CHAPTER 3: AFFECTED ENVIRONMENT

The Affected Environment chapter describes the resources that could be affected as a result of implementation of any of the alternatives. These descriptions provide an account of baseline conditions of the resources, against which potential effects of the proposed actions are compared. The resource topics and their organization in this chapter correspond to the resource impact discussions in "Chapter 4: Environmental Consequences." Description of the general wilderness setting has been included to provide the background information necessary to understand the parks' resources and environmental setting.

The following resources/topics are included in this chapter: wilderness character; soils; water quality; vegetation (wetland and meadows, high-elevation long-lived tree species, alpine vegetation, plants of conservation concern, and nonnative species); wildlife (black bears, birds, and invertebrates); special-status species; cultural resources (historic structures and districts, cultural landscapes, and ethnographic resources and landscapes); socioeconomics; visitor use; and park operations.

WILDERNESS CHARACTER

INTRODUCTION TO WILDERNESS CHARACTER

Sequoia and Kings Canyon National Parks protect 865,964 acres of the central and southern Sierra Nevada, of which nearly 97% is designated or managed as wilderness. The Wilderness Act Section 2 (a) directs wilderness managing agencies to administer wilderness areas "for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness."

However, wilderness character is not specifically defined in the 1964 Wilderness Act, nor is its precise meaning made clear in the legislative history. Managers therefore, needed a framework for monitoring and preserving wilderness character as the act requires. Scholars, on behalf of wilderness-managing agencies, have looked to the definition of wilderness contained in Section 2 (c) of the Wilderness Act, examined the writings of the framers of the Wilderness Act, and developed a framework based on four qualities of wilderness character that unify all wilderness areas regardless of size, location, or any other feature (Landres et al. 2005; Landres et al. 2008). These four defining qualities of wilderness are 1) untrammeled, 2) natural, 3) undeveloped, and 4) having outstanding opportunities for solitude or a primitive and unconfined type of recreation.

The legislative and administrative direction and the conditions to be preserved in specific wilderness areas are established at the time of designation by Congress. Therefore, each wilderness is unique in terms of how the four qualities of wilderness character are expressed and managed. The legislative history of a wilderness may inform managers about why Congress designated that area and the special values or special features, purposes, and places within it (NPS 2014a). This uniqueness means that change in wilderness character must be understood in the context of the particular area and its history and legislative origins.

In 2012, the parks initiated a wilderness character assessment, using the four qualities of wilderness character as a framework. This assessment describes what is unique and special about this wilderness and examines the current state of the wilderness areas within the parks. The assessment narrative also identifies important scenic, cultural, educational, or other features that contribute significantly to and are unique to the parks' wilderness character, often referred to as the fifth or "other" quality of wilderness character (note the assessment did not detail the full extent of this quality). Information for the wilderness character assessment was derived from surveys, interviews, and a workshop with current and past employees of the parks who have extensive experience in the parks' wilderness. It also considered and incorporated public comments from scoping, wilderness visitor surveys and previous wilderness planning efforts. The following is summarized from the wilderness character assessment (Frenzel and Fauth 2014), unless otherwise noted.

UNTRAMMELED

The Wilderness Act states that wilderness is "an area where the earth and its community of life are untrammeled by man" and that "generally appears to have been affected primarily by the forces of nature." The uncommon but intentionally chosen word "untrammeled," often mistaken for "untrampled," describes something that is unconstrained, not limited or restricted. The untrammeled wilderness is one in which ecological systems and their biological and physical components are autonomous and free from human intervention. Human actions that restrict, manipulate, or control the natural world within wilderness degrade the untrammeled quality. The untrammeled quality is distinct from the natural quality. The former is negatively impacted by purposeful human manipulation of natural processes, whereas the latter can be positively or negatively affected by human actions that are purposeful or accidental. In many cases in managed wildernesses, actions that are taken to improve the natural quality through some form of ecological restoration degrade the untrammeled quality by intervening in natural processes.

Attributes of the Untrammeled Quality — Unbridled natural forces predominate in the parks' wilderness. Cases of human intervention affecting the untrammeled quality of wilderness are limited. While most of the physical features, flora, and fauna within wilderness are unimpeded by human intervention, the NPS does authorize manipulation of some natural processes. In general, management intervention in the parks' wilderness is undertaken to restore or preserve ecosystems in a natural, resilient, or sustainable state to support native biodiversity.

One form of trammeling in the parks is the removal of nonnative species from wilderness. This includes restoration of selected high-elevation aquatic ecosystems by removing introduced nonnative trout, which are aquatic predators that cause profound changes in food webs and threaten native species. The NPS also actively targets 19 introduced plant species for removal using combinations of hand pulling, tarping, and applying herbicides. Large-scale plant removal from wilderness has been focused on species that displace native plants in two mid- to low-elevation areas: the Roaring River and lower Kern River drainages.

Another type of trammeling occurs when there is intervention in the behavior or lives of native plants and animals. In the parks' wilderness, these include management of human/bear conflicts through hazing, and rarely, capturing or killing bears that pose unacceptable safety threats. The act of capturing, collaring, and tagging animals for research also diminishes the untrammeled quality of wilderness (the collar or tag diminishes the undeveloped quality). The most notable species in this regard are the federally endangered Sierra Nevada bighorn sheep, Sierra Nevada yellow-legged frog, and the northern distinct population segment of the mountain yellow-legged frog. Other scientific activities permitted in the parks that affect the untrammeled quality of wilderness include capturing animals to take blood or tissue samples, harvesting seeds, installation of enclosures, and relocating animals.

The untrammeled quality is also affected when areas of wilderness are restored. Wilderness rangers have obliterated and restored hundreds of campsites in order to direct use away from sensitive areas and to reduce and concentrate the signs of human occupation. Park trail crews restore braided trails and trails through meadows. Large projects to reroute trails and restore meadows have recently been completed at

Taboose Pass, Bubbs Creek, and Cloud Canyon. The NPS has also stabilized eroding meadows heavily impacted by historical grazing by cattle and sheep in the Roaring River area and other locations.

Interference in natural energy flows and disturbance processes is also a trammeling of wilderness. In the East Fork Kaweah watershed, there are four dams in 112 acres of designated potential wilderness additions. The dams regulate water flow for downstream hydroelectric generation.

The most widespread interference in disturbance processes within the parks is the management of fire. Periodic fire ignited by lightning and Native Americans was historically an important agent that structured vegetation and played an important role in the reproduction of sequoias and other species, especially at the middle elevations of the park. Fire regimes in the parks changed significantly beginning in the 1860s with European American settlement and reductions in Native American populations (Caprio and Swetnam 1995). From 1904 through 1968, NPS policy was to extinguish all fires within the parks. This practice began to change in the 1960s, but from 1980 to 2008, 43% of the 791 lightning ignitions recorded in wilderness were suppressed or controlled. In the same period, there were 66 prescribed fire ignitions in wilderness that burned more than 30,000 acres. Both suppression of lightning-ignited fires and ignition of prescribed fires contribute to impacts on the untrammeled quality of the parks' wilderness.

Unauthorized trammeling may also affect wilderness character. Within Sequoia and Kings Canyon National Parks, unauthorized trammeling is almost entirely due to illegal marijuana cultivation. These operations introduce nonnative species, divert water flows, disturb animal behavior and life cycles, and introduce thousands of pounds of foreign chemicals such as fertilizers, herbicides, and pesticides into park ecosystems. These operations are most prevalent in the lower elevations of the Kaweah River drainage and have notable, but localized effects.

NATURAL

An undegraded natural wilderness quality shows minimal effects of modern civilization upon ecological systems and their biological and physical components.

Attributes of the Natural Quality — The wilderness in the parks comprises distinctive and varied natural landforms. It includes rugged 14,000-foot peaks and steep canyons rivaling the Grand Canyon in depth. The headwaters of four major river systems (South Fork San Joaquin, Kings, Kaweah, and Kern) are protected within wilderness (figure 23 on page 297). The Kern River is the only river in the Sierra that runs parallel to the axis of the Sierra Nevada, with the rain shadow caused by the Great Western Divide resulting in a distinctive, dry environment in the Kern River drainage in which unique species assemblages exist. Cave and karst formations are another outstanding physical feature of the parks' wilderness. The parks contain more than 250 known caves, many within designated or proposed wilderness. The parks' wilderness contains the longest cave in California (Lilburn), uncommon high-elevation caves (White Chief), caves that support endemic species found nowhere else, and caves with outstanding and undisturbed mineral formations.

The subalpine and alpine areas are also distinctive natural elements of the parks' wilderness. Relative to the rest of the central and southern Sierra Nevada region, the parks contain a disproportionately large fraction of high-elevation habitats; more than 50% of park land is above 9,800 feet, while only 11% of the entire region is above that elevation. These high-elevation lands are a valuable conservation resource. They are less affected by polluted air and are less invaded by nonnative species. Lying at the southern end of the great Cascade/Sierra mountain range, the parks support not only species found at the southern end of their ranges, but also species from adjacent desert and Great Basin biogeographic provinces plus a host of endemics. The combination of location, large size, and diversity of habitats contributes to great numbers of species in the parks. The parks contain more than 334 native vertebrate species, including 9 amphibian species, 23 reptile species, 5 fish species, 84 mammal species, and approximately 212 bird species (Austin et al. 2013 lists 203 bird species that are confirmed to maintain a presence in the parks, while Schwartz et al. 2013 lists 212 bird species). Native plant taxa include more than 1,200 vascular plant species. Of the vertebrate and plant taxa present in California, 15% have been observed in Sequoia and Kings Canyon National Parks. In addition to overall diversity, the parks' wilderness is also notable in the number of endemic species it protects. This is especially pronounced in caves, where 35 invertebrate species have been found that exist only within single cave systems or watersheds in the parks. The parks are also home to 11 taxa of plants that exist only within 5 miles of the park boundary, as well as 39 taxa considered endemic to the southern Sierra Nevada.

Below the White Chief area near Mineral King

The regional endemics include two very visible and characteristic tree species – giant sequoias (*Sequoiadendron giganteum*) and foxtail pines (*Pinus balfouriana* ssp. *australis*). Approximately 65% of sequoia groves in the parks lie within designated wilderness. The subspecies of foxtail pine found in the parks exists only in the Sierra Nevada; it grows no farther north than the Middle Fork of the Kings River in Kings Canyon National Park and reaches its southern limit just south of the Sequoia National Park boundary. These two globally significant tree taxa form distinctive forests in the parks' wilderness. Subalpine woodlands of whitebark pine (*Pinus albicaulis*) in the parks' wilderness are notable because they have been largely unaffected by the blister rust and bark-beetle outbreaks that have decimated whitebark pine in the Rocky Mountains.

In addition, terrestrial food webs are largely intact within the parks' wilderness. For example, most of the historically present vertebrate predators — with some exceptions including the grizzly bear (*Ursus arctos horribilis*) and wolverine (*Gulo gulo*) — still exist in the parks.

A particularly valuable aspect of the parks' natural quality is the presence of large biophysical gradients. Tracts of wilderness crossed only by footpaths stretch from foothills and canyons starting at 1,400 feet in elevation to Mount Whitney, the tallest peak in the contiguous United States at 14,494 feet. This represents the greatest elevation range of any protected area in the lower 48 states. Only one road (Generals Highway) completely divides the westernmost wilderness segment from the remainder; only two seasonally used roads (one to Mineral King and another to Cedar Grove) penetrate the deeper canyons of the western slope; and no road crosses the crest of the Sierra Nevada. The large size and continuity of this wilderness protect important wildlife corridors and bird-migration routes between high-elevation protected areas of the southern Sierra and relatively undeveloped areas to the east of the parks, as well as a major corridor along the Sierra Crest connecting the Tehachapi Mountains and the central Sierra Nevada.

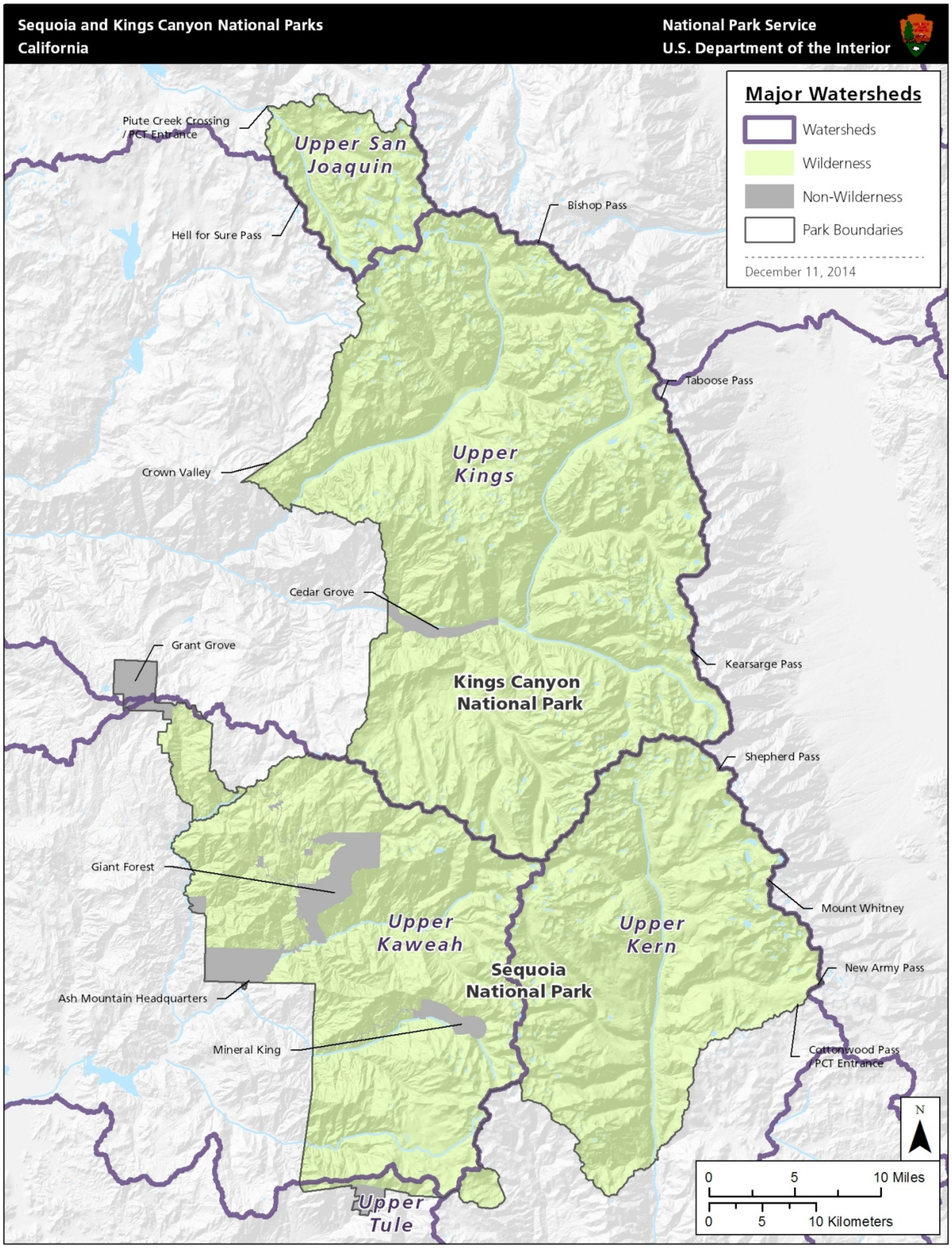

Figure 23: Major Watersheds in Sequoia and Kings Canyon National Parks

Due to this lack of human-caused landscape fragmentation, and because the parks' wilderness abuts wilderness in the Inyo, Sierra, and Sequoia national forests, the parks' wilderness is at the heart of a contiguous area of wildlands that provide the highest level of natural resource protection for roughly 25% of the southern Sierra Nevada. This large size and great diversity of habitats is likely to be important in the long term as species ranges shift in response to climate change. The vast area can also provide habitat for species with large home ranges that may be affected by California's increasing population and the resulting fragmentation of undeveloped lands.

Many of the agents that degrade natural conditions in wilderness originate outside of the parks. These agents include airborne pollutants and contaminants such as nitrogen, sulfur, heavy metals, pesticides, and herbicides that are concentrated along the western side of Sequoia. In a study of western national parks, Sequoia and Kings Canyon National Parks ranked highest in contamination of air, vegetation, snow, and water by semivolatile organic compounds. Fish from the Kaweah River drainage contained high levels of dieldrin (DDT – dichloro-diphenyl-trichloroethane), and mercury that pose health risks to humans and other animals. Changes in global climate beginning in the 1970s have had several impacts in the Sierra Nevada including increased temperatures, a greater proportion of precipitation falling as rain, earlier snow melt and peak water flows, and a loss of glaciers and permanent snowfields. Climate is strongly suspected to have increased drought stress and mortality rates of trees at mid-elevations and is probably responsible for shifts in some small mammal and bird ranges in the Sierra Nevada.

Illegal marijuana cultivation degrades the natural quality of wilderness by introducing thousands of pounds of fertilizers, herbicides, and pesticides into the parks. Growers also clear vegetation, divert water, and kill native animals. Marijuana cultivation has been especially problematic in the low- to mid-elevation portions of the parks' wilderness, though recent information shows it to be on the decline.

Introduced organisms are a serious threat to the natural quality of the parks' wilderness. These include pathogens such as the chytrid fungus that infects mountain yellow-legged frogs and the blister rust that weakens five-needled pine species. More than 200 nonnative plant taxa have been observed in the park; these are most abundant in the lowest elevations, but are present across the middle elevations of the parks as well. Austin et al. (2013) list 25 nonnative vertebrates (1 amphibian, 11 birds, 9 fish, and 4 mammals) that are either confirmed or suspected of maintaining a presence in the parks, either through a breeding population or through continued replenishment from outside park boundaries. Trout introduced to the high-elevation basins of the parks have had profound impacts on food webs and depressed populations of native species such as mountain yellow-legged frogs.

Human-caused changes in fire regimes have also decreased the natural quality of the parks' wilderness. For example, periodic fire is important to the life cycle of giant sequoia and other organisms. Fire suppression in the mid-elevations of the parks has resulted in decreases in the reproduction of sequoias and some pine species. In addition, it has resulted in increased forest density and unnaturally high fuel loads, both of which increase the probability of unnaturally large and severe stand-replacing fires.

Human presence in wilderness can also degrade its natural quality. Human and stock traffic mobilizes soil that may erode at an unnaturally high rate, may trample native vegetation, and can introduce nonnative plants. Stock grazing in the parks has averaged more than 8,000 stock nights per year from 1986 to 2011; this decreases the natural quality of park meadows and associated vegetation as no grazers larger than bighorn sheep were present before the arrival of Europeans. Human and stock waste introduce pathogens and nutrients into soils and waterways. Wild animals may become conditioned to human presence, detracting from their wild quality. For example, some bears, marmots, and coyotes regularly seek food from visitors at popular recreational destinations.

Campsite Condition—Impacts on wilderness character from visitor use can be biophysical, social, or both. Biophysical impacts can include effects on water resources, fish and wildlife, and sensitive vegetation. Social impacts, such as the number of people or groups encountered, can affect opportunities for solitude or primitive and unconfined recreation. Campsite monitoring is one way to measure visitors' effects on wilderness character, as well as effects on natural resources and visitor experience. Campsite condition is presented in this section to provide the background for assessing effects of visitor use on the natural quality of wilderness character.

In the late 1970s, in response to rapidly increasing visitor use and proliferating impacts, the condition of all campsites in the backcountry (pre-wilderness designation) of Sequoia and Kings Canyon National Parks was assessed by park research staff. All campsites were located and assigned to one of 273 different subzones (geographic nodes or concentrations of sites within travel zones). The conditions of campsites was assessed on the basis of eight parameters: 1) vegetation density, 2) vegetation composition, 3) total area of the campsite, 4) barren core area, 5) campsite development, 6) litter and duff, 7) social trails, and 8) tree mutilations. The initial survey found that there were more than 7,700 campsites in wilderness. The campsites were classified from Class 1 sites, those sites that are small and barely noticeable, to class 5 sites, those that have extreme impacts. The survey found that 37% of campsites were Class 1, 34% were Class 2, 18% were Class 3, 7% were class 4, and 4% were class 5 sites. In the late 1970s, there were 329 class 5 sites in the entire wilderness.

Campsite Classifications

***Class 1** – usually no more than a small sleep site and possibly a small fire ring with little or no sign of trampling or vegetation impact.*

***Class 2** – obvious campsites that do not appear highly worn.*

***Class 3** – well-impacted popular sites, without attributes of severe impact.*

***Class 4** – highly impacted, with some aspects of extreme impact. They often have large areas completely devoid of vegetation, litter, and duff (organic matter in various stages of decomposition on the floor of the forest).*

***Class 5** – a large, heavily used barren area, often with numerous, leveled sleep sites, fire rings, and perhaps rock walls or mutilated trees.*

(Parsons and Stohlgren 1987)

In 2006 and 2007, to ascertain trends in impacts in wilderness, the campsite survey was repeated in 120 of the 273 subzones (44% of wilderness) (NPS 2013e). A total of 2,955 sites were located during the 2006–2007 surveys. Of these, 1,795 were identified as active campsites, and another 1,160 were identified as restoration sites. Restoration sites are sites that appear to no longer be used for camping but where campsite impact is still at least marginally evident. Since the repeat sample included 44% of the subzones originally surveyed, this suggests that there are approximately 6,600 impacted sites in wilderness, of which about 4,000 are being actively used as campsites.

The 2006–2007 survey revealed that most of the campsites in wilderness were not highly impacted. Of the active campsites, 60% were rated as Class 1 campsites and 30% were rated as Class 2 sites. Only 7% of the active campsites were rated Class 3; 2% were rated as Class 4 sites; and none were rated Class 5. When restoration sites are considered, about 70% of sites were considered lightly impacted (all Class 1 campsites and most restoration sites). Only about 6% of the total number of campsites (about 350 sites in the entire wilderness) was classified as Class 3 or 4 campsites, and no sites had the extreme levels of impact found at Class 5 sites.

The most important finding of this study was that campsite conditions in the wilderness of Sequoia and Kings Canyon National Parks have improved dramatically since the late 1970s. Depending on assumptions made regarding the comparability of the two surveys, aggregate campsite impact in 2006–2007 was about one-third less than what it was in the 1970s. No other wildernesses where trends in impact have been studied have improved so dramatically.

The second fundamental finding was that the improvement that has occurred over the past 30 years was remarkably uniform. With only a few localized exceptions, conditions have improved throughout the wilderness of the parks. Impacts are not spreading or intensifying. The installation of bear-resistant food-storage boxes in the 1980s may have intensified use in the immediate vicinity of boxes. However, the sites selected for food-storage boxes were usually places that were already impacted. Given increased use of minimum impact techniques, these sites are often in better condition now than they were in the past, even if use intensity has increased. The 2012 trends analysis concluded that food-storage boxes have had no apparent effect on campsite impact at the scale of the subzone.

Despite wilderness-wide improvement, campsite impacts are not evenly distributed. They are more substantial along primary trails, particularly the John Muir Trail (JMT), and they are concentrated both in popular subzones (e.g., Rae Lakes) and within subzones at trail junctions, creek crossings and along lakeshores. However, because the most highly impacted areas are the ones that have improved the most since the 1970s, the difference between more and less impacted areas has actually decreased. In the 1970s, campsite impact decreased significantly with increases in elevation, distance from the trailhead and distance from the closest ranger station. The 2012 survey and trends analysis concluded that campsite impact no longer varies with these factors.

There are several competing potential explanations for the decrease in campsite impact since the initial survey. Visitor data show that use levels are not as high today as they were in the 1970s. It is also evident that use is more concentrated than it was in the 1970s. Although the relationship between impact and the spatial distribution of use is complex, total impact is often less where use is concentrated rather than more widely distributed. Visitor behavior has also changed. There has been widespread adoption of minimum impact techniques, including Leave No Trace©, and some of the activities with high impact potential (e.g., campfire building and traveling with large stock groups) are more tightly regulated and may be less popular with the general public.

Finally, in the period between the two surveys, there has been a concerted on-the-ground management effort by park staff to reduce campsite impacts. The strategy includes concentrating use, reducing the number and size of campsites, moving camp areas to more appropriate locations, reducing development at campsites (e.g., removing fire rings), and educating visitors on minimum-impact techniques. Specific actions taken to implement this strategy include:

- obliterating unnecessary campsites;
- eliminating sites too close to water, particularly those within 25 feet of a lake or stream;
- eliminating campsite developments, such as visitor-built tables, chairs, and rock walls;
- replacing large fire rings with smaller fire rings;
- reducing the size of large sites;
- eliminating campfire evidence where fires are illegal; and
- educating visitors about how to minimize their impact.

All of these factors have worked synergistically toward notably improved conditions in the Sequoia and Kings Canyon National Parks wilderness.

UNDEVELOPED

The Wilderness Act states that wilderness is "an area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation," with "the imprint of man's work substantially unnoticeable." The undeveloped quality of wilderness is impacted by the presence of structures and installations, and by the use of motor vehicles or motorized equipment. These developments are also prohibited by Section 4 (c) of the Wilderness Act, and are only permissible if they are "necessary to meet minimum requirements for the administration of the area" as wilderness.

The Sequoia and Kings Canyon National Parks' wilderness areas contain a variety of administrative developments. Some developments, such as radio repeaters, have little consequence to the other qualities of wilderness, and are only assessed as potential impacts on the undeveloped quality. Other developments, such as food-storage boxes or ranger stations, may concentrate visitor use or result in a less self-reliant wilderness experience. In these cases the impacts will be assessed against the natural quality and the solitude and unconfined quality as well as the undeveloped quality. Specific developments are described in the "Alternative 1: No-action / Status Quo" section of chapter 2 and in the "Park Operations" section of chapter 3.

Attributes of the Undeveloped Quality — The Wilderness Act references many ways in which humans modify and show dominance of the land: the construction and presence of roads, trails, and structures indicating habitation, and the use of various modern machines in managing wilderness lands.

Roads and trails that ease access to otherwise extremely difficult-to-access areas are developments. With the exception of the historic Colony Mill and Hidden Springs roads (now closed to vehicles) in the North Fork Kaweah River drainage, and the access road to Oriole Lake inholdings, there have been few roads of any consequence in what is now park wilderness. The maintained trail network in the parks' wilderness is relatively extensive, with approximately 650 miles of maintained trails in the 1,309 square miles of wilderness. Most trails were present in some form prior to wilderness designation, with some routes having been pioneered by American Indians centuries ago.

Buildings and structures, such as patrol cabins and ranger stations (some of which are historic), tend to be located in conjunction with primary trails such as the High Sierra Trail (HST), the John Muir Trail (JMT), and the Pacific Crest Trail (PCT). Almost all of the patrol cabins and ranger stations pre-date wilderness designation and are usually staffed for three to four months during the peak-use summer season (see figure 7 on page 85). Administrative pastures are present at one patrol cabin and three ranger stations. Administrative pastures are fenced to keep stock confined adjacent to ranger stations and to be readily available for emergency response. Administrative camps (permanent camps established for enforcement/patrols, resource management/research, and trail maintenance/project activities) may contain food-storage boxes, a fire ring, and, in some cases, a hitching rail. Administrative camps may also be used by visitors.

Other administrative installations include radio repeaters (consisting of transmitters, solar arrays, and antennas); resource-management and research installations (stream gauges, snow-measuring equipment, plot and tree markers, and other long- and short-term instrumentation and monitoring devices); and Redwood Canyon Cabin, used to hold supplies for cave research in the nearby Lilburn Cave.

The acreage in potential wilderness and inholdings serves as an indicator of the undeveloped quality of wilderness. There are two areas with inholdings in wilderness (Oriole Lake and Empire Mine) that total 27 acres. In addition, two utility easements are located in designated potential wilderness additions: 12 acres in the Middle Fork Kaweah River drainage and 21 acres in the South Fork Kings river drainage. Four reservoirs in the Mineral King area are inside 112 acres of designated potential wilderness.

Motorized transport and mechanized equipment is used regularly by the NPS to administer the parks' wilderness. Each year, crews use chainsaws to clear trails and cut firewood for crew use and wilderness ranger stations. Motorized rock drills are used to maintain trails. There has been some recent increase in the frequency of use of primitive tools and transportation for patrols and trail maintenance. Although there is an emphasis on using primitive tools, mechanized tools may be approved, through a minimum requirement analysis, for use by trail crews and other crews administering wilderness.

Helicopters are used each year to bring supplies and tools to ranger stations, trail crews, and resource management crews. Helicopters are also used to maintain six radio repeaters. Four dams and about 15 snow-survey locations are accessed and maintained primarily through the use of helicopters within wilderness. Helicopters respond to fires, search and rescue missions, and medical emergencies in wilderness; out of the approximately 100 search and rescue and medical emergency incidents each year, one-third involve evacuation of visitors from wilderness by helicopter. On average, there are 288 hours of helicopter flight time in the parks each year, including flights within and outside wilderness. Non-emergency landings of helicopters in the parks' wilderness average 140 per year. All installations and use of mechanized equipment must first go through an MRA before being authorized (appendix I).

OPPORTUNITIES FOR SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION

The Wilderness Act states in Section 2(c) that wilderness has "outstanding opportunities for solitude or a primitive and unconfined type of recreation." Opportunities for solitude or primitive and unconfined recreation provide visitors a chance to connect with the natural world, to practice traditional skills, and to have transformative personal experiences. What constitutes solitude, primitive conditions, or unconfined recreation depends on the perceptions of individuals, and impacts on these experiential dimensions can be difficult to evaluate. Management focuses on the Wilderness Act's mandate to provide outstanding opportunities and the WSP/FEIS assesses impacts on these opportunities that may result from the plan alternatives.

Opportunities for solitude or primitive and unconfined recreation can be affected by encounters with other visitors or by changes in management that alter visitor recreation behavior. For example, infrastructure like food-storage boxes may reduce opportunities for primitive recreation by eliminating the need for visitors to manage their own food storage. Ranger stations may concentrate visitor use, increasing encounter frequencies in those areas. The WSP/FEIS will assess impacts on the opportunity for solitude from visitor encounters and the attractions that increase visitor encounters, and will assess the impact of management activities on opportunities to experience primitive and unconfined recreation.

There is great variability in visitor density in the parks' wilderness, and this variability depends on both the time and location of a visitor's trip. While there are certain times and places where visitors may experience frequent encounters with other visitors, those that choose less popular destinations or less popular times of the week or times of the year will easily find solitude in the parks' wilderness.

Attributes of the Opportunities for Solitude or Primitive and Unconfined Recreation Quality — The Sequoia and Kings Canyon National Parks wilderness areas provide opportunities for visitors to engage in a variety of primitive recreation activities, such as backpacking, hiking, climbing, fishing, rafting, kayaking, skiing, and riding and packing with stock. Backpacking along the approximately 650 miles of maintained trails is the most common form of primitive recreation. Granite monoliths, cliffs, and numerous 13,000- and 14,000-foot mountain peaks offer climbing and mountaineering opportunities ranging in difficulty from easy walk-ups to technically demanding climbs. In the winter, there are opportunities for wilderness skiing and snowshoeing. The parks provide excellent opportunities for riding and packing with horses, mules, burros, and llamas; the Roaring River and Hockett Plateau areas in particular have had a tradition of recreational stock use for more than 120 years. This activity preserves traditional primitive skills that have been used for generations to transport people and supplies through wilderness.

