Conservation Agreement
for the
Eagle Lake Rainbow Trout
(*Oncorhynchus mykiss aquilarum*)
Lassen County, California

California Department of Fish and Wildlife
Northern Region

USDA Forest Service, Pacific Southwest Region
Eagle Lake Ranger District, Lassen National Forest

U.S. Fish and Wildlife Service, Pacific Southwest Region
Sacramento Fish and Wildlife Office

2015

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INVOLVED PARTIES/SIGNATORIES TO THIS CONSERVATION AGREEMENT AND STRATEGY

United States Department of the Interior
U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office

Represented By: _____
Field Supervisor

State of California Natural Resources Agency
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Represented By: _____
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United States Department of Agriculture
U.S. Forest Service
Lassen National Forest

Represented By: _____
Forest Supervisor

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10.0 Attachment Conservation Strategy

This Conservation Agreement (Agreement) and associated Conservation Strategy (Strategy) have been developed to expedite implementation of conservation measures for the Eagle Lake Rainbow Trout (ELRT) in California as a collaborative and cooperative effort among resource agencies. Threats that warrant ELRT listing as a special status species and might lead to listing under the Endangered Species Act of 1973, as amended will be eliminated or reduced through implementation of this Agreement and Strategy.

1.0 Executive Summary and Purpose

The ELRT (*Oncorhynchus mykiss aquilarum*) is a subspecies of rainbow trout endemic to Eagle Lake and its main tributary, Pine Creek located in Lassen County, CA. The ELRT has been designated as a California Heritage Trout, a California Department of Fish and Wildlife Species of Special Concern and US Forest Service sensitive species. Cumulative impacts during the second half of the 19th century and the first half of the 20th century resulted in sharply declining numbers of ELRT which ultimately prompted the construction of the Pine Creek Fish Trap and barrier weir in 1959 and subsequent hatchery production to sustain the fishery and augment the existing population. While this program has been effective, substantially increasing the population from historic lows observed in the 1930s-1940s, the lack of natural spawning opportunities has resulted in the ELRT's complete dependence on hatchery spawning for continued survival.

The purpose of the Strategy (Attachment) is to restore natural spawning and rearing of ELRT, preserve the uniqueness of the subspecies, and restore stream habitat. The Conservation Strategy describes the current conditions and threats, prioritizes and describes the specific conservation actions needed to establish a stable, wild-spawning population, describes success criteria for each action, provides a timeline for accomplishing each conservation action, and identifies the roles and responsibilities of collaborating agencies for each action. The essential conservation measures needed to establish a self-sustaining wild population of ELRT fall into six categories listed below in order of priority. Specific conservation actions are provided to support each category described below.

1. Improve passage into and through Pine Creek for migration and spawning of ELRT. This specifically includes providing improved passage through the trap/weir structure at the mouth of Pine Creek as well as effective coordination with hatchery operations.
2. Remove or control of the brook trout population in the headwater reaches of Pine Creek and the subsequent establishment and management of a stream based population of ELRT.
3. Implement artificial spawning program and monitor genetic integrity to ensure retention of adequate genetic diversity to maintain lake and creek populations.
4. Implementation of effective habitat restoration projects and management strategies to improve watershed function and riparian and aquatic habitat conditions. Adaptive management and monitoring of land use activities in coordination with ELRT conservation objectives.
5. Develop and support research projects to inform adaptive management and success criteria of conservation actions outlined herein.
6. Expand outreach and education programs relating to ELRT and the conservation of its habitats.

2.0 Distribution and Status of ELRT

The historical range of ELRT includes Eagle Lake and Pine Creek located in the Northern Lahontan Basin portion of Northeastern California, making ELRT the only species of rainbow trout native to the Lahontan Basin. Eagle Lake is a closed basin with only one main tributary, Pine Creek, that historically provided critical spawning and rearing habitat. Other secondary tributary watersheds are much smaller than that of Pine Creek and may have historically provided habitat for the ELRT. However, these tributaries do not currently provide sufficient stream flow to support spawning and rearing. The majority of Pine Creek is highly intermittent and generally flows for 2 to 3 months out of the year. The perennial sections of Pine Creek and Bogard Springs Creek, a tributary of Pine Creek, are approximately 25 miles upstream of Eagle Lake. Successful spawning of ELRT is dependent upon timing, sufficient amount and duration of flows, and temperatures in the lower sections of Pine Creek (Pustejovsky 2007).

Anthropogenic impacts within the Eagle Lake basin and the Pine Creek watershed in the latter half of the 19th Century led to the decline of the ELRT and its natural spawning habitat. Beginning in the 1940's the CDFW (formerly the California Department of Fish and Game) became concerned about the low numbers of this fish and recognized that human intervention must occur if it was to survive (Dean and Chappell 2005). As a result the Pine Creek Trap (Trap) was constructed in 1959 thus facilitating artificial propagation to augment the existing population. Consisting of a fish/egg collection station and barrier weir, the Trap was designed to block upstream migration to reduce loss of ELRT from stranding caused by the seasonal nature of lower Pine Creek. Since the Trap's installation, ELRT have been entirely sustained by the CDFW hatchery program (Dean and Chappell 2005). This program is believed to have saved the species from extinction; however, the continued reliance upon artificial propagation to sustain the population may have altered the genetic integrity of the fish and led to a loss of expression of ELRT's full life history. For this reason, the CDFW constructed a fishway in the existing Trap facility in 2012 with the intention of allowing adult ELRT to pass through the Trap and continue upstream to spawn naturally. Additionally, ELRT spawning and rearing success in upper Pine Creek is limited by high numbers of non-native brook trout (*Salvelinus fontinalis*) which were introduced into upper Pine Creek in the 1940's.

In 1987, the Pine Creek Coordinated Resources Management and Planning (CRMP) group was formed. The CRMP is composed of government agencies, timber companies, cattle ranchers, and other local individuals and groups. The group was formed to improve hydrologic conditions on Pine Creek, restore the stream/riparian ecosystem, and to restore a natural ELRT fishery in Pine Creek. Pustejovsky (2007). Over the last two and a half decades, the CRMP has improved much of the watershed, including moving ELRT spawners upstream of the Trap to spawn and providing habitat for them. These efforts and subsequent monitoring indicate the re-establishment of natural spawning and rearing by the ELRT at Eagle Lake has a strong potential for success.

Management of the ELRT to date has been heavily influenced by the recreational fishery created by the hatchery rearing program. However, there has been an increased emphasis on restoration of Pine Creek and creation of conditions to support natural spawning of ELRT. With completed projects improving the in-stream conditions, monitoring, and new projects being developed,

natural production has become a top priority. Future management of Pine Creek will focus on the improvement and monitoring of fish passage, brook trout control, and watershed restoration to enhance the natural production of ELRT in Pine Creek. Actions will be taken in order to restore this critical life history component and the genetic attributes associated with the historic utilization of Pine Creek by ELRT for spawning and juvenile rearing.

The U.S. Fish and Wildlife Service (USFWS) has been petitioned three times to list the ELRT under the authority of the Endangered Species Act of 1973, as amended (ESA). The first petition was dated April 25, 1994, and a not substantial 90-Day finding was issued on August 7, 1995 (USFWS 1995). The finding was based on the lack of supporting information included with the petition, and on the existence of significant conservation efforts underway at that time. The 90-Day finding reviews the information presented in the petition to determine if it contains substantial information on the status of the species that listing under the ESA may be warranted. The second and third petitions were dated August 15, 2003, and September 28, 2003. Pursuant to the 2011 settlement agreement for Wild Guardians v. Salazar, the 90-day finding on these petitions was issued by the USFWS on September 5, 2012 (USFWS 2012). The 12 month finding is forthcoming in the near future.

3.0 Life History and Ecology

Historically ELRT likely exhibited two life histories, stream resident and lake dwelling. The lake form lives much of its life in Eagle Lake, only ascending tributaries during the spring runoff period at the time of spawning. The timing of the spawning run ranges from late February to early May, which is the only time of the year that Pine Creek connects to Eagle Lake. Historically ELRT would migrate up Pine Creek as conditions allowed. The spawning migration of ELRT begins when stream temperatures are nearing 40°F and taper off once they exceed 50°F. Rising stream temperatures in Pine Creek also attracts a migration of adult spawning Tahoe suckers and Lahontan redsides from Eagle Lake. These migrations are typically heaviest during high water years when Pine Creek has longer flow duration and sustained temperatures nearing or exceeding 50°F.

The ability of ELRT to access the perennial reach is restricted to wetter years with deep snow pack to provide sufficient runoff sustaining a prolonged duration of flow. Eagle Lake rainbow trout historically migrated to the upper portions of the Pine Creek watershed to spawn and juveniles are thought to have reared in Pine Creek for one to two years before migrating downstream to Eagle Lake to grow to adult size (Moyle 2002). It is possible that some ELRT juveniles remained in Pine Creek and became fully stream resident, although data are lacking to support this assumption. In recent years the lower intermittent portion of Pine Creek has shown some evidence of spawning success as indicated by juvenile ELRT returning to Eagle Lake; however, given the lack of perennial flows even prior to human disturbance to the watershed, it is likely that lower Pine Creek provided little, if any, rearing habitat. The best opportunity for ELRT to spawn successfully is during wet years with prolonged higher flow when conditions would be most suitable for migration into the upper perennial headwaters. The infrequency of the larger flow events and lack of connectivity with Eagle Lake may be the reason ELRT mature later and live to an older age than other rainbow trout. In the past, during dry years with insufficient flow, upper Pine Creek's resident population may have been crucial to the survival

of the species, since the lake form would have been prevented from spawning, potentially for multi-year periods.

The surface of Eagle Lake usually begins to freeze by late November and can be completely frozen by early January. After the spring thaw, ELRT are distributed throughout the lake. As summer progresses, warming water makes trout habitat less suitable in the northern basin, driving trout to the deeper, cooler waters at the southern basin. The south basin typically stratifies in mid-July through August providing cool water refuge 25 to 35 feet from the surface. By late September surface temperatures cool and the south basin "turns-over." As the lake continues to cool ELRT move into shallower water and feed aggressively on invertebrates and large schools of native Eagle Lake tui chub and other native minnows.

Eagle Lake is highly alkaline with a pH range of 8.3 to 9.7. ELRT have adapted to these harsh conditions and thrive in the lake. Other trout species (with the exception of Lahontan cutthroat) generally cannot tolerate pH more than about 8.4 as a result of the severe inhibition of branchial ammonia excretion (Wright, 1992). This ability to survive harsh alkaline conditions gives these fish the ability to grow exceptionally well in less alkaline conditions found in most other freshwaters in California (Dean and Chappell 2005). ELRT are typically stocked back into Eagle Lake at 8 ounces. Fish stocked in the spring are usually smaller, averaging about 10 inches, while fall stocked fish are larger, averaging about 13 inches (Dean and Chappell 2005). Once in the lake, ELRT typically grow three inches per year. By the end of the third year, length growth slows and average weight increases. The average size from creeled fish surveys varies from about 16 to 18.5 inches (Dean and Chappell 2005).

Eagle Lake is apparently the only large lake in California where the historic fish assemblage is still present (Moyle, 2002), likely as a result of its high alkalinity. Along with ELRT, the native fish assemblage in Eagle Lake includes: Tahoe sucker (Catostomus tahoensis), Lahontan redside (Richardsonius egregius), Eagle Lake tui chub (Siphateles bicolor ssp.), and speckled dace (Rhinichthys osculus). Numerous aquatic invertebrate species can also be found in the lake including mayflies (Ephemeroptera), caddis flies (Trichoptera), stoneflies (Plecoptera), black flies (Simulidae), shoreflies and gnats (Diptera and others), leeches, a few gastropods, various zooplankton (Daphnia and Leptodora,) and scuds (Hyalella) (Moyle, 2002).

4.0 Conservations Actions To Date

Table 1 in the Strategy provides an overview of major conservation actions completed since approximately 1989, via the Pine Creek CRMP collaborative effort.

5.0 Conservation Goals and Objectives

The desired conditions for ELRT will have been met upon completion of these conservation actions. However, because this Strategy is based on adaptive management, actions may be removed, added or adjusted annually as new information is realized, and thus incorporated into the Strategy for conservation and management of ELRT.

Conservation actions that will significantly contribute to the protection and restoration of ELRT have been identified and prioritized for each goal of this Strategy. Table 2 in the Strategy provides an overview of the implementation of these actions and details on the objectives, actions, action time lines, and agencies or non-governmental organizations responsible for implementation of the actions.

Goal 1. Provide natural production for and maintain genetic integrity of ELRT - All Parties

A primary threat to ELRT is the lack of natural production and the potential genetic risks associated with artificial propagation (see Section 5.0 in the Strategy). There are several contributing factors impacting ELRT's ability to spawn naturally and the genetic integrity of the subspecies. The following actions have been planned, developed and/or are currently being implemented to restore natural production and protect the genetic integrity of this subspecies.

Objective 1.1 Operate the Pine Creek Trap fish ladder to facilitate natural spawning migration - CDFW

Objective 1.2 Identify and remove any existing potential barriers to migration - USFS/CDFW

Objective 1.3 Remove brook trout from the Pine Creek watershed and reestablish stream population of ELRT - CDFW/USFS

Objective 1.4 Implement artificial spawning practices to provide highest level of genetic diversity possible - CDFW

Goal 2. Provide suitable stream/riparian habitat conditions for ELRT in the Pine Creek watershed - All Parties

To support the reestablishment of a natural spawning population of ELRT in Pine Creek, suitable habitat must be provided and maintained. Restoration of stream and riparian habitat, hydrologic function and other watershed processes, as well as monitoring of these restoration activities, will occur to ensure appropriate actions are being taken and objectives are being achieved. Improving instream conditions will increase the likelihood of successful ELRT migrations, spawning, and rearing in upper Pine Creek. Restoring watershed processes will make Pine Creek more resilient to climate change and catastrophic events.

Objective 2.1 Reduce impacts and restore Pine Creek stream habitat and channel from grazing -USFS

Objective 2.2 Assess and restore natural hydrologic and stream function processes -USFS

Objective 2.3 Implement water conservation measures to buffer impacts from drought – USFS

Goal 3. Continue and expand research and monitoring - All Parties

In order to adaptively manage ELRT, pertinent research and monitoring must be continued and expanded to improve our understanding of the status of the ecology (population dynamics, genetics, and habitat) of ELRT and to guide future management decisions. The Pine Creek CRMP, technical review team will continue to facilitate the prioritization and identification of research needs. Many of the conservation objectives and actions outlined herein require monitoring or evaluation prior to implementing projects. The objectives and actions below have been identified as key areas of study to determine project efficacy, document existing conditions, and provide information to guide existing conservation actions and develop future actions.

Objective 3.1 Monitor adult spawning migrations -CDFW

Objective 3.2 Monitor genetic integrity of ELRT stream and lake populations and evaluate artificial spawning and hatchery rearing program- CDFW

Objective 3.3 Monitor effectiveness of brook trout removal and ELRT reestablishment in Pine Creek- CDFW

Objective 3.4 Monitor lake population for naturally spawned ELRT - CDFW

Objective 3.5 Watershed assessments and monitoring - USFS/CDFW

Goal 4. Increase delivery of outreach and education programs relating to ELRT and the conservation of its habitat - All Parties

Many restoration and conservation efforts to benefit and sustain ELRT have been implemented and considerably more are planned. The protection and conservation of California's natural resources and native species will provide future generations with lasting legacy benefits that are immeasurable. Resource management agencies need to better articulate that message so that public support can be garnered and greater emphasis placed on the inherent value of California's diverse native flora and fauna. Conservation of ELRT and its habitats is one example of the shift in resource management practices and principals from management almost exclusively for consumptive uses toward a broader, more holistic, approach that emphasizes restoring ecosystem function as a fundamental goal, while still allowing the use of resources to benefit our growing population. The best way for resource management agencies to continue to facilitate that shift is to educate and gain support from the public. Education and outreach opportunities related to the uniqueness and value of ELRT as part of California's heritage need to be developed and delivered.

Objective 4.1 Expand educational efforts to increase public awareness about ELRT and the unique ecology of Eagle Lake - All Parties

Objective 4.2 Increase public outreach and engagement in the conservation of ELRT - All Parties

6.0 Authority

The authorities for the agencies and others to enter into this voluntary Agreement and Strategy derive from the ESA and a National Memorandum of Agreement which exists between the USFS, USFWS, BLM, NPS and the National Marine Fisheries Services. The CDFW enters into this Agreement and Strategy as the trustee agency for fish and wildlife in California under the general authority of Fish and Game Code Section 1802 and other applicable provisions of law.

1. This agreement is subject to, and is intended to be consistent with, all applicable federal, tribal, and state laws and interstate compacts.
2. All parties to this Agreement recognize they each have specific statutory responsibilities that cannot be delegated, particularly with respect to the management and conservation of wildlife and its habitat.
3. This Agreement does not restrict the parties from participation in similar activities with other public or private agencies, organization or individuals.
4. All parties to this Agreement do not waive any immunity provided by federal, state, local or tribal laws by entering into this agreement and each fully retains all immunities and defenses provided by law with respect to any action based on, or occurring as a result, of the Agreement.
5. Modifications to the Agreement must be mutually agreed upon by all signatories to the Agreement. Such changes shall be executed as an addendum to the original agreement.

7.0 Conservation Action Implementation

The Strategy outlines the actions to be implemented for the conservation of the ELRT over the next 15 years. In addition, the following administrative actions outlined below will be implemented:

A. Coordinating Conservation Actions
   - The ELRT Conservation Strategy Team (Team) will implement the attached Strategy that encompasses the goals, objectives and actions.
   - Administration of the Agreement will be conducted by the Conservation Strategy Team. The Team shall consist of, at a minimum, one designated representative from each signatory agency. In addition, the Team may include other stakeholders as deemed necessary by the signatories.
   - Responsibilities of the Team will include coordinating all the conservation activities.
   - The Team will meet at least annually to document progress toward achieving Strategy goals and objectives, develop priorities, and review any other elements related to planning or implementation of the Strategy as necessary.
   - Team meetings will be open to the public.

B. Implementation

- Each signatory will coordinate, implement and monitor actions in the Strategy for which they and their cooperators are responsible. Accomplishments will be presented in an annual summary report at Team meetings. In addition, a five-year status assessment will be prepared to document the implementation of the Strategy.
- All funds required for and expended in accordance with this Agreement are subject to approval by the appropriate state or federal appropriations. This Agreement is not a fiscal obligation document.

8.0 Duration of Agreement

The term of this Agreement shall be 15 years. If, after each 5 year assessment, continued progress has been made toward the benefit of ELRT then the Agreement will be reviewed, updated as necessary, and reauthorized. Any party may withdraw from the Agreement with sixty working days written notice to the other parties. The basis for the withdrawal shall be provided to the signatories.

