
30 minutes at 38 mm/hr	0.75” in 30 minutes	24%
60 minutes at34 mm/hr	1.35” in 60 minutes	6%

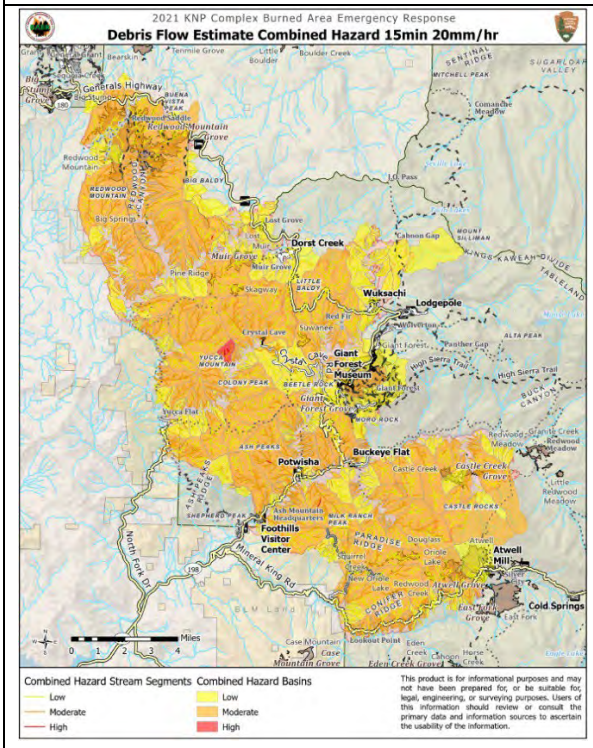
The USGS DFE model was used to identify areas of concern for rock fall and debris movement along the upper reaches of the burned area along the Generals Highway, for the Mineral CreekRoad, at trail locations and for hillslopes above hydroelectric flume infrastructure.



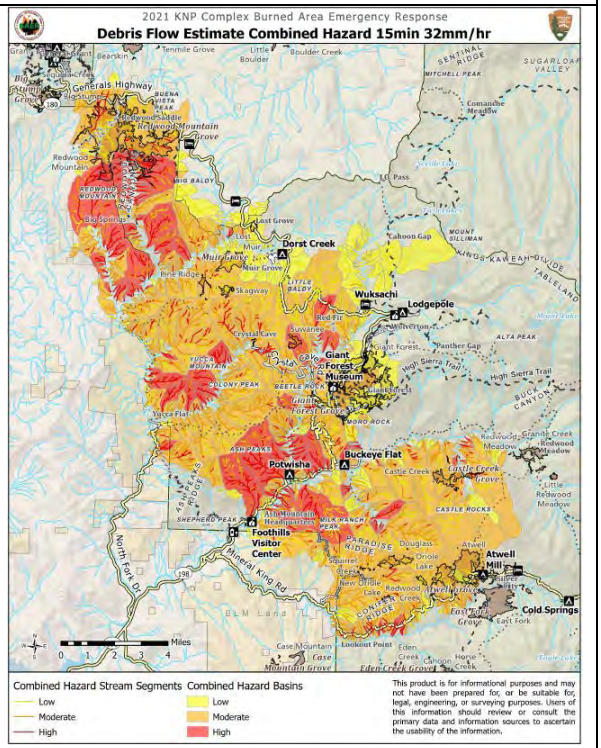
Probability of debris flow from a probableintense rainstorm.



Probability of debris flow from a less probable intense rainstorm.

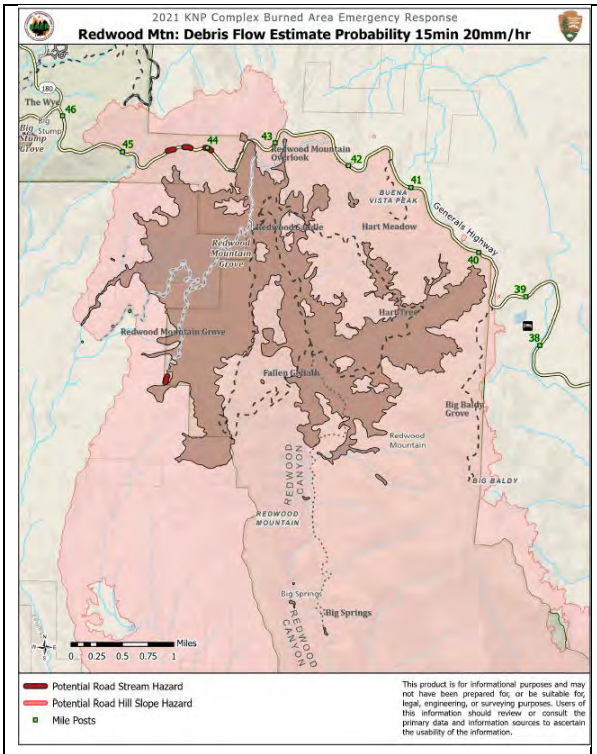


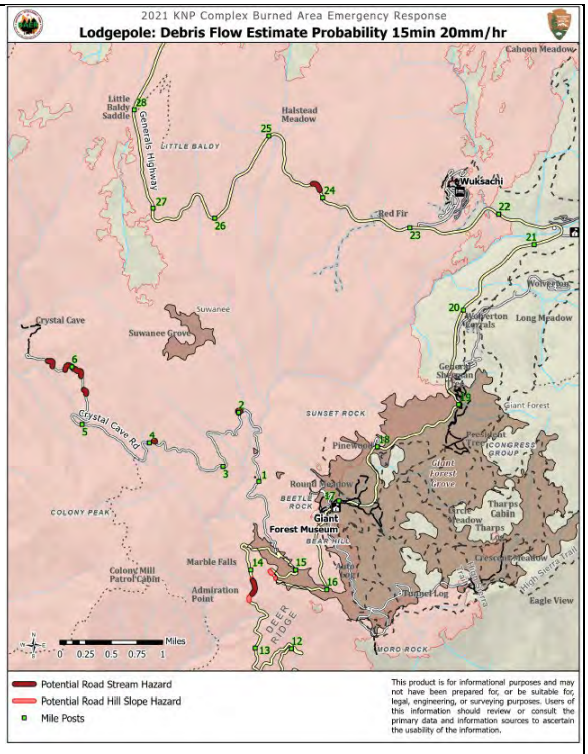
Debris flow hazard ratings for a probable



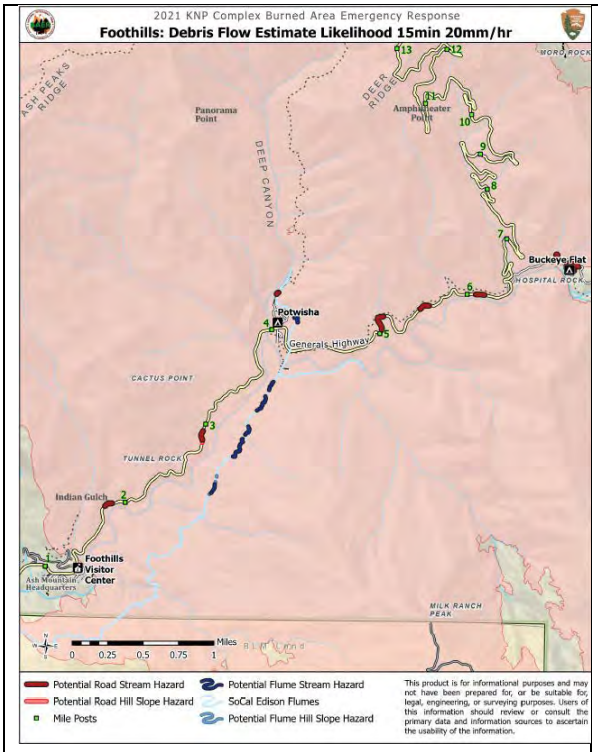
Debris flow hazard ratings for a less probable

intense rainstorm	intense rainstorm

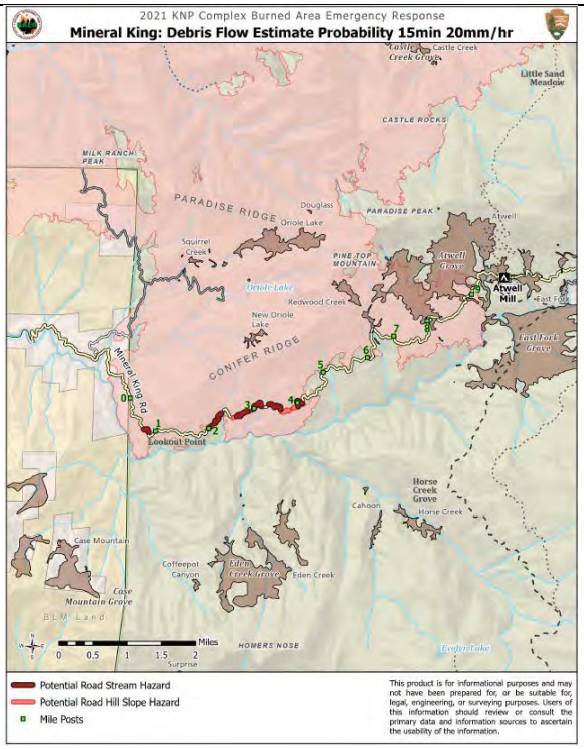




Locations of probable debris movement onto roadways near Redwood Mountain	Locations of probable debris movement onto roadways near Giant Forest



Locations of probable debris movement onto roadwaysand hydroelectric flumes near Potwisha



Locations of probable debris movement onto the Mineral King Road

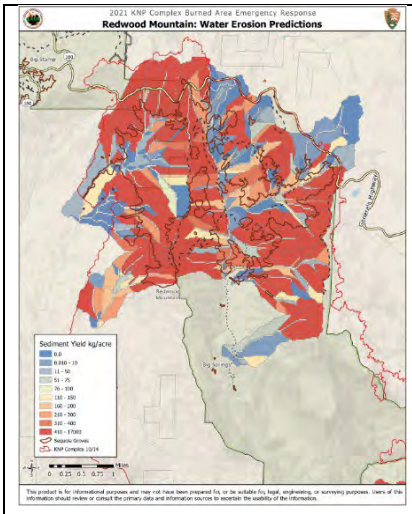
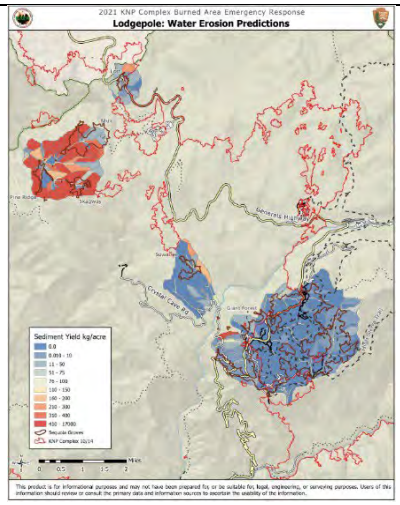
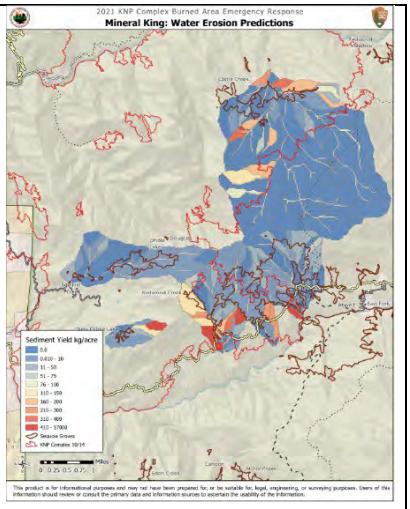
Soil Erosion Modeling (FS WEPP-PEP)

To evaluate soil erosion and sediment potential in giant sequoia groves, modeling using the WEPP (Watershed Erosion Prediction Project) Cloud, post-fire erosion prediction (PeP)was performed on select groves (https://wepp.cloud/weppcloud/runs/hygroscopic-

waste/baer/). The model predicts hillslope erosion and deposition, channel erosion, and totalsediment discharge for a catchment based on inputs and reports erosion rates by hillslope and/or channel (Elliot 2006). The inputs that WEPP-PeP utilizes are:

18. USGS DEM and Land Use Layers
19. NRCS SSURGO and STATSGO soil databases
20. PRISM climate information
21. SBS map uploaded for the fire perimeter area

This model was used exclusively to illustrate where within the giant sequoia groves will be atmost risk of elevated post-fire erosion.

		
Relative sediment yields for hillslopes impacting sequoia groves near Redwood Mountain	Relative sediment yields for sequoia groves near Lodgepole	Relative sediment yields for sequoia groves near MineralKing

WEPP PeP MAPS of sequoia groves

FINDINGS

Park Roads

Generals Highway-Hydrology

Alder Creek

Hydrologic modeling indicates a 2-3 fold increase in peak flow rates at this location due to the fire impacts, so long as the culvert here is kept clear, no issues are anticipated. The deep road

fill setting may lead to ponding and pressurized flow during large storm events, but water is notexpected to overtop the road.

Elk Creek

Five-fold to very large degrees of change in peak flow rates are anticipated where Elk Creek crosses the Generals Highway. This is in part due to the lower peak flow rates expected in the unburned condition. Modeling indicates that short-duration higher-intensity storms with a 10%chance of happening any given year (AEP) may test the capacity of the box culvert here, and themore intense 4% AEP may overwhelm it.

Un-named Creek MP6

Widely varying degrees of change from pre-fire to post-fire peak flow response is predicted by hydrologic modeling at this location. The large degree of change is due to low expectations for runoff for longer duration storms in the pre-fire condition reaching peak flows of ~50 cfs in thepost-fire condition. This increase in storm response at this location is not anticipated to be problematic so long as debris does not inhibit the flow through the double barrel culvert.

Double barrel culverts are very susceptible to accumulation.

Un-named Creek MP7

Though this drainage way has several road crossings, the modeled change in storm responsesdo not indicate concerns for overwhelming stream crossing infrastructure.

Generals Highway-Debris and rock fall

According to USGS DFE, both the 15min 20mm/hr and 15min 32mm/hr events indicated portions of Generals Highway at mile marker 2, 3, 5 and 6 will likely experience an increase in watershed response in drainages that cross the road. The increase in surface flow will likely inundate culverts with sediment and debris. In addition, roadways will likely experience sediment deposition from drainages and contributing hillslopes. Portions of the road from milemarker 7 to 13 indicate less susceptibility to debris flow hazards. Rock falls from roadcuts and natural slopes are most likely to occur coincident with the rainfall events described above but can also occur independent of storms.

Mineral King Road-Debris and rock fall

Based on the USGS DFE models, several portions of the Mineral King Road (mile post 1 to 4) arepredicted to experience an increase of surface flow with rain events varying in intensity from 15min 20mm/hr to 15 min 32mm/hr. Within this vicinity, hillslopes above the road are likely to deposit sediment and debris to road causing potential hazards. Portions of the road extending beyond mile marker 4 show a significant decrease in debris flow response.

Redwood Mountain Road

Two USGS DFE models were run on Redwood Mountain Road. One at 15min 20mm/hr and theother at 15min 32mm/hr. Both models indicated that Redwood Mountain Road will likely haveimpacts from debris flows. The most potential for hazards from surface runoff is along the southern fork of the road at the edge of the sequoia grove.

Buckeye Flat Campground

Moderate to high SBS on the hillslope high above Buckeye Flat Campground may lead to erosion and detachment of rounded granitic boulders on the slope. Once dislodged, these boulders would then roll down the slope, potentially as far as Buckeye Flat Campground. The USGS DFE model highlights specific regions within the campground that will experience an increase in watershed response that will elevate risk for the movement of hillslope materials.

Sequoia Groves

Redwood Mountain Grove and Skagway Grove, and Muir Grove will likely experience the greatest post fire impacts from erosion based on the WEPP-PEP models. Large portions of thegroves will experience a range of 410 to 1700 kg/acre of sediment deposition and erosion.

The WEPP-PEP model indicates Oriole Lake, Castle Creek, Redwood Creek, and Atwell sequoia groves will have less post-fire erosion. Most drainages will experience 0 to 11 kg/acre of sediment loss while only four drainages will experience 410 to 17,000 kg/acre of sediment loss.

Caves

Of the major caves affected by the KNP Complex, Lilburn Cave in Redwood Canyon is most likelyto experience impacts from elevated water and sediment discharges, primarily due to the sizeof the watershed contributing water to the cave and the large patches of moderate and high SBS within that watershed. Crystal Cave, located within the Cascade Creek and Yucca Creek watersheds, is less likely to be affected due to lower SBSs within those watersheds, but may stillexperience impacts during intense rainfall events. Both caves have diffuse sink points for the streams that flow through them, reducing the likelihood of coarse sediment deposition.

Crystal Cave Trail Foot Bridge

AGWA models indicate no significant change in peak flows post storm event. As a result, theconcerns for large flows post rain event impact the bridge are small.

Sediment to Kaweah River

AGWA watershed modeling indicated a large increase in sediment yields to Yucca Creek, tributaries of the North Fork Kaweah River, the main stem Kaweah River, as well as the EastFork Kaweah River below Mineral King Road.

Hydroelectric

Hydrologic modeling indicates minimal to large degrees of change in peak flow response at thislocation. Overwhelming of the intake infrastructure by increased flow rates or debris accumulation is not anticipated to damage the intake, but debris accumulation on the intake may prohibit flume function.

RECOMMENDATIONS

Specifications

Park Roads

A Road Patrol Specification (ES-2) is recommended to clear culverts before and after storm events. This prevents culverts from becoming blocked and potentially causing damage to roadsand drainages. Furthermore, keeping culverts clear of debris and sediment enables surface water to remain in designated channels and mitigate impacts of sheet flow.

BAR-12, Replace Hydrologic/Scientific Equipment is recommended to fund replacement of scientific equipment that was destroyed by the fire. There were 44 shallow groundwater monitoring wells lost at the Halstead Meadow site, and a stream sampling flume that was located in Elk Creek.

Non-Specification

Park Roads

Coordinate multi-stakeholder winter weather storm team coordination to develop readinessand capacity to respond to Generals Highway, Mineral King Road, Crystal Cave Road, and Redwood Mountain Road.

Buckeye Flat Campground

Keep campground closed for the duration of winter. Prior to opening the campground, it is recommended to investigate evidence of rock falls and debris flows from slopes above the campground.

Sequoia Groves

While no ES or BAR specifications were made by Watershed, it is recommended that groves with high potential for erosion based on the WEPP-PeP model are monitored and documentedto protect erosion to root structures and the seedbank.

Caves

Lilburn Cave, Crystal Cave, and perhaps Hurricane Crawl Cave should be monitored for increased sediment loads following storm events. It is recommended to avoid entering caveswhen intense rainfall is forecasted due to potential threats from increased flows.

Sediment to Kaweah River

Document and monitor elevated concentrations of sediment and nutrient loads to surface waters in reaches highlighted by the by the AGWA/KINEROS2 model for impacts to fish and other aquatic species.

Hydroelectric

Monitor hydroelectric flume intakes and flumes for sedimentation and debris accumulation preand post storm events.

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at: http://pubs.usgs.gov/of/2016/1106/

CONSULTATIONS

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Greg Stock, Geologist, National Park Service, Yosemite National Park

FORESTRY/HAZARD ASSESSMENT

Incense Cedar, Crystal Cave Road

OBJECTIVES

1. Identify and assess hazard trees resulting from the fire in developed areas of the park, especially where there are stationary targets such as buildings or utilities or high trafficareas such as parking areas, pullouts, campgrounds and trailheads.
2. Assess all roadways in the park.
3. Assessments are in accordance with the Regional Hazard Tree Management Directive and SEKIpolicy to reduce the chance of injury to visitors and damage to infrastructure.

ISSUES

Potential injury to people in the following areas or damage to assets listed below:

1. **Park Infrastructure**
    1. Beetle Rock Nature Center
    2. Wuksachi Developed Area & Water Tank
    3. Red Fir Maintenance Yard
    4. Red Fir Spray Field, Effluent Tanks, Instrument Building & Helispot
    5. Moro Rock Comfort Stations
    6. Redwood Mountain Ranger Station and Garage
2. **Private Inholder Cabins**
    1. Oriole Lake Cabins
3. **Parking Areas / Pullouts**
    1. Beetle Rock Nature Center
    2. Moro Rock Trailhead
    3. Pullouts on the Generals Highway from Eleven Range to the Wye in Kings Canyon
    4. Crystal Cave Trailhead Parking
4. **Roads**
    1. Generals Highway
    2. Crystal Cave Road
    3. Crescent Meadow / Moro Rock Roads
    4. Red Fir Spray Field
    5. Mineral King Road
    6. Redwood Mountain Road
5. **Picnic Areas**
    1. Crystal Cave
6. **Paved Walking Paths**

1. Beetle Rock to the comfort station

BACKGROUND

Sequoia and Kings Canyon National Parks have 132 miles of paved road and 22 miles of gravelroad, 19 campgrounds, and 11 picnic areas. Of these, 69 miles fall within the fire footprint.

None of the campgrounds or picnic areas were impacted directly by the fire but some infrastructure was damaged. With 1.9 million visitors coming through the park annually, visitorsafety is a top priority.

Hazard trees are common following fires; potential targets within the burn perimeter includepark infrastructure, parking lots, overlooks, and front country paved trails. The Generals Highway and part of the road to Mineral Kings are the only major park roads within the fire perimeter. The road to Crescent Meadow, Morro Rock, Crystal Cave and Redwood Mountainare the other roads that fall in the fire scar.

We assessed areas in accordance with the park Superintendent's priority list below.

KNP Recovery Hazard Tree Priorities

1. Assess labor required to clear:
    1. High priority trees threatening park residences and private cabins throughoutburn area (including Oriole Lake, etc.).
    2. High priority trees threatening other park structures throughout burn area (including concessions).
    3. High priority trees threatening stationary targets (parking lots, overlooks, andany place people congregate on foot such as picnic tables, exhibits, scenic pedestrian overlooks, etc.) along Generals Highway corridor:
        1. From Ash Mountain to Hospital Rock.
        2. Ditto Hospital Rock to Lower Sherman.
        3. Ditto Lower Sherman Parking to Red Fir.
        4. Wye to USFS boundary.
    4. High priority trees threatening open roads along Generals Highway corridor:
        1. From Ash Mountain to Hospital Rock.
        2. Ditto Hospital Rock to Lower Sherman Parking.
        3. Ditto Lower Sherman Parking to Red Fir.
        4. Wye to USFS boundary.
    5. High priority trees threatening front country paved walking paths (includingclosed roads):
        1. From Ash Mountain to Hospital Rock.
        2. Ditto Hospital Rock to Lower Sherman Parking.
        3. Ditto Lower Sherman Parking to Red Fir.
        4. Wye to USFS boundary.

Fire severity varied in the areas we surveyed from unburned to high fire intensity. In many cases the full range of burn intensity occurred in the same developed area. Tree species observed in the survey areas included: giant sequoia (*Sequoiadendron giganteum*), red fir (*Abies magnifica*), white fir (*Abies concolor*), Jeffrey pine (*Pinus jeffreyi*), ponderosa pine (*Pinus ponderosa*), sugar pine (*Pinus lambertiana*), incense cedar (*Calocedrus decurrens*), blue oak (*Quercus douglasii*), live oak (*Q. wislizeni*), and canyon live oak (*Q. chrysolepis*). Each tree species is

affected by fire differently. Trees killed easily by a small amount of fire include red fir,white fir, blue oak and canyon live oak. Other species, such as giant sequoia and incense cedar, can withstand more intense fire. Within the same species, younger, smaller diameter trees are more susceptible to fire mortality than are larger, more mature trees. We used the Post-fire Assessment of Tree Status and Marking Guidelines for Conifers in Oregon and Washington as a reference to assist in estimating the probability of future tree mortality by measuring crown scorch and bark charring at the base of the tree.

Matt Kennedy, Red Fir Effluent Tanks

RECONNAISSANCE METHODS

The type of survey conducted depended on various factors such as potential targets, fire intensity andtree species. A Basic or Complete survey was performed on all developed areas where accessible and windshield surveys were conducted along roads by BAER Team Foresters Clark Cowan and Matt Kennedy and Sequoia National Parks Forester Tom Warner and crew.

2. Prior to our arrival, Tom Warner and his crew did windshield surveys the entire length of the Generals Highway. Approximately 11,200 trees were determined to be possible hazards.

3. 10/22: Crescent Meadow & Moro Rock Roads, Generals Highway, Giant Forest Ranger Station & Wuksachi Lodge: Windshield surveys were performed with Tom Warner and his crew along the Crescent Meadow and Moro Rock Roads. Over 1,100 trees were determined to be possible hazards. Complete surveys were performed at the Giant Forest Ranger Station and Wuksachi Lodge and a fewpullouts on the Generals Highway.

4. 10/23: Mineral King Road & in-holder cabins on the Oriole Lake Road: A windshield survey was performed with Tom Warner and his crew along the Mineral King Road with some more complete surveys as needed along the way. Almost 1,800 trees were determined to be possible hazards. A complete survey was performed at the 2 in-holder cabins near the end of the Oriole Lake Road where there were no fire-caused hazard trees detected.

