Sequoia and Kings Canyon National Parks

NPS
U.S. Department of the Interior
Sequoia and Kings Canyon National Parks
California

RESTORATION OF NATIVE SPECIES IN HIGH ELEVATION AQUATIC ECOSYSTEMS PLAN AND DRAFT ENVIRONMENTAL IMPACT STATEMENT

Volume 1: Chapters 1-5

September 2013

Note to Reviewers and Respondents

If you wish to comment on this Draft Environmental Impact Statement (DEIS), you may post comments online at http://parkplanning.nps.gov/seki or mail, hand deliver, or fax comments to Superintendent, Sequoia and Kings Canyon National Parks, Attn: Aquatic Ecosystems Plan, 47050 Generals Highway, Three Rivers, CA 93271, Fax: 559-565-4202. Email comments will not be accepted.

This DEIS will be on public review for 60 days.

Before including your address, phone number, email address, or other personal identifying information in your comment, you should be aware that your entire comment—including your personal identifying information—may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we would be able to do so. We make all submissions from organizations and businesses, and individuals identifying themselves as representatives or officials of organizations or businesses, available for public inspection in their entirety.

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EXECUTIVE SUMMARY

This *Restoration of Native Species in High Elevation Aquatic Ecosystems Plan / Draft Environmental Impact Statement* (Restoration Plan/DEIS) analyzes a range of management alternatives for the restoration and conservation of high elevation aquatic ecosystems within Sequoia and Kings Canyon National Parks (SEKI or parks), California. This Restoration Plan/DEIS analyzes the impacts that could result from no action, or implementation of any of three action alternatives.

The National Park Service (NPS) is considering expanding the current high elevation aquatic ecosystem restoration program within SEKI to encompass additional sites and incorporate alternative methods. Thus far, SEKI has restored or is in the process of restoring 26 lakes and ponds by eradicating nonnative fish using physical tools (e.g., gill nets and electrofishers). Although fish eradication is feasible and beneficial for native species (Vredenburg 2004, Knapp et al. 2007, NPS 2012A), eradication using physical tools is only feasible in relatively simple (non-complex) habitat: generally lakes with few and/or small connected stream sections. Some of the remaining potential restoration areas in SEKI that have value for addressing ecosystem recovery (including whole basins) contain much more complex habitat involving large lakes or clusters of many lakes with many and/or large connected streams. Many of these areas also contain large, deep and/or cold lakes that have the best capacity to resist drier and warmer conditions expected in the future due to global climate change. Restoring larger areas is thus critical for native species to continue to have access to high-quality habitat once smaller waterbodies dry up or become too warm.

The current methodology of physically eradicating nonnative fish, although successful on a small scale, does not meet goals to restore and conserve aquatic ecosystems on the parks scale. An average of less than one lake is currently restored per year, and only lakes with relatively-short or simple connected stream sections are restorable using physical methods. To increase the rate of restoration and the size of aquatic habitat that can be restored (including whole basins), the NPS is proposing to expand the current program, both in the number of waterbodies to be restored and the types of treatment methods to be used.

This SEKI Restoration Plan/DEIS therefore proposes to recover smaller relatively-simple habitats using physical tools and larger more-complex habitats (including whole basins) using alternative tools. These habitats are collectively important for conservation of native species, ecosystems and processes, and for mitigating potential effects from climate change. Because eradication of nonnative fish from larger, more-complex habitats has been determined infeasible using gill nets and electrofishers, the NPS is considering using piscicides (rotenone) in order to restore these ecologically significant habitats.

A piscicide is a substance that is toxic to fish and whose intended function is to eliminate undesirable fish from a waterbody. Two piscicides have been widely used by fishery managers to eliminate trout species - rotenone (derived from plants) and antimycin A (derived from bacteria). However, the CFT Legumine™ formulation of rotenone is currently the only piscicide registered for use in California. Therefore, CFT Legumine™ is the only proposed piscicide treatment evaluated in this plan.

Project Site Location

SEKI protects 865,964 acres (350,443 hectares) along the western slope of the Sierra Nevada mountain range in east-central California (Figure 1). Sequoia National Park, established in 1890, and Kings Canyon National Park, established in 1940, are administered as a single unit that rises from the low western foothills at 1,370 ft (418 m) to the summit of Mount Whitney at approximately 14,494 ft (4,418 m). These two parks make up the geographical study area for this Restoration Plan/DEIS. Two wilderness areas are located within SEKI, including the Sequoia-Kings Canyon Wilderness and John Krebs Wilderness. The entirety of SEKI is within Tulare and Fresno counties. Drivable access is by California State Routes 180 and 198, which within SEKI is known as the Generals Highway.

The high elevation aquatic ecosystems addressed in this Restoration Plan/DEIS include selected lakes, ponds, streams and marshes found from approximately 6,000 ft (1,800 m) to 12,000 ft (3,700 m) in elevation, with the majority of sites found above 10,000 ft (3,000 m). In these areas, SEKI contains approximately 3,500 high elevation lakes, ponds and marshes (waterbodies) (Knapp 2003), and more than 1,000 miles (1,600 km) of rivers and streams (NPS 2005), including portions of the headwaters of the Kaweah, Kern, Kings, San Joaquin and Tule Rivers. The majority of the 3,500 waterbodies – approximately 2,500 - are ponds (< 2.5 acres; 1 hectare), many of which are very small, only holding snowmelt water during early summer and drying completely during late summer (~1,000 are < 0.25 acres; 0.1 hectares). Approximately 1,000 of the 3,500 waterbodies are lakes [2.5 acres (1 hectare) or larger], all of which currently hold water year-round. In addition, approximately 600 of the 1,000 lakes are 5 acres (2 hectares) or larger, which will buffer drying expected over time due to climate change.

These waterbodies occur in historically fishless lake basins and provide habitat for a diverse assemblage of native species that developed over thousands of years in a fishless environment (Moyle et al. 1996). From 1870 to 1988, one or more species of nonnative trout, including golden, rainbow, golden x rainbow hybrid, brook, and brown trout, were introduced into many heretofore fishless waterbodies throughout SEKI (Christenson 1977, Knapp 1996). Surveys conducted from 1997 to 2002 determined that self-sustaining nonnative trout populations had become established in 575 lakes, ponds and marshes (Knapp 2003), plus connecting streams, and nearly all streams that drain these sites from high to low elevations.

Purpose of the Action

The purpose of this Restoration Plan/DEIS is to guide management actions by the NPS to restore and conserve native species diversity and ecological function to selected high elevation aquatic ecosystems that have been adversely impacted by human activities, and to increase the resistance and resilience of these species and ecosystems to human induced environmental modifications such as nonnative fish, disease and unprecedented climate change. The Final Restoration Plan/FEIS would be implemented over a period of 25 to 35 years, with an internal evaluation of management effectiveness scheduled every 5 to 10 years.

The overall goal of this Restoration Plan/DEIS is to restore clusters of waterbodies to their naturally fishless state in strategic locations across SEKI to create high elevation ecosystems having more favorable habitat conditions for the persistence of native species and ecosystem processes. The Restoration Plan/DEIS presents a range of alternative management actions to restore and conserve native species diversity and ecological function to selected high elevation aquatic ecosystems in SEKI that have been disturbed by human activities, particularly the stocking of nonnative trout. The Restoration Plan/DEIS describes the no action alternative and three action alternatives that are being considered during this planning effort, and presents an analysis of the impacts of the alternatives on the natural, cultural and physical resources in SEKI. The alternatives represent a range of reasonable and feasible options for addressing the goals and objectives of this plan and the issues and concerns raised by parks staff, other government agencies, and members of the public during the plan's scoping process. Upon conclusion of this Restoration Plan/DEIS, one of the four alternatives will become the *Restoration of Native Species in High Elevation Aquatic Ecosystems Plan* and guide future restoration management actions for a period of 25 to 35 years, with an internal evaluation of management effectiveness scheduled every 5 to 10 years.

Need for the Action

This Restoration Plan/DEIS is needed to provide long-term management direction to restore and conserve SEKI's high elevation aquatic species and ecosystems. Preserving and restoring native wildlife and the communities and ecosystems in which they occur is one of the guiding principles for managing biological resources in national parks (NPS 2006A) and is among the desired conditions established in SEKI's *Final General Management Plan/Final Environmental Impact Statement* (GMP; NPS 2007).

Action is needed at this time:

- because nonnative fish have severely reduced native biological diversity and disrupted ecological function;
- to prevent the extinction of two species of mountain yellow-legged frogs (*Rana muscosa* and *Rana sierrae;* MYLF) and to restore MYLF populations to many locations in the parks where they have gone extinct;
- to enable the NPS to fulfill its mission and policy directives to conserve native animals, plants and processes found in SEKI's aquatic ecosystems;
- because large scale restoration of more complex habitat (areas containing large lakes or clusters of many lakes with many and/or large connecting stream sections) is critical for native species and ecosystem recovery;
- to increase the resistance and resilience of native high elevation aquatic species and ecosystems to human induced environmental change; and
- to restore and protect the natural quality of wilderness character.