Although there are approximately 650 miles of maintained trails, these trails are located in 1,309 square miles of wilderness. Some trails and trailheads are very popular, reducing opportunities for solitude in those areas. However, one of the most exceptional aspects of the parks' wilderness is the opportunity to travel through truly undeveloped and primitive areas without trails. The ability to travel off-trail adds greatly to the unconfined quality of the parks' wilderness and fosters feelings of discovery, exploration, and self-reliance. Travelers, once inside wilderness, are mostly free to change their itineraries mid-trip and select the routes or destinations they desire. This ability to freely select one's itinerary contributes notably to the sense of solitude and of being "unconfined."

The opportunity to leave the trail means that solitude may be found even during the busiest parts of the summer. Solitude is also easily experienced outside of the summer season. While an average of nearly 25,000 people visit wilderness each year, visitation declines sharply as snow covers the mountains throughout winter and spring. Visitors during these times are unlikely to encounter another person, and skiers look forward each year to the Sierra's renowned spring corn snow. Visitor encounters are discussed below.

Mt. Cotter, Kings Canyon National Park

Developments that support public recreation decrease the primitive quality of wilderness. There are 33 bridges and thousands of other human-built trail features (including causeways, boardwalks, rock walls, tunnels, laid-rock tread, etc.), historic stone shelters on Muir Pass and Mount Whitney, and hundreds of signs in wilderness that aid travelers. Other recreational developments and installations in wilderness include designated campsites, privies and restrooms (Emerald and Pear lakes), food-storage boxes, drift fences for stock, and the Bearpaw Meadow High Sierra Camp. Specific recreational developments are described in the "Alternative 1: No-action / Status Quo" section of chapter 2.

Restrictions on visitors can reduce the unconfined quality of wilderness. In the parks, regulations are established to protect natural features, preserve opportunities for solitude, and protect the primitive and undeveloped qualities of the park. Overnight visitor use is limited during the most popular time of year (late May to late September) by daily trailhead entry quotas. Party size is limited in order to keep campsites small, prevent formation of new trails in areas without constructed trails, and preserve the feeling of solitude for other groups. Campfire limitations above specified elevations protect slow-growing subalpine forests from depletion of ecologically and scientifically important downed wood. Camping along lakeshores or other water bodies is prohibited to protect water quality and fragile riparian banks and vegetation. Three popular destinations require the use of designated campsites (Emerald and Pear lakes, Bearpaw Meadow, and Paradise Valley), and areas near frontcountry trailheads are closed to camping to prevent overuse. The location, timing, and amount of grazing by stock are limited to protect meadows and large portions of off-trail areas are closed to stock travel and access. Current limits are described in the “Alternative 1: No-action / Status Quo” section of chapter 2.

Visitor Encounters — The parks’ wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation. Research suggests that wilderness visitors associate wilderness areas with low visitor density as well as limited development and evidence of human occupation, limited restrictions on visitor activities or behaviors, and natural conditions (Martin and Blackwell 2013). Wilderness visitors vary in their expectation of solitude conditions, and respond in a variety of ways to perceived crowding problems, including avoiding places that have undesirable conditions (Manning 2011). However, the frequency of encounters with other people is nonetheless a relevant and useful measure of opportunities for solitude (Broom and Hall 2009).

The NPS commissioned a survey of overnight visitors to the parks’ wilderness during the summer and fall of 2011 (Martin and Blackwell 2013). The survey was conducted to gain a better understanding of the characteristics of wilderness visitors, the characteristics of their visits, and their responses to things they encounter in the parks (Watson 2013). Some of these responses were compared to responses from an earlier 1990 survey (Watson et al. 1993). One focus of these studies was on visitor encounters while traveling and camping. These findings are summarized below. Other findings (e.g., visitor demographics and trip characteristics) are summarized in the “Visitor Use” section of this chapter.

The 2011 survey examined a limited list of 19 potential attributes that might define wilderness character of the parks’ wilderness. The survey respondents evaluated this list on a four-point scale of one (not at all important) to four (very important). Eleven items averaged greater than three, including “a place where I can go with low density of people” (3.70), and “a place where human influences are relatively unnoticeable” (3.65) (Watson 2013). It is clear that visitors value low density as an attribute of wilderness.

A substantial portion of respondents (32.8%) reported that they avoided certain times or places due to conditions. While snow was the most commonly volunteered reason for avoiding certain places, density-related concerns – people, noise, heavy-use campsites, and crowded trails – were the second most-commonly volunteered reason for place avoidance. The busy season (before Labor Day and weekends) at the parks was the most commonly cited condition to avoid, but other specific areas identified by respondents included the JMT, Mount Whitney/Whitney Portal, Rae Lakes Loop, HST, PCT, Evolution Valley, Guitar Lake, Goddard Canyon, and Bearpaw Meadow (Martin and Blackwell 2013). These are areas that are recognized by park management as being popular areas, except perhaps Goddard Canyon.

Regardless of trip destination, the great majority of respondents did encounter at least some other people while traveling, but most respondents did not feel that these encounters detracted from their experience or that fewer encounters should occur. Approximately 98% of respondents said they noticed the presence of people along the trail, and while visitors to popular areas were more likely to notice other visitors than those to lower-use areas (98.7% versus 95.2%), the difference was not great. The majority of visitors (63.3%) indicated that the presence of other visitors along the trail neither added nor detracted from the quality of their visit. Of the remainder, 20.7% reported that this presence of other visitors detracted from the quality of their experience while 16.0% reported that it added to their experience quality. When asked if the presence of other people should be less or the same, the great majority of visitors to both popular (77.1%) and lower-use areas (81.7%) reported that the presence of other visitors should be the same (Martin and Blackwell 2013). While visitors value low visitor density as an aspect of wilderness, they did not emphasize current encounter frequencies as a problem that needs to be addressed.

Visitor encounter frequency, however, is a common and important indicator of the quality of visitor experience in wilderness (Broom and Hall 2009) and is proposed as a visitor capacity indicator in the WSP/FEIS. Survey results suggest that there is great variability in terms of encounter frequencies reported by survey respondents. Popular areas were found to have a higher average number of group encounters per day and a higher maximum number of encounters per day, but even in popular areas some respondents encountered no other visitors on at least one day of their trip, and this was true for all of the location classes. Survey data from 1990 (Watson et al. 1993) shows that average encounters per day has gone up from 3.4 groups per day to just greater than 4 groups per day, a modest increase. In both the 1990 and 2011 surveys, visitors were asked their opinions of the perceived degree of impacts or problems in wilderness. As in 1990, while no potential problems are rated as extremely high (nothing averaging as high as 2 = small problem on a scale of 1 [no problem] to 4 [big problem]), one of the problems that rated highest was "too many people" (1.74) (Watson 2013). Visitors do not appear to consider encounter frequency to be more of a problem today than twenty years ago.

The average, minimum, and maximum encounters per day in Sequoia and Kings Canyon National Parks' wilderness, as reported by Martin and Blackwell (2013), are summarized by general location in table 54.

Table 54: Average Encounters with Groups per Day in the Sequoia and Kings Canyon National Parks Wilderness, 2011, by General Location Category within Wilderness

Types of Groups	Average Encounters per Day	Minimum Number of Encounters per Day*	Maximum Number of Encounters per Day*
All groups, all location (n=528)	4.1	0	33
Groups traveling in popular areas (n=384)	4.7	0	33
Groups traveling outside popular areas (n=139)	2.6	0	17
Groups traveling the Rae Lakes Loop (n=51)	5.3	0	30
Groups hiking the JMT (n=19)	2.9	0	10
Groups climbing Mount Whitney	4.4	0	20
Groups traveling cross country, including popular areas (n=91)	3.9	0	33
Groups traveling cross country, excluding popular areas (n=45)	2.5	0	13

*Days = total nights + 1

Encounter frequencies were also collected by NPS staff during the 2012, 2013, and 2014 summer seasons. Trails were divided into discrete segments that could be traversed by park staff in a reasonable time and which represented logical segments in between trail junctions. Staff walked these trails at a pace judged to be similar to that of wilderness visitors, and the number of encounters with other individual visitors per hour was calculated. Trail segments within a given area were grouped into "analysis areas." Within analysis areas, data was examined to identify the trail segments with the highest encounter frequencies.

These were identified as the "constraining" trail segments in terms of encounter conditions (i.e., if the constraining segment is within standard, it is highly likely that the related area segments would be within standard). Table 55 lists the analysis areas and the constraining trail segment within each one. It summarizes the mean, minimum, maximum, and 90th percentile for observed encounter frequencies with individuals on constraining trail segments within the named analysis area. The 90th percentile encounter frequency means that on 90% of sample days the observed encounter frequency was at or below the number shown in that column. Sample sizes are not large, but will increase as this data collection method is incorporated into an ongoing monitoring program. Because locations with fewer than ten sample days were omitted, this table does not include some low-use areas that will be included in the monitoring program.

Table 55: Observed Number of Encounters per Hour with Individuals: 2012–2014[1]

Analysis Area	Trail Class	Constraining Trail Segment	Sample Size[2]	Mean	Minimum	90th Percentile	Maximum
Mount Whitney	Major	Crabtree – 3	38	25.9	0	44.0	66.6
Evolution Basin	Major	McClure – 1	26	12.5	1.1	21.1	52.0
Road's End	Day- use	Cedar Grove – 1	66	13.2	0.0	43.7	62.0
Lakes Trail	Day-use & Major	Pear Lake – 4	38	8.0	0.0	15.7	34.1
Mineral King Valley	Major	Mineral King – 6	43	7.9	0.0	18.8	25.3
Crabtree Ranger Station to Trail Crest	Major	Crabtree – 2	38	8.9	0.0	16.7	45.0
Rae Lakes/JMT	Major	Charlotte Lake – 1	31	6.9	0.0	13.9	21.6
Rae Lakes Loop — Lower Portion	Major	Cedar Grove – 3	27	5.7	0.0	11.5	15.3
West side of Kearsarge Pass	Major	Charlotte Lake – 2	27	4.9	0.0	9.5	22.9
Dusy Basin	Major	LeConte – 2	48	4.6	0.0	8.5	14.4
Timber Gap Jct. to Monarch Lakes	Major	Mineral King – 2	20	4.7	1.0	9.3	15.3
Twin Lakes Trailhead to Silliman Creek	Major	Lodgepole – 1	28	3.6	0.0	9.0	14.4
HST: Hamilton Lakes to Wallace Creek	Major	Little Five – 5	15	3.5	0.0	7.7	18.0
Rock Creek	Major	Rock Creek – 5	47	2.8	0.0	9.2	16.0
Little Five	Major	Little Five – 2	22	2.7	0.0	5.3	12.8

[1] Observations made by park staff. Encounters within 25 feet only were recorded. Individuals were counted only once. Congregation points such as trail junctions and scenic vistas were omitted. Areas are listed in order by mean number of encounters, high to low.
[2] Number of sampling events.

These findings are consistent with the areas considered by management to be popular areas, and consistent with the locations identified by respondents to Martin and Blackwell (2013). The ability to experience low encounter frequencies on some days even in the highest use areas was reinforced.

OTHER FEATURES OF VALUE

All wilderness shares the four principal qualities of wilderness character: untrammeled, natural, undeveloped, and opportunities for solitude or primitive and unconfined recreation. However, the Wilderness Act also provides for protection of "ecological, geological, or other features of scientific, educational, scenic, or historical value" that contribute to wilderness character. Given that Sequoia and Kings Canyon National Parks are predominantly wilderness, it is worth highlighting two additional elements that contribute to the parks' wilderness character: 1) historic and cultural features, and 2) scientific activities.

Attributes of the Other Features Quality

Historic and Cultural Features – People have been exploring what is now the parks' wilderness for centuries. This use and exploration of the land has intrinsic wilderness character values. The parks are mandated to preserve and protect cultural resources in the parks' wilderness, including both prehistoric and historic habitations. Ethnographic evidence suggests use by several groups of American Indians. In both prehistoric and historic times, American Indians including the Western Mono, Paiute, and Tübatulabal groups travelled through the Southern Sierra Nevada. In more recent centuries, these groups included Eastern Mono (Owens Valley Paiute) groups as well as Western Mono (possibly Wobonuch) bands in addition to Yokuts groups from the floor of the Great Central Valley and the valley's eastern foothills. They navigated through the mountain landscape, hunted and harvested, and sought the best camps. Signs of their presence in wilderness are found in remnant camps and shelters, hunting blinds, and artifacts they left behind including arrow and spear points, bedrock mortars and mills, and lithic and ceramic scatters.

The arrival of Europeans in California brought many new explorers and settlers, including shepherds and ranchers, trappers and hunters, miners and loggers, and scientists. Later the U.S. Army, the Civilian Conservation Corps, the Sierra Club, and recreational travelers would follow American Indian footpaths into wilderness. Some came for economic gain, others for duty, and others for the challenge and pleasure of being in the mountains. Some, such as John Muir, also communicated their reverence for the place and successfully advocated for its preservation in its unaltered condition, and began a world-wide movement to protect large tracts of wildlands. Artifacts and features from the historic period include tree carvings, cabins, trails, camps, fences, summit registers, stone shelters on Mount Whitney and Muir Pass, and a resort on the Kern River.

Historic and cultural resources serve as reminders that humans have been part of the region's wilderness ecosystem for centuries. Some visitors have described how finding historic objects like an ancient pot or spear point, or travelling the same routes described by American Indians or historical figures, such as John Muir or Norman Clyde, added to their wilderness experience.

Scientific Activities – Protection of scientific values is one of the public purposes of wilderness, and NPS policy encourages scientific activities within wilderness, provided they are consistent with the preservation and management of wilderness. Because of its great diversity of habitats, large biophysical gradients, and its relatively undisturbed condition, the parks' wilderness is a sought-after and relevant study area for understanding landscape ecology and species niches, and their probable alteration as a result of climate change and other perturbations. Research of these types includes:

- Studies of the relationship between fire and giant sequoias conducted in the Redwood Canyon area, which has had a transformative effect on national fire policy and opened up a new area for scientific study.

- Cave research in the parks has discovered 35 invertebrate taxa new to science and contributed to a better understanding of karst systems and their importance in local hydrology.
- Studies of the growth patterns recorded in the rings of subalpine foxtail pines have provided insight into past climate patterns and may help inform predictions of future climate shifts.
- The search to understand the factors contributing to the decline of the two species of mountain yellow-legged frog (*Rana muscosa* and *R. sierrae*), and ongoing restoration efforts, is still underway in the remote sub-alpine and alpine lake basins of the two parks.
- Emerald Lake and the Tokopah Valley are the best-equipped and most thoroughly researched alpine sites in the Sierra Nevada with consistent meteorological and hydrological measurements, extensive snow-sampling programs, and 31 years of limnological analyses dating back to 1982. Research is focused on how altered climate, changing snow regime and changes in atmospheric deposition are driving biogeochemical and trophic changes in high-elevation ecosystems.

The parks' wilderness character faces a number of threats. The most challenging to deal with, and potentially the most damaging, are those that are outside of NPS control, such as air pollution and climate change. As the NPS seeks to protect the natural quality of wilderness character, it will face difficult tradeoffs with other qualities. This will require thorough and extensive analysis of values that take into account the degree and length of management impacts on the untrammeled and undeveloped qualities and to opportunities for solitude. Continued refinement of a thoughtful wilderness-character monitoring strategy will also need to determine and consider which developments were present and what the conditions of natural resources were at the time of wilderness designation. This will allow for more accurate descriptions of trends in wilderness character over time, allowing stewards to make informed and conscientious decisions.

SOILS

INTRODUCTION TO SOILS

Soil is a biologically active mixture of minerals and organic matter capable of supporting plant life. Minerals mainly in the form of sand, silt, and clay are produced from the weathering of a parent rock and move downslope under the influence of gravity where they accumulate in low areas. Accumulations of minerals that lack organic material, and which are therefore incapable of supporting biologic processes, are known as parent material. As the parent material begins to mix with organic material such as decayed vegetation, it becomes capable of storing water, air, and organisms ranging from bacteria to vertebrates. Acting together, the minerals, organic matter, and organisms transform the parent material into soil in a process known as pedogenesis. With the passage of time, soils can develop a characteristic texture and distinct horizons that are capable of supporting and nourishing vegetation.

As a group, soils form the largest terrestrial ecosystem and serve many important functions. They act as a medium for plant growth; they capture, store, and purify water; they are important modifiers of the atmosphere; and serve as a habitat for organisms; therefore, it is important to protect soils from adverse impacts.

SOILS IN SEQUOIA AND KINGS CANYON NATIONAL PARKS

Detailed soil information is largely lacking throughout the parks. Huntington and Akeson (1987) completed an extensive soil survey in the Middle and Marble forks of the Kaweah River, which included the southern side of Ash Peaks Ridge, Giant Forest, and much of the headwaters of the Marble Fork. It also included an intensive, localized soil survey of study areas around Emerald Lake, Log Meadow, and

Elk Creek. These yielded a general soil map and a reconnaissance soil map. However, there is an ongoing project to map soils in the parks, working with the United States Department of Agriculture's Natural Resource Conservation Service. Field work is expected to be completed in 2016, and final data is expected to be available by 2018. Even without comprehensive soils data, broad generalizations about park soils can be made.

Empire Mountain in the Mineral King area

Soils in the parks reflect their parent material, which has some pre-Cretaceous outcroppings but is largely comprised of Mesozoic granitic rock typical of the Sierra Nevada (Vankat and Major 1978). Soils tend to be acidic, owing to this igneous intrusive parent material. Soil characteristics in the Sierra Nevada generally are geologically controlled and some broad generalizations can be made relative to elevation.

The Soil Resource Inventory of the parks (Huntington and Akeson 1987) found that foothill soils had the most diverse range of soil orders. Mollisols (one of the 12 soil orders) were most frequently encountered, followed by Entisols, Alfisols, and Inceptisols. Mollisols and Alfisols are the most fertile and well developed soils of the parks and generally support dense vegetation such as chaparral and grasslands. Entisols and Inceptisols are the least mature of the soils found in the foothills and generally support sparse vegetation.

Mid-elevation regions of the parks are dominated by Inceptisols. Inceptisols are immature soils with few diagnostic characteristic features. Inceptisols support shrubs and mixed conifers where deeper soils fill joints in the bedrock.

High-elevation soils are sparse and separated by large areas of exposed bedrock. Recently formed, unmatured Entisols can be found in high-elevation environments along with more mature Inceptisols and Spodosols, some of which were formed and emplaced by glacial action. Some high-elevation soils classified in the 1987 Soil Resource Inventory as Inceptisols may be appropriately reclassified as Gelisols to conform to current soil taxonomy guidelines (Buol et al. 2011).

Independent of elevation, wetland soils are found distributed across the wilderness. Where the soil is saturated throughout the year and for hundreds or thousands of years, peat accumulation can occur. As organic matter accumulates in saturated, anoxic soils, peat accumulates at a rate of approximately 20 cm per thousand years (Cooper and Wolf 2006). Some of these peat-accumulating soils meet the criteria for Histosols.

In all cases, soils form a relatively thin mantle over massive bedrock intrusion, and slope steepness, runoff intensity, and vegetative cover are among the variables controlling erosion (Cooper et al. 2005).

CLIMATE CHANGE AND SOILS

With the warmer temperatures, decreasing snow pack, and increasing water deficit predicted over the next century for the Sierra Nevada by climate change models, impacts to soil are likely to change under the alternatives presented in this WSP/FEIS. As discussed above, climate is one of the key factors controlling soil production and erosion. It is possible that biological activity in high-elevation soils will increase due to increasing temperature and shorter frozen conditions. This increase could be offset by a reduction in soil moisture especially during a prolonged, dry summer. At this time, no trends have been detected in total annual precipitation data (Das and Stephenson 2013); however, increases in spring snowpack at higher elevations have been noted in the highest elevations (Andrews 2012). This coupled with the normal, highly variable precipitation and increasing temperature in California could lead to larger runoff events and erosion, especially during the January to April period. Climate trends along elevation gradients (generally west to east) are expected to vary in direction and magnitude, making it difficult to predict the magnitude or extent of impact among the proposed alternatives.

WATER QUALITY

INTRODUCTION TO WATER QUALITY

Sequoia and Kings Canyon National Parks contains the entirety of the headwaters of three major river systems: the Kings River, the Kaweah River, and the Kern River; and portions of two others, the San Joaquin River and the Tule River. According to the NPS Hydrographic and Impairment Statistics (NPS 2014c), the parks contain 1,938 miles of perennial and intermittent streams. The same dataset shows 3,028 perennial and intermittent lakes in the two parks.

The waters of alpine and subalpine environments within Sequoia and Kings Canyon National Parks are generally cold and clear, with water temperatures ranging between 59 and 68 degrees Fahrenheit, depending on sunlight exposure and depth. Water in montane and foothill areas is generally warmer. The surface waters generally have low turbidity in lakes and streams, with higher turbidity in meadows and ponds. Streams and lakes often have a high oxygen saturation (>8 milligrams per liter (mg/l)), while wet meadows often have a lower oxygen content due to decomposing vegetation and more organic material in soils. The pH of the waters at alpine and subalpine elevations in the parks is generally slightly acidic.

Surface water and groundwater quality in the parks can be affected by anthropogenic and natural factors, including air quality and climate change (NPS 2013c). Specifically, anthropogenic deposition of acids and nutrients can affect water quality, as well as natural processes occurring within the systems. Air pollution is a threat to water quality at the parks because it adds acidic compounds, nutrients, and other contaminants to park waters. Originating in granite, Sierra waters are naturally low in nutrients. There is some evidence that the addition of airborne nitrates and ammonia is causing nutrient enrichment in Sierra waters, increasing the levels of nutrients naturally found in aquatic systems. Another issue is the upwind movement of pesticides and other chemicals from agricultural areas in to the parks, as these chemicals have been found in measurable quantities in aquatic animal tissues in the parks.

Water quality conditions were assessed in surface water within the parks using the criteria set by the USEPA. Conditions for pH, neutralizing capacity, and dissolved oxygen are generally better than those set by federal standards. Nutrient levels are also generally better than those set by federal standard. Pesticide levels (DDT and dieldrin) in fish found within a few lakes exceeded the contaminant health thresholds for fish-eating animals and for subsistence fishing. Toxic metals (mercury, lead, and zinc) were found to be at or above threshold toxicity levels for aquatic species (NPS 2013c).

There is little evidence that human and animal waste has affected water quality in the parks. Studies show detectable effects on water quality in the parks' wilderness where visitors recreate, but these effects are very small (Suk et al. 1987; Clow et al. 2011). *Giardia* and *Escherichia coli (E. coli*) are susceptible to destruction by sedimentation, insolation, UV exposure, desiccation, freeze-thaw cycles, competition, and predation, and thus are quickly eliminated from wilderness waters (Whitman 2004; Cilimburg 2000; Flint 1987). Water quality in the parks' wilderness is often better than other wilderness areas with similar use patterns, and any measurable effects on water quality are far below levels of concern for human health or ecological effects.

WATER QUALITY INDICATORS

Biological Water Quality — There are many biological indicators that can be used to assess the quality of water. Microbial contaminants such as total coliforms, *E. coli*, *campylobacter*, and *Giardia* can give some indication of soil-water interaction and can also indicate if excretory waste has been introduced to the water. Presence and abundance of insects or algae can also indicate the overall quality of the water. For many years, total coliform was used as the primary indicator of excretory waste contamination in municipal water systems. In natural settings, it is recognized that many coliforms are naturally occurring in soils, algae, and leaf litter and are unassociated with fecal waste. Furthermore, studies have found no link between total coliform and human health impacts as many coliforms are not pathogenic and pose no health concerns (USEPA 2012). With improving technology, *E. coli* has become the standard indicator for fecal contamination of water. Like other coliforms, most *E. coli* strains are harmless, but some can cause serious health effects when consumed. Because *E. coli* lives most readily in the gut of warm blooded animals, its presence in water is an accepted indicator of recent contamination by fecal waste.

Chemical Water Quality — Commonly measured chemical properties of water quality include pH, hardness, alkalinity, nitrates, dissolved oxygen, phosphates, and any number of dissolved elements. To a large extent, the chemical properties of water are a result of the soil or bedrock that the water is exposed to as it flows through and across the surface of the earth. Atmospheric deposition of natural and anthropogenic chemical compounds also impacts the chemistry of waters in seemingly pristine, remote areas. Mercury, pesticides, and fertilizers from local and global sources can be carried on air currents and deposited throughout the parks' wilderness (Landers et al. 2008). Sunscreen and bug repellant residues from swimmers and bathers have been measured in remote locations in Yosemite National Park (Clow et al. 2011) and in Sequoia and Kings Canyon National Parks (USEPA 2014). Human and stock urine and feces are often rich in nitrogen and phosphorous. These compounds can be introduced into water directly or be delivered by runoff, and act as fertilizers that can contribute to algae growth. Human and stock impacts associated with waste disposal are considered further in the "Soils" section, but their impact on water quality is discussed in the "Water Quality" section of chapter 4.

Physical Water Quality — Physical properties of water are often used as water quality indicators. Common physical water properties include temperature, turbidity, total solids, odor, color, or taste. All of these physical properties are interrelated and can be affected by natural and human processes. For instance, natural processes or human activities can start erosion, which can deliver sediment to nearby waters. Increasing sediment directly impacts water quality by increasing total solids, increasing turbidity, and affecting the odor, color, or taste of the water. Because suspended particles in the water absorb more heat, higher turbidity results in higher water temperature. Suspended particles also increase light attenuation (decrease the depth to which sunlight can penetrate), leading to altered ecological conditions and changes in biological communities. Mechanisms that lead to erosion are discussed further in the

"Soils" section, but specific impacts on water quality that result from erosion are discussed in the "Water Quality" section of chapter 4.

VEGETATION

INTRODUCTION TO VEGETATION

Extreme topographic differences and a striking elevation gradient (ranging from approximately 1,400 feet in the foothills to 14,494 feet along the Sierran Crest) create a rich tapestry of environments in the wilderness of Sequoia and Kings Canyon National Parks, 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 1,200 species (and more than 1,560 taxa, including subspecies and varieties) of vascular plants that make up more than 150 unique vegetation associations or 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. Where soils are too saturated or shallow to support tree growth, numerous meadows can be found in the montane, subalpine, and alpine zones. Wet meadows support a remarkably diverse assemblage of grasses, sedges, and wildflowers, which provide essential habitat for many small mammals, birds, and insects. Dryland meadows, too, are an important source of food and shelter for animals of the higher elevations.

Individual species of plants and the communities they make up may be affected by visitor use and administrative activities, primarily by deliberate removal, trampling, consumption by stock, or through the introduction of nonnative invasive species. In most cases these disturbances in wilderness are generally localized, affecting individuals, but not affecting the species or habitat overall. The alternatives in the plan, however, may have an effect on several specific plant species and communities. Plants and vegetation with the potential to be affected by the alternatives, which will be further evaluated in chapter 4, include wetlands, meadows, riparian habitats, high-elevation long-lived conifers, alpine communities, and a selection of species recognized as "park sensitive." Also included is a discussion of nonnative plant species that have the potential to impact native vegetation, and how climate change may affect native plants and plant communities. Federally or state-listed plant species are discussed in the "Special-status Species" section of this chapter.

WETLANDS AND MEADOWS

Wetlands — Wetlands are ecologically productive habitats that support a rich array of both plant and animal life. They sustain a great variety of hydrologic and ecological functions vital to ecosystem integrity. These functions include flood abatement, sediment retention, groundwater recharge, nutrient capture, and a supporting environment for high levels of plant and animal diversity. Because they provide disproportionately important services relative to their area, disturbance to or modification of even small wetland areas can induce effects that are proportionally greater than elsewhere in an ecosystem (Graber 1996). Therefore, wetlands receive special protection under Executive Order 11990, "Protection of Wetlands," and section 404 of the Clean Water Act. Section 404 of the Clean Water Act assigns regulatory jurisdiction over "waters of the United States" (of which wetlands are a subset) to the U.S. Army Corps of Engineers. Under Section 404 of the Clean Water Act, the Army Corps of Engineers has jurisdiction over waters of the U.S. in the watersheds of the Kings, Kaweah, Kern, San Joaquin, and Tule River watersheds within Sequoia and Kings Canyon National Parks. These waters include traditionally navigable waters as well as their relatively permanent tributaries, and associated instream, adjacent, and abutting wetlands.

A variety of definitions have been developed for wetlands as a result of their high ecological diversity, special legal status, and their intersection with different scientific fields (NRC 1995; Tiner 1999; Mitsch and Gosselink 2007). All definitions recognize, to one degree or another, the key role of hydrologic processes in wetland formation and the resulting suite of soil and vegetation characteristics. The NPS classifies and maps wetlands using a system created by the U.S. Fish and Wildlife Service (USFWS), which is often referred to as the Cowardin classification system (Cowardin et al. 1979). Wetlands, as defined by the USFWS, are transitional lands between terrestrial and aquatic systems, where the water table is usually at or near the surface or the land is covered by shallow water (Cowardin et al. 1979). For purposes of this classification, wetlands must have one or more of the following attributes:

- The land supports predominantly hydrophytes, at least periodically. Hydrophytes are plants that grow in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content.
- The substrate is predominantly undrained hydric soils. Hydric soils are wet long enough to periodically produce anaerobic conditions.
- The substrate is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin et al. 1979).

All wetlands within the two parks fall into one of three system types: riverine (rivers, creeks, and streams), palustrine (shallow ponds, marshes, swamps, and sloughs), or lacustrine (lakes and deep ponds). The lacustrine wetland class represents wetlands and deepwater habitats that are situated in topographic depressions or dammed river channels; that lack trees, shrubs, and emergent mosses and lichens over 60% of their area; and that are greater than eight hectares (20 acres) in size. Similar habitats totaling less than eight hectares are also included in the lacustrine system if a bedrock shoreline feature makes up all or part of the boundary.

The riverine and palustrine wetland classes represent community characteristics that can be described as riparian, which may be best described as the zone of direct interaction between land and water (Swanson et al. 1982; Gregory et al. 1991; Cushing et al. 2006). This zone consists of the plant community adjacent to a river or stream channel that serves as the interface between the river and the surrounding meadows, floodplain, and upland plant communities. Riparian areas are characterized by a combination of high species diversity, high species density, and high productivity and are found along streambanks, lakes, rivers, and other bodies of water. Commonly found riparian wetlands in the parks include deciduous broad-leaved palustrine scrub-shrub (primarily willow thickets), upper perennial riverine (permanent rivers and streams), lacustrine (lakes), open-water palustrine (ponds), and intermittent riverine (ephemeral streams). Many of the rivers and streams have riparian areas that are either forested palustrine (e.g., alder [*Alnus* sp.]) or deciduous broad-leaved palustrine scrub-shrub (e.g., spicebush [*Calycanthus* sp.] or willow [*Salix* sp.]) along their banks (NPS 2007a).

The National Wetland Inventory (USFWS 1996) for Sequoia and Kings Canyon National Parks represents wetland features in three ways: points, lines, and areas (figure 24, table 56). Lacustrine features are almost exclusively mapped as area features. Small palustrine features are represented as points, while larger ones are represented as line or area features. Riverine features may be represented as lines or areas.