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Conservation Strategy for the Eagle Lake Rainbow Trout (*Oncorhynchus mykiss aquilarum*) Lassen County, California

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Lassen County

Honey Lake Valley Resource Conservation District

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1.0 Executive Summary and Purpose

The Eagle Lake rainbow trout (*Oncorhynchus mykiss aquilarum*) (ELRT) is a subspecies of rainbow trout endemic to Eagle Lake and its main tributary, Pine Creek, located in Lassen County, CA. The ELRT has been designated as a California Heritage Trout, a California Department of Fish and Wildlife Species of Special Concern and US Forest Service sensitive species. Cumulative impacts during the second half of the 19th century and the first half of the 20th century resulted in sharply declining numbers of ELRT which, ultimately, prompted the construction of the Pine Creek Fish Trap and barrier weir (Trap) in 1959 and subsequent hatchery production to ensure the persistence of the subspecies and sustain the fishery. While this program has been effective, substantially increasing the population from historic lows observed in the 1930s-1940s, the lack of natural spawning opportunities has resulted in the ELRT's complete dependence on hatchery spawning for continued survival.

The purpose of this conservation strategy is to serve as a framework for the conservation and protection of the ELRT and to contribute to the species' persistence into the future. This document identifies conservation actions that will be implemented to reduce and/or eliminate the threats to the natural spawning and rearing of ELRT and preserve the uniqueness of the subspecies. This strategy describes current conditions and threats, prioritizes and describes the specific conservation actions needed to establish a stable, wild-spawning population, provides a timeline for accomplishing each conservation action, and identifies the roles and responsibilities of collaborating agencies for each action. The essential conservation measures for establishing a self-sustaining, wild population of ELRT fall into six categories listed below in order of priority. Specific conservation actions are provided to support each category described below.

1. Improve passage into and through Pine Creek for migration and spawning of ELRT. This, in particular, includes providing improved passage through the Trap as well as effective coordination with hatchery operations (Objective 1.1 and 1.2, Goal 1).
2. Removal or control of the brook trout population in the headwater reaches of Pine Creek and the subsequent establishment and management of a stream-based population of ELRT (Objective 1.3, Goal 1).
3. Continue the artificial spawning program and monitor genetic integrity to ensure retention of adequate genetic diversity to maintain unique life history traits of both lake and stream populations (Objective 1.4, Goal 1).
4. Continue implementation of effective habitat restoration projects and management strategies to improve watershed function and riparian and aquatic habitat conditions. Adaptive management and monitoring of land use activities in coordination with ELRT conservation objectives are key to this goal (Goal 2).
5. Develop and support research projects to inform adaptive management and success criteria of conservation actions outlined herein (Goal 3).
6. Expand outreach and education programs relating to ELRT and the conservation of its habitats (Goal 4).

A corresponding Memorandum of Agreement commits participating agencies, specifically the California Department of Fish and Wildlife, US Fish and Wildlife Service, US Forest Service, and Lassen County to provide, to the extent possible, necessary financial and logistical support

for the proposed work. The implementation of this Conservation Strategy is intended to effectively restore ELRT spawning habitat and provide migratory access to spawning habitat with the goal of establishing a stable, naturally spawning population of ELRT.

2.0 Introduction

The historical range of ELRT includes Eagle Lake and Pine Creek, located in the Northern Lahontan Basin portion of Northeastern California, making ELRT the only species of rainbow trout native to the Lahontan Basin. Eagle Lake is a closed basin with only one primary tributary, Pine Creek, that historically provided critical spawning and rearing habitat. Other secondary tributary watersheds (e.g., Papoose and Merrill creeks) are much smaller than Pine Creek but may have historically provided habitat for the ELRT during wetter climatic conditions. However, these tributaries do not currently provide sufficient stream flow to support spawning and rearing. The majority of Pine Creek is highly intermittent and generally flows for only two to three months out of the year. The perennial sections of Pine Creek and Bogard Springs Creek, a tributary of Pine Creek, are approximately 25 miles upstream of Eagle Lake. Successful spawning of ELRT is dependent upon timing, sufficient amount and duration of flows, and temperatures in the lower sections of Pine Creek (Pustejovsky 2007).

Anthropogenic impacts within the Eagle Lake basin and the Pine Creek watershed in the latter half of the 19th Century led to the degradation of its natural spawning habitats and decline of the ELRT. Beginning in the 1940's, the California Department of Fish and Wildlife (CDFW; formerly the Department of Fish and Game), became concerned about the low numbers of ELRT and recognized that human intervention was required for its persistence (Dean and Chappell 2005). As a result, the Trap was constructed in 1959 to facilitate artificial propagation and augment the existing population. Consisting of a fish/egg collection station and barrier weir, the Trap was designed to block adult upstream migration of ELRT in order to reduce loss of ELRT from stranding caused by the seasonal nature of the lower reach of Pine Creek. Since the Trap's installation, ELRT have been entirely sustained by the CDFW artificial spawning program (Dean and Chappell 2005). The artificial spawning program conducted by CDFW is believed to have saved the species from extinction; however, it is speculated that the continued reliance upon artificial propagation to sustain the population may have altered the genetic integrity of the fish and led to a loss of expression of ELRT's full life history. As a first step toward reversing the process of total reliance upon artificial propagation, CDFW constructed a fishway in the existing Trap facility in 2012, with the intention of allowing adult ELRT to pass through the Trap volitionally and continue upstream to spawn naturally. However, ELRT spawning and rearing success in upper Pine Creek is limited by high numbers of non-native brook trout (*Salvelinus fontinalis*) which were introduced into upper Pine Creek in the 1940's.

In 1987, the Pine Creek Coordinated Resources Management and Planning (CRMP) group was formed. The CRMP is composed of government agencies, timber companies, cattle ranchers, and representatives of local organizations. The group was formed to develop strategies and implement restoration actions to improve hydrologic conditions within Pine Creek, work to restore the stream and riparian ecosystems, and to restore a natural ELRT fishery in Pine Creek Pustejovsky (2007). Over the past several decades the CRMP has facilitated restoration projects

to improve much of the watershed, including moving adult ELRT upstream of the Trap to spawn and utilize stream habitats. These efforts and subsequent monitoring indicate the re-establishment of natural spawning and rearing of ELRT in Pine Creek has strong potential for success. There is a subset of resource specialist within the CRMP, the Fisheries Technical Review Team (TRT), which specifically meets to coordinate and assess restoration and monitoring efforts for ELRT. The fisheries TRT is comprised of CDFW, USFS, USFWS, Susanville Indian Rancheria, Honey Lake Valley Resource Conservation District, Trout Unlimited, and Lassen County UC Cooperative Extension resource specialists and meets at least bi-annually. The Fisheries TRT will continue to serve as a technical team to: review monitoring reports, identify management needs, and help to facilitate the implementation of conservation activities identified in this Strategy.

Past management of ELRT was heavily influenced by the recreational fishery supported by the artificial spawning and hatchery rearing program. However, there is now an increased emphasis on restoration of Pine Creek to provide conditions favorable for natural spawning and stream rearing of ELRT. Already completed projects have improved in-stream conditions, monitoring is ongoing, and new projects are being developed; as a result, natural production has become a top priority. Future management of Pine Creek will focus on the improvement and monitoring of fish passage, brook trout control and/or eradication, and restoration of stream and hydrologic function to enhance the natural production of ELRT in Pine Creek. Actions will be taken in order to restore this critical life history component and the genetic attributes associated with the historic utilization of Pine Creek by ELRT for spawning and juvenile rearing.

The U.S. Fish and Wildlife Service (USFWS) has been petitioned three times to list the ELRT under the authority of the Federal Endangered Species Act of 1973, as amended (ESA). The first petition was dated April 25, 1994, and a 90-day finding was issued on August 7, 1995 (USFWS 1995), stating listing was unwarranted. The finding was based on the lack of supporting information included with the petition and on the implementation of significant conservation efforts underway at that time. The second and third petitions were dated August 15, 2003, and September 28, 2003. Pursuant to the 2011 settlement agreement for *Wild Guardians v. Salazar*, the 90-day finding on these petitions was issued by the USFWS on September 5, 2012 (USFWS 2012). The USFWS determined that the 2003 petitions and the information present at the time of the petitions presented substantial information and listing the ELRT may be warranted. Completion of the 12 month finding, determining the USFWS's listing action, is anticipated to be completed in June, 2015.

3.0 Eagle Lake Rainbow Trout Background and Ecology

3.1 Native Range

Eagle Lake rainbow trout are endemic to the Eagle Lake basin. In addition to the lake itself, the historical stream habitat for this subspecies was limited primarily to Pine Creek. While other tributaries to Eagle Lake may have historically provided limited habitat for the ELRT, Snyder (1940) reported, "the only spawning and nursery stream was Pine Creek, a small tributary with a fitful flow."

Within the Pine Creek drainage, the only perennial stream habitat available for year-round utilization by ELRT is limited to approximately five to ten miles in the headwaters. The amount of perennial habitat is highly variable across water years, depending largely upon the amount of precipitation and associated snowmelt runoff. Eagle Lake rainbow trout currently reside (in low densities) in the lower perennial reaches of upper Pine Creek. The ELRT population in Pine Creek has been intermittently augmented by CDFW hatchery stocking. However, some natural recruitment of ELRT in Pine Creek and its tributaries has been documented in recent years (Carmona et al. 2011).

With the exception of fish migration studies, the manual release of untagged migrating adults, and rare high flow events, ELRT have not migrated freely upstream of the barrier weir associated with the Trap located near Eagle Lake at the mouth of Pine Creek since 1959. The lowest 25 miles of Pine Creek are intermittent and are presumed to have historically served primarily as a seasonal migration corridor for ELRT, from the lake to the perennial headwaters, where year-round habitat is available. However, during wetter periods with an extended duration of flow, ELRT have spawned successfully in lower Pine Creek with newly emerged fry emigrating back into Eagle Lake (2010 and 2011 P. Divine and T. Pustejovsky, pers. obsv.).

3.2 Environmental Setting

Eagle Lake is approximately 15 miles north of Susanville in Northeast California (see Figure 1) at an elevation of approximately 5,100 feet above sea level. Eagle Lake is the second largest natural lake entirely within the State of California. The southern end of the lake is surrounded by mixed coniferous forest, while the northern end is juniper woodland and sagebrush scrub. Eagle Lake is highly alkaline and seasonally exhibits relatively warm water temperatures, making it unsuitable for most freshwater fishes with exception of the native fishes that are uniquely adapted to this environment. Along with ELRT, the native fish assemblage in Eagle Lake includes: Tahoe sucker (*Catostomus tahoensis*), Lahontan redside (*Richardsonius egregius*), Eagle Lake tui chub (*Siphateles bicolor* ssp.), and speckled dace (*Rhinichthys osculus).*

Pine Creek is approximately 40 miles long, much of which is intermittent, and flows west to east from the Caribou Wilderness Area (~7,100 feet) to the northwest shore of Eagle Lake (~5,100 feet), near Spalding (see Figure 2). Pine Creek flows through several vegetation communities such as mixed coniferous forest, eastside pine and sagebrush scrub and through three low gradient valleys: Pine Creek Valley, Champs Flat and McCoy Flat. Perennial waters of Pine Creek support populations of speckled dace, Tahoe sucker, and a small number of ELRT, but the entire system is currently dominated by non-native brook trout.

3.3 Geology and Hydrology

Geology

Eagle Lake is located near the convergence of several geomorphic provinces and is considered to have physical characteristics most similar to the volcanic Modoc Plateau, merging with the western Basin and Range, the southeastern Cascade Range, and the northeastern extent of the Sierra Nevada (BLM 2010).

The principal lithologic units at Eagle Lake and the surrounding area are composed of Holocene and Pleistocene age sedimentary lake basin deposits consisting of thin-bedded clay, silt, and sand

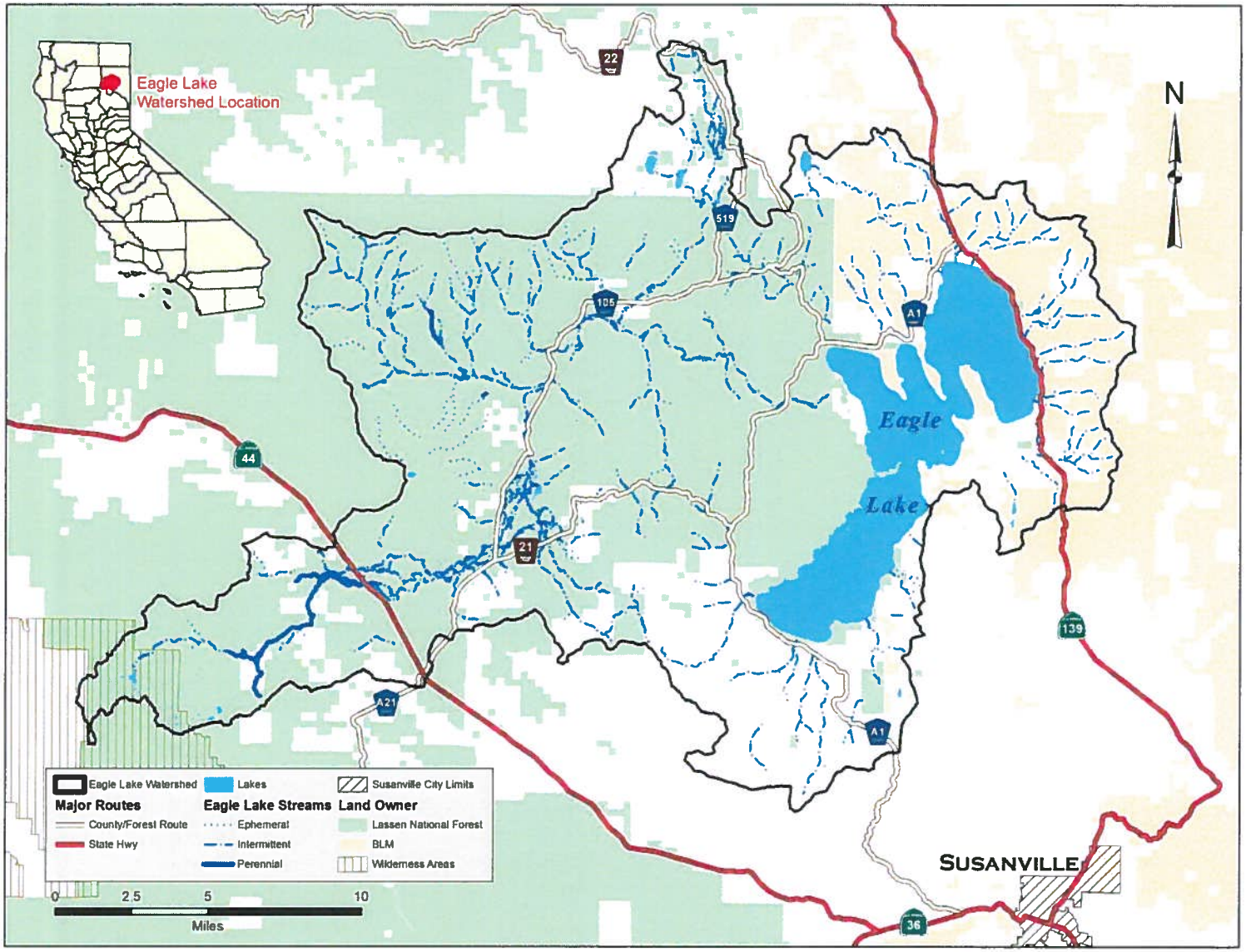

Figure 1: Eagle Lake Basin Map

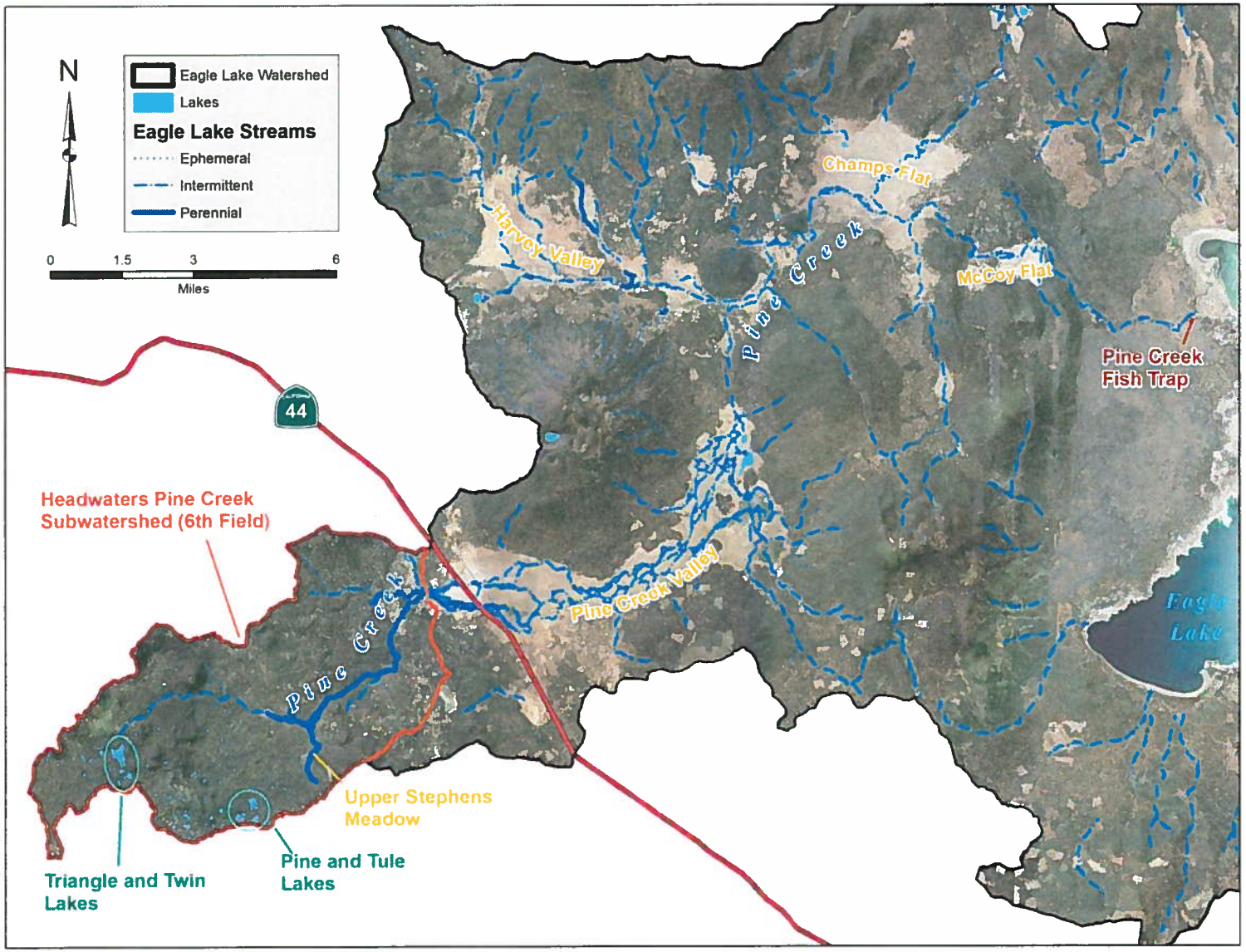

Figure 2: Pine Creek Watershed Map

material, as well as more recent to Pliocene age volcanics, consisting of basalt, and layered pyroclastic rocks (including volcanic ash and tuff) (BLM 2010).