Many studies conducted in SEKI and elsewhere in the Sierra Nevada analyzed the effects that nonnative trout have on native species and ecosystems. These studies consistently document that the widespread introduction and continued presence of nonnative trout has caused substantial impacts to native species and ecosystems. Because nonnative trout are efficient predators and competitors, their introduction results in modifications to native food webs: they prey on large organisms such as amphibians and large-bodied aquatic insects and zooplankton, and alter, deplete or eliminate populations of these animals from naturally fishless habitats. This results in less food being available to native aquatic and terrestrial predators, altering their distribution and abundance in turn. Thus, the presence of nonnative trout has negative, cascading effects on entire ecosystems, and their presence in individual lakes, connecting streams and entire lake basins in SEKI continues to cause negative impacts to native species and ecosystem processes. These impacts are replicated on a landscape scale across the parks' high elevations. The NPS has shown that eradication of nonnative trout from relatively-simple habitats in SEKI can reverse these impacts on a small scale (NPS 2012A), but the parks have not had the tools necessary to restore habitats on larger scales. Therefore, this Restoration Plan/DEIS is needed to establish tools for conducting high elevation aquatic ecosystem restoration at the landscape scale in SEKI.

Two species that are integral components of SEKI's high elevation aquatic ecosystems are the MYLFs. Nonnative trout and disease (amphibian chytrid fungus) are the primary factors that have caused formerly abundant MYLFs to disappear from more than 92% of historic sites in the Sierra Nevada (Vredenburg et al. 2007). Most of the remaining MYLF populations are small, isolated, often restricted to small ponds vulnerable to drying, and diseased – with low survival and recruitment rates. As a result, both species were listed under the California Endangered Species Act in 2012 (CFGC 2012), and both species were proposed for listing under the federal Endangered Species Act in April 2013 (FWS 2013).

Intervention is urgently needed to prevent extirpation of both MYLF species from the parks, and SEKI has a viable solution. Eradication of nonnative trout from 12 SEKI lakes and ponds since 1997 has allowed remnant MYLF populations to quickly expand (Knapp et al. 2007), with two growing into the largest MYLF populations existing today. Native snakes, birds and invertebrates have also benefited from the fish eradication and frog increases (NPS 2012A).

Using a combination of physical tools and piscicides, SEKI could eradicate trout at a larger scale than previously achieved, thereby maximizing restoration while providing climate change buffered habitat for MYLFs and other native species. Simultaneously, SEKI could increase MYLF survival and recruitment at these sites by treating frogs for disease with antifungal agents. This strategy shows high potential to eradicate trout from large areas, while strengthening imperiled MYLF populations to also overcome

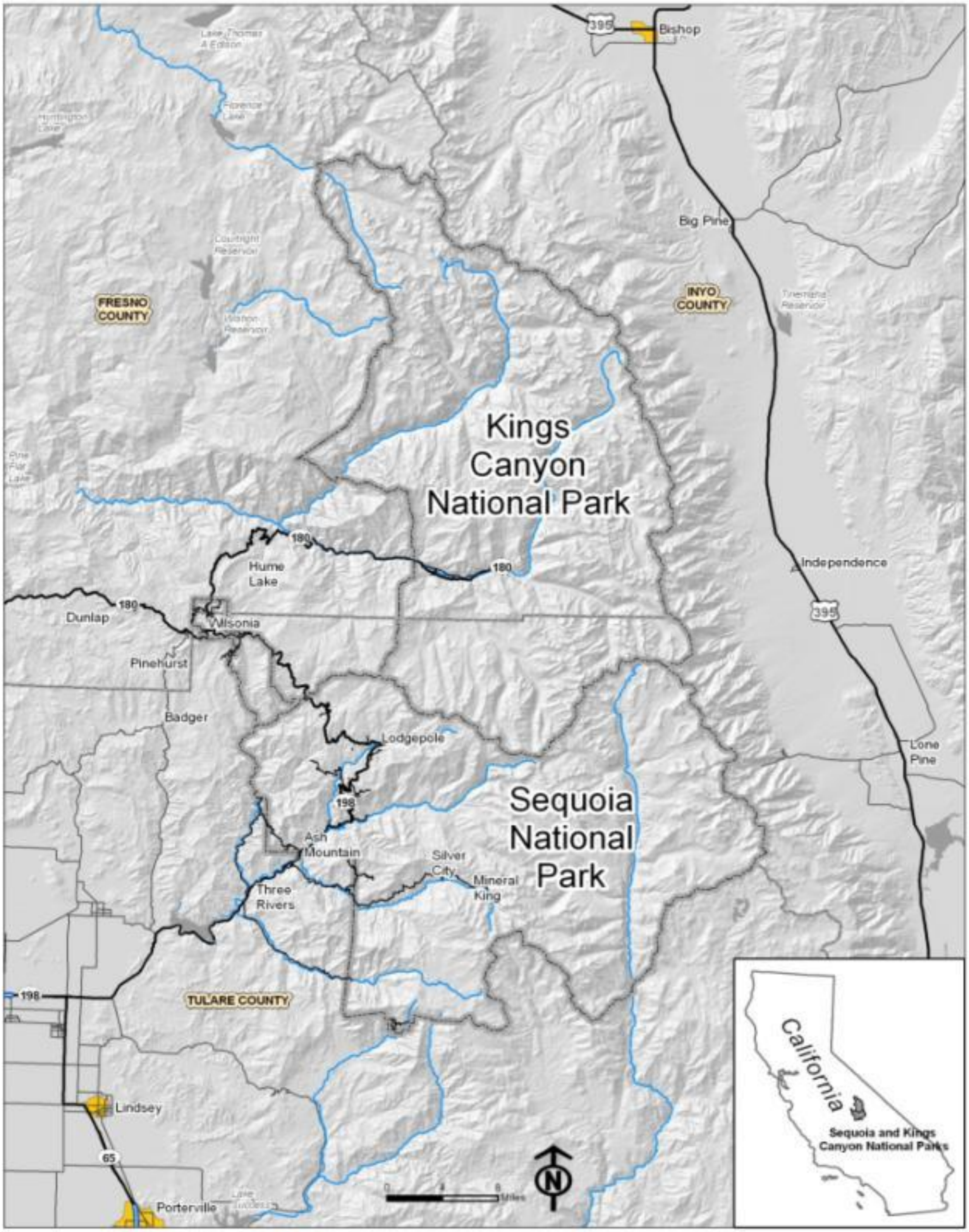

Figure 1. Regional map of Sequoia and Kings Canyon National Parks.

disease and climate change, and restoring and conserving high elevation aquatic ecosystems at the landscape scale.

Objectives in Taking Action

The following management objectives were developed for this Restoration Plan/DEIS based on the purpose and need for the plan, are in accordance with the executive orders, laws, policies, and plans that guide management of natural resources in National Parks, and are summarized below.

A) Restore and conserve the natural abundances, distributions and functions of native species, populations and communities within selected high elevation aquatic ecosystems, by:

- implementing management actions to create more favorable conditions for these populations to persist and be more resilient to human induced changes to environmental conditions; and
- restoring habitat to its historically fishless condition at the parks scale, including the eradication of fish from up to 87 (16%) of 549 nonnative fish-containing lakes, ponds and marshes, approximately 41 miles of streams, and connected fish-containing habitat as necessary.

B) Develop a long-term conservation strategy for both species of MYLFs (*Rana muscosa* and *Rana sierrae)* to ensure the self-sustaining, long-term viability and evolution of MYLF populations in perpetuity within portions of their present and historic geographic range within the parks, and to maintain the genetic and ecological diversity of these species. Specific objectives related to this strategy include:

- reverse widespread loss of the ecological function formerly provided by MYLFs and maintain the viability of existing MYLF populations throughout the range of both species within the parks;
- restore selected habitat and expand existing MYLF populations;
- re-establish MYLFs in selected basins where populations were historically present but are now absent; and
- collaborate with partner agencies and organizations to exchange information, enhance use of available resources, and strategically restore and conserve MYLFs in the Sierra Nevada.

C) Identify presently incomplete information that is needed for effective conservation and management of aquatic ecosystems in the face of unprecedented rates of human-induced change.

D) Use results from restoration efforts and new knowledge from research studies to refine program methodologies over time and mitigate impacts that have the potential to occur during restoration.

E) Restore and protect natural processes in wilderness, using an appropriate range of management actions derived from thorough analyses of potential effects to wilderness character and resources.

F) Provide an appropriate range of visitor experiences and recreational opportunities at wilderness lakes and streams concurrent with minimizing the degradations that have occurred to the biological integrity of high elevation aquatic ecosystems.

The objectives for this plan are grounded in the fundamental mandates of the NPS which are the *Organic Act of 1916* (Organic Act) (16 U.S.C. 1, 2–4) and the *General Authorities Act* (16 U.S.C. 1a–8).

Background

Historically, SEKI's high elevation waterbodies were inhabited by a diverse assemblage of aquatic species that developed over thousands of years in a fishless environment, due to extensive Pleistocene glaciation that created the waterbodies, and steep topography that contained many barriers to fish passage (Moyle et al. 1996). As a result, fish were naturally restricted in distribution to low or middle elevation streams depending on the watershed (Moyle et al. 1996).

The first recorded stocking of nonnative trout into SEKI's fishless high elevation waterbodies occurred in 1870, and unrecorded stockings potentially occurred as early as the 1850s (Christenson 1977). Easily accessible waters were stocked by pack animals until the 1940s, and then virtually all waters were stocked by aircraft until 1988, when all stocking was terminated. Although stocking no longer occurs in SEKI, nonnative trout established self-sustaining populations in approximately 575 water bodies and hundreds of miles of streams, due to an abundance of suitable habitat that fish were able to utilize once introduced.

