PAIUTE CUTTHROAT TROUT
Oncorhynchus clarkii seleniris

High Concern. Status Score = 2.1 out of 5.0. PCT have a high likelihood of extirpation in their native range within the next 50 years without continued commitment to intense monitoring and management. All populations are small and isolated, and therefore highly susceptible to illegal introductions of alien trout and local stochastic events.

Description: The Paiute cutthroat trout (PCT) and Lahontan cutthroat trout (LCT, *O. c. henshawi*) are morphometrically and meristically identical. However, LCT are heavily spotted (particularly below the lateral line) and are bronze to olive in coloration, while PCT are virtually spotless, have iridescent copper, green, or purplish-pink body coloration, and retain their parr marks into adulthood (Moyle 2002, USFWS 2004, Finger et al. 2013). Originally described by Snyder (1933) as being spotless, most Paiute cutthroat trout have 1-5 small spots, with some having up to 9 spots above the lateral line (USFWS 2004). They possess the characteristic cutthroat reddish-orange slash at the base of the mandible and all meristic characteristics such as gill raker counts, pyloric caeca, lateral line scales, and number of vertebrae are within the range of those for LCT (Moyle 2002, USFWS 2004).

Taxonomic Relationships: The Paiute cutthroat trout is closely related to the Lahontan cutthroat trout and is the least genetically diverse species of trout in the state (Finger et al. 2013). Snyder (1933, 1934) first described this trout as *Salmo seleniris*, a species distinct from LCT based on coloration, the complete or near absence of spotting, and slender body shape. The name *seleniris* is a reference to the moon goddess, Selene (Moyle 2002). Vestal (1947) reclassified PCT as a subspecies of LCT. Subsequently, all North American *Salmo* have been reclassified as *Oncorhynchus*, and PCT is known today as *Oncorhynchus clarkii seleniris* to reflect the original, double-i spelling (USFWS 2004). Recent investigations of population structure for the Lahontan group of cutthroats (Lahontan, Paiute, and Humboldt) show that there are approximately 90 genetic markers that are distinct in Paiute cutthroat trout, and that these fish did not go through an evolutionary bottleneck in the past as previously hypothesized (Finger et al 2011, 2013). Interestingly, PCT share the most genes with Lahontan cutthroat trout from the out-of-basin Independence Lake, not the downstream Carson River, from which it has had the most recent connection, about 8,000-10,000 years ago (Behnke 2002, Finger et al. 2013).

Life History: We can assume that the life history of LCT in small, cold headwater streams is similar to that of PCT in the drainages in which they reside. No PCT populations exist in areas that have temperature extremes observed in some of the LCT habitat and it is unknown if they have the capacity to survive the high levels of alkalinity, turbidity and temperature that LCT can withstand. Descriptions of LCT life history are presented in Moyle (2002) and Behnke (2002) and updated in the LCT chapter here.

Few life history studies have been conducted on PCT and most of what is known about them comes from studies of introduced populations in Cottonwood Creek in the White Mountains by Wong (1975) and Caldwell and Titus (2009) of the California Department of Fish and Wildlife (CDFW). PCT life expectancy is about 3-4 years of age in the wild, although some individuals live up to 6 years (Titus and Calder 2009). They mature at 2 years of age, and thus most have the potential to successfully spawn for only about two years on average (Wong 1975,

USFWS 2004). Peak spawning activity takes place during the months of June and July (USFWS 2004). Mature fish range from 15-25cm TL. Females use their tails to dig redds in clean gravel substrate. The fertilized eggs hatch in approximately 6-8 weeks, and embryos spend an additional 2-3 weeks in the gravel as alevin before emerging as fry. The juveniles rear in backwaters, shoals and small tributaries until they reach approximately 50mm TL (Wong 1975, USFWS 2004). Adult fish establish dominance hierarchies and defend their established territories from intruders. The larger fish possess the more desirable pool habitats and smaller fish are relegated to riffle and run territories. Most fish do not undertake large-scale movements, and instead reside in close proximity to areas in which they were reared or introduced (USFWS 2004, W. Somer, CDFW, pers. comm. 2016). They require pools for overwintering habitat and are consequently vulnerable to ice scour during low winter flows, which are common in the small headwater tributaries they inhabit (USFWS 2004).