5. 10/24: Crystal Cave Road: A windshield survey was performed with Tom Warner and one of his crew members on the first section of the road to about 2 miles past the Crystal Creek Bridge.

6. 10/26: Generals Highway: Assessed and marked trees from Ash Mountain to Hospital Rock. AssessedPotwisha and Buckeye Campgrounds. Neither of these campgrounds burned so no hazard trees were present.

7. 10/27: Generals Highway: Assessed and marked trees around the Beetle Rock building, the parkingarea and the paved trail to the comfort station. Assessed and marked trees around the Moro Rock parking lot and comfort stations. Assessed and marked trees around the Wuksachi developed area.

8. 10/28: Generals Highway: Assessed and marked trees along pullouts from Big Fern Springs to Halstead Meadows. Assessed and marked trees as needed around infrastructure at Red Fir maintenance yard, Lost Grove comfort stations. Dorst Campground and Halstead Picnic Area did notburn and had no hazard trees from the fire.

9. 10/29: Crystal Cave Road: A hazard tree count was performed with Tom Warner and his crew for the entire length of the road. Almost 5,200 trees were counted as possible hazards to the road. The Red Fir spray field road was also surveyed, and trees marked for removal around the two holding tanks and the maintenance shed. The crew met with Ned Aldrich at Eleven Range on the Generals Highway to discuss costs of removing trees using the SEKI or YOSE hazard tree crew.

10. 10/30: Generals Highway: Assessed and marked trees along pullouts from Halstead Meadows to the Wye in Kings Canyon. Redwood Mountain Road: A windshield survey was performed with Tom Warner and his crew. Over 600 trees were counted as possible hazards to the road. Redwood Mountain RangerStation and garage: A complete survey was performed with 23 trees marked for removal.

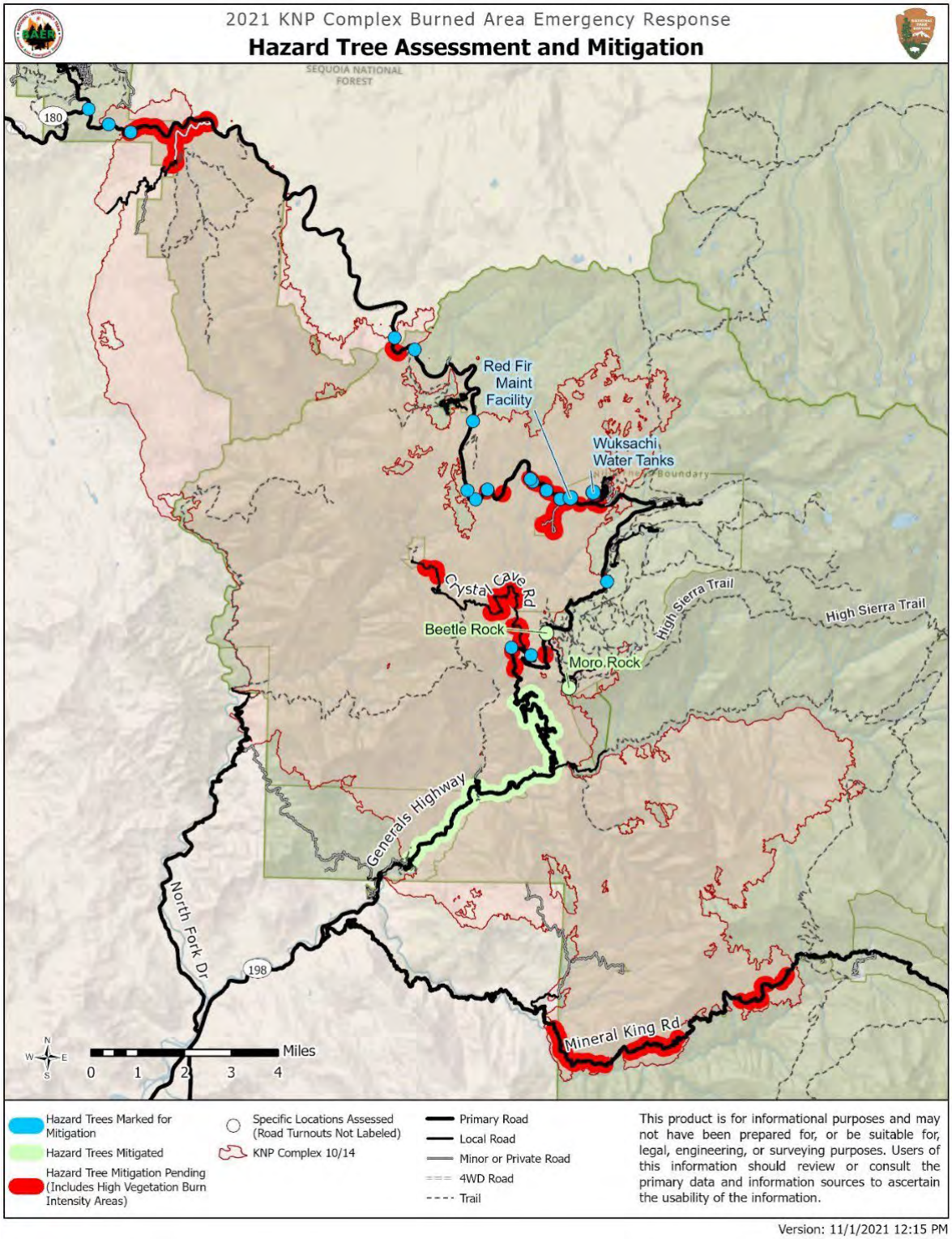
Clark Cowan, Moro Rock Comfort Station Remains

FINDINGS

All developed areas within the burn perimeter were assessed and trees marked for removal as needed. Values at risk were considered as potential targets for fire impacted trees. The tree species was identified and then assessed for remaining green foliage, severity of bark char and any visible defects such as lean, cat face, root flare char. Since most of the hazard tree concerns are along park roadways, windshield surveys were performed to get a rough estimate of possible hazard trees along each road. More thorough assessments were performed at pullouts and parking areas along the Generals Highway with trees marked for removal. If a tree would likely survive it was not marked for removal. All areas are recommended for further assessment and mitigation, if needed, over the next few years.

In developed areas, hazard tree data was entered into Collector under the BAFO (BAER Forestry) layer. Individual trees were mapped with species and dbh (diameter at breast height) documented. Roads were divided into geographic sections. Trees were then tallied into 4 size classes (1 = 4-10” dbh, 2 = 12- 24” dbh, 3 = 26-40" dbh, 4 > 42” dbh). A summary of the results by site and asset are in Table 1 below. The findings are summarized below in the recommendations section. Trees in developed areas, around structures, and at pullouts along the Generals

Highway were marked for removal with blue tree marking paint with a dot at the base of the tree and a blue line further up on the trunk for easy visibility.


2021 KNP Complex Burned Area Emergency Response
Hazard Tree Assessment and Mitigation
SEQUOIA NATIONAL FOREST
180
Red Fir Maint Facility
Wuksachi Water Tanks
Crystal Cave Rd
Beetle Rock
Moro Rock
High Sierra Trail
High Sierra Trail
Generals Highway
North Fork Dr
198
Mineral King Rd
N
W
E
S
Miles
0 1 2 3 4
Hazard Trees Marked for Mitigation
Hazard Trees Mitigated
Hazard Tree Mitigation Pending (Includes High Vegetation Burn Intensity Areas)
Specific Locations Assessed (Road Turnouts Not Labeled)
KNP Complex 10/14
Primary Road
Local Road
Minor or Private Road
4WD Road
Trail
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RECOMMENDATIONS

One ES specification (ES-1, Hazard Tree Assessment and Mitigation) is recommended to addressimmediate hazard tree removal needs and to complete hazard tree assessments and removal for delayed mortality hazard trees. Remove trees as recommended below for each site. All areas will need continued assessments for multiple years to look for delayed fire mortality or changing environmental factors such as drought or high winds that could affect future survival of the already stressed fire impacted trees.

Park Infrastructure - Remove marked hazard trees around infrastructure at Beetle Rock, Wuksachi, Red Fir, Moro Rock, and Redwood Mountain ranger station & garage as soon as possible. Some of this mitigation has already been done by fire crews. Continued assessmentswill be needed to monitor for post fire mortality.

Generals Highway Pullouts / Overlooks – Mitigate marked hazard trees at the pullouts or closethe unmitigated pullouts prior to opening the road to the public. Some of this mitigation has already been done by fire crews. Continued assessments will be needed to monitor for post fire mortality.

Generals Highway Open Road Sections – Prioritize mitigation of hazard trees starting with roadsections that had high severity fire intensity. Areas that had low to moderate fire severity should be monitored for post fire mortality and mitigation performed when necessary. The Generals Highway is clear of hazard trees from the Foothills Entrance Station to just below the Eleven Range pullout.

Red Fir Spray Field Road – Mitigate hazard trees around the tanks and building as soon as possible. Mitigate hazard trees along the road and around the spray field as soon as possible since this area had high fire intensity. Employees working in this area should wear a hard hatuntil hazards are mitigated.

Crescent Meadow / Moro Rock Roads - Keep roads closed to the general public until next spring. Admin travel should be restricted. It appeared that the fire crews have removed all imminent threats and some trees around the Moro Rock comfort station and parking lot. Letthe winter take care of some of the trees. Reassess trees and mitigate new imminent threatsand other hazard trees (heavy leaners, spike tops) as needed prior to opening.

Crystal Cave Road - Keep this road closed to the general public until or thru next summer. Admin travel should be severely restricted. Some imminent threats still exist. Lots of tree debris still on the road. Let the winter take care of some of the trees. Reassess trees and remove imminent threats and other hazard trees (heavy leaners, spike tops) as needed prior toopening.

Mineral King Road - Keep the road closed to the general public until next summer. Admin travel should be restricted, maybe only to NPS and private inholders. It appears that fire crews have removed all imminent threats. Let the winter take care of some of the trees. Reassess trees and mitigate any new imminent threats and other hazard trees (heavy leaners, spike tops)

as needed. It will be difficult to haul material out of there so chip what is possible and leave thelarger logs on site.

Redwood Mountain Road - Keep the road closed to the general public until next summer. Admin travel should be severely restricted. It appeared that the fire crews have removed all imminent threats. Let the winter take care of some of the trees. Reassess trees and mitigate new imminent threats and other hazard trees (heavy leaners, spike tops) as needed next springprior to opening.

All road sections should be signed with a warning that you are entering a burned area and thathazard trees may exist.

REFERENCES

NPS Pacific West Region Directive PW-062 (Hazard Tree Management, 2015)

Vegetation Management Plan (For The Development Zone), Sequoia and Kings Canyon NP(1987)

Tree Hazard Management Addendum (1997) to Vegetation Management Plan SEKI (1987)

USDA Pacific Northwest Region – Post-fire Assessment of Tree Status and Marking Guidelinesfor Conifers in Oregon and Washington (Report # R6-FHP-RO-2020-02)

Hazard Tree "Seven Point" Rating System (Mills & Russell 1980).

CONSULTATIONS

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Summary

Location	Distance (Mi)	Diameter Size Classes				
		4-10”	12-24”	26-40”	42+”	Totals
Generals Hwy. (NPS)	39.5	3,874	4,946	1,989	436	11,245
Generals Hwy. (USFS)	9.5					
Crescent Meadow/Moro Rock Rd.	3.4	440	550	116	18	1,124
Mineral King Rd.	9.3	1,060	634	62	23	1,779
Crystal Cave Rd.	6.5	2,470	2,220	387	99	5,176
Redwood Mountain Rd.	2.1	180	420	27	8	635
Totals	60.8	8,024	8,770	2,581	584	19,959

VEGETATION ASSESSMENT

OBJECTIVES

1. Evaluate impacts of fire and fire suppression activities on vegetation resources, including special status plants, native plant communities, and giant sequoia groves
2. Evaluate the potential for invasive plant species to encroach into and negatively impactnative plant communities
3. Recommend management actions to control the spread of invasive plant species in burned and disturbed areas
4. Assess potential impacts to vegetation from increased social trails within the burn area
5. Recommend actions to mitigate damage caused by fire suppression activities or equipment that might impede vegetation and habitat recovery

ISSUES

6. Invasive plants already established within the fire perimeter spreading onto burned soilsor into areas disturbed by fire operations footprints (bulldozer and hand lines, helispots, equipment staging areas, drop points, spike camps, and retardant drop zones)
7. Establishment and spread of new invasive plants from outside the fire perimeter caused by movement of people, equipment, and vehicles during fire suppression
8. Large safety zones and dozer lines that are unlikely to recover naturally
9. Increased off-trail visitor access through burned vegetation that could result in resource damage and erosion
10. Large patches burned with high intensity, thereby limiting the potential for seedling recruitment in mixed conifer forests, giant sequoia groves, and foothill shrublands
11. Protecting meadows from post-fire degradation

BACKGROUND

Sequoia and Kings Canyon National Parks (SEKI) manage 865,964 acres of land in Tulare and Fresno Counties. The parks encompass extreme topographic differences and a striking elevationgradient (ranging from 1,360 feet (412 m) in the foothills to 14,494 feet (4,417 m) along the Sierra crest). This gradient creates a rich tapestry of environments, from the hot, dry lowlands along the western boundary to the stark and snow-covered alpine high country. This topographic diversity in turn supports more than 1,500 vascular plant taxa, which make up dozens of unique plant communities. These include not only the renowned groves of massive giant sequoia, but also vast tracts of montane forests, spectacular alpine habitats, and oak woodlands and chaparral.

Plant Communities

The KNP Fires burned across a broad elevational gradient and affected a mix of evergreen and deciduous forest and woodland types, as well as meadow, grassland and other herbaceous communities (Table 1). The majority of the vegetation affected by the fire was Sierra Mixed Conifer Forest, including plant associations dominated by white fir, incense cedar, Jeffrey pine, lodgepole pine, sugar pine, and giant sequoia. In these forests, the understory is often sparse, but is made up of native shrubs, grasses, and forbs. In the absence of disturbance, intact forestcommunities resist invasion by non-native plants in part due to a lack of weed propagules as well as high cover of native species.

Table 1. Acres burned by RAVG burn intensity class and California Wildlife Habitat Relationshipsvegetation type (https://wildlife.ca.gov/Data/CWHR/Wildlife-Habitats).

Vegetation Type	Acres Burned by Intensity Class				Total Acres Within SEKI	Percent Burned in KNP Fires
	Unburned / Low	Moderate	High	Fire Total:		
UPLAND FORESTS AND WOODLANDS						
Aspen	2	1	0	3	6,159	<1%
Blue oak woodland	152	421	137	710	1,636	43.4
Giant sequoia	2,966	738	616	4,320	10,261	42.1%
Jeffrey pine	1,878	967	662	3,507	40,747	8.6%
Lodgepole pine	12	1	0	13	51,122	<1%
Montane hardwood	13,715	7,803	5,056	26,574	53,163	50%
Ponderosa pine	272	490	533	1,295	7,239	17.9%
Red fir	1,393	228	28	1,549	49,354	3.3%
Subalpine conifer	18	0	1	19	143,569	<1%
Sierran mixed conifer	9,171	5,456	4,061	18,688	81,622	22.9%
Valley oak woodland	20	5	1	26	139	18.7%
White fir	1,750	737	955	3,442	12,961	26.6%
UPLAND SHRUBLANDS						
Chamise-redshank chaparral	431	971	5,783	7,185	9,965	72%
Mixed chaparral	838	1,283	2,290	4,411	7,070	62.4%
Montane chaparral	1,095	854	1,032	2,981	30,598	9.7 %

Sagebrush	1	0	0	1	16,126	<1%
UPLAND HERBACEOUS						
Annual grassland	37	97	119	253	509	50%
Perennial grassland	25	12	3	40	6,934	<1%
WETLAND AND OTHER						
Lacustrine	171	16	5	192	11,659	1.6%
Montane riparian	258	43	10	311	21,614	1.4%
Valley foothill riparian	136	42	19	197	340	58%
Wet meadow	91	22	9	122	15,744	<1%
Barren (unvegetated)	1617	333	212	2,162	277,406	<1%
Total Acres:	41,252	23,433	24,530	89,143		

Foothill communities of oak woodlands or chaparral dominate slopes below the mixed conifer zone. Interior live oak, canyon live oak, and/or blue oak form an open canopy in the woodlands,often with a significant element of California buckeye, birchleaf mountain mahogany, California laurel, and California redbud. Chaparral communities are usually a mix of chamise, birchleaf mountain mahogany, yerba santa, and manzanita, occupying the driest sites at low elevations within the fire perimeter. These areas have a history of human-caused disturbance and invasive annual grasses are a common element of the understory.

Four vegetation communities will be discussed in more detail due to their management, biological importance, and degree of impact from the fires: meadows, mixed conifer forest,foothill shrublands (with a focus on chaparral), and giant sequoia groves.

Meadows

Meadows in SEKI occur primarily throughout the montane and subalpine areas of the parks. Although meadows comprise only 3% of the landscape in the Sierra Nevada, they support disproportionately high levels of biodiversity relative to their geographic extent (Ratliff 1985). Many invertebrate, bird, mammal, and amphibian species rely on meadow habitat for at least aportion of their reproductive life cycle. In addition, meadows provide vital ecosystem services such as nutrient retention, flood abatement, sediment storage, and carbon sequestration.

Meadows also serve as destinations for the many visitors who are attracted by their aesthetic qualities, and also for those travelling with pack stock, which rely on meadow vegetation as a primary source of forage.

Even in protected landscapes such as SEKI, meadows are threatened by stressors includingclimate change, overgrazing, and anthropogenic use (Mutch et al. 2008, Zedler and Kercher2005, Weltzin et al. 2003, Poff et al. 2002, Winter 2000).

Mixed Conifer Forests

Mixed conifer and yellow pine forests of the Sierra Nevada evolved with frequent, low to moderate severity fire with small patches of high severity (Safford and Stevens, 2017). More than a century of fire exclusion, drought, and a warming climate are contributing to increasingly high severity fire burn patch sizes at scales to which the dominant conifers in these forests are not well adapted. Live trees are needed to provide for forest regeneration, but the seeds of these species generally only fall within ~200 feet of the parent tree (McDonald, 1980). Increasesin high severity patch size increase the distance to live tree seed sources across extensive areas (Stevens et al., 2017), potentially facilitating type conversion to shrub-dominated landscapes (Coop et al., 2020). This process has implications for carbon storage and wildlife habitat, particularly for the endangered Pacific fisher.

Chaparral

Oak woodlands and chaparral shrubland comprise the two major vegetation types in SEKI foothills. Chaparral prefers drier, warmer sites than oak woodland and dominates on rocky or shallow soils. The term “chaparral” describes a complex mix of various combinations of chamise, ceanothus, manzanita, scrub oak, toyon, yerba santa, and other native shrubs. Stands are usually dominated by few species which form dense, closed canopies with little understory.Examples of common chaparral communities in SEKI include the Chamise Shrubland Alliance, Chaparral Whitethorn Shrubland Alliance, and Greenleaf Manzanita Shrubland Alliance.

Many chaparral species are adapted to fire and drought, including specialized post-fire regeneration strategies of resprouting and/or fire-stimulated seeding. Overall diversity in interior chaparral communities peak in the years immediately after a fire (Keeley et al. 2005).Chaparral is resilient to fire return intervals between 25 and 100 years (Keeley 1986); typical intervals are 50 to 70 years (Minnich 1995; Zedler 1995; Conard and Weise 1998).

Chaparral communities are susceptible to invasion by annual grasses and other invasive forbs inhigh severity burn areas, especially in areas with no recorded fire history. Park records indicate that 77% of the chaparral within the fire perimeter had burned at least once between 1920- 2020, while 23% has no recorded fire history.

Giant Sequoia Groves

Giant sequoias are the world’s most massive non-clonal organisms on earth, storing immense amounts of carbon and ranking only second to coast redwood forests in this capacity on a per acre basis (Sillett et al. 2015). Giant sequoia forests have a limited distribution, covering

~28,000 acres in ~70 groves across the western slope of the Sierra Nevada (Stephenson and Brigham 2021). Because of their great size, age, and limited distribution, they have captured thepublic’s imagination and have been central to the origin of many state and national parks. They are specifically referenced in the enabling legislation for Sequoia National Park and are a focal resource within the park’s Foundation Statement. They are the premier destination within Sequoia and Kings Canyon National Parks (SEKI), attracting over 1.5 million visitors per year.

SEKI has 38 delineated groves of giant sequoias, covering roughly 10,000 acres. Extensive surveys in the 1960s and 1970s estimated around 49,645 individual sequoia trees greater than12 inches in diameter at breast height (DBH) and 31,572 greater than 48 inches DBH.

Like the mixed conifer forest matrix in which giant sequoia occur, historically fire was frequent and generally of low to moderate severity, with a historic fire return interval of ~15 years (Swetnam et al., 2009) which fluctuated with climate (Swetnam, 1993). Accordingly, the oldesttrees experienced many dozens of fires in their lifetimes. Small patches of high intensity also occurred and were important for sequoia regeneration, because they would thin the canopy and help open the cones. Small openings created by localized high intensity fires varied between 0.1 - 0.4 hectares (0.25 acres to 1 acre) in size (Stephenson, 1994). With Euro- American settlement, lightning strikes were extinguished and indigenous burning was prohibited, resulting in high levels of surface fuels and tree densities in many groves (Kilgore and Taylor, 1979; Parsons and DeBenedetti, 1979; Stephens et al., 2015).

As early as the 1960s, sequoia managers realized the importance of fire and began reintroducing fire into several groves with prescribed fire and managed wildfire (Kilgore, 1970). However, resource limitations, as well as policy and planning impediments, have limited their implementation. Of the ~10,000 acres of giant sequoia in SEKI, 4,610 acres have received one ormore prescribed or managed wildfire in the last 20 years, mostly in Giant Forest.

High Severity Fire and Giant Sequoias

Giant sequoia are highly fire-adapted, but they are not adapted to larger-scale high severity fire. They cannot sprout after crown loss, and recent work suggests that large sequoia are unlikely to survive with >~85% crown damage for trees with a catface and >~90-95% for treeswithout a catface (Shive et al., in review).

Since 2015 there has been a dramatic increase in area burned and amount of high severity fire in sequoia groves, resulting in significant mortality of large, legacy sequoias (Shive et al. in review; Stephenson and Brigham, 2021). This increase is consistent with increases in high severity fire throughout the western US which has been linked with warmer, drier fire seasons (Parks and Abatzoglou, 2020) and increasing fuel aridity linked with climate change (Williams et al., 2019). The warming climate is also directly impacting forests via “hotter droughts” (Williamset al. 2015). The hotter drought of 2012-2015 resulted in widespread conifer die-off (Young et al., 2017) which may be contributing to higher fire severity in this region (Wayman and Safford, 2021). The interaction of these climate-driven trends with elevated fuel loads as a result of fire exclusion is increasingly putting sequoia groves at risk of severe fire (Kilgore and Taylor, 1979; Parsons and DeBenedetti, 1979; Stephens et al., 2015).

Surveys in old growth groves that burned in three wildfires from 2015 to 2017 identified an average mortality rate of ~84% in high severity areas, which includes delayed mortality three tofive years post fire (Shive et al., in review). In 2020, the Castle Fire burned 9,531 acres of giant sequoia, 2,810 of it in high severity. In total, it is estimated that 10-14% of all existing large sequoias (>4’) across the range were killed as a result of the Castle Fire (Stephenson and Brigham, 2021). Significant amounts of high severity fire effects were observed within SEKI boundaries, mostly concentrated in Board Camp Grove. Simultaneous with the KNP Complex, the Windy Fire also burned 1,723 acres of giant sequoia groves in the Giant Sequoia National Monument, of which 411 acres was high severity.

Additionally, there are anecdotal reports of regeneration failures in many high severity areas. Heat generated from higher intensity fires dries out cones before mass seed releases which occur in the receptive post-fire environment characterized by bare mineral soil, receptive ash layers and canopy openings (Hartesveldt et al., 1975). Because of the relationship between seed release and fire, scientists and managers have hoped that although there have been majorlosses of giant sequoias in high severity areas that regeneration would nevertheless be prolific. Preliminary data from the Black Mountain Grove (2017 Pier Fire) suggests that this is the case inmany high severity areas. However, data from Nelder Grove where there was significant crown torching, the highest regeneration was documented in moderate severity areas with minimal

regeneration in the highest severity area (Amarina Wuenschel and Andrew Latimer, unpublished data). Preliminary field surveys by NPS staff in Board Camp Grove (2020 Castle Fire) suggest similar patterns (C. Brigham personal communication). Regeneration failures havealso been noted in high severity areas in locations with high heat loads, such as south or west- facing slope (Tony Caprio, personal communication).