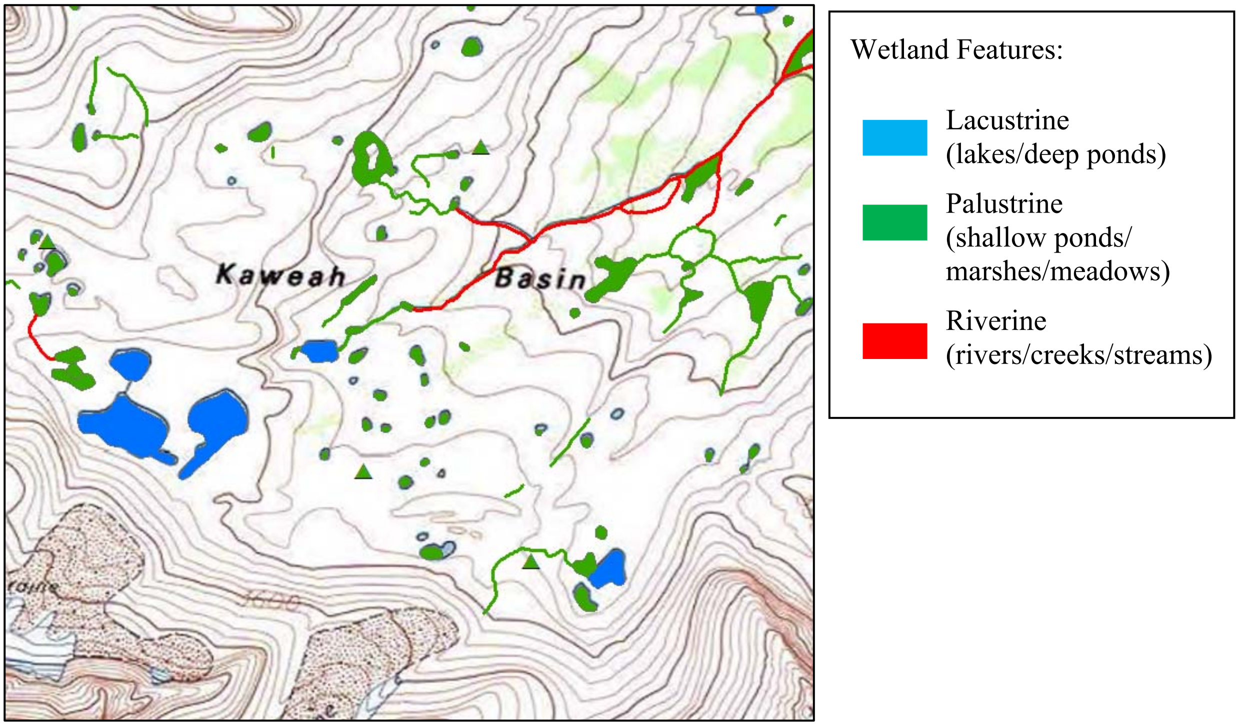

Figure 24: Wetland features in the Kaweah Basin

Table 56: Classes and Areal Extent of Wetlands According to Cowardin System in Sequoia and Kings Canyon National Parks

Cowardin System	Points (Count)	Linear Features (Miles)	Area Features (Acres)
Lacustrine	0	0.5	9643
Palustrine	285	776.8	16,387
Riverine	0	1,370.9	543
Total	285	2,148.1	26,573

Meadows — In Sequoia and Kings Canyon National Parks, as well as the Sierra Nevada as a whole, much attention has been paid to the understanding and management of meadows. Meadows are a vegetation type that can exist in both wetland and upland settings.

Wetlands and meadows overlap at the wet end of the hydrology spectrum; meadows exist in river floodplains, on streambanks, along lake margins, and at groundwater seeps and springs. Meadows also overlap with upland habitats at the dry end of the hydrology spectrum. Portions of any given meadow may be associated with lacustrine, palustrine, and riverine systems, as well as non-wetlands, reflecting the topography, hydrology, and soils that drive vegetation composition. Analysis of impacts on meadow vegetation necessarily overlaps with analysis of impacts on wetlands and uplands. They are analyzed because they are a recognizable landscape feature that is directly impacted by visitor-use activities, and because of their importance to hydrologic and ecological processes and their role in the provisioning of ecosystem services.

Managers in the Sierra Nevada have emphasized the meadow as an ecological and management unit. Weixelman et al. (2011) define and characterize Sierra Nevada meadows as follows:

> In the simplest terms, meadows are defined by hydrology, vegetation, and soil characteristics. Meadows in the Sierra Nevada and Southern Cascades in California have these characteristics in common:
>
> - A meadow is an ecosystem type composed of one or more plant communities dominated by herbaceous species.
> - It supports plants that use surface water and/or shallow groundwater (generally at depths of 3.3 feet).
> - Woody vegetation, like trees or shrubs, may exist and be dense but are not dominant.
>
> Meadows are characterized by the existence of two fundamental abiotic conditions: (1) a shallow water table (usually less than 3.3 feet) during the summer; and (2) surficial soil material that is fine-textured. Water tables are high and persistent enough to favor hydric herbaceous species and limit the establishment of trees and most shrubs. Hydrologic processes control the amount, source, and duration of water entering a meadow. Geomorphology (landform) controls where water comes from and whether it leaves the meadow system. Directional flow of water is also important.

The kinds of impacts from visitor use that are of concern may depend on the hydrology of the meadow. For this reason, it is useful to look at subsets of all meadow vegetation in the park. In addition to the overall population of meadows, impacts are considered on two subsets of meadows (dry meadows, and wet meadows/fens) in order to evaluate visitor-use impacts.

Wet Meadows and Fens — Wet meadows and fens (peat-accumulating wetlands) are a subset of meadow vegetation that exists on the wettest end of the hydrology spectrum. Most of the wet meadow and fen area corresponds to vegetation classified as intermittently to seasonally flooded meadow, semi-permanently to permanently flooded meadow, and willow/meadow shrubland, although some would be categorized as other vegetation such as willow shrublands or lodgepole pine (*Pinus contorta*) forests.

Both wet meadows and fens are classified as palustrine systems, both have water tables near the surface during the growing season, and support similar vegetation. In meadows with soils saturated through the growing season over hundreds or thousands of years, decomposition of plant material is slower than accumulation, which allows organic material (peat) to accumulate (Bartolome et al. 1990). Meadows with extensive areas of peat accumulation are considered fens, while those that are wet without significant peat accumulation are considered wet meadows. Peat accumulation is generally patchy within a given meadow, so meadow-fen complexes are common.

A wet meadow below Fin Dome

Fens are distinguished from wet meadows by the presence of organic soils, and are among the most common wetland types, globally. However, outside of boreal landscapes, they typically represent a small proportion of total wetland area and this is true in the Sierra Nevada. Fens have been classified using a variety of criteria such as vegetation, water chemistry, and hydrology (Wheeler and Proctor 2000). Fens have stable water supplies with water tables at or close to the ground surface for most of the growing season (Windell et al. 1986; Winter 2001; Chimner and Cooper 2003). While fens often exist in stream valleys as part of larger wetland complexes, they do not experience high velocity surface flows or sediment deposition from fluvial processes like riparian ecosystems. In contrast to marshes, fens do not experience deep inundation, although some microsites can have more than 0.6 feet of standing water (Cooper 1990). Using the Cowardin classification, fens are generally classified as either (1) palustrine, emergent, persistent, with a saturated water regime and organic soils, or (2) palustrine, scrub-shrub with a saturated water regime and organic soils where multi-stemmed woody species dominate. The stable groundwater-driven hydrologic regimes with the high water tables characteristic of fens retard organic matter decomposition and promote peat accumulation (Cooper 1990, Bedford and Godwin 2003, Cooper and Wolf 2006).

In the Sierra Nevada, fens develop in several geomorphic settings (Weixelman et al. 2011), associated with: open water features such as small lakes or ponds (basin fens), the base of hills or on hillslopes where ground water discharges from alluvial fans, glacial moraines, and other aquifers (sloping fens), and distinct springs (spring mound fens) (Cooper and Wolf 2006; Weixelman et al. 2011). Many wetland types have high water tables through June; however, in the Rocky Mountains, only sites with a water table within approximately 8 to 12 inches of the soil surface during July accumulate peat (Cooper 1990; Chimner and Cooper 2003). This may represent a hydrologic threshold distinguishing wet meadows from fens. Although the relatively stable hydrology of fens may buffer them against the effects of climate change in the near term, their ability to recover from disturbance to the peat body once oxidation has occurred is limited.

Wet meadows are characterized by seasonally saturated soils, but lack the perennial high water tables and organic soils of fens or the large seasonal and inter-annual water table fluctuations characteristic of marshes. Wet meadows lack deep peat soil but have significantly more organic matter than soils in drier meadows or surrounding forests. Like fens, wet meadows also fall within the palustrine system, and, depending upon their vegetation, may be placed in the emergent or scrub-shrub class (Cowardin et al. 1979). Wet meadows can be characterized as depressional, lacustrine fringe, discharge slope, or riparian, depending on several factors such as the availability of water, soil characteristics and topography (Viers et al. 2013). Riparian and discharge slope meadows generally contain flowing surface water, while the surface water in lacustrine fringe and depressional wetlands is often standing (Viers et al. 2013).

Wet meadows typically are dominated by herbaceous perennial vegetation, such as sedges, grasses and rushes. Some riparian shrub species can also be found in wet meadows, and some wet meadows may include a dense cover of riparian shrubs (Viers et al. 2013). The dominant vegetation of wet meadows in the parks depends on many factors, but is influenced primarily by elevation and moisture regime.

Sedges and mosses are characteristic of peat-accumulating wetlands

Both wet meadows and fens are important breeding grounds for invertebrates, which are key elements of many food chains (Holmquist and Schmidt-Gengenbach 2006; Mutch et al. 2008a). They are also important destinations for park visitors, who are attracted to the open vistas, availability of water, and for those travelling with stock, the forage provided by meadow systems.

Dry Meadows — Dry meadows are those that lack surface water for a large proportion of the year. Dry meadows are typically found in upland areas within the subalpine and alpine zones of the park, and are commonly dominated by the perennial shorthair sedge (*Carex filifolia*) (Hopkinson et al. 2013). Although trampling impacts on dry meadows are not as pronounced as in wet meadows, shorthair sedge meadows are subject to reductions in productivity and shifts in species composition when grazed intensively (Cole et al. 2004).

Distribution of meadow types in Sequoia and Kings Canyon National Parks — Defined broadly, there are more than 5,300 meadows that occupy approximately 23,800 acres within the parks (USGS-NPS 2007; Hopkinson et al. 2013; Pyrooz et al. 2014). This represents slightly less than 3% of the parks' area. Meadows are most commonly found in the montane and subalpine zones (elevations between 5,000 and 9,000 feet). Most are 2.5 acres or less in area, though there are a few larger meadows that are around 250 acres in size (Hopkinson et al. 2013). The herbaceous vegetation of the meadows generally includes perennial grasses, sedges, and broadleaf herbs. These habitats may also support moss or lichens, as well as some woody vegetation (NPS 2013c).

For purposes of analysis, meadows were classified according to their hydrologic, vegetation, and soil characteristics into one of five classes. At the wet end of the spectrum, meadows that have saturated soils during most of the growing season can be classified as *fens,* which are mostly peat-accumulating, *fen/wet meadow* complexes with both peat-accumulating and non-peat-accumulating areas, or *wet meadows* with little or no peat accumulation. *Moist meadows* also have saturated soils through a portion of the growing season, but the duration is less than the three previous classes. *Dry meadows* have the shortest period of saturation, and water tables are generally far below the soil surface during the growing season.

Each meadow can also be characterized by the percentage of its area that is peat-accumulating. Multiplying the overall size of the meadow by the percentage of the meadow that is accumulating peat gives an approximate peat-accumulating area.

The breakdown of meadow area and peat-accumulating area by type is presented in table 57. *Moist meadows* contribute the most (39%) to the total area of meadows in the park, followed by *wet meadows* (33%). Meadows with significant peat accumulation contribute a relatively small area: *fen* contributes less than 1% and *fen-meadow* contributes 11%. *Dry meadows* contribute the remaining 18%.

Less than 2% (371 acres) of meadow area in the parks is peat-accumulating. The greatest amount of peat-accumulating area (91%) is in fen-meadow complexes. Fen and wet-meadow mapping classes contribute roughly equal amounts of peat-accumulating area (4% and 5% respectively).

Table 57: Distribution of Meadow Types in Sequoia and Kings Canyon National Parks

Meadow Types	Acres	% of Total	Total Peat-accumulating Area (Acres)	Peat-accumulating Area (% of Total)
Fen	24	0.1%	15	4%
Fen/wet meadow	2,575	10.8%	338	91%
Wet meadow	7,859	33.0%	19	5%
Moist meadow	9,181	38.6%	0	0%
Dry meadow	4,161	17.5%	0	0%
Grand Total	**23,800**	**100%**	**371**	**100%**

Meadows can also be characterized by whether they occur along lakeshores; there are approximately 179.6 miles of meadow edge that occur along lakeshores.

HIGH-ELEVATION LONG-LIVED TREE SPECIES

Four long-lived tree species with special resource or research value grow in the high elevations of the parks' wilderness: whitebark pine (a candidate for federal listing); foxtail pine, Sierra juniper (*Juniperus grandis*), and limber pine (*Pinus flexilis*). Three of the species are relatively common (whitebark pine, foxtail pine, and Sierra juniper) and one quite restricted (limber pine). These species, which do not survive fire well, exist where natural fire is infrequent. Given that, plus the cold, dry conditions of their subalpine habitat, their dead wood can be much older than any living tree (often two to three times older). It can persist, standing or on the ground for millennia.

This wood is a rare and valuable paleo-resource. Foxtail pine wood is particularly valuable. Foxtails can live up to 2,000 years and are climatically sensitive: their annual growth varies markedly with annual climate. As a result, they contain information on annual weather variations (showing measurable year-to-year variation in tree-ring width); long-term climate change (visible tree-line changes or stand-population dynamics and long-term growth trends in response to multi-decade climate trends); abrupt climate anomalies (e.g., frost rings associated with volcanic eruptions that impacted hemispheric temperatures); and information on past fire regimes.

Foxtail pine

Recreational effects on the forests and woodlands formed by subalpine conifers in the parks' wilderness include localized habitat degradation, primarily in the form of soil compaction, and consumption of dead and downed wood for campfires. In some high-elevation areas, fuelwood regeneration does not keep up with the depletion of wood (Davilla 1979). Where campfires have been allowed in places where available dead and downed wood is limited, damage to both live trees and snags and resulting visual or aesthetic impacts has resulted from chopping of live branches and trees. Since attaining status as a candidate for protection under the Endangered Species Act, cutting or removal of whitebark pine by park crews during trail maintenance or fire management activities has largely ceased. Recognizing the sensitivity and slow-growing nature of foxtail pine, Sierra juniper, and limber pine, cutting or removal of these long-lived trees is similarly avoided.

Less apparent than the aesthetic impacts are the subtle ecological impacts resulting from the collection of firewood, from either living trees or dead wood. Both the quantity and quality (e.g., logs versus fine branches) of dead wood are important in ecosystem dynamics (Stokland et al. 2012). Removal of coarse woody debris (more than 3 inches in diameter) can have localized adverse ecosystem effects (Harvey et al. 1979). Decaying coarse woody debris has an unusually high water-holding capacity, and accumulates nitrogen, phosphorus, and sometimes calcium and magnesium. It serves as an important site for nitrogen-fixing microorganisms and as a substrate for seedling establishment. Ectomycorrhizal fungi are concentrated in decayed wood. These organisms develop a symbiotic relationship with a plant's roots, improving the plants' ability to extract water, nitrogen, and phosphate from less fertile soils. As a result, elimination of coarse woody debris is likely to reduce site productivity, particularly on dry and infertile soils (Hendee and Dawson 2002). Wood collection also extends the area of impact around a campsite (Cole and Dalle-Molle 1982).

The following paragraphs describe foxtail pine, limber pine, and Sierra juniper at the parks. Whitebark pine is included in the "Special-status Species" section, as it is a candidate for federal listing.

Foxtail Pine — The heart of the distribution of the southern foxtail pine is found in the headwaters of the Kern River watershed in Sequoia National Park, although the species also exists at high elevations in the Kaweah and southern portions of the King River drainages. North of the Kings-Kern Divide, foxtail pine gives way to whitebark pine as the dominant high-elevation conifer, with the northernmost stands found in the Bench Lake area on the south fork of the Kings River. In the two parks, foxtail pine is found on gentle to steep subalpine slopes of varying aspects between 8,220 and 12,560 feet. Strip bark growth form and trees with multiple crowns are seen with trees typically exceeding 1,000+ years in age. The parks contain approximately 61,260 acres of suitable foxtail-pine habitat. The open tree canopy is dominated by foxtail pine, but may also include red fir (*Abies magnifica*), Sierra juniper, whitebark pine, lodgepole pine, limber pine, Jeffrey pine (*Pinus jeffreyi*), or western white pine (*Pinus monticola*).

Limber Pine — Limber pine has a restricted distribution in the parks, limited to isolated trees and small stands found almost exclusively in the Kern watershed, where it grows on moderate to steep southwest to northeast facing slopes between 7,320 and 11,620 feet. A total of 1,344 acres of limber pine has been mapped in the two parks (NPS 2007b). The tree canopy of this seldom-encountered type is characterized by the presence of limber pine, but may include red fir, whitebark pine, foxtail pine, lodgepole pine, Jeffrey pine, and/or western white pine. In stands near the Sierra Crest east of the Kern Canyon, the canopy is most frequently codominated by foxtail pine; west of the Kern, lodgepole pine is more dominant.

Sierra Juniper — Sierra juniper is found throughout the two parks at sites between 6,450 and 10,950 feet. Because this species has low resistance to fire-caused injury, old trees (individuals reaching 500 to 1,000 years in age are common) are typically located on steep rocky slopes or canyon walls where discontinuous fuels and physical barriers limit fire spread. A total of 20,984 acres of Sierra juniper has been mapped within the two parks (NPS 2007b). Jeffrey pine, red fir, foxtail pine, lodgepole pine, and western white pine are also common associates. Note: Because Sierra juniper was previously classified as western juniper, some figures and tables in the EIS refer to it as JUOC, the botanical abbreviation for western juniper.

ALPINE VEGETATION

At higher elevations, the climate becomes increasingly inhospitable for trees. Closed forests in the montane zone give way to sparse woodlands in the subalpine zone, and then to a treeless area called the alpine. The wilderness of Sequoia and Kings Canyon National Parks protects most of the subalpine and alpine environment of the southern Sierra Nevada of California. With nearly half the area of the parks (48%) above 10,000 feet, they are dominated by high-elevation habitats. Crowning the tops of mountain systems worldwide, the alpine ecosystem is considered quite rare from a global perspective (Heywood 1995), making the protected status of the Sierra Nevada alpine critical to the conservation of alpine ecosystems worldwide. In these environmentally extreme and biogeographically isolated highlands, life is tightly constrained by harsh growing conditions. Despite this, the alpine is rich in biodiversity. Although at first glance the high peaks and tablelands may appear nearly devoid of life, the alpine flora of the Sierra Nevada includes approximately 600 species of vascular plants (Major and Taylor 1988), with at least 200 of those restricted to the alpine zone (Sharsmith 1940). Dominated by slow-growing perennial plants that are adapted to the extreme climatic conditions that characterize high elevations, alpine vegetation is thought to be particularly vulnerable to the shifts in temperature and snowpack dynamics predicted under anticipated climate change scenarios. In the context of the alternatives evaluated in this plan, the primary impacts of concern are trampling by cross-country hikers or stock, especially in those areas where new routes may become popularized and established.

Delineating a boundary between the alpine and subalpine poses an ecological and cartographic challenge. Although at the landscape scale it may appear that the transition between the subalpine and the alpine occurs at a distinct elevation, alpine species are found not only above the treeline, but also in openings in subalpine woodlands (Major and Taylor 1988). Subalpine and alpine communities thus intermix and create a mosaic of vegetation types over a range of elevations and environments.

To describe the distribution of the alpine in Sequoia and Kings Canyon National Parks, vegetation associations and mapping units from the parks' vegetation map were used (USGS-NPS 2007). Two categories of associations were recognized: those that are exclusively alpine and those that could be considered conditionally alpine (occurring both in the alpine and subalpine). The vegetation types and mapping units used to define the alpine of the two parks are listed in table 58.

Table 58: Vegetation Associations and Mapping Units Recognized in the Alpine of Sequoia and Kings Canyon National Parks

Exclusively Alpine Mapping Units	Conditionally Alpine Vegetation Types and Mapping Units (if occurring above 10,000 feet)
Alpine Talus Slope	Boulder Field
Alpine Scree Slope	Dome
Alpine Snow Patch Communities	Intermittently to Seasonally Flooded Meadow
Alpine Fell-field	Mesic Rock Outcrop
Alpine Permanent Snowfield/Glacier	Oceanspray Shrubland Alliance
	Semi-permanently to Permanently Flooded Meadow
	Shorthair Sedge Herbaceous Alliance
	Sierra Willow/Swamp Onion Seasonally Flooded Shrubland Alliance
	Sparsely Vegetated Riverine Flat
	Sparsely Vegetated Rocky Streambed
	Sparsely Vegetated to Non-vegetated Exposed Rock
	Sparsely Vegetated Undifferentiated
	Upland Herbaceous
	Water
	Willow spp. Riparian Shrubland Mapping Unit
	Willow spp. Talus Shrubland Mapping Unit
	Willow spp./Meadow Shrubland Mapping Unit

Source: USGS-NPS 2007

Using the classification rules described above, 275,915 acres of these parks are mapped as alpine habitat. Of this total, approximately 45% (124,147 acres) is mapped as exclusively alpine, while the remaining 55% is derived from "conditionally alpine" mapping units (treeless types occurring above 10,000 feet). Taken together, the alpine habitats defined here account for approximately 32% of the area encompassed by the two parks (Haultain 2013).

PLANTS OF CONSERVATION CONCERN (PARK SENSITIVE PLANT SPECIES)

Sequoia and Kings Canyon National Parks support a rich and diverse vascular flora composed of more than 1,560 taxa. Of these, only one plant species from the parks is listed under the California Endangered Species Act, and one is under review for federal endangered listing. However, an absence of threatened and endangered species recognized by Endangered Species Acts is not equivalent to an absence of species at risk. The parks are home to an additional 77 vascular plant and non-vascular species and subspecies of conservation concern that have been ranked as rare by the California Native Plant Society (CNPS) and the California State Natural Diversity Database (CNDDB) (Huber et al. 2013). These plants have no federal or state status but may be recognized as rare in California, have extremely limited distributions in the park, represent relict populations from past climatic or topographic conditions, or occur at the extreme extent of their range. They are distributed throughout wilderness and inhabit a wide range of environments along the elevation gradient that characterizes the parks. Of these 77 plants of concern (also referred to as park sensitive), 29 have been retained for analysis within this plan; they are listed in appendix O.

A relatively small proportion of the planning area has been systematically surveyed for park sensitive plants. What is known about their distribution and abundance within the parks is based on a number of NPS investigations conducted between 1980 and 2013, holdings at regional herbaria, and observation data housed in the CNDDB. These data sources are described in detail by Huber et al. (2013), which together with the most recent CNPS Rare Plant Inventory (CNPS 2014) and CNDDB Special Vascular Plants, Bryophytes, and Lichens List (January 2014) was used in the development of appendix O and subsequent analysis of environmental effects. Many of the known populations tend to be near trail corridors, in meadows visited as part of the park monitoring program, or within specific inventory plots, which reflects where most of the search effort has been focused. This implies that additional undiscovered populations may exist in wilderness, especially in less accessible areas.

Relative to the vascular flora, much less is known about the presence, distribution, and abundance of bryophytes in the parks. Four datasets served as the primary source of information about bryophytes in the two parks as reported in Huber et al. 2013: the *NPS Inventory and Monitoring Wetland Ecological Integrity Surveys*; James Shevock's personal dataset (which includes records of specimens collected by him and others); the CNDDB; and the parks' herbarium holdings.

The 29 plants retained for analysis in chapter 4 are those that exist in habitats that are more likely to be impacted by recreational or administrative activities, and include those that are found in meadows used by stock, uplands open to cross-country travel by stock, and destinations popular with rock climbers and cross-country hikers.

NONNATIVE PLANT SPECIES

Nonnative plant species are species that have been introduced in areas outside the range of where they originated or where they naturally exist (Tu et al. 2013). Invasive species are nonnative plant species that can establish in natural habitats, where they can outcompete or displace native plants, provide unsuitable forage or nesting sites for native wildlife species, alter gene pools through hybridization, or alter vital ecosystem processes such as fire, hydrology and nutrient cycling (Chornesky & Randall 2003). The threat of nonnative and invasive species in the parks has been known for some time, and current management activities and programs have been implemented to address the monitoring and control of nonnative and invasive species at the parks (Tu et al. 2013).

Surveys have detected 219 nonnative plant taxa present within the parks (Tu et al. 2013). These taxa were introduced by humans, either deliberately (cultivated) or accidentally. Of these, 78 are currently considered invasive (Gerlach et al. 2003; Tu et al. 2013). Of the invasive species, 54 were assessed as causing or having the potential to cause serious negative impacts on native vegetation, were restricted to a small number of sites, and require management to eliminate or isolate the population (these comprise Management Category 1). Twenty of the species were assessed as having a lesser effect on native vegetation and were also restricted to a small number of sites (Management Category 2). Many Category 2 species could be feasibly managed along with Category 1 species without expending significant additional effort. Lastly, four species were assessed as causing serious negative impacts on native vegetation, were widely distributed throughout the parks, had increasing ranges, and would be difficult or impossible to eliminate (Management Category 3).

The invasive plant species of highest concern in wilderness include those that spread rapidly, form persistent seed banks, are difficult to detect and identify, and/or cause severe ecological impacts (that is, they displace native species and habitats, reduce local diversity, form monotypic stands, or alter ecosystem processes such as hydrologic regimes, biogeochemical cycling, fire regimes, and other disturbance regimes). The species of highest concern in these parks' wilderness include smooth brome (*Bromus inermis*), cheatgrass (*Bromus tectorum*), velvet grass (*Holcus lanatus*), reed canary grass (*Phalaris arundinacea*), oxeye daisy (*Leucanthemum vulgare*), yellow star thistle (*Centaurea solstitialis*), and Himalayan blackberry (*Rubus armeniacus*). Other species of concern such as bull thistle (*Cirsium vulgare*), orchard grass (*Dactylis glomerata*), and prickly lettuce (*Lactuca serriola*) may not cause ecological impacts that are as severe as the species of highest concern, but can also spread rapidly and contribute to reduced diversity of native species locally.

Distribution and abundance of nonnative plants are influenced by many factors, including elevation, disturbance, sources of introduction and spread, stock use, and the ability of the NPS to prevent, detect and manage nonnative species. Following are discussions on elevation, disturbance, and sources of introduction and spread.

Elevation — In the Sierra Nevada, the strongest variable associated with the distribution and abundance of nonnative plants is elevation. Gerlach et al. (2003) found that nonnative species richness in Sequoia and Kings Canyon National Parks is strongly negatively correlated with elevation, even when site type (e.g., campground, pack station, trail) is considered. Keeley et al. (2003) similarly concluded that nonnative species richness and cover declined with increasing elevation, and added that a history of cattle and sheep grazing, as well as fire severity and time since fire, are important determinants of nonnative plant presence. D'Antonio et al. (2004) found that nonnative plant species present in the Sierra Nevada tend to occupy lower elevation (below 5,900 feet) meadows and foothill woodland/grasslands, while fewer nonnative species occupy intact conifer forest areas and higher elevation meadows (above 5,900 feet). The understory of the lower elevation oak woodlands in the western portions of the parks is dominated by nonnative plant species (Parsons and Stohlgren 1989).

There are multiple factors influencing this relationship between elevation and nonnative plant species richness and cover. Current, low levels of invasion observed globally at high altitudes might be explained by increasing climatic severity (negative effect on invasion) and decreasing human disturbance and propagule pressure with increasing altitude (Pauchard et al. 2008). Montane plant communities have greater tree canopy cover and thus decreased light levels at the soil surface. With increasing elevation, plant communities have reduced growing seasons, decreased soil aridity, different disturbance regimes, decreased potential propagule sources, and decreased frequency and severity of past and present human disturbance (Keeley et al. 2003). Sixteen nonnative plant species have been detected above 7,000 feet elevation. The most invasive of these are velvetgrass (*Holcus lanatus*), foxglove (*Digitalis purpurea*), Himalayan blackberry, woolly mullein (*Verbascum thapsus*), reed canary grass, bull thistle (*Cirsium vulgare*), cheatgrass, and Kentucky bluegrass (*Poa pratensis*) (Tu et al. 2013).

Disturbance — In the parks and the Sierra Nevada, nonnative plants are more abundant in disturbed areas. The USGS conducted a survey to fully inventory invasive plants in both human and naturally disturbed habitats, such as river corridors, campgrounds, developed areas, roadsides, trailsides, pack stations, pastures, and montane meadows. This survey, conducted 1996 to 1998 (Gerlach et al. 2003), produced a nonnative plant list of 209 nonnative plant taxa (Tu et al. 2013). Maps show a pattern of nonnative plant distribution along roads, trails, and valley bottoms (Tu et al. 2013). Riparian habitats are particularly at risk for the introduction of nonnative species because of the regular disturbance in these habitats, the ease of propagule transport along streams and rivers, and the abundant moisture present (Moore and Gerlach 2001, 1).

In particular, park staff observe that probability of invasion is highest in areas where recent or continued disturbance and propagule introduction overlaps with high resource availability, such as trail crossings of meadows, streams, or seeps; sites with recent fires; locations with past and current stock activity; and areas of high visitor use.

Sources of Introduction and Spread — Introduction of species into the parks' wilderness depends in part on whether surrounding areas have been invaded, and on the vectors available to transport the plant or its propagules into wilderness. Natural transport vectors, such as wind, animals, and water, can move propagules. Plants or propagules may also be transported by human activities that import materials into the parks. These materials may include equipment, soil, sand, gravel, hay, straw, cultivated plants, car tires, clothing, and shoes. Nonnative plant establishment is most successful in current and past natural and human-caused disturbances such as roads, trails, developed areas, recently burned areas, helicopter landing sites, camps, and riparian sites. Most of the mapped invasive plant populations in the parks' wilderness are found along trails, which are recognized as important vectors for the dispersal of invasive plants into the cores of protected areas (Mutch et al. 2008b).

Potential vectors in the wilderness include hikers, their equipment, helicopters, and stock. While seed adherence to hiker boots, clothing, and equipment can transport nonnative plant propagules into wilderness, stock used on recreational trails represent a potentially important dispersal vector for nonnative plants into western wildlands (Wells and Lauenroth 2007, Hammit and Cole 1987). Stock can pass large numbers of seeds through their digestive tracts. Seeds can remain viable in the gut for several days. St. John-Sweeting and Morris (1991) found that peak seed transmission occurred three to four days after consumption, with some species being transmitted up to ten days later. Vander Noot (1967) found that 84 % of ingesta were transmitted after two days and 99.8 % transmitted after four days. Janzen (1981) found that a tropical seed species remained viable in horse digestive tracts for up to two months. Therefore, nonnative plant seeds that were ingested in pastures or holding areas well outside the parks have the potential to be transported long distances into the parks' wilderness. Many of the detections of nonnative plants in the parks' wilderness are pasture grasses, including orchard grass (*Dactylis glomerata*), velvetgrass, barley (*Hordeum* spp.), reed canary grass, cultivated timothy (*Phleum pretense*), and Kentucky bluegrass.