In contrast, MYLFs were historically one of the most abundant vertebrates in high Sierra Nevada lakes and streams (Grinnell and Storer 1924). These frogs are endemic to high elevations of the Sierra Nevada and southern California and are vital species in these aquatic ecosystems, functioning as predators, abundant prey, and agents of nutrient and energy cycling (Finlay and Vredenburg 2007). By 1915, MYLFs became rare to extinct in lakes containing non-native trout, while remaining common to abundant in most fishless lakes (Grinnell and Storer 1924).

In the 1980s and 1990s, researchers and NPS staff observed that amphibians, particularly MYLFs, appeared to be declining (D. Graber, pers. comm., 2012). Several studies ensued to quantify the MYLF decline and attempted to determine its causal factors. The primary conclusions from these studies were that 1) lake acidity levels were not elevated and thus did not appear to be a contributing factor to MYLF decline (Bradford et al. 1994a), and 2) MYLFs were much less likely to occur in lakes with nonnative fish versus fishless lakes (Bradford et al. 1994B, Knapp and Matthews 2000).

Studies in the past 15 years determined that MYLF populations have disappeared from more than 92% of historic localities in the Sierra Nevada, including SEKI (Vredenburg et al. 2007). Due to this steep decline, in 2003, the U.S. Fish and Wildlife Service (FWS) listed the Sierra Nevada population of MYLFs as a federal candidate species under the Endangered Species Act (FWS 2003).

Extensive research identified two primary factors for this decline. The first factor is the introduction of nonnative trout, which prey on MYLFs, compete with them for food, restrict their breeding to marginal, shallow habitat, and fragment remaining populations (Bradford et al. 1993, Knapp and Matthews 2000, Vredenburg 2004, Finlay and Vredenburg 2007).

The second factor is the recent spread of the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*), 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 (Morgan et al. 2007) and has infected nearly all remaining MYLF populations including those in SEKI and Yosemite National Park (YOSE). Most MYLF populations severely declined within a few years after becoming infected and some populations went extinct. Chytrid fungus has thus been a major factor in accelerating the decline of MYLFs caused by nonnative trout throughout the Sierra Nevada. As a result, in 2007 the FWS reaffirmed the listing of the Sierra Nevada population of MYLFs as a federal candidate species under the Endangered Species Act (FWS 2007A).

Current studies indicate that both MYLF species are continuing to decline and are on trajectories toward extinction (Knapp et al. 2011). As a result, in 2012, *R. muscosa* was listed as endangered and *R. sierrae* was listed as threatened under the California Endangered Species Act (CFGC 2012), and in April 2013 both species were proposed for listing as endangered under the federal Endangered Species Act (ESA; FWS 2013). SEKI is the only park that contains both species of MYLFs, making it ground zero for their restoration and conservation.

To further investigate the effects of nonnative trout, researchers studied the response of MYLFs and other native species (e.g., aquatic invertebrates and zooplankton) when nonnative fish disappeared from historically fishless lakes due to stocking termination or experimental eradication. Results showed that native species quickly recovered toward pre-disturbance levels following the return of lakes to a fishless condition (Knapp et al. 2001, 2005, 2007; Vredenburg 2004; Knapp and Sarnelle 2008).

From 1997 to 1999, researchers experimentally showed that fish eradication using gill nets was feasible after they successfully eradicated nonnative fish from two of the parks' waterbodies (Vredenburg 2004). In 2001, SEKI began to implement preliminary (experimental) restoration of MYLFs (NPS 2001). The primary goal was to assess the feasibility of SEKI staff using gill nets and electrofishers to eradicate nonnative fish from low- to moderate-use lakes having short associated streams. The purpose of the program was to restore aquatic habitat for native species, with an emphasis on improving the status of declining MYLFs.

From 2001 to 2012, SEKI removed nearly 48,000 fish from targeted lakes and streams (NPS 2012A, NPS unpublished data). By 2012, fish were fully eradicated from 10 lakes and nearly eradicated from nine lakes. The final 5 waterbodies previously approved for nonnative fish eradication (NPS 2001, 2009A) were initiated in 2012. Thirteen of the treated waterbodies, in three different basins, were located near small ponds occupied by remnant MYLF populations, all of which quickly recolonized the treated habitat and experienced substantial population increases (Vredenburg 2004, Knapp et al. 2007, NPS 2012A).

Although SEKI has improved MYLF populations in three restoration basins, all remaining MYLF populations are extremely vulnerable to extirpation due to multiple threats and thus are in urgent need of intervention. First, many populations occupy large basins in which multiple large lakes contain nonnative trout and MYLFs are restricted to small and/or shallow ponds. The trout severely limit frog distribution and abundance by excluding them from large amounts of lake habitat, while at the same time restricting them to pond habitat that is highly vulnerable to climate change. These ponds can completely dry up in even relatively short droughts as has already occurred in SEKI (Lacan et al. 2008). When this happens, multiple cohorts of MYLF tadpoles are lost, and populations already suppressed by trout can be quickly extirpated. In addition, shallow ponds can freeze solid during atypical climate patterns as occurred in SEKI during the winter of 2011 to 2012. This event appears to have killed most of the adult MYLFs that remained in one basin in the parks. Eradicating nonnative trout as quickly as possible in such areas will allow MYLF populations to expand (Knapp et al. 2007) and recolonize large lake habitat that is much more protected from climate effects.

Second, all of the recently restored MYLF populations in SEKI were disease-free and primarily being suppressed by trout, allowing them to easily expand following trout removal. However, nearly all remaining MYLF populations in SEKI are infected with amphibian chytrid fungus. Nearly all of SEKI's infected MYLF populations have experienced severe die-offs, and the remaining remnant populations have very low survival and recruitment from year to year, making them extremely vulnerable to extirpation. In addition to trout removal, these MYLF populations would likely benefit from an emerging disease treatment technique using antifungal agents, designed to increase short-term survival and potentially long-term recruitment, thus changing the outcome for many frogs from mortality to persistence. Preliminary results of several field trials conducted in SEKI from 2009 to 2012 show promise for future management application, and a large-scale study is scheduled for 2013.

A few MYLF populations are showing evidence of persistence – surviving and reproducing while continuing to be infected (Vredenburg et al. 2010; Knapp R., pers. comm., 2010). All persisting MYLF populations are in fishless areas and had high abundance prior to infection. Eradication of nonnative fish near existing MYLF populations would allow these populations to expand (Knapp et al. 2007) and should increase their resiliency to chytrid fungus by improving their ability to develop resistance to the disease before going extinct.

This Restoration Plan/DEIS is also aligned with the NPS Climate Change Response Program - Natural Resource Adaptation Strategy (NPS 2013), enhancing all of the elements identified in the strategy to make natural systems more resilient to climate change. Nonnative trout eradication and MYLF disease treatments in large lake complexes would create 1) climate refugia that will persist as reliable high-quality habitat for endangered MYLFs and other native species as climate changes; 2) fish-free migration corridors for MYLF populations to effectively function as metapopulations; 3) populations of MYLFs that maintain existing genetic diversity and promote conditions for increased diversity over time; and 4) large blocks of landscape lacking nonnative trout and mitigated for disease to enhance resilience to disturbance and change over time. In addition, this Restoration Plan/DEIS would create multiple climate refugia (large fish-free lake complexes) and restored MYLF populations in each of three MYLF genetic clades known to occur in SEKI, which simultaneously restores habitat, native species and natural processes across the geographic and elevational extent of SEKI's high elevation aquatic ecosystems.

Management Alternatives
A total of nine potential action alternatives and the no action alternative were originally identified for this plan. Of these, six action alternatives were dismissed from further consideration as described in Chapter 2. Three action alternatives and the no action alternative were carried forward for further analysis.

Alternative A (the no action alternative) describes current management of high elevation aquatic ecosystems in SEKI and provides a baseline for comparison against the action alternatives. Alternatives B, C and D (action alternatives) describe a range of reasonable and feasible approaches that partially or fully 1) meet the purpose and need for action and 2) achieve the plan objectives.

In addition, there are a number of activities described as common to all action alternatives. These include the development of criteria for the selection of basins for restoration; the development of criteria for selection of crew camp locations; ecosystem restoration and management, including protection and rebuilding extant populations of MYLFs where opportunities still exist and reintroducing MYLFs to locations where populations have recently gone extinct; monitoring restoration work and ecosystem responses; continuing research; and fish disposal methods.

The following selection process was used to determine which basins and individual waterbodies should be proposed for aquatic ecosystem restoration in this Restoration Plan/DEIS. Initial basin/site selections were based on examination of maps, staff familiarity with the parks and discussions with scientists. A number of criteria were then developed and used to identify project sites that would be feasible for nonnative fish eradication and have the best potential for success while providing for crew safety (Table 1). For example, all proposed treatment sites are located at the upstream ends of each basin so that no fish would remain above each treatment area. Second, all proposed sites also have a natural cascade at the downstream end of the treatment area that would act as a fish barrier and prevent fish remaining in untreated areas downstream from recolonizing the treatment area. Third, all proposed sites are safely accessible by crews on foot and by helicopter or stock for transport of equipment and supplies. Fourth, a total number of fish eradication waterbodies was targeted that could be completed in the 25 to 35 year time frame of this project. While conservation of MYLFs, other native species, and ecosystem processes is identified as the highest priority consideration, SEKI also is maintaining recreational fishing opportunities where those opportunities do not compromise the recovery and conservation of MYLFs and other native species.

Table 1 shows the basin selection criteria used to determine which waterbodies should be considered for proposed aquatic ecosystem restoration:

- First, waterbodies possessing the characteristics listed under "Rule-out" in Table 1 were removed from consideration for additional nonnative fish eradication.