PCT, like most trout, are opportunistic feeders, consuming a variety of aquatic and terrestrial invertebrates in drift (Wong 1975, USFWS 2004). Growth rates depend on water temperature, stream size, and food availability, which can be quite low in the high-elevation, low-productivity Silver King drainage and out-of-basin habitats where PCT currently reside (W. Somer, CDFW, pers. comm. 2016). Titus and Caldwell (2009) back-calculated growth curves for PCT in different drainages based on length-at-age measurements and found that 1 year-old PCT were typically around 30mm TL, and that 6 year-old PCT could grow to about 260mm TL. Few PCT reach lengths over 25 cm, and the largest recorded PCT in Silver King Creek was 34cm (USFWS 2004). The largest PCT found in a lake measured 46cm and weighed 1.1 kg (USFWS 2004, Behnke 2002). There are no known naturally occurring populations of lacustrine Paiute cutthroat trout, although several attempts have been made in the last century to establish them in lakes outside their historical range through stocking.

Habitat Requirements: The only studies of PCT habitat requirements and preferences come from introduced populations in the North Fork of Cottonwood Creek, which were planted there in 1946 (W. Somer, CDFW, pers. comm. 2016). PCT seem to have similar requirements to other alpine stream trout, especially LCT: cold (<18-20°C), well oxygenated water, abundant cover and vegetation, clean gravel to spawn in and an adequate food source. Spawning begins when water temperatures reach 6-9°C (Behnke 2002). Despite decades of heavy grazing in the area, riparian vegetation is rebounding to provide shading and woody debris in Silver King Creek (W. Somer, CDFW, pers. comm. 2016). Deeper pool habitat and overhanging vegetation provide important refuge and overwintering areas (USFWS 2013).

Distribution: PCT are native to just a single drainage, Silver King Creek, in eastern California. Silver King Creek is a tributary of the East Fork Carson River located at an elevation of about 2400m in the Carson-Iceberg Wilderness in Humboldt-Toiyabe National Forest (Alpine Co.) (Caldwell and Titus 2009). As such, the native habitat of this species is the smallest of any known salmonid in North America (W. Somer, CDFW, pers. comm. 2016). They are thought to have existed in only 14.7 km of habitat from the base of Llewellyn Falls downstream to Silver King Canyon, including three small tributary creeks in the drainage, Tamarack Creek, Tamarack Lake Creek, and the lower reaches of Coyote Valley Creek downstream of barrier falls (USFWS 2004). By the time they were described in 1933, their native range had already been invaded by rainbow trout (*O. mykiss*), Lahontan cutthroat trout, and California golden trout (*O. m. aguabonita*). Conflicting recollections of the Silver King Basin's early settlers has complicated

the true early distribution of PCT. CDFW records indicate that the first transfer of PCT out of their historical range took place in 1912 by Joe Jaunsaras, a Basque herdsman and early grazing permittee in the basin (USFWS 2004). Virgil Connell, another early settler in the area, reported that during this period the fish below the falls became "...mixed with other kinds, probably due to the stocking on the lower stream of different varieties." By the 1930s, PCT below the Llewellyn Falls were already highly introgressed with rainbow, golden, and Lahontan cutthroat trout (USFWS 2004). Two more creeks in the Silver King Drainage, Corral Valley Creek and Coyote Valley Creek, held PCT by the time Virgil Connell lived there. Falls near the mouth of Corral Valley Creek were presumably a historical upstream barrier to fish, but Vestal (1947) attributed the fish's presence there to herdsmen who "... reportedly planted Piute (*sic*) trout a few at a time in buckets from Upper Fish Valley" (USFWS 2004).

Throughout the 1900s, many transfers were made of Paiute outside the Silver King Basin. The first transfer to Leland Lakes in 1937 failed probably due to the presence of other salmonids. Next, about 400 fish were taken to the North Fork of Cottonwood Creek, a high elevation spring-fed creek in the White Mountains, in Mono County. That population persists to this day and has been a source population for most of the studies (Wong 1975, Titus and Calder 2009) and potential source for reintroduction of genetically pure PCT back into their native range. Introductions continued but were ultimately unsuccessful at McGee Creek (1956), Bull Lake (1957), Delaney Creek (1966), and nearby Heenan Lake (already a broodstock hatchery for LCT) in 1983. The only self-sustaining lacustrine population of PCT became established in Bircham Lake in Inyo County (1957), but by the early 1980s, this population was highly introgressed with rainbow trout (USFWS 2004). Of the 10 known introductions of PCT, there are reproducing populations only in Cottonwood Creek (Mono Co.), Cabin Creek (Mono Co.), Stairway Creek (Madera Co.), and at the outflow of Sharktooth Lake (Fresno Co., See Table 1). In addition to those four out-of-basin populations, another five pure populations of PCT exist in Coyote Valley, Corral Valley, Four Mile Canyon, and Upper Silver King creeks above the historical barrier at Llewellyn Falls (Finger et al. 2013).

