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RECORD OF DECISION

Paiute Cutthroat Trout Restoration Project

Silver King Creek, Alpine County, California

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U.S. Fish and Wildlife Service

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I. Background

Paiute cutthroat trout (*Oncorhynchus clarkii seleniris*) (PCT) were listed by the U.S. Fish and Wildlife Service (Service) on March 11, 1967, as endangered under the Endangered Species Preservation Act of 1966 (Service 1967) and subsequently reclassified as threatened on July 16, 1975, under the Endangered Species Act of 1973 (ESA), as amended, to facilitate management (Service 1975). The PCT is an inland subspecies of cutthroat trout (one of 14 recognized subspecies of cutthroat trout in the western United States) endemic to the Silver King Creek watershed, Alpine County, California (Behnke 1992).

A recovery plan for the PCT was prepared in 1985 (Service 1985). The objectives of the 1985 recovery plan were to reestablish a pure population of PCT in Silver King Creek above Llewellyn Falls, and secure and maintain the integrity of the occupied habitats in Silver King Creek, North Fork Cottonwood Creek, and Stairway Creek, all which occur outside of the historical range. In 2004, the Service published a Revised Recovery Plan to incorporate recent research data and address the species' current status, threats, distribution, and recovery needs (Service 2004). The Service also recently published the PCT 5-year review (Service 2008). The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). A brief summary of our findings in the 5-year review is presented below.

At the time of reclassification, PCT had been extirpated from its historical range by habitat loss and displacement by non-native trout species (*Oncorhynchus* sp.). Today, small PCT populations remain where they had been introduced to stream reaches where natural barriers prevent the invasions of non-native trout species. All PCT populations are isolated and confined to narrow and short lengths of stream. These factors reduce gene flow between populations, and reduce the ability of populations to recover from catastrophic events thus threatening their long-term persistence and viability. The primary threats at the time of reclassification were habitat loss due to livestock grazing practices and recreation development, and the introduction of non-native trout into streams inhabited by PCT. Little has changed since the time of reclassification. Some habitat improvement has occurred due to changes in grazing management. Recreation still occurs in and around PCT streams and poses a risk to streambank stability and fish habitat. However, introduced trout pose the greatest risk to PCT. Effective fish barriers occur downstream of remaining PCT populations, but the threat of humans moving other trout species into these protected reaches continues. Legal challenges to proposals to remove non-native trout species have impaired attempts to reduce this threat. Due to the small restricted populations that continue to face threats from recreation and non-native fish introductions, the Service concluded that PCT continues to meet the definition of threatened.

II. Summary of Decision

This Record of Decision (ROD) for the Paiute Cutthroat Trout Restoration Project (Project) documents my decision to implement a project which eradicates non-native and hybrid trout and restores PCT to its entire historical range in Silver King Creek, Alpine County, California, as analyzed in the Final Environmental Impact Statement/Environmental Impact Report (FEIS/EIR). As the Responsible Official for the Service, I have decided to implement FEIS/EIR Alternative 2.

In summary, my decision:

- Selects the use of rotenone to eradicate non-native and hybrid trout in Silver King Creek from Llewellyn Falls downstream to the confluence with Snodgrass Creek including associated tributaries; and

- Authorizes the restoration of PCT to its historical range through stocking.

III. Project Area

The project area is located in the Carson-Iceberg Wilderness on the Carson Ranger District of the Humboldt-Toiyabe National Forest (HTNF), Alpine County, California. The project area comprises the Silver King Creek watershed which is located about 22.5 kilometers (km) (14 miles (mi)) northwest of Markleeville, California.

IV. Proposed Action and Purpose and Need for Action

As presented in both the Draft Environmental Impact Statement/Environmental Impact Report (DEIS/EIR) and the FEIS/EIR, the Service (in cooperation with the California Department of Fish and Game (CDFG) and the HTNF, herein referred to as “Agencies"), is proposing to implement recovery actions 1 and 2 in the Revised Recovery Plan for PCT (Service 2004). To accomplish this, the Agencies will act cooperatively to chemically eradicate non-native trout from Silver King Creek and associated tributary habitat between Llewellyn Falls and Snodgrass Creek. The goal of the proposed action is to preserve existing PCT, currently found outside the area to be treated, by eliminating all non-native and hybrid trout that could compromise PCT genetics in the treatment area, to restore PCT back into its historical range. The trout present in the project reach from Llewellyn Falls to barriers in Silver King Canyon occupy the historical range of the PCT and are a genetic mixture of rainbow trout (*O. mykiss*), PCT, Lahontan cutthroat trout (*O. c. henshawi*), and golden trout (*O. m. aguabonita*) (Finger *et al*. 2008). Expansion of the current range of PCT is another key element in continued survival and recovery of the subspecies (Service 2004). Stocking the treated stream reach with PCT will expand the current range, restore the subspecies to its historical range, increase the population size and improve gene flow, which will enhance population viability (Lande and Barrowclough 1996, Hildebrand and Kershner 2000, Rieman and Allendorf 2001, Pritchard *et al.* 2007). This proposed action will also reduce the risk of catastrophic loss of PCT due to illegal stocking or stochastic events, such as flood or drought. Our process for implementing this proposal is also consistent with direction in the ESA, and complies with requirements of the National Environmental Policy Act (NEPA) for displaying the environmental impacts of proposed Federal actions.

The DEIS/EIR descriptions of the Proposed Action and purpose and need generated considerable comment and discussion both externally and among the Agencies. All responses to comments received on the DEIS/EIR can be found in Appendix F of the FEIS/EIR. Some of these issues are further explored in Section VIII of this ROD.

V. Public Involvement

Public participation helps the Service identify concerns with possible effects of its proposals. It is also a means of disclosing the nature and consequences of actions proposed by Federal agencies.

The Agencies developed a list of public individuals, organizations, governments, and agencies that would likely be interested in the Project. These included local citizens, advocacy and user-group organizations, county governments, tribal governments, other Federal agencies, State agencies, and local news media. We communicated with the public extensively during our analysis and DEIS/EIR preparation. Highlights of this involvement are provided below.

The Service published a Notice of Intent (NOI) to prepare an EIS for the Project in the Federal Register on June 2, 2006 (Service 2006). The NOI requested public comment on the Project from June 2 through July 3, 2006. The Service held a public scoping meeting in Markleeville on June 19, 2006. Nine citizens attended the meeting. The Service used the comments from the meeting to develop a list of issues requiring further analysis in the DEIS/EIR.

To comply with the California Environmental Quality Act (CEQA), CDFG issued a Notice of Preparation (NOP) on September 16, 2008. The NOP opened the State's public scoping period and public comments on the Project were accepted until October 31, 2008. One public scoping meeting for the EIR was held in Markleeville on October 7, 2008. A news release was issued to local radio, television, and print media outlets to notify the public of the meeting. CDFG sent approximately 210 direct mail notices to potentially interested parties including residents, and various State, local, and Federal agencies along with existing CDFG, Regional Water Quality Control Board (RWQCB) and U.S. Forest Service (USFS) contacts. The Service and CDFG presented information on the Proposed Action and its potential effects and the role of the public in the environmental review process. Participants were encouraged to provide verbal comments at the scoping meetings or to provide written comments. The Agencies met with the Alpine County Board of Supervisors on October 21 and November 18, 2008, and the Alpine Watershed Group on January 13, 2009, to discuss the Proposed Action.

The Notice of Availability (NOA) for the DEIS/EIR was published in the Federal Register on March 20, 2009, and a 45-day comment period extended from March 20 through May 4, 2009 (Service 2009). Written and oral comments were received from regulatory Agencies, non-profit and community organizations, and private individuals. The NOA for the FEIS/EIR was published in the Federal Register on April 9, 2010 and a 30-day public comment period was open until May 10, 2010 (Service 2010).

VI. Alternatives Analyzed in Detail

Based on public input, agency policies, the ESA, and Council on Environmental Quality regulations implementing NEPA, the Agencies developed three alternatives (including the Proposed Action) for detailed analysis. The alternatives are described in detail in the FEIS/EIR. Summaries of the alternatives follow.

Alternative 1-No Action: This alternative involves continuing the current stream and fishery management practices into the foreseeable future. Under the No Action Alternative, recovery actions 1 and 2 in the Revised Recovery Plan (Service 2004), as addressed in the Proposed Action, would not be implemented. No eradication of non-native and hybridized trout or restoration of PCT downstream of Llewellyn Falls would be implemented. Therefore, this alternative would result in continued ESA protection of PCT in the Silver King Creek watershed as well as out-of-basin populations, and the recovery of PCT would not be obtainable.

Alternative 2-Proposed Action: This alternative was presented in the DEIS/EIR as the preferred alternative. This alternative involves the use of chemicals to remove non-native and hybridized trout from the project area. The Agencies will use the commercially available rotenone formulation CFT Legumine™ which is a recently developed "alternative" formulation that is less toxic to non-target species such as macroinvertebrates (Finlayson *et al*. 2010).