- Second, for all remaining waterbodies, those that possessed the characteristics described in the left column under "Other Consideration Factors" were identified as higher priority for additional nonnative fish eradication because their inclusion helped achieve multiple project objectives. Waterbodies from this group that fell under the right column were identified as lower priority for additional nonnative fish eradication because their inclusion would achieve fewer project objectives.
- Third, from the group of waterbodies identified as higher priority for additional nonnative fish eradication, waterbodies were selected from across the parks to ensure the proposed sites would restore and conserve native species, genetic diversity and ecosystem processes in areas encompassing the geographic and elevational diversity contained within the parks.

Table 1. Basin Selection Criteria.

Favorable	**Rule-out**
Elevation is between 6,000 and 12,000 ft (1,800 and 3,700 m).	Elevation is under 6,000 ft (1,800 m) or above 12,000 ft (3,700 m). Lake basins in SEKI typically do not occur outside of these elevations.
Adequate downstream barrier (large waterfall or long, steep cascade) exists naturally, or the stream could be altered by blasting to create a vertical fish barrier, which would prevent fish from recolonizing restoration area. Barrier potential would be assessed prior to the onset of restoration.	No adequate downstream fish barrier exists naturally and there is no potential to create a barrier by blasting. Fish are observed breaching all possible barriers and would likely continue breaching even after blasting.
Fish eradication is feasible from a logistical standpoint. Habitat structure would allow fish eradication without extreme difficulty, and site can be safely accessed by field crews.	Fish eradication is considered infeasible from a logistical standpoint. Habitat structure is so complex that it would be extremely difficult to eradicate fish, and/or site cannot be safely accessed by field crews.
Crew presence unlikely to jeopardize the existence of known threatened or endangered plant or wildlife species.	Crew presence could jeopardize the existence of known threatened or endangered plant or wildlife species.
Evidence of current or recent populations within natural distribution of MYLFs (includes sites where frogs recently died out due to disease).	There is no evidence of current or past MYLF populations. Removal of fish would benefit other native species.
Other Consideration Factors	
Achieves Comparatively More Objectives	**Acheives Comparatively Fewer Objectives**
Restores/conserves genetic diversity of MYLFs within SEKI – several sites restored within each of three major genetic groups.	Total number of restoration sites is imbalanced with respect to genetic diversity of MYLFs within SEKI.
Restores/conserves spatial representation MYLFs within SEKI – sites restored across park latitudes and longitudes.	Total number of restoration sites is imbalanced with respect to historic representation of MYLFs within SEKI.
Groupings of waterways appropriate for treatment. For basins in which some fish lakes would remain, restoration lakes are at top of basin. Several entire basins are restored, spread across SEKI.	Groups of waterways not considered appropriate for treatment. For basins in which some fish lakes would remain, restoration lakes are at middle or bottom of basin. No entire basins are restored in SEKI.
For individual lake selection, recreational fishing value of lake is medium to low – not a very popular or trophy fishery. For the overall project, fishing opportunities within SEKI continue to exist that satisfy a range of visitor values, including multiple fish lakes within each of the following categories: 1) near trailheads for easy access; 2) in remote basins for solitude; 3) having large fish for a trophy experience;	For individual lake selection, recreational fishing value of lake is high – a very popular or trophy fishery. For the overall project, multiple fish lakes within each of the following categories do not continue to exist within SEKI: 1) near trailheads for easy access; 2) in remote basins for solitude; 3) having large fish for a trophy experience; 4) having many fish for a high-catch experience.

4) having many fish for a high-catch experience.	
Other known threats not an issue.	Other threats make site less desirable. For example, considering piscicide use in areas close to human populations.

The four management alternatives are summarized below.

Alternative A: No Action
Under the "No Action" alternative, the existing high elevation aquatic ecosystem restoration effort for 26 waterbodies would be completed, maintained and monitored, but no new fish eradication activities would be initiated. Native species and ecological processes in high elevation aquatic ecosystems would continue to be monitored. Research on native species, ecological processes and their stressors would continue in accordance with NPS policy (Table 5, Figures 5 and 6). After all treatments are completed, self-sustaining nonnative trout populations would continue to exist in 549 waterbodies (259 lakes, 235 ponds, 55 marshes) and hundreds of miles of stream.

Alternative B: Prescription Treatment (Physical and Piscicide) Preceding Restoration (NPS Preferred Alternative)
Under this alternative, a prescription (detailed plan of action) for restoration would be developed for each proposed restoration area based on the criteria for basin selection, pre-treatment surveys, habitat size, basin topography, wilderness values, visitor use and field crew safety. Prescriptions would consider the actual distribution of fish, results of amphibian surveys and whether any unique habitats were detected (such as springs). Physical treatment (gill netting, electrofishing, trapping, disturbing redds and/or temporarily covering redds with boulders) would be utilized. Piscicide treatment methods would be considered for waterbodies determined infeasible for physical treatment.

Based on current knowledge of the proposed fish eradication sites, physical treatment would be applied in 49 waterbodies (26 lakes, 22 ponds, 1 marsh; total of 483 acres/195 hectares) and 14 miles (22 km) of streams in 15 basins, and piscicide treatment would be applied in 38 waterbodies (6 lakes, 28 ponds, and 4 marshes; total of 225 acres/91 hectares) and 27 miles (43 km) of streams in 11 basins (Tables 8, 9 and 10 and Figure 7). In addition, any unsurveyed habitat adjacent to treated lakes, ponds, marshes and streams found to contain nonnative fish would also require treatment in order to eradicate fish from the geographic area. Although the total acreage requiring treatment may change slightly based on site-specific survey information and prescription development, the number of waterbodies and stream miles identified for treatment represents the maximum number of waterbodies to be treated in this alternative. After all treatments are completed, self-sustaining nonnative trout populations would continue to exist in 462 waterbodies (227 lakes, 185 ponds, 50 marshes) and hundreds of miles of stream.

Alternative C: Physical Treatment Preceding Restoration
Alternative C would use physical treatment methods only to eradicate nonnative fish by gill netting, electrofishing, trapping, disturbing and/or covering redds, and blasting rock to create vertical fish barriers. In comparison to alternative B, excluded from the list of proposed restoration waterbodies are long reaches of stream, several large lakes, and interconnected lake complexes that are too large for effective physical treatment. Under this alternative, a prescription for restoration would be developed for each proposed restoration area based on the criteria for basin selection, pre-treatment surveys, habitat size, basin topography, wilderness values, visitor use, field crew safety, and the actual distribution of fish and amphibians.

The following locations would be specific to this alternative (see Tables 8 and 11, Figure 9). Physical treatment methods would be applied in 49 waterbodies (26 lakes, 22 ponds, and 1 marsh; total of 483 acres/195 hectares) and 14 miles (22 km) of streams contained in 15 basins. In addition, any unsurveyed habitat adjacent to treated lakes, ponds, marshes and streams found to contain nonnative fish would be treated to eradicate fish from the entire scope of the restoration area. Although the total acreage requiring treatment may change slightly based on site-specific survey information and prescription development, the number of waterbodies and stream miles identified for treatment represents the maximum number of waterbodies to be treated in this alternative. After all treatments are completed, self-sustaining nonnative trout populations would continue to exist in 500 waterbodies (233 lakes, 213 ponds, 54 marshes) and hundreds of miles of stream.

Alternative D: Piscicide Treatment Preceding Restoration
Alternative D emphasizes speed in recovering habitat because MYLF populations are declining rapidly. To achieve this speed, only piscicide treatment would be used for nonnative fish eradication. Properly applied, piscicides can eliminate fish from targeted waterbodies in 1 to 2 years, in contrast to physical treatment methods which can take up to 6 years for lakes and up to 10 years for streams (NPS 2012A). A prescription for treatment would be developed as described in alternative B. Based on initial examination of maps, staff familiarity with the park, and discussions with scientists, piscicide treatment would be used for 87 waterbodies (32 lakes, 50 ponds, and 5 marshes; total of 708 acres/287 hectares), approximately 41 miles (66 km) of streams, and connected fish-containing habitat as necessary (see Tables 8 and 12, Figure 10). Although the total acreage requiring treatment may change slightly based on site-specific survey information and prescription development, the number of waterbodies and stream miles identified for treatment represents the maximum number of waterbodies to be treated in this alternative. After all treatments are completed, self-sustaining nonnative trout populations would continue to exist in 462 waterbodies (227 lakes, 185 ponds, 50 marshes) and hundreds of miles of stream.

Issues and Impact Topics
The following issues and impact topics were identified based on internal and public scoping; federal laws, regulations, and executive orders; NPS *Management Policies 2006*; site visits; and NPS knowledge of limited or easily impacted resources. These topics were evaluated in this Restoration Plan/EIS in Chapter 4. A summary of the impacts from each alternative are described in Table 2.

Special Status Species. This plan would affect the two species of MYLFs that are currently proposed for federal listing under the ESA as endangered. Therefore, MYLFs will be further evaluated in this document.

Several special-status species or species of management concern occur in or near the proposed project areas, and may be affected by project activities. Species to be evaluated in this document include the Yosemite toad (*Anaxyrus [Bufo] canorus*), the Little Kern golden trout (*Oncorhynchus mykiss whitei)*, and the Sierra Nevada bighorn sheep (*Ovis canadensis sierrae*).

Wildlife (including vertebrates and invertebrates). Vertebrates and invertebrates would be affected by nonnative fish removal. If piscicides are used, fish removed from the proposed restoration areas would be left in the environment thus providing a short-term nonnative nutrient and food source for wildlife.