Special Status Plants

Ten percent of SEKI's flora (150 taxa) are identified as having special status. The term "special status" includes taxa that are state or federally listed, rare in California, or at risk because of limited distribution. Special status plants are distributed throughout SEKI and inhabit a wide range of environments along the entire elevation gradient which characterizes these parks. The KNP Complex did not impact any plant species currently listed or being considered for listing under the federal Endangered Species Act. However, several SEKI plant taxa that are consideredimperiled or vulnerable by the California Natural Diversity Database were potentially affected by fire or fire suppression (Table 2).

Table 2. Partial list of SEKI special status plant species documented as occurring within the KNP Fires. California Rare Plant Rank is a measure of rarity in California and elsewhere. Plants with a rank of 1B.2 or 1B.3 are the rarest. Taxa are listed alphabetically by scientific name.

Scientific Name	Common Name	Rare Plant Rank
Agrostis humilis	mountain bent grass	2B.3
Allium tribracteatum	three-bracted onion	1B.2
Carlquistia muirii	Muir's tarplant	1B.3
Eriogonum nudum var. murinum	mouse buckwheat	1B.2
Eryngium spinosepalum	spiny-sepaled button-celery	1B.2
Hulsea brevifolia	short-leaved hulsea	1B.2
Iris munzii	Munz's iris	1B.3

Mimulus (Erythranthe) norrisii	Kaweah monkeyflower	1B.3
Plagiobothrys torreyi var. torreyi	Yosemite popcornflower	1B.2
Ribes menziesii var. ixoderme	aromatic canyon gooseberry	1B.2
Ribes tularense	Sequoia gooseberry	1B.3
Utricularia intermedia	flat-leaved bladderwort	2B.2

The KNP Complex is likely to have had either a neutral or positive impact on many special statusspecies, especially where fire severity was low or moderate. However, most of these species are endemic to SEKI or the Sierra Nevada and are thus vulnerable to extirpation due to their limited distribution. Therefore, the primary concerns for special status plants within the fire boundary are related to (1) suppression activities that may have impacted populations, (2) high severity fire that may have caused mortality or reduction in seedbank, and (3) expansion of invasive species into rare plant habitat**.**

Invasive Plants

Invasive plants are not widespread in SEKI and are especially uncommon at elevations above the foothills zone. Because of the enormous threat that invasive plants pose to native plants and animals, SEKI is committed to treating existing infestations and preventing movement of invasive species into designated wilderness. SEKI invasive species management targets the mostproblematic invaders that threaten natural communities, critical wildlife habitat, and ecosystemprocesses. The Park focuses its efforts on those invasive species that are feasible to control and at sites of high ecological value (Table 3). Approximately one dozen high-priority invasive plant species are under annual management, and several low-abundance, zero-tolerance species are removed whenever detected. Additional species are treated as they become problematic in specific areas. Manual, mechanical, and chemical treatments are used as appropriate and effective means of controlling invasive species.

Table 3. Priority invasive plant species known to occur within the KNP Fires' perimeter.

Species	Common Name	Cal IPC Rank	CDFA Rank	Acres w/in Fire and Suppression Action Areas
HIGH PRIORITY				
Arundo donax	Giant Reed	High		<0.1
Carduus pycnocephalus	Italian thistle	Moderate		79.4
Centaurea solstitialis	Yellow star thistle	High	CW	<0.1

Elymus caput-medusae	Medusahead			<0.1
Genista monspessulana	French broom	High	CW	2.1
Holcus lanatus	Velvetgrass	Moderate		27
Phalaris arundinacea	Reed canary grass			52.3
Rubus armeniacus	Himalayan blackberry	High		14.8
Silybum marianum	Milk thistle	Limited		<0.1
Sorghum halepense	Johnsongrass		CW	<0.1
Taraxacum officinale	Dandelion			2.7
			High Priority Total:	184.7 acres
MEDIUM PRIORITY				
Brassica nigra	Black mustard	Moderate		11.6
Bromus inermis	Smooth brome			4.4
Cirsium arvense	Canada thistle	Moderate	BW	1.8
Cirsium vulgare	Bull thistle	Moderate		234.8
Dactylis glomerata	Orchardgrass	Limited		26.4
Digitalis purpurea	Foxglove	Limited		72.3
Festuca arundinacea	Reed fescue	Moderate		1.2
Hedera helix	English ivy			<0.1
Hirschfeldia incana	Wild mustard	Moderate		26.3
Lathyrus latifolius	Perennial sweet pea			1.9
Oxalis pes-caprae	Bermuda buttercup			<0.1
Poa bulbosa	Bulbous blue grass			2.7
Ranunculus repens	Creeping buttercup	Limited		0.3
Rubus laciniatus	Cutleaf blackberry			6.4
Tribulus terrestris	Puncture vine		CW	2.2
			Medium Priority Total:	385.9
			Grand Total:	**570.6 acres**

The KNP Complex presents three primary threats with respect to invasive species:

1. Expansion of existing small populations of priority invasive species into adjacent foothilland montane habitats newly disturbed by fire.
2. Introduction of invasive species into uninvaded areas through disturbance due to firefighting activities, i.e. the transport of seeds and other propagules on firefighters orfirefighting equipment and the creation of habitat through soil disturbance.
3. Where fire or fire suppression removed foothill shrubland communities, there is a riskthat invasive grasses may colonize these openings and convert them permanently to annual grasslands.

Despite the many benefits of wildfire, it increases the chances of invasive plant introduction and distribution (Klinger et al. 2006). Established infestations of high priority non-native plants have a high potential of invasion and spread into surrounding burned native plant communities.These areas also have a high likelihood of new invasive plant introductions from fire suppression activities (Merriam et al. 2006).

Fire suppression disturbs soil and fire personnel and equipment can act as vectors for the spread of plant propagules (Backer et al. 2004, Keeley 2006). Fire facilitates establishment of invasive species by creating disturbance and releasing nutrients (D'Antonio and Vitousek 1992, Brooks et al. 2004). Post fire erosion causes further disturbance and creates suitable habitat forinvasive species (Johansen et al. 2001).

The alteration of natural fire regimes by invasive plants can also impact native plant communities and ecological processes post fire. Invasive annual grasses now dominate many lower elevation Sierra Nevada ecosystems, further reducing the patchiness of fuel types by filling open spaces with flashy fuels (Underwood et al. 2004) and shortening fire return intervals (Franklin 2010). Annual grasses alter fire regimes by completing their life cycle to become highlyflammable thatch by early summer (Zouhar 2003). These grasses increase the fire season length and carry fire between patches of shrubs or trees (D'Antonio and Vitousek 1992, Nafus and Davies 2014). Thatch promotes frequent low intensity fires that kill native seedlings and prevents recovery of native plant communities (Melgoza et al. 1990, Keeley 2006).

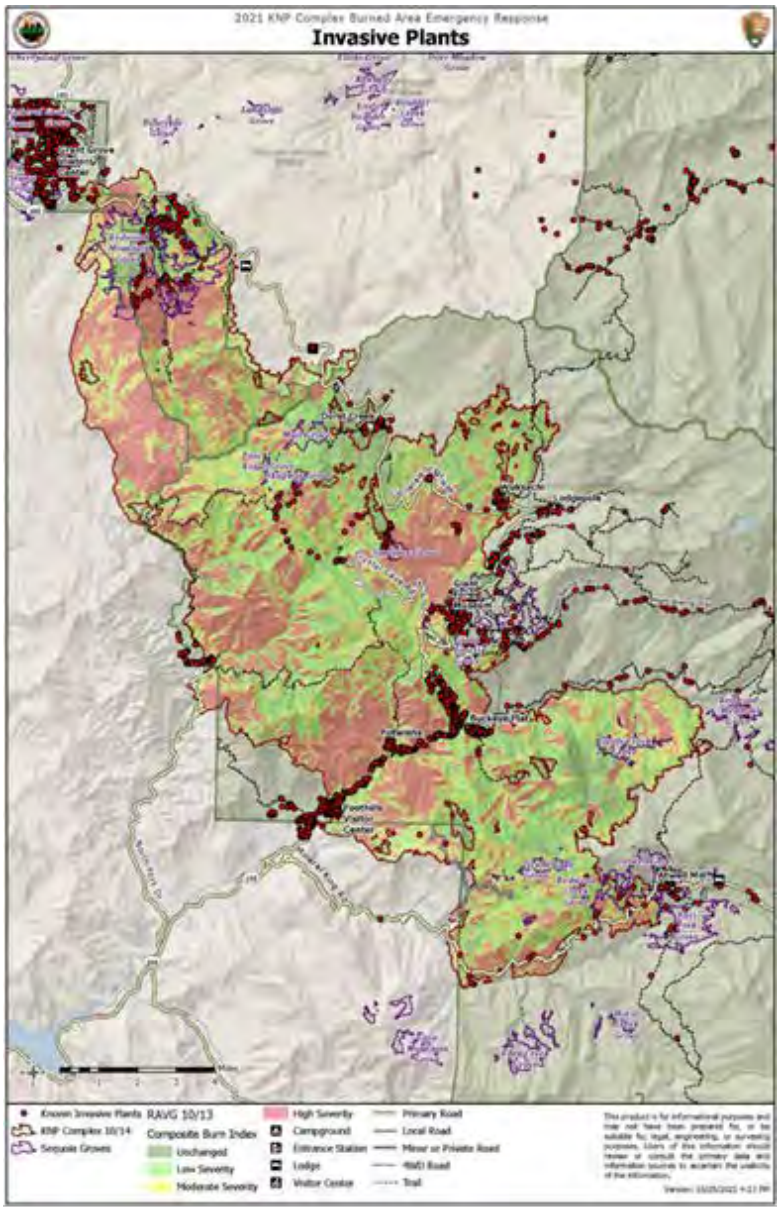

Figure 1. Mapped locations of high priority invasive plants within the KNP Complex

RECONNAISSANCE METHODS

BAER team members conducted field reconnaissance of accessible areas with SEKI resources management staff members on October 22-24, 27, and 29. Field visits were supplemented withinformation provided by SEKI staff, reports produced by Resource Advisors (READs) assigned tothe fire, photos and reports from other BAER team members, overflights, and remote sensing data.

FINDINGS

Plant Communities, Disturbance, and Burn Severity

All the vegetation communities burned in the KNP Fires evolved with fire, although fire regimesvary. Except for the chaparral communities, most vegetation types are adapted to low- to moderate-severity surface fire, not stand-replacing crown fire. However, the nature of fires burning in the Park is changing.

Changes to fire regimes stem from fire exclusion, climate change, the replacement of native vegetation with invasive plant species, and tree mortality. More than a century of fire exclusionhas led to denser forests and increased fuel loads. Climate change has led to longer droughts, higher average temperatures, decreased snowpack, and longer periods of fire receptivity in live and dead vegetation. Non-native plant invasions, especially by annual grasses, has changed the behavior of fire. Tree mortality has increased due to insects, drought, and increased fuel loading. As a result of these changes, hotter, more extensive fires are further exacerbating the spread of invasive plants. These changes in ecosystem dynamics can lead to the permanent conversion of forests to shrublands or foothill woodlands to annual grasslands.

To assess the potential impacts of the KNP Complex on SEKI vegetation, the BAER Team examined the Rapid Assessment of Vegetation Condition (RAVG) remote sensing products produced for this incident by scientists at the U.S. Geological Survey. RAVG products are generated by comparing changes in vegetation canopy appearance in pre- and post-burn satellite imagery to produce an estimate of low, moderate, and high burn intensity (Table 1).

Fire and Fire Suppression Impacts on Vegetation Communities

Fire Suppression Impacts: Potential for New Invasive Species Introductions

New bare ground created by fireline construction, safety zones, helispots, social trailing and other activities during the management of the KNP Fires provides an opportunity for establishment and rapid spread of invasive plant species. Resource Advisors and Field Observers (FOBS) documented a variety of ground-disturbing suppression impacts within SEKI(Figure 2, Table 4).

Eshom Valley on Sequoia National Forest land to the west side of Kings Canyon National Park was identified as an area heavily infested by a number of non-native invasive species, includingspecies not currently established in the park such as yellow star-thistle and medusahead. The construction of fire suppression lines and movement of personnel from Eshom into the park was identified as a top concern by SEKI staff.

Invasive species new to the park may have been transported on equipment and fire personnel.Fire crews and equipment were staged in lowland areas outside SEKI that contain a large number of weeds not found in the parks. Additionally, firefighting personnel originated from states across the western US, and elsewhere. Although crews are asked to clean equipment

between deployments, they may not have done so consistently, given the intensity of the 2021fire season in which crews rapidly deployed between incidents.

Fire Suppression Impacts: Soil Disturbance

Fire suppression activities often include clearing burnable material from the soil surface to create fuel breaks, firefighter safety zones, or helicopter drop zones. The most dramatic examples of soil disturbance on the KNP Complex in SEKI were the large-scale disturbances created along Milk Ranch Road. Bulldozers cleared an approximately five-acre safety zone andconstructed firelines averaging 75 feet wide (Figure 3). While suppression damage repair will restore some physical impacts, these areas are now primed for infestation by annual invasive grasses known to occupy adjacent foothill plant communities.

Figure 3*. Large safety zone on Milk Ranch Road.*

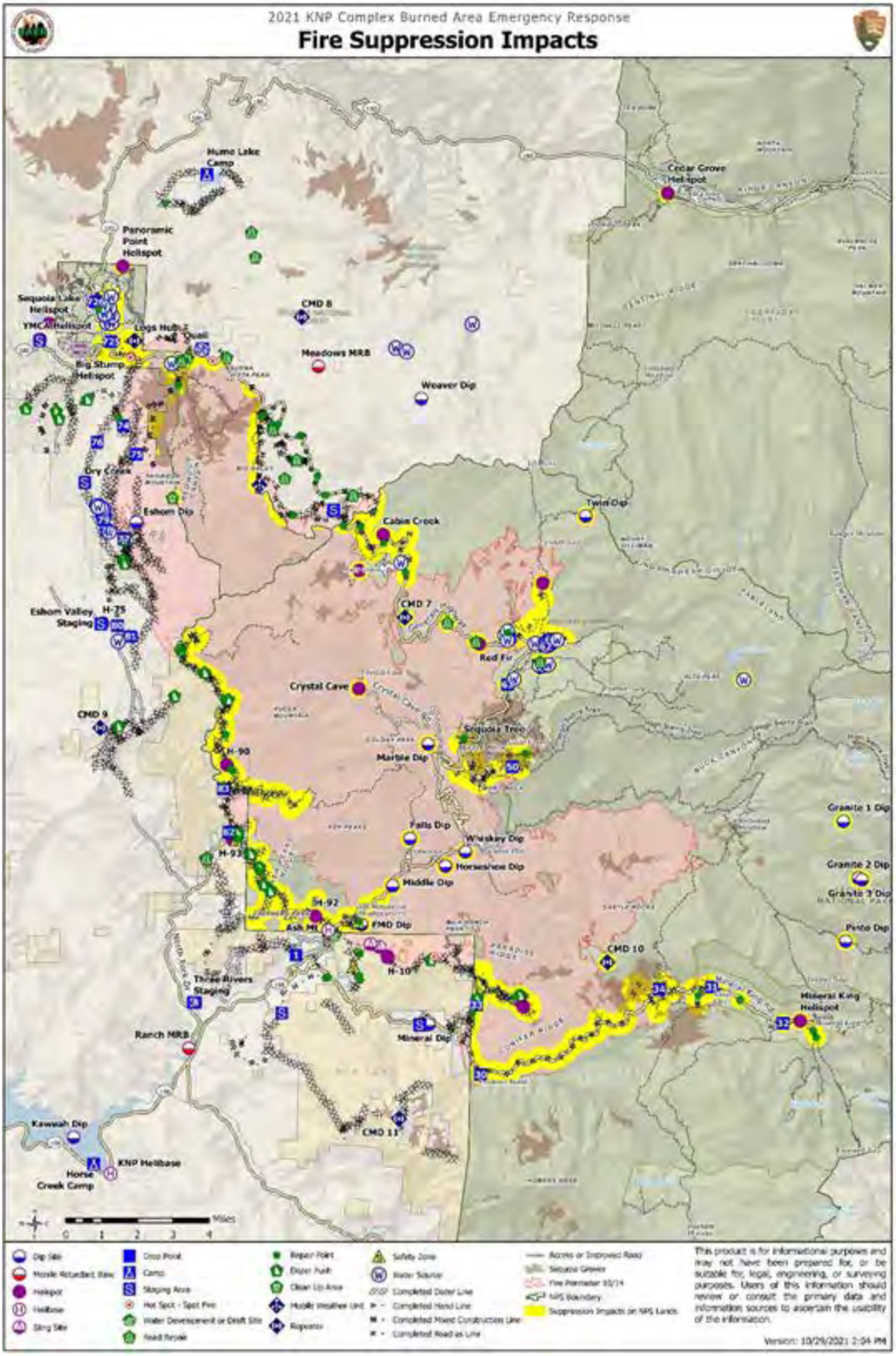
2021 KNP Complex Burned Area Emergency Response
Fire Suppression Impacts
Hume Lake Camp
Cedar Grove Helispot
Panoramic Point Helispot
Sequoia Lake Helispot
YMCA Helispot
Big Stump Helispot
CMD 8
Meadows MRB
Weaver Dip
Dry Creek
Eshom Dip
Cabin Creek
Twin Dip
Eshom Valley Staging
H-75
CMD 7
Red Fir
Crystal Cave
CMD 9
Sequoia Tree
Marble Dip
H-90
Granite 1 Dip
Falls Dip
Whiskey Dip
H-93
Horseshoe Dip
Granite 2 Dip
Granite 3 Dip
Middle Dip
H-92
Ash Mt
FMD Dip
Pinto Dip
CMD 10
H-10
Three Rivers Staging
Mineral King Helispot
Ranch MRB
Mineral Dip
Kaweah Dip
CMD 11
KNP Helibase
Horse Creek Camp
Miles
Dip Site
Helispot
Helibase
Camp
Staging Area
Hot Spot - Spot Fire
Road Retired
Repeater
Dozer Push
Clean Up Area
Safety Zone
Completed Dozer Line
Completed Hand Line
Completed Road as Line
Access or Improved Road
Private Ownership
NPS Boundary
Suppression Impacts on NPS Lands
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Figure 2. Fire suppression impacts on the KNP Fires in SEKI (compiled from incident and ResourceAdvisor data)

Table 4. KNP Fires' suppression impacts documented within SEKI (compiled from Field Observer and Resource Advisor data in National Incident Feature Service (NIFS) database and analyzed by BAER Team)

Activity	Number / Acres	Notes
Dozer Line	54 / 82.0	Fire control lines where heavy equipment scrape away all vegetation
Dozer Push	11 / 3.0	Scraping of vegetation by heavy equipment for fire control, opening up staging areas, etc.
Roads as Line	24 / 120.4	Dirt roads often widened with heavy equipment, vegetationremoved and scraped along paved and dirt roads
Major Roads in Fire perimeter	Multiple roads / 290	Major roads including two miles from fire perimeter in the parkused by fire operations (doesn't include all USFS roads, but may consider survey of those areas near park boundary)
Road Repair Points	4 / 0.06	Areas where road damage and subsequent repair occurred
Handline	118 / 89.1	Fire control lines made by hand crews cutting and scraping vegetation away to bare ground
Safety Zones	2 / 5.0	Larger areas usually pushed open with heavy equipment for fire fighter safety and staging areas
Spike Camps	2 / 2.0	Primitive camps for firefighters where trampling and social trailing occur
Spot Fires	4 / 0.04	Line cutting and removal of vegetation to control fire spread
Helibases and Helispots	16 / 34	Cleared ground where firefighters & helicopters can be vectors
Sling Sites	1 / 0.01	Helicopter drop points for firefighting material, usually cleared. Material and firefighters can act as invasive plant vectors
Drop points	18 / 6.9	Cleared or developed sites where equipment and firefightersstage for deployment and communication
Radio Repeaters and Mobile Weather Units	4 / 0.1	Equipment installed and used for incident, area often cleared and regularly disturbed

Water Sources and Draft Sites	37 / 1.2	Areas regularly accessed by engines and water tenders
Suppression RepairPoints Identified by Resource Advisors	28 / 1.1	Miscellaneous impacts including cut vegetation in streams andalong roads, trampling, and social trailing
Prepped Sequoia Groves	4 / 25	Sequoia Groves where preparation and scraping around large trees occurred
Estimated Total Disturbed Area	**660 acres**	**Recommended high priority areas for early detection and rapid response surveys**

Fire Suppression Impacts: Damage to Conservation Plantings

In Giant Forest and at Potwisha Campground, fire suppression actions damaged or destroyed plantings that were installed to restore or protect other resources. At Potwisha, at least 20 blue

oak saplings were cut in an area of the campground that was planted 20 years ago to restore oak woodlands in that area (Figure 4). In Giant Forest, 10 to 15 sites with severely compacted soils due to previous building footprints were planted with mixed conifer forest species, including giant sequoia, to restore a mixed-age forest structure. Approximately 10 of these sitestotaling about two acres, were burned in a burnout operation designed to protect the largest sequoias in the adjoining area. Most of the planted vegetation in the burned area was destroyed.

Figure 4. Twenty year-old blue oak that were planted to restore age diversity to the woodland atPotwisha Campground. These trees were cut as part of a fuel break project for the KNP Complex.

Fire Suppression Impacts: Fire Retardant

READ and BAER staff noted misapplied retardant in Sycamore Creek (Figure 5). Adjacent populations of *Iris munzii* were not directly affected. Amphibians known to occupy this drainagemay be affected as runoff transfers retardant throughout the stream. The KNP BAER Wildlife Assessment addresses this issue in greater detail. Invasive plants are less of an issue because retardant was applied in areas already heavily infested by invasive annual grasses.

Figure 5. Retardant impacts to Sycamore Creek. Newts and western pond turtle inhabit this drainage.

Tunnel Rock (above) is a popular stop for visitors, who use social trails to climb the slopes at either end of the rock that forms the “tunnel”. Eroded areas around the rock were planted to help slow erosion that was threatening the rock’s stability. The plantings were killed by the KNPFires, exposing the area to renewed social trailing and erosion.

Tunnel Rock (left) is a popular stop for visitors, who use social trails to climb the slopes at eitherend of the rock that forms the “tunnel”. Eroded areas around the rock were planted to help slow erosion that was threatening the rock’s stability. The plantings were killed by the KNP Fires, exposing the area to renewed social trailing and erosion.

Meadows

Approximately 122 acres of wet meadows mapped within the KNP Complex’s perimeter burned, and about 31 acres are mapped as having burned with moderate or high intensity (Table 1). BAER team botanists were able to observe fire effects only in Halstead Meadow. Other meadows, and grasslands are likely to have burned, but the fire effects described hereare inferred.

In Halstead Meadow, the BAER Team observed fire effects that may impact the ongoing wetland restoration effort. A row of filled burlap sandbags just downstream of the highway bridge burned and is starting to fail as fill material leaks from burned holes (Figure 6). This structural failure could lead to the development of channels downcutting through the meadowand reversing the restoration benefits.

The KNP Fires may have had a beneficial effect on other wet meadows where it burned hotenough to kill encroaching lodgepole or other woody vegetation. When woody vegetation

establishes within meadow systems, the water table typically drops, causing a cascade ofchanges that result in a loss of meadow extent and function.

Conversely, high intensity fire in dry meadows, or drier areas of wet meadows, can negatively impact the ecosystem by exposing mineral soil where woody plants or non-native invasive species can become established. Pack stock foraging can exacerbate this effect. Two meadowswithin the burned area are open to pack stock grazing: Cahoon Meadow (74-4) and North ForkKaweah River (96-1). The BAER Team did not directly observe either meadow but RAVG data indicates that at least half of both meadows burned at moderate to high intensity. Both of these pack stock forage areas receive little to no use. The last recorded use at North Fork Kaweah, an annual grassland, was in 1997. Cahoon meadow does not have recorded use.

Figure 6. A row of sandbags designed to spread out surface flow in restored Halstead Meadow wasdamaged in the KNP Complex and started to fail in the October 25 storm.

Mixed Conifer

In the KNP Complex, roughly 35,509 acres of historically frequent-fire forests (Jeffrey pine, ponderosa pine, white fir, and mixed conifer) burned. Of this acreage, 7,697 acres burned at high severity. Within these forests, the conifer regeneration prediction tool (POSCRPT; (Shive etal., 2018; Stewart et al., 2021)) predicts that even under ideal post-fire conditions (high seed rain and precipitation), 5,180 acres of pre-fire forest area are predicted to have low or very low probability (<40% chance) of conifer regeneration (Figure 7). Excluding contiguous low probability areas under 10 acres, 3,925 acres exhibit a very low probability of regeneration.

Below this patch size, a lack of forest regeneration could contribute to desirable habitatvariability (Boisramé et al., 2017; Collins and Stephens, 2010).