A neutralization station will be operated downstream of the treatment area near the confluence of Silver King Creek and Snodgrass Creek. Potassium permanganate will be applied using a motorized auger until it is no longer necessary to neutralize the rotenone.

Post-treatment stocking of PCT will begin in early summer during the year following the final treatment, and will occur annually until the target population density is established, with guidance from ongoing fish population monitoring and historic population data (Deinstadt *et al*. 2004). Stocking will be conducted pursuant to guidelines and recommendations for stocking and genetic diversity management in the Revised Recovery Plan (Service 2004), recent genetic studies (Cordes *et al*. 2004, Finger *et al*. 2008), and past restocking efforts (CDFG 1996).

Stocking criteria were developed by the Agencies during a Threatened Trout Committee meeting in 1994. The following criteria were implemented in 1994 after the rotenone treatments in Silver King Creek between 1991 and 1993: 1) collect fish (PCT) from different parts of the donor stream; 2) take fish of different age classes to avoid "Founder's Effect" – 25 percent adults, 50 percent sub-adults, and 25 percent fingerlings; 3) collect 30 fish to capture 95 percent of genetic diversity or 150 fish to get 100 percent of the genetic diversity; and 4) retain at least 150 individuals in the donor population to maintain genetic diversity (CDFG 1996). These criteria have been successfully implemented for PCT populations in donor streams (Fly Valley and Coyote Valley Creeks) and receiving waters of Silver King Creek in Upper Fish Valley have shown no adverse affects from stocking (CDFG 2009). Additionally, genetic diversity in the donor streams has been maintained (Cordes *et al*. 2004). Similar criteria will be used to stock the project area once eradication of non-native and hybrid trout has been confirmed. PCT populations fluctuate naturally on an annual basis; therefore, numbers of PCT stocked annually will vary. This Project is consistent with the International Union for Conservation of Nature (IUCN) position statement on translocation of living organisms (IUCN 1998) and other recent directions in reintroduction biology (Armstrong and Seddon 2007).

The Agencies will conduct pre-treatment and post-treatment monitoring of benthic macroinvertebrate communities in the treatment areas and control sites. The monitoring program is designed to assess the duration of short-term treatment impacts and focuses on assemblage level measures such as total abundance, and taxa richness, and diversity measures, and avoids assessing impacts to individual invertebrate taxa. The monitoring program is consistent with recent literature concerning the impacts of rotenone treatments on macroinvertebrates (Vinson *et al*. 2010).

To prevent impacts on amphibian species, the Agencies will continue to conduct annual amphibian surveys. The Agencies will also conduct amphibian surveys immediately before treatment. If adult or tadpole life stages of any threatened, endangered, sensitive, candidate or rare amphibians are found during the pre-treatment surveys, they will be captured by nets and relocated out of the treatment area to suitable nearby habitat within their historical habitat.

Finally, to educate the public regarding the Project and prevent reintroduction of non-native fish to the area, the Agencies have committed to developing informational handouts to inform anglers entering the Carson-Iceberg Wilderness of the sensitivity and risks associated with PCT. The handouts will be in addition to the informational kiosks and signage currently located at the trailheads.

Alternative 2 provides for the most effective method for eradicating non-native and hybridized fish from Silver King Creek. The elimination of non-native and hybridized fish and the restoration of PCT into their historical habitat is anticipated to recover the subspecies to the point where delisting may be warranted.

Alternative 3-Combined Physical Removal: This alternative includes the use of non-chemical means to remove non-native and hybridized trout from the project area. It includes a combination of electrofishing, gill netting, seining, and other physical methods to remove fish from Silver King Creek and its tributaries. This alternative would not employ rotenone or any other chemical treatment. The low potential effectiveness of Alternative 3 is discussed in Section IX of this ROD. This alternative would result in continued ESA protection of PCT in the Silver King Creek watershed as well as out-of-basin populations, and the recovery of PCT would not be obtainable.

VII. Environmentally Preferred Alternative

Title 40 of the Code of Federal Regulations (CFR), Section 1505.2 and 43 C.F.R. 46.450 requires the Service to identify the environmentally preferable alternative(s) in the Record of Decision. Alternative 1 (No Action) is an environmentally preferable alternative. Alternative 1 (No Action) would be the environmentally preferred alternative because it would avoid all of the potentially significant impacts of the Proposed Action. However, the No Action alternative would: (1) fail to remove the non-native salmonids in Silver King Creek for the purpose of preventing hybridization with PCT; (2) not implement recovery actions 1 and 2 from the Revised Recovery Plan; (3) not restore PCT to its full historical range; and (4) not reduce its vulnerability to stochastic events, further hybridization, and possible extinction. While the significant impacts of the Proposed Action would be completely avoided in the short-term under the No Action alternative, the No Action would fail to protect and preserve the subspecies (See FEIS/EIR, Chapter 5.10 and Table 5.10-1).

Based on the information and analyses presented in the FEIS/EIR, the Service has determined that Alternative 2 (Proposed Action) is also an environmentally preferable alternative because of the shorter timeframe needed to implement the action as compared to Alternative 3, and the monitoring in place to ensure proper application of rotenone. Alternative 2 will also best achieve the Project's purpose and need (See FEIS/EIR, Chapter 5.10 and Table 5.10-1).

Alternative 3 (Combined Physical Removal) would result in direct physical impacts of greater duration and intensity from crews walking in the stream for potentially a decade worth of summer seasons and because it may not be effective in the long-term potentially creating repeated actions that would carry a similar level of disturbance (see FEIS/EIR, Chapter 5.10 and Table 5.10-1 and discussion below regarding the effectiveness of Alternative 3).

VIII. Issues Raised during Public Comment on the DEIS/EIR

The DEIS/EIR for the Project was issued on March 20, 2009, the same day the Notice of Availability for the DEIS/EIR was published in the Federal Register. The required 45-day comment period began on March 20 and ended on May 4, 2009.

Numerous and extensive comments were received on the DEIS/EIR. In the process of preparing the FEIS, all comments were reviewed and responses provided in Appendix F of the FEIS/EIR for public review. Because of the complexity and importance of issues raised in several of the comments, I summarize our responses to selected issues below.

Species level inventory and minimizing impacts to aquatic macroinvertebrates

Several individuals commented on the need for a species-level inventory of all aquatic macroinvertebrates in the watershed prior to implementation of the Project. Species-level aquatic macroinvertebrate inventories were not included as a method for establishing baseline information or assessing impacts because of the difficulties in developing a thorough inventory, the lack of comparison data from other watersheds which would be needed to determine the rarity or endemism of any particular species, and the fact that the Project avoids effects on unique aquatic macroinvertebrate habitats where potentially endemic species are most likely to occur. The methods used, and proposed for use by the Agencies to describe the baseline conditions for, and assess impacts on, aquatic macroinvertebrate taxa were chosen because they provide extensive information on the invertebrate community, are robust and thorough, meet the accepted standards of both regulatory and management agencies, and have been scientifically peer-reviewed (Vinson *et al*. 2010). There has never been a complete species-level assessment conducted on any freshwater body (Vinson *et al*. 2010), and as such, I believe this type of analysis is beyond the scope of treatment assessment for the Project.

To determine the baseline condition of macroinvertebrate taxa, to analyze impacts for the Project, and to monitor effects of the Project, the Agencies have used, and are planning to use, data acquired using scientifically accepted collection methods, protocols, metrics, and taxonomic resolution in accordance with accepted standards used by regulatory and land management agencies. These methods include describing and assessing the status of invertebrate assemblages (groups of similar species and genera) and communities.

The proposed action avoids, to the extent possible, unique habitats such as seeps and springs; these habitats types have a high probability of containing rare invertebrates (Erman 1996). The likelihood that there are rare macroinvertebrates in Silver King Creek is very low because waters within the treatment area are not unique. Few springs and seeps have been located within the project area and most are located above barriers outside of the treatment area. For those springs and seeps located within the project area, a thorough examination will be performed to determine if they provide fish habitat and whether or not they need to be treated.

The proposed action will not involve treating Silver King Creek's headwaters or the upper fishless reaches of tributaries. Approximately 27.4 km (17 mi) of tributary streams will be left untreated under the proposed action, some of which have never been treated with rotenone (*e.g*., Fly Valley Creek). Headwater areas, upstream and outside of the proposed treatment area, including Bull Canyon Creek, Corral Valley Creek, Coyote Valley Creek, and Four Mile Canyon Creek, have also never been treated with rotenone. These headwater areas are above natural barriers and do not support trout populations. These untreated areas will provide source populations of benthic macroinvertebrates for recolonizing treatment areas.