Wild and Scenic Rivers. This plan includes project work that would occur near designated and eligible/suitable Wild and Scenic Rivers.

Water Quality. Project activities and techniques considered in the alternatives could affect water quality.

Natural Soundscapes. Work associated with the implementation of project activities would create human-generated noise during the project work.

Wilderness Character. This plan would occur within designated wilderness. Activities occurring in wilderness have the potential to impact wilderness character and values, primarily through impacting the untrammeled quality of wilderness character in the short term, and benefitting the natural quality of wilderness in the long term.

Health and Safety. The safety of the parks' visitors and employees could be affected by components described in this plan.

Visitor Experience and Recreational Opportunities. Elements considered in this plan would have an effect on visitor experience and recreational opportunities. Recreational opportunities, such as angling, could be eliminated from proposed restoration sites and replaced with other opportunities, such as opportunities to view wildlife characteristic of pristine lakes.

Table 2 shows a summary of the differences between the alternatives. For detailed information on the impacts from each alternative and a description of the impacts from elements common to all alternatives, see Chapter 4.

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Table 2. Impact Summary Table.

	Actions Common to All Alternatives	Alternative A: No Action	Alternative B: Prescription Treatment (Physical and Piscicide) Preceding Restoration (Preferred Alternative)	Alternative C: Physical Treatment Preceding Restoration	Alternative D: Piscicide Treatment Preceding Restoration
Summary of Alternatives	•Site assessments would occur for each restoration basin to confirm the treatment approach. •Crew camps would be established for each project area. •Helicopters and/or stock would be utilized to transport tools and equipment. •Reintroduction of mountain yellow-legged frogs would be considered. •Monitoring, research and scientific studies would continue to inform project, and may result in the expansion of management tools available for future management activities. •Captured fish would be disposed of by sinking them in lakes or by scattering them in nearby terrestrial areas.	This alternative limits nonnative fish eradications to 26 previously approved waterbodies, including 2 waterbodies for experimental restoration by researchers from 1997 to 1999, and 24 waterbodies for preliminary restoration by SEKI from 2001 to 2016. No new waterbodies for nonnative fish eradication are proposed.	Nonnative fish would be eradicated from an additional 87 waterbodies and 41 miles (66 km) of stream in 20 basins, including 49 waterbodies and 14 miles (22 km) of stream using physical treatment methods in 15 basins; and 38 waterbodies and 27 miles (43 km) of streams using piscicide treatment in 11 basins. MYLFs and other native species would be restored to these 87 waterbodies using natural recolonization where adjacent source populations exist, and reintroductions where adjacent source populations do not exist.	Nonnative fish would be eradicated from an additional 49 waterbodies and 14 miles (22 km) of stream in 15 basins using physical treatment methods. Blasting is considered in up to five locations to create vertical fish barriers in streams. MYLFs and other native species would be restored to these 49 waterbodies using natural recolonization where adjacent source populations exist, and reintroductions where adjacent source populations do not exist.	Nonnative fish would be eradicated from an additional 87 waterbodies and 41 miles (66 km) of stream in 20 basins using piscicide treatment only. MYLFs and other native species would be restored to these 87 waterbodies using natural recolonization where adjacent source populations exist, and reintroductions where adjacent source populations do not exist.

Impact Topic	Actions Common to All Alternatives	Summary of Impacts Alternative A: No Action	Summary of Impacts Alternative B: Prescription Treatment (Physical and Piscicide) Preceding Restoration (Preferred Alternative)	Summary of Impacts Alternative C: Physical Treatment Preceding Restoration	Summary of Impacts Alternative D: Piscicide Treatment Preceding Restoration
Special-Status Species *Mountain Yellow-legged frog (MYLF)*	• The establishment and use of crew camps will have no effect on special status species. • The use of helicopter and/or stock will have no effect on MYLF, Yosemite toad, and Little Kern golden trout. The use of helicopters may affect, but is not likely to adversely affect, Sierra Nevada bighorn sheep. • The reintroductions of MYLF would have no effects on Yosemite toad, Sierra Nevada bighorn sheep, and Little Kern golden trout. There would be short term adverse effects and long-term beneficial effects on MYLF. • Monitoring, research, and scientific study would have no effects on Yosemite toad, Little Kern golden trout, and Sierra Nevada bighorn sheep. Handling some individual MYLF may adversely affect individual frogs, but there would be long-term beneficial effects from increased resistance to chytrid fungus. • Fish disposal would have no adverse effects on special status species and short-term beneficial effects on MYLF and Yosemite toads from nutrient pulses related to fish decomposition.	MYLF: • *may affect, likely to adversely affect* due to the potential for disturbance, injury or mortality to individuals from gill netting and electrofishing; • *may affect, likely to adversely affect* due to the long-term adverse effects caused by the continued presence of self-sustaining nonnative trout populations in basins known to have current or recent MYLF occupancy. • *long-term beneficial effects* in 14 waterbodies and 1.2 miles (1.9 km) of streams contained in five basins, due to expected increases in existing populations to a larger (less-vulnerable) size in response to nonnative trout removal, and the reestablishments of populations in restored habitat. • *No effect* on Yosemite toad, Little Kern golden trout, and Sierra Nevada bighorn sheep.	MYLF: • *may affect, likely to adversely affect* due to the potential for disturbance, injury or mortality to individuals from gill netting, electrofishing, and piscicide use. • *may affect, likely to adversely affect* due to the long-term adverse effects caused by the continued presence of self-sustaining nonnative trout populations in basins known to have current or recent MYLF occupancy. • *long-term beneficial effects* in an additional 87 treated waterbodies and 41 miles (66 km) of streams contained in 20 basins, due to expected increases in existing populations to a larger (less-vulnerable) size in response to nonnative trout removal, and the reestablishments populations in restored habitat. •Yosemite toads: *no effect* in 18 of the 20 treated basins; *may affect, not likely to adversely affect* in Upper Evolution and McGee Basins. •No effect to Little Kern golden trout in 19 of the 20 treated basins; *may affect, likely to adversely affect* in Crytes basin due to the eradication of this population of Little Kern golden trout. •Sierra Nevada bighorn sheep: *no effect* in 18 or 19 of the 20 treated basins; *may affect, not likely to adversely affect* in Sixty Lake and potentially Laurel Basins.	MYLF: • *may affect, likely to adversely affect* due to the potential for disturbance, injury or mortality to individuals from gill netting and electrofishing, and from blasting in up to five locations. • *may affect, likely to adversely affect* due to the long-term adverse effects caused by the continued presence of self-sustaining nonnative trout populations in basins known to have current or recent MYLF occupancy. • *long-term beneficial effects* in an additional 49 treated waterbodies and 14 miles (22 km) of streams contained in 15 basins, due to expected increases in existing populations to a larger (less-vulnerable) size in response to nonnative trout removal, and the reestablished populations in restored habitat. • Yosemite toads: *no effect* in 13 of the 15 treated basins; *may affect, not likely to adversely affect* in Upper Evolution and McGee Basins. • Little Kern golden trout: *no effect* in 14 of the 15 treated basins; *may affect, likely to adversely affect* in Crytes basin due to the eradication of this population of Little Kern golden trout. • Sierra Nevada bighorn sheep: *no effect*	MYLF: • *may affect, likely to adversely affect* due to the potential for disturbance, injury or mortality to individuals from piscicides. • *may affect, likely to adversely affect* due to the long-term adverse effects on caused by the continued presence of self-sustaining nonnative trout populations in basins known to have current or recent MYLF occupancy. • *long-term beneficial* effects in an additional 87 treated waterbodies and 41 miles (66 km) of streams contained in 20 basins, due to expected increases in existing populations to a larger (less-vulnerable) size in response to nonnative trout removal, and reestablished populations in restored habitat. • Yosemite toads: *no effect* in 18 of the 20 treated basins; *may affect, not likely to adversely affect* in Upper Evolution and McGee Basins. • Little Kern golden trout: *no effects* in 19 of the 20 treated basins; *may affect, likely to adversely affect* in Crytes basin due to the eradication of this population of Little Kern golden trout. • Sierra Nevada bighorn sheep: *no effect* in 18 or 19 of the 20 treated basins; *may affect, not likely to adversely affect* in Sixty Lake and potentially Laurel Basins.
Wildlife *Vertebrates*	**Vertebrates** • The establishment and use of crew camps may cause short-term disturbance and flight response, resulting in short-term negligible adverse effects. • Helicopter and stock use would result in short-term disturbances and flights responses, resulting in short-term negligible adverse effects to some vertebrates, and no effect to others. . • Fish disposal would result in both short and long-term negligible effects on vertebrates due to changes in nutrient and water chemistry, and short- and long-term beneficial effects from increased food sources during fish decomposition. • Restoration, research, and scientific studies would have short-term negligible adverse effects on vertebrates from disturbance, and long-term beneficial effects from restoration.	**Vertebrates** • Short-term moderate adverse effects on vertebrates in treated waterbodies due to the potential for disturbance, injury or mortality to individuals from gill netting and electrofishing. • Long-term major adverse effects on vertebrates in 549 untreated waterbodies contained in 88 basins, due to the continued presence of self-sustaining nonnative trout populations. • Long-term beneficial effects on vertebrates in 14 current treated waterbodies and 1.2 miles (2 km) of streams contained in five basins, due to increased natural food sources in response to nonnative trout removal.	**Vertebrates** • Short-term moderate adverse effects on vertebrates in treated waterbodies due to the potential for disturbance, injury or mortality to individuals from gill netting, electrofishing, and piscicide use. • Long-term major adverse effects on vertebrates in 462 untreated waterbodies contained in 69 basins, due to the continued presence of self-sustaining nonnative trout populations. • Long-term beneficial effects on vertebrates in an additional 87 treated waterbodies and 41 miles (66 km) of streams contained in 20 basins, due to increased natural food sources in response to nonnative trout removal.	**Vertebrates** • Short-term moderate adverse effects on vertebrates in treated waterbodies due to the potential for disturbance, injury or mortality to individuals from gill netting and electrofishing, and from blasting. • Long-term major adverse effects on vertebrates in 500 untreated waterbodies contained in 80 basins, due to the continued presence of self-sustaining nonnative trout populations. • Long-term beneficial effects on vertebrates in an additional 49 treated waterbodies and 14 miles (22 km) of streams contained in 15 basins, due to increased natural food sources in response to nonnative trout removal.	**Vertebrates** • Short-term moderate adverse effects on vertebrates in treated waterbodies due to the potential for disturbance, injury or mortality to individuals from the use of piscicides. • Long-term major adverse effects on vertebrates in 462 untreated waterbodies contained in 69 basins, due to the continued presence of self-sustaining nonnative trout populations. • Long-term beneficial effects on vertebrates in an additional 87 treated waterbodies and 41 miles (66 km) of streams contained in 20 basins, due to increased natural food sources in response to nonnative trout removal.