Some areas with predicted low probability of regeneration may have been historically maintained as montane chapparal by frequent, severe fire due to their location on the landscape (Nagel and Taylor, 2005; Safford and Stevens, 2017) and were only forested beforethe fire as a result of fire exclusion. Such areas are most likely to occur at lower elevations on steep south or west-facing slopes. Other communities might represent marginal sites that should be avoided under the warming climate. Outside of these areas, strategic reforestationwill be needed to restore Pacific fisher habitat.

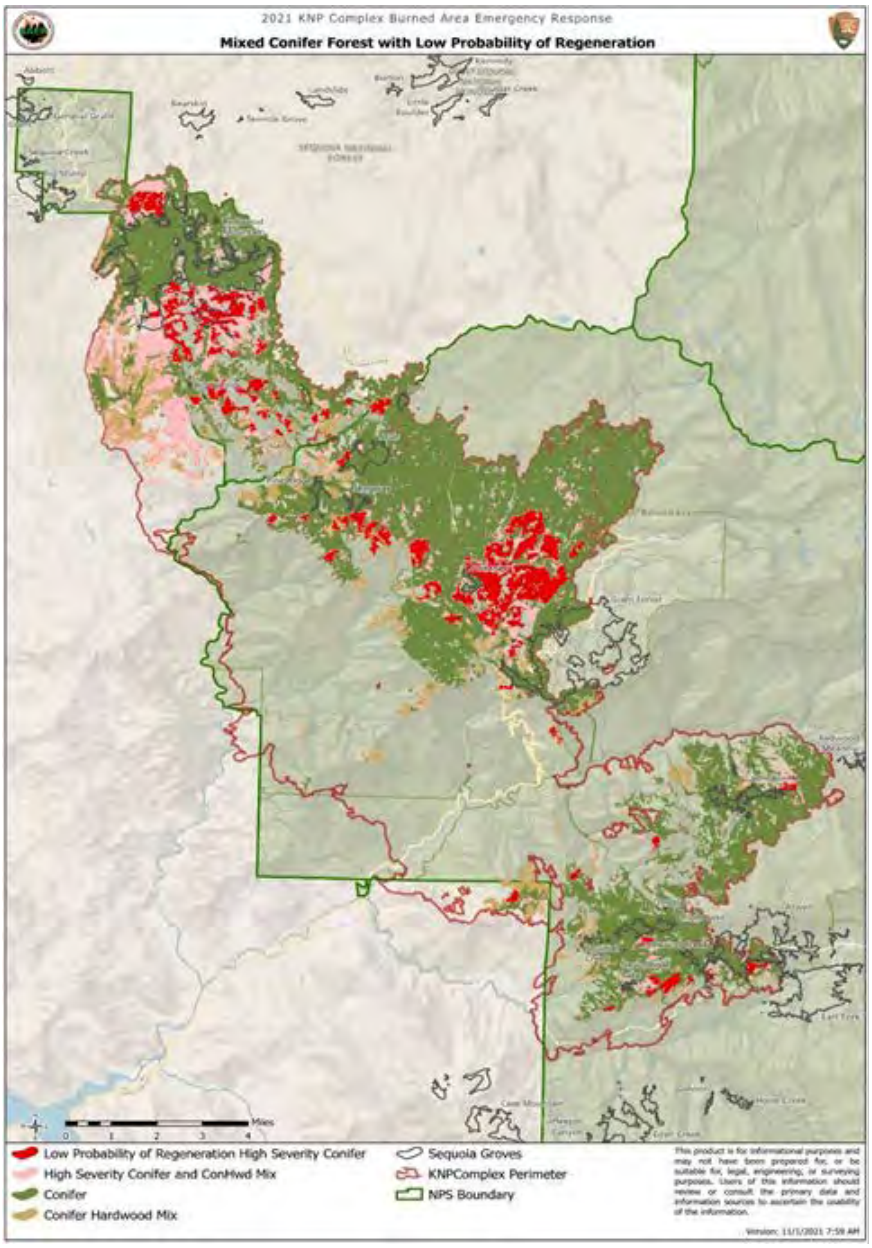

Figure 7. Range of mixed conifer (green) within the fire perimeter (maroon outline) with areas of low or very low predicted probability of conifer regeneration shown in red. Sequoia groves are outlined in gray and are typically embedded within mixed conifer.

Chaparral

The BAER Team noted substantial fire effects in chaparral communities resulting both from the fire as well as from fire suppression operations. Sixty-eight percent of the parks' low elevation chamise and mixed chaparral communities burned in the KNP Complex; 11% at low intensity and 57% at moderate to high intensity (Table 1, Figure 8). Because chaparral grows naturally in dense stands, total canopy loss is expected in high intensity burned areas. Unless root systems are destroyed by the fire's heat, many of the shrubs will resprout and the seeds of others will be stimulated to germinate (Keeley 1986). The majority of suppression impacts from dozerlines occurred in the oak and chaparral zones (Figure 2).

While we expect some resprouting and seedling germination in burned and bulldozed areas, long-term vegetation recovery is highly dependent on the water year conditions. Extended droughts, such as those that California has experienced multiple times since 2000, will limit native plant recovery in favor of non-native annual grasses. These conditions will increase thepotential for type conversion of native shrubland to annual grassland.

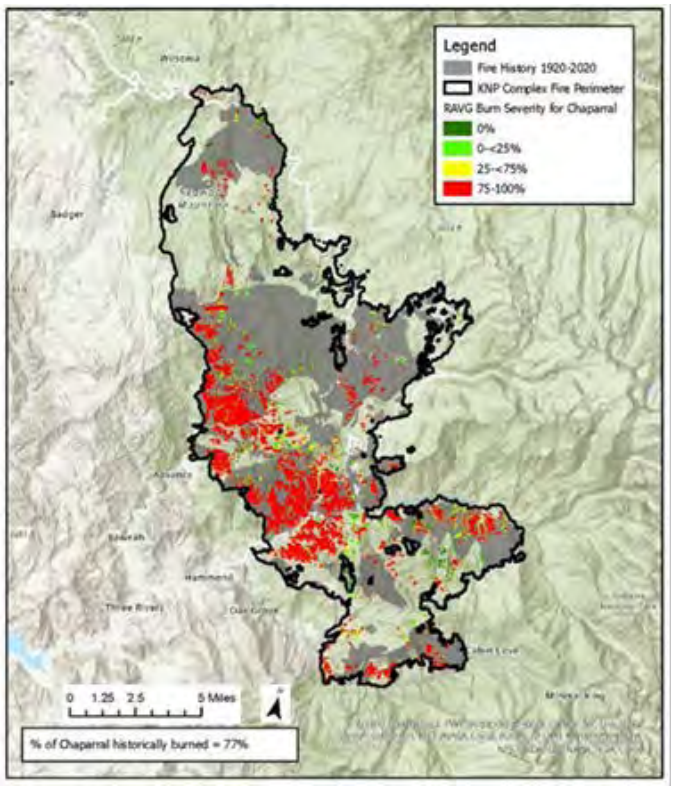

Figure 8. Fire history and fire burn severity for chaparral affected by the KNP Fires within SEKI.

Giant Sequoias

Patterns of burn severity

A total of 4,320 acres of sequoia groves burned in the KNP Complex which included portions of 16 distinct groves. In the limited areas that the BAER Team was able to ground truth or observeburn severity via helicopter, the areas designated as "undetected change" typically display some degree of low-intensity consumption. More detailed surveys are needed to confirm the extent of this pattern. Low severity fire was likely largely restorative and represents the largest proportion by severity class of total grove area burned (42%). While undetected change within the fire perimeter and low severity represent 70% of the burned grove area, the absolute acreage of high and moderate severity, where most mortality of large sequoias is expected to occur, is substantial (Tables 5a and 5b, Figure 9).

Table 5a. Acres burned by sequoia grove and severity.

Grove	Outside fire perimeter	Severity				Total burned area:
		Undetected change	Low	Moderate	High	
Atwell	621	45	187	50	19	301
Big Springs	0	0	2	0	0	2
Castle Creek	0	44	123	49	2	218
Douglass	0	0	1	0	0	1
East Fork	741	3	1	0	0	4
Giant Forest	1,639	259	179	24	4	466
Lost	6	17	12	0	0	29
Muir	0	70	140	28	7	245
New Oriole Lake	0	0	8	4	3	15
Oriole Lake	0	49	91	6	0	146

Pine Ridge	0	1	39	3	0	43
Redwood Creek	2	6	32	5	2	45
Redwood Mountain						
NPS	0	549	657	412	458	2,158
USFS/UCB	0	82	301	108	103	512
Skagway	0	7	48	4	1	60
Squirrel Creek	0	0	6	1	0	7
Suwanee	0	0	7	44	17	68
Total acreage:		1,132	1,834	738	616	4,320
Percent of total:		26%	42%	17%	14%	

Table 5b. Percent of area burned by severity (including percent outside fire perimeter) by sequoia grove.

Grove	Outside fire perimeter	Severity			
		Undetected change	Low	Moderate	High
Atwell	67%	5%	20%	5%	2%
Big Springs	0%	0%	100%	0%	0%
Castle Creek	0%	20%	56%	22%	1%
Douglass	0%	0%	100%	0%	0%
East Fork	99%	0%	0%	0%	0%
Giant Forest	78%	12%	9%	1%	0%
Lost	17%	49%	34%	0%	0%
Muir	0%	29%	57%	11%	3%
New Oriole Lake	0%	0%	53%	27%	20%
Oriole Lake	0%	34%	62%	4%	0%

Pine Ridge	0%	2%	91%	7%	0%
Redwood Creek	4%	13%	68%	11%	4%
Redwood Mountain					
NPS	0%	25%	30%	19%	21%
USFS/UCB	0%	16%	59%	21%	20%
Skagway	0%	12%	80%	7%	2%
Squirrel Creek	0%	0%	86%	14%	0%
Suwanee	0%	0%	10%	65%	25%

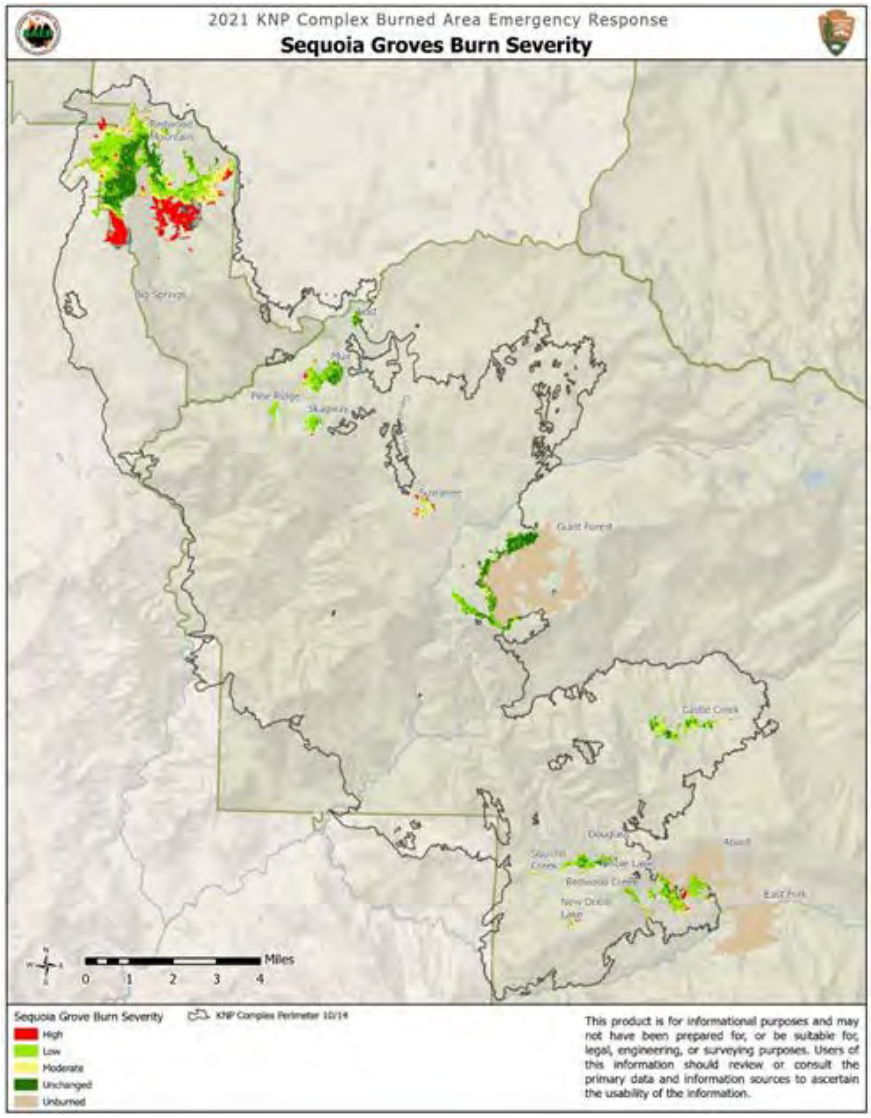

Figure 9. Map of groves with burn severity, correlating roughly with loss of canopy.

Redwood Mountain Grove had the most substantial acreage impacted by high severity fire (Figure 10a, 10b) followed by Atwell and Suwanee. In the areas in which the Atwell Grove burned severely, the forest was mostly second growth. Reconnaissance via helicopter over theSuwannee Grove indicated that the areas classified as moderate severity were underpredictedin the severity map, potentially resulting in more mortality than expected (Figure 11).

Figure 10. Redwood Mountain Grove. Views of (a)top large high severity patch at the southern end ofthe grove from 10/12/2021 and (b)bottom a close-up view of dead sequoias from 10/27/2021.

Figure 11. Suwanee Grove. View of high and moderate severity across the grove from 10/27/2021.

Large sequoia mortality

To estimate mortality of large sequoias (>4' DBH) in SEKI, the BAER Team used the Sequoia TreeInventory (STI) data to query the number of trees present in each burned grove by severity class. We then applied mortality rates by severity class from surveys in other recent wildfires (Table 6), which include delayed mortality 3-5 years post-fire (Shive et al., in review). The Team did not separate out immediate versus delayed mortality, because there was only data from one fire to support this distinction. The Team did note, however, that for the 2017 Pier Fire of the total number of dead trees estimated by year three, approximately 71% (72 trees) were considered initial mortality. The BAER Team also identified mortality estimates in the context of the estimated total population of large sequoias across the range, which was estimated by Stephenson and Brigham (2021) to be approximately 75,580 trees.

Table 6. Mortality rates observed by Shive et al. (in review) for the Rough and Pier Fires*. The rates forthe Railroad Fire used in this assessment are from Stephenson and Brigham (2021).

Survey area	Low	Moderate	High
2015 Rough Fire (Evans, Kennedy and Lockwood Groves)	0.0%	14.0%	75.7%
2017 Railroad Fire (Nelder Grove)	5.9%	22.2%	100.0%

2017 Pier Fire (Black Mountain Grove)	11.9%	24.5%	74.6%

* The surveys for the Pier Fire and Rough Fire were focused on moderate to high severity. Inthese fires, observations in low severity were immediately adjacent to moderate and high

severity which could somewhat elevate the mortality rate. However, the Rough Fire had a 0%mortality rate in low severity so the Team feels it is sufficiently conservative (Shive et al., in review). For the Railroad Fire, the Team used the mortality rates in Stephenson and Brigham (2021) which are based on additional surveys outside of the Shive et al. (in review) study. TheBAER Team used the rates from Stephenson and Brigham (2021) which relied on unpublisheddata (Amarina Wuenschel, USFS) because they had a larger sample size in low severity and were overall more conservative.

The BAER Team then applied these rates to the SEKI STI data by fire severity class, parsed intotwo size classes: 4-10 feet DBH (Table 7a) and >10 feet DBH (Table 7b). When the size classes are combined (Table 7c) these estimates suggest that approximately 1,095 - 2,016 large sequoias were either killed directly by the fire or will experience delayed mortality within 3-5 years post-fire. This represents approximately 1 - 3% of the range-wide population of large sequoias (Stephenson and Brigham, 2021).

Table 7a. Estimated mortality by grove of sequoias 4-9.9' in diameter in the KNP Complex on NPS land. Estimates shown by the minimum and maximum mortality rates per severity class from reference data.

Grove	Low		Moderate		High		Total	
	min.	max.	min.	max.	min.	max.	min.	max.
Atwell	0	31	9	16	3	4	12	51
Big Springs	0	1	0	0	0	0	0	1
Castle Creek	0	20	10	17	1	1	11	38
East Fork	0	0	0	0	0	0	0	0
Giant Forest	0	24	3	5	3	4	6	33
Lost	0	3	1	1	0	0	1	4
Muir	0	35	6	9	3	4	9	48
New Oriole Lake	0	3	1	1	3	3	4	7
Oriole	0	12	1	1	0	0	1	13
Pine Ridge	0	6	0	0	0	0	0	6
Redwood Creek	0	6	2	2	2	2	4	10
Redwood Mountain	0	109	76	130	435	583	511	822
Skagway	0	8	1	1	2	2	3	11
Squirrel Creek	0	1	0	0	0	0	0	1
Suwanee	0	3	11	18	12	16	23	37

Total:	0	262	121	201	464	619	585	1,082

Table 7b. Estimated mortality by grove of sequoias >10' diameter in the KNP Complex on NPS land. Estimates shown by the minimum and maximum mortality rates per severity class from reference data.

Grove	Low		Moderate		High		Total	
	min.	max.	min.	max.	min.	max.	min.	max.
Atwell	0	23	5	9	1	1	6	33
Big Springs	0	1	0	0	0	0	0	1
Castle Creek	0	8	3	5	3	4	6	17
East Fork	0	0	0	0	0	0	0	0
Giant Forest	0	22	2	3	3	4	5	29
Lost	0	3	0	0	0	0	0	3
Muir	0	22	3	5	2	3	5	30
New Oriole Lake	0	1	1	1	1	2	2	4
Oriole	0	13	1	2	0	0	1	15
Pine Ridge	0	3	0	0	0	0	0	3
Redwood Creek	0	5	0	1	1	1	1	7
Redwood Mountain	0	105	71	122	392	525	463	752
Skagway	0	5	1	1	1	2	2	8
Squirrel Creek	0	1	0	0	0	0	0	1
Suwanee	0	2	6	11	13	18	19	31
Total:	0	214	93	160	417	560	510	934

Table 7c. Combined mortality estimates of sequoias >4' diameter for all groves in the KNP Complex onNPS land. Estimates shown by the minimum and maximum mortality rates per severity class from reference data.

Size Class	Low	Moderate	High	Total
4-10 feet				
Minimum estimated mortality	0	121	464	585
Maximum estimated mortality	262	201	619	1,082

>10 feet				
Minimum mortality	0	93	417	510
Maximum estimated mortality	214	160	560	934
All >4'				
Minimum estimated mortality	0	207	881	1,095
Maximum estimated mortality	476	361	1,179	2,016

The BAER Team also estimated mortality in 594 acres of Redwood Mountain Grove which are outside of SEKI's boundaries. For the 300 acres that burned on Whittaker's Research Forest (which is managed by UC Berkeley) the Team used an existing stem map that included 233 largesequoias (>4 feet) to estimate mortality. This portion of the grove burned at primarily lower severity with an estimated mortality of 9-26 large sequoias. Staff at UC Berkeley plan to do a field assessment of Sequoia morality in the summer of 2022.

For the approximately 294 acres in the Giant Sequoia National Monument, the Team did not have access to stem maps so we used the mean density of large sequoias per acre from the STI (~2.61 per acre) to estimate the number of large sequoias on the landscape. We then used the mortality rates from Table 7c, estimating 214-333 large sequoias may have been killed on theseacreages.

Finally, we also applied our estimation method to the 2021 Windy Fire, estimating that 968- 1,563 large trees were killed with that fire. Combining both NPS and non-NPS lands burned in the KNP Complex with the Windy Fire, approximately 2,286-3,938 large sequoias are estimated to have been either killed outright or will die within a few years. This suggests that the 2021 fireseasons resulted in a loss of approximately 3-5% of the large sequoia population. When considered with mortality from the 2015-2017 fire events and the estimated loss of 10-14% of large sequoias in the 2020 Castle Fire, this fire season contributes to an alarming trend.

Regeneration impacts

The BAER Team assessed patch sizes of high severity in sequoia groves to assess the potential for regeneration failure due to lack of seed survival, creating greater dependence on seeds from a live tree seed source. Since there is no empirical model of regeneration or seed dispersalfor giant sequoia, we focused on the acreage that is >100m from live tree seed sources.

Of the 207 distinct patches of high severity, only five patches are >10 acres. Where the patcheswere smaller, they may have contributed to heterogeneity. Two areas of Redwood Mountain Grove had 436 acres >100m from a likely surviving giant sequoia seed source; 353 acres of these are within SEKI (Figure 12). These acreages were calculated to exclude some very small patches of moderate severity within the larger high severity patches, because drone imagery suggests that these areas may be fully or near-fully scorched (Paul Hardwick, personal communication, Figure 13). Active reforestation may be needed in this area for giant sequoia, with the extent of this need to be determined by field surveys in 2022.

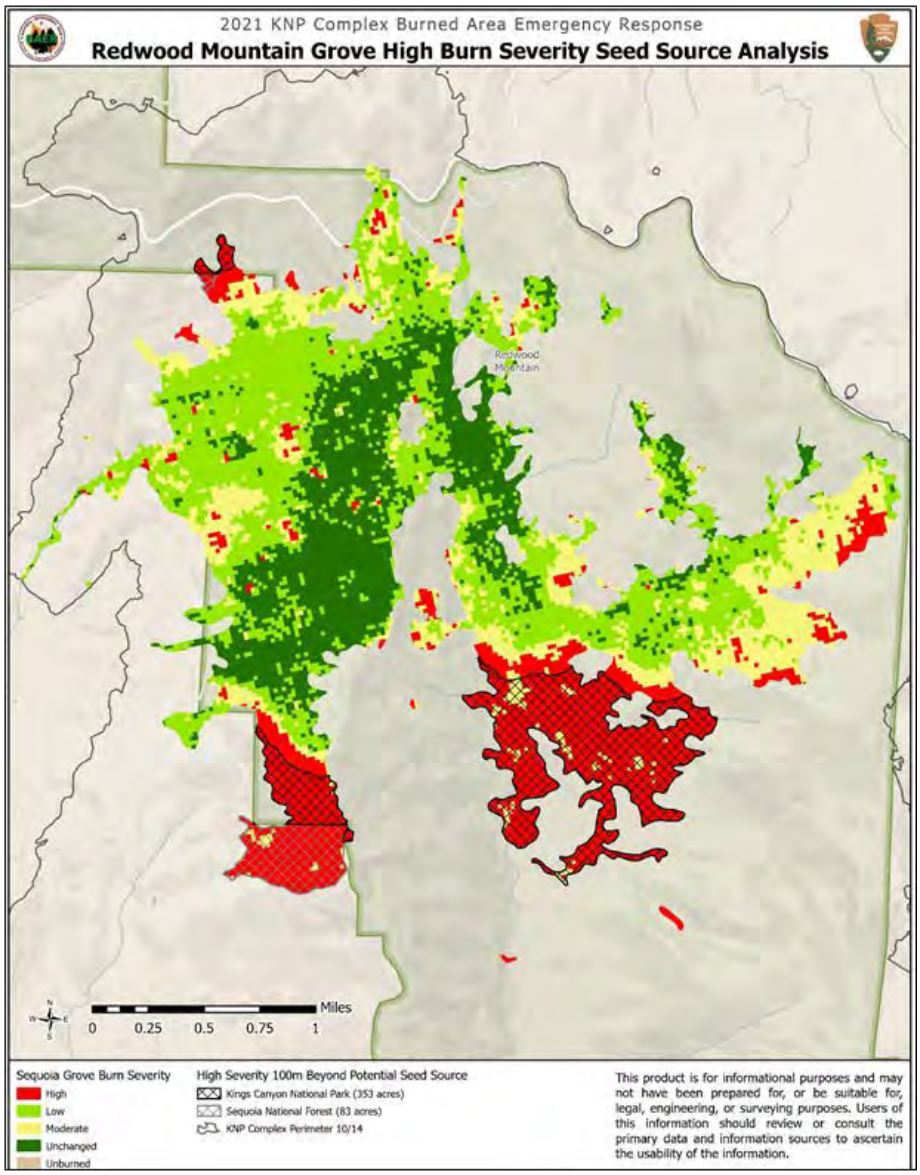

Figure 12. Southern end of Redwood Mountain Grove with significant patches of high severity.

Figure 13. Ortho-rectified drone imagery of small moderate severity patches within the large high severity patch of Redwood Mountain Grove. Because surviving trees in these patches could be limited, the acreage calculation for distance to live tree excluded these for the regeneration analysis (Paul Hardwick, personal communication). Orange squares are classified as moderate severity in RAVG.

Special Status Plant Species

Limited time in the field meant that BAER staff were able to check fire effects on only a few roadside populations of two rare plant species: mouse buckwheat (*Eriogonum nudum* var. *murinum*) and Munz's iris (*Iris munzii*). We found that a roadside population of mouse buckwheat lost approximately 20 individuals to either direct fire effects or from being buriedunder soil sliding from burned slopes above (Figure 14). This population is the type locality forthis taxon and therefore has significant scientific value. Conversely, a brief survey along Shepherd's Saddle road showed no impacts to roadside populations of Munz's iris from bulldozers working to reinforce the road as a fireline (Figure 15).