Finally, by using the rotenone formulation CFT Legumine™ which is less toxic to non-target species such as aquatic macroinvertebrates (Finlayson *et al*. 2010), by limiting the treatment concentration and duration of rotenone activity to the shortest time period needed to meet the fish removal objective, and by limiting the downstream impacts by neutralizing rotenone with potassium permanganate, I believe the Agencies have designed the Project to have minimal impacts to aquatic macroinvertebrates and that it is consistent with recent recommendations to reduce impacts to aquatic macroinvertebrates (Vinson *et al*. 2010). I also believe the monitoring program developed and being implemented is more than adequate and is also consistent with recent literature on monitoring impacts to the aquatic macroinvertebrate community from rotenone treatments (Vinson *et al*. 2010).

Historical range of PCT

Several individuals commented that we have inappropriately described the historical range of PCT. Based on the scientific record, the Agencies define the historical range of PCT as the section of Silver King Creek from Llewellyn Falls downstream to a series of barriers located in Silver King Canyon as well as the accessible reaches of three small named tributaries: Tamarack Creek, Tamarack Lake Creek, and the lower reaches of Coyote Valley Creek downstream of barrier falls. The historical range has been documented in numerous agency and scientific documents (Busack 1975, Behnke and Zarn 1976, Ryan and Nicola 1976, Behnke 1979, Behnke 1992, Moyle 2002). Behnke (1992) clarifies the discrepancy between the type locality (the location from which the original specimen (the 'type specimen' or 'holotype') was collected) furnished by Snyder (1933) and the historical range, "The distribution of the Paiute cutthroat trout is unique in that the subspecies is not native to its type locality above Llewellyn Falls in Silver King Creek, but was introduced there in 1912 by sheepherders (Behnke and Zarn 1976, Ryan and Nicola 1976, Busack 1975). When Snyder (1933) described seleniris, he believed it was native only to the headwaters isolated by Llewellyn Falls. Virgil Connell, a stockman who pastured sheep in the Silver King Creek watershed, later provided the information that no fish existed above Llewellyn Falls until transplanted from below the barrier in 1912. This transplant was fortunate because by 1933 the trout below Llewellyn Falls represented a rainbow X cutthroat hybrid swarm (Behnke 1960)." This account of the historical range of PCT is well established in the scientific literature and is the accepted description by all agencies involved in the management of PCT.

Effectiveness of Alternative 3

We received numerous comments on the effectiveness of Alternative 3 (Combined Physical Removal). I acknowledge that this methodology has been used in other non-native fish eradication efforts; however, I discuss below why the Agencies believe this method will be ineffective for the Project.

Non-native rainbow trout are currently the greatest threat to PCT, resulting in loss of the PCT population throughout its historical habitat through competition and hybridization. Competition from non-native trout has been identified as one of the most detrimental threats to native inland cutthroat trout (*Oncorhynchus clarkii* spp.) (Gresswell 1988, Behnke 1992, Young 1995). Both abiotic and biotic processes can influence competitive advantages for non-native trout over native cutthroat trout (Dunham *et al.* 2002, Peterson *et al.* 2004, Shepard 2004, de la Hoz Franco and Budy 2005, Quist and Hubert 2005, Korsu *et al.* 2007, McGrath and Lewis 2007, Budy *et al.* 2008, Seiler and Keeley 2009, Wood and Budy 2009).

Hybridization from non-native salmonids is also a threat to all native western trout species (Gresswell 1988, Behnke 1992, Young 1995). Non-native rainbow trout readily hybridize with native cutthroat trout and produce fertile offspring; however, fitness decreases as the proportion of rainbow trout admixture increases (Muhlfeld *et al.* 2009). Even with reduced fitness over time, hybridization spreads rapidly because the initial F_1 hybrids have high fitness, hybrids tend to stray more frequently, and all offspring of hybrids are hybrids (Boyer *et al.* 2008, Muhlfeld *et* *al.* 2009). Extensive genetic mixing of natives, non-natives, and hybrids contribute to the loss of locally adapted genotypes and can lead to the extinction of a population or an entire species or subspecies (Rhymer and Simberloff 1996).

The level of risk from non-native species depends on the mechanism by which the non-native species threatens the native species (*e.g.*, competition, predation, hybridization). Complete eradication of non-natives is usually desirable; however, it is not always feasible. When native species coexist with competing or predatory non-native species (*e.g.*, cutthroat trout and brook trout), reduction and suppression of the non-native species may be a management option. Reducing the population of the non-native species decreases their ability to suppress the native species. During suppression activities the native species is able to reoccupy former habitat and maintains its genetic purity. Reduction of the non-native species is only temporary, however, and maintenance (repeated suppression effort) of that population will have to occur to perpetuity (Peterson *et al.* 2008). In contrast, when native and hybridizing species coexist together (*e.g.*, cutthroat trout and rainbow trout), complete eradication is the only management option if a genetically pure population of the native species is the desired outcome. If only a few hybridizing individuals are left in the population, they can still reproduce with the native species. All offspring are hybrids which perpetuates the problem.

Techniques for eliminating non-native species from stream environments are limited (Meronek *et al.* 1996). Electrofishing has been shown to be costly and time consuming, and effectiveness is limited to small, relatively noncomplex streams (Moore *et al.* 1986, Finlayson *et al.* 2000, Moore *et al.* 2005, Meyer *et al.* 2006). Additionally, electrofishing has been used when control (suppression) of non-native competing species is desired rather than eradication (Larson *et al.* 1986, Moore *et al.* 1986, Thompson and Rahel 1996, Kulp and Moore 2000, Shepard *et al.* 2002, Meyer *et al.* 2006, Peterson *et al.* 2008).

Electrofishing efficiency is influenced by biological, environmental, and technical factors (Reynolds 1996). Two important biological factors that influence capture probabilities include the species and size of fish being targeted (Reynolds 1996, Dolan and Miranda 2003). Salmonids are more susceptible to electrofishing than other groups of fishes (*e.g.*, cyprinids), making electrofishing a useful tool to sample salmonid populations, especially in stream environments (Reynolds 1996). Larger fish are more prone to capture than smaller fish (Anderson 1995, Dolan and Miranda 2003, Peterson *et al.* 2004). Additionally, as the number of passes increases (number of times a sampling effort moves through specific habitat units) and individuals are removed, the capture efficiency decreases, significantly increasing the effort needed to remove fewer and fewer individuals (Peterson *et al.* 2004, Rosenberger and Dunham 2005).

Important environmental factors which influence capture probabilities in stream environments are water conductivity and stream complexity which includes size of stream (*e.g.*, length, width, flow), substrate, and cover (Reynolds 1996). Streams with low conductivity (*e.g.*, Silver King Creek) exceed the capacity of most power sources which reduces capture probabilities (Reynolds 1996, Kolz and Reynolds 2000). As stream complexity increases, electrofishing efficiency and capture probability decrease due to the inherent difficulties in sampling larger habitat sizes (Kennedy and Strange 1981, Habera *et al.* 1992, Kruse *et al.* 1998, Rosenberger and Dunham

2005). Additionally, large cobble and boulders, undercut banks, deep pools, large woody debris, and riparian vegetation decrease the ability of observers to locate and capture stunned fish (Kennedy and Strange 1981, Peterson and Cederholm 1984, Habera *et al.* 1992, Rodgers *et al.* 1992, Kruse *et al.* 1998, Peterson *et al.* 2004, Rosenberger and Dunham 2005).

Technical factors influencing electrofishing efficiency include personnel, equipment, and organization (Reynolds 1996). Most technical factors can be either selected for or controlled to a degree by maintaining equipment, training personnel, timing of sampling, and allowing for the appropriate number of personnel to accomplish stated goals and objectives (Reynolds 1996).

Certain lakes and streams within the Sequoia-Kings Canyon National Parks have been successfully eradicated of fish using gillnets and electrofishing (D. Boiano, NPS Aquatic Ecologist, pers. comm. 2009). However, the streams that were successfully eradicated are short in length, small in width, have effective downstream barriers which prevent fish from reinvading, and all but one are ephemeral. The one perennial stream which was successfully eradicated is a short stream connecting two lakes which were eradicated using gill nets. Another stream, which has been electrofished annually since 2001, has had a significant reduction in the fish population; however, fish have not been completely eradicated. This stream is 1.8 km (1.1 mi) long, has an incomplete fish barrier downstream, and is perennial.

The USFS's Lake Tahoe Basin Management Unit (LTBMU) has initiated a brook trout eradication program using gill nets in several small lakes and electrofishing methods in approximately 16 km (10 mi) of stream habitat in the Upper Truckee River watershed. The LTBMU estimates that it may take 15 years to complete if they are successful. There are substantial differences in the size and flow regimes between the Upper Truckee River watershed and Silver King Creek (Lawson 2009). Another difference between the two streams is the number of fish barriers which occur in the Upper Truckee River (12-14) compared to Silver King Creek (LTBMU 2008). The numerous barriers in the Upper Truckee River allows biologists to treat short sections of stream without brook trout reinvading. Silver King Creek has no barriers within the treatment area except for Llewellyn Falls and the series of barriers in Silver King Canyon. It is also characterized by meadow habitats that contain large undercut banks and deep pools. The system also has higher gradient reaches that have large boulders, cobbles, deep pools and large woody debris. The other key difference is the species of non-native fish which occur in the two streams; brook trout (competitor) in the Upper Truckee River and rainbow trout/hybrids (competitor/hybridizing) in Silver King Creek.