Impact Topic	Actions Common to All Alternatives	Summary of Impacts Alternative A: No Action	Summary of Impacts Alternative B: Prescription Treatment (Physical and Piscicide) Preceding Restoration (Preferred Alternative)	Summary of Impacts Alternative C: Physical Treatment Preceding Restoration	Summary of Impacts Alternative D: Piscicide Treatment Preceding Restoration
Invertebrates	**Invertebrates** • The establishment and use of crew camps would result in negligible adverse effects on invertebrates associated with disturbance, flight response, and trampling. • Helicopter and stock use would result in no to negligible effects. • Fish disposal activities would result in negligible adverse effects due to disturbance, and beneficial effects due to increases in nutrients released via fish decomposition. • Restoration, research, and scientific studies would have short-term negligible adverse effects on vertebrates from disturbance, and long-term beneficial effects from ecosystem restoration.	**Invertebrates** • Short-term negligible to minor adverse effects in treated areas due to the potential for disturbance, injury or mortality to individuals from gill netting and electrofishing. • Long-term major adverse effects on invertebrates in 549 untreated waterbodies plus connecting streams contained in 88 basins due to the continued presence of self-sustaining nonnative trout populations. • Long-term beneficial effects on invertebrates in 14 current treated waterbodies and 1.2 miles (2 km) of streams contained in five basins, due to invertebrate populations increasing in abundance, distribution and diversity in response to nonnative trout removal.	**Invertebrates** • Short-term negligible to minor adverse effects in treated areas from gill netting and electrofishing due to the potential for disturbance, injury or mortality to individuals. • Short-term major adverse effects from piscicide use in 38 waterbodies and 27 miles (43 km) of streams contained in 11 basins, due to disturbance, injury or mortality to individuals and reduction in abundance and diversity of populations. • Long-term moderate adverse effects from piscicide use in 38 waterbodies and 27 miles (43 km) of streams contained in 11 basins, due to the potential for prolonged reduction in abundance and diversity of populations. • Long-term major adverse effects on invertebrates in 462 untreated waterbodies plus connecting streams contained in 69 basins, due to the continued presence of self-sustaining nonnative trout populations. • Long-term beneficial effects on invertebrates in an additional 87 waterbodies and 41 miles (66 km) of streams contained in 20 basins due to invertebrate populations increasing in abundance, distribution and diversity in response to nonnative trout removal.	**Invertebrates** • Short-term negligible to minor adverse effects in treated areas from gill netting, electrofishing, and blasting due to the potential for disturbance, injury or mortality to individuals. • Long-term major adverse effects on invertebrates in 500 untreated waterbodies plus connecting streams contained in 80 basins due to the continued presence of self-sustaining nonnative trout populations. • Long-term beneficial effects in an additional 49 waterbodies and 14 miles (22 km) of streams contained in 15 basins, due to invertebrate populations increasing in abundance, distribution and diversity in response to nonnative trout removal.	**Invertebrates** • Short-term major adverse effects on invertebrates from piscicide use in 87 waterbodies and 41 miles (66 km) of streams contained in 20 basins, due to disturbance, injury or mortality to individuals and reduction in abundance and diversity of populations. • Long-term moderate adverse effects on invertebrates from piscicide use in an additional 87 waterbodies and 41 miles (66 km) of streams contained in 20 basins, due to the potential for prolonged reduction in abundance and diversity of populations. • Long-term major adverse effects on invertebrates in 462 untreated waterbodies plus connecting streams contained in 69 basins due to the continued presence of self-sustaining nonnative trout populations. • Long-term beneficial effects on invertebrates in an additional 87 waterbodies and 41 miles (66 km) of streams contained in 20 basins, due to invertebrate populations increasing in abundance, distribution and diversity in response to nonnative trout removal.
Wild and Scenic Rivers	Crew camps, helicopter and stock use, and restoration, monitoring, research, and fish disposal would have no direct effects on wild and scenic rivers. In upper basin areas associated with wild and scenic rivers, there would be limited indirect effects on scenic values related to the presence of crews working and camping in project areas near tributaries to wild and scenic rivers. Recreational and fish and wildlife values would be changed in the future as ecosystems are restored, primarily due to an increase in opportunities to view native wildlife. This would result in beneficial effects to associated wild and scenic rivers values.	There would be long-term adverse effects on recreational opportunities related to decreased fishing opportunities in upper basin areas that drain into wild and scenic rivers, and long-term beneficial effects on native wildlife populations, but to a lesser degree than alternatives B, C, and D.	There would be long-term adverse effects on recreational opportunities related to decreased recreation (fishing) in upper basin areas associated with wild and scenic rivers, and long-term beneficial effects on native wildlife populations.	There would be long-term adverse effects on recreational opportunities related to decreased recreation (fishing) in upper basin areas associated with wild and scenic rivers, and long-term beneficial effects on native wildlife populations, but to a lesser degree than alternatives B and D.	Same as alternative B.
Water Quality	• Crew camps would have a negligible effect on water quality due to a slight potential for upland sediment, food, and personal care items to reach waterways. • The use of helicopters would have no effect on water quality. Stock use would result in a negligible to minor adverse effect on water quality. • The restoration, monitoring, and research program would result in short-term negligible to minor adverse effects on a localized scale during project work; the	This alternative would have short-term negligible adverse impacts on water quality due to slight increases in turbidity during project work from walking in and adjacent to waterbodies.	Physical treatments would result in short-term negligible adverse effects on water quality due to slight increases in turbidity during project work from walking in and adjacent to waterbodies. Piscicide treatments, including increased turbidity during project work and the application of rotenone to treated areas would result in short-term negligible to minor adverse impacts on water quality.	Physical treatments would result in short-term negligible adverse effects on water quality due to slight increases in turbidity during project work from walking in and adjacent to waterbodies and from blasting.	Piscicide treatments, including increased turbidity during project work and the application of rotenone to treated areas would result in short-term negligible to minor adverse impacts on water quality.