CLIMATE CHANGE AND VEGETATION

With the warmer temperatures, decreasing snow pack, and increasing water deficit predicted for the Sierra Nevada, changes are expected in the locations of ideal habitat for many plant species (Huber et al. 2013). As a consequence, the distribution and abundance of many plants may shift significantly along the climate gradient, which is largely aligned with elevation but also includes other important physical factors. The sensitivity of an individual species to climate change can be determined by a number of factors, including dispersal ability; temperature, moisture and substrate requirements; dependence on snowpack extent and duration; genetic diversity; and reliance on special interactions between particular species of herbivores and pollinators (Anacker et al. 2013). Because information about these species-specific factors is largely lacking for most wildland plants (and particularly so for rare species), it is difficult to predict how they will respond to changing conditions (Lomba et al. 2010). The capacity of both vascular and nonvascular plants to respond to a warming environment will also be affected by changing disturbance regimes, such as the frequency and intensity of fire, extreme weather events including drought and increased storm activity, and other global change factors. In the following section, the potential impact of predicted changes in climate are briefly discussed for wetlands, meadows, high-elevation long-lived conifers, alpine communities, plant species of conservation concern, and nonnative plants.

Wetlands and Meadows — Wetlands, which are defined by their underlying hydrologic regime, are thought to be directly vulnerable to forecasted changes in the type, amount and seasonal availability of precipitation. In the montane, subalpine and alpine zones, wetlands and meadows receive much of their water from snowmelt, from both surface flow and through groundwater recharge. The increases in temperature which are expected to continue to cause a greater proportion of total precipitation to fall as winter rain, as opposed to snow, and to drive earlier snowmelt, are likely to have consequences for the hydrology and functioning of these systems. Although the high elevation meadows of the southern Sierra may prove to be somewhat buffered from these effects, as they are currently well above the average snowline, those closer to snowline are not (Viers et al. 2013). Meadow vegetation may also be vulnerable to increases in high velocity run-off events (floods), which have the potential to destabilize streambanks and lead to increased erosion and stream incision; incised channels can lower water tables and alter the hydrologic conditions that allow wetland and meadow vegetation to occur.

Changes in climate also have the potential to impact processes such as productivity and carbon cycling. How different meadow types will respond to these changes is likely to vary. In a seven-year study of annual net primary productivity in dry, moist and wet meadows in Yosemite National Park, Moore et al. (2013) described the patterns and variability in aboveground live vascular plant biomass in relation to climate. Their results suggest that, under projected warmer and drier conditions, annual above-ground net primary productivity may increase in moist meadows but remain unchanged in dry meadows. Recent research in two meadows of the central Sierra suggests that multiple years of stress (such as extreme drought, or frost events exacerbated by a lack of protective snowpack) may have the potential to lead to dramatic shifts in vegetation and have significant consequences for carbon cycling (Arnold et al. 2014).

High Elevation Long-lived Trees — Contemporary high elevation long-lived tree species in the Sierra Nevada have experienced variation in late Holocene climate over the last several millennia, which has resulted in a dynamic treeline ecotone, changing at decadal to century time scales. With future climate changes high elevation forests will be critical barometers for detecting and characterizing effects and responses of vegetation. However, the climatic effects will be complex (Bunn 2004; Ettinger et al. 2011) with upper and lower areas of high elevation forests likely affected differentially as trees respond to varying environmental factors, such as warming temperatures, CO_2 fertilization, changes in the summer moisture deficit, the timing, frequency, and extent of wildfires, and biotic interactions. Forest treeline that is currently temperature limited may expand into alpine sites while CO_2 fertilization may increase tree growth rates (Salzer et al. 2009) but could also result in decreased longevity of individuals (Bugmann and Bigler 2011). At lower elevations competitive interactions with lower elevation species, also expanding their elevational range, could increase. This may result in the expansion of more fire prone forests (red fir), which would be detrimental to relatively fire intolerant high elevation species. Increasing temperatures may also permit outbreaks of species such as bark beetles, which have already caused dramatic changes in some high elevation forests in the Rocky Mountains (Bentz et. al. 2010). Because of this complexity there is uncertainty in predicting long-term vegetation changes in these long-lived species. Most changes in high elevation forests will occur over long time scales, from many decades to centuries. However, exceptions might be the rapid changes that accompany events such as wildfire or bark-beetle disturbances outside the natural range of variability, which could trigger vegetation type conversions at local to watershed scales.

Alpine Vegetation — Dominated by slow-growing perennial plants that are adapted to the extreme climatic conditions that characterize high elevations, alpine vegetation is thought to be particularly vulnerable to the shifts in temperature, growing season, and snowpack dynamics predicted under anticipated climate change scenarios. Although considerable uncertainty exists regarding how vegetation will respond to these changes, simulation models evaluated under nine different climate scenarios by Lenihan et al. (2008) agreed in predicting significant loss—on average, a 66% reduction in areal extent--of alpine and subalpine habitat in California. However, recent field research results suggest that the extensive microclimate heterogeneity found in the alpine environment may provide diverse thermal niches, or refugia, for alpine plants to colonize and re-establish in (Graham et al. 2012; Birks 2013).

Small-scale habitat diversity may thus confer more resilience to the alpine flora as a whole than is currently predicted by coarse-scale dynamic vegetation models.

Plants of Conservation Concern — It is also expected that many of the traits that confer rarity in plants—limited geographic range, small population size, limited dispersal ability, and habitat specificity--may increase the vulnerability of the park's sensitive plants to such changes (Anacker et al. 2013). As with animals, some plant species with restricted distributions may become further limited in both distribution and abundance, while others could expand or shift their ranges. As noted above, the lack of species-specific information about plants with limited or restricted distributions hampers the ability to predict how individual species will respond to a changing climate. Vascular and non-vascular plant (including plants of conservation concern) responses to climate change will depend not only on their physiological tolerances but also on their phenology, establishment properties, biotic interactions, and capacity to evolve and migrate.

Nonnative Plant Species — With the warmer temperatures, decreasing snow pack, and increasing water deficit predicted for the Sierra Nevada by climate change models, some nonnative plant species may find suitable habitat at increasingly higher elevations. Previously, propagules may have been introduced to disturbed soils at mid- to high-elevations, but the climate envelope was unsuitable and the species did not establish. In the future, the same propagule pressure and disturbance level at a given elevation may result in more frequent and successful nonnative plant establishment because the area is now within the climate envelope for additional species. Higher-elevation areas that have, until now, been relatively resistant to nonnative plant invasions may become more susceptible (Pauchard et al. 2009) and novel species that have not previously found suitable habitat in the parks may successfully establish.

Although the distribution and abundance of individual plant species, the composition of plant communities, and nonnative plant establishment patterns may shift significantly in response to changes in climate, at this time the effects of climate change are not expected to interact significantly with the potential impacts from human activity in wilderness. Therefore, climate change impacts on vegetation are not further analyzed within each alternative in chapter 4.

WILDLIFE

INTRODUCTION TO WILDLIFE

There are essentially two general forms of wildlife impacts caused by human activities in the parks' wilderness: impacts on wildlife behavior and impacts on wildlife habitat. The disturbances in wilderness are generally not measurable and are localized, affecting individuals, but not affecting the species or habitat overall. The alternatives in the plan, however, may have an effect on several species. Wildlife with the potential to be affected by the alternatives, which will be further evaluated in chapter 4, include black bears, birds, and invertebrates. Special-status species will be considered separately.

BLACK BEAR

The black bear (*Ursus americanus*) is an important and commonly observed wildlife species in the parks. Black bears are widely distributed, occupying a diverse variety of habitats from the oak woodlands of the foothills up to the subalpine zone. No population estimates are available but several hundred bears are likely present and the population is considered stable. Black bears are a focal attraction for visitors, and the opportunity to see a bear contributes significantly to the public's enjoyment of the parks. However, interactions between people and bears increase the probability that bears will become habituated and/or food-conditioned—behaviors that must be managed because they often result in negative impacts on both bears and people (McCullough 1982; Herrero 1985). Because the NPS is mandated to both conserve wildlife and provide for the public's enjoyment of that wildlife by the NPS Organic Act, managing human/bear interactions to minimize habituation and food-conditioning, yet still provide viewing opportunities, is a challenging endeavor. In this context, these two mandates of the NPS Organic Act create a management dilemma.

Bears that associate people with food (i.e., they are food-conditioned) often become aggressive towards people and must be lethally removed out of concern for public safety. The national park environment is ideal for the development of these behaviors because with a high amount of public visitation, bears frequently encounter people without experiencing negative consequences; as a result they often tolerate people in close proximity or become comfortable foraging on natural foods within developed areas (i.e., they are habituated). Once habituation occurs, access to human food can result through intentional (e.g., hand-feeding) or though unintentional means (e.g., improperly secured food-storage containers), and bears "graduate" from being habituated to being food-conditioned. Extinguishing food-conditioned behavior is particularly difficult because the behavior is transmitted across bear generations. For example, Mazur and Seher (2008) found that roughly 80% of bears that foraged for human foods with their mothers as cubs continued this behavior as independent adults. Although aversive conditioning techniques, such as chasing, projectiles, and pepper spray have had some success in lessening food-conditioned behavior, lethal control is still necessary in many cases (Mazur 2010). Black bears are adept at problem solving, and as a result food-storage techniques have had to increase in sophistication as bears have learned to defeat them (Mazur 2008). In wilderness, this progression has gone from sleeping next to one's food, to hanging food over a branch with a rope tied to a tree, to suspending food over a branch without using side ropes (i.e., counterbalancing, which can be effective but is extremely difficult to perform correctly), to the use of food-storage boxes and portable bear-resistant containers (Mazur 2008). A discussion of food-storage techniques and the associated impacts with these techniques can be found in "Chapter 4: Environmental Consequences."


Photo Courtesy of Isaac Chellman

Black bear in LeConte area

Between 1959 and 2009, 14,450 black bear incidents were reported in the parks, averaging 283 incidents per year. Over the same time period, property damage caused by bears (e.g., breaking into vehicles or buildings to obtain human food items) exceeded $2.3 million, averaging $46,103 per year when adjusted for inflation. The vast majority of these incidents occurred in non-wilderness. Wilderness bear incidents have declined substantially in recent years, yet conflicts still occur annually. While there has been a promising downward trend in bear incidents parks-wide for the past decade, the historical record indicates that periodic eruptions of conflict occur, likely related to failures of mast crops (the fruit of forest trees, e.g., acorns). Over the long term, there is no downward trend overall.

Modern bear management began in 1972, with the development and implementation of a *Sequoia and Kings Canyon National Parks Bear Management Plan* that shifted management focus away from bear control (i.e., relocating problem bears and destroying dangerous ones) to a proactive approach that emphasized control of human food, visitor and employee education, enforcement of food-storage regulations, use of efficient bear handling procedures, and reporting of bear incidents and management actions (Zardus and Parsons 1980). Several revisions of the 1972 plan have been made, most recently in 1992. The 1992 revision is the plan the parks operate under today.

BIRDS

The Sierra Nevada is home to a rich assemblage of bird species. Austin et al. (2013) list 203 bird species that are confirmed to maintain a presence in the parks, while Schwartz lists 212 bird species (Schwartz et al. 2013). Twenty-seven species have either a state or federal listing status or both (appendix L). The diversity of habitats within the parks and the lack of extensive development provide an important refuge for many bird species, and birds are found from the foothill zone up to the top of Mount Whitney. Bird diversity is closely correlated with the major river canyons of the parks. Overall, the low-lying southwestern region has the highest diversity, and this peak diversity is associated with montane hardwoods, montane riparian habitats and water.

Some of the common bird species in the parks include the dark-eyed junco (*Junco hyemalis*), mountain chickadee (*Poecile gambeli*), yellow-rumped warbler (*Setophaga coronata*), Steller's jay (*Cyanocitta stelleri*), red-breasted nuthatch (*Sitta canadensis*), American robin (*Turdis migratorius*), California towhee (*Pipilo crissalis*), western tanager (*Piranga ludoviciana*), American kestrel (*Falco sparverius*), and Anna's hummingbird (*Calypte anna*) (Holmgren et al. 2012, NPS 2013b).

A Clark's nutcracker (*Nucifraga columbiana*), whose call is familiar in the highcountry

A variety of visitor and administrative activities potentially impact bird species in the parks. These include (1) stock grazing, which may alter bird habitat positively or negatively (depending on the species considered) or facilitate invasion of brown-headed cowbirds (*Molothrus ater*) that parasitize the nests of dozens of host species (see Steel et al. 2012 for a list of known host species); and (2) hiking and camping, rock climbing, or intrusive birding, which may cause disturbance to nesting birds, impacting reproductive success. Because birds are a highly diverse group with varying habitats needs and life histories, not all species would be impacted in the same manner or at the same intensity.

The nonnative brown-headed cowbird has the potential to affect native bird species. The brown-headed cowbird has expanded its range in California since the 1930s as a result of human activities, particularly those associated with cattle and stock operations (NPS 2013c). The preferred foraging habitat of this species includes heavily grazed meadows and open areas (Graber 1996). Brown-headed cowbirds are nest parasites, and have been known to parasitize the nests of dozens of Sierra Nevada bird species. This species does not produce a nest of its own. Females lay eggs in the nests of host species and do not participate in the rearing of their own offspring, which allows females to lay up to 40 eggs in a season in multiple different nests (Siegle and Ahlers 2004). The host birds act as unknowing foster parents, sometimes at the expense of their own offspring. The cowbird eggs hatch more quickly than other bird eggs, allowing the cowbirds to get more food from the foster parents. Cowbird eggs also have thick shells, and may crush other eggs in the nest when they are rolled around or when they are laid (Siegle and Ahlers 2004). Because cowbirds are obligate nest parasites, there is concern about their impacts on a variety of open-cup-nesting native bird species, most notably flycatchers, vireos, and warblers; cowbirds have been hypothesized to be a contributing factor to the range-wide decline of many songbird populations (NPS 2013c). Most brown-headed cowbirds observed within the parks have been in relatively open forests and forest boundaries at lower-elevation sites and near roads, although they have also been observed throughout much of the parks (NPS 2013c). Observations of brown-headed cowbirds peaked in the 1980s, with few observations in recent years.

INVERTEBRATES

Invertebrate species have not been inventoried in the parks, and thus the number of species is not known. Of all animal species present in the parks, it is likely that ≥97% are invertebrates (Buchsbaum et al. 1987). Invertebrates can be found throughout all elevations and waterbodies within Sequoia and Kings Canyon National Parks (NPS 2013c). Some of the more familiar taxa are arthropods (e.g., insects, spiders, centipedes, etc.), mollusks (e.g., snails), and annelids (e.g., earthworms). The most abundant groups in aquatic habitats in the montane areas are primitive minnow mayflies, spring stoneflies, black flies, midges, and fingernail clams. In terrestrial subalpine meadows, the most abundant invertebrates are mites, ants, leafhoppers, lesser dung flies, sheetweb and dwarf spiders, slender springtails, short-horned grasshoppers, bugs, beetles, butterflies and moths, flies, and spiders. The most abundant terrestrial montane meadow families are the lesser dung fly, leafhoppers, pomace flies, delphacid planthoppers, mites, rove beetles, and braconid wasps. The parks are also publicized for their abundance of cave-dwelling species (e.g., Anderson 2010). There are no species that are federal or state listed, although information to make status assessments, particularly of the cave fauna, is quite limited. The invertebrates that could be affected by the alternatives in this plan include those occupying meadows, riparian areas, and areas around trail corridors and popular visitor-use and camp areas.

Erman (1996) speculated that aquatic invertebrate species richness and diversity has declined over the past 200 years in the Sierra Nevada due to a variety of land-use changes, including conversion of running water to standing water, sedimentation from mining, logging, grazing, roads and construction, loss of riparian cover from grazing, removal of coarse woody debris, stream diversion into ditches and pipes, heavy metal contamination, ground water pumping, exotic fish/fish introductions, and use of rotenone and other pesticides on a large scale. In contrast, writing in the same volume as Erman (1996) – the Sierra Nevada Ecosystem Project reports to Congress – Kimsey (1996) provided no speculation about historical human impacts on terrestrial insects in the Sierra Nevada, restricting the analysis to a description of the taxa present with a focus on areas of endemicity.

While the parks have not experienced most of these major disturbances, invertebrates may be impacted, both positively and negatively, by a variety of ongoing human-induced manipulations of habitat in wilderness, the most important of which are the presence of nonnative trout, trampling (by both people and stock), and grazing by stock. Trampling and stock grazing impacts on invertebrates will be evaluated in "Chapter 4: Environmental Consequences," but nonnative trout will not be evaluated because there are no alternatives that would modify trout conditions. There are also a variety of minor disturbances, such as removal and consumption of downed wood for campfires, increased nutrient availability from discarded food scraps at campsites, and exotic vegetation removal that may impact invertebrates, but there has been no research to address these subjects and it is likely that effects are localized and of negligible impact and will not be evaluated in chapter 4.

CLIMATE CHANGE AND WILDLIFE (INCLUDING SPECIAL-STATUS WILDLIFE)

Many aspects of wildlife ecology may be influenced by a changing climate, such as shifts in species distribution (often along elevational gradients), the timing of life-history events (such as breeding and migration), and demographic rates (such as survival and fecundity). Montane species or others with restricted distributions may experience reduced abundance or even extirpation while other species, including nonnative ones, may increase in abundance and distribution. Climate change may result in decoupling of co-evolved interactions, such as plant-pollinator relationships or predator-prey interactions, direct loss of habitat (e.g., through increased fire frequency or drying/warming of lakes/ponds), and increased spread of disease and parasites (Mawdsley et al. 2009). The effects of climate change on wildlife may be pronounced but are not expected to interact significantly with the potential impacts from human activity in wilderness.

SPECIAL-STATUS SPECIES

Special-status species are plants and animals that are legally protected under state regulations and the federal Endangered Species Act (ESA) of 1973 or other regulations. In this section, the presence of federally and state-listed threatened and endangered species and potential habitat to support these species, as well as candidate species and any designated critical habitat is presented. Presence data were compiled through agency consultation, the collection of existing electronic data, the review of natural resource reports, and the results of field surveys conducted in the parks' wilderness.

- *Endangered species* — If the USFWS determines that a species is in danger of extinction throughout all or a significant portion of its range, it is listed as endangered. Listing as endangered gives the species protection under section 9 of the federal ESA, which prohibits the unauthorized take of a federally listed endangered wildlife species and malicious damage to or destruction of federally listed plant species.
- *Threatened species* – If the USFWS determines that a species is likely to become endangered in the foreseeable future, the species is classified as threatened. Species listed as threatened do not automatically have protection under the federal ESA, but the USFWS has applied most of the same protection described above to threatened species (authorized by section 4(d) of the federal ESA).
- *Candidate species* – Plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the ESA, but for which development of a proposed listing regulation is precluded by other higher priority listing activities.

The California ESA is similar to the federal ESA both in process and substance, and it is intended to provide additional protection to threatened and endangered species in California. The California ESA does not supersede the federal ESA, but operates in conjunction with it. Species listed as threatened or endangered by the ESA and the California ESA are referred to as federally listed and state listed, respectively. The California Department of Fish and Wildlife (CDFW) maintains a list of plant and wildlife species of special concern because of population declines and restricted distributions, and/or because they are associated with habitats that are declining in California. Through the CDFW, the California Natural Heritage Program uses a ranking methodology for plant and wildlife species that was originally developed by The Nature Conservancy. Heritage ranking includes a Global rank (G rank), describing the rank for a given taxon (species) over its entire distribution and a State rank (S rank), describing the rank for the taxon over its state distribution. In addition to the CDFW, the CNPS has developed lists of plants of special concern in California. However, these species are still given equal consideration in this WSP/FEIS compared to the federally and state-listed species that are included in this section.

For federal and state-listed wildlife and plant species, mapped observations were used to determine if special-status species exist within the parks' wilderness. These data were assembled from previous reports or electronic data layers. If specific data were not available, electronic vegetation and habitat data were used to determine the potential for special-status species to occur. While many popular areas in the parks' wilderness are linear features (trails), it is understood that impacts from actions of visitors and stock are not limited specifically to the trails, but could occur beyond these linear features. Although habitats in the parks support many species with special status, only those species potentially affected by this WSP/FEIS are discussed in this section. Special-status species that are considered vagrants (i.e., individuals of species that have been documented in the parks on occasion) are not discussed further because these species are not likely to be affected by the WSP/FEIS due to the short-term nature of their presence at the parks. Federal- and state-listed plants and animals that are considered special-status and exist in the parks' wilderness are presented in appendix L. A total of five threatened and endangered species and associated critical habitat (when applicable) are being considered in this WSP/FEIS. Below are detailed life histories for each of the species evaluated in this WSP/FEIS.

FEDERALLY AND STATE-LISTED AQUATIC AND TERRESTRIAL WILDLIFE SPECIES

Yosemite toad (*Anaxyrus canorus*) — The Yosemite toad is listed as a federally threatened species (USFWS 2014). Under the ESA, designated critical habitat for the Yosemite toad was recently proposed in April of 2013 (USFWS 2013). Critical Habitat Unit 15 (Upper Goddard Canyon) consists of approximately 36,830 acres of federal land, a portion of which is located in the northwest portion of Kings Canyon National Park (see figure 25 on page 335), between the South Fork of the San Joaquin River and the Middle Fork of the Kings River (USFWS 2013).

The Yosemite toad has been found in a variety of high montane, subalpine and alpine lentic habitats. However, it is most commonly found in shallow, warm water areas, including small permanent and ephemeral ponds, normally located in meadows (Mullally 1953; Karlstrom 1962; Kagarise Sherman 1980; Knapp 2003). Toads require a combination of habitat types to support their life history stages including breeding, rearing, foraging, dispersal, and overwintering habitat. Yosemite toads are generally inactive from early October until mid-May to early June, typically hibernating under snow in rodent burrows or crevices under rocks or bushes (Karlstrom 1962; Sherman and Morton 1984). Juveniles appear to remain in their natal meadow for the first year (C. Brown, pers. comm., 2012) and juveniles and adults are often found in moist meadow habitats where they forage. Willow thickets and springs and seeps in adjoining uplands and forests are also important features of dispersal and overwintering habitat (Kagarise Sherman 1980; Martin 2008). Natural meadow depressions, cavities, and holes, such as those created by deer hooves or rodents, or crevices near boulders or logs and vegetation such as willow thickets, provide temporary cover and refuge for juvenile and adult toads. Breeding and rearing takes place in shallow ponds, slow-moving streams, marshes, and along shallow protected shores of lakes (Karlstrom 1962; Kagarise Sherman 1980). Water depth and water temperature appear to be important limiting factors in the survival of eggs and larvae (Kagarise Sherman and Morton 1993). Suitable breeding habitats are often warmer than other aquatic components in the landscape.

Yosemite toads were once a common species in the Sierra Nevada. Estimates suggest that the toad has disappeared from between 47% and 69% of the sites that it previously occupied (Jennings and Hayes 1994; Jennings 1996; Drost and Fellers 1994, 1996). Remaining populations appear more scattered across the landscape and consist of a small number of breeding adults (Kagarise Sherman and Morton 1993). A two-year survey for the Yosemite toad and its habitat was conducted in 2010 and 2011 by the USGS to determine the current status and distribution of this species and the quality of its habitat within the parks. Although the results are currently being published, these recent surveys of suitable Yosemite toad habitat observed the species in approximately 30 meadows (USGS n.d., unpublished data). One or more Yosemite toad individuals were observed in these meadows in a total of 171 instances during the two years of study. The USGS results from 2010 to 2011 combined with additional Yosemite toad observations in the parks since 1993 (NPS n.d. a, unpublished data) show that Yosemite toads have been documented in approximately 42 meadows. The majority of the mapped occurrences are located in the northwestern portion of Kings Canyon National Park, with the most concentrated observations in the upper South Fork San Joaquin. Many of the sites historically occupied by Yosemite toads were still occupied during the 2010 and 2011 surveys — although these occupied sites exhibited very low abundance — or were isolated from other populations (USGS n.d., unpublished data). The only robust population of Yosemite toads in the parks appears to be in the headwaters and bench meadows of the South San Joaquin River. The USGS survey data will be used to conduct a broad-scale modeling effort to identify meadow attributes (e.g., size, elevation, etc.) that can be used to classify specific meadows as suitable for Yosemite toads, even if toads were not present during the project surveys (NPS 2013c). These data are currently being published and peer reviewed.

Multiple factors, both individually and likely through a variety of complex interactions, may have contributed to the Yosemite toad's decline (USFWS 2013). Factors analyzed by the USFWS for their potential impact on this species and its habitat include, in no order of importance: 1) meadow habitat loss and degradation (due to livestock grazing and use, roads and timber harvest, fire management regime, recreation [packstock grazing and use; human and vehicular traffic], dams and diversions, and climate effects); 2) overutilization for commercial, recreational, scientific, or educational purposes; 3) disease or predation; 4) inadequacy of existing regulatory mechanisms; and 5) other factors affecting its continued existence (contaminants, UV-B radiation, climate change, sources of direct and indirect mortality, small population size, and cumulative impacts of extant threats).

The USFWS concluded that the Yosemite toad is likely to become endangered within the foreseeable future based on several primary threats. These include: 1) habitat loss associated with degradation of meadow hydrology consequent to the cumulative effects of historic land-management activities, notably livestock grazing, and also the anticipated hydrologic effects upon habitat from climate change; 2) chytrid fungus, which likely contributed to its decline and may remain an important factor limiting recruitment in remnant populations; and 3) the direct effects of climate change impacting small remnant populations, likely compounded with the cumulative effect of other threat factors (such as disease).

Additional threats considered of currently moderate magnitude to the toad include meadow habitat loss and degradation due to fire management regime, and mortality due to stock use, especially where it coincides with breeding meadows. Threats considered of currently low magnitude include meadow habitat loss and degradation due to roads and timber harvest, dams and water diversions, and recreational land uses; predation and indirect effects from fish; contaminants; UV-B radiation; and mortality due to recreational activity, wildfires, and roads. Factors not considered a threat to the Yosemite toad include overutilization for commercial, recreational, scientific, or educational purposes, and inadequacy of existing regulatory mechanisms.

In the parks, packstock grazing occurs in primary toad habitat (meadows), while recreation may overlap all segments of toad habitat (NPS 2013c). Introduced fish may be having continuing impacts on toad populations, as well. Fish are often not a concern since the toads breed primarily in ephemeral areas where fish are not present (Drost and Fellers 1994). However, during drought years, Yosemite toads have been documented shifting breeding sites from ephemeral ponds to streams (USFWS 2013). This ensures an adequate water supply but increases exposure to introduced trout. Introduced fish may also impact toads by increasing their exposure to diseases. Both viral (Mao et al. 1999) and fungal (Blaustein et al. 1994) pathogens have been known to be shared by fish and amphibians (NPS 2013d).

Of greater disease concern, however, is chytrid fungus, which has recently been shown to be present in many Yosemite toad populations in the Sierra Nevada, including those in Sequoia and Kings Canyon National Parks (Dodge and Vredenburg 2012). The prevalence and spread of this pathogen appears to have coincided with the recorded declines of Yosemite toads in the late 1970s. Chytridiomycosis was first detected in Yosemite toad populations in 1961, became highly prevalent in the late 1970s, and peaked in the 1990s when 85% of museum specimens showed infection (Dodge and Vredenburg 2012). Recent samples collected from extant populations between 2006 and 2011 showed chytridiomycosis ranging from 17% to 26% prevalence. Although infection levels currently appear lower than peak measurements in the 1990s, chytrid fungus remains present in Yosemite toad populations and may be reducing survival during metamorphosis and recruitment through to breeding populations, as has been documented for mountain yellow-legged frogs (Vredenburg et al. 2010). In addition, chytrid infection may interact with changing climate to further suppress recruitment. Overall, it appears the threat to Yosemite toads from chytrid fungus was historically substantial, is likely ongoing, and is thus continuing to pose a moderate risk to the species (USFWS 2013).

Because of its historic abundance, the toad was likely an important link in energy and nutrient cycling within meadow ecosystems. Therefore, past and predicted future losses of the toad could impact food webs and nutrient cycling with potentially significant and important consequences for Sierra Nevada high-elevation wet-meadow ecosystems (NPS 2013d).

Mountain Yellow-legged Frogs – Northern distinct population segment (DPS) of mountain yellow-legged frog (*Rana muscosa*) and Sierra Nevada yellow-legged frog (*Rana sierrae*) — Mountain yellow-legged frogs are a native amphibian species complex within the parks that includes two species (Vredenburg et al. 2007): the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog. Both species are federally listed as endangered (USFWS 2014), while the Sierra Nevada yellow-legged frog is state listed as threatened and the northern DPS of the mountain yellow-legged frog is state listed as endangered (CFGC 2012). Both species are of management concern to the NPS. The USFWS, the NPS, the USFS and the CDFW are currently collaborating on the development of the *Mountain Yellow-legged Frog Complex Conservation Strategy* (NPS 2013d).

At Sequoia and Kings Canyon National Parks, both species of mountain yellow-legged frogs generally live along the eastern boundary of both parks, although some populations occur to the west, such as on the Monarch Divide. Under the ESA, critical habitat for the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog was proposed in April of 2013 (USFWS 2013), including six subunits in the parks (figure 25 on page 335).

Mountain yellow-legged frog

The natural habitats of mountain yellow-legged frogs include mountain lakes, ponds, marshes and streams at elevations that range from 4,500 to 12,000 feet (Stebbins and McGinnis 2012). Due to the fact that they overwinter in waterbodies, and their tadpoles take multiple years to develop, waterbodies that do not freeze solid in the winter or dry out in the summer are required (Lannoo 2005). Open lake and stream edges with a gentle slope seem to be preferred. Mountain yellow-legged frogs are most active during the day. Both species of mountain yellow-legged frogs only exist in high-elevation waterbodies of the Sierra Nevada and southern California and were thought to be one of the most abundant vertebrates in these systems (Grinnell and Storer 1924), providing critical ecological function as predator, prey and agents of energy and nutrient cycling between aquatic and terrestrial ecosystems (Finlay and Vredenburg 2007). Within the montane zone, mountain yellow-legged frogs were reported as inhabiting wet meadows, but streams probably provided the necessary areas for over-wintering and connectivity to other meadows (Pope and Matthews 2001). In the parks, mountain yellow-legged frogs disappeared from many montane areas by the late 1900s (Jennings and Hayes 1994) due to the implementation of a fish stocking program.

The first recorded stocking of nonnative trout into the parks' fishless high-elevation waterbodies occurred in 1870 and unrecorded stockings may have occurred as early as the 1850s (Christenson 1977). Fish stocking continued under the management of various sporting groups, U.S. Army staff, NPS staff, and CDFW (Knapp 1996; Christenson 1977) until the 1970s when the parks began phasing out nonnative fish stocking (Zardus et al. 1977). In 1988, the NPS terminated all fish stocking in Sequoia and Kings Canyon National Parks lakes. Although stocking no longer occurs in the parks, nonnative fish had established self-sustaining populations in approximately 575 waterbodies (Knapp 2003) and in hundreds of miles of stream. The presence of these fish in naturally fishless mountain ecosystems has resulted in negative ecological effects on these systems (Anderson 1971, Bahls 1992, Knapp 1996).

By the early 1900s, mountain yellow-legged frogs generally became rare to extinct in lakes containing nonnative fish, while remaining common to abundant in most fishless lakes (Grinnell and Storer 1924). Studies in the past decade, however, determined that mountain yellow-legged frog populations have disappeared from approximately 92% of historic localities in the Sierra Nevada including the parks (Vredenburg et al. 2007). This decline has largely been attributed to the widespread introduction of nonnative fish (Bradford et al. 1994; Knapp and Matthews 2000) and the recent emergence of disease (Rachowicz et al. 2006).