In summary, electrofishing and other mechanical methods are a legitimate way to eradicate non-native fish under certain conditions. However, these conditions do not exist within the project area. Chemical treatments are the most effective technique of eradicating non-native species in large, well connected, complex stream habitat (Finlayson et al. 2000, Moore et al. 2005, Peterson et al. 2008). Therefore, I conclude that Alternative 2 is the best choice to achieve the goals of the Project.

Past rotenone treatments in the area

Several comments were received requesting the Agencies disclose all past rotenone treatments within the Lahontan Basin, including Silver King Creek. The FEIS/EIR provides this information including problems encountered during implementation of these rotenone treatments. Chemical treatments in the Lahontan Basin have led to successful restoration of many other native cutthroat trout populations throughout their historical ranges. The establishment of the Lahontan Regional Water Quality Control Board (LRWQCB) and implementation of Basin Plan standards have increased the level of monitoring and ensure that projects are carried out in a manner that is least detrimental to other components of the aquatic ecosystem. Initial restoration efforts (1964, 1976, and 1977) for PCT did not have the regulatory oversight that more recent projects have required. Technology and methods of rotenone treatments have progressively improved using streamflow dye studies and water quality monitoring to ensure project control and compliance are carried out to the best available standards. The information gained from each past project has been incorporated into subsequent project design; thus ensuring that the best available management practices for chemical treatments are used. Additionally, new formulations of rotenone have become available which are less toxic to non-target species. I have reviewed these past projects and believe the project design for the Project has incorporated lessons learned from past restoration efforts and uses the best available science to reduce impacts to non-target species.

Treatment of Tamarack Lake

As a result of extensive sampling from 2001 to 2009, the Agencies have deemed Tamarack Lake to be fishless (Hanson 2009, Somer and Hanson 2009). Tamarack Lake will not be chemically treated and is no longer considered part of this Project. In the unforeseen event that salmonids return to Tamarack Lake, the Agencies will initially attempt mechanical removal. If the Agencies determine that chemical treatment of Tamarack Lake is necessary, the Agencies will take all necessary steps to ensure that any subsequent treatment of Tamarack Lake satisfies the requirements of NEPA and CEQA.

Climate Change

The Agencies do not contest the potential deleterious effects of climate change on habitat. Nor do the Agencies contest the effects of climate change on biota. No information specific to climate change in the project area is available. However, general information on past and potential future climate changes on a regional and world-wide scale is available.

Research has shown that the annual mean temperature in North America has increased from 1955 to 2005; however, the magnitude varies spatially across the continent, is most pronounced during spring and winter months, and has affected daily minimum temperatures more than daily maximum temperatures (Field *et al.* 2007). Other effects of climate change include, but are not limited to, changes in types and amounts of precipitation (Knowles *et al.* 2006, Seager *et al.* 2007), earlier spring run-off (Stewart *et al.* 2005), longer and more intense fire seasons (Brown *et al.* 2004, Westerling *et al.* 2006, Bachelet *et al.* 2007), and more frequent extreme weather events (Diffenbaugh *et al.* 2005, Rosenzweig *et al.* 2007). Climate change is predicted to have several effects on cold water habitat including: (1) increased water temperature; (2) decreased stream flow; (3) change in the hydrograph; and (4) increased frequency and severity of extreme events such as drought and floods (Stewart *et al.* 2005, Ficke *et al.* 2007, Bates *et al.* 2008, Webb *et al.* 2008). These changes in climate and subsequent effects can be attributed to the combined effects of greenhouse gases, sulphate aerosols, and natural external forcing (Karoly *et al.* 2003, Barnett *et al.* 2008).

Warming trends seen over the past 50 years are predicted to continue (Field *et al*. 2007). The Intergovernmental Panel on Climate Change states that of all ecosystems, freshwater ecosystems will have the highest proportion of species threatened with extinction due to climate change (Kundzewicz *et al.* 2007). Species with narrow temperature tolerances and cold-water species (*e.g*., salmonids) will likely experience the greatest effects from climate change, and it is anticipated that populations located at the margins of the species' hydrologic and geographic distributions will be affected first (Meisner 1990, Dunham *et al*. 2003b, Bates *et al*. 2008). Several studies have modeled the effects of increased water temperatures on North American salmonids (Meisner 1990, Keleher and Rahel 1996, Jager *et al*. 1999, Rahel 2002, Mohseni *et al*. 2003, Flebbe *et al*. 2006, Preston 2006, Rieman *et al*. 2007, Kennedy *et al*. 2009). The extent of habitat predicted to become unsuitable for salmonids ranges from 17 to 97 percent, depending on various factors such as the magnitude of the temperature increase and the region of North America in which the species exists (Rahel 2002, Flebbe *et al*. 2006, Preston 2006, Rieman *et al*. 2007). Additionally, these studies predict the loss of suitable habitat for salmonids mainly at the southern extent of their range and at lower elevations.

In response to increasing temperatures, salmonids will shift their distributions to northern latitudes (if possible) and/or higher elevations to find adequate stream temperatures (Keleher and Rahel 1996, Poff *et al*. 2002). This will likely increase fragmentation of populations and coupled with increases in stochastic events, will further disrupt metapopulation dynamics which increases the probability of extinction (Dunham *et al*. 1997, Fagan 2002, Opdam and Wascher 2004, Frankham 2005, Wilcox *et al*. 2006). Restoring physical connections among aquatic habitats may be the most effective and efficient step in restoring or maintaining the productivity and resilience of many aquatic populations (Bisson *et al*. 2003, Dunham *et al*. 2003a, Rieman *et al*. 2003, Dunham *et al*. 2007). The focus should be to protect aquatic communities in areas where they remain robust and restore habitat structure and life history complexity of native species where aquatic ecosystems have been degraded (Gresswell 1999, Seavy *et al*. 2009). All PCT populations are currently at their most upstream extent and cannot move their distributions to higher elevations. Additionally, Silver King Creek is the most northern occupied stream and constitutes the largest connected occupied habitat.

All existing populations of PCT are isolated in headwater drainages which make them susceptible to stochastic events such as fire, flood, and drought (Dunham *et al*. 2003a; Rieman *et al.* 2003). These events have increased in recent history and are predicted to increase as our climate continues to change (Hayhoe *et al*. 2004, Kim 2005, Westerling *et al*. 2006, Bates *et al*. 2008, Westerling and Bryant 2008, Miller *et al*. 2009). PCT will always be susceptible to stochastic events because of its limited range. PCT in Silver King Creek, once it becomes re-established throughout its native range, will be less susceptible than the out-of-basin populations due to the size of the drainage, the size of the population, and the quality and distribution of habitat in which it evolved over thousands of years. Further, because this subspecies was originally adapted to this stretch of stream, it is expected to provide the best quality habitat and the highest probability of long-term persistence.

Climate change could have an effect on invertebrates worldwide, not just in Silver King Creek and not just at high altitudes. Burgmer (2007) describes how Odonata are expanding their range northward through Britain, improving water quality indices. The authors caution that improvements in calculated indices may actually be a function of species changes resulting from climate change. Chessman (2009) looked at response to drought and extrapolated results to conclude that species may be vulnerable to climate change. Hogg (1996) conducted an experiment by splitting a stream and subjecting one half to warming and describing the changes in species composition. Hogg (1996) also described the uncertainties of extrapolating these data.

The Agencies believe that to make findings regarding the potential impacts of the Project to invertebrates using the limited available scientific literature would require considerable extrapolation regarding the extent of climate change, where temperature rises may occur, the extent to which these changes will affect baseline conditions, the adaptability of invertebrates to temperature changes, and finally, considerable speculation regarding the potential effects of the proposed action when considered together with the effects of climate change. The impacts of global warming to macroinvertebrates are likely to occur over the long-term, be slow to materialize, and are highly uncertain. Other than making a general qualitative statement, it would be highly speculative to evaluate the potential loss of invertebrates resulting from the Project on top of possible losses of invertebrates from global warming decades or centuries in the future.

The Proposed Project is limited in duration and very focused geographically. Given the differences in the time frames for the impacts, there is no reasonable basis on which to conclude that our brief Project will have any synergistic effect with the potential long-term impacts associated with global warming.

IX. Comments Received on the Final EIS/EIR

The Service received three letters opposed to the project, three letters supporting the project, and one neutral letter from the Environmental Protection Agency (EPA). I have made the suggested changes from the EPA in this ROD and I wanted to thank all those individuals and groups who have and continue to support this project. I also want to thank the individuals and groups who have opposed this Project because through their diligent efforts and input we have improved the Project planning and monitoring, and have reduced unintended impacts from the rotenone treatment.