Impact Topic	Actions Common to All Alternatives	Summary of Impacts Alternative A: No Action	Summary of Impacts Alternative B: Prescription Treatment (Physical and Piscicide) Preceding Restoration (Preferred Alternative)	Summary of Impacts Alternative C: Physical Treatment Preceding Restoration	Summary of Impacts Alternative D: Piscicide Treatment Preceding Restoration
	long-term effects would be beneficial as healthy functioning native ecosystems are restored. • Impacts of fish disposal on water quality would be short-term, negligible to moderate and adverse based on the type of operation (whether gill netting or piscicide use) and the timing (more fish are caught during the early stages of the treatment)				
Wilderness Character (untrammeled, natural, undeveloped, opportunities for solitude or primitive and unconfined recreation, other features of value).	**Untrammeled:** • Crew Camps – No effect. • Use of Helicopter and Stock – No effect. • Restoration, Monitoring, and Research – Restoration would result in trammeling actions periodically for the life of the project (20 to 35 years). Monitoring and research sometimes result in trammeling actions, if there is intentional manipulation of the natural environment. • Fish Disposal - The disposal of fish is not an intentional manipulation of the natural element, but is a result of a manipulation (i.e. the removal of nonnative fish from waterbodies). Therefore there would be no effect on untrammeled as a result of the disposal of fish.	**Untrammeled:** There would continue to be trammeling actions at five basins until the current restoration project is completed in 2016. Trammeling actions include netting and electrofishing to remove nonnative fish from the lakes and streams within the project area.	**Untrammeled:** The project itself constitutes a long-term trammel as it would continue for the next 25 to 35 years. There would be site-specific trammeling associated with the removal of nonnative fish at up to six treatment sites per year, for several weeks each summer, over a 1 to 7 year period, with some sites treated for up to 10 years. There would be additional trammeling associated with invertebrate sampling as part of pre- or post-treatment assessments at up to four sites per year, 1 to 2 weeks per site per summer, over a 4 year period. This alternative includes physical and piscicide treatments that involve trammeling actions at 87 waterbodies and 41 miles (66 km) of streams, plus connected fish-containing habitat (as necessary). This alternative results in more trammeling actions than alternative A and C, and the same as alternative D, but trammeling actions would occur over a longer time period under this alternative (up to 35 years vs. up to 20 years).	**Untrammeled:** The project itself constitutes a long-term trammel as it would continue for the next 25 to 35 years. There would be site-specific trammeling associated with the removal of nonnative fish at up to six treatment sites per year, for several weeks each summer, over a 5 to 7 year period, with some sites treated for up to 10 years. This alternative includes physical treatment that involves trammeling actions at 49 waterbodies and 14 miles (22 km) of streams, plus connected fish-containing habitat (as necessary). Blasting rock to create vertical fish barriers at up to five locations is an intentional manipulation of the stream substrate, resulting in a long-term manipulation of the biophysical environment and a permanent modification/trammel of the stream. This alternative results in more trammeling actions than alternative A, and fewer trammeling actions than alternatives B and D, but includes a permanent trammeling action.	**Untrammeled:** The project itself constitutes a long-term trammel as it would continue for the next 15 to 20 years. There would be site-specific trammeling associated with the removal of nonnative fish at up to two treatment sites per year, 2 to 3 weeks per site per summer, over a 1 to 2 year period. There would be slight site-specific trammeling associated with invertebrate sampling as part of pre- or post-treatment assessments at up to four sites per year, 1 to 2 weeks per site per summer, over a 4 year period. This alternative includes piscicide treatment that involves trammeling actions at 87 waterbodies and 41 miles (66 km) of streams, plus connected fish-containing habitat (as necessary). This alternative results in more trammeling actions in the short-term than all other alternatives and fewer trammeling actions in the long-term because treatment actions would be accomplished faster.
	Natural • Crew Camps - Small crews staying in one location for several weeks would have an impact on soils in a localized area from trails and compaction around the camp and project area, and could trample vegetation. There could be displacement of wildlife at the camp location, and disturbance from the presence of humans. Crews would be instructed on minimum impact techniques to reduce effects on the natural quality. Areas have been shown to recover after project work thus there would be no long-term effect on the natural from crew camps. • Helicopters and Stock - Helicopters affect the natural quality of wilderness by causing disturbance and flight responses in wildlife causing short-term minor adverse effects. Stock use would result in short-term minor adverse effects from trampling and stock waste.	**Natural:** Long-term beneficial effects from restoring the natural ecosystem and processes in 26 waterbodies. A total of 549 untreated waterbodies plus connecting streams contained in 88 basins would continue to contain self-sustaining nonnative fish populations, resulting in a continued long-term major adverse effect.	**Natural:** Long-term beneficial effects from restoring the natural quality of wilderness in 16% of the approximately 549 waterbodies that are known to contain nonnative fish populations. Short-term moderate to major adverse effects from the use of piscicides. Long-term major adverse effects on the natural quality of wilderness from the continued presence of nonnative fish in 462 waterbodies and connecting streams. This alternative results in more restoration of the natural quality (more treatment sites) than alternatives A and B, and the same level of restoration as alternative D, but alternative D would be accomplished in a shorter time period.	**Natural:** Long-term beneficial effects from restoring the natural quality of wilderness in 9% of the approximately 549 waterbodies that are known to contain nonnative fish populations. However, most long reaches of streams, large lakes, and interconnected lake complexes would not be treated and the natural quality of wilderness would continue to be adversely affected. Long-term minor to moderate adverse effects to the natural quality of wilderness due to blasting in up to five locations. Long-term major adverse effects on the natural quality of wilderness from the continued presence of nonnative fish in 500 waterbodies and connecting streams. This alternative results in more restoration of the natural quality (more treatment sites) than alternative A, but less than alternatives B and D.	**Natural:** Long-term beneficial effects of restoring the natural quality of wilderness in 16% of the 549 waterbodies known to contain nonnative fish populations. Short-term moderate to major adverse effect on the natural quality of wilderness from the use of piscicides. Long-term adverse effects on the natural quality of wilderness from the presence of nonnative fish in 462 waterbodies and connecting streams. This alternative results in the most short-term adverse effects on the natural quality from the exclusive use of piscicides, and would result in the restoration of the same number of sites as alternative B, but restoration of the natural quality at treatment sites would be accomplished in a shorter time period.

Impact Topic	Actions Common to All Alternatives	Summary of Impacts Alternative A: No Action	Summary of Impacts Alternative B: Prescription Treatment (Physical and Piscicide) Preceding Restoration (Preferred Alternative)	Summary of Impacts Alternative C: Physical Treatment Preceding Restoration	Summary of Impacts Alternative D: Piscicide Treatment Preceding Restoration
	• Restoration, Monitoring, and Research - Short-term minor to moderate adverse effects, but long-term beneficial effects on native ecosystems as species are prevented from going extinct, and ecosystem restoration is accomplished. • Fish Disposal – There would be a short-term effect as a result of adding nutrients to the system as fish biodegrade, and also by providing an unnatural food source to native wildlife.				
	Undeveloped • Crew Camps - Short- term minor to moderate adverse effects from the presence of crew camps and associated installations and transport of supplies. • Helicopter and Stock Use – Helicopter flights would result in a short-term minor to moderate adverse effect. Stock use would have no effect. • Restoration, Monitoring, and Research – These activities could include temporary installations, resulting in minor to moderate short- and long-term adverse effects on undeveloped. • Fish Disposal – There is no effect on undeveloped.	**Undeveloped:** The tools used to accomplish the restoration (the installation of nets, storage lockers, and the use of helicopters) create short- to long-term minor to moderate adverse effects on the undeveloped quality of wilderness.	**Undeveloped:** The installation of gill nets, the use of small electric pumps associated with piscicide use, and the use of helicopters create short-term adverse effects on the undeveloped quality of wilderness. There would be up to six crew camps in wilderness per year, generally occupying each site periodically through the summer season for approximately 6 years per lake or pond treatment site, and up to 10 years at treatment sites with long or complex streams. This alternative results in the greatest effect on the undeveloped quality as more tools are used at more locations.	**Undeveloped:** The installation of gill nets, the presence of crew camps and storage lockers, blasting of streams to create barriers, and the use of helicopters create short-term adverse effects on the undeveloped quality of wilderness. There would be up to five temporary crew camps in wilderness per year, generally occupying each site for several weeks each season for approximately 6 years per site for lakes and ponds, and up to 10 years for sites with long or complex streams. Blasting would create a long-term minor adverse effect on the undeveloped quality of wilderness in up to five locations because “the imprint of man’s work” (i.e. visible scarring) would remain. This alternative results in a greater effect on the undeveloped quality than alternative A and D, but fewer effects than alternative B, as fewer tools are used at fewer locations.	**Undeveloped:** The use of a small electric pump associated with piscicide use creates a short-term adverse effect on the undeveloped quality of wilderness. There would be up to six temporary crew camps in wilderness per year, including up to two conducting piscicide treatment activities and up to four conducting pre- or post-treatment assessment activities. Treatment sites would be occupied for 2 to 3 weeks in the summer for up to 2 years per site; assessment sites would be occupied for 1 to 2 weeks in the summer for up to 4 years per site. There would be no installations related to the crew camps. Helicopter use would be similar to alternative B. This alternative results in the least impact on the undeveloped quality as fewer mechanized/motorized tools are used, there are fewer installations, and there would be no long-term “imprint of man’s work” since there is no blasting included.
	Opportunities for solitude or primitive and unconfined recreation: • Crew Camps- The presence of crew camps in several locations in the wilderness would reduce opportunities for solitude in the project areas. • Helicopter and Stock Use – Helicopters would reduce opportunities for solitude and unconfined recreation on a temporary basis. Stock use could reduce opportunities for solitude on a temporary basis. • Restoration, Monitoring, and Research - The presence of crews associated with these activities would result in negligible to minor adverse effects on solitude. There would be minor adverse effects on opportunities for primitive recreation as a result of the loss of angling opportunities at restoration sites and long-term beneficial effects from restoring	**Opportunities for solitude or primitive and unconfined recreation:** Long-term minor adverse effects on opportunities for primitive recreation (e.g. angling) resulting from the eradication of nonnative trout from 14 of the parks’ waterbodies. Negligible adverse effect on solitude from the presence of two to three person crews. Long-term beneficial effects from the restoration of healthy native ecosystems at treated sites, leading to enhanced opportunities for primitive recreation.	**Opportunities for solitude or primitive and unconfined recreation:** Negligible adverse effect on solitude from the presence of 1 to 6 crews comprised of 2 to 3 persons for physical treatment methods, and 8 to 15 people for piscicide treatment methods. Long-term minor to moderate adverse effects on opportunities for primitive recreation (e.g. angling) resulting from reduced angling opportunities at 87 of the parks’ waterbodies and 41 miles (66 km) of streams. Long-term beneficial effects from the restoration of healthy native ecosystems at treated sites, leading to enhanced opportunities for primitive recreation. Short-term adverse effects on unconfined recreation from area closures due to the application of piscicides. This alternative changes opportunities for	**Opportunities for solitude or primitive and unconfined recreation:** Negligible adverse effect on solitude from the presence of 1 to 5 crews comprised of 2 to 3 persons. Long-term minor adverse effects on opportunities for primitive recreation (e.g. angling) resulting from the eradication of nonnative trout from 49 of the parks’ waterbodies and 14 miles (22 km) of streams. Long-term beneficial effects from the restoration of healthy native ecosystems at treated sites, leading to enhanced opportunities for viewing native wildlife in wilderness This alternative changes opportunities for solitude or primitive and unconfined recreation more than alternative A, and less than alternatives B and D. Angling opportunities would be reduced in fewer locations than	**Opportunities for solitude or primitive and unconfined recreation:** Negligible to minor adverse effect on solitude from the presence of 1 to 2 crews comprised of 8 to 15 people for 2 to 3 weeks during piscicide treatment activities. Negligible adverse effect on solitude from the presence of 1 to 4 crews comprised of 2 to 4 people for 1 to 2 weeks during pre- or post-treatment assessment activities. Long-term minor to moderate adverse effects on opportunities for primitive recreation (e.g. angling) resulting from the eradication of nonnative trout from 87 of the parks’ waterbodies and 41 miles (66 km) of streams. Short-term adverse effects from area closures due to the application of piscicides. Long-term beneficial effects from the restoration of healthy native ecosystems at