Figure 14. Type locality of mouse buckwheat, showing the impact of fire and rock/soil movement. Approximately 20 plants were lost at this location.

Figure 15. Munz's iris on Shepherd's Saddle road. Heavy equipment reinforced this road as a potentialfuel break but avoided impacting this rare plant thanks to READ flagging.

Invasive Plant Species

The BAER team evaluated the threat to native plant communities posed by invasive species andthe actions necessary to mitigate those impacts. Field visits allowed BAER botanists to observe fire effects and suppression impacts. We also analyzed existing invasive plant occurrence data as well as suppression impact data from the incident. Park vegetation management staff were consulted to interpret the data and construct an appropriate response.

Known Populations of Medium to High Priority Invasive Plants Within the KNP Complex

Management documents, such as the SEKI Invasive Species Programmatic Categorical Exclusion(NPS 2010), identify the highest priority sites and species for control. Through consultation withSEKI resource managers, the BAER team identified 570.6 acres of existing infestations to be targeted for post-fire treatment (Table 3, Figure 1); 184.7 acres of high-priority species and

385.9 acres of medium priority species. A brief summary of each high priority species follows.

Arundo donax (Giant reed) invaded the Ash Mountain/Alder Creek area. Most populations havebeen eradicated, but a few small remnants may need treatment. Three Rivers has significant populations and giant reed remains a high priority for early detection.

Carduus pycnocephalus (Italian thistle) swept into Sequoia NP in the 1990s and continues toadvance to higher elevations using the highway as a corridor. SEKI has worked for years to contain this plant and prevent it from invading the giant sequoia groves, particularly Giant Forest. The KNP Complex's perimeter overlaps the leading edge of the infestation, increasingthe concern that Italian thistle will spread rapidly on burned ground.

Centaurea solstitialis (Yellow star thistle) is a highly invasive plant that forms dense spiny thickets. It can be poisonous if consumed by livestock. It is common in the San Joaquin Valley and is invading the foothill areas around SEKI. READs found it in the Redwood Mountain Groveduring the KNP Fires. It is present in the Eshom area (USFS lands adjacent to the western park boundary) through which crews and equipment regularly travelled to enter the Redwood Mountain area of the park. Early detection surveys for this species will be critical in order to catch infestations while they are small and can be eradicated.

Elymus caput-medusae (Medusahead) populations occur just outside SEKI, particularly in theEshom and Hartland areas. Two populations have been detected (and possibly eradicated) in Kings Canyon NP, one of them inside the burn perimeter. This species will be a high priority target for early detection.

Genista monspessulana (French broom) was apparently eradicated from Ash Mountain headquarters area 5-10 years ago. This species can persist in the seed bank for at least 5 years. Methodical surveys of the area should occur to ensure it does not invade into the fire footprint.

Holcus lanatus (Velvetgrass) is a perennial grass that can severely disrupt meadow ecosystems.It spreads rapidly if not actively controlled. SEKI has spent more than half a million dollars and

fifteen years working to eradicate velvetgrass in the Kern River Canyon. The park has succeededin reducing populations down to just a handful of infestations. Known populations within the KNP Fires perimeter will be treated to prevent further spread.

Phalaris arundinacea (Reed canarygrass) is SEKI's most virulent and ecologically impactful plantinvader and highest priority for control. It occurs primarily in the Grant Grove and Wilsonia areas of Kings Canyon NP with one small population in Giant Forest. It also occurs just outside the park in Sequoia National Forest.

Rubus armeniacus (Himalayan blackberry) and ***Rubus laciniatus*** (cutleaf blackberry) are highlyinvasive shrubs that only occur in a handful of locations within SEKI. They resprout readily after fire and are dispersed by birds. Rapid post-fire expansion is likely without treatment.

Silybum marianum (Milk thistle) invaded SEKI via the North Fork Kaweah drainage repeatedly.It has been controlled and possibly eradicated from the park, although surveys in the North Fork drainage are incomplete. This plant occurs outside SEKI in the Three Rivers, Eshom, and Hartland areas.

Sorghum halepense (Johnsongrass) surveys are incomplete. It has been reported as occurringalong the Generals Hwy in the Amphitheater Point area inside the KNP Complex's perimeter.

Taraxacum officinale (Dandelion) is reported anecdotally park-wide. The species likely hasexpanded into many park areas, including wilderness. This species is a particular threat to alpine environments and will be targeted within the KNP Complex footprint to reduce the chance of spread into higher elevation areas.

RECOMMENDATIONS

The BAER Team developed two Emergency Stabilization (ES) and six Burned Area Rehabilitation(BAR) specifications to address post-fire vegetation issues. We also provide non-specification management recommendations to assess the condition of meadows open to stock grazing, giant sequoia conservation, and rare plant status.

<u>Revegetation of Fire- and Fire Suppression-Damaged Plant Communities</u>

Burned Area Rehabilitation Specification 6: Replace Conservation Plantings. Replace plantings that were installed to protect other resources, reduce erosion, or restore community structuralcomplexity. Replace plants destroyed by fuel break cutting or backburning in areas SEKI was restoring to native vegetation at Giant Forest and Potwisha Campground. Replace plantings installed to control social trailing and erosion at Tunnel Rock that were destroyed by fire.

Burned Area Rehabilitation Specification 7: Safety Zone Revegetation. Revegetate oversized safety zones cut by bulldozers into foothill shrublands. Safety zones and dozer lines on Milk Ranch Road are excessively large, the soils are highly compacted and these areas are unlikely to

recover without restoration. Collect seed, grow plant plugs, hydroseed, plant plugs, fence entrypoints to restoration areas and water plantings.

Meadows

Emergency Stabilization Specification 14: Halstead Meadow Protection. This should be implemented the fall of 2021 to address the potential for damage to the Halstead meadow restoration. In this action a row of new sandbags added to the top of the gabion structure justdownstream of the bridge will help to ensure that no new gullies develop in the restored wetland. If the new sandbags are laid next to the damaged ones (instead of on top of them), they may vegetate more quickly.

Non-Specification Recommendation. As a non-specification recommendation, we suggest that SEKI conduct an early-season evaluation of 74-4 Cahoon meadow and determine whether a delayed opening or closure for pack stock grazing is needed. Alternative grazing can be found at Clover Creek Meadow, a couple miles north of Cahoon. 96-1 N Fork Kaweah does not require anevaluation. In addition, pack stock stream crossings exposed to moderate or high fire intensity could be assessed for potential treatments needs.

Mixed Conifer Forest

Burned Area Rehabilitation Specification 11: Revegetation of Pacific Fisher Critical Habitat. As part of this BAER/BAR plan, we have developed a reforestation specification to address mixed conifer forest loss. Not all of the area identified of being at risk of forest conversion to shrubland is feasible to restore or is capable of maintaining forest cover over the long-term due to changing climatic conditions. In addition, impacts to wilderness character and other resource values mustbe considered when evaluating the feasibility and desirability of reforestation activities. In order to provide an initial cost estimate for reforestation for consideration for Burned Area Rehabilitation (BAR) funding, we have costed out reforesting an area that at this time seems feasible to execute with additional funding and staffing. This value is 500 acres, which is approximately 13% of the acres considered at risk of forest loss. During FY 22 the Park will work with cooperators at USFWS and other partners to use the framework for prioritization ofreforestation (Meyer et al. 2021) to further refine target areas for reforestation which will be used to update this BAR specification. Highest priority areas will be targeted for restoration.

This includes area that increase habitat connectivity, occur in or adjacent to Pacific fisher criticalhabitat, increase landscape-scale forest resilience, and have a high likelihood of success even under a changing climate. The "Recommendations for Long-Term Restoration" document in the appendixes supports the BAR specification.

Chaparral

Burned Area Specification 7. Described above.

Non-Specification Recommendation. Visit bulldozed fire lines in the North Fork, Shepherd Saddle, and Eshom Valley areas to determine whether foothill shrubland and woodland communities are recovering or whether intervention will be needed to prevent large-scale typeconversion to invasive annual grasslands.

Giant Sequoia Groves

Burned Area Specification 9: Revegetation of Selected Sequoia Groves. Reforestation of up to 350 acres of the Redwood Mountain giant sequoia grove destroyed by high severity fire duringthe KNP Complex. This specification is supported by the "Recommendations for Long-Term Restoration" document in the appendices.

Non-Specification Recommendations

1. Accurately report to the public wildfire impacts to sequoia groves during the KNP Complex by reporting current mortality estimates and field verifying these estimatesduring 2022-2025 (see #2).
2. Monitoring & Research
    1. Track individual sequoias for at least three years for delayed mortality, including documentation of cedar bark beetle activity.
    2. Survey high severity areas to assess regeneration patterns in Redwood MountainGrove in the summer of 2023 to inform potential sequoia planting.
    3. Survey high severity areas to assess regeneration patterns in Redwood Mountain Grove to better identify the drivers of regeneration patterns specific to high severityareas that have not been investigated to date, including differences in scorched versus torched stands and site conditions.
    4. Investigate mortality and survivorship from this event so that these response variables can be correlated with other predictor variables (slope, aspect, management history, fuel

loading). Knowledge gained will be used to prioritize other sequoia groves for fuel reduction treatments before they are impacted by high severity fire.

5. Fully assess (or design stratified random subsamples for) fire effects in sequoia groves in spring and summer 2022.

6. Model connections between pre-fire fuel loading, management history, weather, slope, aspect and other relevant factors and fire effects observed in burned sequoia groves during the Castle Fire. Use this model to maintain reduced fuel loads in areas that burned in low to moderate severity or other areas of the park where groves are in a resilient condition due to recent fire.

7. Assess fuel loading (both standing dead and large woody debris) in current groves, including those that burned at low and moderate severity, to inform future treatment plans.

8. Generate mechanistic hypotheses to explain fire, drought and beetle interactions and continue to test pre-burn treatments to eliminate physiological damage that results in vulnerability to beetle attack.

9. Develop a strategy with partners for characterizing and communicating "good" fire versus "bad" fire, especially with respect to giant sequoias.

Special Status Plants

Burned Area Rehabilitation Specification 8: Replace Rare Buckwheat. Propagate and install up to 50 plants grown from seed collected from the type locality (1/2 mile into the park from the visitor center) to replace plants burned in the fire or buried by soil and rock falling from burnedslopes above.

Non-specification Recommendation. Conduct post-fire vegetation surveys for other special status plant populations. Prioritizing the rarest plants (e.g., state rarity ranks 1B.2 or 1B.3) forsurvey, as well as any populations located within high soil burn severity (e.g., *Mimulus inconspicuous*, *Ribes tularense*), will give the Park a clearer sense of how well these species adapt to fire and highlight those that need additional management.

Invasive Plants

Emergency Stabilization Specification 13 AND Burned Area Rehabilitation Specification 5: Invasive Plant Management. These specifications address invasive plant issues created by the KNP Complex. Under the ES specification, perform Early Detection/Rapid Response (EDRR) in high priority burned or impacted areas in FY22. EDRR is a cost-effective approach to preventingnew infestations from becoming large problems that are impossible to control. Under the BAR specification, continue EDRR within the KNP Fires' perimeter in FY23 and FY24.

Non-Specification Recommendation. We recommend that the park treat all known high priority invasive plants within and adjacent to the fire perimeter and to strategize a treatment plan forthe known medium priority invasive plants identified in the findings section. The total acreage of known medium to high priority species is likely too great for treatment within a single season and additional prioritization will be needed. Emphasis should be placed on areas of high severity burn where a high likelihood for movement of invasive species has occurred such as along roads; near natural resource values at risk (adjacent to sensitive habitats or special status species), and areas affected by suppression activities where soil disturbance has created habitatthat will be receptive to non-native plant invasion.

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FACILITIES/MINOR INFRASTRUCTURE ASSESSMENT

OBJECTIVES

1. Assess impact of fire or post-fire effects on park facilities
2. Prescribe treatments to replace or repair fire damaged facilities

ISSUES

3. Boundary fencing may have burned in the fire
4. Boundary markers attached to trees may have been lost in the fire
5. Shooting range storage building is damaged
6. Sewage spray field may have been damaged
7. Redwood Mountain Ranger Station is lost to the fire
8. Redwood Canyon Cave Research Cabin is lost to the fire
9. Milk Ranch communication site may have been damaged by the fire
10. Crystal Cave solar array may have been damaged by the fire
11. Wuksachi bridge was partially burned by the fire
12. Campgrounds may have been damaged
13. Picnic areas may have been damaged
14. Administrative facilities may have been damaged by the fire
15. Wuksachi Lodge facilities may have been lost
16. Lodgepole housing may have sustained damage

BACKGROUND

DOI policy for Burned Area Emergency Response (BAER) issues allows for the repair or replacement of minor improvements and facilities that have burned within a fire for the narrowpurposes of public health and safety and for specific resource protection purposes. DOI policy for Burned Area Rehabilitation (BAR) issues allows broader flexibility for the repair or replacement of minor improvements and facilities within a fire. Due to the significant resourceprotection, park communications, and public safety concerns associated with some of the facilities, BAER treatments are appropriate for mitigating the damage at some of these burned facilities. BAR-funded treatments are appropriate for those structures where public health and safety are not a significant issue.

The fire burned through many administrative areas and facilities managed by NPS, most alongor adjacent to the Generals Highway or Mineral King Road. Some of those facilities were damaged by the fire.

RECONNAISSANCE METHODS

Administrative areas and facilities along the Generals Highway and Mineral King administrativeareas were assessed by vehicle between October 22 and 28. Rains on October 25 stopped assessment for the day. Campgrounds, picnic areas, maintenance facilities, Wuksachi Lodge, boundary fence and markings, a shooting range, sewage spray field, communication site, a bridge and other features were GPSed, photographed and mapped in Collector.

FINDINGS

17. Two miles of boundary fencing have been damaged by the fire in the Yucca Creek (1.1m), Whitaker (.8) and Milk Ranch (.1) areas. These segments of fencing are inCongressionally designated wilderness
18. Boundary markers have been damaged in the Yucca Creek, Milk Ranch area andWhitaker Experimental Forest
19. A shooting range was burned over and a shed was burned
20. A sewage spray field was not damaged in the fire (other than a small electrical box), as most of the above-ground equipment is metal. Functionality could not be confirmed viaa post-fire spray test
21. The Redwood Mountain Ranger Station structure was lost to the fire
22. The Redwood Canyon Cave Research Cabin could not be accessed. SEKI staff on an overflight (Oct. 26) indicated the cabin may have burned, but could not confirm withouta site visit
23. The Milk Ranch communication site was burned; the superstructure is intact but the communication equipment is a loss
24. A small outbuilding on a former inholding along the Oriole Lake Road burned
25. The Crystal Cave solar array was not damaged
26. A bridge at Wuksachi Lodge was damaged by fire but is repairable
27. No campgrounds were damaged by fire
28. No picnic areas were damaged by fire
29. No administrative facilities were damaged by fire

30. The Lodgepole housing unit was not damaged by fire

RECOMMENDATIONS

31. Repair two miles of boundary fencing at Yucca Creek, Whitaker and Milk Ranch sites. Many of the wooden fence posts have burned but the T posts and wire are intact. Fencing is in wilderness, and it is recommended to prepare an MRA including the Necessity Determination. The Yucca Creek site has two parallel strands of fencing the inner most being superfluous and may not be necessary. The boundary aligned fence isdown and allows trespass, the inner fence alignment concedes several acres to cattle trespass. Consider removing the inner fence alignment and repairing the fence that follows the park boundary. At the Whitaker site, there is a star shaped drift fence alignment to confine cattle to the roadway during herd movement from leases in the south and north. The east/west alignment may not be necessary; consider an MRA analyses to determine the necessity of this fence alignment.

32. Reestablish boundary markers at Yucca Creek, Milk Ranch and Whitaker sites, also alongthe burned boundary where roads and trails intersect the boundary and where visitors or hunters are likely to encounter the park boundary, including the climbing access area on Mineral King Road and the North/South boundary near Old Baldy.

33. Replace the 6 x 8 shed at the shooting range

34. Replace the communications equipment at the Milk Ranch communication site

35. Repair the bridge at Wuksachi Lodge

See the Fence and Boundary map and the Facilities map for locations

Figure 1. Fencing and Boundary Signs at Redwood Canyon

Figure 2. Shooting Range Building and Wuksachi Bridge

Figure 3. Milk Ranch Communications Site

Four specifications are proposed – two ES and two BAR – to address damaged facilities withinthe KNP Complex.

Specifications

ES-02 BAER Crew and Storm Patrol, will replace 2 miles of boundary fencing and boundarymarkers.

ES-03 Milk Ranch Communication Site, will replace communication infrastructure.BAR-02

Wuksachi Bridge Repair, will repair the bridge for foot traffic.

BAR-01 Shooting Range Building Replacement, will replace the storage building.

Non-Specification

Clean up of the Redwood Mountain Ranger Station should be completed. This work is not covered by BAER and should be completed by park staff and the PWR Regional Environmentaldivision.

Park staff should check the condition of the Redwood Canyon Cave Research Cabin and decideif the structure in designated wilderness will be replaced.

Park staff should test the Red Fir spray field to see if functions properly by running water through the emitters. If issues with the system are found that are related to the fire, staffshould consider a BAER plan amendment for repair costs.

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ROADS ASSESSMENT

OBJECTIVES

36. Assess damage from fire to NPS roads
37. Assess and prescribe treatment for fire damage and post fire effects to roads

ISSUES

38. Road drainage features may fail due to sedimentation or floating debris blocking the inlet
39. Storm events will deposit debris and trees on the road surface blocking traffic
40. Wooden guard rail features have been burned and are compromised
41. Fire damaged trees have fallen on the road surface and guardrail causing damage
42. Burning trees have fallen on the road surface and continued to burn, damaging the surface
43. Road retaining walls may be destabilized by loss of vegetation
44. Visitor and vehicle management may be complicated post fire

BACKGROUND

DOI policy for Burned Area Emergency Response (BAER) issues allows for the repair or replacement of minor improvements and facilities that have burned within a fire for the narrowpurposes of public health and safety and for specific resource protection purposes.

Roughly 28.7 miles of the Generals Highway, 6.0 miles of the Mineral King Road, and 6.6 mile of Crystal Cave road were impacted by the fire. Many of the wooden features have burned, fallingtrees have damaged the road surface, burning trees laying on the road have damaged the road surface, culverts may plug from increased sediment, and floating debris and storm events will bring down falling trees and rocks that may damage the road surface or block traffic.

RECONNAISSANCE METHODS

The Generals Highway, Mineral King road, Crystal Cave and Redwood Canyon roads were assessed by vehicle between October 22 and 29. Rains on October 25 stopped road assessmentfor the day. Road signs, culverts, damaged areas, guard rail and other features were GPSed, photographed and mapped in Collector. Culverts were measured and condition recorded especially on blue line drainages.

FINDINGS

All ditch relief culverts have been cleaned and are open on the Generals Highway. Blue line culverts are plugged to some degree as the park doesn't have a long reach excavator to reach down to the culvert inlet. A culvert above Red Fir is plugged and will not pass water (Figure 1),

a culvert on Redwoods Canyon is plugged and water is flowing over the road incising the road surface. The storm of 10/25 plugged several culverts with sediment and mud flows have covered Mineral King Road is several places. Many significant culverts on Generals Highway have a second culvert placed on top of the original culvert during a recent road reconstructionwith the lower culvert in many cases being plugged. Culverts on the Mineral King Road are generally undersized and are in need of cleaning to bring them to their full design function capacity.

Fire damaged trees have fallen on the road damaging the road surface and burning trees have fallen on the road and damaged the road surface. Guardrail has been damaged by fire and fallen trees in three locations. Road retaining walls in two locations on Generals Highway may have been destabilized. Future storm events will bring down trees and rock that may damage the road surface or block traffic. Highway signs have been burned, road hazards including rolling rock and falling trees will threaten the road, road closures and rangers to manage thoseclosures are needed to manage road traffic.

The Oriole Lake road has lost a non-engineered road retaining structure, destabilizing the road (Figure 2). The BAER Crew with leased equipment may be able to repair the road. This section of road is very dangerous and should be closed until the lost retaining structure is resolved. Theroad is in Congressionally designated wilderness, suggest an MRA analyses to determine the minimum necessary for the administration of the area.

Figure 1. A culvert up the road from Red Fir Maintenance facility before and after the Oct 25storm

Figure 2. Oriole Lake road retaining structure lost

RECOMMENDATIONS

Clear rockfall and tree fall from the Generals Highway, Mineral King Road, Crystal Cave and Redwood Canyon, Milk Ranch and Oriole roads following storm and wind events. Inspect andclean culvert inlets.

Cut and replace road surface damaged by fallen trees and burning trees at identified locations,Repair guard rail in three locations, inspect and replace damaged fill, asphalt and chip seal.

Contract a Geo-Tech firm to analyze roadbed fill retaining walls destabilization in two locationsdown slope of the Generals Highway.

See the Roads Map for locations; Figure 3 below depicts a variety of road damage examplesalong the Generals Highway.

Figure 3. Road damage on Generals Highway

Two specifications – ES-2, BAER Crew and Storm Patrol, and ES-4, Road Damage Repair – areproposed to repair damaged road assets and mitigate public safety threats in the post-fire environment.

Specifications

ES-02 BAER Crew and Storm Patrol. A crew to implement many of the specifications enumerated in this plan. Including but not limited to storm patrol, fence repair and signinstallation.

ES-04 Road Damage Repair. Contract specifications to repair asphalt damage, guard rail andconcrete curb.

Non-Specification

The plugged culverts at Red Fir and Redwoods Canyon must be cleaned and flow through them restored before the next precipitation event to prevent loss of that section of Generals highwayand Redwood Canyon roads.

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TRAILS ASSESSMENT

OBJECTIVES

45. Identify and assess trails that have burned within the perimeter of the fire in the Park.

ISSUES

46. The KNP Complex burned roughly 79,000 acres of Sequoia and Kings Canyon NP and across many of the Park trails. Park trails provide extensive visitor recreational opportunities for noviceday users and experienced backcountry users, and provide for public safety and resource protection.

BACKGROUND

Sequoia National Park averages almost 1.3 million visitors per year. Many visitors drive the Generals Highway and stop at the Giant Forest area, which has roughly 40 miles of front country trails and giant sequoias that are primary visitor attractions. Many of these visitors are novice trail hikers, and the trail network within the Giant Forest area provides ample opportunity for these visitors to wander amongst the giant sequoias. North of the Giant Forest area, trailheads off the Generals Highway provide access to higher elevations (such as Little Baldy and Big Baldy trails) and into other sequoia groves, such as Muir Grove. In lower elevations, trails similarly provide day-use access off the Generals Highway through the oak woodland-chaparral vegetation communities of the foothills.

The northern end of the KNP Complex extends into Kings Canyon National Parks, which in recent years has averaged almost 700,000 visitors per year. A primary visitor attraction is the Grant Grove area just north of the fire, with many trails south of the Generals Highway in the Redwood Mountain / Redwood Canyon area.

Some trails within the burn perimeter extend deeper into the wilderness, primarily west of GeneralsHighway.

One other primary visitor attraction site is Crystal Cave, which lies west of the Generals Highway down the 6.5-mile Crystal Cave Road. The site features a cave that lies roughly two-thirds of a mile down a highly developed trail. Annual use of this trail to access the cave is 65,000 visitors.

DOI policy for Burned Area Emergency Response (BAER) issues allows for the repair or replacement of minor improvements and facilities – including trails – that have burned within a fire for the purposes ofpublic health and safety and for specific resource protection. Similarly, DOI policy for Burned Area Rehabilitation (BAR) issues allows broader flexibility for the repair, replacement, or improvement of minor facilities and infrastructure within a fire. Due to the significant resource protection and public safety concerns associated with some of the trails that receive high public use, which would also be difficult to restrict visitor access to, BAER treatments can be appropriate for mitigating the immediate threats at some of these burned facilities. BAR-funded treatments are appropriate for most of the structures burned along Park trails *(Figure 1).*

Figure 1. Soil and woody debris on Crystal Cave trail.

RECONNAISSANCE METHODS

Several trails were surveyed onsite for fire-damage. BAER personnel (Jack Oelfke) and Sequoia NP TrailsSupervisor Tony Fiorino surveyed multiple trails along Generals Highway on Oct. 22, 2021 (trail bridge near Potwisha; trail bridge at Paradise Creek near Buckeye Flat; trail bridge at Silliman Creek; trail bridge at Crescent Creek at Log Meadow; Wuksachi Lodge bridge). On Oct. 23, BAER personnel (Oelfke) assessed multiple trails in the Giant Forest area (Moro Rock; Hanging Rock: Bear Hill; Sunset Rock) and Muir Grove. On Oct. 24 BAER personnel (Oelfke and Cedar Drake) surveyed the Sugar Pine and Little Baldy Trails. On Oct. 26 BAER personnel (Oelfke) assessed the Hospital Rock to Potwisha trail above the Generals Highway. On Oct. 27 Oelfke and Trails Supervisor Fiorino flew to Crystal Cave to assess the parking lot area for broader facility impacts and assess the trail down to Crystal Cave. Also surveyed wasthe lower 2/3 of the Paradise Creek trail. On Oct. 28 Oelfke and Kings Canyon Trails Work Leader Andy Head surveyed the Sugar Bowl/Hart Tree Loop trail.