Fractured geologic structure and varying degrees of permeability between lithological units contribute to complex groundwater flow patterns in the Eagle Lake basin. Basalt rocks in the area are dense and have low porosity and permeability. Pyroclastic rocks deposited between the basalt units tend to be more porous and permeable. The near surface volcanic rocks contain significant zones of fractures and joints, which tend to act as pathways for groundwater flow. Lava tubes within the basalts also act as avenues for groundwater flow. Faults within these units act as either barriers or conduits to groundwater flow. Faults with intense zones of fracturing and fissuring are permeable zones, whereas faults offsetting rock units and containing cemented fractures create barriers to groundwater flow (BLM 2010). The complex geologic structure of this region, consisting of varying fracture and jointing patterns, lava tubes, and fault zones make it very difficult to predict the flow and movement of groundwater. The geologic conditions described above suggest that the groundwater and surface water associated with Eagle Lake are probably interconnected. The extent of the direct effect of groundwater on lake level and volume of water in Eagle Lake at any given time is unknown due to complex geologic conditions and limited data (BLM 2010).

Uplands in the Pine Creek watershed consist of volcanic centers, while valley floors are composed of shallow layers of alluvium underlain by alternating fractured and dense volcanic rocks and alluvium layers. Most of the watershed above 6,200 feet elevation was glaciated 10,000-70,000 years ago (Villalovos 2013). A clay layer is notable in the lower flats (Champs and McCoy). This creates a hardpan layer that keeps water on the surface in areas that would otherwise quickly drain into fractured basalts, out of the surface and usable groundwater zones (Villalovos 2013).

Soils are almost entirely derived from recent and Pleistocene basalts and andesites. Infiltration rates are high except in the valley bottoms and rocky channel reaches along Pine Creek and low gradient reaches of some major tributaries. Very little sediment reaches Pine Creek from upland areas, even when local sheet erosion is occurring. Most sediment in the creek is mobilized within the stream channel, by bank and channel erosion and washed downstream (Villalovos 2013).

Hydrology

Eagle Lake is a closed basin located in the North Lahontan 4th level hydrologic unit. The Eagle Lake Basin covers 438 square miles, 222 square miles of which are in the Pine Creek watershed. Precipitation over this large area is highly variable, with the western, mountainous portions receiving higher levels. Most precipitation falls in the form of snow, which provides runoff and surface flow to the intermittent streams in the basin, including Pine Creek. The average annual precipitation within the basin is highly variable; with an average of 18 inches per year at the lake, nearly 60 inches per year in the higher elevations to the west, and 14 inches per year in the lower elevations to the northeast. On average, Eagle Lake can lose 42 inches per year in evaporation alone (DWR 1972) and, therefore, lake level fluctuations are directly correlated with drought periods. The average annual inflow to Eagle Lake has been estimated at 48% ground water, 38% direct precipitation, and 14% surface water (BLM 2010). Pine Creek contributes 75-85% of the surface inflows to the lake. The average annual outflow has been estimated to be 89%

evaporation, 10% ground water movement out of the basin and 1% ground water pumping (BLM 2010). In the past, some outflow exited Eagle Lake via the Bly Tunnel, transferring water into the Willow Creek drainage to the east. Several attempts have been made in the past to stop water from entering the tunnel and, in 1986, a concrete plug was constructed with a small bypass pipe to reduce the amount of outflow. In February 2012, the bypass pipe within the tunnel plug was sealed and no water is currently exiting the tunnel.

Eagle Lake's surface area varies from 16,000 to 29,000 acres, due to lake level fluctuations (ranging from 5,091 to 5,125 feet above sea level) and the lake's shallow nature. Eagle Lake can essentially be divided into three separate lakes, the north, central, and south basins, based on physical, chemical, and biological characteristics. The circulation between the three basins is extremely limited due the sharp angle of the connecting straits and differences in concentrations of dissolved solids and salts (Huntsinger 1976). Typically, the northern and central basin of Eagle Lake exhibit harsher water conditions due to their shallow nature and isolation from the deeper south basin; however, the water quality of the central basin can be heavily influenced by inflows from Pine Creek. The south basin is the deepest and is the only portion of the lake that stratifies during the summer, making this basin particularly important during drought years, when it provides cool water refuge for fishes. The lake is highly alkaline, with pH ranging from 8.3 to 9.7 and total alkalinity ranging from 300 to 900 ppm, depending upon the lake's water level and location within the lake. In general, Eagle Lake's water can be described as a sodium-bicarbonate type that is strongly buffered against changes in pH (Vail 1979). Water temperatures within the three basins are highly variable. Due to their shallow nature, the north and central basins warm and cool rapidly with changes in air temperature. Summer high water temperatures often reach 75-80° F while, during winter months, the surface is typically covered in ice. Water temperatures in the south basin are typically cooler, with summer surface maximum temperatures reaching 72-74° F and deeper water in the thermocline and hypolimnion 5 to 15° F cooler.

Pine Creek only flows in the lower reaches in the spring as snowpack melts. Snow typically begins to melt in late February in the lower valleys, later connecting to the upper watershed in mid-March. The duration of flow in the intermittent sections of Pine Creek is highly variable and depends upon the amount of snowpack, air temperature, rain and rain-on-snow events, and other climatic variables. From 1961 to 2014, flows at the Trap have ranged from 9 to 242 days (Figure3). During extremely wet years the intermittent reach has been known to flow for up to 11 months and in drier years, due to inadequate snowpack, has not flowed at all (i.e. 1977 and 2014). During that same time period, the average flow at the Trap was 87 cubic feet per second (cfs) and ranged from 0.1 to 1,770 cfs (Figure 4). During the early part of spring thaw, stream temperatures are cold (32-36° F in late February to mid-March), as water is flowing over and through melting snow. Usually by late March to mid-April, as daytime air temperatures increase and snow has melted off in the lower flats, water temperatures increase to 40-45° F. By late April or early May, temperatures can reach and exceed 50° F.

The amount of perennial water in upper Pine Creek is also highly variable and depends upon water year type. Approximately 5 to 10 miles of perennial stream exists, which includes as much as 1.5 miles of Bogard Springs Creek and 1.5 miles of other tributaries. Triangle Lake is commonly referred to as the upper extent of the headwaters of Pine Creek; however, it is likely to contribute flow to Pine Creek only in years with exceptional snowpack and resulting runoff.

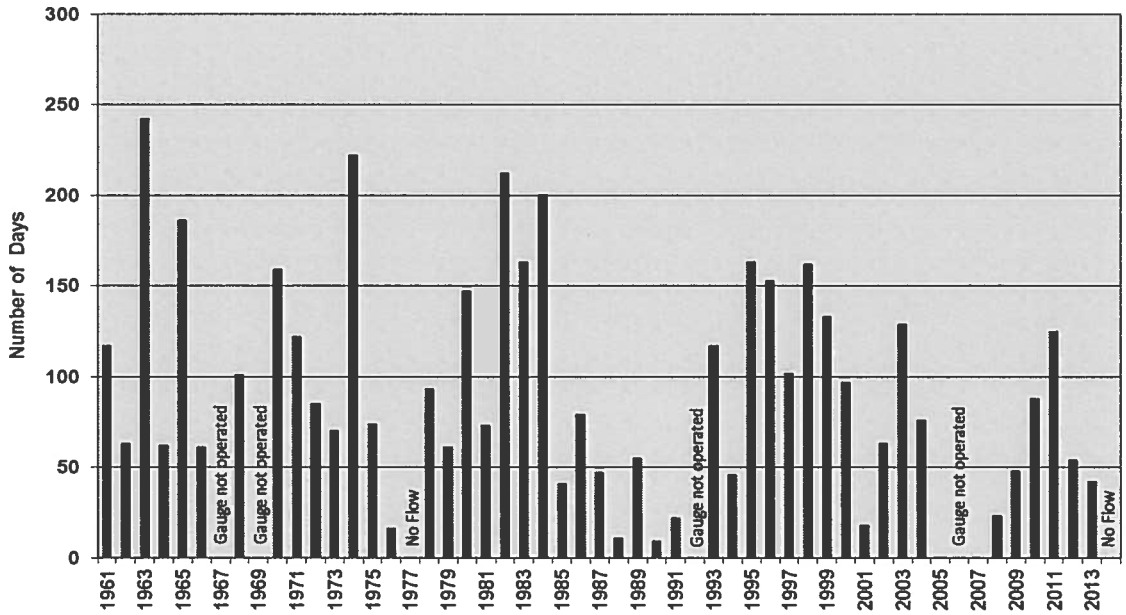

Figure 3*: Pine Creek Annual Duration of Flow (number of days with stream flow per water year); Average is 92 days per year for years with recorded flow and ranges between 9 to 242 days.

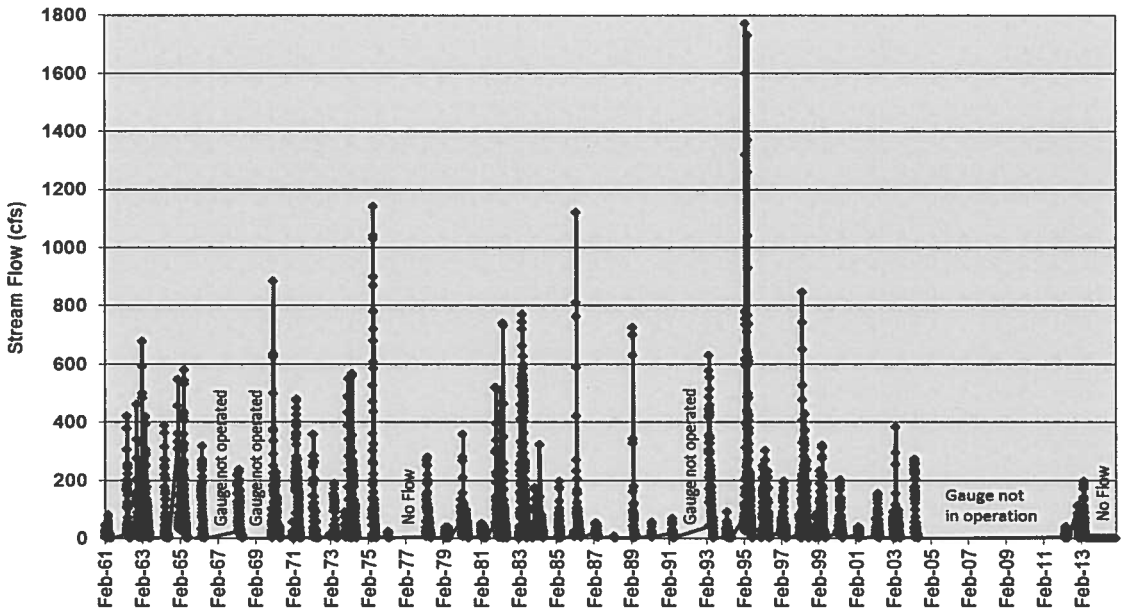

Figure 4*: Pine Creek Mean Daily Flow (average is 87 cfs for days with recorded flow and flow ranges between less than 1 to 1,770 cfs.)

*Figures 3 and 4 were created using stream gauge data located at the Pine Creek trap from Oct.1961-June 2004 and Oct. 2011 to Dec. 2014. Gauge was non-operational for years 1967, '69, '92, and abandoned from 2005-2011, gauge was reinstalled in Oct. 2011. No flow was present in 1977 and 2014. Duration of flow data from 2008 to 2011 was taken from notes taken during CDFW trap operation. Flows were present, prior to ELRT migrations, sometime between Oct. and Jan. in the years 1962, '64, '70, '73, '81, '83, '95, '98, 2003, and 2012.

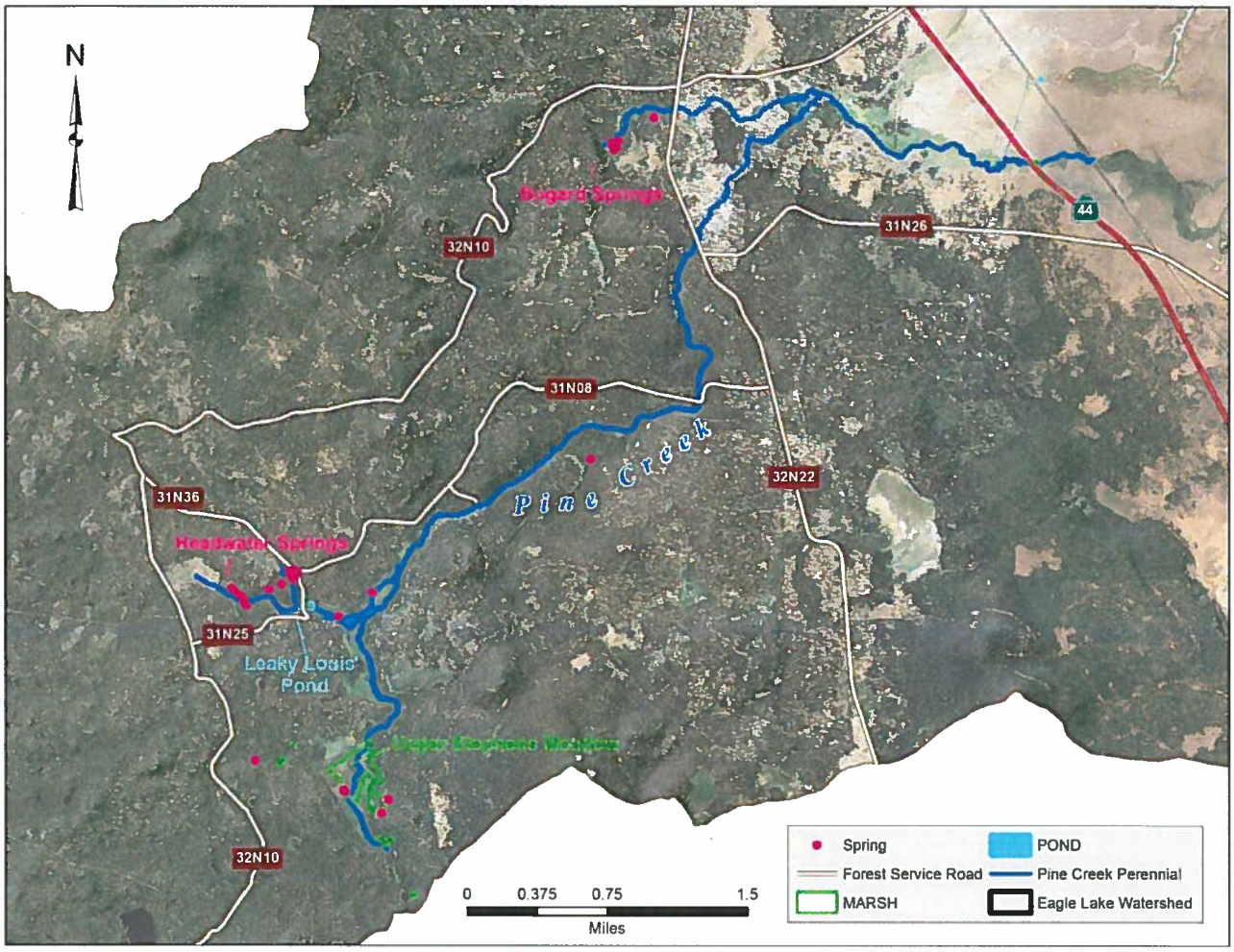

Figure 5: Upper Pine Creek Map (perennial reach)

Perennial flows are maintained during summer months by numerous springs (Figure 5). The upstream extent of Pine Creek during normal or below average water years ranges from 0.75 to 0.9 miles upstream of Leaky Louie's Pond. The lower extent ranges between 31N08 and 32N22 road crossings and State Highway 44 (Figure 5). Summer water temperatures in upper Pine Creek are typically cool, ranging from 40-50° F in areas with spring influence and 45-65° F further downstream. Flows can range from 0.3 to 4.9 cfs, with common base flows averaging between 1.5 to 2.5 cfs.

3.4 Taxonomy

Snyder (1917) described ELRT as a subspecies of rainbow trout, (*Salmo gairdneri aquilarum*). However, Hubbs and Miller (1948) examined Snyder's specimens and concluded that ELRT

were derived from hybridization between native Lahontan cutthroat trout (presumed to have occupied Eagle Lake prehistorically) and introduced rainbow trout. Miller (1950) later retracted the hybridization theory. Needham and Gard (1959) then suggested that ELRT were descended from introduced or immigrant rainbow trout from the Feather or Pit River drainages. Behnke (1965, 1972) proposed a redband-rainbow hybrid origin, although redband trout are now considered to be rainbow trout subspecies. Busack et al. (1980), in an extensive electrophoretic, karyotypic, and meristic analysis, suggested that ELRT were derived either from immigration or an unrecorded introduction of a rainbow trout with 58 chromosomes. The distinctive morphology, ecology, and physiology of this form all point to ELRT being derived from natural colonization from the Sacramento River drainage. Behnke and Tomelleri (2002) speculated that Lahontan cutthroat trout were the original inhabitants of Eagle Lake but disappeared during the Pleistocene era, due to an extended period of drought. During a subsequent wetter climatic period, rainbow trout presumably invaded through an unspecified headwater connection. Recent genetic studies (ALFP DNA techniques) suggest that the closest relatives of ELRT are rainbow trout from the headwaters of the Feather River (M. Stephens 2007, Simmons 2011). Given the relatively recent volcanism and resulting uplift and mountain building in the vicinity of Lassen National Park (near the headwaters of the Feather River), it is plausible that historic wetted connectivity existed between the Feather River and Pine Creek (R. Bloom, CDFW, pers. comm. 2012).

3.5 Subspecies Description

This subspecies is similar to other rainbow trout in gross morphology, but differs slightly in meristic counts (Moyle 2002). As described by J. O. Snyder in 1917, ELRT are distinguished by a deep body, thick caudal peduncle, large fins, and rich color, with spotting and coloration being highly variable. Spotting patterns can be dense and cover most of the fish or may be light and only found dorsally and on the caudal peduncle and caudal fin. The size of spots is also highly variable and spots tend to be irregularly shaped. Coloration varies from bright (silver and iridescent blue) to dark (brassy olive and/or coppery red) and intensifies during spawning. Fins are long and robust, most notably the large, thick adipose fin and the broad caudal fin with its straight posterior edge (Snyder 1940). Adult ELRT have been documented in the past to reach sizes equaling or surpassing 9 pounds and reaching 30 inches total length. In general, larger adults currently reach a maximum size of 5 pounds and measure 24 inches in fork length, with an average of 17 inches and 2 pounds (CDFW unpublished data). This subspecies is a particularly long-lived trout, with the oldest ELRT documented at 11 years of age (McAfee 1966). More commonly, ELRT have been estimated to live to 5 years, with older fish reaching 8 to 9 years of age. This longevity is thought to be a result of the intermittent nature of Pine Creek's connectivity to Eagle Lake and an adaptation that allow adults to hold in the lake for extended drought periods, when no stream spawning habitat is available. After decades of artificial spawning and hatchery rearing, the age structure of the ELRT population in the lake has significantly changed, due to annual stocking of hatchery-reared ELRT yearlings.