I have reviewed the letters received and determined that no new issues have been raised that are pertinent to this project that have not already been thoroughly discussed in the FEIS/EIR including the following: impacts to macroinvertebrates, genetics, the historical range of the PCT, downstream barriers, and recreational fishing. I believe that the analyses presented in the FEIS/EIR are sound and uses the best information available. The Proposed Project and monitoring will enable the Agencies to implement the rotenone treatment safely and effectively. The information obtained through monitoring will aid in future native fish restoration efforts.

One letter discusses the 2007 treatment of Lake Davis by CDFG which has not been discussed during this process prior to receiving this letter. The Agencies do not agree with the comparison of treatment monitoring results from the tributary streams at Lake Davis to the proposed stream treatment in Silver King Creek. The two treatments are different with respect to hydrology and fluvial geomorphology. The baseline streamflow conditions during the 2007 Lake Davis treatment were an order of magnitude less than base flows projected for the treatment in Silver King Creek. Flows that were recorded in the Lake Davis tributaries ranged from less than 0.1 cubic feet per second (cfs) to 0.3 cfs and the habitats were primarily slow moving ponded environments. Base flows that are expected during the treatment period for Silver King Creek are expected to range between 10-20 cfs and the habitats are comprised primarily of runs, riffles, and pools. The higher flows that are present in Silver King Creek will allow for a significantly greater exchange rate with backwater or slow moving habitat and more efficient mixing.

The Lake Davis stream treatments were conducted primarily by spray application while the Silver King Creek treatment will be conducted primarily through the use of controlled drip stations that will be frequently evaluated via volumetric measuring. Drip stations are more likely to yield uniform concentrations than the spray treatment method used in the Lake Davis streams. Additionally, to address the concern that slow water areas will retain the piscicide after the application is concluded, the CDFG will sample three additional sites (ponded, stagnant, or slow moving areas) the day after the treatment. The National Pollutant Discharge Elimination System permit (NPDES No. CA0103209) issued by the LRWQCB also increased post-treatment sampling at all of the water quality monitoring sites within the project area to address the residence time of the piscicide and inactive ingredients.

In summary, the two stream systems and treatments are completely different based on hydrology, geomorphology, and application techniques. The Agencies are required as part of the FEIS/EIR, CEQA Findings of Fact and Statement of Overriding Consideration (CDFG 2010), and the NPDES permit to comply with EPA label requirements and to use the lowest concentration possible to maintain project objectives.

X. Decision

As the Responsible Official for the Service, I have decided to implement Alternative 2, which is comprised of recovery actions 1 and 2 in the Revised Recovery Plan (Service 2004). The Selected Action does the following:

- Selects the use of rotenone to eradicate non-native and hybrid trout in Silver King Creek from Llewellyn Falls downstream to the confluence with Snodgrass Creek and associated tributaries; and

- Authorizes the restoration of PCT to its historical range through stocking.

To minimize impacts from Project implementation, the Selected Action does the following:

- Aquatic and water quality impacts will be minimized by using the rotenone formulation CFT Legumine™ which is less toxic to non-target species such as macroinvertebrates (Finlayson *et al*. 2010) and by limiting the treatment concentration and duration of rotenone activity to the shortest time period needed to meet the fish removal objective.

- To eliminate the toxic effects of rotenone downstream of the proposed treatment area, potassium permanganate will be administered using generator-powered volumetric augers at a downstream detoxification station. The in-stream application of potassium permanganate below Silver King Canyon will ensure that no adverse effects of rotenone are experienced downstream of the treatment area.

- Block nets will be placed at selected locations throughout the proposed treatment area to catch dead fish. The nets will be maintained at a frequency adequate to minimize decomposition of captured fish.

- The Agencies will monitor stocked PCT as well as donor populations for changes in productivity and abundance to minimize impacts to donor streams and maximize genetic diversity of receiving waters.

- The proposed action will not involve treating Silver King Creek's headwaters or the upper fishless reaches of tributaries or springs. Approximately 27.4 km (17 mi) of tributary streams will be left untreated under the proposed action, some of which have never been treated with rotenone (*e.g*., Fly Valley Creek). These areas will provide source populations of benthic macroinvertebrates for recolonizing treatment areas. This measure is consistent with recent recommendations to reduce impacts to macroinvertebrates (Vinson *et al*. 2010).

- The Agencies will conduct pre-treatment and post-treatment monitoring of aquatic benthic macroinvertebrate communities in the treatment areas and control sites. The monitoring program is designed to assess the duration of short-term treatment impacts and long-term species composition recovery. The monitoring program is consistent with recent literature concerning the impacts of rotenone treatments on macroinvertebrates (Vinson *et al*. 2010).

- To prevent impacts on amphibian species, the Agencies will continue to conduct annual amphibian surveys. The Agencies will also conduct amphibian surveys immediately before treatment. If adult or tadpole life stages of any threatened, endangered, sensitive, candidate or rare amphibians are found during the pre-treatment surveys, they will be captured by nets and relocated out of the treatment area to suitable nearby habitat within their historical habitat.

- To educate the public regarding the Project and prevent reintroduction of non-native fish to the area, the Agencies have committed to developing informational handouts to inform anglers entering the wilderness of the sensitivity and risks associated with PCT. The handouts will be in addition to the informational kiosks and signage currently located at the trailheads.

As discussed extensively in the FEIS/EIR, the Selected Action provides specific measures to reduce impacts to the environment and non-target species. These measures are consistent with the American Fisheries Society's guidelines on the use of rotenone (Finlayson *et al.* 2000), recent literature regarding the use of rotenone (Finlayson *et al.* 2010, Vinson *et al*. 2010), and the LRWQCB's Basin Plan (1995).

XI. Rationale for Decision

In selecting a course of action for the Project, I have determined that my decision is consistent with agency policy, regulations, and all laws. In particular, I have reviewed guidance provided by the ESA. Section 4(f)(1) of the ESA states that the Secretary shall develop and implement plans (recovery plans) for the conservation and survival of endangered species and threatened species. Additionally, Section 4(f)(1)(B) states that the Secretary shall incorporate into each plan a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species. I find that the Proposed Action which uses rotenone to remove hybridized trout from historical PCT habitat (a site-specific management action) is consistent with the direction provided to the Service in Section 4 of the ESA.

By selecting Alternative 2, I am also meeting direction provided to Federal agencies for the conservation of threatened species. Section 7(a)1 of the ESA states that Federal agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of endangered and threatened species. I have considered the potential cumulative effects of reasonably foreseeable activities and read the public comments received on the DEIS/EIR and FEIS/EIR. I believe my decision provides the best balance of management activities to respond to the purpose and need, issues, and public comments, while complying with all applicable laws and regulations.

XII. Findings Required by Other Laws and Regulations

Wilderness Act: As documented in Chapter 5.7 in the FEIS/EIR, this decision is consistent with the Wilderness Act of 1964 and the California Wilderness Act of 1984. Implementation of the Project is contingent on CDFG obtaining a Special Use Permit from the HTNF regarding use of pesticides and motorized equipment in wilderness areas.

Endangered Species Act: The Service completed an intra-service consultation under Section 7 of the ESA for this Project which analyzed the effects of the Project on federally protected species located within the project area. With the actions to be undertaken, including conditions and mitigation measures as described herein, I find that the legal requirements of the ESA have been satisfied.

Environmental Justice (Executive Order 12898): As documented in Chapter 5.9 of the FEIS/EIR-Environmental Justice, my decision will have no disproportionate effects on minority populations or low-income populations.

National Historic Preservation Act: It is the policy of the Service (Service) to identify, protect, and manage cultural resources located on Service lands and affected by Service undertakings for the benefit of present and future generations in accordance with the National Historic Preservation Act (NHPA). The Service will comply with all applicable cultural resource regulations and policies prior to advancing funds, issuing a permit, or implementing ground disturbing activities. An undertaking includes providing funds and technical assistance to state and local agencies. A programmatic agreement (PA) has been developed between the Service and the California State Historic Preservation Officer (SHPO). The PA outlines procedures for complying with the NHPA.

The proposed Project is an activity that will occur within the active stream channel and thus qualifies as an Appendix A project, which by definition is considered an undertaking, but will have negligible potential to affect historic properties, and therefore does not require a field inspection, monitoring, or other form of cultural resource identification, and does not require consultation with the SHPO except for that called for in Stipulation IV (as a yearly summary) (Programmatic Agreement 1997). The Project has been considered and there will be no effects to cultural resources.

Clean Water Act: Based on discussions in Chapter 5.4 in the FEIS/EIR and the project record concerning water quality, this decision is consistent with the Clean Water Act and amendments. The CDFG obtained a National Pollution Discharge Elimination System permit from the LRWQCB on April 14, 2010.

Clean Air Act: Based on discussions in Chapter 5.5 in the FEIS/EIR and the project record concerning air quality, this decision is in compliance with the Clean Air Act, which defines the National Ambient Air Quality Standards for various sources of pollutants that must be met to protect human health and welfare, including visibility.