Data points and information (including photos) were taken in the Collector app and later uploaded intothe Collector database. Follow-up discussions were held with Sequoia NP and Kings Canyon NP Trails

supervisors (Fiorino and Barnaby Fisher, respectively) regarding repair/replacement costs, which led to the development of the funding specifications discussed later in this assessment.

Miles of trail within the burn perimeter and by soil burn severity were calculated by BAER GIS Specialist Elizabeth Hale using the Soil Burn Severity map developed by the BAER team. Maps of potential debris flow locations along trails was produced by SEKI GIS/Information Branch Chief Paul Hardwick.

FINDINGS

Of the 68.4 miles of trails within the burn perimeter, most (62.3 miles) lie wholly within the burn, whilethe remainder (6.1 miles) served as a containment line along the perimeter. Burn severity varies across the trails, as shown in Table 1. The Kings Canyon trails have higher amounts of Moderate-High burn severity, particularly along the Sugar Bowl/Hart Tree loop, where 3.2 miles of the 6.5-mile loop have Moderate-High soil burn severity. Damage along those 3.2 miles was particularly severe due to the rilling of the slopes above the tread, tread erosion, and gully washouts. Much of the Redwood Canyon Big Springs trail had High burn severity, but time did not permit assessment of that trail. Over 40% of the Kings Canyon trails within the burn perimeter lie within the Moderate-High soil burn severity classes, whereas about 20% of the Sequoia NP trails within the burn perimeter are in the Moderate-High soil burn severity classes, most of which is in the Moderate class.

Table 1. Miles of trail by burn severity in Sequoia and Kings Canyon NPs.

Burn Severity	Trail miles in Sequoia NP	Trail miles in Kings Canyon NP
High	0.3	4.0
Moderate	8.7	3.4
Low	24.9	8.4
Unburned	10.3	2.3
Total	**44.2**	**18.1**

Damage to trails was documented on all trails surveyed (approximately 20 miles of trail), with ageneral observation that more severe tread damage occurred in areas of moderate and high burn severity, particularly following the atmospheric river storm event of Oct. 25, 2021. This storm dumped between 2-3" of rain across the burned area and caused significant hillslope rilling above the tread and/or caused increased runoff down the trail tread itself. A summary of damage to those trails surveyed is found in Table 2.

Table 2. Damage to trails in KNP Complex that were assessed by the BAER team.

Trail/Location	Damage summary
Potwisha-Hospital Rock, above Generals Hwy	1 stump hole in tread; 200' of damaged tread including draining/erosion issues; burned 20' bridge (steel stringers intact,plank burned); considerable woody debris across trail
Paradise Creek trail, lower half of trail	Roughly 120' of rock/debris across trail and tread issues; woodydebris across trail
Crystal Cave trail	Extensive damage: Rock/soil debris on trail (300 lineal feet, 6" – 3' deep, 4 feet wide); damaged 20 sq ft of historic rock wall masonry; 30' handrail loss; 1700 sq ft Stalok tread patching; 20 trees across trail; considerable woody debris on trail
Moro Rock trail	17 stump holes in tread; 450' damaged tread; log check and bar burned near Hanging Rock tr; considerable woody debris across trail
Hanging Rock trail	3 stump holes in tread; 300' damaged tread
Bear Hill trail	1 stump hole in tread; 100' damaged tread
Sugar Pine trail	11 stump holes in tread; 500' tread damage, especially within the first ½ mile of trail starting at the Moro Rock end; burned crib logs along 30' turnpike structure; woody debris across trail
Bobcat Point trail	2 stump holes in tread near junction with Sugar Pine trail
Sunset Rock trail	3 stump holes in tread; burned 2-stringer 40' decked boardwalk; considerable woody debris on trail
Lower Kaweah trail	Burned 80' section of outer tread log cribbing; considerable woodydebris on trail
Wuksachi trail	3 stump holes in tread; 150' of tread damage' 20' of rock wall damage; 20 trees across trail. Suppression crews cut switchbacksand created easily seen social trails – approx. 350' in 4 sections
Little Baldy trail	5 areas with stump hole/rootwad damage, including 4 that impingeon rock walls and have destabilized sections of the rock walls; considerable woody debris across trail
Muir Grove trail	8 stump holes in tread; 600' of tread damage; considerable woody

	debris across trail. NOTE: trail tread essentially disappears for approximately 1000’ once the grove is reached; then reappears

	near the rock outcrop overlook. Social trails and trampling in and around the many sequoia trees there is inevitable unless action is taken to direct visitors along a defined path thru the sequoia grove.
Sugar Bowl Loop/Hart Tree loop	This trail has the most extensive trail tread damage, due in largepart to heavy rilling of slopes above the trail that has deposited considerable material across the trail and/or eroded the tread 9 stump holes in tread; approx. 7000’ of tread damage; 50’ of rock wall damage; 47 wooden drain bars burned; 103 trees acrosstrail; considerable woody debris across trail.
Atwell-Hockett trail	A READ reported that a 30’ section of trail below the Atwell Mill campground may have slumped in a section of high burn severity. The READ also reported many trees down across this ¼-mile sectionof trail within the burn perimeter. This area burned post BARC data acquisition and was not included in the analysis.

Some trails within the Low soil burn severity suffered extensive damage as well, with the Crystal Cave trail a prime example. Park staff estimate it will take a crew of 8 up to 3 months tocomplete needed mitigation to restore the trail to pre-fire conditions.

It is important to note that one trail has a particularly dangerous area for visitor passage, the Hospital Rock to Potwisha trail. A burned bridge on a very steep slope poses a significant safetyhazard to get past. It would be extremely easy for visitors to slip off the remaining very narrow trail and fall downslope to the roadway below, a fall of perhaps 100’ to the roadway. See Figure 2 below.

Based on trail damage found on those trails surveyed, it is likely that significant trail tread damage (rock/soil deposition, erosion of tread or burning of outside tread surface on downslope side) also occurred on the Redwood Canyon Big Springs, Redwood Canyon HartTree, Hidden Springs, Colony Mill Road, Admiration Point, and Marble Falls trails.

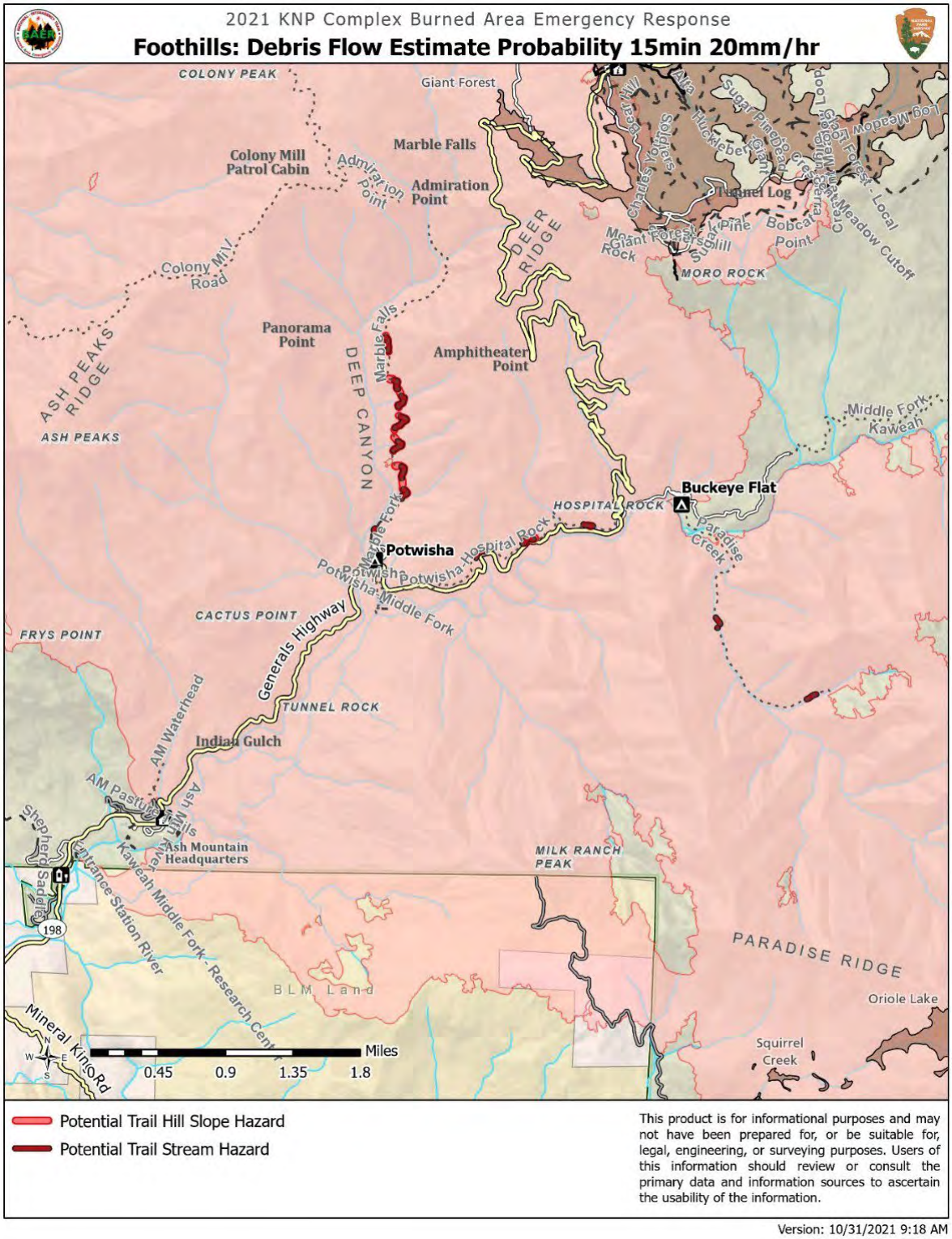
Debris flow modeling indicates a greater than 50% chance of material movement at the MarbleFalls, Sugar Bowl, Hart Tree, and Big Springs trails in response to intense rainfall (20mm/hr in a 15-minute period). Maps 1, 2, and 3 below indicate the debris flow potential for trails in threebroad areas of the fires.

Finally, the Muir Grove trail now presents risks of considerable social trailing and possible damage to sequoia regeneration. The trail essentially disappears once you arrive at the first giant sequoias, due to complete burn over of the tread. It later reappears closer to the rock outcrop approximately 300 yards later. Without some

type of route guidance, visitors will likelywander all throughout that recently burned grove, leading to social trails and soil compaction.

Increased agency presence and route markers will help confine foot traffic to a specific routethrough the area until it meets up again with the old trail.

Figure 2. Burned boardwalk, Hospital Rock-Potwisha trail.


2021 KNP Complex Burned Area Emergency Response
Foothills: Debris Flow Estimate Probability 15min 20mm/hr
COLONY PEAK
Giant Forest
Colony Mill Patrol Cabin
Admiration Point
Marble Falls
Admiration Point
Colony Mill Road
DEER RIDGE
Tunnel Log
Bobcat Point
MORO ROCK
Panorama Point
Amphitheater Point
Marble Falls
DEEP CANYON
ASH PEAKS RIDGE
ASH PEAKS
Middle Fork Kaweah
Buckeye Flat
HOSPITAL ROCK
Potwisha
Potwisha Hospital Rock
Potwisha-Middle Fork
Paradise Creek
CACTUS POINT
FRYS POINT
Generals Highway
TUNNEL ROCK
Indian Gulch
AM Waterhead
AM Pasture
Ash Mountain Headquarters
Shepherd Trail
Kaweah Middle Fork - Research Center
Tunnel Station River
198
MILK RANCH PEAK
PARADISE RIDGE
BLM Land
Oriole Lake
Squirrel Creek
Mineral King Rd
Miles
0.45
0.9
1.35
1.8
Potential Trail Hill Slope Hazard
Potential Trail Stream Hazard
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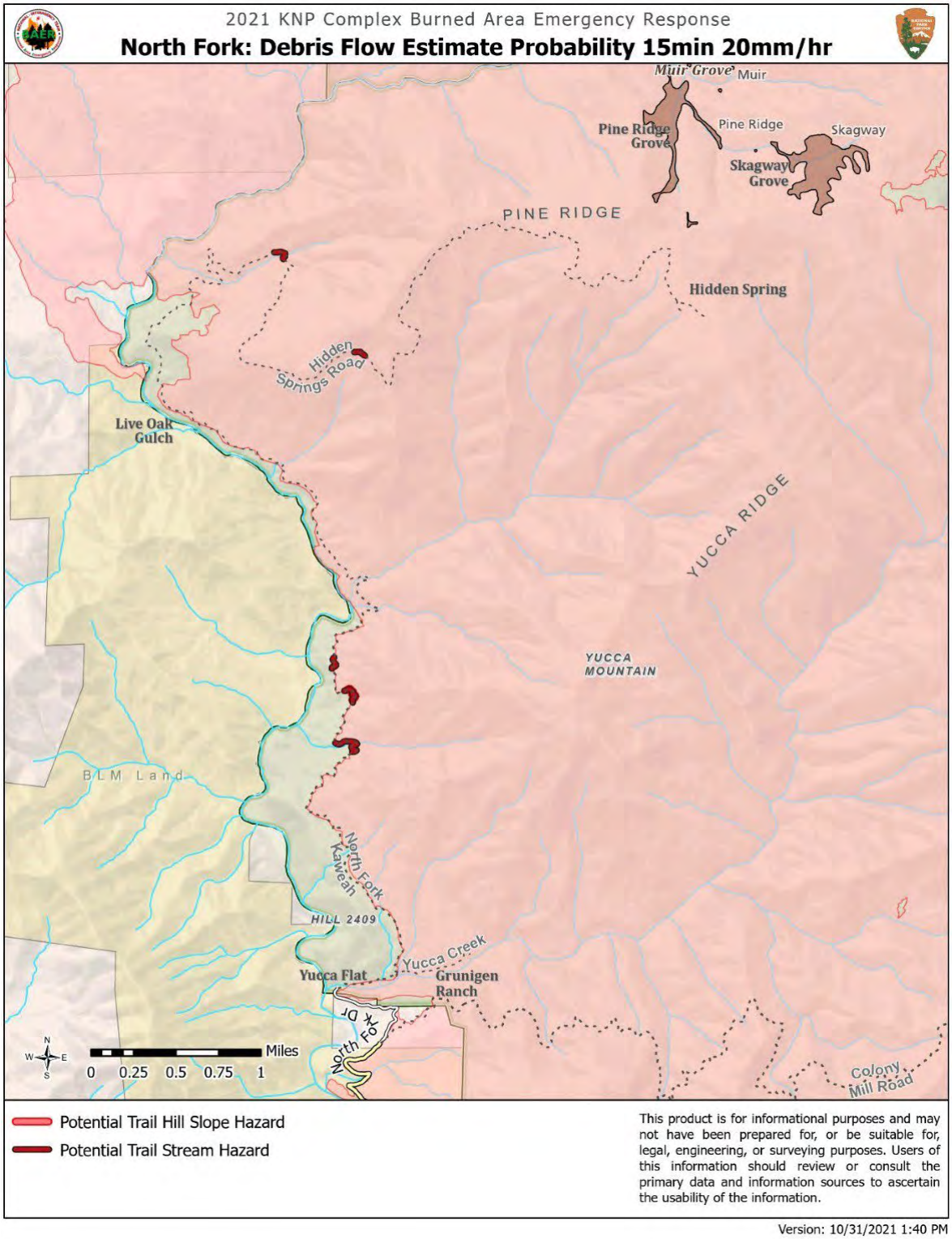
Map 1: Potential debris flow locations along trails in the Foothills area.


2021 KNP Complex Burned Area Emergency Response
North Fork: Debris Flow Estimate Probability 15min 20mm/hr
Muir Grove
Muir
Pine Ridge Grove
Pine Ridge
Skagway
Skagway Grove
PINE RIDGE
Hidden Spring
Hidden Springs Road
Live Oak Gulch
YUCCA RIDGE
YUCCA MOUNTAIN
BLM Land
North Fork Kaweah
HILL 2409
Yucca Creek
Yucca Flat
Grunigen Ranch
North Fork Dr
Colony Mill Road
N
W
E
S
Miles
0 0.25 0.5 0.75 1
Potential Trail Hill Slope Hazard
Potential Trail Stream Hazard
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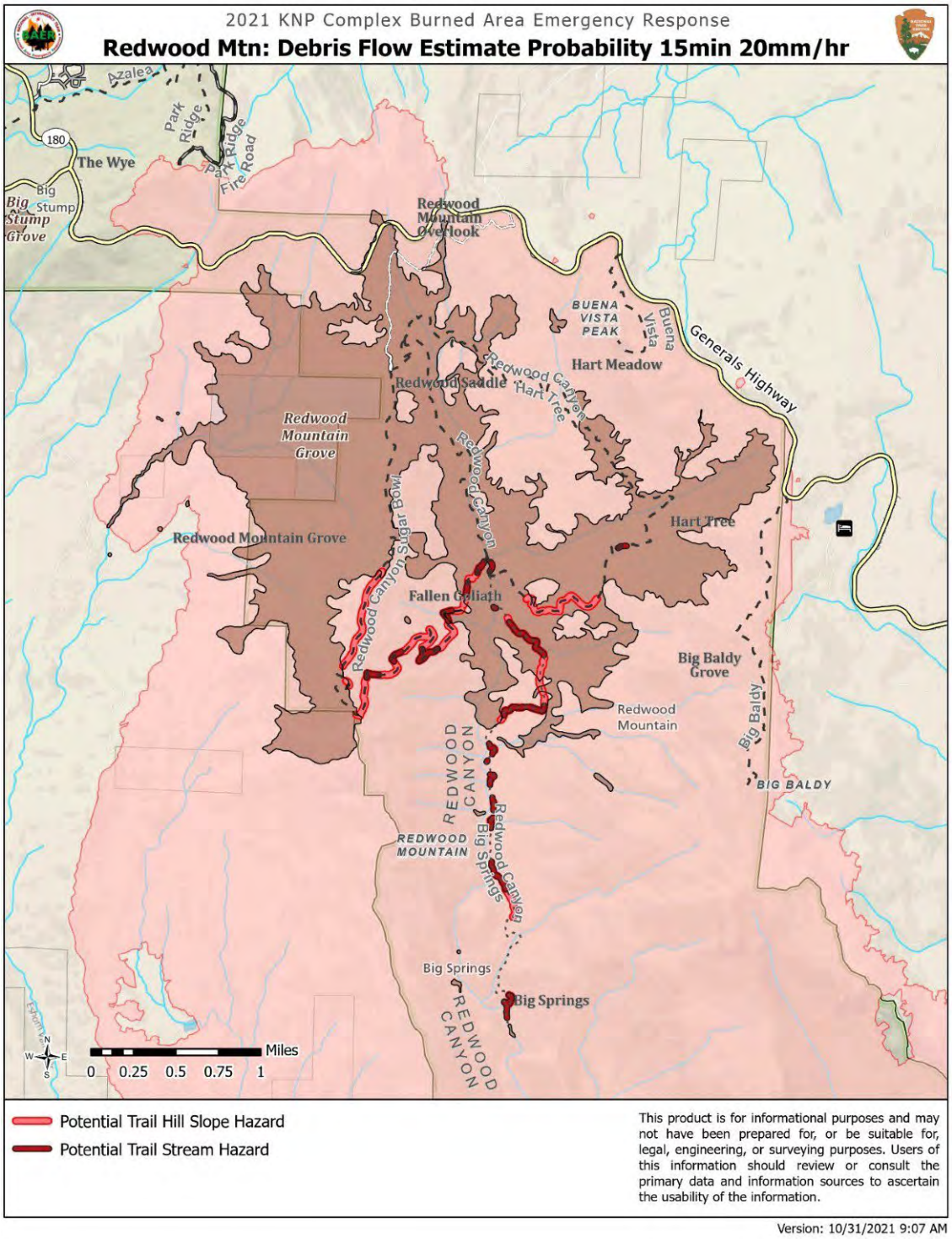
Map 2. Potential debris flow locations along trails in the North Fork area.


2021 KNP Complex Burned Area Emergency Response
Redwood Mtn: Debris Flow Estimate Probability 15min 20mm/hr
Azalea
Park Ridge
Park Ridge Fire Road
180
The Wye
Big Stump
Big Stump Grove
Redwood Mountain Overlook
BUENA VISTA PEAK
Buena Vista
Generals Highway
Hart Meadow
Redwood Saddle
Redwood Canyon
Hart Tree
Redwood Mountain Grove
Redwood Canyon Sugar Bowl
Redwood Canyon
Hart Tree
Redwood Mountain Grove
Fallen Goliath
Big Baldy Grove
Redwood Mountain
Big Baldy
BIG BALDY
REDWOOD CANYON
REDWOOD MOUNTAIN
Redwood Canyon
Big Springs
Big Springs
Big Springs
REDWOOD CANYON
N
W
E
S
Miles
0 0.25 0.5 0.75 1
Potential Trail Hill Slope Hazard
Potential Trail Stream Hazard
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Version: 10/31/2021 9:07 AM

Map 3. Potential debris flow locations along trails in the Redwood Mountain area.

RECOMMENDATIONS

Ideally, all trails should remain closed to public use until trees and debris have been removedfrom the trails and the tread is considered stabilized and passable to the public. Some trails will require considerably more effort than others to make them safe for public use, and sometrails will likely require more attention than others in subsequent years to keep them open – refer to the debris flow map potential for likely areas requiring greatest outyear maintenance.

There are approximately 50 documented locations of special status plants along trails in the KNF burn area. Where trail stabilization, hazard mitigation, and outyear trail maintenance workis performed that have the potential to directly impact known special status plant populations, a field assessment will be needed to 1) determine whether the population will be impacted bytrail work and 2) develop site and/or species-specific mitigations to avoid impacts to special status plants.

Two specifications, both through BAR, are prescribed to address post-fire trails issues.

Specifications

BAR-3, Trails Stabilization and Hazard Mitigation, will address the myriad issues and damagethe fire caused on trails, ranging from extensive rock/soil/debris on the trail tread, burned stump holes impinging on the tread, damaged rock walls, burned wooden structures, fallen trees, and loss of the outer edge of tread in some areas.

BAR-4, Out-year Trails Maintenance, provides funding for small additions to the existing trail crew to address the anticipated increased workload in 2023 and 2024. Increased windfall of fire-killed trees, deposition of rocks/soil onto the trail tread, and increased efforts to maintaindrains to prevent tread erosion will all be above normal years

Non-Specification: Park staff noted a concern about the increased potential of rockfall along the highly-popular Crystal Cave trail. The Park should consider a Technical Assistance Requestthrough the NPS Geological Resources Division to gauge the threat, or request a site visit fromthe Yosemite NP geologist.

CONSULTATIONS

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KNP Complex

PREPARER(S)

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PUBLIC SAFETY & RESOURCE PROTECTION ASSESSMENT

OBJECTIVES

1. Identify, communicate, and prevent or mitigate threats to human safety when NPS staffor the public enters burned areas.
2. Identify, communicate, and prevent or mitigate threats to sensitive cultural and natural resources resulting from post-fire conditions.

ISSUES

3. The KNP Complex has destroyed a number of road and regulatory signs throughout thePark, particularly along the Generals Highway. A wilderness permit station was destroyed along the Mineral King Road.
4. Burned terrain may produce hazards on roads and trails (rockfall, flash floods, mudslides, roadway debris, falling trees, etc.). The potential for these hazards will needto be communicated to the public.
5. Sections of Park roads and trails may need to be periodically closed to prevent public exposure to post-fire hazards.
6. Burned vegetation and consumed logs may expose sensitive natural and cultural resources and change visitor use patterns via the creation of new social trails

Permanent Road Closure Gate

Burned NPS Regulatory Sign

Burned Speed Limit Sign

BACKGROUND

Post-fire conditions resulting from the KNP Complex elevate concerns for public safety and increase the vulnerability of sensitive natural and cultural resources to damage. Threats to public safety and sensitive resources are amplified by trends in increased visitation. Between2011 -2019, annual visitation at SEKI averaged 1,131,181 visitors. Park visitation reached 1,246,053 in 2019, constituting a 24% increase over the preceding decadal average and this trend is anticipated to continue into the future.

Hazard trees present a widespread risk following fire events. Much of the KNP fire footprint is forested, resulting in the creation of large number of hazardous snags throughout the burned area.

In areas of the Park where steep slopes have burned, potential exists for the downslope movement of rock or soil, particularly following heavy rainfall events. Flash flooding may occurwithin and below severely burned drainages. Roads, structures, developments, or other points of interest which may attract visitor use should be identified and signed for avoidance as appropriate.