Chytrid fungus is a recently discovered fungal pathogen (Weldon et al. 2004) that causes a highly infectious disease (chytridiomycosis) in many amphibian species. Studies indicate it recently spread into the Sierra Nevada (Rachowicz et al. 2006; Morgan et al. 2007; Vredenburg et al. 2010) and has infected nearly all remaining mountain yellow-legged frog populations in the parks. Most mountain yellow-legged frog populations severely declined within a few years after becoming infected and many populations have gone extinct. Chytrid fungus has thus been a major factor in accelerating the decline, which was initially caused by the presence of nonnative fish throughout the Sierra Nevada (NPS 2013d). Chytrid fungus is not well understood and is currently being investigated in several studies. A few mountain yellow-legged frog populations are showing evidence of persistence, surviving and reproducing while continuing to be infected (Vredenburg et al. 2010; NPS unpublished data). All persisting mountain yellow-legged frog populations are in fishless areas and had high abundance prior to infection. Eradication of nonnative fish near existing mountain yellow-legged frog populations would allow these populations of frogs to expand (Knapp et al. 2007), and the resulting recovery should increase their chances of long-term persistence (NPS 2013d). Air pollution has also been implicated in the mountain yellow-legged frog decline by depositing contaminants into aquatic habitat, which may make mountain yellow-legged frogs more susceptible to disease (Davidson et al. 2002; Davidson and Knapp 2007; Fellers et al. 2007). In addition, global climate change has been implicated in drying up critical breeding habitat in one mountain yellow-legged frog population (Lacan et al. 2008) and may have more impact in the future.

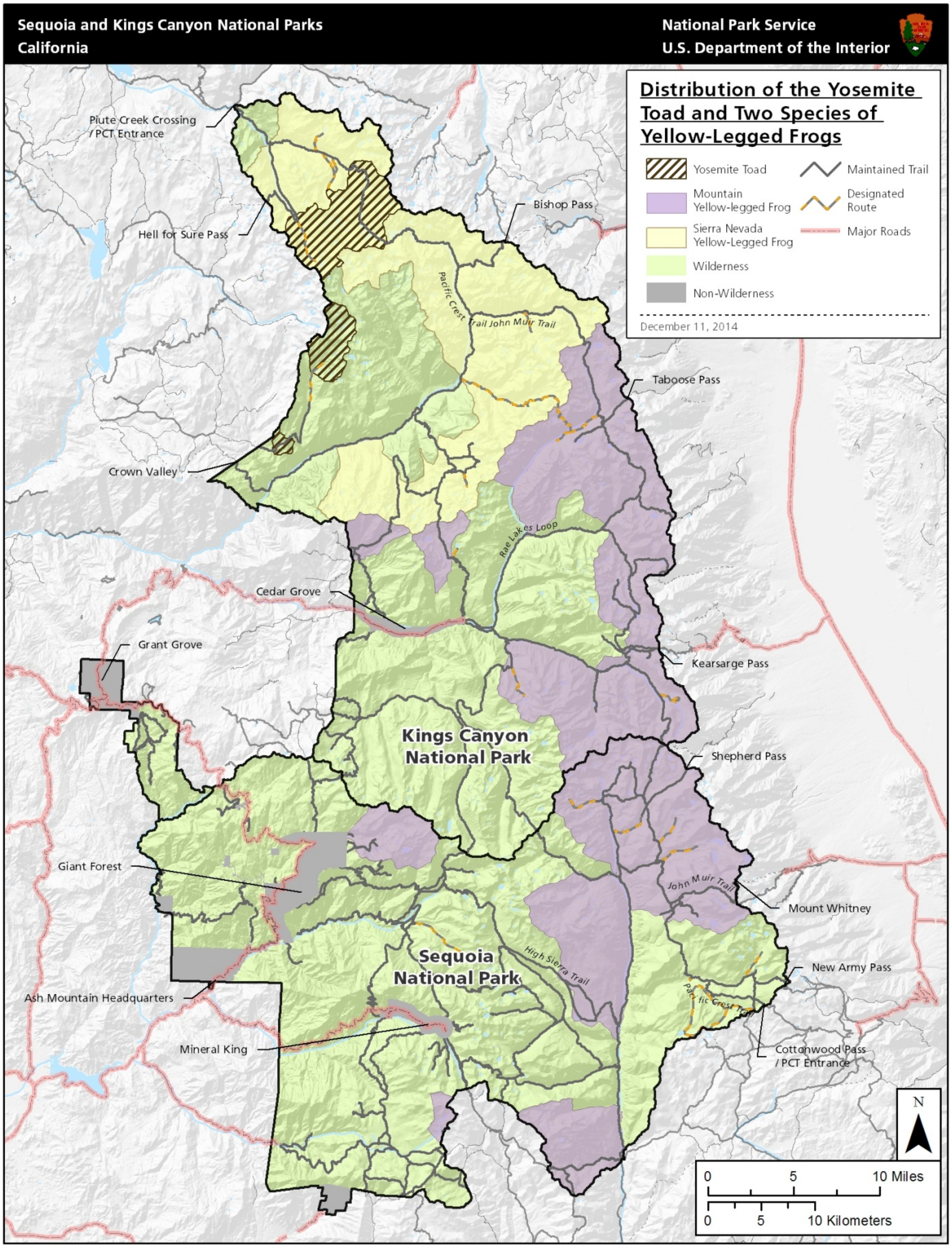

Figure 25: Distribution of the Yosemite Toad and Two Species of Yellow-legged Frogs in Sequoia and Kings Canyon National Parks

The ecological effects of continuing losses of formerly abundant mountain yellow-legged frogs from most of their ranges have been substantial, and current studies indicate that both species are continuing to decline and are on trajectories toward extinction (Vredenburg et al. 2010; Knapp et al. 2011). Because important interactions occur between mountain yellow-legged frogs, other aquatic and terrestrial species, and key ecosystem processes, the presence of mountain yellow-legged frogs in an ecosystem today indicates a system that has retained much of its native species diversity and ecological function, and thus likely has stronger potential for resistance and resiliency to ecosystem stressors and uncertain future conditions (Knapp et al. 2005).

Mountain yellow-legged frogs and proposed mountain yellow-legged frog critical habitat overlap with relatively popular areas of wilderness located near the PCT/JMT, Bishop Pass, Rae Lakes Loop, Mount Whitney area, the HST, and the Lakes Trail. Several lakes where mountain yellow-legged frogs live are directly adjacent to the PCT/JMT and Bishop Pass, and there are a few mountain yellow-legged frog lakes in the Mount Whitney area. One lake occupied by mountain yellow-legged frogs occurs near the HST. There are many more lakes along these trails that historically contained mountain yellow-legged frogs, and visitors can access occupied mountain yellow-legged frog habitat by hiking off trail.

Sierra Nevada bighorn sheep (*Ovis canadensis sierrae*) — These animals have been listed as federally endangered since 2000 (USFWS 2007). At the time of listing, only 122 animals were known to exist (USFWS 2007), making them one of the rarest large mammals in North America. Since then, management actions have focused on minimizing the two primary concerns identified in the recovery plan for the species (USFWS 2007): (1) negative effects of mountain lion predation and (2) the threat of respiratory disease that could result from contact with domestic sheep grazed on public lands. In 2012, the population was estimated at more than 500 individuals (CDFW 2013). With continued support for management, the CDFW projects that recovery goals could be reached by 2022 (Few et al. 2013).

Sierra Nevada bighorn sheep near Forester Pass

Bighorn sheep in the Sierra Nevada use a wide range of elevations, from alpine peaks in excess of 13,120 feet to the base of the eastern escarpment as low as 4,760 feet (Wehausen 1980). Critical habitat for the bighorn sheep was designated in September 2008 (USFWS 2008b); the 93,174 acres of critical habitat within these parks accounts for 22% of the total. In the recovery plan, potential bighorn sheep habitat is divided into 16 herd units, 10 of which are located wholly or partially within the parks (table 59). Of these 16 herd units, 12 have been identified as essential to recovery of the species because of habitat characteristics that make them the most likely areas where recovery will occur (i.e., they are designated critical habitat); eight of the 12 essential herd units are located wholly or partially within the parks, primarily located along the eastern boundary of both parks within wilderness (figure 26 on page 338). This WSP will address visitor and administrative activities throughout the eight areas of bighorn critical habitat located in the parks.

Table 59: Sierra Nevada Bighorn Sheep Herd Units Located Wholly or Partially in Sequoia and Kings Canyon National Parks

Herd Unit Name	Herd Unit Essential	Currently Occupied by Bighorn Sheep
Wheeler Ridge	Yes	Yes
Coyote Ridge	No	No
Taboose Creek	Yes	No
Sawmill Canyon	Yes	Yes
Mount Baxter	Yes	Yes
Mount Gardiner/Bubbs Creek	No	Yes
Mount Williamson	Yes	Yes
Mount Langley	Yes	Yes
Big Arroyo (as of March, 2014)	Yes	Yes
Laurel Creek	Yes	No

The PCT/JMT, Rae Lakes Loop, HST, and Rattlesnake Trail are relatively popular trails that travel through essential herd units. The PCT runs through the eastern side of the parks from north to south and travels through three essential bighorn sheep herd units (Taboose Creek, Sawmill Canyon, and Mount Baxter) and touches the edge of a portion of the Mount Williamson unit. The PCT is also located near the Wheeler Ridge and Mount Langley essential bighorn sheep herd units but is separated by fairly extreme topography. The Rae Lakes Loop travels through the Mount Baxter essential bighorn sheep herd units and travels along the boundary of the Sawmill Canyon unit. Mount Whitney lies between the Mount Williamson and Mount Langley essential bighorn sheep herd units. The HST travels through the Big Arroyo bighorn sheep critical habitat where 10 ewes and 4 rams were reintroduced in March 2014 in an attempt to reestablish sheep populations in this area. The Rattlesnake Trail can be accessed from the Mineral King area and this trail passes through the Laurel Creek essential bighorn sheep herd unit; the Laurel Creek unit does not currently contain any bighorn sheep, but eventual occupancy (most likely through reintroductions) is a requirement of the recovery plan. Finally, Mount Langley is located within the center of the Mount Langley essential bighorn sheep herd unit. This area is a popular off-trail destination.

Bighorn sheep are generally considered to be sensitive to human activity (Krausman et al. 1999) but there are many conflicting reports (Schoenecker and Krausman 2002) and the threshold at which such disturbances become adverse to bighorn sheep population welfare is not clear (Krausman et al. 1999). In a meta-analysis of 59 studies on the subject of ungulate flight responses to human disturbance, Stankowich (2008) noted that factors such as the type of recreation, presence of hunting, history of exposure, availability of alternative habitats, population size, presence of other predators, and physical terrain all interact in different ways in different locations. The report concluded that "it is important to recognize that populations may differ in the way they respond to human disturbance." Correspondingly, long-term bighorn sheep responses to human disturbance have varied from complete range abandonment (e.g., Etchberger et al. 1989; Schoenecker and Krausman 2002) to habituation with little negative impact (e.g., Hicks and Elder 1979; Stanger et al. 1986; Jansen et al. 2007). Papouchis et al. (2001) found evidence of both avoidance and habituation within the same population in Canyonlands National Park, Utah.

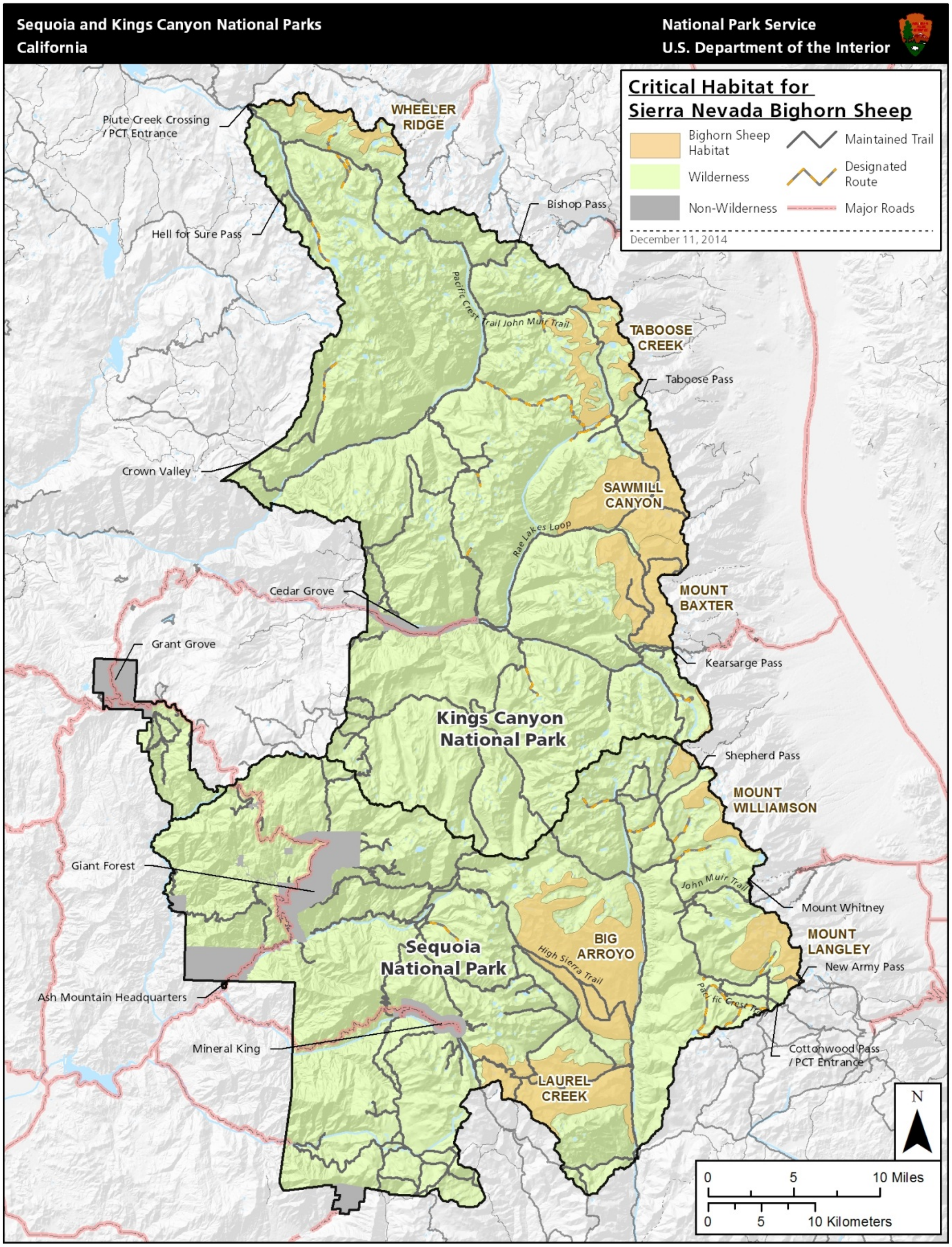

Figure 26: Critical Habitat for Sierra Nevada Bighorn Sheep in Sequoia and Kings Canyon National Parks

Federally and State-listed Plant Species

Whitebark pine (*Pinus albicaulis*) — Whitebark pine is a candidate species for listing as federally endangered. This slow-growing, long-lived coniferous tree is a keystone species, one whose presence is critical to maintaining the structure of an entire community. It inhabits cold, windy, high-elevation sites in western North America (USFWS 2011). In the two parks, whitebark pine grows on gentle to very steep subalpine slopes of varying aspect between elevations of approximately 8,200 feet and 12,600 feet. It is the dominant high-elevation conifer in Kings Canyon National Park, and reaches the southern limit of its Sierra distribution near Mount Whitney in Sequoia National Park (see figure 27 on the following page). From a global perspective, the primary threat to whitebark pine is from the nonnative disease white pine blister rust and its interaction with the effects of predation by the native mountain pine beetle (*Dendroctonus ponderosae*), fire suppression, and climate change. In the Rocky Mountains whitebark pine populations are experiencing a long-term pattern of decline and the USFWS anticipates that the species could be in danger of extinction within three generations (USFWS 2011). Although incidence of white pine blister rust is currently low in the Sierra Nevada populations, the disease is now nearly ubiquitous throughout the northern range of the tree. Recent surveys found very low levels of infection in whitebark pine in the parks, but studies have documented continued expansion of the rust among populations of the two lower-elevation white pines, sugar pine (*Pinus lambertiana*) and western white pine (*Pinus monticola*) (Duriscoe and Duriscoe 2002, J. Nesmith, pers. comm., 2013).

The USFWS has concluded that white pine blister rust will likely continue to intensify and kill whitebark pine throughout its entire range. A secondary factor in whitebark pine mortality is predation by the native mountain pine beetle; conditions will likely remain favorable for epidemic levels of mountain pine beetle to continue (in the Rocky Mountains) into the foreseeable future. It is also anticipated that under predicted warming scenarios, climate change will result in direct habitat loss for whitebark pine, which is limited to cold, high-elevation environments. Although important in the decline of Rocky Mountain populations, fire suppression is not considered a major factor in whitebark pine population dynamics in the Sierra Nevada (Nesmith 2013, pers. comm.).

Recreational effects on subalpine conifers in the parks' wilderness include localized habitat degradation in heavily used areas, primarily in the form of soil compaction in campsites, and consumption of dead and downed wood for campfires. Since 1978, park managers have established campfire limits based on best-available estimates of the treeline and ground-fuel availability. Limits started at 10,000 feet in Kings Canyon National Park and 11,200 feet in Sequoia National Park in 1978 and have been modified as more sophisticated analyses of the vegetation at the parks have become available. Current campfire limits are defined per watershed: 10,000 feet in the Kings River drainage, 9,000 feet in the Kaweah River drainage, and 10,400 feet in the Kern River drainage.

In the past, whitebark pines were occasionally cut in the course of trail maintenance/construction and fire operations; since attaining status as a candidate for protection under the ESA, cutting or removal of whitebark pine by park crews has largely ceased.

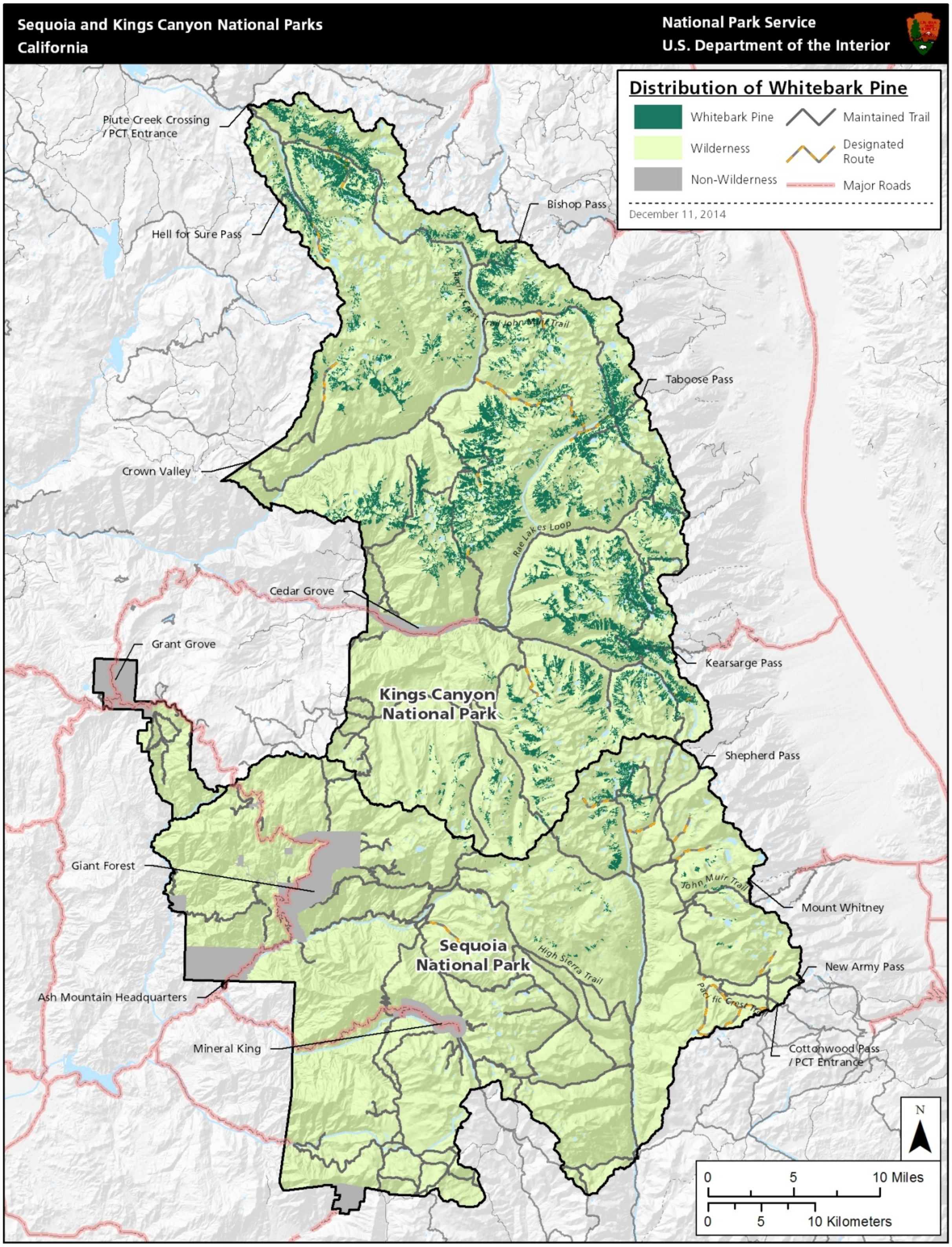

Figure 27: Distribution of Whitebark Pine in Sequoia and Kings Canyon National Parks

CULTURAL RESOURCES

This section is limited to cultural resources located in wilderness. It is organized with a general discussion of the prehistory and history of areas now designated as wilderness, followed by descriptions of specific cultural resources located in wilderness. For the purposes of this plan, cultural-resource topics focus on archeological resources, historic structures and districts, ethnographic resources, and cultural landscapes.

The National Historic Preservation Act (NHPA) recognizes five property types: districts, sites, buildings, structures, and objects. To focus attention on differing management requirements within these property types, NPS *Management Policies 2006* categorizes cultural resources as archeological resources, historic structures, cultural landscapes, ethnographic resources, and museum objects. Cultural resources may be linked to historic events or noteworthy people; they may be embodiments of technical accomplishment, design, or workmanship; they may be sources of information important in historical or archeological research; or they may be important in the cultural system of an ethnic group (NPS 1998c).

The rich human history of Sequoia and Kings Canyon National Parks is reflected in the abundance of cultural resources throughout the parks. Every cultural resource in the parks represents a time in the history or prehistory of the Sierra Nevada. These resources include evidence of sheep and cattle herding and ranching, recreation, evidence of scientific research, and extractive activities including mining and logging; as well as habitation structures, cultural landscapes, ethnographic resources, and archeological sites. Under certain circumstances and to the extent permitted by law, sensitive or confidential information about the specific location, character, nature, ownership, or acquisition of cultural resources on park lands is withheld from public disclosure. This is to reduce the likelihood of looting and to address the concerns and wishes of American Indians.

HISTORICAL OVERVIEW OF THE PARKS

American Indians — It is unclear when present-day Sequoia and Kings Canyon National Parks were first inhabited. The likelihood of Paleo-Indian presence is supported by the presence of projectile-point evidence dating from 12,000 B.C. to 9,000 B.C. Human occupation in the parks from around 1,000 B.C.is better documented, indicating more intensive use that continued into the historic period.

The Tübatulabal occupied a territory that included the Kern River drainage. The population was isolated and apparently rather small, with an estimated peak population of 1,000 members. There were less than 150 Tübatulabal by the 1920s. Due to their small population and relative isolation, Tübatulabal influence on the Kern River area was likely not profound, but it is not very well documented. The Western Mono population, estimated at up to 2,000 individuals by the time of contact with Europeans (mid-19th century), was both larger and more resilient than the Tübatulabal. By 1935, an estimated 1,000 Western Mono were living in the vicinity of Sequoia National Park (Steward 1935). The Western Mono occupied large camps at lower elevations and ventured to smaller seasonal camps in the middle and higher elevation zones in the summer. They modified some of the environments in which they lived through the use of fire. The Kaweah River drainage, therefore, was more intensively modified than the Kern River drainage (Vankat 1977).

The Eastern Mono are part of an extensive group of tribes known collectively as the Northern Paiute. Each tribe controlled its own territory and varied slightly in dialect from the others. The Eastern Mono lived in villages in the Owens Valley and Inyo Mountains in the winter. During spring and summer, kin groups traveled into the Sierra Nevada in search of game and wild foods. They also crossed over the Sierra Crest to trade with the Western Mono and other western Sierra tribal groups. Trade items included obsidian, which was used by the western tribes for tool making and weaponry. Intermarriage was not uncommon between the Western and Eastern Monos. The Eastern Mono congregated for communal hunts, harvests, and ceremonies in the fall before returning to their winter villages. Population estimates for the Eastern Mono range from 1,800 to 4,000 for the pre-contact period. There were approximately 1,500 Eastern Mono in 1920 (Kroeber 1919, Cook 1976).

Archeological evidence includes projectile points and tools of different cultural complexes and periods, pictographs and petroglyphs, small encampments and larger village sites, trade rendezvous places, granite bedrock mortars used to prepare acorns and other seeds, rock shelters associated with habitation sites, and so-called "workshops" where projectile points were manufactured from materials such as obsidian.

European/Euro-American — European and Euro-American use of the area that became Sequoia and Kings Canyon National Parks was rare prior to the 1860s. Trapping was the first activity that brought non-Indians into the Sierra Nevada. Trappers, who usually left little lasting evidence of their presence, crossed into the Sierra and into the mountains' western foothills in the late 1820s and early 1830s. Trapping was still practiced into the 20th century. In particular, a trapper named Shorty Lovelace operated throughout what is now Kings Canyon National Park from 1910 until 1940. He left behind a series of small trapper cabins in wilderness (Tweed 1977).

Use of the future parklands expanded in the 1860s and 1870s. Cattle ranchers occupied most of the grazing land on the lower western slopes of the mountains by the 1860s. Hale Tharp, a rancher, is credited as the first Euro-American to enter the Giant Forest sequoia grove in 1858. In subsequent years he explored the high country from Kings Canyon to Mineral King.

Sheepherders, unable to access forage on the lower slopes, made the first commercial use of the Kings, Kaweah, and Kern watersheds and wilderness during the 1860s and 1870s. Basque shepherds became a summer fixture in the high country. Harry Quinn, an immigrant from Ireland, developed the most extensive sheep operation in the parks. Based out of a headquarters ranch in the foothills, he gained control of some of the most important grazing land in Kern Canyon. Eventually his mountain holdings included a mountain "horse camp" as a secondary base (Tweed 2010).

Prospectors and loggers also participated in the exploration and utilization of future parklands. Logging began in the 1860s. In 1885, colonists associated with the utopian Kaweah Colony filed timber claims to lands in the Giant Forest vicinity and built the Colony Mill Road to provide logging access. After years of futile efforts to find valuable minerals, silver was discovered in 1873, which touched off a rush to the Mineral King Valley. Prospectors eagerly entered the southern Sierra and by 1874 they had filed more than 200 claims in the Mineral King area (Dilsaver and Tweed 1990).

The California Geological Survey turned its attention to the high country of the southern Sierra Nevada in 1864. Members of the survey included some of the most dynamic scientists of their day: Josiah D. Whitney, William H. Brewer, and Clarence King. Brewer and King, along with a survey party, spent the summer exploring the region that became Sequoia and Kings Canyon National Parks. They passed near Grant Grove on their way to the high country, before going on to name several features, including Mount Whitney, Mount Silliman, Mount Tyndall, Mount Williamson, Table Mountain, and Milestone Mountain (Brewer 1966). King unsuccessfully attempted to climb Mount Whitney from the west in 1864. He finally reached the summit from the east in 1873. Another intrepid explorer, John Muir, made four trips to the canyons of the Kings and Kaweah rivers in the 1870s. On one of these journeys, he traced the belt of giant sequoias south from the Mariposa Grove in Yosemite, crossing the North and Marble forks of the Kaweah River and climbing into a "noble forest," which he named "The Giant Forest."

Meanwhile, efforts to save the magnificent sequoias had begun. Congress established Sequoia National Park on September 25, 1890, the second national park designated in the United States. Less than a week later, they tripled the park in size and created General Grant National Park, now the Grant Grove area of Kings Canyon National Park.

Administration of these new national parks was assigned to the military; a national park service did not yet exist to do the job. On June 7, 1891, Captain J. H. Dorst of Troop K, Fourth United States Cavalry, established a camp outside the parks at Mineral King and became their first acting superintendent. He and 58 men spent the summer patrolling and maintaining the new national parks. Their greatest challenge in the first summer was in preventing continued logging and grazing in the parks. They constructed trails and patrol cabins to support their mission. One of these cabins was built at Harry Quinn's mountain "horse camp." These activities dominated military management of the parks for the next two decades. African American soldiers known as Buffalo Soldiers patrolled Sequoia National Park in 1899, 1903, and 1904. Captain (later Colonel) Charles Young, one of the first African American graduates of West Point, commanded the troops in the park in 1903 and was thus the first black national park superintendent (Dilsaver and Tweed 1990). His troops accomplished a significant amount of work in both the frontcountry and what is now wilderness.

Efforts to improve access to the national parks and to develop their recreational potential began in the early 1900s while the parks were under U.S. Army administration. Several road projects were undertaken at Sequoia and General Grant national parks. In 1902, a contract was awarded to John Broder and Ralph Hopping, two local ranchers, to operate the first commercial transportation and camping facilities in Sequoia National Park. In 1903, the Colony Mill Road was improved and extended to Round Meadow and Moro Rock in Giant Forest (Dilsaver and Tweed 1990).

The Army managed the parks until 1914. Subsequently, Walter Fry was appointed the first civilian superintendent of the two national parks. Originally hired as a road foreman in 1901, he had become a park ranger in 1905 and chief ranger in 1910. Fry was still superintendent when the NPS was established in 1916.

Franklin Delano Roosevelt's New Deal facilitated road work and many other projects, including the Civilian Conservation Corps (CCC), which was established in April 1933. Five CCC camps were established in Sequoia National Park that summer; two more were added later. Enrollees constructed campgrounds, trails, ranger stations, and other administrative facilities; landscaped roadsides; cut firewood; and controlled forest fires. Enrollees built structures in wilderness, including the Hockett Meadow Ranger Station and the Bearpaw Meadow High Sierra Camp (Dilsaver and Tweed 1990). After the United States entered World War II the CCC Program was disbanded, but the Civilian Public Service, comprised of men with conscientious-objector status, continued to use the camps and perform work for several more years.

Congress established Kings Canyon National Park on March 4, 1940. The new 710-square-mile park encompassed scenic mountains and rugged canyon wilderness on the west slope of the Sierra Nevada and absorbed the former General Grant National Park. Several months later the Redwood Mountain area north of Sequoia National Park was added to Kings Canyon. In 1943, administration of the two parks was unified as a wartime economy measure, an arrangement that continues to the present day.

Almost two decades of austerity during the Great Depression and World War II gave way to a burst of park use. Park and concession facilities, roads, and other infrastructure, already in need of maintenance, were unable to accommodate the dramatic expansion of post-war visitation. National Park Service leadership was not oblivious to these trends. Director Conrad Wirth, a career NPS planner, revealed a plan known as "Mission 66" in the winter of 1956. The Mission 66 Program emphasized a decade-long expansion of park staff, increased development of interpretive services, construction of modern facilities, and the improvement of roads, trails and campgrounds. Mission 66 projects were also implemented in wilderness, including a new ranger station at Bearpaw Meadow High Sierra Camp (Dilsaver and Tweed 1990).