Migratory Bird Treaty Act and Executive Order: Based on discussions in Chapter 5.2 in the FEIS/EIR and the project record concerning migratory birds, this decision is in compliance with the Migratory Bird Treaty Act of 1918, as amended, subsequent Executive Order 13186, and memorandum of understanding between the Service and USFS, which provides for the protection of migratory birds.

Executive Order 119990 of May 1977 (Wetlands): This order requires Federal agencies to take action to minimize destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. In compliance with this order, Service direction requires that an analysis be completed to determine whether adverse impacts to wetlands would result. The FEIS/EIR and the project record confirm that the decision complies with EO 11990 by maintaining and restoring riparian conditions.

Executive Order 11988 of May 1977 (Floodplains): This order requires the Federal agencies to provide leadership and to take action to (1) minimize adverse impacts associated with occupancy and modification of floodplains and reduce risks of flood loss; (2) minimize impacts of floods on human safety, health, and welfare; and (3) restore and preserve the natural and beneficial values served by flood plains. The FEIS/EIR and the project record confirm that the decision complies with EO 11998 by maintaining floodplain integrity.

XIII. Implementation Date

I intend to implement this decision as soon as possible to meet the fall 2010 Project timeline. The earliest possible implementation date is 30 days after the EPA publishes their notice of the FEIS in the Federal Register.

XIV. Contact

For additional information concerning this decision, contact:

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Date

Acting Deputy Regional Director

XV. Literature Cited

Anderson, C.S. 1995. Measuring and correcting for size selection in electrofishing mark-recapture experiments. Transactions of the American Fisheries Society 124:663-676.

Armstrong, D.P., and P.J. Seddon. 2007. Directions in reintroduction biology. Trends in Ecology and Evolution 23:20-25.

Bachelet, D., J.M. Lenihan, and R.P. Neilson. 2007. Wildfires and global climate change: the importance of climate change for future wildfire scenarios in the western United States. Pages 22-41 in K.L. Ebi, G.A. Meehl, D. Bachelet, J.M. Lenihan, and R.P. Neilson, R.R. Twilley, D.F. Boesch, V.J. Coles, D.G. Kimmel, and W.D. Miller (contributors), Regional impacts of climate change: four case studies in the United States. Pew Center on Global Climate Change, Arlington, Virginia.

Barnett, T.P., D.W. Pierce, H.G. Hidalgo, C. Bonfils, B.D. Santer, T. Das, G. Bala, A.W. Wood, T. Nozawa, A.A. Mirin, D.R. Cayan, and M.D. Dettinger. 2008. Human-induced changes in the hydrology of the western United States. Science 319:1080-1083.

Bates, B.C., Z.W. Kundzewicz, S. Wu, and J.P. Palutikof (editors). 2008. Climate change and water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva. 210 pp.

Behnke, R.J. 1960. Taxonomy of the cutthroat trout of the Great Basin with notes on the rainbow series. Master of Arts Thesis. University of California, Berkeley. 98 pp.

Behnke, R.J. 1979. Monograph of the native trouts of the genus Salmo of western North America. U.S. Department of Agriculture, Forest Service, Lakewood, Colorado. 215 pp.

Behnke, R.J. 1992. Native trout of Western North America. American Fisheries Society Monograph 6.

Behnke, R.J., and M. Zarn. 1976. Biology and management of threatened and endangered western trouts. General Technical Report GTR-RM-28. Fort Collins, Colorado: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experimental Station. 45 pp.

Bisson, P.A., B.E. Rieman, C. Luce, P.F. Hessburg, D.C. Lee, J.L. Kershner, G.H. Reeves, and R.E. Gresswell. 2003. Fire and aquatic ecosystems of the western USA: current knowledge and key questions. Forest Ecology and Management 178:213-229.

Boyer, M.C., C.C. Muhlfeld, and F.W. Allendorf. 2008. Rainbow trout (*Oncorhynchus mykiss*) invasion and the spread of hybridization with native westslope cutthroat trout (*Oncorhynchus clarkii lewisi*). Canadian Journal of Fisheries and Aquatic Sciences 65:658-669.

Brown, T.J., B.L. Hall, and A.L. Westerling. 2004. The impact of twenty-first century climate change on wildland fire danger in the western United States: an application perspective. Climatic Change 62:365-388.

Budy, P., G.P. Thiede, P. McHugh, E.S. Hansen, and J. Wood. 2008. Exploring the relative influence of biotic interactions and environmental conditions on the abundance and distribution of exotic brown trout (*Salmo trutta*) in a high mountain stream. Ecology of Freshwater Fish 17:554-566.

Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate driven temperature changes on the diversity of freshwater macroinvertebrates. Oecologia 151: 93-103.

Busack, C.A. 1975. Genetic variation among population of Paiute trout (*Salmo clarki seleniris*). Master of Science Thesis. University of California, Davis. 155 pp.

California Department of Fish and Game (CDFG). 1996. Memorandum to Patrick O'Brien from Department of Fish and Game – Region 2. Subject: Paiute cutthroat trout management, 1994. May 20, 1996. Sacramento, California. 10 pp.

California Department of Fish and Game (CDFG). 2009. Unpublished fish population data for Silver King Creek, Alpine County, California.

California Department of Fish and Game. (CDFG). 2010. California Environmental Quality Act Findings of Fact and Statement of Overriding Considerations of the California Department of Fish and Game for the Paiute Cutthroat Trout Restoration Project. Rancho Cordova, California. March 15, 2010. 41 pp.

Chessman, B. 2009. Climate changes and 13 year trends in stream macroinvertebrate assemblages in New South Whales, Australia. Global Change Biology 15: 2791-2802.

Cordes, J.F., J.A. Israel, and B. May. 2004. Conservation of Paiute cutthroat trout: the genetic legacy of population transplants in an endemic California salmonid. California Fish and Game 90:101-118.

Deinstadt, J.M., D.C. Lentz, E. Gerstung, D.E. Burton, R. Bloom, W. Somer, S. Lehr, and R. Wickwire. 2004. Survey of fish populations in streams of the East Fork Carson River drainage, California. CDFG Fisheries Program Branch, Administrative Report No. 2004-8.

de la Hoz Franco, E.A., and P. Budy. 2005. Effects of biotic and abiotic factors on the distribution of trout and salmon along a longitudinal gradient. Environmental Biology of Fishes 72:379-391.

Diffenbaugh, N.S., J.S. Pal, R.J. Trapp, and F. Giorgi. 2005. Fine-scale processes regulate the response of extreme events to global climate change. Proceedings of the National Academy of Sciences 102:15774-15778.

Dolan, C.R., and L.E. Miranda. 2003. Immobilization thresholds of electrofishing relative to fish size. Transactions of the American Fisheries Society 132:969-976.

Dunham, J.B., G.L. Vinyard, and B.E. Rieman. 1997. Habitat fragmentation and extinction risk of Lahontan cutthroat trout. North American Journal of Fisheries Management 17:1126-1133.

Dunham, J.B., S.B. Adams, R.E. Schroeter, and D.C. Novinger. 2002. Alien invasions in aquatic ecosystems: toward an understanding of brook trout invasions and potential impacts on inland cutthroat trout in western North America. Reviews in Fish Biology and Fisheries 12:373-391.

Dunham, J.B., M. Young, and R.E. Gresswell. 2003a. Effects of fire on fish populations: landscape perspectives on persistence of native fishes and non-native fish invasions. Forest Ecology and Management 178:183-196.

Dunham, J.B., R.E. Schroeter, and B.E. Rieman. 2003b. Influence of maximum water temperature on occurrence of Lahontan cutthroat trout within streams. North American Journal of Fisheries Management 23:1042-1049.

Dunham, J.B., A.E. Rosenberger, C.H. Luce, and B.E. Rieman. 2007. Influences of wildfire and channel reorganization on spatial and temporal variation in stream temperature and the distribution of fish and amphibians. Ecosystems 10:335-346.

Erman, N.A. 1996. Chapter 35: Status of Aquatic Invertebrates. In Sierra Nevada Ecosystem Project: Final Report to Congress, Vol. II. Assessments and scientific basic for management options. Section III: Biological and Physical Elements of the Sierra Nevada. Davis: University of California, Center for Water and Wildland Resources.

Fagan, W.F. 2002. Connectivity, fragmentation, and extinction risk in dendritic metapopulations. Ecology 83:3243-3249.

Ficke, A.D., C.A. Myrick, and L.J. Hansen. 2007. Potential impacts of global climate change on freshwater fisheries. Reviews in Fish Biology and Fisheries 17:581-613.

Field, C.B., L.D. Mortsch, M. Brklacich, D.L. Forbes, P. Kovacs, J.A. Patz, S.W. Running, and M.J. Scott. 2007. North America. Pages 617-652 in M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (editors), Climate change 2007: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom.