Alpine County	Mono/Inyo/Tuolumne Counties	Fresno/Madera Counties
Silver King Creek (above Llewellyn Falls)* Corral Creek* Coyote Creek* Fly Valley* Four Mile* Bull Lake** Heenan Lake**	North Fork Cottonwood Creek Delaney Creek** McGee Creek** Cabin Creek Bircham Lake**	Sharktooth Lake Stairway Creek
*Introduced in-basin population (Tributaries of Silver King Creek) **Failed Introduction	**Failed Introduction	

Table 1. Known introductions of Paiute cutthroat trout in California by County.

Trends in Abundance: Paiute cutthroat trout were originally listed under the ESA as Endangered in 1967 due to their very small distribution and abundance, but were later downlisted to threatened in 1975 to allow flexible management of the species (USFWS 2013).

The USFWS (2013) determined that Paiute cutthroat trout currently occupy 37.8 km of stream habitat in five widely distributed drainages, and while they face several important threats,

they have a high potential for recovery based on recent actions of CDFW, USFWS, USFS, and other partners to eliminate introgressed trout in their native range. Different creeks in- and -out-of-basin support different densities, size, and age classes of PCT based on a variety of factors such as growing conditions, carrying capacity of streams, available feeding, spawning, and rearing habitat, etc. CDFW population assessments in 2007 found approximately 1,025 PCT per mile in Coyote Valley Creek and about 485 PCT per mile in Silver King Creek (CDFW 2007). Further study by Titus and Caldwell (2009) indicated that from 2004 to 2007, the mean number of age classes present in population segments increased from 2 to 5, indicating demographic expansion associated with population stability. Upper Silver King Creek in Upper Fish Valley and Coyote Valley Creek also supported a complete age structure during those years (Titus and Caldwell 2009).

According to the USFWS (2013) and UC Davis researchers (Finger et al. 2011, 2013), there are nine streams that currently hold pure populations of Paiute cutthroat trout. Four Mile, Fly Valley, and Corral Creeks have all had numerous surveys and those populations appear to have long-term stability (despite some fluctuations) with about 400 to 700 fish in each (USFWS 2004). The out-of-basin populations (North Fork Cottonwood, Cabin, Stairway, and Sharktooth creeks) have been surveyed by visual assessment or fly fishing to prevent injury or mortality from electrofishing (W. Somer, CDFW, pers. comm. 2016). They appear to be stable, though populations likely declined somewhat in tributary streams due to reductions in available habitat resulting from ongoing drought, such as drying and anchor ice during winter (W. Somer, CDFW, pers. comm. 2016). Over three summers (2013-15), field crews have monitored populations at each source, and will continue to do so in the coming field seasons. (W. Somer, CDFW, pers. comm. 2016).

PCT populations have changed since the turn of the century due to impacts stemming from the ongoing drought in California. PCT numbers likely declined in the last three years due to the effects of lower flows and associated anchor ice due to drought (W. Somer, CDFW, pers. comm. 2016). Current populations are small, isolated by barriers and cannot interbreed. Non-native trout have been eradicated below Llewellyn Falls down to barriers in Silver King Canyon; though unlikely, conservation efforts could be unraveled by illegal introduction of non-native fish upstream of the barriers into the current PCT refuge habitat (C. Mellison, USFWS, pers. comm. 2016). In the short term, Paiute cutthroat trout are susceptible to decline due to small population size that can lead to genetic bottlenecks and drift, loss of habitat due to drought, habitat, and solid freezing in winter (as seen with McCloud redband trout) (USFWS 2013, R. Bloom, CDFW, pers. comm. 2016). The USFWS determined that individual population extirpation due to a catastrophic event (such as an extreme fire event) is likely in PCT. Any reduction in the population size and stability of PCT and resulting loss of genetic diversity can combine to create an extinction feedback cycle in which each threat exacerbates and makes the impacts of the other threats more likely (Lusardi et al. 2015).

After a multi-year rotenone treatment of Silver King Creek and tributaries to remove introgressed trout concluded in summer 2015, PCT now have access to 17.7 km of unimpeded stream habitat on Silver King Creek without barriers (W. Somer, CDFW, pers. comm. 2016). Some individuals from refuge populations in tributaries to Silver King Creek have already volitionally recolonized the treatment area (W. Somer, CDFW, pers. comm. 2016). CDFW will continue to direct considerable resources to monitoring the treatment site and population of PCT in the coming field seasons to document the expansion of PCT back into their native range. The recovery plan lays out a goal of 2,500 individuals greater than 75 cm in length in order to make

sure three or more age classes of PCT inhabit their native range downstream of Llewellyn Falls over five consecutive years.