3.6 Life History and Ecology

Historically, ELRT likely exhibited two life histories: stream-resident and lake-dwelling. The lake form lives much of its life in Eagle Lake, only ascending tributaries during spring runoff to spawn. Spawning run timing ranges from late February to early May, when Pine Creek connects to Eagle Lake.

In the past, ELRT would migrate up Pine Creek as conditions allowed. Spawning migrations are triggered as soon as tributary flows reach Eagle Lake. Large numbers of adults begin to migrate as stream temperature nears 40° F and sharply taper off once temperature exceed 50° F. Rising stream temperature in Pine Creek also attracts spawning migrations of adult Tahoe suckers and Lahontan redsides from Eagle Lake. These migrations are typically larger during high water years, when Pine Creek has extended flow duration and maintains temperatures above 50° F.

Successful spawning of ELRT is heavily dependent upon timing, sufficient amount, and duration of flow, as well as suitable temperatures in the lower sections of Pine Creek (Pustejovsky 2007). Eagle Lake rainbow trout historically migrated to the upper portions of the Pine Creek watershed (Figure 5) to spawn, while juveniles are thought to have reared in Pine Creek for one to two years before migrating downstream to Eagle Lake to grow to adult size (Moyle 2002). It is possible that some ELRT juveniles remained in Pine Creek and became fully stream-resident, although data are lacking to support this assumption. In recent years, the lower intermittent portion of Pine Creek has apparently provided suitable spawning habitat, as juvenile ELRT have been observed returning to Eagle Lake. However, given the lack of perennial flows even prior to human disturbances to the watershed, it is likely that lower Pine Creek has never provided much rearing habitat. The best opportunity for ELRT to spawn successfully is during wet years, with prolonged higher flows, when conditions would allow for migration into the perennial headwaters. It is noteworthy that, in the past, during dry years with insufficient flow, upper Pine Creek's resident population may have been crucial to the survival of the species, since the lake form would have been prevented from spawning, potentially for multiple year periods. This suggests that reestablishment of a stream-resident portion of the population is an important step toward recovery and long-term persistence of ELRT.

The surface of Eagle Lake usually begins to freeze by late November and, in some years, can be completely frozen by early January. After the spring thaw, ELRT are distributed throughout the lake. As summer progresses, warming water makes habitat less suitable in the northern basins, particularly during low water years, driving trout to the deeper, cooler waters in the southern basin. During periods of high water levels, the northern basins maintain cooler water temperatures and have provided excellent habitat and forage conditions. The south basin typically stratifies in mid-July through August, providing cool water refuge 25 to 35 feet from the surface. Typically, by late September, surface temperatures cool and the south basin "turns-over." As the lake continues to cool, ELRT move into shallower water and feed aggressively on invertebrates and large schools of Eagle Lake tui chub, other native minnows, and invertebrates.

Eagle Lake rainbow trout are particularly adapted to harsh, alkaline water chemistry and thrive in the lake. Other trout species (with the exception of Lahontan cutthroat) generally cannot tolerate pH levels higher than about 8.4, as a result of the severe inhibition of branchial ammonia excretion (Wright, 1992). This ability to survive harsh alkaline conditions gives ELRT the ability to grow exceptionally well in less alkaline conditions found in most other freshwaters in California (Dean and Chappell 2005). Eagle Lake rainbow trout are typically stocked back into Eagle Lake as yearlings at about 8 ounces. Fish stocked in the spring are usually smaller, averaging about 10 inches, while fall stocked fish are larger, averaging about 13 inches (Dean and Chappell 2005). Once in the lake, ELRT typically grow three inches per year. By the end of the third year, length growth slows and average weight increases. The average size from creeled fish surveys varies from about 16 to 18.5 inches (Dean and Chappell 2005).

Eagle Lake is apparently the only large lake in California where the historic fish assemblage is still intact (Moyle 2002), likely a result of its high alkalinity. Numerous aquatic invertebrate species can also be found in the lake, including: mayflies (Ephemeroptera), caddis flies (Trichoptera), stoneflies (Plecoptera), black flies (Simulidae), shoreflies and gnats (Diptera and others), leeches, three species of gastropods, various zooplankton (Daphnia and Leptodora) and scuds (Hyalella) (Moyle 2002).

4.0 Lassen National Forest Land and Resource Management Plan

The Land and Resources Management Plan or Forest Plan is the principal document that guides the decision making of Forest Service managers. Forest Plans provide long–range management direction. The current Forest Plan for the LNF is the Lassen National Forest Land and Resource Management Plan (LNF LRMP), which was adopted in 1993 (USDA 1993), but includes more recent amendments.

The Lassen National Forest Land and Resource Management Plan (hereafter referred to as the Forest Plan) provides direction for planning and conducting resource management activities on National Forest System (NFS) lands within the administrative boundary of the Lassen National Forest (LNF). The Forest Plan directs management of the public lands of the LNF. It does not apply to any state, private or other federal land within the forest administrative boundary. The purpose of the Forest Plan is to guide the integrated protection and use of the forest's resources, meet requirements of legislation, and address local, regional and national issues.

NFS lands have direction for specific management and protection of aquatic and riparian-dependent species. The management direction for riparian areas is covered under what is referred to as an aquatic management strategy. The following provides an overview of key elements or concepts of the aquatic management strategy of the Forest Plan, as amended by the Sierra Nevada Forest Plan Amendment (SNFPA 2004) (USDA 2004), and is applicable to all stream/riparian areas on NFS lands.

The fundamental principle of the strategy is to retain, restore, and protect the processes and landforms that provide habitat for aquatic and riparian-dependent organisms, and produce and deliver high-quality waters for which the national forests were established. Strategy goals relate to water quality; species viability; plant and animal community diversity; species habitat; watershed connectivity; floodplains and water tables; watershed condition; streamflow patterns and sediment regimes; and streambanks and shorelines. These goals support the Forest Service's mission to provide habitat for riparian and aquatic dependent species. It is anticipated that similar strategies will persist within the new Forest Plan and/or revisions.

In areas of NFS lands that are available for multiple use management (e.g., non-wilderness areas), riparian and aquatic ecosystems receive special consideration through the designation of Riparian Conservation Areas (RCAs). Riparian Conservation Areas are land allocations designated along all water bodies and fluvial systems to ensure riparian-dependent resources receive primary emphasis and serve to help maintain the integrity of aquatic ecosystems. Designation of RCAs, and implementation of specific standards and guidelines that limit or regulate activities within them, are intended to directly and indirectly protect and restore aquatic

and riparian communities through the development and maintenance of healthy, functioning riparian areas.

4.1 Land Management Planning

The National Forest Management Act (NFMA) is the primary statute governing the administration of national forests. The National Forest System land management planning rule (planning rule) interprets the NFMA and guides the amendment and revision of all land management plans.

In 2012 the USDA adopted a new planning rule. The new planning rule guides the development, amendment, and revision of land management plans for all units of the NFS. This planning rule sets forth process and content requirements to guide the development, amendment, and revision of land management plans to maintain and restore NFS land and water ecosystems while providing for ecosystem services and multiple uses. The planning rule is designed to ensure that plans provide for the sustainability of ecosystems and resources; meet the need for forest restoration and conservation, watershed protection, and species diversity and conservation; and assist the Forest Service in providing a sustainable flow of benefits, services, and uses of NFS lands that provide jobs and contribute to the economic and social sustainability of communities (USDA 2012).

As of 2014 three Sierra Nevada National Forests (Inyo, Sequoia and Sierra) are revising their Forest Plans using the 2012 Planning Rule. The LNF Forest Plan is planned for revision within the next 3 to 5 years. Once LNF enters into a plan revision phase, proper management of land uses and aquatic resources within the Eagle Lake basin will continue to be of upmost importance. At this time it is difficult to project how such revisions will alter current management strategies. However; as this conservation strategy is intended to be adaptive to the conservation needs of ELRT, LNF will incorporate, within their ability, the management direction (goals and objectives) and restoration activities of this conservation strategy into future revisions of the Forest Plan.

4.2 Existing Land Uses

The majority of the land in the Pine Creek watershed (86%) is managed by the LNF, with the remaining 14% under private ownership (Platts and Jensen 1991). The landscape consists primarily of forests, rangelands, riparian, and meadows. Accordingly, the main land uses are grazing, vegetation management, timber production, and dispersed recreation.

Grazing

With the formation of the USFS in 1912 and adoption of the Taylor Grazing Act of 1934, much of the grazing lands in the basin came under the control of federal agencies. The south and west sides of Eagle Lake, including the Pine Creek watershed, are managed predominantly by the USFS, while the north and east sides are mostly managed by the Bureau of Land Management. The majority of privately owned ranch lands occur on the north shore of Eagle Lake and in Champs Flat and Stephens Meadow on Pine Creek. Privately held timberlands are commonly leased for grazing, although they are often administered by the LNF under federal grazing permits.

There are seven active grazing allotments in the Pine Creek watershed. Most of the ongoing grazing management strategies in place today were developed with input from the CRMP in the 1990's and were largely based upon recommendations from Platts and Jenson (1991). Typical livestock operations turn-out cow/calf pairs, with a small component of dry cows (those without calves) and heifers as part of most herds. Grazing starts with early summer turn-out (generally after June 1), with the grazing season lasting through September.

Approximately 35% of the Pine Creek mainstem is currently protected from grazing by exclusionary fencing or by management, including most of the perennial stream reaches managed by the LNF. Excluded reaches in the valley bottoms had heavy historical grazing use (e.g. Champs Flat, Little Harvey Valley, and Logan Springs). Of the remaining stream reaches, several are in confined rocky channel types not susceptible to livestock impacts. In areas where livestock do have access to the stream channel, management strategies range from rotational short duration use to occasional fall gathering, in order to reduce impacts from prolonged livestock use. None of the grazing units are scheduled for season long (summer long), and the standard for annual use on grazed reaches is not to exceed 40 percent of the current year's herbaceous growth. Annual grazing use and photo trend data are collected by USFS resource specialists at the end of each summer. A more detailed summary of grazing management by stream reach and allotment can be found in Pustejovsky (2007).

Vegetation Management

The primary vegetation management activity on USFS lands in the watershed consists of forest restoration via thinning of small trees to reduce amount of fuels, reduce drought impacts, improve understory vegetation, and release hardwood species if present, creating a more fire, disease, and drought resilient landscape. More recently, these projects have incorporated meadow restoration to setback the encroachment of lodgepole and ponderosa pine into meadow complexes. Some upland timber harvest and sales still continue presently within the watershed; however, most large timber sales occurred in the 1930's and 1940's. Remaining private lands are typically managed for sustainable timber production and harvest; however, some meadow and aspen restoration work has been completed and is being planned on these lands as well. Timber harvest in upland areas tends to have little impact on streams within the watershed. Surface runoff from upland areas does not usually reach Pine Creek or its tributaries due to upland soils having rapid infiltration rates and the wide, buffering infiltration plains offered by the broad valley bottoms (Young 1989). The largest impacts on the landscape from past timber operations have been from the construction of roads and railroads.

Conifer thinning to release and promote restoration of aspen stands has been an on-going vegetation management practice, including project areas along upper Pine Creek and Bogard Springs Creek. An intensive "before and after project" stream monitoring effort, conducted on Pine Creek and Bogard Springs Creek by Dr. Ken Tate (UC Davis), has shown little to no change in water quality attributes (Tate 2012). "In principle, vegetation can be managed to meet water-resource goals, particularly in forests where trees create dense canopies. As net primary productivity (i.e., plant growth) increases, evapotranspiration (the primary cause of water loss) also increases. Any manipulation that reduces the productivity (e.g., removes trees, shrubs or grasses) reduces evapotranspiration and thus may increase water availability." (Bales et al. 2011)

At the stream scale, impacts of vegetation management projects to ELRT habitat are primarily indirect and beneficial in the long-term. Tate (2012) found that conifer removal activities had no effect on stream chemistry or aquatic macroinvertebrates, had a significant increase in soil moisture, and did not influence stream temperature. Tate's results indicate that conifer removal using timber harvesting/thinning to restore aspen stands can be conducted without degradation of riparian ecosystems and stream conditions. At the watershed scale, benefits are accrued by reducing likelihood of catastrophic wildfires and potentially improving overall hydrology within the watershed. Increases in water yield have been demonstrated in several paired-watershed studies comparing treated (thinned) stands with untreated stands (Bales et al. 2011). Reducing tree densities tend to lower the amount of water loss through reducing evapotranspiration losses and sublimation of snow (the interception of snow by the tree canopy), thereby increasing the amount of available water for groundwater recharge and runoff.

Recreation

Recreational activities in the Eagle Lake Basin are varied and include angling, boating, camping, hiking, hunting, off-highway vehicle use, and winter sports such as snowmobiling and cross-county skiing. Eagle Lake itself is primarily used for angling, boating, swimming, and similar water activities. There are five developed campgrounds at Eagle Lake and one along the perennial reaches of Pine Creek, which are all popular in the summer and fall months. Recreational impacts to ELRT are minimal or nonexistent since activities are dispersed and primarily limited to roadways, campgrounds, trails, and watersports on the lake.

Road Management

The road network in the Pine Creek watershed is comprised of state highways, the Burlington Northern Railroad, county roads, NFS roads and a limited number of private roads. All of these entities have worked with the CRMP to address road management issues in the watershed, most typically related to culvert replacement to below-grade, fish friendly designs. Only a few new permanent roads have been constructed in the watershed in recent decades and construction of new permanent roads is likely to be minimal due to the existing network of roads. Road decommissioning has been and continues to be utilized to reduce potential impacts to Pine Creek. Larger USFS projects (e.g., timber management and restoration projects) now include a transportation analysis plan that includes criteria to consider hydrological and biological risks and recommended potential alterations to the road system and mitigation measures to minimize impacts to natural resources.

Concern has been raised about water catchments along borrow ditches of certain roads in the Pine Creek watershed. The net effect to natural runoff due to road systems and borrow ditches has not been well quantified. While water may be trapped and impounded along some roads, other road systems may act more as a conveyance system, increasing peak runoff. The impact to ELRT from roads is thought to be indirect and related to overall watershed hydrology. Direct impacts, particularly those relating to fish passage for ELRT, have been largely addressed throughout the watershed (see Section 6.0 - Past Conservation Actions).

5.0 Threats and On-Going Conservation Actions

Threats to ELRT within its historical range can be grouped into three categories: 1) lack of natural production (which has several contributing factors); 2) habitat degradation; and 3) climate change. Of these three primary threats, the greatest risk is from the effects of lack of natural production. Climate change may be a future risk to ELRT; however, varying results from multiple prediction models and studies bring uncertainty to the level of risk climate change will have on ELRT. To better describe the current status of these threats and their contributing factors, this section includes discussions of recent conservation actions (also discussed Section 7.0) that have been implemented to assess and/or reduce the impacts of these threats.

5.1 Lack of Natural Production

The primary threat to ELRT is lack of natural production, which encompasses several contributing factors that negatively affect ELRT including: life history, interspecific interactions, habitat, and population and adaptive genetics. In order to reestablish a natural spawning component to the ELRT population, access to spawning and rearing habitat must be provided and maintained, competition from and predation by brook trout within the spawning and rearing habitat must be eliminated, and the genetic diversity and adaptive potential of lake and stream populations must be maintained. The following contributing factors are discussed and listed in order of priority.

5.1.1 Passage Barriers

The principal barriers to upstream movement of ELRT are the Trap and the intermittent nature of flows in the lower reaches of Pine Creek. However, with the installation of a fishway in 2012 and successful testing of passage in 2013, the Trap is now no longer a barrier and can be utilized to actively facilitate passage. Three remaining artificial fish passage barriers exist; two in the upper watershed and a third located between Pine Creek Valley and Champs Flat. The two upper watershed barriers are the abandoned U.S. Geological Survey (USGS) gauging weir and the fish ladder at Leaky Louie's Pond. The lower most barrier is a cement ford at the 33N33 road crossing near Little Harvey Mountain. The 33N33 cement ford has been determined to be a depth barrier to passage of adult fish below flows of approximately 10.5 cfs. The USGS gauging weir is located near the Bogard Campground (near Hwy. 44) and is constructed of concrete that is slowly eroding. Passage under higher flows may be possible along the right bank, in the eroded area, but the weir is generally considered an impediment. The fish ladder at the 31N25 Forest Road crossing below Leaky Louie's Pond (Shown on Figure 5) is the upper most barrier. The ladder is a concrete plunge and pool design, created to allow passage through the road crossing culvert, but the stream has eroded underneath the concrete structure. During low flow periods, pools are not maintained and the concrete structure is mostly dry, with nearly all flow going subsurface. These barriers need to removed or modified to provide full passage to upper Pine Creek.

Due to the complexity of stream flows in Pine Creek and low lake levels, many natural barriers to migration may exist. The complex hydrology, geology, and seasonal nature of the intermittent section of lower Pine Creek makes ELRT spawning migrations inherently challenging, particularly if trends in climate change result in reduced snowpack (see Section 5.3). Currently, Pine Creek provides access to the perennial headwaters waters only in extreme high water years,

approximately once every 10 years). Additionally, water temperatures in Pine Creek may create thermal barriers that affect ELRT's spawning behavior at critical times during the migration period. A cold temperature barrier exists early in the runoff period as snow melts. As daytime temperatures increase, Pine Creek's water continues to warm prompting fish to migrate upstream, typically once 40° F is reached. Conversely, a warm temperature barrier is created as temperatures increase to 55° F and above, sharply reducing the number of ELRT entering the trap and triggering adults to return back to the lake.

Stream conditions in Pine Creek are most likely different than in pre-settlement times (the mid-1800's) due to changes in land use, stream morphology, and vegetation (see Section 5.2). Some channel reaches may be broader and shallower than in the past and, coupled with little vegetative structure to provide stream shading, stream temperatures may be abnormally high and serve as an impediment to passage. This issue warrants further study to determine temperature patterns in Pine Creek Valley, Champs Flat, and McCoy Flat during periods when ELRT juveniles and adults migrate. Other potential natural barriers include: beaver dams, large woody debris jams, and braided channels. Low lake levels during extended drought periods may also impede ELRT migration from the lake to Pine Creek to spawn. As lake levels continue to decrease, access to the mouth of Pine Creek becomes limited or non-existent. The bay where Pine Creek enters the lake is shallow without a defined stream channel that extends into the lake. As lake level recedes, ELRT may be unable to reach Pine Creek due to insufficient water depth unless flows from Pine Creek are substantial enough to scour a channel to the lake. "In the mid 1930's trout were unable to reach Pine Creek to spawn. The lake had dropped to such a low level that water barely covered the muddy bottom and the channel into the lake had silted in. The winter of 1937-38 produced heavy runoff with flooding and the channel into the lake was flushed out, allowing trout to once again spawn in the creek" (Purdy 2003). It is noteworthy that current (2014) lake levels are at all-time recorded historic lows, due to drought conditions in the recent past, indicating that this issue may continue to negatively affect ELRT spawning migrations without human intervention (e.g., trapping and trucking adults from the lake to the perennial headwaters and potentially the reverse for assisted juvenile outmigration to the lake).