The 1960s also ushered in a new stewardship philosophy that emphasized preservation of natural habitat and wildlands. The Wilderness Act of 1964 became one emblem of this stewardship that stressed preservation and ecosystem-based management. The law included a mechanism for designating areas as wilderness. Wilderness areas were soon proposed within the parks. Eventually, in 1984 and 2009, about 93% of the parks were designated as wilderness. Another 3.4% are currently managed as wilderness according to policy.

Archeological Resources — These resources include both the remains of past human activity and records documenting the scientific analysis of these remains (NPS 1998c). The remains are often buried but may extend above ground.

In this document the term "prehistoric" refers to archeological resources associated with American Indians, particularly before contact with Europeans/Euro-Americans. It also refers to cultural resources that predate the beginning of written records, and includes isolated artifacts, petroglyphs, and pictographs. The term "historic" is used in referring to archeological resources that postdate Euro-American contact with American Indians. Historic archeological resources may include trails, building remnants, and a variety of other features.

As of November, 2013, there are 598 known archeological sites in the parks. About 9% of the parks' acreage (approximately 77,930 acres out of 865,964) has been surveyed for cultural resources. Most survey work has been in the parks' frontcountry, which is more accessible and where developments or projects are most often proposed (e.g., roads, campgrounds, overnight accommodations, and prescribed fires). Comparatively fewer wilderness surveys have been carried out (excluding historic-structure evaluations, trail surveys, and topic-specific research) largely due to the fact that fewer projects are undertaken that might affect potential sites. Both prehistoric and historic archeological sites are found in the parks. Two sites located in wilderness have been evaluated for National Register of Historic Places (National Register) eligibility. One was determined eligible and the other was deemed ineligible.

Although relatively unsurveyed, the parks' wilderness contains a variety of site types. For example, 88 archeological sites with obsidian fragments have been recorded in wilderness areas along the eastern boundary of the parks (Burge 2010). Sites in east-west passes, such as Taboose Pass in Kings Canyon National Park, suggest trade routes because obsidian from distant sources has been recorded at the sites. Many trade sites also reflect the presence of women with children, because grinding stones have been found as evidence of food preparation. Archeologists have also recorded stone structures thought to have served as hunting blinds or shelters (Burge 2010). At least one site suggests evidence of use over many years because its artifacts range from 1200 B.C. to A.D. 1850 – from prehistoric stone tools to 19th-century trade beads (Burge 2010). There is also archeological evidence that sheep and cattle herding as well as extractive activities (including mining and logging) occurred in many locations throughout the parks, in both frontcountry and wilderness (NPS 2007a). Other types of historic sites from a variety of eras include aircraft wreckage, abandoned trails and roads, cabins (some still in use), rock walls, fences, dendroglyphs (tree carvings), survey markers, and many other features (NPS 2007a).

HISTORIC STRUCTURES AND DISTRICTS

Historic Properties Listed on the National Register of Historic Places — A historic structure is "a constructed work … consciously created to serve some human activity" (NPS 1998c). Historic structures are usually immovable, although some have been relocated and others are mobile by design. Historic structures in Sequoia and Kings Canyon National Parks include buildings, cabins, historic districts, shelters, CCC structures, campgrounds, roads, fences, and other structures of historic, utilitarian, aesthetic, or scientific importance.

According to federal law and NPS management policies, all historic structures in which the NPS has a legal interest are to be managed as cultural resources. Regardless of type, level of significance, or current function, every structure is to receive full consideration for its historical values whenever a decision is made that might affect its integrity. Historic structures that are central to the legislated purposes of parks, especially those that are to be interpreted or used in education, may be subjects of additional, specialized efforts appropriate to their functions and significance.

The National Register was authorized in 1966, coinciding with the passage of the NHPA. It is a program for identifying, evaluating, and protecting historic and archeological resources on private and public lands. While having a site listed on the National Register is considered a great honor and can assist parks in acquiring funds for documentation and preservation efforts, all historic structures and sites (i.e., those greater than 50 years of age) on federal lands must be treated as though they are eligible for listing on the National Register unless they are found not eligible through consultation with the California state historic preservation office (CA SHPO).

Historical sites having integrity of various attributes (including location, design, setting, materials, workmanship, feeling, and association) may be found eligible for listing on the National Register under one or more criteria, which include:

a) Association with events that have made a significant contribution to the broad patterns of our history;
b) Association with lives of persons significant in our past;
c) Those embodying the distinctive characteristics of a type, period, or method of construction, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
d) Having yielded, or may be likely to yield, information important in prehistory or history (36 CFR 60.4; NPS 1997).

The following historic structures and districts in the parks are located in wilderness or in a DPWA and have either been determined eligible for listing or are currently listed on the National Register:

- Barton-Lackey Cabin – Listed on the National Register March 30, 1978
  - This is a small (17’ x 21’) cabin built around 1910. It is associated with the development of cattle ranching in the region.
- Colony Mill Road – Determined Eligible for Listing on the National Register April 25, 1978
  - Approximately 10 miles long, the road was built in the 1880s and improved in 1903. It has not been maintained for vehicles since 1969. The unsurfaced road is 10–12 feet wide. There are some remnants of stone retaining walls along the route.
- Hockett Meadow Ranger Station – Listed on the National Register April 27, 1978
  - The CCC constructed the ranger station and barn in 1934. The 23’ x 33’ cabin and 17’ x 26’ barn are both constructed of logs.

- Pear Lake Ski Hut (also known as Pear Lake Ranger Station) – Listed on the National Register May 5, 1978
  - The 17' x 30' masonry building was erected by the CCC between 1939 and 1941. It originally served as a winter ski-touring hut, but took on a second role as a summer ranger station in the 1970s.
- Quinn Ranger Station (also called Quinn Patrol Cabin) – Listed on the National Register April 13, 1977
  - The U.S. Army erected the ranger station in 1907 at the site of Harry Quinn's horse camp. The building is constructed of logs and measures 13' x 19'.
- Redwood Meadow Ranger Station (also called Redwood Meadow Patrol Cabin) – Listed on the National Register April 13, 1978
  - The CCC built the ranger station and associated barn in 1938. The 23' x 33' cabin and 17' x 26' barn are both constructed of logs.
- Shorty Lovelace Historic District – Listed on the National Register January 31, 1978
  - The district includes Cloud Canyon, Vidette Meadow, Gardiner Creek, Woods Creek, and Granite Pass Cabins, which were all built by trapper Shorty Lovelace between 1910 and 1940. Located at disconnected sites in Kings Canyon National Park, they are all small (5' x 7') one-room log cabins with shake roofs.
- Smithsonian Institution Shelter (also known as Mount Whitney Summit Shelter, Mount Whitney Shelter) – Listed on the National Register March 8, 1977
  - This 31' x 11' stone structure was built on top of Mount Whitney in 1909 to provide shelter for scientists performing atmospheric research on the mountain. The shelter was used for its intended purpose for only 11 years. It is currently used to store search and rescue supplies and equipment.

Properties on the National Park Service List of Classified Structures — The List of Classified Structures is defined by the NPS as an evaluated inventory of all historic and prehistoric structures that have historical, architectural, and/or engineering significance within units of the national park system in which the NPS has, or plans to acquire, any legally enforceable interest. The list is evaluated or "classified" by the National Register criteria. Structures are constructed works that serve some form of human activity and are generally immovable. They include buildings and monuments, dams, millraces and canals, nautical vessels, bridges, tunnels and roads, railroad locomotives, rolling stock and track, stockades and fences, defensive works, temple mounds and kivas, ruins of all structural types that still have integrity as structures, and outdoor sculpture.

Currently there are 218 structures on the List of Classified Structures – a number of them in wilderness – in Sequoia and Kings Canyon National Parks (note: not all structures have been evaluated, so the number of classified structures in the wilderness could increase). The NPS is required to make a reasonable effort to preserve and maintain these structures. Although little may be known about some of the listed structures, and the subject-matter expertise and associated funding to classify and preserve some of them may be limited, that does not preclude their historical and cultural significance or the parks' obligation to ensure their protection.

Historic Properties Potentially Eligible for Listing on the National Register of Historic Places — Simpson Meadow Ranger Station has not been officially evaluated for listing on the National Register.

This WSP/FEIS has evaluated impacts on the ranger station, which is now used for storage, as if it is eligible for listing on the National Register.

The Muir Hut was constructed by the USFS in 1930, with funds donated to the Sierra Club. This stone shelter is located along the JMT at Muir Pass. The NPS is preparing a national register nomination for the hut, with the goal of submitting it to the CA SHPO in 2015. The building is currently managed as if it is eligible for listing on the National Register.

The historic Muir Hut

Additionally, other draft national register nominations and/or Determinations of Eligibility have been prepared for numerous cultural resources within the parks. These nominations, including those in wilderness, require further work before they can move forward to receive CA SHPO concurrence for National Register eligibility.

The WSP does not anticipate having any effect on Barton Lackey Cabin, Quinn Ranger Station, Hockett Meadow Ranger Station, Shorty Lovelace Historic District, Muir Hut, or the Smithsonian Shelter, under any of the proposed alternatives. These specific resources are therefore not addressed further in the WSP/FEIS.

CULTURAL LANDSCAPES

Cultural landscapes are complex resources ranging from large rural tracts covering several thousand acres to formal gardens of less than an acre. Natural features such as landforms, soils, and vegetation are not only part of the cultural landscape; they provide the framework within which it evolves. In the broadest sense, a cultural landscape is a reflection of human adaptation and use of natural resources and is often expressed in the way land is organized and divided, patterns of settlement, land use, systems of circulation, and the types of structures that are built. The character of a cultural landscape is defined both by physical materials, such as roads, buildings, walls, and vegetation, and by use that reflects cultural values and traditions. Identifying significant characteristics and features in a landscape and understanding them in relation to each other and to significant historic events, trends, and persons allows us to experience and study the landscape as a cultural resource. In many cases, these features are dynamic and change over time. In many cases, too, historical significance may be ascribed to more than one period in a landscape's physical and cultural evolution.

Cultural landscape management involves identifying the type and degree of change that can occur while maintaining the historic character of the landscape. The identification and management of an appropriate level of change in a cultural landscape is closely related to its significance. In a landscape significant for its association with a specific style, individual, trend, or event, change may diminish its integrity and needs to be carefully monitored and controlled. In a landscape significant for the pattern of use that has evolved, physical change may be essential to the continuation of the use. In the latter case, the focus should be on perpetuating the use while maintaining the general character and feeling of the historic period(s), rather than on preserving a specific appearance (NPS 1998c).

Four types of cultural landscapes, not mutually exclusive, are recognized (definitions are taken from NPS 1998c):

- **Historic designed landscapes** are deliberate artistic creations reflecting recognized styles, such as the twelve-acre Meridian Hill Park in Washington, D.C., with its French and Italian Renaissance garden features. Designed landscapes also include those associated with important persons, trends, or events in the history of landscape architecture, such as Frederick Law Olmsted National Historic Site and the Blue Ridge Parkway.
- **Historic vernacular landscapes** illustrate peoples' values and attitudes toward the land and reflect patterns of settlement, use, and development over time. Vernacular landscapes are found in large rural areas and small suburban and urban districts. Agricultural areas, fishing villages, mining districts, and homesteads are examples. The 17,400-acre rural landscape of Ebey's Landing National Historical Reserve represents a continuum of land use spanning more than a century. It has been continually reshaped by its inhabitants, yet the historic mix of farm, forest, village, and shoreline remains.
- **Historic sites** are significant for their associations with important events, activities, and persons. Battlefields and presidential homes are prominent examples. At these areas, existing features and conditions are defined and interpreted primarily in terms of what happened there at particular times in the past.
- **Ethnographic landscapes** are associated with contemporary groups and typically are used or valued in traditional ways. In the expansive Alaska parks, Native Alaskans hunt, fish, trap, and gather, and imbue features with spiritual meanings.

The four cultural landscape categories are not mutually exclusive. A landscape may be associated with a significant event, include designed or vernacular characteristics, and be significant to a specific cultural group.

All or part of seven proposed cultural landscapes located in wilderness have currently been identified in the parks; one has been evaluated for listing on the National Register. Currently identified cultural landscapes in wilderness include the following:

- Kern Canyon Ranger Station / Lewis Camp Area
  - Lewis Camp is located at the southern edge of Sequoia National Park along the Kern River. It was established in the 1870s as a supply camp for commercial fisherman who operated in Kern Canyon. There was a store and tent cabins for travelers. A sawmill and suspension bridge were added in the early decades of the 20th century. The NPS erected a ranger station nearby in 1927. The camp was abandoned in 1951 and the buildings eventually fell into disrepair or were razed over subsequent years. However, the ranger station was rehabilitated in 1952. The potential cultural landscape includes the archeological remnants, landscape structures (irrigation ditches) and historic objects associated with Lewis Camp and the extant Kern Canyon Ranger Station.
- Bearpaw Meadow High Sierra Camp
  - Located 11 miles east of Giant Forest, the camp is accessed by the HST. It consists of six tents on platforms for guests, a dining hall and kitchen platform and tent, a manager's tent, an employee-restroom tent, a shower, a wood-fueled water heater, guest toilet, and other small features. The guest tents, dining hall, and kitchen were constructed in 1934. All except one guest cabin remain in their original locations. The other structures were probably built in the 1990s and are not eligible.
  - Two ranger stations were built just north of the camp. The first, a rustic log cabin, was built by the CCC in 1934 and is now used for storage. The second ranger station, an A-frame building, was constructed in 1964 as part of the Mission 66 initiative and is still used by the NPS.
  - The ranger stations, a trail segment (see HST below), five guest tents, dining hall, and kitchen may be contributing elements to the cultural landscape. The Determination of Eligibility is under review by the CA SHPO.
- Barton Lackey Complex
  - This potential cultural landscape in the Roaring River area of Kings Canyon National Park is associated with the Barton Lackey Cabin (which is listed on the National Register). It includes the cabin and historic archeological resources associated with the cattle camp that was located at the site between 1910 and 1940.
- Colony Mill Road
  - Listed on the National Register April 25, 1978, the remnant road (now used as a trail) is approximately 10 miles long. This potential landscape district was first built in the 1880s and improved in 1903. There are some remnants of stone retaining walls along the route.
- John Muir Trail
  - This trail, which runs from Yosemite Valley to Mount Whitney, was conceived in 1915 as a tribute to its namesake. Trail planning and construction took nearly three decades. The NPS constructed the 22 miles of trail in Sequoia National Park between 1926 and 1931, and a few alterations to its alignment were made in the early 1930s. In 1938, the USFS completed the 75-mile section through the region that became Kings Canyon National Park. The current alignment of the JMT has been in place since 1938.

- High Sierra Trail
  - The HST, constructed in 1934, begins at Crescent Meadow and travels east about 49 miles to the JMT. Bearpaw Meadow High Sierra Camp lies about 11 miles up the trail from the Giant Forest.
- Early Trail System Assessment
  - This proposed assessment will verify locations, inventory, and subsequently develop consensus determinations of eligibility for all other trails in Sequoia and Kings Canyon National Parks.

Hiker on the historic Colony Mill Road

The evaluation of cultural landscapes for listing in the National Register has not been completed; therefore, all of the cultural landscapes listed above are treated as if they are eligible.

ETHNOGRAPHIC RESOURCES

Ethnographic resources are expressions of human culture and the basis of continuity of cultural systems (NPS 1998c). Ethnographic resources can include sites, structures, objects, traditional landscapes, or a natural-resource feature assigned traditional legendary, religious, subsistence, or other significance in the cultural system of a traditionally associated group.

Ethnographic information collected in the 20th century varies in its depth and utility relative to the primary American Indian groups who traditionally occupied or used park areas. Currently a comprehensive ethnographic overview and assessment is lacking at Sequoia and Kings Canyon National

Parks. However, via the NPS Cultural Resources Preservation Program, a Multipark Ethnographic Overview for Sequoia and Kings Canyon National Parks, Yosemite National Park, and Devils Postpile National Monument is funded in FY2014. It will provide needed research, emphasizing accessible archival and documentary data as well as consultation with American Indian elders, tribal historians, and leaders.

A new synthesis of available information will improve the ability to interpret, for park visitors, the historic and contemporary activities and concerns of the area's American Indian groups. Additionally, it will enhance formal consultation with American Indian Tribes and organizations and will enable parks management to preserve and protect traditional cultural properties and practices that are important to current tribes.

SOCIOECONOMICS

GENERAL SETTING

Sequoia and Kings Canyon National Parks comprise the eastern portions of Fresno and Tulare counties, California. Inyo County borders the parks to the east. Federal lands administered by the USFS surround the vast majority of the parks. Private lands involved primarily in agriculture, along with public lands managed by the Bureau of Land Management, border Sequoia National Park to the southwest.

Fresno, Tulare, and Inyo counties are large, ranging from 4,839 square miles to 10,227 square miles of land and water, ranking them among the largest counties in California (table 60). Together the two parks encompass 1,353 square miles, accounting for 12.5% of the combined area of Fresno and Tulare counties. Federally managed lands in the three counties total nearly 13,400 square miles including the parks, which is 63.4% of the total land.

Table 60: Summary Area and Federal Land Management Characteristics

Federal Land Management Characteristics	Fresno County	Inyo County	Tulare County	California (State)
Total Area (square miles)	6,017	10,227	4,839	163,695
Rank among the 58 California counties (1 being largest)	6th	2nd	7th	NA
Federal Lands (% of total area)	40%	84%	50%	42%

Sources: California Department of Finance 2009 and BLM 2013.
NA – Not Applicable

Fresno and Tulare counties are primarily agricultural land plus undeveloped forest and parklands, but more than 80% of the residents in each county live in urban centers. Each county has a major central city: Fresno with more than 508,000 residents and Visalia with more than 128,000 residents in 2013. Inyo County is predominately rural, with a rich ranching and mining history, but less than 2.0% of the land in the county is privately owned. Bishop is the largest community in Inyo County. Population densities in 2010 for the three counties ranged from 1.8 persons per square mile in Inyo County to 156.2 persons per square mile in Fresno; all considerably lower than the statewide average of 239.1 persons per square mile.

Fresno, Tulare and Inyo counties had a combined population of 1.43 million at the beginning of 2013 – a net increase of 240,000 residents, or 20%, compared to 2000 (table 61). This change in resident population is not reflective of annual visitation to the parks during the same period.

Table 61: Population Change, 2000 to 2013

County	2000	2010	2013	Change 2000 – 2013
Fresno County	799,407	930,450	952,166	19.1%
Tulare County	368,021	442,179	455,599	23.8%
Inyo County	18,071	18,546	18,573	2.8%
Three-county total	1,185,499	1,391,175	1,426,338	20.3%

Sources: U.S. Census Bureau 2000, 2010 and California Department of Finance 2013a.

The cities of Fresno and Visalia are the largest gateway communities to the parks, each offering a wide array of recreation, entertainment, lodging, and other businesses catering to park visitors and other tourists and travelers. Business establishments in many other smaller communities west of the parks, including Porterville, Springville, and Three Rivers, and individual establishments along the primary access routes, also cater to park visitors.

Visitors at the Kings Canyon Overlook on the Generals Highway

Smaller gateway communities east of the parks include Bishop, Big Pine, Lone Pine, and Independence, all in California. There is no highway access from these communities into the parks, but there are nearby trailheads used by wilderness visitors. For the most part these communities offer essential needs of wilderness visitors — overnight lodging before or after their visits, meals, water and other beverages, snacks, groceries and other supplies, and motor-vehicle fuel. Bishop is the base of operations for several of the authorized pack stations providing service into the parks. A number of other communities also serve as gateways for wilderness visitors who hike into the parks via trails from adjacent national forests. Given the overall number of wilderness visitors, the overall economic contributions and economic dependency of the local community economies attributable to those visitors is important, but likely limited in the context of the overall regional economy.

The vast majority of visitor use in the parks occurs in the developed frontcountry, which includes the Cedar Grove, Grant Grove, Lodgepole, and Foothills visitor centers and associated campgrounds, Giant Forest Museum, concession-operated lodging, trails, and other visitor services. More than 1.5 million visitors annually enter the parks from the west, primarily in private vehicles via State Highway 180 from Fresno and State Highway 198 from Visalia. No motorized access to the parks exists from the north, south, or east (Inyo County). Some visitors to wilderness access the parks from Inyo County, entering by foot or horseback after passing through Inyo and Sequoia national forests and the Golden Trout and John

Muir wilderness areas. The combined influences of the travel and access patterns, and levels of use in the frontcountry, skew the parks' commercial and economic influence on the local environment heavily toward Fresno and Tulare counties. However, wilderness visitors support the local hospitality industries, retail sector, and outfitter and guide services in many of the smaller gateway communities to the parks, including those near the national forest trailheads.

Projected Population Growth to 2040 — Information compiled as part of the NPS Visitor Services Project reveals that the majority of visitors to the parks – approximately 65% in 2002 – are California residents. Residency information specific to wilderness use is not compiled by the parks; however, according to recent visitor surveys, California residents comprise at least a comparable share of the total wilderness use (Martin and Blackwell 2013; Watson 2013).

Long-term population projections from the California Department of Finance anticipate population growth of nearly 750,000 additional residents (a 54% increase in population) projected for the three-county region between 2010 and 2040 (table 62). Statewide growth of 10.3 million residents is anticipated for the 30-year period.

Table 62: Projected Population Growth, 2010 to 2040

County	2010	2020	2030	2040	Projected Change 2010–2040	
					Abs.	%
Fresno County	932,277	1,071,728	1,241,773	1,397,138	464,861	50%
Inyo County	18,528	19,350	20,428	22,009	3,481	19%
Tulare County	443,066	526,718	630,303	722,838	279,772	63%
Three-county total	1,393,871	1,617,796	1,892,504	2,141,985	748,114	54%

Source: California Department of Finance 2013b

Population growth of the magnitude projected is not viewed as a precursor to comparable increases in wilderness use, in part due to the effects of trailhead permits and quotas in regulating actual visitor use. Rather, the projected population growth is viewed as indicative of continued long-term demand for the wilderness experience provided by the parks' wilderness and other nearby wilderness.

ECONOMIC CONDITIONS

Total employment in the three counties in 2011 mirrored their respective populations, ranging from more than 428,000 jobs in Fresno County to 10,426 jobs in Inyo County. Farm employment, expressed as a share of the total employment, is considerably higher in Fresno and Tulare counties than across the state, particularly in Tulare County (7.8% of the total). In Inyo County, government and government enterprises account for a disproportionately high share of total employment; 30.2% compared to the statewide average of 13.1% (table 63).

Table 63: Employment by Place of Work (Number of Jobs), 2011

Place of Work	Fresno County	Inyo County	Tulare County	California (State)
Total employment	428,951	10,426	187,073	19,969,266
By major category (% of Total)				
Farm employment	5%	1%	8%	1%
Private nonfarm employment	80%	69%	75%	86%
Government and government enterprises	16% *	30%	17%	13%

*The total for Fresno County exceeds 100% due to rounding.
Source: U.S. Department of Commerce, Bureau of Economic Analysis 2012

Business establishments catering to market demands from travelers, visitors to the parks and other tourists and outdoor enthusiasts, and demand from residents are important elements of the local economies (table 64). Fresno and Tulare counties each have more than 1,400 accommodation and food service establishments, including those located in the parks and nearly one-third of all establishments in Inyo County are in the arts, entertainment and recreation, and accommodation and food services sectors. The guides, stables, pack stations and outfitters operating in the parks under commercial-use authorizations (CUAs) are included in the "recreation" sector. Bearpaw Meadow High Sierra Camp and Pear Lake Ski Hut, both of which operate seasonally to provide limited-scale overnight lodging opportunities in wilderness, fit the definitions for the accommodations and food-services sector, but may not be included as they are each operated by a larger operating entity, the Delaware North Companies Parks and Resort, Inc. and the Sequoia Natural History Association, respectively.

Table 64: Selected Tourism-related Establishments and Employment in the Three-county Area, 2011 County Business Patterns

Tourism-related Establishment	Fresno County		Inyo County		Tulare County	
	No. of Estab.	Total Paid Employees	No. of Estab.	Total Paid Employees	No. of Estab.	Total Paid Employees
All industries	15,700	227,628	531	5,149	6,109	83,911
<u>Selected tourism related sectors:</u>						
Arts, entertainment & recreation	162	4,968	22	275	58	563
Accommodation & food services	1,431	24,027	88	1,418	1,413	8,048
Selected tourism total	1,593	28,995	110	1,693	1,471	8,611
Selected tourism share of total	10.1%	12.7%	20.7%	32.9%	24.1%	10.3%

Note: "Estab." is the abbreviation for Establishments.
Source: U.S. Department of Commerce, Census Bureau 2013.

Average annual unemployment for 2012 was above 15% in Fresno and Tulare counties and 9% in Inyo County. Collectively, those rates translated into more than 101,000 individuals seeking work. Statewide unemployment for 2012 was 10.5%. The regional economy experiences substantial seasonal expansion and contraction that is reflected in unemployment over the course of the year. Seasonal fluctuation in agricultural labor needs is a major contributor to the fluctuation. Visitation patterns at the parks also contribute to seasonal declines in unemployment as the NPS, in-park concessioners, and lodging, dining, entertainment and retail establishments outside the parks hire seasonal staff. Seasonal employment related to wilderness use includes alpine backpacking guides and the wranglers/packers of the outfitters and pack stations.

Residents of the three counties in the study area earned a total personal income of $43.75 billion in 2011; 2.7% of the statewide total. On a per capita basis, personal incomes ranged from $29,460 in Tulare County to $37,905 in Inyo County — all below the statewide average of $43,647. Again, the seasonal effects of the region's agriculture and tourism industries are contributing factors to the differences. More than 25% of residents in Fresno and Tulare are in poverty. In Inyo County, an estimated 13% of residents were in poverty in 2011, less than half the rates in Fresno and Tulare counties.

ECONOMIC CONTRIBUTIONS OF SEQUOIA AND KINGS CANYON NATIONAL PARKS

The parks are an important, albeit not a dominant element of the overall regional economy. Spending by visitors to the parks and NPS personnel, as well as capital outlays, research, environmental restoration, and operating and maintenance expenditures by the NPS and other entities, support local businesses and generate tax revenues that help support the state and local government.

Over the 20-year period from 1993 to 2012, recreation visits to the two parks fluctuated from about 1,340,800 in 1996 to more than 1,706,000 in 1994 (figure 28). In 2012, the parks received nearly 1,700,000 recreation visits, more than 10% more than the 20-year average of 1,536,600 visits.

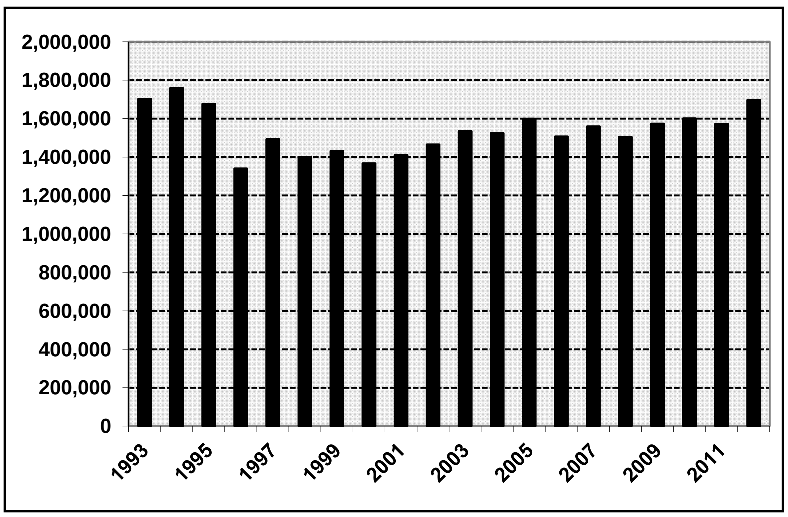

Figure 28: Annual Recreation Visits to Sequoia and Kings Canyon National Parks, 1993 to 2012

Overnight visitors to the parks, including guests at concession-operated lodging in the parks, tent and RV campers using campgrounds, and wilderness campers, historically accounted for more than 400,000 annual visits. Wilderness hikers and backpackers, including pack station clients and visitors who stay at the Bearpaw Meadow High Sierra Camp and Pear Lake Ski Hut, account for approximately 10% of all overnight visitors and 2.5% of the annual total visits.

An analysis of the economic contributions of units of the national park system, based on visitor origin, length of stay, type of overnight accommodations, and typical spending of park visitors, estimated that a total annual spending of $122.14 million occurred in the parks or within 80 miles of the parks, primarily in Fresno and Tulare counties, in conjunction with recreation visits to the parks in 2012 (Cook 2013). The total includes entry and wilderness-permit fees collected by the parks; outlays for accommodations, fuel, food and beverage purchases; boat, canoe, and other equipment rentals; and other miscellaneous expenditures (table 65).

The bulk of the total spending (62%) was by nonlocal visitors staying overnight in area motels and hotels and camping. Total expenditures reported by overnight visitors not staying at the lodges located in the parks, including those staying in developed campgrounds, backcountry and wilderness visitors, presumably including expenditures at the Bearpaw Meadow High Sierra Camp (summer) and Pear Lake Ski Hut (winter), and those staying with friends or relatives and not reporting lodging expenditures, totaled $16.24 million, or 13% of the total. Of that amount, $7.2 million was spent inside the park.

Table 65: Total Visitor Spending by Visitor Segment, 2012

Expenditures	Spending by Visitor Segment (Millions)							All Visitors
	Local	Day Trip	Motel Inside	Motel Outside	Camping Inside	Camping Outside	Other Overnight	
Inside the parks	$1.118	$4.063	$10.138	$8.563	$3.996	$2.814	$3.213	$33.904
Outside the parks	1.319	1.779	2.361	66.720	2.340	7.025	6.692	88.236
Total inside & outside	$2.437	$5.842	$12.499	$75.284	$6.335	$9.839	$9.905	$122.14
% of the total	2%	5%	10%	62%	5%	8%	8%	100%

Source: Cook 2013.

A breakdown of the direct spending, jobs and labor income effects, presented in table 66 below, shows that spending for lodging and camping is the single largest category of spending. The spending estimates capture any pre- or post-visit lodging expenditures by wilderness backpackers and pack station clients, as well as expenditures by overnight visitors to the Bearpaw Meadow High Sierra Camp and Pear Lake Ski Hut. Visitor outlays for wilderness permits, which allow camping in wilderness, are accounted for in the admissions and fees expenditure category.

Table 66: Selected Tourism-related Sales, Jobs and Labor Income Effects Attributed to Sequoia and Kings Canyon National Parks Visitor Spending, 2012

Sector/Expenditure Category	Sales (Thousands)	Jobs	Labor Income (Thousands)
Direct effects			
Motels and camping fees	$47,393	487	11,134
Restaurants and bars	$17,917	318	5,730
Groceries and takeout food	$8,807	148	2,733
Gas, oil, and local transportation	$13,736	250	7,322
Admissions and fees	$3,521	21	1,645
Souvenirs and other expenses	$8,302	107	3,433
Total direct effects	$ 99,676	1,331	$ 31,997
Secondary effects	$ 63,706	486	$ 19,211
Total Economic Effects	**$163,382**	**1,817**	**$51,208**

Source: Cook 2013.

Spending by the parks visitors also includes purchases made at the visitor center bookstores operated by the Sequoia Natural History Association. The Sequoia Natural History Association is a nonprofit cooperating association that supports education, interpretation, and research in the two parks.