Impact Topic	Actions Common to All Alternatives	Summary of Impacts Alternative A: No Action	Summary of Impacts Alternative B: Prescription Treatment (Physical and Piscicide) Preceding Restoration (Preferred Alternative)	Summary of Impacts Alternative C: Physical Treatment Preceding Restoration	Summary of Impacts Alternative D: Piscicide Treatment Preceding Restoration
	opportunities to view native wildlife. • Fish Disposal – No effect.		solitude or primitive and unconfined recreation more than alternatives A and C, but less than alternative D. Angling opportunities would be reduced in the same locations as alternative D, but at a slower rate. Native wildlife viewing would be increased at the same locations as alternative D, but at a slower rate.	alternatives B and D. Native wildlife viewing opportunities would be available at fewer locations than alternatives B and D.	treated sites, leading to improved opportunities for viewing native wildlife in wilderness This alternative changes opportunities for solitude or primitive and unconfined recreation the most, as crews would be larger and more areas would be closed to visitor use during treatment activities. Angling opportunities would be reduced in the same locations as alternative B, but would be reduced at a faster rate. Native wildlife viewing opportunities would be available at more locations in a shorter time period than alternatives A, B, and C.
	Other features of value: • Crew Camps – No effect. • Helicopter and Stock use – No effect • Restoration, Monitoring and Research – These activities fulfill the scientific and education component and results in a beneficial effect on other features of value. • Fish Disposal – No effect.	**Other features of value:** No effect.	**Other features of value:** No effect.	**Other features of value:** No effect.	**Other features of value:** No effect.
Natural Soundscapes	• Crew Camps - The presence of these camps may adversely affect the visitor experience for those who hear noise generated from the camp areas, but this noise would primarily be crew members talking and would be short-term, temporary and localized, resulting in short- term negligible adverse impacts on natural soundscapes. • Helicopter and Stock Use - the use of helicopters results in short-term moderate adverse effects on natural soundscapes within the project areas, and within and around transportation corridors (whether flight lines or trails) to the project areas, and the use of stock results in short-term minor adverse effects on natural soundscapes. • Restoration, Monitoring and Research - Most of the work associated with these activities does not generate noise above a normal speaking voice, resulting in short- to long-term negligible adverse effects on the natural soundscape in localized areas. • Fish Disposal - Most of the work related to fish disposal would not generate noise above a normal speaking voice, resulting in short- to long-term negligible adverse effects on the natural soundscape in localized areas.	Sounds made by crews would have a short-term negligible adverse impact on natural soundscapes in a localized area. As each restoration site is completed, natural sounds would be restored as native species return to the sites. This would improve the natural soundscapes in the restoration areas. Under this limited restoration alternative, components of the natural soundscape over much of the high elevation landscape, including frog vocalization in many areas of the parks, would be lost, resulting in a major adverse long-term effect.	Sounds made by crews would have a short-term negligible adverse impact on natural soundscapes in a localized area. As each restoration site is completed, natural sounds would be restored as native species return to the sites. This would improve the natural soundscapes in the restoration areas. The natural soundscape would be restored in more areas than alternatives A and C, and in the same number of areas as alternative D but at a slower rate.	Sounds made by crews would have a short-term negligible adverse impact on natural soundscapes in a localized area. As each restoration site is completed, natural sounds would be restored as native species return to the sites. This would improve the natural soundscapes in the restoration areas. Noise from blasting to create vertical fish barriers in up to five locations would result in a short-term minor to moderate adverse effect on the natural soundscape in a localized area. The natural soundscape would be restored in more areas than alternative A, but in fewer areas and at a slower rate than alternatives B and D.	Sounds made by crews would have a short-term negligible adverse impact on natural soundscapes in a localized area. As each restoration site is completed, natural sounds would be restored as native species return to the sites. This would improve the natural soundscapes in the restoration areas. The natural soundscape would be restored in more areas in alternatives A and C, and in the same areas but at a faster rate than alternative B.

Impact Topic	Actions Common to All Alternatives	Summary of Impacts Alternative A: No Action	Summary of Impacts Alternative B: Prescription Treatment (Physical and Piscicide) Preceding Restoration (Preferred Alternative)	Summary of Impacts Alternative C: Physical Treatment Preceding Restoration	Summary of Impacts Alternative D: Piscicide Treatment Preceding Restoration
Visitor and Employee Health and Safety	• Crew Camps – There are risks to employees associated with living in the wilderness, but risks are reduced by proper training and conducting job hazard analyses. There is no effect on public health and safety. • Helicopter and Stock Use – There are risks to employees associated with working around helicopters and stock. These risks are mitigated by proper training and the use of an experienced crew. There is no effect on public health and safety. • Restoration, Monitoring and Research - Crews working in the wilderness have the potential for accidents and injuries. This risk is mitigated through the implementation of standard practices, conducting job hazard analyses, and training employees on proper procedures. These project components would not affect public health and safety. • Fish Disposal - Crews working in the wilderness have the potential for accidents and injuries. This risk is mitigated through the implementation of standard practices, conducting job hazard analyses, and training employees on proper procedures. These project components would not affect public health and safety.	This alternative would result in no appreciable effect on visitor health and safety. Employee risks are mitigated, but employees still assume personal responsibility for their safety, whether on or off duty. There still could be risks to employee safety until the ongoing project work is completed, but the risks are low to moderate.	Due to the remoteness of the proposed project areas, the distance to any downstream human population, and the low likelihood of exposure to visitors during and after treatment, there would be a low risk of human exposure to the piscicides, and a negligible threat to the health and safety of wilderness users and the parks' neighbors. For crews, the short-term risk of piscicide treatments is low to moderate, but the piscicide treatments provide a long-term benefit by reducing total exposure from an average of 6 years (field seasons) per lake treatment site and up to 10 years per sites with long or complex streams (during summer months) to 2 to 4 weeks each year for up to 2 years for sites selected for piscicide treatment. Piscicide treatments increase the risk for crews slightly, but provide a long-term benefit by reducing total time exposed to work hazards.	The effects on visitor health and safety would be the same as alternative A except the duration of the project would be longer, and there would be more sites. In addition, there would be a negligible to low increase in risk to visitors due to blasting (if determined necessary) in up to five locations. The effects of this alternative on employee health and safety would be the same as described under alternative A, though the duration of the project would be longer and there would be more project sites, resulting in a slightly increased risk. In addition, there would be a slight increase in risk for crews performing blasting activities (if determined necessary) in up to five locations. Crew members could spend approximately 6 to 10 field seasons per treatment site for the duration of the project, which is expected to continue for the next 35 years.	The effects of this alternative related to the use of piscicide treatments on visitor health and safety are the same as alternative B. Piscicide treatments increase the risk for crews slightly, but provide a long-term benefit by reducing total time exposed to work hazards from 6 to 10 years per site, to 2 to 3 weeks per site over a 1 to 2 year period.
Visitor Experience and Recreational Opportunities	• Crew Camps - The likelihood of visitors seeing crew camps is slight, and would result in negligible short-term adverse effects to those few park visitors who happen to travel by the site. • Helicopter and Stock Use – The use of helicopters and stock can have a positive or negative effect on the visitor experience. Generally, the use of helicopters results in a short-term moderate adverse effect. The use of stock results in minor short-term adverse or beneficial effects. • Restoration, Monitoring and Research –Tthe effects are negligible to minor and adverse, but as ecosystems are restored, the effects would be long-term and beneficial. • Fish Disposal –The presence of dead fish would result in short-term negligible to minor adverse effects.	Visitors may experience a slight change in recreational opportunities as a result of the ongoing program, primarily due to reduced angling opportunities and ecosystem restoration in the 26 treatment waterbodies. Effects would be short- and long-term negligible to minor adverse and beneficial.	Visitors would experience a moderate change in recreational opportunities as a result of expanding the existing program, primarily due to reduced angling opportunities and ecosystem restoration in the 20 additional treatment basins. Visitors to the restored waterbodies should notice the effects associated with this alternative. Effects would be short- and long-term minor to moderate and adverse and beneficial.	Visitors would experience a negligible to minor change in recreational opportunities as a result of expanding the existing program, primarily due to reduced angling opportunities and ecosystem restoration in the 15 treatment basins. Visitors to the restored waterbodies should notice the effects associated with this alternative. Effects would be short- and long-term minor to moderate and adverse and beneficial.	Impacts would be similar to alternative B except that this alternative would result in a greater number of short-term site closures, and take the least amount of time to complete, meaning that angling would be excluded sooner and opportunities for observing restored ecosystems would improve faster when compared to the other alternatives.

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