Fire hazard and roadway signs provide critical information to ensure that visitors safely navigatePark roads relative to post-fire hazards. Speed limit, curve warnings, and falling rock are examples of regulatory signage that the public expects to see along roads to inform safe driving practices.

Signage and maps informing the public of off-limits burned areas enhance safety for those whoare unaware of post-fire hazards and discourage access to sensitive cultural and natural resource sites. Many archeological sites at SEKI were protected by dense vegetation before thewildfire. With a substantial portion of the landscape now denuded, many sites may be threatened from increased visibility and exposure resulting in a higher risk of looting and damage to artifacts. Likewise, sensitive natural resources in the post-burn environment may become more accessible to the public and could lead to vandalism, disturbance to recovering vegetation, the creation of new social trails, increased erosion, and other impacts.

Post-fire public messaging is a critical tool for informing Park visitors of safety concerns and ensuring that sensitive resources remain protected. In order for outreach to be effective, it must be delivered across a variety of platforms including social media, online applications, maps, interpretive displays, written materials, and face-to-face interactions. Increased agencypresence from Park staff on the ground can effectively reinforce this messaging.

Wilderness Permit Station on Mineral King Road

RECONNAISSANCE METHODS

A survey of fire damaged signs and roadside burn severity was conducted by BAER Team members Cedar Drake, Chris Holbeck, and Brad Jost from October 22 to October 29 across much of the affected Sequoia National Park road system including the General's Highway, Mineral King Road, Milk Ranch Road, North Fork Road, Crystal Cave Road, and Redwood CanyonRoad.

Consultations associated with this assessment were conducted with the SEKI Visitor and Resource Protection Division, the Interpretation Division, the Maintenance Division, and theSEKI Sign Shop.

A GIS analysis was conducted to assess the level of fire severity impacts along the primary roadways within the Park. This assessment, in conjunction with consultation with SEKI staff, wasused to inform the number and nature of new post-fire hazard signs, burned area closure signs, temporary barriers, and road closure gates needed to augment post-fire public safety and resource protection.

Visitors to Sequoia NP

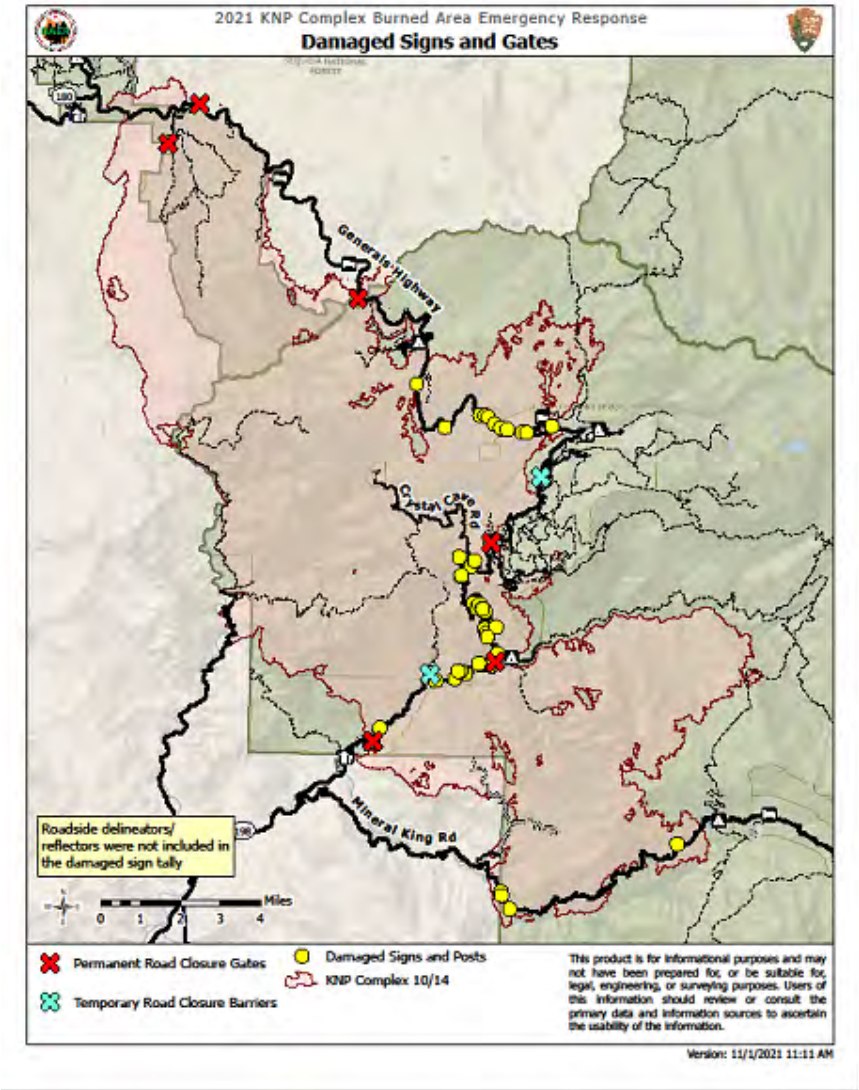
FINDINGS

A survey of pre-existing signs which were damaged by the KNP Complex revealed the need forthe replacement of the following:

Replacement Signs Needed	Quantity
Chains Required (Old)	1
Chains Required	1
Curvy Road	2
Delineator (Reflector)	134
Entering Kings Canyon NP	1
Entering Sequoia NP	1
High Water	1
Left Hand Curve	5
Loose Gravel	1
Mineral King Wilderness Permit Station	1
Mineral King Winter Use	1
Next 5 Miles	1
NPS Elevation	1
NPS Hunting	1
Orange Chevron (Turn)	5
Orange MPH	9
Right Hand Curve	3
White Speed Limit	4
Total Signs to Replace	173

Replacement Posts Needed	Quantity
Sign Post	69
Delineator Post	30

Total Posts to Replace	99



The GIS analysis of fire severity along the SEKI road system identified the following:

Soil Burn Severity Along SEKI Roads					
	Soil Burn Severity				
ROAD	High	Moderate	Low	Unburned	Grand Total
Generals Highway	0.6	2.9	18.3	6.9	28.7
Crystal Cave Rd	0.9	2.5	3.1	0.1	6.6
Mineral King Rd	0	2.3	3.4	0.3	6
Milk Ranch Rd	0	0.1	0.6	0	0.8

Oriole Lake Rd	0	0.9	1.3	0	2.3
Grand Total (miles)	1.5	8.6	26.8	7.4	44.3
Grand Total (percentage)	3.4%	19.4%	60.5%	16.7%	

Analysis of soil burn severity with the vicinity of the SEKI road system and accompanyingconsultation informed the need for the following new signs:

New Signs Needed	Quantity
Falling Rock	20
Entering High Severity Area	40
Road Closed	10
Burned Area Closure	30
New Signs	100

New Posts Needed	Quantity
New Posts	90

Analysis of soil burn severity with the vicinity of the SEKI road system and accompanyingconsultation informed the need for the following temporary and permanent road gates:

Location	Purpose	Relation to Park Priorities	Approximate Coordinates	Possibly Temporary
Generals Highway at Foothills Visitor Center Ash Mountain (current closure site)	Prevent access to Generals during storm events or when roadway is obstructed	Manage Priority 1 area for park	36.49131, -118.82577	No
North boundary of Sequoia NP at entrance sign	Prevent access to Generals during storm events or when roadway is obstructed, allows access to USFS section of Generals to Stony Creek	Manage Priority 3 area for park	36.65183, -118.83619	No
At USFS road 14S34 entering Kings Canyon NP southwest of Redwood Mountain grove	Prevent access to Redwood Mountain Road from USFS Land	long term closure?	36.70672, -118.92323	No
Redwood Mountain Road at Generals Highway	Prevent access to Redwood Mountain Road from Generals Highway	Manage Priority 3 area for park	36.72121, -118.90928	No
Generals Highway at Wolverton Road Generals Highway	Prevent Access to Lodgepole and upper Generals Highway	Manage Priority 2 area for park	36.58831, -118.75238	Yes
Generals Highway at Giant Forest Museum	Prevent access to Lower Generals from upper Generals	Used if upper Generals is open and there is roadway obstruction on switchbacks.	36.564120, -118.774203	No
Generals Highway at Hospital Rock	Prevent Access to Generals above Hospital rock	Manage Priority 1 area for park	36.52098, -118.77139	No
General Highway at Potwisha Campground	Prevent access to Generals above Potwisha if that is a closure segment	Low Priority	36.51598, -118.80070	Yes

Public messaging and interpretive signage in conjunction with increased agency presence frominterpretive and law enforcement rangers (ES-5) will be required in the following instances:

7. Minimize the establishment of new social trails from the Generals Highway to the Middle Fork of the Kaweah River in response to increased accessibility due to burned vegetation.

8. Re-establish the intended trail route and minimize the establishment of new social trailsin the Muir Grove. Temporary Carsonite route markers may be needed to guide Park visitors along a single path and to connect to the preexisting trail leading to the rock outcrop.

Burned Area Avoidance Sign Example

RECOMMENDATIONS

Three specifications – ES-6, Signage and Gates, ES-7 Post-Fire Communication, and ES-8 Post- Fire GIS Support - are proposed to mitigate potential safety concerns and minimize threats to cultural and natural resources in the post-fire environment.

Specifications

ES-6 Signage and Gates: This specification addresses post-fire public safety in the need to replace damaged, pre-existing roadway regulatory signs and to install new burned area hazard/avoidance signs (e.g., falling rock, entering burned area, and burned area closure). The specification also recognizes the need to establish temporary barriers and to construct permanent roadway closure gates at critical locations along the SEKI road system to control access for public safety and resource protection. The replacement cost of the wilderness permitstation damaged along the Mineral King Road is included in this specification.

ES-7 Post-Fire Communication: This specification supports the need for effective public outreach, interpretation, and education to promote post-fire safety and resource protection. ATerm Visual Information Specialist position will be funded to produce and communicate wildfire-related content via the SEKI webpage, mobile app, social media, the Park newspaper, apost-fire safety pamphlet, mobile interpretive displays, and signage. This position will also develop a system to track and communicate fire-related Park closures to the public and will collaborate with a post-fire Cartographic Technician (ES-8) to produce interpretive spatial

content. Additionally, a seasonal interpretive ranger position will be funded to provide increased agency presence, deliver public safety and resource protection messaging, and maintain interpretive displays and signage. The cost of interpretive displays, signage, and othermaterials are included in this specification.

ES-8 Post-Fire GIS Support: This specification supports many of the specifications found within this report. A seasonal GS-07 Cartographic Technician position will be funded to support online,mobile, and hard copy mapping that informs Park staff and visitors of areas, trails, and facilities that are open and closed based on the changing conditions of the weather and landscape. The position will also assist with compliance and the tracking of infrastructure repair and replacement, natural and cultural resources, tree hazards, restoration, signage, and waysides.

CONSULTATIONS

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Kevin Turner, Interpretive Operations Branch Chief, Sequoia & Kings Canyon National ParksErika Williams, Visual

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Cedar Drake, Lead Fire Effects Monitor, North Cascades National Park

Paul Hardwick, Information Resources Branch Chief, Sequoia & Kings Canyon National Parks

CULTURAL RESOURCES ASSESSMENT

OBJECTIVES

9. Consult with agency representatives to determine VARs within burn area perimeter.

10. Complete assessments of VARs to evaluate for fire-related concerns.

11. Prescribe ES specifications to avoid or mitigate adverse impacts to cultural resources within and adjacent to the burn area perimeter.

12. Identify if prescribed ES treatments for other BAER disciplines could impact cultural VARs.

13. Meet the requirements of all federal and legal mandates including Section 106 of theNHPA and consultation with American Indian Tribes.

ISSUES

14. Cultural VARs within the KNP Complex perimeter on NPS SEKI lands were directly affected or threatened by the fire, including 92 archaeological sites, 20 ethnographic resources, eight historic structures, and five cultural landscapes and historic districts. Ten of these cultural resources are NRHP eligible.

15. Cultural resources adjacent to and downstream of the burn area are also vulnerable topost-fire conditions. An additional 21 cultural resources are located within a 100 m buffer of the KNP Complex perimeter.

16. Identified concerns include erosion, flooding, hazard trees, increased site exposure, looting and vandalism, fire-related debris and HAZMAT, increased visitation, and public safety.

17. Direct fire impacts and post-fire conditions pose risks to the stability of cultural resources and have the potential to threaten life and safety.

BACKGROUND

This assessment describes the impact of the KNP Complex on known cultural resource VARslocated on NPS SEKI lands. The NPS divides cultural resources into five categories: historic structures, cultural landscapes, archaeological resources, ethnographic resources, and museum objects. Cultural VARs identified during the KNP Complex BAER assessment were divided into the same categories.

Historic structures are constructed works consciously created to serve human activity that retain integrity and exhibit historical, architectural, or engineering significance. Historic structures at SEKI include buildings, structures, roads, stairs, and other features. Many reflect

early Park development and are considered examples of NPS Rustic Style. Other structures arerepresentative of vernacular use of the park or mid-century administrative developments.

Cultural landscapes are intertwined patterns of things both natural and constructed, human- modified ecosystems, and constructed works (prehistoric and historic) that have significance in American history and authenticity to a specific time period. They include both cultural and natural resources associated with a historic event, activity, or person, or exhibit other cultural or aesthetic values. For example, the Generals Highway, constructed between 1922 and 1935, is a cultural landscape significant for its association with transportation, recreation, and social history. The Mineral King Road, with a period of significance ranging between 1915 and 1942, issignificant for its association with the work of the Civilian Conservation Core and the overall architectural design.

Archaeological resources consist of the physical evidence of past human activity that are generally managed as spatially discrete archaeological sites. Numerous archaeological surveyshave been completed with SEKI, which are documented within the NPS CRIS database and in Park-specific databases. Prehistoric sites are associated with precontact Native American occupations in the Park. Historic period sites are often associated with transportation, homesteading, Park management and infrastructure development, and industries including mining, logging, and tourism.

Ethnographic resources are the cultural and natural features of a park that are of significance totraditionally associated peoples. These peoples are the contemporary park neighbors or occupational communities that have been associated with a park for two or more generations, and whose interests in the park's resources began prior to the park's establishment. Examples include Native Americans, Inuit, Native Hawaiians, African Americans, Euro-Americans, farmers,ranchers, and fishermen.

Museum objects are collected records of events and ideas from human experience and naturalhistory. They are evidence of technical development and scientific observation, of personal expression and curiosity about the past, of common enterprise, and daily habits. Museum objects range from specimen collection to fragments of prehistoric objects to film and field notes.

RECONNAISSANCE METHODS

The BAER Cultural Specialists completed field assessments of known VARs potentially affected by the KNP Complex from October 21-24, 26-28, and 30, 2021. BIA Archaeologist Dan Hall and NPS Archaeologists Caitlin Holloway and Weston Bacon-Schulte completed archaeological assessments and NPS Historical Architects John Olson and Elle Farias completed historic structure and cultural landscape assessments. The team examined fire incident and SEKI cultural resources data to identify VARs within and adjacent to the KNP Complex perimeter withthe greatest likelihood of being impacted by the fire.

The team consulted with SEKI Cultural Resource Program Manager Juanita Bonnifield and theKNP Complex Lead READ Garret Dickman to determine accessibility to VARs within the burn area. All accessible historic structures and cultural landscapes within the fire perimeter were assessed. The team considered the importance to affiliated Tribes, potential for fire-related threats, and accessibility when selecting archaeological sites for field assessments. Although NRHP listed resources were given the highest priority for field assessments, most sites within SEKI boundaries have been determined eligible with California SHPO concurrence. All archaeological sites within the burn area should be assessed for post-fire impacts.

Due to limited accessibility and time constraints, only six historic structures, one historic district, and 21 archaeological sites were assessed in the field. Field documentation included notes, photographs, and geospatial data collection with ESRI Collector. At archaeological sites, burn severity and fire-related impacts such as hazard trees, stump and root holes, erosion, andexposure were noted. Sensitive data and field photos were not synced to the BAER AGOL map and were manually downloaded offline and retained on a secure network for SEKI Park use.

Geospatial analysis was completed by the BAER GIS Team to compare archaeological sites located with the fire perimeter against ranked burn severity data derived from the RAVG and BARC datasets. Sites within the burn perimeter were also considered in relation to debris flow estimates modeled for likely weather events (15 min at 20 mm/hr). These datasets can be usedas a proxy for potential above and below ground disturbance for cultural resources within the burn area perimeter. Last, sites were assessed for proximity to established roads (within 50 m) and trails (within 100 m) to consider potential risk for looting, vandalism, and informal social trail development due to increased site exposure.

FINDINGS

Historic Structures

1. Redwood Mountain Ranger Station and Equipment Storage Garage

The Redwood Mountain Ranger Station and its Garage/Equipment Shed are in the Redwood Mountain Grove along the Redwood Mountain Road south of the General's Highway. The structures were built in 1940 in the rustic style with a concrete foundation covered in an ashlar cut rock wall veneer. The Ranger Station had a vertical board and batten wood upper story, a horizontal wood clapboard covered walk-out basement level, and a wood shingled gable roof. The Garage/Equipment Shed shares a similar construction type and style. While the Garage/Equipment Shed sustained no burn or suppression damage, all wooden elements of theRanger Station were destroyed by fire.

Ranger Station – All that remains of the two-story primary Ranger Station are the foundation masonry walls and two masonry chimneys, along with miscellaneous metal wall lath and kitchen/bathroom plumbing. The condition of the masonry stones and mortar appears scorched on the exterior and deteriorated along the wall tops. *(See Photos 1 & 2)* Abrick constructed chimney with an ashlar stone veneer above roofline is located near the kitchen area. It is intact with only a very slight lean to the south. The primary ashlar stone

chimney at the living room is also intact and has rubble stone and rough mortar exposed midway where the frame structure once protected the exterior. The concrete hearthstoneat the fireplace base now cantilevers over the basement void. Each chimney is 20 feet or more in height.

Photo 1 Redwood Mountain Ranger Station masonry remnants. View looking west.

There is a substantial amount of burned debris within and around the structure. The contents and hazardous nature of this debris are unknown at this time, but it is assumed that in addition to burned construction materials (nails, glass, plaster, plumbing, etc.) there is known to have been lead paint and likely asbestos-containing plumbing wrap and possiblyflooring or ceiling tile. These elements are indicated as hazardous for human contact, especially after exposure to fire.

Photo 2 Redwood Mountain Ranger Station masonry remnants. View looking northeast.

A wood hose box for fire protection is located near the entrance walk to the Ranger Station and displayed only surface fire damage. A propane tank on the site between the Ranger Station and Garage/Equipment Shed shows severe burn marks on its exterior and is in directproximity to a burned tree stump. The smell of propane near the tank was noted while theBAER team was on site. *(See Photo 3)*

Photo 3 Redwood Mountain Ranger Station propane tank. View looking southeast.

Garage Storage Garage – The Garage structure is located immediately downslope to the southwest from the primary Ranger Station. No fire or suppression damage is apparent on thestructure and only a single charred piece of tree bark is visible on its wood shingled roof. *(See*

Photo 4) The fire appears to have jumped over and around the garage, but possibly due to expanded boundary areas on three sides without direct tree or foliage exposure the garagesurvived with no visible damage.

Photo 4 Redwood Mountain Garage/Equipment Shed. View looking west.

2. Barton's Log/Crose's Cabin

A downed Sequoia log along Redwood Canyon Hart Tree trail had been used by John S. Crose asa shelter for supplies and equipment as early as the 1890s. This log was later converted to a cabin structure by members of the Barton family in the 1920s. The cabin featured a fireplace at one end and an elevated platform on the other. Shingle construction filled voids in the log asidefrom at least two framed windows and a single door entry.

The entire structure was lost as a direct result of fire except for one short rock wall at the mid- point of the footprint where the interior had been elevated, and a crumbling granite wall at thesouthwest end used as both an end wall and fireplace. The hollowed log/cabin was wrapped inits entirety with structure wrap to resist effects from heat and fire once wildfire spread was indicated for the Redwood Mountain Grove area. Remnants of the structure wrap are found within and around the footprint of the cabin. Very little other construction debris is evident. *(See Photo 5)*

Photo 5 Barton's Log/Crose's Cabin remains. View looking north.

3. Moro Rock Comfort Station

The Moro Rock Comfort Station is located along Moro Rock Loop Road south of Crescent Meadow Road in the Giant Forest Grove area. It was built in 1934 and is associated with the nearby Moro Rock Staircase which is listed in the National Register of Historic Places. The comfort station was designed in the rustic style with a rounded boulder foundation on three exposed downslope sides, a concrete foundation for two interior walls and the upslope retaining wall, and a wood log frame construction above grade with sawed shingle siding and wood shingled gable roof.

The Moro Rock Comfort Station was consumed by fire leaving only its masonry foundation. Construction debris is found both within its footprint and immediately adjacent to the masonryremains. Debris present includes remnants of the log wall framing, plumbing, metal sinks and receptacles, porcelain toilets, and structure wrap remains (which was applied to the exterior prior to the fire's approach). While the exact contents of the debris are not entirely known, thethreat of hazardous materials is thought to be lower based on the known use and general makeup of the simple structure. The comfort station site was within an area of high burn severity and hazard trees were identified within immediate proximity. It is also noted that theapproach to the existing foundation has been compromised with retaining wall failure both above and below the main comfort station walkway. *(See Photo 6)*

Photo 6 Moro Rock Comfort Station remains. View looking west.

4. Lilburn Cabin

The Lilburn Cabin is a one room cabin located along the Redwood Saddle Trail to Redwood Creek Trail. Its construction is documented as being completed in the 1920s when the area was used for both logging and mining. The cabin is known to consist of dimensional wood construction on stone piers with shingle siding and roof. The RAVG map showed the Lilburn Cabin in an area of moderate to high severity burn. If fire damaged or consumed the cabin, a 12' high, rounded granite constructed chimney may be a surviving resource. Because of fire conditions and the cabin's distance from an established road, the BAER team was unable to confirm the condition of the cabin or make any further assessment. *(See Photo 7)*

Photo 7 Historic Photo of Lilburn Research Cabin. It was rehabilitated in 1980.

5. Lost Grove Comfort Station

The Lost Grove Comfort Station is a timber framed building built in 1936 with two main roomsfor men's and women's lavatories and two additional support spaces totaling approximately 320 square feet. It is located just south of the road along Generals Highway in the Lost Grove area of Sequoia National Park near the boundary with Sequoia National Forest. The comfort station is built in the NPS Rustic style with a gabled wood shingle roof, exposed log rafters, gable brackets, and Sequoia bark covering the areas between exposed square timbers. An ashlar cut stone veneer covers the concrete foundation as a threshold on three sides and is exposed for several feet on the south side. *(See Photo 8)*

Burn activity was evident downslope of the Lost Grove Comfort Station, but no direct fire or suppression damage was visible to the structure or the immediate surrounding area. Hazard trees will be examined in the area to gauge whether any are a threat for the building. Evidence of structure wrap is indicated on the exterior due to the presence of many staples still lodged inthe bark and in the timber framing. An electrical box has been overturned on the southeast corner but doesn't appear to be fire related.

Photo 8 Lost Grove Comfort Station. View looking upslope, east.

6. Cabin Creek Ranger Station and Dormitory

The Cabin Creek Ranger Station and Dormitory were listed in the National Register on April 27, 1978. They are excellent examples of the NPS Rustic Style and were both built over the summers of 1934 & 1935 by CCC crews. They are located directly in line to the west of Cabin Creek just north of the Generals Highway at mile marker 31. Both are completed in the NPS Rustic style with wood timber framing, horizontal tongue and groove siding, vertical tongue andgroove siding at the gables, wood shingle roofs with gable brackets, and a concrete foundation veneered with cut granite. Each building is approximately 34'x21' and configured in a similar exterior fashion, except for two garage doors on the Dormitory in the same location as the main entrance on the Ranger Station.

The properties were threatened by the fire from the west and south and a fire break was created to help protect the structures and surrounding property. The site currently does not show any signs of fire damage and it appears that fire did not cross the Generals Highway fromthe south. Trees are in direct contact with the Dormitory and there is branch damage to an eave section of the Ranger Station, but these conditions were not caused by the fire or any fireactivity. *(See Photos 9 & 10)*

Photo 9 Cabin Creek Ranger Station. View looking northwest.

Photo 10 Cabin Creek Dormitory. View looking southwest.

1. Colony Mill Ranger Station

The Colony Mill Ranger Station was constructed in 1927 along the Colony Mill Road. The RAVG map showed the Ranger in an area of moderate to high severity burn. If fire damaged

or consumed the structure, the chimney may be a surviving element. Because of fire conditions and the cabin's distance from an established road, the BAER team was unable toconfirm the condition of the structure or make any further assessment.