The net direct effect of the $122.1 million in spending is estimated at $99.7 million in new direct sales, after adjusting for spending by local residents and day-trip visitors to the parks and the wholesale costs of goods imported into the area for retail sales that do not represent new economic stimulus. Those sales support the equivalent of 1,331 jobs and nearly $32.0 million in labor income in the regional economy. Subsequent iterations of local spending (i.e., the secondary effects) support an additional 486 jobs and $19.2 million in labor income).

The total spending and jobs specifically attributable to wilderness visits by hikers, backpackers, and clients of the saddle horse, spot and dunnage services and the pack stations was not addressed in the aforementioned analysis. An insight into the major portion of that spending is provided by the reports filed by CUA permit holders summarizing their activities in the parks and gross income derived from those activities. The number of CUAs issued by the parks has varied from 32 to 35 over the four year period from 2009 to 2012, with 13 pack and saddle horse/mule services and 19 backpack/hiking guide service CUA permit holders providing services in wilderness in the parks in 2012 (table 67 and appendix B). The total number of clients served ranged from 970 to 1,582 during the same period, with an increase of 43% reported between 2011 and 2012, representing approximately 7% of all wilderness users. These numbers can vary greatly each year due to the amount of snowpack and the opening and closing dates of meadows for stock grazing. Additionally, some of the year-to-year variation may reflect changes in reporting procedures over time and between different permit holders. Many of the CUA permit holders do not record the number of day-use clients or report a “client” for trips for administrative or resupply purposes. Because of the way that the data from the annual CUA reports is captured, the number of commercial clients served from these reports may vary from other reporting sources (i.e., wilderness permits and stock-use reports).

Table 67: Number of Commercial Use Authorizations Issued for Activities in Wilderness and Number of Clients Served, 2009 to 2012

Types of CUAs	2009	2010	2011	2012
Number of CUAs				
Pack and Saddle (Stock)	15	14	13	13
Backpack/Hiking Guides	16	21	19	19
Total	31	35	32	32
Reported Clients Served[1]				
Pack and Saddle (Stock)	469	669	617	819
Backpack/Hiking Guides	501	663	490	763
Total	970	1,332	1,107	1,582

[1] These totals undercount the actual number of clients because some permit holders do not report day users.

The summary activity reports also provide information regarding the duration of activity by wilderness visitors taking day or overnight trips with one of the wilderness guides or outfitters. Based on data for more than 930 total trips over the four-year period, approximately 45% were day trips or administrative and resupply trips. On the other end of the range, 5% were 10 days or longer, many of which were summer backpacking/hiking adventure camps sponsored by Outward Bound and other organizations. The distribution of trips by duration is shown in figure 29 on the following page.

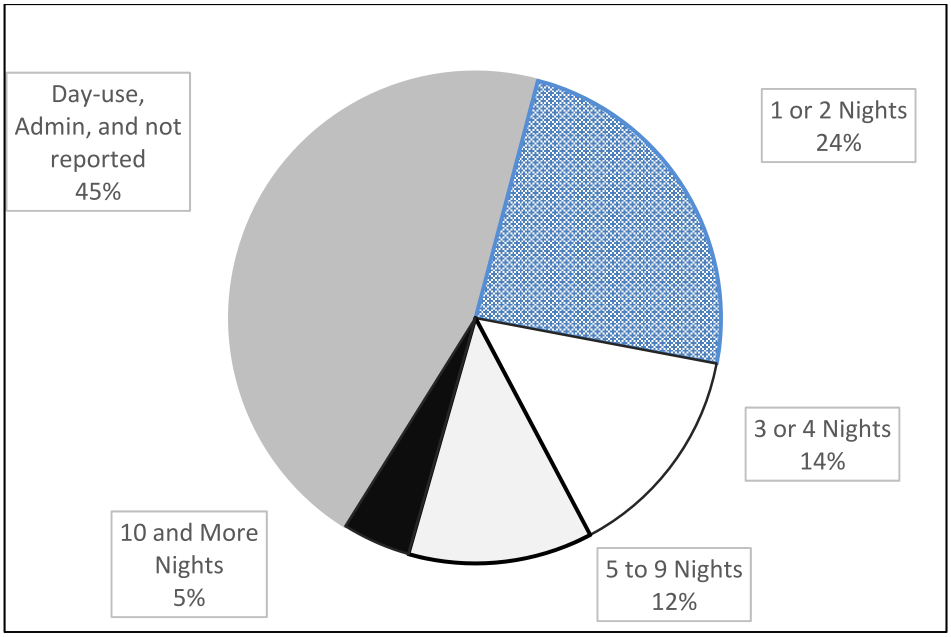

Figure 29: Duration of Activity in Wilderness Reported by Commercial Use Authorization Permit Holders in Sequoia and Kings Canyon National Parks, 2009 to 2012

The gross income reported by these CUA permit holders for their wilderness-related activities (both inside and outside the parks) ranged from a low of $882,451 in 2010 to a high of $1.26 million in 2012, averaging just greater than $982,000 per year over the four-year period. Income derived from backpack and hiking guide services has accounted for most of the variability in overall income, including an increase of $389,000 from 2011 to 2012 (figure 30).

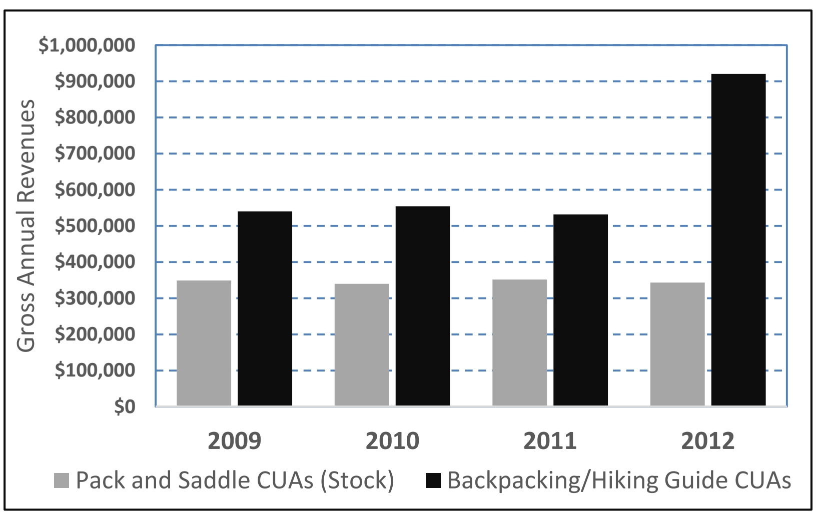

Figure 30: Annual Gross Revenue Reported by Commercial Use Authorization Permit Holders in Sequoia and Kings Canyon National Parks, 2009 to 2012

The revenues from clients, including the NPS, and the additional spending made outside the parks by wilderness visitors are critical to supporting the continued economic viability of the individual guides and outfitters, however, they represent but a small segment of the overall regional economy.

In summary, the visitor spending supported an estimated 1,817 jobs, with an estimated annual income of $51.2 million in the regional economy, with the majority of the benefits accruing in Fresno and Tulare counties. These totals include the local employees, managers and operators of the CUAs that are authorized to operate in wilderness in the parks. Although the jobs supported by the parks visitor spending represent only about 0.3% of the total regional employment, the visitor spending and jobs supported are important to many businesses in the gateway communities and the full and part-time concession employees in the parks.

Park Operations and Maintenance — The annual budget for NPS operations at the parks also contributes to the regional economy, as spending for utilities, supplies, and services, and spending by NPS employees support additional business sales, jobs, income, and generates tax revenues to help support state and local governments. These effects are in addition to those associated with visitor spending.

The annual base operating budget at the parks for fiscal year (FY) 2012 was $16.5 million. The base budget was supplemented in several ways: by donations; funding for equipment purchases; funding for specific construction, environmental monitoring, restoration projects, management planning (including this plan), and implementation projects; fees from concessions; and a portion of the entry and camping fees. The FY 2012 budget supported approximately 550 permanent and seasonal NPS employees and the NPS payroll and park operations spending supported the equivalent of more than 65 additional jobs in the region (Stynes 2011). The majority of the economic benefits accrue to Fresno and Tulare counties due to the location of NPS administration, maintenance, and visitor centers / contact stations.

Partner organizations provide additional benefits to the regional economy in the form of purchases of goods and services to support their research, educational, community outreach, and other missions conducted in support of the parks, as well as the spending by members and guests at events and activities hosted by the organizations. In addition, a cadre of more than 800 volunteers provides support for the parks operations, maintenance, and visitor services.

Payments in Lieu of Taxes — All three counties receive federal payments in lieu of taxes due to the combination of NPS, USFS and other federal lands located within their boundaries. Administered by the Department of the Interior, the payments in lieu of taxes program distributes payments to county governments to help offset the diminished property tax receipts resulting from federal ownership. For FY 2012, payments in lieu of taxes to the three counties were $2.285 million to Fresno County, $1.71 million to Inyo County, and $2.91 million to Tulare County (BLM 2013).

VISITOR USE AND EXPERIENCE

INTRODUCTION TO VISITOR USE AND EXPERIENCE

This section describes overall wilderness use levels and visitor characteristics, and provides information on the types and amounts of recreational activities occurring in wilderness.

In 2010, Sequoia and Kings Canyon National Parks had more than 1.6 million visitors. The frontcountry of the parks comprises only 2.5% of their total area but receives around 98% of the visitor use (i.e., number of visitors). Areas designated or managed as wilderness make up nearly 97% of the parks' area but receive only about 2% of the visitors (NPS 2007a). Wilderness visitors tend to stay an average of 75 hours or longer in the parks, while frontcountry visitors average less than 8 hours (NPS 2011a).

Approximately 25,000 to 35,000 people enter the Sequoia and Kings Canyon National Parks' wilderness each year (NPS 2011a). Visitor-use data from 1990 to 2010 indicates that visitation is lower in terms of total numbers of permits, people, and visitor-use nights relative to 1970 to 1990 (NPS 2011a.). However, there are still areas of concentrated use, such as the JMT, the Mount Whitney area, and in popular day-use areas, where high encounter frequencies in wilderness may occur.

Visitors to the parks' wilderness are subject to permit regulations, trail quotas and party size limits, campfire limits, requirements to stay in designated campsites in certain areas, and other regulations depending on their trip's origin and destination. They are also encouraged to be familiar with and employ Leave No Trace© practices to minimize their impact on resources.

This section describes wilderness visitor characteristics, methods of travel, camping and campsite conditions, and visitor experience in Sequoia and Kings Canyon National Parks.

WILDERNESS VISITOR CHARACTERISTICS

The NPS has conducted surveys and studies in the past to more accurately understand visitor characteristics and how visitors respond to management actions. A study conducted in Sequoia and Kings Canyon National Parks during the early 1990s (Watson et al. 1993) documented the differences and similarities between wilderness hikers and stock users and the role these characteristics play in conflicts between the users. Another survey was conducted in 2011 among overnight wilderness visitors to provide a more current understanding of visits and visitors to wilderness and how visitors respond to various elements of the parks' wilderness (Martin and Blackwell 2013). These two studies provide a variety of visitor-related information, including demographics and use characteristics, which allow the NPS to understand the characteristics of today's wilderness visitor. Table 68 compares the parks' wilderness visitors in 1990 and 2011.

Table 68: General Trends in Wilderness Visitor Characteristics

Wilderness Visitor Characteristics		1990	2011
Average Age	• ≤ 29 years old • 30–59 years old • ≥ 60 years old	N/A	11% 36% 16%
Education Level	• High school or less • Some college • College graduate • Graduate study	10% 18% 23% 49%	2% 9% 33% 54%
Gender	• Male • Female	N/A	83% 17%
Race and Ethnicity	• White • Hispanic/Latino • Asian • Other	N/A	91% 2% 5% 1%
Experience	• First visit • 1–2 previous visits • 3–8 previous visits • >8 previous visits	27% 27% 29% 17%	11% 21% 30% 38%

Source: Martin and Blackwell 2013 in NPS 2013e

Young and old enjoy wilderness, each according to his or her abilities and interests

Visitor-use Patterns and Trends — The average age of visitors to the parks' wilderness in 2011 was 47. The average level of education of wilderness visitors is apparently increasing. The 1990 survey recorded that 72% of wilderness campers had at least a four-year college degree, while an additional 18% had "some college" education (total of 90% with college attendance). The 2011 survey showed that 87% of wilderness campers had at least a four-year college degree, while an additional 9% had "some college" education (total of 96% with college attendance) (Martin and Blackwell 2013).

The respondents were predominantly male (83%) and described their race as white (91%) (see table 68) (Martin and Blackwell 2013).

The parks' wilderness visitors in general are very experienced wilderness users. In 2011, 38% had been to the parks' wilderness more than eight times (with 16% having made more than 20 trips) and 30% had made between three and eight trips. Approximately 21% have been there between one and two times, and only 11% were making their first visit. Previous experience in wilderness seems to be increasing among visitors to the parks' wilderness, as the 1990 survey showed a more evenly distributed variation in the level of previous experience in the parks' wilderness. The 1990 survey also recorded that 65% of respondents had visited more than five other wildernesses (Watson et al. 1993), while the 2011 survey recorded that 76% of respondents had been to six or more other wildernesses (Watson 2013). The 2011 survey also noted that more than one-fourth of visitors report their first trip to the parks' wilderness more than 33 years ago; and almost half first visited this wilderness more than 20 years ago (Watson 2013).

TRIP CHARACTERISTICS

Visitors may travel through the parks' wilderness on foot or with the assistance of stock, which includes horses, mules, burros, and llamas. Visitor use of stock is discussed further under the "Visitor Experience" section.

Seasonality — Because of the extended winter season of the alpine environment, much of the parks' wilderness use is concentrated in the months when wilderness is more easily accessed. The most popular time to visit is late spring through early fall (June through September; table 69). Peak visitation occurs during the 80-day period from approximately June 20 through September 10 (the third weekend in June through Labor Day). There are some notable spikes outside this period occurring during Memorial Day weekend (depending on snow conditions), early June, and later September weekends, adding an additional 15 days to the peak visitation period (NPS-USFS 2013).

During the summer months, the parks' frontcountry roads and trailheads are ordinarily accessible and the weather is more stable and favorable for wilderness excursions. With these favorable conditions, visitors of a variety of skill levels can experience wilderness. Also during the summer months, wilderness visitors engage in the widest variety of activities and the parks' wilderness areas are at maximum staffing. Commercial-service use, including stock use, is highest during this time period.

People also visit wilderness in winter and spring months, engaging in activities such as snowshoeing and cross-country skiing. Visitors during this period are typically more experienced and prepared to withstand potentially difficult conditions and less predictable weather. Some winter visitors take advantage of commercial services, most of which provide wilderness ski tours or snowshoe hikes. Winter use, from early November through mid-May, likely accounts for less than 4% of annual wilderness visitation (NPS 2012a).

Table 69: Overnight Wilderness Visitor Use by Month (Number of People)

Month	2007	2008	2009	2010	2011	2012	2013	% Annual Use
Jan	87	121	85	118	108	116	92	0.4
Feb	108	74	102	117	98	155	199	0.5
Mar	139	223	224	171	111	203	211	0.8
Apr	199	216	302	146	183	214	307	0.9
May	1108	918	1176	815	681	1088	1559	4.4
Jun	2557	2081	2477	1496	1344	3771	3926	10.6
Jul	5922	6504	7035	6489	5449	9483	8352	29.7
Aug	6455	7095	7933	7985	7877	10122	7370	33.1
Sep	3057	2494	3730	3970	4293	5259	3197	15.7
Oct	753	674	816	779	862	676	167	2.9
Nov	243	169	153	151	90	122	224	0.7
Dec	72	43	35	48	80	41	55	0.2

Geographic Distribution of Use — In the 2011 visitor survey, a high percentage (76%) of respondents reported that they visited wilderness destinations considered popular by the park, although many visited areas of less-concentrated use as well. The popular areas noted in the survey include JMT, HST, Rae Lakes Loop, Whitney area (Crabtree to Mount Whitney), Dusy Basin, Kearsarge Lakes, Rock Creek, and Pear Lake areas. Popular areas for stock include Roaring River, the Kern Canyon, Hockett Plateau, and Rock Creek (both upper and lower) (Martin and Blackwell 2013). Bearpaw Meadow, Sawtooth Pass, Woods Creek Trail, Bubbs Creek Trail, and Charlotte Lake also receive moderate to high levels of use.

The most popular wilderness destination in the parks is Mount Whitney, which receives approximately 16,000 to 20,000 visitors annually. Other popular entry points and destinations for day users include Tokopah Falls, Lakes Trail/Watchtower and Heather Lake, and Mist Falls and Paradise Valley. Wolverton/Alta Peak and Panther Gap, Sawtooth/Monarch Lake and Sawtooth Peak, Franklin/ Farewell Gap and Franklin Lakes, and Bishop Pass/Dusy Basin are also popular, receiving relatively high levels of use (NPS 2013f).

The wilderness in Sequoia and Kings Canyon National Parks offers opportunities for both on- and off-trail travel. Almost all visitors (97%) indicate they spent time hiking on trails. Approximately 42% of visitors also traveled off-trail. Those traveling off-trail spent an average of 1.6 nights in these areas. While there is no baseline information on the amount of off-trail travel in the parks, managers in many locations perceive that off-trail travel may increase with the rising use of hand-held technological devices. This trend could serve to spread out visitor impacts on wilderness over time, and even cause some increased impacts in trail-less areas as visitors share information about them with each other. These trends challenge managers to monitor the growing use of off-trail areas and the potential for increased impacts on those areas. Off-trail areas offer visitors the challenge of navigation and may offer more opportunities for solitude in wilderness (Martin and Blackwell 2013).

Meadows and their surroundings are often perceived as a focal point of the wilderness experience as they frequently serve as principal destinations for wilderness travelers. For those who ride and/or pack into wilderness, these areas also may provide forage for their stock. While the popularity of meadows remained fairly constant from 1992 to 2012 (varying only with the snowpack), several trends have become apparent. Stock groups repeatedly use the same meadows and campsites. As a result, some meadows open to grazing receive little or no use while others receive use sufficient to necessitate management controls.

Party Size — The typical party visiting the parks' wilderness averaged just fewer than three people per party between 2002 and 2012 (NPS 2012a). Respondents to the 2011 survey were part of parties ranging from one (24% of respondents), two (38% of respondents), three to four (24% of respondents), and more than four people (14% of respondents).

During each year between 2002 and 2012, parties traveling with stock usually had an average of slightly more than four people per party. This average ranged from a low of 1.9 people per party in 2009 to a high of five people per party in 2006. The average number of stock per person over the 11-year period was 1.9 (NPS 2012a).

Trip Length — The majority of visitors (54%) to the parks' wilderness during the summer of 2011 spent two to four nights. Five-to-seven-night trips were also common (26% of visitors). Only 9% spent eight to ten nights, while just 2% stayed in wilderness for 11 nights or longer. This represents a slight increase in trips of four nights or more since 1990, and a slight decrease in trips less than three nights. The average trip length for 2011 was slightly more than four nights (Watson 2013).

Approximately 18% of wilderness overnight visitors stay fewer nights than anticipated. Actual trip lengths were, on average, about one night shorter, or about 20% shorter, than the expected or intended trip length recorded on wilderness permits. Recent research has shown a similar trend in Yosemite National Park, where the average trip was about 15% shorter than planned (Watson 2013).

Overnight Use and Day-use

Overnight Use — Visitors who wish to stay overnight in wilderness must obtain a permit from the NPS or USFS. An average of 7,582 wilderness permits was issued each year between 2002 and 2012 by the USFS and the NPS combined for trips into the parks. An average of 141 stock-use permits (private and commercial) was issued each year between 2002 and 2012 (NPS 2012a).

The average number of overnight wilderness visitors to the parks for the past 3 years (2010–2012) is approximately 23,000, accounting for an average of approximately 111,000 visitor-use days (VUD) per year. These figures are compiled from permits issued by Sequoia and Kings Canyon National Parks and Inyo, Sequoia, and Sierra national forests. The average does not include PCT users coming from south of

Sequoia National Forest or coming from north of Inyo and Sierra national forests or JMT users coming from Yosemite National Park or other points north of Sierra National Forest (NPS 2012a).

It is estimated that these additional 3,500 users account for 28,000 visitor-use days (based on projected numbers of users and days of use; the estimate of visitor-use days in these parks per trip per person for the PCT and JMT users is eight). For the purposes of the WSP, only the VUDs calculated from wilderness permits are used. The estimates from PCT/JMT long-distance use have not been included, though they have been considered in visitor capacity decision making.

Wilderness stock-use permits average about 2% of total permits issued each year by the NPS and USFS. Overnight stock-use levels vary with the persistence of the snowpack each year, but were fairly consistent in the 1980s and 1990s. In 1996, following the establishment of the 1986 SUMMP, stock use was about one third of the level of the early 1950s and about one-sixth of the peak levels reported in the 1930s (NPS 1998a).

Day-use — Several destinations are very popular among day users, including Mount Whitney, Mist Falls, and the Watchtower. Day trips provide an important introduction to wilderness and may be the only wilderness experience available to many people. Though day-use visitors spend much less time in the parks' wilderness than overnight users, they may still have impacts on natural and cultural resources and other visitors' experiences due to the brief, spatially compressed nature of their visit (NPS 2013f).

VISITOR EXPERIENCE

Activities — The parks' wilderness includes high-elevation lakes, streams, meadows, and peaks, which are destinations for wilderness visitors. These areas offer opportunities to experience a variety of recreational activities away from the busy pace and noise of modern daily life. Visitors use wilderness in many different ways and for many different reasons. Surveys of overnight wilderness visitors showed that popular activities included hiking on trails (97%), hiking in trail-less areas (42%), fishing (24%), non-technical mountain climbing (without gear) (22%), speed hiking (6%), technical mountain climbing (with gear) (3%), and trail running (2%) (Martin and Blackwell 2013). Other recreational opportunities in wilderness include boating, photography, nature study, horseback riding/pack trips, swimming/wading, and cross-country skiing and snowshoeing during the winter.

Stock use is a popular activity in Sequoia and Kings Canyon National Parks. Recreational stock use in the parks predates their establishment and peaked in the 1930s. Stock-use levels have varied since then, peaking again in the 1950s and then decreasing in the 1960s and 1970s as backpacking became more popular (NPS 1998a). In 1996, about 54% of stock use was commercial use, 14% was private use, and the remaining 32% was for administrative purposes. In 2012, total stock use was comprised of 41% commercial use (one concession, 15 CUA holders), 9% private use, and 51% administrative use (NPS 2012a).

There are four different methods in which wilderness visitors use stock. People can travel with stock for their entire trip, spot trips occur in which visitors ride in and are dropped off, after which the stock leave, dunnage trips occur in which visitors hike in and stock carry supplies and then leave, or stock can make mid-trip resupply trips to overnight visitors. Horses and mules account for 97% of total stock use and burros and llamas account for about 3%.

Commercial day-use involving stock for spot and dunnage trips to support overnight wilderness visitors (i.e., excluding day rides) totaled 896 stock days in 2012, higher than the 2007 to 2012 average of 793 stock use days. It is not known how many private stock day-rides occur, but the number is believed to be very low considering the low number of points of entry.

Camping — Camping is rarely restricted in the parks' wilderness. Wilderness visitors are generally free to choose their camp areas, except in three popular destinations where use of designated campsites is required (Emerald and Pear lakes, Bearpaw Meadow, and Paradise Valley), as well as areas near frontcountry trailheads that are closed to camping to prevent overuse. First location at which camping is allowed and other camping limits are presented in the "Alternative 1: No-action / Status Quo" section of chapter 2.

Several activities related to camping were included in the Martin and Blackwell survey (2013) to provide managers with information on campfire use and food storage. The results are summarized below.

Campfires **—** In 2011, visitors surveyed reported that 40% of groups had at least one campfire; nearly all of those visitors with at least one fire reported having both evening campfires (99%) and non-cooking campfires (97%). Of the groups having campfires, 86% of the groups had two or fewer during their trip. The groups having campfires had an average of one campfire for every four nights of camping (Martin and Blackwell 2013).

The survey also showed that visitors built campfires in trail-less areas much less frequently than those who traveled on-trail. Only 15% of off-trail travelers built fires, resulting in an average of about one campfire every 14 nights spent in wilderness. In contrast, 45% of those traveling on trails built campfires, amounting to an average of one fire every four nights (Martin and Blackwell 2013).

Fuel types for stoves used by surveyed visitors included propane (58%), liquid (30%), wood (9%), and solid/pellet fuel (4%). Approximately 5% reported no stove/cooking use. The total percentage exceeds 100% because some visitors used multiple fuel types (Martin and Blackwell 2013).

Most visitors responding in 1998 (89%) said that campfires should be allowed, but many felt campfire use should be limited by conditions such as elevation (29% set the limit at 9,000 feet) and fuel type. Prohibiting the use of wood, charcoal, and other campfire fuels from outside the parks was favored by 55% (NPS 1998a).

Food Storage **—** A variety of food-storage options are available to overnight wilderness visitors in these parks. Portable food containers are the most prevalent; 90% of visitors surveyed in 2011 reported using them. There are also 86 food-storage boxes installed by the parks at selected locations, which were used by 29% of visitors surveyed in 2011. Food may also be hung from trees or boulders (which is not permitted), or hung via the counterbalance method in which two bags are hung opposite each other over a branch or rock. Approximately 12% of visitors surveyed reported counterbalancing food in a tree. Less than 5% of visitors hid or buried their food, left it sitting out, or stored it in a tent (all of which are not permitted) or kept it in a bear-resistant drum carried by stock (which is permitted), or employed other methods (Martin and Blackwell 2013).

For those parties carrying portable containers, approximately 40% carried one, 34% carried two, 12% carried three, 8% carried four, and 6% reported carrying more than five (up to 30). This averages about two containers per person. Visitors carried an average of about six person-nights of food per container. However, while 85% of visitors carrying four person-nights of food or less in each container were able to fit all food, trash, and other scented items in their containers during every night of their trip, that percentage dropped to 64% for those carrying more than four person-nights of food per container (Martin and Blackwell 2013). There is clearly a direct relationship between food-storage outcomes and the amount of food, measured in person-nights that visitors try to fit into a container. While experienced backpackers can often fit six, eight or ten person-nights of food into a container, four person-nights of food per container is recommended for those that are not very experienced (Martin and Blackwell 2013).

These data also show that wilderness visitors often have trouble fitting all their food into their food containers unless they carefully plan out how many containers they need prior to leaving the trailhead. Of the survey respondents who were unsure if all their food would fit into their containers, or who had not considered it, 69% subsequently reported that they were not able to fit everything into their container(s) on every night of their trip (Martin and Blackwell 2013).

Factors Affecting Visitor Experience — The number of encounters with other visitors and the type of groups encountered can affect some visitors' experience in wilderness. The frequency of encounters with others is described under "Wilderness Character – Opportunities for Solitude or Primitive and Unconfined Recreation" of this chapter. The visitor reactions to the various types of groups encountered are described below, as are the visitor perceptions of facilities and the condition of the wilderness.

Encounters with Other Types of Parties **—** The 2011 survey asked overnight wilderness visitors whether encounters with others interfered with their enjoyment of wilderness. Of those who said yes, 10% reported that hikers with backpacks or daypacks had interfered with their experience and 8.5% reported that groups with stock had interfered with their experience. Behaviors that visitors reported as interfering with their enjoyment of wilderness included inconsiderate or inexperienced people, the presence of stock or manure, people who were not following regulations, overcrowding, the presence of rangers, park staff, or trail crews, and noise from planes, jets, or helicopters (Martin and Blackwell 2013).

Large parties of more than 10 people on trails were noticed by 37% of visitors, all of whom felt that the presence of large groups detracted from their enjoyment of wilderness. Approximately 49% felt that the number of large groups should be less, 50% felt it should be the same, and 1% felt it should increase. Groups camping nearby were noticed by 70% of visitors in the 2011 survey. The presence of these groups detracted from 37% of visitors' trips, added to 7% of visitors' trips, and had no effect on 56% of visitors. Approximately 37% of visitors suggested the amount of groups camping nearby should decrease while 63% felt it could stay the same (Martin and Blackwell 2013).

Groups traveling with stock were noticed by 56% of visitors in the 2011 survey. The presence of groups with stock detracted from the quality of 45% of visitors' trips, added to 6% of visitors' trips, and had no effect on 49% of trips. Approximately 49% felt that the number of groups with stock should be lower, 50% felt it should stay the same, and 1% indicated that it should increase (Martin and Blackwell 2013). Data from the 1990 survey is used in table 70 to compare the changes in the average number of encounters by group type in 1990 and 2011. Overall the numbers have slightly decreased.

Table 70: A Comparison of Average Group Encounters in 1990 and 2011

Group Type	Average Number Encountered per Day	
	1990	2011
Large groups (>10) seen per day	0.2	0.2
Groups camped within sight or sound of visitors	1.2	0.9
Groups with horses or mules per day	0.3	0.2

Source: Martin and Blackwell 2013 in NPS 2013e

Facilities **—** Toilets and sanitation in wilderness were not considered a problem by 67% of survey respondents. Approximately 19% thought they were a small problem, 8% considered them a moderate problem, and 5% thought they were a big problem.

The presence of ranger stations and camp crews can also affect visitor experience. Approximately 37% of visitors noticed ranger stations in wilderness, though only 2% said the stations detracted from their experience. Ranger stations added to the enjoyment of 32% of visitors and had no effect on 66% of visitors. Most visitors (94%) thought the number of wilderness ranger stations should remain at current levels. Camp crews were noticed by 23% of visitors. Again, few (5.2%) felt camp crews detracted from their experience, while most visitors were indifferent to the presence of camp crews (77%) and felt the number of camp crews in wilderness should stay the same (93%) (Martin and Blackwell 2013).

The survey respondents were also asked if they noticed different types of facilities and equipment in wilderness, whether seeing these facilities detracted from the quality of their visit, and whether they would suggest that the parks offer the same number or fewer of these facilities. Of the ten different types of facilities, the two that detracted from the quality of the most visitors' trips were stock gates and drift fences (24.6%) and helicopters (26.5%). Visitors found the eight other items to be minimally distracting and most recommended a similar amount. Table 71 provides a summary of these responses (Martin and Blackwell 2013).

Table 71: Summary of Facilities Encountered

Facility	Notice? (Yes %)	Detract? (Yes %)	Recommend Fewer	Recommend Same
Directional signs	95.6	2.2	2%	96%
Regulatory signs	86.7	7.9	10%	89%
Informational signs	81.3	3.0	5%	94%
Bridges	73.4	1.2	2%	96%
Food-storage boxes	71.2	7.3	8%	90%
Wilderness ranger stations	62.6	1.9	5%	94%
Stock gates/drift fences	50.9	24.6	35%	65%
Science equipment or Installations	25.0	5.0	6%	94%
National Park Service crew camps	22.7	5.2	7%	92%
Helicopter overflights or landings	21.5	26.5	35%	65%

Source: Martin and Blackwell 2013 in NPS 2013e

Condition of Wilderness — Respondents to the 2011 survey were asked to give their perception of the severity of various impacts and problems within wilderness by ranking them on a scale of 1 (not a problem) to 4 (a big problem). Most impacts and problems were rated less than a 2 (no problem to small problem). The seven items that were considered the biggest problems (1.5 or above) were horse manure on trails (1.96), too many people in certain places (1.74), too many stock animals on trails (1.6), stock damage to vegetation (1.55), too many hikers on trails (1.52), litter (1.51), and improper human-waste disposal (1.50). Again, none of these problems received a mean rating of greater than 2, equaling a "small problem." Table 72 presents the survey results for impacts/ problems that received an average score of greater than 1.5.