Finger, A., M. Stephens, and B. May. 2008. Paiute cutthroat trout genetics report. Genomic Variation Laboratory, University of California, Davis. 26 pp.

Finger, A., M. Stephens, N.W. Clipperton, and B. May. 2009. Six diagnostic single nucleotide polymorphism markers for detecting introgression between cutthroat and rainbow trouts. Molecular Ecology Resources 9:759-763.

Finlayson, B.J., R.A. Schnick, R.L. Cailteux, L. DeMong, W.D. Horton, W. McClay, C.W. Thompson, and G.J. Tichacek. 2000. Rotenone use in fisheries management: administrative and technical guidelines manual. American Fisheries Society, Bethesda, Maryland. 200 pp.

Finlayson, B.J., W.L. Somer, and M.R. Vinson. 2010. Rotenone toxicity to rainbow trout and several mountain stream insects. North American Journal of Fisheries Management 30:102-111.

Flebbe, P.A., L.D. Roghair, and J.L. Bruggink. 2006. Spatial modeling to project southern Appalachian trout distribution in a warmer climate. Transactions of the American Fisheries Society 135:1371-1382.

Frankham, R. 2005. Genetics and extinction. Biological Conservation 126:131-140.

Gresswell, R.E. 1988. Status and management of interior stocks of cutthroat trout. American Fisheries Society Symposium 4.

Gresswell, R.E. 1999. Fire and aquatic ecosystems in forested biomes of North America. Transactions of the American Fisheries Society 128:193-221.

Habera, J.W., R.J. Strange, and S.E. Moore. 1992. Stream morphology affects trout capture efficiency of an AC backpack electrofisher. Journal of the Tennessee Academy of Science 67:55-58.

Hanson, J. 2009. CDFG memo fish evaluation for Tamarack Lake, Alpine County.

Hayhoe, K., D. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser, S.H. Schneider, K.N. Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S. Kalkstein, J. Lenihan, C.K. Lunch, R.P. Neilson, S.C. Sheridan, and J.H. Verville. 2004. Emisions pathways, climate change, and impacts on California. Proceedings of the National Academy of Science 101:12422-12427.

Hilderbrand, R.H., and J.L. Kershner. 2000. Conserving inland cutthroat trout in small streams: how much is enough? North American Journal of Fisheries Management 20:513-520.

Hogg, I.D., and D.D. Williams. 1996. Response of stream invertebrates to a global-warming thermal regime: an ecosystem level manipulation. Ecology 77: 395-407.

International Union for the Conservation of Nature (IUCN). 1998. Guidelines for re-introductions. Prepared by the IUCN/SSC Re-introduction Specialist Group. IUCN, Gland, Switzerland and Cambridge, United Kingdom. 10 pp.

Jager, H.I., W. Van Winkle, and B.D. Holcomb. 1999. Would hydrologic climate change in Sierra Nevada stream influence trout persistence? Transactions of the American Fisheries Society 128:222-240.

Karoly, D.J., K. Braganza, P.A. Stott, J.M. Arblaster, G.A. Meehl, A.J. Broccoli, and K.W. Dixon. 2003. Detection of a human influence on North American climate. Science 302:1200-1203.

Keleher, C.J., and F.J. Rahel. 1996. Thermal limits to salmonid distributions in the Rocky Mountain region and potential habitat loss due to global warming: a geographic information system (GIS) approach. Transactions of the American Fisheries Society 125:1-13.

Kennedy, G.J.A., and C.D. Strange. 1981. Efficiency of electric fishing for salmonids in relation to river width. Fisheries Management 12:55-60.

Kennedy, T.L., D.S. Gutzler, and R.L. Leung. 2009. Predicting future threats to the long-term survival of Gila trout using a high resolution simulation of climate change. Climatic Change 94:503-515.

Kim, J. 2005. A projection of the effects of the climate change induced by increasing CO_2 on extreme hydrologic events in the Western U.S. Climatic Change 68:153-168.

Knowles, N., M.D. Dettinger, and D.R. Cayan. 2006. Trends in snowfall versus rainfall for the western United States, 1949-2004. Journal of Climate 19:4545-4559.

Kolz, A.L., and J.B. Reynolds. 2000. Power threshold response curves. Pages 5- 35-5- 44 in Kolz, A.L., J.B. Reynolds, A. Temple, J. Boardman, and D. Lam, editors. Principles and techniques of electrofishing. U.S. Fish and Wildlife Service, National Conservation Training Center, Shepherdstown, West Virginia.

Korsu, K., A. Huusko, and T. Muotka. 2007. Niche characteristics explain the reciprocal invasion success of stream salmonids in different continents. Proceedings of the National Academy of Sciences 104:9725-9729.

Kruse, C.G., W.A. Hubert, and F.J. Rahel. 1998. Single-pass electrofishing predicts trout abundance in mountain streams with sparse habitat. North American Journal of Fisheries Management 18:940-946.

Kulp, M.A., and S.E. Moore. 2000. Multiple electrofishing removals for eliminating rainbow trout in a small southern Appalachian stream. North American Journal of Fisheries Management 20:259-266.

Kundzewicz, Z.W., L.J. Mata, N.W. Arnell, P. Döll, P. Kabat, B. Jiménez, K.A. Miller, T. Oki, Z. Sen, and I.A. Shiklomanov. 2007. Freshwater resources and their management.

Pages 174-210 in M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (editors), Climate change 2007: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom.

Lahontan Regional Water Quality Control Board (LRWQCB). 1995. The Water Quality Control Plan for the Lahontan Region. South Lake Tahoe, California. 491 pp. + appendices. (http://www.waterboards.ca.gov/lahontan/water_issues/programs/basin_plan/references.shtml)

Lake Tahoe Basin Management Unit (LTBMU). 2008. Biological Assessment for the Upper Truckee River Lahontan Cutthroat Trout Restoration Project. U.S. Department of Agriculture, Forest Service, Lake Tahoe Basin Management Unit. South Lake Tahoe, California. 17 pp.

Lande, R., and G.F. Barrowclough. 1996. Effective population size, genetic variation, and their use in population management. Pages 87-123 in M.E. Soulé (editor), Viable Populations for Conservation. Cambridge University Press, Cambridge.

Larson, G.L., S.E. Moore, and D.C. Lee. 1986. Angling and electrofishing for removing non-native rainbow trout from a stream in a national park. North American Journal of Fisheries Management 6:580-585.

Lawson, E.A. 2009. CDFG memo on watershed basin comparison, Silver King Creek and Upper Truckee River.

McGrath, C.C., and W.M. Lewis, Jr. 2007. Competition and predation as mechanisms for displacement of Greenback cutthroat trout by brook trout. Transactions of the American Fisheries Society 136:1381-1392.

Meisner, J.D. 1990. Potential loss of thermal habitat for brook trout, due to climatic warming, in two southern Ontario streams. Transactions of the American Fisheries Society 119:282-291.

Meronek T.G., P.M. Bouchard, E.R. Buckner, T.M. Burri, K.K. Demmerly, D.C. Hatleli, R.A. Klumb, S.H. Schmidt, and D.W. Coble. 1996. A Review of Fish Control Projects. North American Journal of Fisheries Management 16:63-74.

Meyer, K.A., J.A. Lamansky, Jr., and D.J. Schill. 2006. Evaluation of an unsuccessful brook trout electrofishing removal project in a small Rocky Mountain stream. North American Journal of Fisheries Management 26:849-860.

Miller, J.D., H.D. Safford, M. Crimmins, and A.E. Thode. 2009. Quantitative evidence for increasing forest fire severity in the Sierra Nevada and southern Cascade Mountains, California and Nevada, USA. Ecosystems 12:16-32.

Mohseni, O., H.G. Stefan, and J.G. Eaton. 2003. Global warming and potential changes in fish habitat in U.S. streams. Climate Change 59:389-409.

Moore, S.E., G.L. Larson, B. Ridley. 1986. Population control of exotic rainbow trout in streams of a natural area park. Environmental Management 10:215-219.

Moore, S.E., M.A. Kulp, J. Hammonds, and B. Rosenlund. 2005. Restoration of Sams Creek and an assessment of brook trout restoration methods. U.S. National Park Service Technical Report, NPS/NRWRD/NRTR-2005/342, Fort Collins, Colorado.

Moyle, P.B. 2002. Inland Fishes of California. University of California Press. Berkeley, Califoirnia. 502 pp.

Muhlfeld, C.C., S.T. Kalinowski, T.E. McMahon, M.L. Taper, S. Painter, R.F. Leary, and F.W. Allendorf. 2009. Hybridization rapidly reduces fitness of a native trout in the wild. Biology Letters 5:328-331.

Opdam, P., and D. Wascher. 2004. Climate change meets habitat fragmentation: linking landscape and biogeographical scale levels in research and conservation. Biological Conservation 117:285-297.

Peterson, D.P., K.D. Fausch, and G.C. White. 2004. Population ecology of an invasion: effects of brook trout on native cutthroat trout. Ecological Applications 13:754-772.