From 1959 through 1994, ELRT were known to migrate over the weir during years of high flow when conditions allowed them to pass. The weir was reconstructed in 1995 prevent stream channel erosion and stranding of ELRT. The 1995 design effectively eliminated all upstream migration of ELRT. Since 1999, select groups of ELRT have been manually passed upstream of the trap to provide natural spawning opportunities and allow for monitoring of migration patterns.

In May, 2012 the water intake flume of the Trap was retrofitted with an orifice weir panel fishway. During the ELRT spawning migration in April, 2013 the fishway was tested using 40 adult ELRT, 20 of which were tagged with Passive Integrated Transponder (PIT) tags. Within two hours, all tagged ELRT passed through the fishway and, within six hours, the first tagged individual had migrated 1.75 miles upstream, reaching the lower PIT tag antennae array. Additionally, Tahoe sucker and Lahontan reside (noted for their limited swimming ability) were observed passing through the fishway, indicating water velocities are well within the range required by ELRT for successful passage. The use of the fishway will allow both egg collection for the artificial spawning program and release of adults upstream without bias from human selection of fish to manually pass upstream.

Eagle Lake rainbow trout were implanted with radio transmitters (1999-2005) and PIT tags (2006-2013) to document their ability to migrate through lower Pine Creek and, ultimately, reach the perennial headwaters of upper Pine Creek. Due to low numbers of adults available, migration run timing and associated logistical constraints, and challenging environmental and stream flow conditions, only limited numbers of adults have been used to-date (ca. 10 to 200 adults, both tagged and untagged, released at any given time) and monitoring efforts have been correspondingly limited. In 1999, one radio transmitter was recovered and, in 2011, one PIT tagged ELRT was recorded upstream of Highway 44, indicating ELRT are capable of passing through lower Pine Creek and reaching the perennial spawning and rearing habitat. It appears some ELRT are selecting suitable spawning sites in lower Pine Creek, based on observations of redds and migration timing of ELRT fry past the trap in 2010 and 2011. Along with intermittent release of fish upstream of the trap, adult spawners have been transported to the perennial portions of upper Pine Creek since 2000 in order to provide opportunity for ELRT to spawn and rear naturally. Eagle Lake rainbow trout were able to spawn and rear successfully (as observed during bank observational and electrofishing surveys) in Bogard Springs Creek, while the brook trout population was being controlled via annual removals using electrofishing equipment (Carmona 2011).

5.1.2 Presence of Non-Native Brook Trout

Non-native brook trout were introduced into Pine Creek from 1940 through 1949 (CDFW unpublished data) by hatchery stocking to presumably offer additional angling opportunities in the area. It is likely that brook trout further suppressed the already diminished ELRT population through competition and predation on early life stages, although this is largely speculation since no studies were performed at a time when introduction of non-native species was considered beneficial. Although planting of brook trout was discontinued over 60 years ago, the species still dominates upper Pine Creek. Juvenile brook trout out-compete juvenile ELRT for habitat and food because of their different spawn timing and ability to thrive in high densities. Brook trout begin to spawn in late September and early October and the first newly emerged fry are observed in May; ELRT spawn from March to May and fry are observed as early as June. In July, 2009, brook trout fry averaged 50 mm (FL), 10 mm longer than ELRT fry (Carmona et al. 2010). Carmona et al. (2010) documented some of the highest book trout densities in California, with localized brook trout densities in Bogard Springs Creek up to 30,000 fish/ha (12,140/acre) and averaging 16,000/ha (6,474/acre). Similar densities have also been recently observed in upper Pine Creek (CDFW 2013 unpublished data). Stocking of brook trout was discontinued in 1950 because of impacts to ELRT and, subsequently, ELRT were planted in Pine Creek. From 1952-1976, ELRT were planted as fingerlings and later planted as catchables (1/2 lb. each), starting in 2002. Recent stocking has varied, with an average of 600 ELRT (ranging from 325 to 1,440 yearlings) stocked from 2002-2006 and in 2010. Eagle Lake rainbow trout were stocked in Pine Creek with the intention, at least in part, that they would displace some of the brook trout (Dean and Chappell 2005); however, there is no evidence that this occurred. Eagle Lake rainbow trout have not been stocked in upper Pine Creek since 2010 and stocking will not continue until brook trout removal throughout Pine Creek has been completed.

In anticipation of treating Pine Creek with rotenone, a piscicide, to eliminate brook trout, CDFW used USFWS funds in 1997 to prepare a report on stream conditions. The report included information gathered from temperature monitoring, flow data, mapping of all water bodies, and

fish species identification of populations in headwater lakes (specifically Triangle Lake in the Caribou Wilderness) that are periodically connected to Pine Creek in very high water years (Miller 1998). Lake Davis, in nearby Plumas County, was treated with rotenone in 1997 to remove the predacious non-native northern pike, but the project caused considerable public controversy. Therefore, it was determined by CDFW that, given the political climate, eradicating brook trout with rotenone at that time would be unfeasible. Concerns were also raised about the uniqueness of the Pine Creek system and the possibility that rare or endemic species of invertebrates may occur in the creek and be inadvertently eliminated by the application of rotenone. Since that time, Lake Davis was again treated successfully with rotenone in 2007 and the project was well received and lacked controversy. Additionally, Silver King Creek (Alpine County) was recently treated with rotenone (2013, 2014) to remove hybridized fishes from the historic habitat of Paiute cutthroat trout. Both projects have improved the chances for future chemical treatments to restore native fishes in California.

From 2007 to 2009 a master's thesis project was conducted in Bogard Springs Creek by Gerard Carmona (UC Davis) to experimentally reduce the brook trout population, assess indirect effects of electrofishing removal upon brook trout life history traits and compensatory effects, and determine if ELRT would benefit from a brook trout removal program within the entire reach of Bogard Springs Creek (Carmona et al. 2010). This effort was continued after completion of the thesis project from 2010 to 2012, in cooperation with the Susanville Indian Rancheria, UC Davis, CDFW, and USFS fisheries specialists. From 2007 to 2012, brook trout were removed annually from this Pine Creek tributary using multiple pass electrofishing. Although the brook trout population was greatly reduced and the project proponents were able to maintain low numbers over several years, they were unable to completely eliminate the population. After three years of electrofishing, the brook trout population had been reduced to <1% of original numbers (Carmona et al. 2010), but removal of the few remaining fish is critical to project success and is often extremely difficult, if not impossible. Unless all brook trout are removed from the entire Pine Creek system, it is almost certain their population would rebound and dominate the ELRT population, as had occurred in the past and has been observed in other stream systems in California, where manual removal projects have failed. Experience with similar projects suggests that manual removal is a very time consuming and costly endeavor, with limited success. Ultimately, given the complexity of the Pine Creek drainage and presence of numerous springs and tributaries, eradication of brook trout will require piscicides (Carmona et al. 2011). Although the use of rotenone is not without some level of controversy related to water quality and non-target species impacts, it is worth noting that successive years of electrofishing has detrimental impacts to favorable fish species that remain in the stream. Repeated electrofishing can cause severe damage to fish, especially salmonids, including internal hemorrhaging, muscle bruising or electrical burns, ruptured vertebrae, or death.

After meeting in March, 2103, the Pine Creek CRMP fisheries technical review team, which includes representatives from USFWS, USFS, UC Davis, Lassen County, Honey Lake Valley Resource Conservation District, and CDFW, reached consensus that the use of piscicides is the most efficient and likely to succeed option for eliminating brook trout from Pine Creek. In January, 2014, CDFW resumed its planning effort in this direction and, in the summer of 2014, CDFW, in cooperation with Trout Unlimited (TU), began collecting baseline information to assess and determine the potential scope of this project. Expanding upon the 1997 effort, additional information was collected on stream flow, habitat, macroinvertebrate assemblage, and

brook trout presence in the upper Pine Creek watershed. As planning continues, additional baseline information will be collected and used in the environmental assessment for the use of rotenone in this project, including the California Environmental Quality Act and National Environmental Protection Act compliance processes.

5.1.3 Artificial Propagation

After more than 50 years of artificial propagation of ELRT, there is growing concern about the genetic integrity of the subspecies, particularly the loss of both genetic diversity and adaptive variation, and how artificial selection may be altering the ELRT genome. Part of this concern stems from the apparent low numbers of adults used in the late 1940's and 1950's for spawning and the stocking of "broodstock" into Eagle Lake, potentially creating a genetic bottleneck at the very beginning of hatchery operations. Nonetheless, the artificial spawning and rearing program has been quite successful and, since the 1960's, the numbers of adults spawned each year have been large enough to presumably maintain genetic diversity in the species. Additionally, ELRT were observed passing over the Pine Creek weir during large flow events until 1995, when the weir was modified, suggesting that successful natural spawning may have occurred and contributed to the gene pool. These two factors may have masked the effects of artificial selection, at least to some degree. However, this assumption has not been adequately quantified by genetic studies and is confounded by the apparent lack of pre-hatchery era museum or other reference specimens against which to compare modern genetics. From 1987 to 2010, the average number of adults spawned annually was 1,147 (using a ratio of two females to three males), with the average female producing 3,500 eggs.

Simmons (2011) found there to be no evidence of a genetic bottleneck from artificial propagation. The effective population size was estimated at 1,125 individuals, indicating that a large population was contributing to reproduction (Carmona et al. 2011). A slight level of inbreeding was detected, although it is comparable to levels found in other lake-stream systems in the region such as Goose Lake's population of redband trout (Simmons 2011). Goose Lake redband are also an adfluvial native rainbow trout subspecies, which has many of the same life history traits as ELRT. These findings are promising; however, Simmons' genetic analysis was only conducted within one brood year (2004), with 30 samples collected from juveniles at Darrah Springs Hatchery. More thorough analyses of the Eagle Lake ELRT population, with analysis of multiple age classes over a longer time frame, are needed to better evaluate ELRT's genetic integrity and the effects of the artificial spawning program's current practices (see below).

Although past spawning practices may have been deemed appropriate at the time and probably saved ELRT from extinction, some inherent biases and practices may have contributed to changes in the genetic structure of the population. A principal concern has been age selection, since ELRT typically mature at three years of age. Age selection has, in the past, been based on size (i.e. larger fish are typically older). Fish of exceptional size (≥21 inches) were selected specifically for spawning and their progeny used for restocking Eagle Lake. This practice has been misinterpreted by some as CDFW selecting larger adults, under the assumption that larger adults will produce offspring that grow to large size in Eagle Lake, to provide a more desirable fishery over time. As this is a misinterpretation of this practice, age selection (based on size and hatchery marks) should be maintained in current spawning practices to ensure earlier maturing

ELRT are not overly selected. Another concern relates to biased spawn timing selection. In the past, egg collection occurred as soon as fish reached the Trap. This practice may have inadvertently selected earlier spawning fish, since eggs were collected and fertilized as adults arrived in order to ensure the annual quota was reached before the spawning migration ended, rather than spacing out spawning throughout the duration of the run. While it is assumed genetic diversity has been maintained by large numbers of adults spawned and large egg quotas, certain historic spawning practices may have limited genetic diversity. The past spawning ratio was two females to three males, with eggs from two females combined into one container and fertilized with milt from three males, one male at a time. This practice was employed for two reasons: 1) to increase diversity under the assumption each male's milt would fertilize a portion of each female's eggs, and 2) to avoid wasting eggs in the event one or more males were sterile. Unfortunately, this method likely decreased genetic diversity because the first male's milt added to the container of eggs would fertilize nearly 100% of the eggs, thus reducing the number of male gametes contributing to the population.

To address these concerns and ensure maximum genetic diversity of the ELRT population, CDFW has modified spawning practices and is considering developing a genetic integrity management plan (as of 2014). The need for a genetic integrity management plan will be determined once a genetic evaluation of the artificial spawning program has been completed in 2018 (see below). Recent improvements to the spawning practices began in 2013, when spawning was performed over a longer time frame to avoid biased spawn timing selection. Based on historic flow information for Pine Creek, it was determined that the spawning process should occur over the course of five weeks in order to spawn adults throughout the entire spawning run. Additionally, to reduce bias of timing selection, the progeny from each spawning event are segregated at the hatchery, based on when they were collected, in order to proportionally restock the lake with fish whose parents were spawned throughout the run. In 2014, the spawning ratio, of three males spawned with two females, was changed to one male spawned with one female. Since the previous ratio was essentially one male to two females, the shift to a 1:1 ratio should increase genetic diversity substantially, while maintaining a high number of fertilized eggs collected. In addition, tissue samples are collected for genetic analysis from every adult spawned each year.

In October, 2014, CDFW submitted a proposal for USFWS, State Wildlife Grant (SWG) funding to evaluate current artificial spawning practices for ELRT using genetic analysis of spawning adults. Due to project timing and funding constraints, this proposal only includes analysis of adults from the 2016 and 2017 spawning seasons; however, samples have been collected in 2014 and will be continue to be collected in subsequent years for future analysis. The SWG proposal is intended to determine whether significant inter-annual genetic variance exists among brood years, acceptable levels of genetic diversity are being maintained, and low levels of inbreeding are occurring within the ELRT population. Collection of baseline genetic data from spawned adults over several years will allow for future genetic analyses, including evaluation of natural production if ELRT spawning runs are restored in Pine Creek. Other desired components of this assessment, if feasible, are determination of the level of genetic distinctiveness of any extant "resident" ELRT in Pine Creek, compared to the main Eagle Lake population, and evaluation of hatchery survivorship. Results from this project will be used to guide future development of a genetic integrity management plan, if deemed necessary, and findings will inform whether the

modified hatchery rearing program is functioning as desired in maintaining genetic integrity, or if additional changes are required to enhance the genetic integrity of future progeny.

5.2 Habitat Degradation

Eagle Lake rainbow trout evolved in two very distinct habitats: Pine Creek (freshwater stream, fed by snowmelt and springs) and Eagle Lake (large, terminal alkaline lake). While the focus of restoration actions over the past 30+ years has been in the Pine Creek watershed, habitat and forage conditions in Eagle Lake play a significant role in growth rates, mortality, and overall population dynamics of ELRT. Habitat within the Eagle Lake varies with changes in lake water levels (see Hydrology section); however, due to its large size and water conditions in the southern basin, the lake historically and presently provides adequate suitable habitat for ELRT. The spawning and rearing habitat in Pine Creek has played a key role in shaping the life history of ELRT and impacts to this habitat are a primary threat to the persistence of ELRT.

Most habitat degradation in Pine Creek can be attributed to legacy effects from human activities and land use in the watershed during the past 120 years. Legacy effects refer to impacts from land use and management that occurred historically and, while the actions that caused these impacts may have been mitigated in many instances, the long-term effects are still observed in the watershed today. Alterations to the watershed that led to habitat degradation include: 1) above grade road and railroad construction across valley floors and flood plains, particularly in the 1930's and 1940's; 2) extremely heavy livestock grazing use prior to and in the early years of the 20th century; and 3) years reduced grazing use in recent decades, but persistent season-long concentration of cattle grazing along streambanks and riparian zones through the 1980's.

The natural, undisturbed condition of Pine Creek prior to settlement (pre-1850's) is not well known. Multiple assessments of watershed hydrology and habitat conditions were conducted by: Young (1989), Platts and Jensen (1991), Jones and Stokes (1992), and the National Riparian Service Team (1999). Subsequently, much of this information was summarized by Pustejovsky (2007). The primary impacts to ELRT identified in the above assessments included: 1) restriction of spawning migration passage due to road culverts and stream channel alterations; 2) reduced and/or degraded aquatic habitat due to lack of streambank stability, incised and laterally eroding stream channels, and lack of riparian vegetation; 3) potential changes in runoff or flow patterns due to hydrologic alterations, particularly in the valley bottoms within the Pine Creek watershed. Many restoration actions have occurred in recent decades (see Section 6.0), so conditions in the Pine Creek drainage are now much improved. Ongoing and planned conservation actions should continue this favorable trend, both instream and across the watershed.

5.2.1 Grazing Impacts

Livestock grazing began in the watershed in the 1860's and, by the 1870's, there were several established ranches, primarily operating out of Tehama County, that used summer range in the Eagle Lake basin for sheep (Purdy 2003). By the early 1900's, cattle were the primary livestock grazed in the basin. A number of wide valley-bottom meadows adjacent to Pine Creek provided a substantial forage base, particularly in late summer and fall. Decades of heavy grazing use, which was largely unrestricted, reduced streambank vegetation and stability, inhibited water retention in meadows and slow-release infiltration into Pine Creek and its tributaries, and

impaired stream channel function. Although the overall numbers of livestock within the watershed were reduced substantially under USFS management in the 1900's, most grazing allotments continued operating under a season-long (summer-long) grazing strategy. This strategy resulted in a disproportionate level of use along the meadows' riparian zones, as cattle tended to congregate along streams for stock water and green forage. This practice continued for many decades until modifications were recommended by the CRMP in the early 1990's.

By 1992, the CRMP was well established and had gathered valuable information on the Pine Creek watershed from a variety of assessments. Platts and Jensen (1991) found that poorly managed livestock grazing resulted in adverse impacts to streamside vegetation and stream channels, thus accelerating runoff. Accelerated runoff produced enlarged and incised channels leading to increased stream discharge and velocities, ultimately increasing streambank erosion. The net effect of poorly managed grazing is an acceleration of drainage and reduction of flow duration, which is of primary concern in the Pine Creek watershed due to naturally arid conditions and intermittent stream flows. The CRMP focused on improving streambank stability and restoring native riparian vegetation, primarily by the USFS removing or significantly reducing livestock access and pressure in riparian zones. The Pine Creek Riparian and Fish Passage Improvement Project Environmental Assessment (EA) decision was completed by the USFS in 1995, which prescribed new grazing management strategies and a number of other range improvement projects to improve watershed conditions. Grazing strategies were modified in the EA to enhance stream/riparian habitat along 30 miles of stream. A total of 33% of Pine Creek is currently not grazed on USFS lands. Additionally, there is no longer any season long grazing within the Pine Creek watershed.