Table 72: Summary of Perceived Severity of Impacts or Problems

Impact or Problem	Percentage of Visitors				Mean[1]
	1=Not a Problem	2=Small Problem	3=Moderate Problem	4=Big Problem	
Horse manure on the trail	41.8%	31.7%	14.7%	11.8%	1.96
Too many people in certain places in the area	53.6%	25.0%	15.2%	6.1%	1.74
Too many stock animals on the trail	66.4%	15.8%	9.5%	8.3%	1.6
Stock damage to vegetation (e.g., trampled meadows, damaged trees)	66.7%	17.8%	9.2%	6.3%	1.55
Too many hikers on the trail	64.0%	23.3%	9.9%	2.9%	1.52
Litter	63.3%	26.0%	7.5%	3.3%	1.51
Improper human waste disposal	67.8%	19.1%	8.2%	4.9%	1.5

[1]Measured on a scale of 1 to 4, where 1=Not a Problem; 2=Small Problem; 3=Moderate Problem; 4=Big Problem.
Source: Martin and Blackwell 2013 in NPS 2013e

Impacts or problems perceived as less problematic than those in table 72 included horse manure in the campsite (1.47), groups with too many horses (1.45), not enough campsite privacy (1.44), too many people in the area as a whole (1.42), rutted trails (1.37), human damage to vegetation (e.g., hatchet/axe damage to trees; 1.36), too many large groups (1.35), overall trail conditions (1.33), too may rules and regulations (1.31), too many fire rings (1.28), helicopter noise (1.24), and lakes and streams appear polluted (1.18).

Visitor Opinion Regarding Management: The 2011 survey included questions on what visitors thought about the rules and regulations governing visitors to Sequoia and Kings Canyon National Parks' wilderness. Survey respondents were asked if there should be limits on the size of groups visiting this wilderness and, if so, to provide their preferred maximum group size for various types of user groups. Almost 80% of respondents said there should be limits. Table 73 provides the preferred average group size.

Table 73: Average Preferred Group Size

Type of Group	Average Preferred Group Size
Number of people in hiking-only groups (no stock) on trails	9.6
Number of people in hiking-only groups traveling cross-country in trail-less areas	7.7
Number of people in groups with stock on trails	6.8
Number of people in groups with stock traveling cross-country in trail-less areas	4.1
Number of stock in groups on trails	5.4
Number of stock in groups in trail-less areas	3.1

Source: Martin and Blackwell 2013 in NPS 2013e.

The survey concluded that preferred maximum on-trail group size was similar between survey respondents who had visited both popular and less-visited areas, and that the preferred off-trail maximum group size was similar between respondents who had traveled on-trail and off-trail. Likewise, the preferred maximum group size for people and stock was similar between those who had visited "high stock-use" areas and those who had not (Martin and Blackwell 2013).

COMMERCIAL SERVICES

The parks permit some commercial services to support activities in wilderness. Currently authorized services include guided hikes and backpacking, climbing, mountaineering, ski mountaineering, cross-country skiing and snowshoeing, and stock trips. Visitors take advantage of guide services to facilitate their wilderness experience for a variety of reasons. Some of these reasons include the extent of preparation and equipment needed by visitors traveling from afar, physical limitations due to age or other conditions, safety concerns, or the desire to experience wilderness with skilled and knowledgeable guides. These commercial services support about 7,500 to 8,000 visitor service days per year (appendix B).

Sequoia and Kings Canyon National Parks issue about 32 CUAs annually for hiking-guide entities (about 19 permits per year) and stock-guide entities (about 13 permits per year), and one concession contract that facilitates stock services in wilderness (Cedar Grove Pack Station). Non-stock guides support about 4,500 visitor service days per year, and stock-guide services support about 3,000 visitor service days per year.

Two destinations, Bearpaw Meadow High Sierra Camp and Pear Lake Ski Hut, are commercially operated overnight facilities. The Bearpaw High Sierra Camp, operated during the summer months, is a commercial lodging enterprise, operated through a contracted concessioner, which provides tent-cabin lodging and meals at a cost to the user. Reservations for Bearpaw are required and it is typically at or near capacity during peak season. From 2006 to 2012, the Bearpaw facility had an annual average of 1,500 visitor service days. The Pear Lake Ski Hut is operated in the winter months and serves as a destination for cross-country and backcountry skiers and snowshoers. The Pear Lake Ski Hut is currently operated through an agreement between the NPS and a cooperating association (currently the Sequoia Natural History Association). From the winter of 2008/2009 through 2012/2013, the Pear Lake Ski Hut provided an annual average of 1,200 visitor service days (appendix B).

PARK OPERATIONS

The superintendent, five division chiefs, and additional support staff comprise the parks management team. In FY 2012, the full-time employees numbered approximately 240, down from FY 2010, which had around 262 (NPS 2013g). During the summer, 300 to 325 seasonal employees are typically hired, and approximately 830 volunteers contribute more than 42,000 hours of work (NPS 2013g). Additionally, there are about 26 cooperating association employees, 45 interagency staff and researchers, and 250 concession employees (NPS 2007a).

This section describes the divisions, operations, programs, and administrative activities and facilities related to wilderness management.

WILDERNESS OFFICE – MANAGEMENT AND COORDINATION

The parks' wilderness office is the principal public-contact point for wilderness information and permits. Associated with this office are the management of a fee collection program for permit reservation; coordination of quota and permit activity among all park units and with surrounding interagency operations; and wilderness education through information dissemination (via hard copy and web). The office provides and updates wilderness information as needed to provide visitors with current information related to the protection of park resources, resource education, and safety. Publications are reviewed annually and revised if necessary. The office staff provides multiple support activities for the public, including trip planning, and dispersal of park information. The staff keeps reports on wilderness trail conditions and publishes meadow opening dates. The coordinator participates in internal and external meetings and coordination with other management divisions of the parks; commercial users, stakeholder organizations and interest groups; and neighboring state and federal land management agencies.

Management staff of the R-2508 Military Aviation Complex is consulted regarding their low-level military overflights above the park. The wilderness office staff provides training for trailhead rangers, which includes permit issuance, Leave No Trace© techniques, and wilderness safety.

The wilderness coordinator serves as primary staff advisor to the superintendent, chief ranger, and district rangers on all matters relating to managing visitor activities in wilderness and is responsible for short-term direction and long-term planning input for the wilderness management program. The wilderness coordinator develops, with the district rangers, strategies to implement operational aspects of existing plans. The program consists of three permanent employees (wilderness coordinator, wilderness assistant, visitor services assistant) and three seasonal employees (one office worker, and two trailhead rangers, one each working at the USFS offices in Lone Pine and Bishop) through an interagency agreement. Three other seasonal trailhead ranger positions (Road's End, Lodgepole, and Cedar Grove trailheads) are supported by project funds from the wilderness office but supervised by area subdistrict rangers.

WILDERNESS RANGER OPERATIONS

The wilderness in Sequoia and Kings Canyon National Parks is patrolled by rangers who are either stationed full time in wilderness or are stationed outside of wilderness and complete periodic patrols into wilderness. The majority of patrols are conducted from June through mid-October each year to coincide with peak visitation. The patrols are completed primarily by foot; however, there are generally one or two stock-mounted rangers each season. There are also infrequent patrols on skis in the winter months.

Trailhead ranger

Wilderness patrol rangers play a key role in the protection of natural and cultural resources, the preservation of wilderness character, and the safety of park visitors and staff. Wilderness rangers provide information on minimum impact techniques, local conditions, route selection, and regulations. They also provide emergency services, including search and rescue and both minor first aid and emergency medical response. Some of these rangers have law enforcement authority and are able to address illegal activity. The parks' rangers also patrol areas where sensitive resources may be at risk, and routinely monitor wilderness conditions.

Park rangers patrolling wilderness carry a modicum of equipment with them; to include camping equipment, emergency medical equipment, food, and communications equipment. Rangers communicate with other personnel at the parks using a variety of methods including two-way radios, satellite phones and satellite tracking and messaging devices.

Rangers who are assigned to wilderness full time reside at designated ranger stations during the patrol season. These rangers complete patrols of the geographic area around the stations, focusing on popular corridors and areas such as the JMT and the Mount Whitney area. These patrols range from single day patrols to ten day patrols. Supplies and equipment to sustain these rangers are delivered to the stations at the beginning of the season. The supplies are delivered by stock or by helicopter; the decision to determine how the supplies are delivered is based on a MRA taking into account the current environmental conditions, including snow coverage and water levels.

Rangers based in the frontcountry and completing periodic patrols into wilderness carry most of their supplies and equipment with them. These rangers are generally patrolling popular areas closer to the frontcountry. As these rangers carry out their patrols they either set up temporary camps or stay at unstaffed ranger stations. There are three lightly developed ranger camps which are used to facilitate patrols; these have weather proof boxes which are lightly stocked with equipment each season. There is one in Paradise Valley, one at Junction Meadow, and one at Ranger Lakes.

The wilderness patrol function is heavily supported by ranger stations in the wilderness of Sequoia and Kings Canyon National Parks. Beyond serving as a home base for rangers, the stations provide a base for emergency operations and the sheltering of wilderness visitors who are sick or injured.

The first stations were constructed in the 1890s to facilitate patrols completed by the military. Since that time a total of 19 ranger stations have been constructed; currently about 10 to 12 stations are staffed each year, another three to five are staffed if budget constraints allow, the remainder are used intermittently by rangers as they patrol those areas. Each station is marked on U.S. Geological Survey (USGS) maps and by a “Ranger Station” sign at the nearby trail junctions. Guidebooks also note station locations.

The stations vary in size and design from single wall tents seasonally erected on wooden platforms to larger multi-room buildings. Most of the stations are about 12 x 15 feet in size and have only one room. Six stations are larger, with two rooms, and the Pear Lake Ranger Station is two stories with a basement storage area. Most of the ranger stations have very basic facilities: a woodstove for cooking and heating, a cot, a table, propane or solar-powered lights, storage cabinets, and an outhouse. Almost all of the stations have solar panels used to power 12-volt interior lights and recharge the batteries for portable equipment. Few have sinks, and only four stations have running water. All are at least a day’s hike or horse ride from a trailhead or road.

Each ranger station has an identified patrol area associated with it, although the patrol areas are not strictly defined. The geographic boundaries of the patrol areas are generally defined by passes, drainages, basins and the park boundary. The rangers are given latitude to patrol outside the defined patrol areas, but are directed to focus on the popular corridors and higher use areas.

Consistently staffed ranger stations and general patrol areas (figure 4 on page 76):

- Charlotte Lake – Glen Pass to Forester Pass, Junction Meadow (Bubbs) and East Lake
- Crabtree – the Mount Whitney area
- LeConte Canyon – Muir Pass south to Mather Pass, upper Middle Fork of the Kings River
- Little Five Lakes (platform and yurt) – Great Western Divide to Kern River
- McClure Meadow – northern portion of Kings Canyon National Park to Muir Pass
- Pear Lake – Marble Fork of the Kaweah and the Tablelands
- Rae Lakes – Pinchot Pass to Glen Pass, Sixty Lake Basin, Baxter Basin
- Roaring River – Mitchell Peak to Avalanche Pass, Cloud Canyon, Deadman Canyon
- Rock Creek – Rock Creek drainage
- Tyndall Creek – Forester Pass to Wallace Creek, west to Kings/Kern Divide

Ranger stations staffed as funding permits and general patrol areas:

- Bearpaw Meadow – West of the Kings/Kern Divide and south to Cliff Creek
- Bench Lake – Mather Pass to Woods Creek Crossing
- Hockett Meadow – Hockett Plateau
- Kern Canyon – Kern Canyon to Junction Meadow and the Coyote Creek drainage
- Monarch – Granite Basin, Simpson Meadow, Monarch Divide

Patrol cabins that are rarely staffed:

- Quinn
- Redwood Meadow
- Simpson Meadow

INTERPRETATION, EDUCATION, AND PARTNERSHIPS

The Division of Interpretation, Education, and Partnerships plays a significant role in wilderness, especially in regard to visitor perception, stewardship, and safety in wilderness. The division accomplishes this via its own staff, as well as by directing the wilderness-related activities of the Sequoia Natural History Association, a non-profit partner.

Interpretive rangers provide wilderness information to hundreds of thousands of visitors. At some locations, they issue permits. Through visitor contacts, ranger-led programs, education, public outreach, and media contacts, they personally interact with wilderness travelers and others about the parks' wilderness. Interpreters regularly travel into wilderness to meet with school, volunteer, and work groups to assist them with understanding this resource.

Through Sequoia Natural History Association backpacking trips, day hikes, and youth-in-wilderness programs, the division and its partners enable direct experience of wilderness. The association also provides logistical support and gear to other youth-in-wilderness courses.

These activities, along with webpages, exhibits indoors and out, newspapers and other publications created by interpretive staff, facilitate connections between visitors and wilderness.

RESOURCE MANAGEMENT AND SCIENCE

Key activities of the Division of Resources Management and Science include survey, monitoring and research; planning; regulatory activities (with regional, state, and federal regulatory groups); partnerships; and education. Much of this work occurs in and is focused on wilderness. Field crews working in wilderness travel primarily by foot, with some support provided by stock when needed. Helicopter use for supporting resource management and science activities is authorized when such use meets the minimum requirements for the administration of the area based on a MRA. Field camps established at project sites are of limited extent and duration and strictly follow Leave No Trace© practices.

The division has five branches, each of which has programs managed by subject-matter experts focused on different aspects of resource stewardship. The division also participates in the Sierra Nevada Inventory and Monitoring Program, and supports the USGS Sequoia and Kings Canyon Field Station. All are described briefly below:

A member of a field crew assessing vegetation in a meadow

Branch of Science Coordination and Data Integration — This branch has three units that directly support wilderness stewardship: science coordination, GIS and data integration, and collections/ archives management. The science coordination program manages the research permit program and leads/supports landscape-scale science-management partnerships and the generation, synthesis, application, and communication of science for addressing management issues, including adapting to changing climatic conditions. Research permitted in wilderness includes studies, inventories, and monitoring conducted by NPS staff as well as scientists from other federal agencies, state and local governments, universities, and nonprofit organizations. From 2010 to 2013, 73% of the parks' permitted research included activities in wilderness covering a wide range of disciplines (figure 31 on the following page). Most frequent were vascular plants/plant communities, herpetology (amphibians/reptiles), geology, caves/karst, invertebrates, and fire (behavior, ecology, and effects). Each of the division's subject-matter experts reviews research proposals within their area of expertise, including analyzing the effects for work proposed in wilderness. Permitted research is detailed in appendix P. The Geographic Information Systems (GIS) and tabular-data section supports wilderness operations and management activities including: maintenance of the parks' Spatial Data Warehouse; development and management of spatial and tabular metadata and data-collection standards; monitoring and analyses of wilderness character conditions; generation of web-based and paper maps for wilderness users (including search and rescue); and training on GPS and GIS tools. The curatorial program is responsible for the collection of wilderness images, administrative history, and artifacts; the archives include nearly 700,000 items, including historical documents, maps, and photographs.

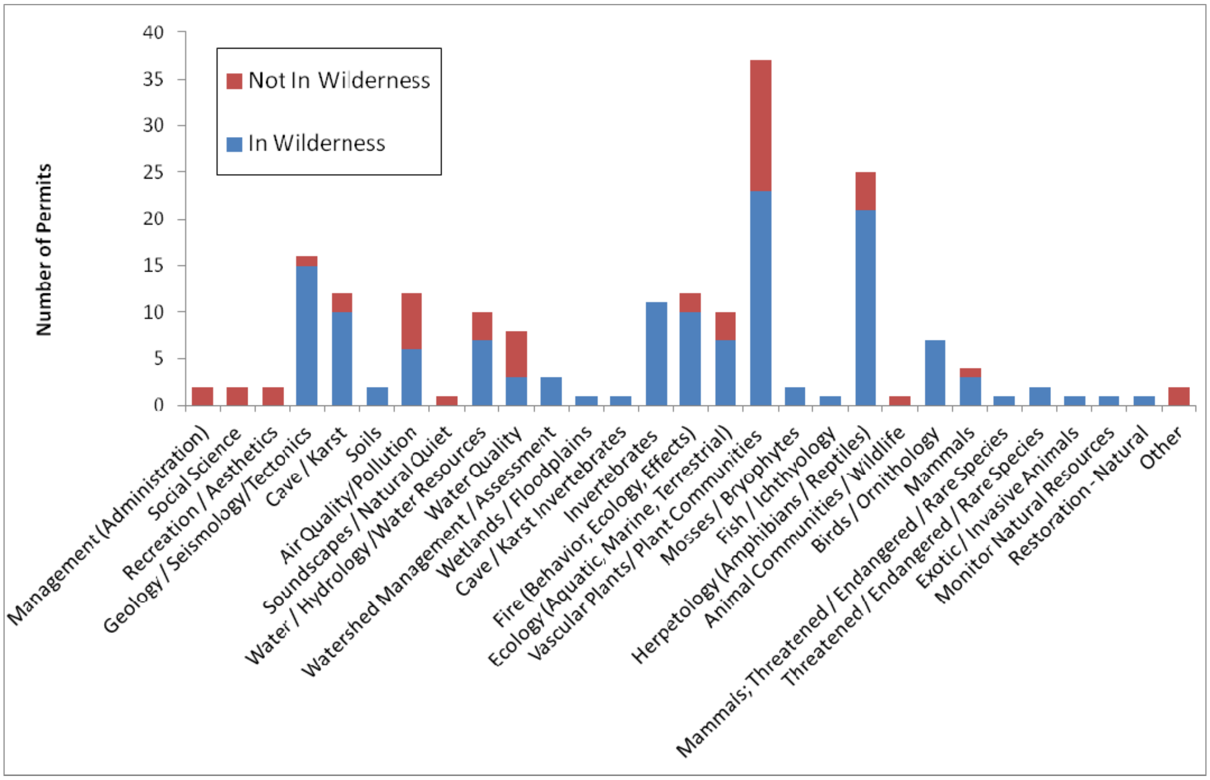

Figure 31: Permitted Research in 2011–2013 (until 8/30/2013)

Branch of Biodiversity and Ecological Resilience — The Branch of Biodiversity and Ecological Resilience includes three components that contribute to wilderness management: the Aquatic Ecosystems Program, the Plant Ecology Program, and the Wildlife Program. The Aquatic Ecosystems Program oversees the restoration of aquatic ecosystems in wilderness. These efforts seek to improve the habitat available to native fauna, with an emphasis on restoring mountain yellow-legged frog habitat. Up to three crews of two to four biologists are stationed in wilderness during the summer season. The program also supports aquatic research on the Yosemite toad, and on the effects of nonnative fish on invertebrates in Sierra Nevada lakes. It supports long-term water quality monitoring in the Marble Fork of the Kaweah River above Tokopah Falls, part of an interagency agreement between the parks and the USGS Hydrologic Benchmark Network Program.

A primary responsibility of the Plant Ecology Program is to monitor administrative, commercial, and private stock use and associated ecological impacts. Stock-use and meadow-monitoring data are central to the adaptive management of stock use and grazing in the parks; as such the program focuses on preventing resource impacts that may be associated with pack-animal use. Efforts include design and implementation of monitoring protocols to evaluate impacts and detect changes due to stock use, disseminating information to stock users and park managers, facilitating research into stock-related ecological effects, and development of standards for acceptable impacts, which can then be translated into effective management.

Annual monitoring by the program is accomplished in cooperation with the wilderness ranger staff; plant ecologists provide technical oversight and field consultation. It includes residual-biomass monitoring in approximately 35 meadows; monitoring of plant composition in five pairs of grazed/ungrazed meadows on a rotational basis (one pair is monitored each year); stock-use monitoring through a system of selfreporting, staff observations, and the wilderness-permit database; surveys for nonnative plants; and site visits to assess condition at meadows of concern throughout the parks.

The Wildlife Program manages efforts to restore and perpetuate the natural distribution, ecology, and behavior of black bears and other wildlife; monitors and minimizes negative human / wildlife interactions; monitors and manages nonnative animals; records wildlife sightings from park employees and visitors; and participates in bighorn sheep research and recovery efforts. Operations are based in the frontcountry but respond to wilderness needs as requested. The wildlife biologist coordinates placement and maintenance of bear-resistant food-storage facilities in wilderness.

Branch of Vegetation Management — The Branch of Vegetation Management includes the Invasive Plant Management Program, the Forestry Program, the Disturbed Lands Restoration Program, and the Fire Ecology Program. The Invasive Plant Management Program coordinates early detection efforts and treatment of selected harmful nonnative plant species. To accomplish this, crews are periodically stationed in wilderness during summer months to implement control efforts, and specialists may address specific issues on a case-by-case basis. The Forestry Program deals primarily with tree-hazard and forest-pest management, plus forest-health monitoring. These take place largely outside of wilderness, but the parks' forester is active in wilderness management as needs arise.

The Disturbed Lands Restoration Program returns natural processes, topography, and vegetation to sites that have been degraded by human activities. Within the wilderness setting, these activities are often associated with trail projects and are conducted in concert with the Trails Management Program. The Fire Ecology Program evaluates resource effects related to fire by collecting and analyzing monitoring and research data, and provides feedback to park managers on the Fire Management Program. This program maintains a network of long-term monitoring plots to assess the effects of fire on vegetation, which field crews read during summer months.

Branch of Physical Sciences — The physical-science programs provide expertise in air resources, hydrology, geology, and cave and karst systems. The Air Resources Program documents the abundance of pollutants that are atmospherically transported into the parks, their health effects on employees and visitors, and their effects on natural resources. It cooperates with the national USEPA, California's Air Resources Board, and the regional San Joaquin Valley Unified Air Pollution Control District. The program also facilitates research into the effects of air pollutants on vegetation; research and monitoring of ozone, nitrogen, particulates, synthetic chemicals, and fine particulate matter; meteorology; wet- and dry-deposition chemistry (acidic, nitrogen, and contaminant deposition); visibility, including availability of dark skies; and soundscapes. The Hydrology and Cave Resources Program provides coordination and consultation on issues related to hydrology and cave environments and their management, as well as soils and geology.

Branch of Cultural Resources Management — The purpose of the program is to proactively protect and preserve the parks' prehistoric and historic cultural resources. Ongoing research informs appropriate management of cultural resources as mandated by key federal legislation. The program manager directs the archeology, ethnography, history, cultural landscapes and historic architecture programs. Staff advise on issues related to prehistoric/historic artifacts, management of historic buildings, and contacts with American Indian tribes and individuals. The program manager serves as senior principal advisor on cultural resources and ensures development of and sustained relationships with researchers, resource managers, and subject-matter experts in other agencies, universities, traditionally associated groups, and other entities in order to facilitate cooperative regional strategies on adjacent lands in order to achieve broad protection strategies and prevent human impacts.

Sierra Nevada Network Inventory and Monitoring Program

The Sierra Nevada Network Inventory & Monitoring Program is one of 32 NPS Inventory & Monitoring networks across the country established to facilitate collaboration, and economies of scale in natural-resource monitoring. The Sierra Nevada Network comprises four NPS units: Devils Postpile National Monument plus Kings Canyon, Sequoia, and Yosemite national parks. Network ecologists are developing and implementing six long-term monitoring protocols as part of the NPS Vital Signs Monitoring Program: birds, climate, high-elevation forests, lakes, rivers, and wetlands. Field monitoring is conducted by crews of two to four biologists who travel to wilderness sites primarily by foot, with some supplies and materials transported by stock and, in limited cases, by helicopter.

U.S. Geological Survey Sequoia and Kings Canyon Field Station

This field station reports directly to the USGS Western Ecological Research Center in Sacramento, which serves the Pacific Southwest of the United States. The staff currently carries out research addressing global climate change, forest demography, ecological impacts and historical patterns of fire, and invasive plants. As part of the Forest Demography Program, ecologists at the field station maintain a network of long-term tree-monitoring plots within wilderness, which are visited annually by biologists traveling by foot; in limited cases, supplies and materials may be transported by stock.

Facilities Management Division

The Division of Facilities Management takes responsibility for annual and periodic maintenance of most structures in wilderness. These include approximately 650 miles of wilderness trails plus trail bridges, historic and non-historic buildings, water and septic systems, several types of toilets, food-storage boxes, radio repeaters, drift fences, and gates.

A CCC crew member maintaining trails

By far the most effort is spent on trail maintenance. Each year eight to ten crews totaling from 60 to 90 workers travel the trails to remove fallen trees and rocks, clear drainages and remove encroaching vegetation, and repair and rebuild trail structures and portions of trails. They may reroute or restore sections of trail to natural conditions. Trail crews also make most of the repairs on drift fences, relocate privies as needed, and repair hinges or latches on food-storage boxes. Second in annual effort is maintenance of historic buildings using a single crew of one to four workers. This crew assesses building condition and completes major renovations such as reroofing, foundation and window repair, painting, staining, and replacement and chinking of logs. The utilities branch occasionally works on septic systems and the restrooms at Emerald and Pear lakes, and at the Bearpaw Meadow Ranger Station. The radio shop maintains, upgrades, and troubleshoots problems with radio repeaters. Special-project crews may be called on for one-time needs, such as the complete replacement of three deteriorated ranger stations during 2010 to 2013.

The typical work season for these activities runs May through October, with June to September seeing the most work. Maintenance crews travel mostly by foot or by horse. Most logistical support is provided via horses and pack mules; helicopters are used occasionally but are subject to approval through an MRA. Although the Facilities Management Division has primary responsibility for upkeep of wilderness facilities, other divisions do operational maintenance as necessary. Wilderness rangers in particular are instrumental in completing some work on ranger stations, signs, and drift fences, and are vital to the timely reporting of problems with facilities.

OTHER FACILITIES AND DEVELOPMENTS

Pastures — Fenced stock pastures are associated with wilderness ranger stations at Kern, Roaring River, Redwood Meadow, and Hockett Meadow. The Kern and Redwood Meadow pastures are used infrequently for administrative purposes, while the Roaring River and Hockett Meadow pastures are used more frequently.

Crew Camps — Crew camps can be established for the short- or long-term for administrative purposes (e.g., wilderness patrols, resource management/research activities, and trail maintenance/project activities). Currently, there are 15 established long-term trail crew camps within Kings Canyon National Park and 10 within Sequoia National Park. The camps are generally located near major junctions or hubs. Camps may be occupied for several days or for several seasons, depending on the project, and may contain food and/or tool storage boxes, a fire pit, and tool caches.

Redwood Canyon Cabin — Redwood Canyon Cabin has been in place for more than 30 years. The cabin pre-dates the wilderness designation of the Redwood Canyon area in 2009, though the area was managed as proposed wilderness since 1984. It is currently used by a nongovernmental organization to facilitate research in Lilburn Cave. The cabin and associated infrastructure is operated and maintained under a memorandum of understanding. The cabin is approximately 12 feet x 18 feet. It is a single story building with the attic/loft space dedicated to sleeping. The main floor houses storage containers, a fireplace, a wood-fired stove, and a kitchen/workbench. Personal protective equipment, ropes, sleeping bags/pads, and rescue gear is stored in the cabin. There is also storage for scientific equipment, caving equipment, and non-perishable food. External infrastructure includes picnic tables, a wood shed, food-storage boxes, water-storage tanks and associated water supply lines. A privy (pit toilet) is also located on the site.

CONCESSIONS AND COMMERCIAL USE

The Concessions Management Office at Sequoia and Kings Canyon National Parks manages the concessions and commercial uses within the parks. Currently, most frontcountry commercial visitor services are provided under concessions contract by Delaware North Companies Parks & Resorts (Delaware North). The frontcountry services include hospitality operations and facilities at Wuksachi, Lodgepole, and Wolverton in Sequoia National Park; and at Grant Grove and Cedar Grove in Kings Canyon National Park. The Bearpaw Meadow High Sierra Camp, located in a designated potential wilderness addition (DPWA), is also operated by Delaware North. Concessions contracts are generally awarded for a 10-year period, after which time a new prospectus is developed and distributed for bid.

Another concessioner operates horseback riding and stock services under a concessions contract at facilities located in Grant Grove and Cedar Grove. The concessioner provides commercial day rides from the pack station at Grant Grove (frontcountry only) and both frontcountry and wilderness day rides and pack services from the pack station at Cedar Grove.

CUAs, which are not considered concession contracts, may be issued pursuant to section 418 of the National Park Service Concessions Management Improvement Act of 1998 (16 USC 5966). A CUA is a permit that authorizes suitable commercial services to park area visitors when those services (1) are determined to be an appropriate use of the park; (2) will have minimal impact on park resources and values; and (3) are consistent with the purpose for which the unit was established, as well as all applicable management plans and park policies and regulations. Guidance for issuance of CUAs also comes from the Wilderness Act, which states, “Commercial services may be performed within the wilderness areas designated by this Act to the extent necessary for activities which are proper for realizing the recreational or other wilderness purposes of the areas” (§4(d)(5) of the Wilderness Act).

Approximately 32 CUAs are issued each year in the parks. Of those, more than half include services in wilderness. From 2003 to 2012, these services have included guide services for backpacking and hiking, mountaineering, snowshoeing, cross country skiing, photography, climbing, and pack and saddle stock services. Commercial use authorizations are issued on a yearly basis and include permit conditions that define and regulate use and specify reporting requirements.

ADMINISTRATIVE STOCK USE

NPS administrative stock use comprises 40% of total overnight stock use in the parks (Frenzel and Haultain 2013). The parks maintain a herd of approximately 90 horses and mules used for packing supplies in and out of wilderness and for ranger patrols. When not working in wilderness, these animals are held in the Ash Mountain administrative pasture in the foothills (nonwilderness) or on lands outside of the parks.

An administrative pasture near the Kern Ranger Station

ADMINISTRATIVE MECHANICAL TRANSPORT AND MOTORIZED EQUIPMENT USE

The parks, in administering wilderness, will on occasion use mechanical transport and motorized equipment, land aircraft (helicopters), and erect installations. The Wilderness Act allows for these actions provided they meet "minimum requirements for the administration of the area," as stated in Section 4(c) of the Wilderness Act, and as outlined and directed in NPS *Management Policies 2006* (6.3.5).

In wilderness trail and facility maintenance operations, transport of supplies, equipment, and personnel may occur through the use of stock or helicopters, as determined through a MRA. Trail operations also use motorized equipment, such as chainsaws, rock drills, and on occasion, generators and electric tools, to accomplish projects in wilderness if determined necessary through a MRA.

Helicopters may also be used to support ranger activities for hauling supplies to ranger stations, and providing emergency services, such as emergency medical response, fire management, and search and rescue. Scientific activities also may receive the support of helicopters to transport sensitive or bulky equipment and samples, or to allow scientists to safely reach remote areas. The parks also use helicopters to reach hard-to-access radio communication equipment to conduct maintenance and repair.

Helicopter use in the parks from the period of 2010 through 2013 averaged 307 "landings" per year (a landing is defined as when a person or object goes from the ground to the air, or from the air to the ground, whether or not the aircraft itself touches down). Of these; 68 per year were for emergency search and rescue and emergency medical response; 99 per year were for emergency fire-management response (of these, 46 per year were "bucket" drops of water onto fires); and 140 per year were for other administrative purposes, as described above.

All actions that require landing of aircraft, use of motorized equipment or mechanical transport, or the erection of installations, with the exception of emergencies, are analyzed through a MRA process prior to occurring. In order to comply with the mandate and intent of the Wilderness Act, the parks have established the use of "primitive" (e.g., foot or stock travel, hand tools, etc.) methods as the first preference in accomplishing projects and tasks in wilderness.

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