Peterson, D.P., K.D. Fausch, J. Watmough, and R.A. Cunjak. 2008. When eradication is not an option: modeling strategies for electrofishing suppression of non-native brook trout to foster persistence of sympatric native cutthroat trout in small streams. North American Journal of Fisheries Management 28:1847-1867.

Peterson, J.T., R.F. Thurow, and J.W. Guzevich. 2004. An evaluation of multipass electrofishing for estimating the abundance of stream dwelling salmonids. Transactions of the American Fisheries Society 133:462-475.

Peterson, N.P., and C.J. Cederholm. 1984. A comparison of the removal and mark-recapture methods of population estimation for juvenile coho salmon in a small stream. North American Journal of Fisheries Management 4:99-102.

Poff, N.L., M.M. Brinson, and J.W. Day, Jr. 2002. Aquatic ecosystems and global climate change: potential impacts on inland freshwater and coastal wetland ecosystems in the United States. Pew Center on Global Climate Change, Arlington, Virginia. 44 pp.

Preston, B.L. 2006. Risk-based reanalysis of the effects of climate change on U.S. cold-water habitat. Climate Change 76:91-119.

Pritchard, V.L., K. Jones, and D.E. Cowley. 2007. Genetic diversity within fragmented cutthroat trout populations. Transactions of the American Fisheries Society 136:606-623.

Quist, M.C., and W.A. Hubert. 2005. Relative effects of biotic and abiotic processes: a test of the biotic-abiotic constraining hypothesis as applied to cutthroat trout. Transactions of the American Fisheries Society 134:676-686.

Rahel, F.J. 2002. Using current biogeographic limits to predict fish distributions following climate change. American Fisheries Society Symposium 32:99-110.

Reynolds, J.B. 1996. Electrofishing. Pages 221-253 in B.R. Murphy and D.W. Willis, editors. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Rieman, B.E., and F.W. Allendorf. 2001. Effective population size and genetic conservation criteria for bull trout. North American Journal of Fisheries Management 21:756-764.

Rieman, B.E., R.E Gresswell, M. Young, D. Burns, D. Lee, R. Stowell, J. Rinne, and P. Howell. 2003. Current status and conservation of native fishes and issues for integration with fire and fuels management. Forest Ecology and Management 178:197-211.

Rieman, B.E., D. Isaak, S. Adams, D. Horan, D. Nagel, C, Luce, and D. Myers. 2007. Anticipated climate warming effects on bull trout habitats and populations across the interior Columbia River basin. Transactions of the American Fisheries Society 136:1552-1565.

Rhymer, J.M., and D. Simberloff. 1996. Extinction by hybridization and introgression. Annual Reviews in Ecology and Systematics 27:83-109.

Rodgers, J.D., M.F. Solazzi, S.L. Johnson, and M.A. Buckman. 1992. Comparison of three techniques to estimate juvenile coho salmon populations in small streams. North American Journal of Fisheries Management 12:19-86.

Rosenberger, A.E., and J.B. Dunham. 2005. Validation of abundance estimates from mark-recapture and removal techniques for rainbow trout captured by electrofishing in small streams. North American Journal of Fisheries Management 25:1395-1410.

Rosenzweig, C., G. Casassa, D.J. Karoly, A. Imeson, C. Liu, A. Menzel, S. Rawlins, T.L. Root, B. Seguin, and P. Tryjanowski. 2007. Assessment of observed changes and responses in natural and managed systems. Pages 79-131 in M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (editors), Climate change 2007: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom.

Ryan, J.H., and S.J. Nicola. 1976. Status of the Paiute cutthroat trout, Salmo clarki seleniris Snyder, in California. California Department of Fish and Game Inland Fish. Administrative Report #76-3. 56 pp.

Seager, R., M. Ting, I. Held, Y. Kushnir, J. Lu, G. Vecchi, H.P. Huang, N. Harnik, A. Leetmaa, N.C. Lau, C. Li, J. Velez, and N. Naik. 2007. Model projections of an imminent transition to a more arid climate in southwestern North America. Science 316:1181-1184.

Seavy, N.E., T. Gardali, G.H. Golet, F.T. Griggs, C.A. Howell, R. Kelsey, S.L. Small, J.H. Viers, and J.F. Weigand. 2009. Why climate change makes riparian restoration more important than ever: recommendations for practice and research. Ecological Restoration 27:330-338.

Seiler, S.M., and E.R. Keeley. 2009. Competition between native and introduced salmonid fishes: cutthroat trout have lower growth rate in the presence of cutthroat-rainbow trout hybrids. Canadian Journal of Fisheries and Aquatic Sciences 66:133-141.

Shepard, B.B. 2004. Factors that may be influencing nonnative brook trout invasion and their displacement of native Westslope cutthroat trout in three adjacent southwestern Montana streams. North American Journal of Fisheries Management 24:1088-1100.

Shepard, B.B., R. Spoon, and L. Nelson. 2002. A native westslope cutthroat trout population responds positively after brook trout removal and habitat restoration. Intermountain Journal of Sciences 8:191-211.

Snyder, J.0. 1933. Description of Salmo seleniris a new California trout. Proceedings of the California Academy of Sciences 20:471-472.

Somer, W., and J. Hanson. 2 009. CDFG memo chemical treatment evaluation for Tamarack Lake, Alpine County.

Stewart, I.T., D.R. Cayan, and D.M. Dettinger. 2005. Changes toward earlier streamflow timing across the western North America. Journal of Climate 18:1136-1155.

Thompson, P.D., and F.J. Rahel. 1996. Evaluation of depletion-removal electrofishing of brook trout in small Rocky Mountain streams. North American Journal of Fisheries Management 16:332-339.

U.S. Fish and Wildlife Service (Service). 1967. Native fish and wildlife: Endangered species. Federal Register 32:4001. March 11, 1967.

U.S. Fish and Wildlife Service (Service). 1975. Threatened status for three species of trout. Federal Register 40:29863-29864. July 16, 1975.

U.S. Fish and Wildlife Service (Service). 1985. Recovery Plan for the Paiute cutthroat trout (*Salmo clarki seleniris*). Portland, Oregon. ix + 68 pp.

U.S. Fish and Wildlife Service (Service). 2004. Revised Recovery Plan for the Paiute cutthroat trout (*Oncorhynchus clarki seleniris*). Portland, Oregon. ix + 105pp. http://ecos.fws.gov/docs/recovery_plan/040910.pdf

U.S. Fish and Wildlife Service (Service). 2006. Notice of Intent to Prepare an Environmental Impact Statement for the Paiute Cutthroat Trout Restoration Project, Carson-Iceberg Wilderness, Humboldt-Toiyabe National Forest, Alpine County, California. Federal Register 71:32125-32126.

U.S. Fish and Wildlife Service (Service). 2008. 5-Year Review: Summary and Evaluation. Paiute cutthroat trout (*Oncorhynchus clarkii seleniris*). Region 8, Sacramento, California. 39 pp. http://ecos.fws.gov/docs/five_year_review/doc1954.pdf

U.S. Fish and Wildlife Service (Service). 2009. Notice of Availability Draft Environmental Impact Statement/Environmental Impact Report for the Paiute Cutthroat Trout Restoration Project. Federal Register 74:11965-11966.

U.S. Fish and Wildlife Service (Service). 2010. Notice of Availability Final Environmental Impact Statement for the Paiute Cutthroat Trout Restoration Project, Alpine County, California. Federal Register 75:18235-18236.

Vinson, M.R., E.C. Dinger, and D.K. Vinson. 2010. Piscicides and invertebrates: after 70 years, does anyone really know? Fisheries 35:61-71.

Webb, B.W., D.M. Hannah, R.D. Moore, L.E. Brown, and F. Nobilis. 2008. Recent advances in stream and river temperature research. Hydrological Processes 22:902-918.

Westerling, A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. Science 313:940-943.

Westerling, A.L., and B.P. Bryant. 2008. Climate change and wildfire in California. Climatic Change 87(supplement 1):S231-S249.

Wilcox, C., B.J. Cairns, and H.P. Possingham. 2006. The role of habitat disturbance and recovery in metapopulation persistence. Ecology 87:855-863.

Wood, J., and P. Budy. 2009. The role of environmental factors in determining early survival and invasion success of exotic brown trout. Transactions of the American Fisheries Society 138:756-767.

Young, M.K. (Technical editor). 1995. Conservation Assessment for Inland Cutthroat Trout. USDA Forest Service General Technical Report GTR-RM-256. Ft. Collins, Colorado:

U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 pp.

Personal Communication

Boiano, D. 2009. Aquatic Ecologist, National Park Service, Sequoia-Kings National Park, California. Telephone conversation with D. Boiano on August 25, 2009. Subject: we discussed the parks efforts to eradicate non-native trout from certain lakes and streams. Personal communication with C. Mellison, Fish and Wildlife Biologist, Nevada Fish and Wildlife Office, Nevada.