Livestock management has changed and adjusted continually in an effort to minimize livestock related impacts and improve riparian, meadow and stream conditions. Several of the riparian exclosures (Logan Spring reaches in Harvey Valley Allotment) identified in the Pine Creek EA were modified to eliminate corridors between adjacent fence lines that would concentrate livestock near unfenced portions of the creek. The Harvey Valley Allotment EA (2013) identified an additional unfenced section of Pine Creek that funnels livestock to the creek. This section will be fenced to eliminate livestock access. The Pine Creek reaches above Highway 44 receive occasional use when livestock trail through or drift into these areas, but livestock are not gathered and placed in the Bogard and McKenzie Cow Camp areas to graze. The Pine Creek EA identified these reaches for fall gathering or occasional use areas. A new gathering corral was constructed in 2010 to replace an old facility near the Pine Creek Valley wetlands that previously encouraged livestock to concentrate in the wet meadow and spring area on a prominent tributary to Pine Creek. Most recently, USFS specialists and the grazing allotment permittee agreed to construct a new boundary fence in 2015 on the Upper Pine Creek Allotment to remove the ongoing problem of livestock drift from the adjacent allotment, which has resulted in repeated grazing along reaches of Pine Creek and excessive levels of use. Livestock numbers are also adjusted based on forage availability and annual conditions (e.g. drought conditions).

Removal of attractant water sources near and on Pine Creek, and locations for alternative water sources away from the creek and meadows are being identified. Beginning in 2015, four in-channel stock ponds are planned for removal and two new ponds, outside the riparian zone, will be created. These improvements are intended to redirect livestock distribution to reduce grazing

pressure and reduce concentration of livestock near stream channels and within riparian corridors.

An EA for the Harvey Valley Allotment was completed in 2013 and included rest from grazing through 2015. Additionally, the EA for three of the allotments in Pine Creek Valley will be initiated in 2015, with an expected decision by the end of 2016.

In 2015, American Rivers (AR) and Trout Unlimited (TU) in coordination with other non-governmental organizations (NGOs) and the USFS will assess stream habitat and all of the meadows within Pine Creek. American Rivers will use Rapid Assessment methodology to document and assess channel entrenchment, stream bank stability, and floodplain functionality. Meadows assessments will include trend analysis and evaluations of current land management practices to develop and prioritize conceptual designs for restoring stream habitat and channel function within highly degraded meadow stream segments. Trout Unlimited will conduct habitat and ecosystem monitoring in support of future restoration planning. Through the use of the Aquatic Habitat Assessment methodology and resulting findings, TU will provide a baseline and template for future management actions, including establishing a framework by which future actions can be quantified post project in terms of change in available habitat, species distribution and abundance, and ecosystem conditions. Additionally, habitat and other data collected in 2015 will enable further evaluation and comparison of different restoration alternatives.

5.2.2 Stream Channel Alterations

Pine Creek's riparian corridor, channel morphology, and hydrologic function have all been highly altered by past land uses in the basin. Road and railroad construction (raised grades and borrow ditches), dug-out stock ponds and diversions, to name a few, have contributed to habitat degradation and impaired the natural hydrology. Although restoration projects and modified land management strategies have addressed many of these impacts, several sites remain that need to be assessed for restoration potential. CDFW is seeking funding, in partnership with the USGS, to acquire light detection and ranging (LiDAR) data coverage of the entire Pine Creek watershed by 2018. The LiDAR coverage will provide ground elevation mapping with extreme detail and accuracy, allowing resource specialists to identify habitat and hydrologic issues within the watershed, leading to the design of treatment alternatives on both the landscape and site-specific scale. LiDAR will become a key tool for identifying hydrologic features and aid immensely in designing restoration projects to reestablish the hydrologic function of the Pine Creek watershed.

Roads and railroads

The primary impact to the Pine Creek watershed from past logging activity came from construction of railroad grades in the 1930's and 1940's, which were used to transport logs out of the watershed. Platts and Jensen (1991) estimated that 52 miles of railroad grades exist within the Pine Creek watershed. While some of these have been converted into roads and are still in use, many have been abandoned. The remnants of these abandoned grades are still found from the vicinity of Highway 44 downstream to the McCoy Flat area.

The rail lines were generally built along the outer edges of valleys and flats to avoid watercourses or wet ground; however, some turnpikes for crossing streams or seasonally wet

meadows were installed. In order to prevent wicking and saturation of the rail line grades, raised grades were constructed using local soil, leaving behind borrow ditches that served to rapidly drain water away from the rail lines. While raised grades and stream ditching functioned as intended, preventing washout of the lines, they created higher water velocities in artificially constricted channels, significantly altering the natural flow patterns in valley bottoms. These alterations have created long-term hydrologic effects including: draining of valley bottoms due to increased run-off over a shorter duration of flow, reduced length of perennial reach, reduced aquifer recharge, lower water tables, increased channel erosion, and channel incision (Pustejovsky 2007, Young 1989).

Localized hydrologic impacts from these grades vary by location. In some instances, stream flows become concentrated through narrow openings in road grades, acquiring more energy and velocity, contributing to increased erosion, channel down-cutting and reduced aquifer recharge. In other cases, the grades may create damming effects, which theoretically, could improve aquifer recharge. At other sites, water remains ponded in borrow ditches once flows recede and are completely cut off from natural stream channels. Road and abandoned railroad grades also create rigidity in an alluvial floodplain system that would otherwise be inherently changing. In addition, constriction of flows into culverts, in many cases, created impediments to fish passage, particularly when such culverts were installed above grade. Impacts from livestock use and road building were cumulative in the watershed. Platts and Jensen (1991) summarize: "Livestock grazing and the drainage of the valley-bottoms during construction of the railroad grades caused deterioration of channels and conversion to drier vegetation types."

Beginning in 2015, the Eagle Lake Ranger District (ELRD), of the LNF will implement restoration actions at several sites on Pine Creek, in Pine Creek Valley (see Section 7, Objectives 2.1 and 2.2). These actions are focused on treating decommissioned and unauthorized roads, railroad grades, diversions, borrow ditches, and dug-out stock ponds to improve watershed function and improve degraded aquatic and riparian habitat. Along with this planned restoration work other sites in the watershed continue to be assessed and additional planning is occurring for future restoration sites.

Water diversion and Impoundments

Existing water diversions and impoundments may negatively affect ELRT by altering flow regimes, particularly during dry cycles. Reduced flow or shortened flow periods during spring runoff may impact adult spawning migration, hatching, and rearing of young in upper Pine Creek, as well as outmigration of ELRT to Eagle Lake. Water diversion during summer and early fall may further reduce already naturally low base flow of some perennial reaches, inhibiting successful rearing of ELRT. Water diversion (under existing water rights) occurs only at Bogard Springs, where a portion of the water originating from the spring is piped to a California Department of Transportation (CalTrans) rest area and LNF Bogard Work Center. Bogard Springs Creek has been documented to provide nearly two miles of suitable perennial habitat for ELRT. However, due to the very small size of this stream during summer base flow, there is concern that water diverted from the spring may reduce its capacity to support rearing of young ELRT, particularly in dry years.

In November, 2014, CalTrans in cooperation with the ELRD, LNF drilled a well to alleviate the need to divert water from Bogard. The well and existing infrastructure were evaluated and

retrofitted in November, 2014 and will be used as a water supply for the rest area and work center. Through use of this well, the water diversion from Bogard Springs is no longer necessary and the ELRD, LNF will allow water from their diversion to flow into Bogard Springs Creek. In 2015, it is anticipated that the pipe coming from the spring box will be capped; ensuring Bogard Springs Creek receives all the natural flows coming into the spring box. The redirection of this water to the stream will improve the quantity of stream flow and habitat conditions in this important tributary of upper Pine Creek.

Impoundments in the Pine Creek watershed were created primarily to enhance existing wetlands for waterfowl nesting and wildlife habitat improvement. Two main impoundment areas in Pine Creek Valley are about 30 and 100 acres in size, respectively. Stock ponds used to provide water for livestock are also scattered throughout the watershed and tend to range from 0.25 to 1 acre in size. Borrow ditches may intercept stream flow or collect surface runoff and hold water along road or railroad grades, altering natural drainage patterns and stream function. Water captured in the impoundments, stock ponds, and ditches is subsequently lost to evaporation when stream flows recede.

To date, the potential effects from existing water impoundments in the Pine Creek watershed have not been well documented. Improved understanding of the potential impacts of existing impoundments to stream flows and water quantity and quality in the Pine Creek watershed has been identified as a priority for the overall conservation of ELRT. Impoundments are currently (2015) under evaluation by USFS resource specialists for potential treatments to improve stream flow while maintaining valuable wetlands and associated wildlife habitat.

5.3 Climate Change

Climate change is likely to have two major impacts on the Eagle Lake watershed: decreased stream flows and changing lake conditions. Reduced snowpack in the mountains surrounding the Pine Creek watershed will presumably reduce the output of springs that feed Pine Creek. Differing climate models show little change in amount of annual precipitation. Regardless; warming temperatures will mostly change the form of precipitation to rainfall. This shift of annual precipitation from snow to rain is likely to be most prevalent in the northern Sierra Nevada, due to relatively lower mountain elevations. The magnitude of this effect, however, will depend on the timing and amount of rain and snowfall and how well meadows are managed to increase their ability to retain water and release it during summer months. Reduced inflow into the lake could potentially increase alkalinity to lethal levels for trout although, if average precipitation remains roughly the same, the lake should maintain itself. Unfortunately, the lake is now (2014) at record low levels, after several years of continued drought, so changing water chemistry is an increasing concern. Surface temperatures of the lake could potentially increase 3-5° F, but presumably, a cold water refuge for trout will continue to exist in the deepest basin of the lake. If climate change produces extended droughts that dry Pine Creek early or for longer periods of time, resulting in increased lake alkalinity and temperatures, ELRT could be driven to extinction in its native range, relegating it to a hatchery fish. Fires, coupled with predicted climate change outcomes, may become more frequent and catastrophic, especially in the dry headwaters of the basin and may interfere with ongoing and planned restoration efforts in the Pine Creek watershed.

With sometimes conflicting results from climate change models and studies, the effect(s) climate change will have on ELRT and its habitats remains uncertain. Across climate prediction models, there is consensus that weather and climatic events, such as storms, will be highly variable for north-eastern California. Several models show air temperatures will gradually increase, summers will become drier, runoff will be earlier, and annual precipitation totals may change, tending toward less snowfall and more rain. These trends are likely to affect ELRT spawning timing and their ability to migrate to upper Pine Creek, but runoff timing and stream flow duration have always been a limiting environmental factor in successful spawning migrations of ELRT.

Merriam et al. (2012) used PRISM climate and Western Regional Climate Center (WRCC) datasets to develop current and future climate trends for the Sierra Cascade Province. Western Regional Climate Center data show that, over the last century, the Northeastern California Climate Region's mean annual temperature has increased 1.7° F; however, the Susanville weather station has shown a significant increase in the number of months below freezing. The Northeast region's annual precipitation has increased almost 3 inches over the last 80 years; however, to the contrary, the Susanville weather station has shown a decrease of nearly 9 inches per year since 1893, with high amounts of inter-annual variation in precipitation and trends toward increasing variation. It is generally assumed that climate trends will likely affect northeastern California's hydrology with decreased stream flow and earlier runoff from snow melt. However, the Pit and Feather River regions (to the north and south of Eagle Lake, respectively) share similar volcanic geology with the Eagle Lake basin, are heavily supported by spring inflow, yet runoff timing has remained unchanged for the last century despite decreases in snow pack (Davisson and Rose 1997). In northern California, by the end of the century, the projected precipitation amounts range from slight increases to decreases by 10-20%. Although little change in northern California precipitation is projected during the twenty-first century, there is a modest tendency for increases in the numbers and magnitudes of large precipitation events (Cayan et al. 2008).

A Watershed Vulnerability Assessment will be conducted by the USFS in 2016 to identify water resource-related values (both physical and biological) within the Pine Creek watershed, and their exposure and sensitivity to climatic changes, based on climate and hydrologic projections for this region. The goal of this assessment is to identify values that are sensitive and related management actions within the watershed that would promote resiliency to climate change.

6.0 Conservations Actions To Date

Table 1 provides an overview of major conservation actions completed since approximately 1989, via the Pine Creek CRMP collaborative effort. Most recent conservation actions and plans for future work are discussed in Sections 5.0 and 7.0. Also for more details, see Pustejovsky (2007).

TABLE 1: Conservations Actions To Date

Objective(s)	Action Description	Completion/ Implementation Year	Comments
Identify and removal of existing potential barriers to migration.	Contract with Jones and Stokes. Conducted analysis of four culverts in upper watershed and provided recommendations	1992	• Report titled: "Hydraulic, hydrologic and fish passage analysis for the upper Pine Creek restoration plan" • All four sites addressed by study (County Rd 105 crossings (2), Hwy 44, 32N22) were improved/modified for passage (reference actions below)
	Construction of fish ladder @ NFS road 31N25 on mainstem of Pine Creek (Leaky Louie's Pond).	1994	• CDFW determined > ¼ mile of habitat was available above pond, therefore fish passage was required
	Enlarged single culvert in existing array of culverts. County Road 105 (upper crossing and @ Camp 10)	1994	• Per CDFW, single culvert oversized by 25% and buried below grade for natural bottom and to ensure passage during all flows (including low).
	Replaced culverts with natural bottom concrete structure @ NFS road 32N22 (Westwood Logging Rd)	1998	• Unimpeded fish passage was created
	Replaced culverts with box culverts @ Hwy 44.	1999	• Implemented in conjunction with channel realignment. • Sized for 100 year flood event.
	Replaced culverts with box culverts under RR downstream of Hwy 44.	1999	• Implemented in conjunction with channel realignment. • Sized for 100 year flood event.

Objective(s)	Action Description	Completion/ Implementation Year	Comments
Identify and removal of existing potential barriers to migration. (continued)	Obliterated road/stream crossing @ NFS road 31N08.	1998	• In the 1980's a fish 'ladder' was attached to the culvert but was highly ineffective. • Road/crossing obliterated; unimpeded aquatic passage provided.
	Retrofitted intake flume of the Pine Creek Trap with a orifice weir panel fishway, allow passage upstream of Trap	2012-2013	• Construction of fishway completed in May 2012 • Spring 2013 fishway was tested using PIT tagged adult ELRT and successfully passed all fish released
Provide natural spawning and rearing.	Limited numbers of spawning ELRT have been passed above the Pine Creek Trap as part of migration tracking studies	1999-present	• In 1999 and 2011 documented one adult reaching upper Pine Creek. • In 2010 and 2011 juvenile ELRT observed at the Pine Creek trap migrating downstream toward Eagle Lake
	CDFW completed the Eagle Lake Fishery Management Plan. Dean and Chappell, 2005	2005	• Identified natural production as a management goal.
	Transplanted ELRT spawners into Bogard and Pine Creek	2008-2012	• Observed successful ELRT spawning and rearing in Bogard Springs Creek in 2009 and 2010
Control/removal of brook trout.	CDFW discussed rotenone treatment for Pine Creek received funding for assessment work and completed assessments	1994-1998	• Mapping completed (see below); invertebrate study, not completed. • Amphibian inventories completed (USFS). • CDFW Region 1 Pine Creek Watershed Reconnaissance Survey (draft report) completed.
	Brook trout removal/control.	2007-2012	• Utilized electrofishing for removal of brook trout in Bogard Springs Creek and completed habitat analysis.

Objective(s)	Action Description	Completion/ Implementation Year	Comments
Control/removal of brook trout (continued)	CDFW reassessing Pine Creek for brook trout removal and planning to produce EIR/EIS for potential treatment types	2013-present	• 2014 Began conducting stream mapping, flow assessments, and invertebrate inventories. • EIR/EIS planned completion in 2018
Assess and reduce impacts to Pine Creek's stream habitat and channel from roads, railroads, diversions and grazing.	Contract with Platts and Jensen for assessment of existing stream channels. Conditions and recommendations for improving stream/riparian habitat	1991	• Report titled: "Pine Creek assessment, Eagle Lake watershed."
	Contract with Jones and Stokes. Evaluated "super ditch" and north/south channel flows. Provided recommendations	1992	• Report titled: "Hydraulic, hydrologic and fish passage analysis for the upper Pine Creek restoration plan".
	Completed Environmental Assessment for the Pine Creek Riparian and Fish Passage Improvement Project	1995	• FS Decision Notice signed 1995. • NEPA document prepared to address various recommendations, including many key recommendations by Platts and Jensen. • Scope of actions, including changes in grazing management, focused primarily on the mainstem of Pine Creek.
	Removed "splitter" diversion structure	1993	• Action to restore natural flow paths.
	Rock structures (3) @ Bradford's crossing	1995	• Raised water table to rehydrate meadow and build streambanks/improve riparian vegetation. • Low-rise rock structures designed to allow for fish passage.
	Constructed Bogard well	1995	• Action to minimize direct use of Pine Creek water for dust abatement and livestock grazing.

Objective(s)	Action Description	Completion/ Implementation Year	Comments
Assess and reduce impacts to Pine Creek's stream habitat and channel from roads, railroads, diversions and grazing. (continued)	Removed/relocated approx. 5 campground sites @ Bogard Campground to outside active floodplain/channel	1997	• Portion of campground still resides in floodplain. • Removed one campground outhouse that annually flooded with high stream flows during spring in 2011.
	Eliminated Bogard Barn/McKenzie Cow camp ditch	1997	• Ditch diverted water to outside the flow path. Action reconnected flow with natural channel(s).
	Channel realignment in vicinity of Hwy 44	1999	• Subsequent to J&S *recommendation to not reroute flows* into south channel, K. Cawley and M. Kossow completed a more site specific assessment of stream channel and valley bottom elevations. Assessment led to recommendation to route main flow into south channel
	Crossing/road obliterated to provide natural flow pattern	1999	• Harvey Valley at Camp Harvey
	Dammed up borrow ditches near HWY 44 @ railroad grades in upper Pine Creek Valley	1999-2001, 2005	• Action was to encourage fish to stay confined in main channel
	CalTrans and LNF drilled well to remove water diversion from Bogard Spring	2014	• Water previously diverted will be reallocated to the stream, thus improving stream habitat, water quality, and quantity
	Livestock Exclosures		
	Upper Pine Creek, Logan Springs, Lower Logan at Bradford	1994-1995	• 1.85 miles of perennial Pine Creek excluded • 1.55 miles of intermittent Pine Creek excluded
	East of BNSF Railroad line	2002	• Mitigation for HWY 44. 350 acre exclosure in valley bottom to protect vegetation in area of rerouted (south) channel

Objective(s)	Action Description	Completion/ Implementation Year	Comments
Assess and reduce impacts to Pine Creek's stream habitat and channel from roads, railroads, diversions and grazing. (continued)	**Livestock Management**		
	Silver Lake, Upper Pine Creek, Lower Pine Creek, Harvey Valley, Champs Flat, North Eagle Lake, and South Eagle Lake Allotments	1994,1995, 2006	• Grazing allotments revised to improve habitat conditions along 30.85 miles of Pine Creek: • 13.8 stream miles; excluded/no grazing by management • 3.6 stream miles; occasionally grazed • 6.95 stream miles; short duration grazing • 3.15 stream miles; rotational grazing • 3.35 stream miles fall gathering • N. Shore gazing limited to 2 weeks • S. Shore excluded/no grazing
	Vegetation treatment (conifer removal) along Pine Creek and Bogard Springs Creek to restore riparian vegetation (aspen)	2005-2008	• Long-term benefits to ELRT/habitat (e.g. improved composition of allochthonous material, potential for increased infiltration, groundwater retention, reduced flashy surface runoff and a sustained, slow groundwater release into streams).
	National Riparian Service Team site visit with progress report/feedback on CRMP goals and management strategies	1998	• Report titled "Trip report – National Riparian Service Team to the Pine Creek coordinated resource management planning group of September 22-25." • Completed "Proper Functioning Condition" assessments at various locations.
Monitoring and research pertinent to the conservation of ELRT.	Fish migration studies	1999-present	• Objectives were to evaluate the relative effectiveness of stream channel restoration efforts in providing for unimpeded fish passage and upstream migration.
	Analysis of ELRT population response in Bogard Springs Creek following implementation of brook trout control measures (electrofishing)	2007-2010	• Evaluated ELRT spawning distribution/recruitment in Bogard and/or Pine Creek via snorkeling, e-fishing and direct bank observation methods (see Carmona 2011)

Objective(s)	Action Description	Completion/ Implementation Year	Comments
Monitoring and research pertinent to the conservation of ELRT. (continued)	Stream attribute monitoring performed to evaluate effects of vegetation treatment along perennial stream reaches of Pine Creek and Bogard Springs Creek.	2003-2010	• Progress report titled "Long-term environmental effects of conifer removal to achieve aspen release in near-stream areas within the northern sierras" (Tate 2010)
Expand educational efforts to increase public awareness of ELRT.	Education display at Pine Creek Trap at mouth of Pine Creek	1998	
	Numerous local/regional presentations by USFS, UC Cooperative Extension (UCCE), CDFW.	1995-present	
	Educational Materials (e.g. presentation posters/abstracts)	2007-present	UCCE,UCD, HLVRCD/RAC

7.0 Conservation Goals, Objectives and Actions to Restore Eagle Lake Rainbow Trout

The desired conditions for ELRT in terms of genetic integrity, population dynamics, habitat quantity and quality, and restoration of a natural spawning component will have been met upon completion of the conservation actions outlined below. Because this strategy is based on adaptive management, actions may be removed, added, or adjusted annually as new information is gathered.