2. Historic Sequoia National Park Entrance Signs

Sequoia National Park North Entrance Sign – The Sequoia North Entrance Sign was constructed in the 1930s during the CCC era. It is the most iconic sign located in Sequoia National Park and is an important feature of the Generals Highway Cultural Landscape at the border of Sequoia National Forest along the Generals Highway. The sign was located within the fire perimeter and evidence of fire activity can be found within 40' of the sign. The sign is not painted and shows weather effects due to age and exposure, but there is no specific evidence of fire or suppression effects on the surface or at its base. Hazard trees arein proximity to the sign to the west and will need to be addressed to reduce further threats to the sign's integrity. *(See Photo 11)*

Photo 11 Sequoia National Park North Entrance Sign. View looking south.

Historic Districts and Cultural Landscapes

1. Generals Highway Historic District

The Generals Highway is the major artery through Sequoia National Park and into Kings Canyon National Park along the western slope of the Sierra Nevada. It extends approximately 32 miles and is a feat of engineering and a scenic highway that contains many distinctive rustics masonryelements built by the CCC. The Generals Highway Historic District is significant under Criteria A and C in the areas of Transportation, Entertainment/Recreation, Engineering, Landscape Architecture, and Social History. The period of significance for the Generals Highway Historic District is 1921-1935. Without a historic landscape architect, the BAER team was unable confirm the condition of many features of the Generals Highway Historic District. It contains a

variety of contributing features including the road itself, masonry walls, signs, retaining walls,culverts.

Photo 12 Generals Highway Historic District. View looking down from helicopter.

2. Mineral King Cultural Landscape District

The Mineral King Road Cultural Landscape District is locally significant under Criterion A for its association with developments which marked nationally administered recreation programs on federal lands in the American West. The Mineral King Road itself is additionally eligible under Criterion A for its 1930s association with CCC projects. The three cabin tracts and the historic structures owned by the Park Service are eligible for listing under Criterion C for their architecture, design, and general integrity as recognizable examples of a class of buildings builtin the rustic vernacular style. The period of significance for the district is 1915-1942, and it waslisted in the National Register in 2003. It contains a variety of contributing features including the road itself, buildings, structures, retaining walls, historic water troughs, turn outs, culverts,and rock cuts.

Due to post-fire erosion conditions, the Mineral King Road was impassible, and helicopter reconnaissance indicated there were several mudslides impacting the roads. The debris flow model generated for the incident showed many areas of the road that are predicted to continue to see debris flow. Without a historic landscape architect, the BAER team was unableconfirm the condition of many features of the Mineral King Road Historic District.

Photo 13 Mineral King Road. View looking northwest from helicopter.

3. Giant Forest Village/Camp Kaweah Historic District

Giant Forest Ranger Residence and Beetle Rock Building – The Giant Forest Village/Camp Kaweah Historic District in Sequoia National Park was entered in the National Register of Historic Places on May 22, 1978. Development of visitor accommodations within the Giant Forest area of Sequoia National Park dates from about 1914. The first sketches and plans forthe District Ranger's Residence in the Giant Forest were prepared in March 1930 by Merel S.Sager, a NPS landscape architect. It was completed in 1931. Camp Kaweah was created in 1926 and opened in 1927 after the opening of the Generals Highway in 1926. The design for the Beetle Rock Building (Assembly Hall) was created as an addition to the camp and was built in 1940. Due to the removal of the bulk of Camp Kaweah development from the Park in the 1990s, the Beetle Rock Building is the last remaining structure from the development. It is now used as a meeting space and for events by the Sequoia Parks Conservancy. *(See Photo 15)*

Observed fire activity near both the Giant Forest Ranger Residence and Beetle Rock Buildingis thought to be the results of a backburn closest to the development of the Giant Forest area. This backburn was completed to reduce the vegetation immediately in proximity to threatened resources. The effort to protect the Giant Forest Village/Camp Kaweah Historic District with a backburn was successful, as no buildings within the district show signs of either fire or suppression effects. Hazard trees could be in the area of both the Giant Forest Ranger Residence and Beetle Rock Building, either as a result of the backburn or wildfire.

Photo 14 Beetle Rock Building (Assembly Hall). View looking west.

4. Crystal Cave Historic District

The Crystal Cave Historic District is located in the Crystal Cave area west of the Giant Forest Grove. A trail originally built by the CCC between 1938 and 1941 facilitates the popular tours offered by the park in summer. The period of significance is 1933 to 1965. The contributing features of the Crystal Cave Historic District include the Crystal Cave Road, the Crystal Cave Parking Area, Comfort Station, Access Trail, and Interior Trail. Because of fire conditions and theimpassable road hazards, the BAER team was unable to confirm the condition of the Crystal Cave Historic District or make any further assessments.

Photo 15 Crystal Cave Trail

5. Colony Mill Road

The Colony Mill Road was partially constructed by the Kaweah Colony, a utopian group who sought to claim the land and create a logging cooperative. The portion of the road closest to theGiant Forest was completed by the Buffalo Soldiers in 1903. This road was previously known as the Giant Forest Road. Due to fire conditions and the impassable road conditions, the BAER team was unable to confirm the condition of any of the Colony Mill Road features or make any further assessments.

Photo 16 Historic Photo of Capt. Charles Young of Buffalo Soldiers with crew upon completion ofroad into Giant Forest. Colony Mill Road was called Giant Forest Road.

Archaeological Resources

Roughly 22% of the KNP Complex fire footprint on SEKI lands has been surveyed for cultural resources and 92 known sites fall within the fire perimeter *(Table 1)*. An additional 21 known sites were identified within a 100-meter buffer of the burn area perimeter, which is significant when considering indirect fire-related impacts on cultural resources through processes such asflooding and erosion. Of the sites that fall within or adjacent to the burn area, three are NR listed, including (CA-TUL-0024), (CA-TUL-1227), and (CA-TUL-0084).

Table 1. KNP Complex burn area total in SEKI boundary and archaeological survey coverage (fireacreages calculated October 29, 2021).

AREA	Acres Total	Survey Coverage (Acres)	Percent Survey Coverage	Known Sites
SEKI	865,509	39,517	4.6%	850*
SEKI KNP Complex Burn Area	78,675	17,420	22.1%	92

*2021 field data not yet included in SEKI database, current estimate for total number of known sites.

Evaluation of Fire-Related Impacts on Archaeological Resources

Archaeological sites contain artifacts, features, and deposits that can be damaged during and after wildfires (Ryan et al. 2012). Data potential is lost when elements and characteristics of cultural resources are damaged, which is significant when evaluating a site's integrity and eligibility for the NRHP. Documentation of the loss is often the extent of treatment options fordamaged and destroyed sites.

During five days of BAER field assessments, six historic sites and 15 precontact sites were visitedwithin the burn area. Fire-related impacts and threats at archaeological sites were directly related to burn severity. In general, burn severity data can be used as a proxy for considering potential impact to subsurface and above ground archaeological components *(Tables 2 and 3)*.

Table 2. Archaeological sites within KNP Complex burn area perimeter by Burn Area Reflectance Classification (BARC) corrected with soil burn severity data – assessed sites (unassessed sites).

SOIL BURN SEVERITY	PRECONTACT	HISTORIC	MULTI-COMPONENT	TOTAL
Unburned	8 (4)	0 (5)	1 (0)	**9 (9)**
Low	3 (24)	5 (22)	0 (4)	**7 (50)**
Moderate	2 (3)	2 (9)	0 (0)	**4 (12)**
High	0 (0)	0 (0)	0 (0)	**0 (0)**
TOTAL	**13 (31)**	**7 (36)**	**1 (4)**	**21 (71)**

Table 3. Archaeological sites within KNP Complex burn area perimeter by Rapid Assessment ofVegetation Condition (RAVG) ranking –assessed sites (unassessed sites).

VEGETATION CONDITION	PRECONTACT	HISTORIC	MULTI-COMPONENT	TOTAL

Unburned	6 (2)	0 (12)	0 (4)	**6 (18)**
Low	5 (13)	3 (18)	1 (0)	**9 (31)**
Moderate	2 (11)	2 (5)	0 (0)	**4 (16)**
High	1 (4)	1 (2)	0 (0)	**2 (6)**
TOTAL	**14 (30)**	**6 (37)**	**1 (4)**	**21 (71)**

Direct fire effects and post-fire concerns were noted at the 21 archaeological sites assessedduring BAER fieldwork *(Table 4)*.

Direct Artifact or Feature Damage: Impacts were noted at seven assessed sites and included sooting on artifacts, spalling on rocks, melted glass, partial or total burn of organic artifacts andfeatures. Wooden components at historic period sites, such as (CA-TUL-2228H), were damaged or destroyed even in areas of low burn severity.

No treatments are proposed for direct artifact or feature damage noted at assessed archaeological sites within the burn area perimeter. Unassessed sites may require emergencystabilization treatments.

Hazard Trees: Wildfires often leave burned snags on the landscape that have lost structural integrity and are in danger of falling or losing large limbs. Fire-killed trees will eventually fall andmay damage above-ground cultural features. Up-turned stumps and roots can disturb subsurface archaeological components. Sites in moderate to high burn areas have high potential for fire-killed trees with potential to damage archaeological sites or historic features.

One hazard tree that will require removal *(ES-1; Photo 18)* was identified at an assessed historicsite, (CA-TUL-2235H). Unassessed sites may require hazard tree removal to prevent damage.

Erosion: Archaeological resources may be subject to increased post-fire run-off, sheetwash, anddirect rainfall. Sites located in moderate to high burn severity areas, below steep slopes, adjacent to drainages, and those that have lost protective surface vegetation coverage are at high risk of erosion. Burned out stump holes and tree roots can also channel water during spring snow melt and heavy precipitation events. Based on the most likely debris flow model (15 min at 20 mm/hr), most archaeological sites in the burn area (n=76) fall within areas of low probability (0-20%) for predicted debris flow.

Table 4. Summary of fire-related issues and concerns observed at assessed archaeological sites(n=21).

ISSUE/CONCERN	PRECONTACT	HISTORIC	MULTI-COMPONENT	TOTAL
Direct Artifact or Feature Damage	1	5	1	**7**
Fire-Weakened Trees	0	1	0	**1**
Erosion Potential	7	5	1	**13**
Increased Site Exposure	6	5	1	**12**
Vandalism & Looting	2	0	1	**3**

Photo 18. Example of a hazard tree hanging over a historic stone fireplace feature at (CA-TUL-2235H). If the tree is still standing after reassessment in FY22, then it should be removed to prevent potential damage to the feature and surrounding artifacts.

Two assessed historic sites, (CA-TUL-2228H) and (CA-TUL-2235H), were flagged for erosion concerns and will require reassessment in FY22 to determine if emergency stabilization is needed *(ES-10)*. At (CA-TUL-2235H), a drainage partially dammed with fire-related debris could back up and overflow on historic artifact scatters and features downslope. At (CA-TUL-2228H), the fire killed protective surface vegetation, exposing a historic structural featurethat could be impacted by severe erosion. Unassessed sites may also require stabilization treatments to prevent further damage caused by post-fire erosion.

Increased Site Exposure, Vandalism, and Looting: Vegetation loss in burn areas can expose artifacts and features that were obscured prior to the fire. Areas of moderate to high burnseverity generally exhibit total loss of protective ground vegetation coverage, while areas oflow burn severity exhibit partial to total loss. Site exposure can lead to increased visitation, informal social trail development, vandalism, and looting.

Sites adjacent to roads and established trails are at the greatest risk for these threats, particularly those with highly visible features (such as rock art and stone) and artifacts (such as glass bottles and complete lithic tools). Of the sites that fall within the burn area perimeter, 25are located within 50 m of established roads and 38 are found within 100 m of established trails

(Table 5). These sites are at greater risk for these threats and will be addressed through *ES-5*

and *ES-9*.

Table 5. Proximity of archaeological sites to established roads and trails within the KNP Complexfire perimeter.

Area	Number of Sites
Roads (within 50 m)	25
Trails (within 100 m)	38

Twelve sites visited during BAER assessments exhibited exposure following vegetation burn thatwill likely result in erosion and increased public use *(Photo 19)*. Three sites were noted for high risk of vandalism and looting, particularly the sites at (CA-TUL-0024), Potwisha (CA-TUL-0028), and (CA-TUL-0084/H). Unassessed sites may also have concerns relating to increased exposure, vandalism, and looting.

Photo 19. Example of exposed historic artifacts eroding downslope in burn area at CA-TUL-3183H. BAER Archaeologist Weston Bacon-Schulte pictured.

Ethnographic Resources

During the KNP Complex, SEKI Cultural Resource staff and incident-assigned ARCHs and READs consulted with Tribal Liaisons to identify traditionally significant areas of concern withinthe burn area perimeter (Charley 2021). Areas of traditional cultural significance often overlap with archaeological site locations, some of which were identified by ARCHs and READs during initial suppression response and suppression repair (Forrestel et al. 2021).

Approximately 20 areas of cultural significance were documented within or adjacent to the KNPComplex burn area perimeter, including four pictograph sites and surrounding areas. Additional archaeological sites were found associated with traditionally significant areas around Mineral King Road, Shepherd

Saddle, Wuksachi Lodge, Dorst Campground, Giant Forest, and Burnt Point Creek. Other areas noted as culturally significant include Marble Falls, Crystal Cave, Hidden Springs, and Big Spring.

Traditional cultural sites impacted by the KNP Complex are at high risk for post-fire impacts including erosion, vandalism, looting, and indirect damage such as social trail development due to increased exposure *(Photo 20).*

Photo 20. Example of significant cultural and archaeological site near (CA-TUL-0028) within the KNP Complex perimeter in SEKI. Portions of the site burned, but theareas around the pictograph and bedrock mortar features at the site were not directly damaged.

Museum Collections

The Park's museum collections are stored in the Ash Mountain Headquarters building, which islocated on the fire perimeter. As the KNP Complex fire perimeter extended to Ash Mountain and the power was cut off, the climate-controlled conditions protecting the nitrate film collection were compromised. The film collection is likely damaged and degraded as a result.

A serious health, safety, and fire risk to the entire museum collections at Sequoia and Kings Canyon National Parks likely exists due to the degradation of the nitrate film. It is highly flammable (can self-ignite at ambient temperatures around 100 degrees F) and cannot be extinguished once ignited. Quantities of nitrate film in excess of 25 pounds are subject to storage and handling standards prescribed by the National Fire Protection Association (NFPA 40). Nitrate film is required to be kept at a temperature below 70-degrees F. The film degrades

when exposed to higher temperatures. It is necessary to isolate nitrate film from other collection items because nitrate film can emit gases that are harmful to humans and to other collection items. The Park did not have the capacity or facilities to complete these assessments internally. It was not possible during the initial BAER planning and assessment process to assessthe 20-cubic feet of nitrate film in the park museum collections because specific expertise was needed and because of the time constraints.

RECOMMENDATIONS

Four (4) specifications – ES-9 through ES-12 – are prescribed to address post-fire culturalresource issues. No BAR specifications are prescribed.

Specifications

ES-9 Cultural Protection and Stabilization:

Redwood Mountain Ranger Station

Site observations concluded that the area has the potential to cause harm either via direct or indirect contact with hazardous debris (primarily within the building footprint, but also in the immediate vicinity), falls into the now-exposed basement area, and proximity to the newly unsupported chimney stacks. In addition, a badly burned propane tank is immediately adjacentto the building and was emitting gas odors at the time of assessment.

Temporary fencing is recommended around the perimeter of the building to ensure protectionagainst inadvertent trespass and injuries. The fencing should encompass all areas of debris andbuffer approximately 4' at minimum beyond the foundation wall. Extensions of the fence should also encompass the remains of the entrance stairs east of the building and the propane tank to the west. While the condition of both chimney stacks appears stable, special consideration should be made to extending the fence perimeter to include a possible catastrophic collapse of either chimney stack. This will mean a buffer of up to 20' to the north to accommodate the living room stone chimney and 20' to the west to accommodate the kitchen brick chimney. It is recommended that signage downslope of the building footprint facing the road should be installed to warn of the danger above due to hazardous conditions.

This specification recommends the use of a heavy duty, UV-resistant tarp material to cover the debris until such time as cleanup can commence. The tarp material should cover all debris within the footprint of the Ranger Station and lap up the interior of the foundation walls 4"-8" to reduce debris loss due to water or wind. The tarp can be attached to the interior of the concrete foundation through the perimeter grommets utilizing masonry screws or anchors withwashers, preferably at mortar joints, to ensure tarps are secured on site. Weep holes may be provided at the downslope foundation door opening(s) to allow for water to exit the building footprint without disturbing debris below. Wattling, preferably with coir construction, can be used to shield the downslope section of the site if contaminated runoff is a concern.

Cleanup of the site should follow the recommendations and guidance as relayed by the California Environmental Protection Agency for Emergency Removal of Debris, Waste, and Hazardous Material. A link to a helpful reference document is: Guidance for Conducting Emergency Debris, Waste and Hazardous Material Removal. All masonry foundation elements should remain intact at the site during cleanup, including the remaining masonry chimney stacks, until such time as cultural site documentation can be completed. If there is detection ofsignificant movement to the chimney stacks during the winter or the following season, this should be directly followed by consultation with a structural engineer to specify emergency removal of the chimney elements to a safe height at 4' or below or lateral bracing to the existing height and a follow-up, on-site assessment. (See non-funded recommendations for further information regarding removal or stabilization of remaining masonry elements.) Effortsshould be made to safely cap and remove the damaged propane tank.

Redwood Mountain Garage/Equipment Shed

Observations of this structure indicate that no visible damage is evident as a result of the fire orsuppression activity. It is recommended to maintain or increase the defensible space between the building and nearby vegetation and coordinate with hazard tree removal to remove examples in immediate proximity which pose a risk to the building's integrity.

Barton's Log/Crose's Cabin

It is recommended to clean up site debris immediately. Site debris consists primarily of structure wrap applied to the exterior of the building to protect the resource from fire effects. Because the structure was consumed by fire and the known building components were primarily wood, very little other material is present except for two prominent masonry elements; the collapsed granite end cap and fireplace and a short support wall for a raised floorlevel within the cabin. Care should be taken when removing the structure wrap debris so as not to disturb these masonry elements until a cultural site documentation can be completed.

Existing signage should be removed from the trailside of the site to help reduce curiosity and possible site disturbance via vandalism or theft. Park presence should be increased in the areato monitor the site periodically through in-person patrols.

Moro Rock Comfort Station

Moro Rock Comfort Station was lost down to the rounded granite wall and concrete foundationwith debris both within and around the foundation footprint. It is understood that tarp materialhas since been applied by Park staff to protect against the scattering of debris. While the contents of the comfort station are not thought to contain multiple hazardous materials, lead may be present in plumbing material and paint material and so guidance for lead cleanup should be followed: Guidance for Conducting Emergency Debris, Waste and Hazardous MaterialRemoval.

Temporary fencing should be installed around the perimeter. The fencing should encompass allareas of debris and buffer approximately 4' at minimum beyond the foundation wall. An additional short fence section should be installed at the entrance to the comfort station walkway from the parking area above with signage indicating the dangerous nature of the path

due to fire effects on its surface and to the retaining walls both above and below. Coordinationshould be done with hazard tree removal to remove burned trees in immediate proximity which pose a risk to the integrity of the remaining foundation wall.

Quail Flat Archaeology Site (CA-TUL-0084)

Protective vegetation was lost during the fire at the NPS portion of the Quail Flat archaeology site (CA-TUL-0084) south of the Generals Highway. Multiple precontact cultural features and historic artifact scatters are visible within the burn area. Due to increased exposure, the site isat greater risk for erosion, vandalism, and looting.

To comply with the Archaeological Resources Protection Act (ARPA), we recommend that two signs indicating "area closed for vegetation stabilization" be placed along south portion of the road leading to the archaeology site. The area of proposed closure leads south from a small pull-out at the junction of the Generals Highway and the Redwood Mountain Road, adjacent tothe Quail Flat pull-out on Forest Service land on the north side of the highway.

ES-10 Cultural Resource Assessments: BAER Cultural Specialists were unable to assess all cultural VARs within the KNP Complex fire perimeter on NPS SEKI lands due to time limitations,personnel capacity, and site inaccessibility. An additional 71 archaeological sites, two historic structures, and four cultural landscapes and historic districts require assessment to identify potential fire-related impacts as well as emergency stabilization needs. The SEKI Cultural Resources Team does not have the capacity to complete the remaining cultural resource assessments internally, so the work will be contracted through a CRM firm. The work will take an estimated 10-14 days for a five-person crew. Each discipline lead (Archaeologist, Cultural Landscape Architect, and Historic Architect / Architectural Historian) will meet or exceed the Secretary of the Interior's Standards for Archaeology and Historic Preservation (GS-11 equivalency). Mitigations will be recommended for sites by respective discipline leads in a final deliverable that will include a report and any accompanying field notes, photographs, and documentation.

ES-11 Museum Collection Assessment: We recommend that the SEKI nitrate film collection beassessed for damage, which resulted in the removal of the film from climate-controlled conditions. It was not possible during the initial BAER planning and assessment process to assess the nitrate film because specific expertise is needed. This collection will need to be transported to an equipped research facility or laboratory where this film can be examined and assessed for damage from degradation. Once the SEKI nitrate film collection has been assessed,the film which has been degraded to the extent that it poses a risk to life, health, and safety should be removed from the collection. The nitrate film should be stabilized by removing it to a specialized storage facility for nitrate film away from the rest of the SEKI museum collections.

Properly storing and separating the nitrate film from the rest of the SEKI museum collections will remove the fire risk to the museum collections. These actions will result in avoiding furtheradverse effects from KNP Fire impacts. It is necessary to isolate nitrate film from other collection items because nitrate film can emit gases that are harmful to humans and to other collection items.

ES-12 NHPA Compliance and Consultation: Many of the BAER Emergency Stabilization (ES) specifications include actions that would be considered undertakings under the National Historic Preservation Act (NHPA). We recommended that a Compliance Archaeologist I (GS-09-10) and a Cultural Liaison (GS-07-10) be hired to assist Park Staff in NHPA Section 106 Compliance and Consultation for all KNP BAER undertakings as a part of post-fire ES actions.

Some examples of the types of ES actions involved in the KNP BAER plan include re-vegetation efforts, road stabilization actions, culvert maintenance, repair of fencing, replacement of fencing, replacement of signage, and trail stabilization. In addition, approximately 20 ethnographic resources identified within and adjacent to the KNP Complex perimeter will require increased agency presence for resource protection and assessment by a Cultural Liaisonto evaluate for potential post-fire impacts, including erosion, vandalism and looting, and indirect damage such as social trail development due to increased exposure.

Non-Specification

1. **Permanent Masonry Stabilization Design & Implementation:** A management decision will need to be made whether to preserve the masonry remnants at Redwood MountainRanger Station and Moro Rock Comfort Station as ruins or to preemptively disassemble them. The former choice will require a long-term solution to stabilize and interpret the remains in a way that is safe for both visitation and maintenance. After stabilization, the exposed wall and chimney caps can be treated with a cementitious skim-coat layer to prevent gravity-fed moisture intrusion into the walls from rain or snow melt. Moisture retention can lead to freeze-thaw damage of the masonry units and ultimately lead to collapse of the walls and chimneys. Ruin stabilization expertise should be sought to design and implement this stabilization project.

2. **Continued Historic Structure Wildfire Fortification Efforts:** Evidence from several sites (e.g., Lost Grove Comfort Station, Beetle Rock Building, Cabin Creek Ranger Station and Dormitory) suggests that past fuels reduction and preemptive wildland fire mitigation efforts around historic structures have been overwhelmingly successful given the burn intensity near these areas. However, in the case of Redwood Mountain Ranger Station, the efficacy of these measures may have been compromised by connected propane lines within the defensible space perimeter. Creeping or smoldering fire can quickly transition from the burn perimeter to standing structures if preventive measures aren't employed to safely disconnect or mitigate these fuel connections. Additionally, previousfield observations by the BACS team suggest that wooden roofs (e.g., shakes, wooden shingles) pre-treated with fire retardant are much more likely to survive close contact with fire. Such treatments should be emphasized and continued moving forward as part of cyclical maintenance in accordance with manufacturer specifications.

3. **NPS CRIS Records Updates:** We recommend that the NPS CRIS database be updated with post-fire condition assessments for archaeological sites, historic structures, and ethnographic resources. If documented cultural resources on SEKI lands are not

currently listed in the CRIS database, then they should be entered to receive an internalSEKI number. Current condition assessments and complete records are necessary for management recommendations and when determining VARs during incidents such as wildfires.

4. **Section 110 NHPA Survey:** Many areas within the burn area are culturally significant andhave high potential for archaeological remains. Although increased site exposure due to burning of surface vegetation can lead to adverse effects such as erosion, looting, and vandalism, it also provides an opportunity to complete systematic survey to identify newly uncovered archaeological sites. We recommend that the SEKI Cultural Resources Program complete additional Section 110 NHPA survey within the burn area and in other high-potential areas within Park boundaries. Identification of cultural resources can contribute our understanding of past land use and can help streamline the compliance process when necessary undertakings occur (such as infrastructure repair associated with wildfire and geohazard response).

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