Conservation actions that will significantly contribute to the protection and restoration of ELRT have been identified and prioritized for each goal of this strategy. Table 2 provides an overview of the implementation of these actions, associated time lines, and agencies responsible for implementation.

Goal 1. Provide natural production for and maintain genetic integrity of ELRT - All Parties

A primary threat to ELRT is the lack of natural production and the potential genetic risks associated with artificial propagation (see Section 5.0). The following actions have been planned, developed and/or are currently being implemented to restore natural production and protect the genetic integrity of this subspecies. Multiple projects, assessments, and studies have been developed to complement and/or guide these efforts and are addressed in Goals 2 and 3 of this section.

Objective 1.1 Operate the Pine Creek Trap fish ladder to facilitate natural spawning migration - CDFW

Until recently, the greatest impediment to passage of spawning ELRT has been the Pine Creek Trap and weir. In 2012 and 2013, conservations actions were implemented to resolve passage issues (see Section 5.1.1) by constructing and testing a fishway within the Trap. Due to extreme drought conditions Pine Creek did not flow in 2014 at the Trap, otherwise passage of spawning ELRT would have commenced that spring. In order to provide access to spawning habitat, the Trap and fishway will be operated annually, beginning in 2015, in a manner that allows for unimpeded passage of migrating adults throughout the migration run, with the exception of days when the Trap will be operated to collect adults for artificial spawning or in the case of insufficient stream flow. A gate within the Trap can be raised and lowered, allowing fish to pass upstream or be held in the Trap prior to reaching the fishway. Lowering the gate will block adults for artificial spawning and tagging for migration studies. During artificial spawning, eggs are collected and fertilized on-site and spawned adults are separated for later return to Eagle Lake. Unspawned adults will be released into the fishway for upstream passage. In order to avoid spawn timing selection, adults will be collected for artificial spawning for a minimum of five weeks or as stream flow permits, with egg collection taking place two days per week. Providing ELRT passage through the Trap to their natal spawning grounds is a high priority conservation action. This ongoing process will restore ELRT to their historic range and reduce genetic impacts from reliance on artificial propagation through reincorporation of natural spawning to their life history.

Objective 1.2 Identify and remove any existing potential barriers to migration - USFS/CDFW

Three known artificial barriers to upstream ELRT migration in Pine Creek exist (see Subsection 5.1.1). These barriers are all likely partial barriers, restricting passage during low flow periods. Project designs need to be developed for these barriers prior to removal or modification. These barriers are currently a medium priority, since they are either located in the upper watershed or only a barrier under low flow conditions. Removal of these barriers will become a higher priority once brook trout removal in upper Pine Creek has been completed. Removal of the USGS weir will be completed by 2020 and modifications or removal of the fish ladder at Leaky Louie's Pond and the cement ford at the 33N33 road crossing will be completed by 2022.

Road crossings with culverts in the Pine Creek Valley were surveyed and modeled in Fish Xing to determine if the crossings allow passage under various stream flow conditions in 2011. The road crossings in Pine Creek Valley were all determined to provide adequate passage through the arrays. The railroad crossing was not assessed but is likely similar to the road crossings. With the documented passage of a PIT tagged ELRT adult in 2011, these crossing (including the 33N33 ford) are known to pass ELRT so have been assigned a medium to low priority. Additionally, beaver dams and log debris jams will be monitored and removed to provide upstream fish passage, as needed, on an annual basis by CDFW and/or LNF.

Objective 1.3 Remove brook trout from the Pine Creek watershed and reestablish stream population of ELRT - CDFW/USFS

In order to reestablish a stream population of ELRT in upper Pine Creek, the threat of competition and predation from non-native brook trout must be eliminated. CDFW is currently (2015) in the planning phase, collecting information that will assist in defining the scope of a removal project. Upon completion of data collection (anticipated in 2016), CDFW plans to complete a joint Environmental Impact Report/Environmental Impact Study (EIR/EIS) with the LNF. The EIR/EIS will address alternative removal treatment methods and a preferred treatment method will be proposed for use. Following a public comment period, a removal treatment method will be decided upon and implemented. CDFW plans to complete the EIR/EIS by January, 2018 and complete the brook trout removal by 2020; however, due to uncertainties that come with public involvement and the outcomes of that process, timing of implementation may be delayed. Brook trout removal is a high priority conservation action.

Following the removal of brook trout, effectiveness monitoring will be conducted by CDFW to determine if the removal project was successful, after which ELRT will be reintroduced into upper Pine Creek. Eagle Lake rainbow trout used to repopulate Pine Creek will likely include both spawning adults from Eagle Lake and juvenile fingerling ELRT reared in the hatcheries. Repopulating with both adults and juveniles will readily establish a population with a diverse age structure and increase the potential for rapid population expansion. Additionally, to provide adequate protection to the newly reestablished ELRT population, sport fishing regulations for upper Pine Creek will be proposed to be changed by 2018, either by closing Pine Creek to all fishing or establishing a zero possession bag limit for ELRT. Reestablishment of an ELRT stream population is a high priority conservation action. This process will restore ELRT to their historic range and reduce genetic impacts from reliance on artificial propagation through reincorporation of natural spawning to their life history. Monitoring will occur annually to

determine project outcome(s) and adaptive management will be applied to address the potential need for multiple years of population "seeding" and/or facilitated movement (trap and truck) of adults and juveniles to reestablish population connectivity between the lake and Pine Creek.

Objective 1.4 Implement artificial spawning practices to provide highest level of genetic diversity possible - CDFW

Artificial propagation, rearing and stocking of ELRT will continue into the future in order to ensure persistence of the subspecies and to maintain a healthy population in Eagle Lake and the popular fishery it supports, with the highest level of genetic diversity possible. To avoid genetic drift, inbreeding depression, or other possible consequences of long-term artificial selection, spawning practices will be adapted, based on the results of ELRT genetic evaluations and monitoring. As of 2014, several changes have been incorporated into the artificial spawning program to increase genetic diversity, as well as to evaluate and monitor the program itself and assess the current status of ELRT genetics (see Section 5.1.3). The artificial spawning program will be continued using spawning practices and genetic sample collection methods developed in 2014 for at least the next three spawning seasons. Based on results from genetic studies (pending grant funding, results may be available by 2018), spawning practices may or may not warrant further modifications to maintain or increase diversity (see Objective 3.2 for genetic evaluation and monitoring details). Following successful reestablishment of an ELRT population in Pine Creek and recruitment of naturally produced ELRT into Eagle Lake, incorporation of naturally produced ELRT into the artificial spawning program will need to be evaluated. Additionally, fertilized eggs will be segregated into individual lots for each week's spawning events. At the completion of the spawning season, it will be determined what proportion of the entire spawn each lot contributes. Yearling ELRT will be stocked back into Eagle Lake proportionately across all lots. Stocking based on lot proportions will avoid bias of size selection (i.e. fish "grading") at the hatcheries.

Goal 2. Provide suitable stream/riparian habitat conditions for ELRT in the Pine Creek watershed - All Parties

To support the reestablishment of a natural spawning population of ELRT in Pine Creek, suitable habitat must be provided and maintained. Restoration of stream and riparian habitat, hydrologic function and other watershed processes, as well as monitoring of these restoration activities need to occur in order to inform the adaptive management process and ensure objectives are being achieved. Improving instream conditions will increase the likelihood of ELRT migration, spawning, and rearing in upper Pine Creek. Restoring watershed processes will make Pine Creek more resilient to climate change and catastrophic events.

Objective 2.1 Reduce impacts and restore Pine Creek stream habitat and channel from grazing - USFS

To improve livestock management and reduce impacts from grazing to stream habitat and stream channels, several projects have been identified and environmental assessments have been initiated for three grazing allotments. These projects and allotment revisions will address stock ponds, redistribution of livestock to upland areas, exclusionary fencing, and assessments of ecological conditions and current livestock carrying capacities.

The LNF's Pine Creek Restoration Project (2014) identified actions to improve watershed function and address several areas of degraded aquatic and riparian habitat. Beginning in 2015, this project will remove four livestock water sources along and within Pine Creek that attract and concentrate livestock within the riparian area. Additionally, two to three water sources will be developed outside the riparian zone to attract livestock away from the stream. These improvements are intended to increase livestock distribution and to reduce grazing pressure and concentration of livestock near stream channels and within riparian corridors.

The Harvey Valley Allotment EA (2013) identified an unfenced section of Pine Creek that funnels livestock to the creek. This section will be fenced to eliminate livestock access. Additionally, the Harvey Valley Allotment will be rested from grazing through 2015. The Pine Creek reach above Highway 44 receives occasional use when livestock trail through or drift into these areas, but livestock are not gathered and placed in the Bogard and McKenzie Cow Camp areas to graze. Most recently, USFS specialists and the grazing allotment permittee agreed to construct a new boundary fence in 2015 on the Upper Pine Creek Allotment. This will alleviate the ongoing problem of livestock drift from the adjacent allotment, which has resulted in repeated grazing along reaches of Pine Creek and excessive levels of use. Livestock numbers will also be adjusted based on forage availability and annual conditions (e.g. drought conditions).

Additionally, the environmental analyses for three of the allotments in Pine Creek Valley will be initiated in 2015, with an expected decision by the end of 2016. The environmental analyses encompass the lower reaches of Pine Creek and will identify additional opportunities for developing off-stream water sources to better distribute livestock into upland areas, re-assess ecological conditions, and adjust allotment carrying capacities as necessary.

Objective 2.2 Assess and restore natural hydrologic and stream function processes - USFS

The LNF's Pine Creek Restoration Project (2014) identified actions focused on removal of decommissioned and unauthorized roads and railroad grades, diversions, and dug-out water holes on Pine Creek and an intermittent tributary in Harvey Valley to improve watershed function and address several areas of degraded aquatic and riparian habitat. These restoration actions will begin in 2015 and include: seven road decommissioning sites totaling 1.6 miles of road to be removed; four railroad grade/ borrow ditch sites totaling 0.95 miles of grades removed; and one diversion site improving the existing check dam. Road decommissioning will help to maintain stream sinuosity, reduce channelization and/or channel constriction, improve channel connectivity and enhance instream flow. Removal of railroad grades will reduce channel constriction, improve flow conditions and eliminate water being captured by associated borrow ditches. Improving the check dam in the overflow ditch at Highway 44 will reduce the amount of diverted flow improving stream flow downstream. The check dam will allow some flow to spill over during flood conditions; however, the overflow ditch reconnects to Pine Creek further downstream. Completion of identified sites is anticipated by 2016; additional sites will be identified and treated as assessments continue to identify impacted areas in the watershed.

Ongoing and planned watershed assessments (see Objective 3.5) will continue in 2015. As new information is gathered additional sites will be identified and plans developed to improve Pine Creek's hydrologic and ecological functions. Assessments will be conducted to further evaluate stressors, including: impoundments and Pine Creek's water budget, incised channels and stream

connectivity with the flood plain, and identification of legacy channel impacts and evaluation of their potential for restoration. Identified sites will be prioritized and designs for restoration actions will be developed for future implementation. Future watershed and stream channel improvements will continue to be priority conservation actions intended to provide beneficial stream and riparian habitats and hydrologic conditions for ELRT.

Objective 2.3 Implement water conservation measures to buffer impacts from drought - USFS

The only surface water diversion in the Pine Creek drainage is the diversion supplying water to the Bogard Work Center and CalTrans rest area. As described in Section 5.2.2, this diversion has been replaced with a well and will no long divert water for consumptive uses. The redirection of this water to the stream, beginning in 2015, will improve the quantity of stream flow and habitat conditions, particularly important during drought years.

Ongoing forest/timber management planning will continue to incorporate stand improvement and restoration projects. Specifically, existing aspen stands and overly dense timber stands will be targeted for treatment to better represent historical conditions (see Section 4.1). This type of vegetation management within the Pine Creek watershed will reduce risk of catastrophic fires and improve hydrologic functions; buffering potential impacts from drought and climate change. Benefits from restoring degraded aspen stands and thinning of overly dense timber stands is increased infiltration, increased groundwater retention, reduced flashy surface runoff and a sustained, slow groundwater release into streams. Increases in water yield have been demonstrated in several paired-watershed studies comparing treated (thinned) stands with untreated stands; some historical studies of forest harvesting have shown increases of between 14 and 34% in snow accumulation (Bales et al. 2011). Preliminary estimates based on average climate information suggest, that in the Sierra Nevada, treatments that would reduce forest cover by 40% of maximum levels across a watershed could increase water yields by about 9% (Bales et al. 2011). Thinning of overly dense timber stands and use of controlled burns will reduce the risk of catastrophic fires by reducing fuel loads and increase tree spacing, thereby reducing the risk of crown fires while also reducing the risk of disease and infestations. Vegetation projects are typically large and active management is needed across the landscape. Planning and implementation of stand restoration and improvement is ongoing and will likely take decades to treat priority areas within the entire watershed. Given that suppression of wildfires will continue into the future, this management strategy will likely need to be continued in perpetuity to mimic and maintain historical forest and drought tolerant conditions.

Goal 3. Continue and expand research and monitoring - All Parties

In order to adaptively manage ELRT, pertinent research and monitoring must be continued and expanded to improve our understanding of the status of the ecology (population dynamics, genetics, and habitat) of ELRT and to guide future management decisions. The Pine Creek CRMP Fisheries TRT will continue to facilitate the prioritization and identification of research needs. Many of the conservation objectives and actions outlined herein require monitoring or evaluation prior to implementing projects. The objectives and actions below have been identified as key areas of study to determine project efficacy, document existing conditions, and provide information to guide existing conservation actions and develop future actions.

Objective 3.1 Monitor adult spawning migrations - CDFW

To document spawning conditions and evaluate success of spawning in Pine Creek, the following actions will be implemented annually: spawning migrations will be evaluated using PIT tags and PIT antenna arrays tracking the distances migrating adults travel upstream; spawning surveys and redd counts will be performed to document spawning areas selected by adult spawners and assess spawning habitat conditions for potential habitat improvement projects; observational surveys and trapping efforts will be employed to document successful spawning events, rearing and out-migration of juveniles into Eagle Lake; stream flow, flow duration, timing of flow, and water temperatures will be monitored to document stream conditions and correlate with spawning; and underwater cameras will be installed to evaluate passage though the fishway and enumerate adults passing through the Trap. These actions are categorized as high priority, since the information collected will demonstrate that natural production is taking place and, if the desired outcomes are achieved, will identify factors affecting natural spawning. Findings may also be useful in the identification of potential habitat restoration and/or enhancement sites.

Objective 3.2 Monitor genetic integrity of ELRT stream and lake populations and evaluate artificial spawning and hatchery rearing program - CDFW

The focus of this objective is to evaluate current artificial spawning practices for ELRT, using genetic analysis of spawning adults over multiple years. This will allow a determination to be made on whether significant inter-annual genetic variance among brood years and acceptable levels of genetic diversity and inbreeding exist within the Eagle Lake population. Such information is necessary to determine whether this supportive rearing program is doing an adequate job or if changes in artificial spawning practices are necessary to enhance the genetic integrity of future progeny. A second objective is to collect baseline genetic data from spawned adults over several years, so that future genetic analysis will be able to determine if natural production is taking place. A third objective, if sampling allows, is to evaluate the level of genetic distinctiveness of any extant "resident" Pine Creek populations relative to the main Eagle Lake population and evaluate hatchery survivorship. Each year during spawning, tissue samples will be collected for every ELRT spawned. Records will be kept to identify each spawning pair, including individual fish information (sex, fork length, hatchery marks, etc.). Tissue samples will be sent to an appropriate laboratory (currently, UC Merced or UC Davis labs are being considered) for genetic analysis using SNP markers developed from RAD-seq high-throughput sequencing. Genetic analysis will consist of evaluation for inbreeding, genetic diversity (e.g., average allelic richness, R, and gene diversity (heterozygosity)) and relatedness, genetic bottlenecks, and effective number of breeders (Nb). A report of genetic findings will be prepared in 2018 that provides recommendations/alternate methods for improving artificial spawning, rearing, or stocking practices if necessary. Tissue samples (N=648) were collected from spawned fish in 2014; it is anticipated collections of similar sample sizes will be made in subsequent years for inclusion in this project. Pine Creek samples may also be examined, unless dry-year conditions preclude sample collection.

Objective 3.3 Monitor effectiveness of brook trout removal and ELRT reestablishment in Pine Creek - CDFW

Following the proposed multi-year brook trout removal effort (2018-2020) in upper Pine Creek, effectiveness monitoring will be conducted to determine if complete removal of brook trout occurred. Trapping and electrofishing techniques will be used to sample Pine Creek for the presence of brook trout for two consecutive years (2021-2022). If the brook trout removal is successful, ELRT will be reintroduced into upper Pine Creek in 2022/2023 and spawning and rearing will be monitored annually thereafter to document reestablishment of an ELRT population in Pine Creek. If brook trout removal efforts fall short of complete eradication, contingency plans will include one or more additional years of chemical treatment and post-treatment monitoring.

Objective 3.4 Monitor lake population for naturally spawned ELRT - CDFW

In order to determine if natural production is occurring and to what extent natural production is contributing to the Eagle Lake population, the lake will be annually monitored for the presence of naturally produced or "wild" ELRT. All hatchery-reared ELRT stocked into Eagle Lake will be marked with a distinguishing mark for each brood year to differentiate them from wild fish. In April and May, 2014, all hatchery-reared ELRT stocked into Eagle Lake were marked by clipping the adipose fin. Beginning in November, 2014, ELRT that will be stocked in 2015 were marked by clipping the right pelvic fin. Marking will continue annually into the future by alternating between clipping the adipose, right and left pelvic fins. If additional marks are required to better distinguish older brood years, right and left maxillary bones may be punched. ELRT will be inspected for these distinguishing marks during annual angler creel census surveys and during artificial spawning operations. Since this marking strategy was implemented in 2014, it will take several years, depending upon the life span of existing unmarked ELRT in Eagle Lake, before it can be determined to what extent natural production and wild ELRT are contributing to the lake population. Therefore, it is anticipated this will be a long-term project spanning at least several brood years of ELRT. Findings from genetic analyses will be used in conjunction with the marking program to further differentiate wild versus hatchery stocks and to establish a genetic "library" for ELRT, creating a baseline against which future studies can be analyzed.

Objective 3.5 Watershed assessments and monitoring - USFS/CDFW

Watershed, stream habitat, and channel function assessments and monitoring are required to identify sites in need of restoration and develop strategies to provide adequate habitat and properly functioning hydrology within the watershed. Restoration of stream habitat and hydrological function will, in turn, lead to stable and/or improving stream channel and habitat conditions, reducing threats from legacy stream and channel alterations.

In 2014, American Rivers, in coordination with other NGOs and the USFS, received funding to assess all of the meadows within the Pine Creek drainage. Assessments will include trend analysis and evaluations of current land management practices to develop and prioritize conceptual designs for restoring stream habitat and channel function within highly degraded meadow stream segments. Also in 2014, Trout Unlimited (TU) received funding for preliminary habitat and ecosystem monitoring in support of future restoration planning. Through the use of

the Aquatic Habitat Assessment methodology, TU will provide baseline data and a template for future management actions; including establishing a framework by which future actions can be quantified post-project in terms of change in available habitat, species distribution and abundance, and ecosystem conditions. Additionally, habitat and other data collected will enable future evaluation and comparison of different restoration alternatives.

In 2016, a Watershed Vulnerability Assessment will be conducted by the USFS to identify water resource-related values (both physical and biological) within the Pine Creek watershed, and their exposure and sensitivity to climatic changes, based on climate and hydrologic projections for this region. The goal of this assessment is to identify parameters that are sensitive and related management actions within the watershed that would promote resiliency to climate change. The assessment will largely be modeled off of the pilot studies in Furniss et al. (2013); which conducted assessments of potential hydrologic change resulting from ongoing and expected climate warming, on elven national forests throughout the U.S., representing each of the nine Forest Service Regions.

Additionally, proposed LiDAR coverage of the entire Pine Creek watershed (see Section 5.2.2) will allow for fine-scale, site specific restoration planning. If funded, LiDAR coverage could be acquired as early as December, 2017 and multiple restoration and enhancement projects could result from analysis of the mapping data.

Objective 3.6 Development of the ELRT Conservation Strategy Technical Team - All Parties

An ELRT Conservation Strategy Technical Team (Team) will be developed to implement the Strategy, encompassing all the goals, objectives, and actions identified herein. The Team will consist of, at a minimum, one designated representative from each signatory agency. Representatives of the CDFW will include a fisheries biologist and hatchery management staff. Representatives of the USFS and USFWS will include a fisheries biologist from each agency and/or supervisory staff (i.e. District Ranger or Field Manager) if needed. Agency representatives will be chosen at the discretion of each respective agency. In addition, the Team may include other stakeholders as deemed necessary by the signatories. Responsibilities of the Team will include coordinating all the conservation activities. The Team will meet at least annually to document progress toward Strategy goals and objectives, develop priorities, and review any other elements related to planning or implementation of the Strategy as necessary. Designated representatives of each signatory agency will be selected to form the Team and the first Team meeting will be held in 2015.

Goal 4. Increase delivery of outreach and education programs relating to ELRT and the conservation of its habitat - All Parties

Many restoration and conservation efforts to benefit and sustain ELRT have been implemented and considerably more are planned. The protection and conservation of California's natural resources and native species will provide future generations with lasting legacy benefits that are immeasurable. Resource management agencies need to better articulate that message so that public support can be garnered and greater emphasis placed on the inherent value of California's

diverse native flora and fauna. Conservation of ELRT and its habitats is one example of the shift in resource management practices and principals from management almost exclusively for consumptive uses toward a broader, more holistic, approach that emphasizes restoring ecosystem function as a fundamental goal, while still allowing the use of resources to benefit our growing population. The best way for resource management agencies to continue to facilitate that shift is to educate and gain support from the public. Education and outreach opportunities related to the uniqueness and value of ELRT as part of California's heritage need to be developed and delivered.

Objective 4.1 Expand educational efforts to increase public awareness about ELRT and the unique ecology of Eagle Lake - All Parties

During the spawning migration in Pine Creek, people are attracted to the Trap to observe the hundreds of migrating ELRT as well as the artificial spawning process. This easily accessed area provides an excellent opportunity for resource managers to interface with and educate the public. The spawning run should be more widely advertised as a valuable and worthwhile event for the public to observe. Currently, only residents from outlying areas and a few local elementary school groups come to observe the spawning events. Increased public knowledge and interest could be generated for Eagle Lake and ELRT, with widespread advertising and an educational campaign. However, Eagle Lake's geographic location (about a 45 minute drive from the nearest town, Susanville) and lack of other activities that might draw visitors provides some degree of challenge, but more can and should be done to inform the public. At a minimum, resource managers should expand the outreach program for local elementary schools and assist with funding, as needed, to support field trips to observe the spawning run. Students could also visit the USFS Eagle Lake Ranger District as part of the trip, allowing for resource managers to provide background information and discuss conservation efforts.

In 1998, a kiosk was installed near the trap with interpretive panels featuring information on the life history and conservation of ELRT. This kiosk will be updated with current and future conservation goals and actions. To expand and provide information though other media, a website featuring Eagle Lake and Pine Creek information and updates should be developed. This site could feature live video feeds of spawning fish at the Trap, anglers enjoying their time fishing Eagle Lake, restoration projects that could involve volunteers, and other promotional features to provide an in-depth, yet remote, look at the Eagle Lake basin. Other outreach materials could be developed such as videos, pamphlets, and additional interpretive signs at key locations within the Eagle Lake basin.

Objective 4.2 Increase public engagement in the conservation of ELRT - All Parties

Annually, several meetings (i.e., Pine Creek CRMP, Lassen County Fish and Game Commission, Eagle Lake Interagency Board) are held to address and update stakeholders on Eagle Lake and Pine Creek issues, management, restoration, and overall information sharing. Several of these meetings are open to the public and have varying levels of public participation. To increase public awareness of, and participation in, these meetings, resource management agencies need to increase public exposure through radio, newspaper, and other media advertisements, as well as maintaining an email list to notify individuals who have participated in previous meetings.

The CRMP should develop an annual ELRT symposium with presentations and other informational displays presented by resource managers and specialists to better disseminate current information on conservation, management, restoration and research efforts. Information on new technologies and techniques should be incorporated and a focus placed on restoration projects with tangible benefits to inform the public and generate interest. A component of this symposium should involve recruitment of volunteers to assist with on-the-ground restoration projects. Volunteer involvement in the conservation of a species is one of the best opportunities for resource managers to build a growing contingent of supporters and advocates. Efforts should be made to identify specific restoration projects and link project leads with updated volunteer contact information to ensure a positive and productive experience for volunteers.

TABLE 2: Conservation Goals, Objectives and Actions to Restore Eagle Lake Rainbow Trout

Priority	Description	Timeline	Lead Agency	Status
GOAL 1: Protect and restore natural production and genetic integrity of ELRT				
OBJECTIVE 1.1: Operate the Trap fish ladder to provide natural spawning migration in Pine Creek				
high	Construct fish passage structure (fishway) at the Trap	May 2012	CDFW	Completed
high	Assess and test successful passage of migrating adults through fishway	April 2013	CDFW	Completed
high	Manage and operate Trap and fishway to allow passage of migrating adults throughout entire spawning migration	March 2015	CDFW	Planned-Annually
OBJECTIVE 1.2: Identify and remove any existing potential barriers to migration				
medium	Develop removal plans for the USGS gauging weir; implement removal project	2020	CDFW/USFS	Planned
medium	Assess, design, implement treatment of fish ladder at Leaky Louie's Pond to improve fish passage	2022	CDFW/USFS	Planned
Med-low	Design and implement modifications to improve low flow fish passage at 33N33 road crossing	2022	CDFW/USFS	Planned
Med-low	Locate and treat beaver dams and log debris jams as needed to avoid passage impediments	Annually as needed	CDFW/USFS	Ongoing
OBJECTIVE 1.3: Remove brook trout from the Pine Creek watershed and reestablish stream population of ELRT				
high	Assess Upper Pine Creek for brook trout removal; assess stream flow, macroinvertebrate species composition, brook trout distribution, amphibian presence; determine scope of project	Sept 2014-Sept 2016	CDFW	Ongoing
high	Complete environmental review (EIR/EIS) for brook trout removal options and develop contingency plans in the event the preferred option and removal project is unsuccessful	Jan 2018	CDFW/USFS	Planned

Priority	Description	Timeline	Lead Agency	Status
OBJECTIVE 1.3: Remove brook trout from the Pine Creek watershed and reestablish stream population of ELRT (continued)				
high	Implement brook trout removal (treatment type will depend on results of the EIR/EIS process)	Aug 2018-Aug 2020	CDFW	Planned
high	Reintroduce ELRT to upper Pine Creek following brook trout removal; perform effectiveness monitoring	May 2022	CDFW	Planned
high	Assess need for trapping and trucking of adult spawning ELRT from Eagle Lake to the perennial headwaters of Pine Creek, as needed, during low water years; assess need for trapping and trucking of juvenile out-migrants from Pine Creek to Eagle Lake, as needed, during low water years	Ongoing/ Annually	CDFW	Planned
medium	Propose changes in the sport fishing regulations to upper Pine Creek and its tributaries to protect stream population	Dec 2018	CDFW	Planned
OBJECTIVE 1.4: Implement artificial spawning practices to provide highest level of genetic diversity possible				
high	Continue artificial spawning and hatchery rearing program to maintain healthy ELRT population in Eagle Lake	Annually	CDFW	Ongoing
high	Conduct artificial spawning throughout the entire spawning run to eliminate spawning timing selection bias	April 2013	CDFW	Completed-Ongoing
high	Modify spawning practices to increase genetic diversity; protocols will be adaptively managed using results from genetic monitoring	March 2014	CDFW	Completed-Ongoing
high	To the extent possible, incorporate "wild" ELRT into spawning matrix (note: relies on results of marking program for hatchery-reared ELRT and recruitment of "wild" ELRT from Pine Creek)	March 2020	CFDW	Planned
high	Segregate egg weekly lots and stock hatchery reared yearlings into Eagle Lake in amounts proportional to those lots annually	April 2014/ annually	CDFW	Ongoing

Priority	Description	Timeline	Lead Agency	Status
GOAL 2: Assess, restore and monitor Pine Creek stream habitat, hydrology, and watershed function				
Objective 2.1 Reduce impacts to Pine Creek stream habitat and channel from grazing				
high	Develop off-stream watering sources to replace existing in-stream stock water impoundments; off-stream sources will be functional prior to removal of existing impoundments	Begin 2015, ongoing	USFS	Planned
high	Fill and stabilize stock ponds that divert flow from Pine Creek	Begin 2015, ongoing	USFS	Planned
high	Summarize, from 2007 to present, management of livestock allotments in the Pine Creek watershed; include areas identified as open/closed to grazing, annual use and distribution, monitoring and trend data, photo points, etc.	2015	USFS	Planned
high	Provide annual updates/reports; as necessary, update allotment management plans	2014	USFS	Ongoing
high	Where findings warrant, adjust grazing strategies to minimize impacts to stream banks and vegetation in riparian areas and meadow habitats, using appropriate management tools	Annually	USFS	Ongoing
high	Enforce lease grazing standards within individual allotments	2014	USFS	Ongoing
high	Improve riparian vegetation and stream bank stability through temporary cattle exclusion fencing	2015	USFS	Planned
OBJECTIVE 2.2 Assess and restore natural hydrology and stream function				
high	Identify and map all existing diversions/impoundments in the Pine Creek watershed	2017	USFS/CDFW	Planned
high	Evaluate the Pine Creek water budget and the effect(s) of impoundments (stock ponds, borrow pits, roadside ditches and railroads) on stream flow	2017	USFS	Ongoing
high	Design and implement appropriate treatment of impoundments to restore stream hydrology and function	2015	USFS/CDFW	Planned
high	Reconnect incised channels to floodplain, where feasible, in order to distribute flood flows	2015	USFS	Planned

Priority	Description	Timeline	Lead Agency	Status
OBJECTIVE 2.3 Implement water conservation and retention measures to buffer impacts from drought				
high	Discontinue water diversion from Bogard Springs by developing well to supply water to CalTrans rest area and Bogard ranger station and disconnecting infrastructure near the springhead to prevent eventual infrastructure failure from dewatering springhead.	Nov 2014-2015	CDOT/USFS	Underway
medium	Restore degraded aspen stands along Pine Creek watershed to increase infiltration and ground water retention	Ongoing	USFS	Ongoing
high	Develop and implement timber management strategies to reduce impacts from dense timber stands within the Pine Creek watershed to increase water yield, infiltration and retention of ground water	Ongoing	USFS	Ongoing
medium	Assess and design water control devices on enhanced wetlands to adjust water releases based on water year type	2014	USFS	Ongoing
GOAL 3. Continue and expand research and monitoring				
OBJECTIVE 3.1 Monitor adult spawning migrations				
high	Continue PIT tagging a proportion of adult spawning migration run to track distances migrating upstream to document if adults are reaching perennial reach in Pine Creek	March-April 2015	CDFW/SIR	Planned
high	Conduct spawning surveys to document spawning areas selected by adult spawners and assess spawning habitat conditions for potential habitat improve projects	March-April 2015	CDFW/SIR	Planned
high	Conduct surveys and trapping efforts to document successful spawning events and rearing of juveniles and recruitment of juveniles into Eagle Lake	March-April 2015	CDFW/SIR	Planned
medium	Monitor stream flow volumes, flow duration, timing of flow, and water temperatures to document and better understand effects on spawning	Annually	CDFW/USFS	Ongoing
medium	Install underwater cameras to evaluate passage though the fishway and enumerate adult passing through at the Pine Creek trap	Feb 2015	CDFW	Planned

Priority	Description	Timeline	Lead Agency	Status
OBJECTIVE 3.2 Monitor genetic integrity of ELRT stream and lake populations and evaluate artificial spawning and hatchery rearing program				
high	Acquire grant funding and implement grant to evaluate and monitor effectiveness of artificial spawning and hatchery rearing programs in maintaining genetic diversity; monitor genetic characteristics of any "wild" ELRT population in Pine Creek; create multiple year genetic library of collected samples to determine if natural production is taking place	Sept 2014-Sept 2018	CDFW/ Molly Stephens, UC Merced	Grant concept proposal submitted Sept 2014
high	Utilize results and recommendations from the genetic evaluation and incorporate any necessary changes to the artificial spawning program	March 2019	CDFW	Planned
OBJECTIVE 3.3 Monitor effectiveness of brook trout removal and ELRT reestablishment in Pine Creek				
high	Following removal of brook trout from upper Pine Creek, conduct annual investigations to document if removal efforts were successful; if removal is unsuccessful implement contingency plans	2021-2022	CDFW	Proposed, following brook trout removal
high	Conduct surveys and trapping efforts to document successful rearing of juveniles to document reestablishment of a Pine Creek ELRT population	2022-2023	CDFW	Proposed, following brook removal
OBJECTIVE 3.4 Monitor lake population for naturally spawned ELRT				
high	Implement marking program for hatchery-reared ELRT stocked into Eagle Lake	May 2014-annually	CDFW	Ongoing
med	Conduct angler creel census and inventory spawning adults to identify unmarked individuals to assess production of "wild" ELRT	Annually	CDFW	Ongoing
high	Assess results from genetic monitoring to evaluate and document presence of naturally produced ELRT; genetic library will allow detection of ELRT that were not products of artificial spawning	March 2015-Sept 2018	CDFW/ Molly Stephens, UC Merced	Grant proposal submitted Sept 2014
OBJECTIVE 3.5 Conduct watershed assessments and monitoring				
medium	Conduct stream channel and habitat trend analyses; evaluate land management practices to develop restoration alternatives to reconnect Pine Creek with the flood plain to improve hydrologic function and stream habitat	Dec 2015	American Rivers/NFWF	Ongoing
medium	Conduct stream habitat assessment (using Aquatic Habitat Assessment methodology) to collect baseline data for comparison and develop alternatives for habitat restoration within Pine Creek meadows	Dec 2015	Trout Unlimited/ NFWF	Ongoing

Priority	Description	Timeline	Lead Agency	Status
OBJECTIVE 3.5 Conduct watershed assessments and monitoring (continued)				
high	Acquire funding to obtain LiDAR coverage of the Pine Creek watershed; use LiDAR information to evaluate habitat and channel condition in the basin to develop restoration actions and resource protection measures	Dec 2017	CDFW /USGS	Grant proposal submitted Oct 2014
medium	Complete Watershed Vulnerability Assessment report to prioritize areas and identify management actions to maintain or improve resiliency of the Pine Creek watershed in response to climate change	2016	USFS	Planned
OBJECTIVE 3.6 Development of the ELRT Conservation Strategy Technical Team				
high	Develop the Team by selecting participating members and developing a meeting frame work and schedule,	2015	All Parties	Ongoing
high	Conduct Team meetings to: coordinate conservation actions, review monitoring and assessment results, monitor Strategy progress, and present of annual agency reports.	Annually	All Parties	Planned
GOAL 4. Increase delivery of outreach and education programs relating to ELRT and the conservation of its habitat				
Objective 4.1 Expand educational efforts to increase public awareness about ELRT and the unique ecology of Eagle Lake				
medium	Increase public awareness of spawning run and develop educational opportunities (e.g., local school field trips); enhance/update existing educational display at Trap/kiosk (e.g. webcam, live video, interpretive displays, etc.)	TBD	CRMP	Proposed
medium	Develop other outreach materials (website, video, pamphlets, signs within the basin)	TBD	CRMP	Proposed
Objective 4.2 Increase public engagement in the conservation of ELRT				
medium	Advertise public meetings addressing management of ELRT to encourage public participation	Annually	CRMP	Proposed
medium	Convene an ELRT symposium; develop volunteer program to assist with restoration projects	Annually	CRMP	Proposed

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