Though Paiute cutthroat have a far more limited distribution than LCT, their habitat is in reasonably good condition and is all on public land (U.S. Forest Service). However, continued reintroduction efforts and transfers will be most likely be required to both maintain and maximize diversity in the nine remaining populations. Monitoring and removal of any alien trout must continue indefinitely to protect genetic integrity of the remaining fish. The high-elevation alpine habitat of PCT could buffer them against some impacts of climate change, but the USFWS still consider it a main threat to the species due to the effects of warming stream temperatures, lower streamflow in summer and autumn months, loss of habitat connectivity, and loss of snowpack (USFWS 2013). In addition, historical drought conditions in California have been much worse than the current drought, likely negatively impacted Paiute and helping to shape their populations (USFWS 2013). Small streams where Paiute live are more susceptible than larger ones to desiccation, high stream temperatures, and loss of adequate deep pool habitat (Haak et al. 2010), though the native range of PCT lies higher than 2,400m in altitude and less likely to rise to unsuitable temperatures. Out-of-basin populations at Cottonwood and Cabin Creeks may be more at risk because of the arid nature of the White Mountains (Haak et al. 2010). The status determination (Table 2) gauges the impacts of such threats on the effective wild populations, including introduced populations, of PCT.

Factors Affecting Status: PCT are relatively stable in number in their remaining refuge populations. Recent, volitional re-colonization is occurring in the Silver King basin following completion of rotenone treatment of the upper Silver King Creek as a priority action of the USFWS Recovery Plan for PCT (W. Somer, CDFW, pers. comm. 2016). The entire native range of PCT is in the Humboldt-Toiyabe National Forest, a factor that eases some of the management difficulties that plague other species' recovery plans, such as LCT, that inhabit a landscape with a patchwork of private and public land. The biggest threats to the persistence of PCT include 1) competition and hybridization with alien trout, especially California Golden trout, coastal rainbow trout, and LCT, 2) loss of genetic diversity due to isolated, small populations developing genetic bottlenecks, and 3) catastrophic loss by stochastic events, such as fire.

Alien species. Alien trout are the principal threat to the continued persistence of PCT. The introduction of non-native rainbow, golden and Lahontan cutthroat trouts in the historical range of the PCT below Llewellyn Falls resulted in the extirpation of PCT there. PCT readily hybridize with rainbow, golden, and cutthroat trout, resulting in the loss of genetic integrity and phenotypic distinctiveness. To conserve PCT, CDFW carried out a large non-native trout removal project spanning summer 2013-2015. After costly, contentious legal battles and delays over use of the piscicide rotenone in Silver King basin, the treatment was completed (Finlayson et al. 2010, W. Somer, CDFW, pers. comm. 2016). For a full treatment of the legal battles of the 1990s and 2000s over California Department of Fish and Wildlife's use of rotenone to eradicate fish species due to concerns about harm to listed invertebrates, water quality, and other issues, see CDFW 2014. The commitment of CDFW, USFWS, US Forest Service, and other partners to remove introgressed and non-native trout and erect barriers in Silver King Canyon has allowed access for downstream recolonization of PCT from refuge populations in headwater streams to their native habitat and the real prospect of PCT recovery.

The nature of the small, low-density, disconnected populations of PCT complicate recovery efforts focused on maintaining and increasing genetic diversity. There are three distinct

lineages within current PCT populations as a result of their stocking history (Cordes 2004). Finger et al. (2013) showed that small PCT populations may suffer founder effects and genetic drift. This is due to the fact that most past transfers of PCT consisted of a few dozen fish into small streams with limited habitat. As a result, no population of PCT currently possesses all of the species' alleles, so future reintroductions from source populations in Silver King Creek should be carefully designed to avoid founder effects and consequent reduction of unique alleles in the remaining PCT population (Finger et al. 2013, UWFWS 2013). For instance, the Cabin and Sharktooth creeks populations have private alleles, or valuable genetic information not found in the other refuge populations, that could be vital to protecting a full range of phenotypic expression in PCT offspring (Finger et al. 2013). Uniqueness among populations must be maintained to confer potentially advantageous ecological adaptations and fitness that will be necessary for recovery of the species facing multiple evolving threats such as climate change (Finger et al. 2013, USFWS 2013).

Implementation of the PCT Genetic Management Plan and careful, adaptive management of reintroduction and potential future translocation efforts can help avoid potentially devastating losses of fitness and ecological adaptation. Using too many or too few individuals without proper monitoring could lead to loss of diversity through in-breeding or out-breeding depression. Since existing populations were originally established with so few individuals, introducing their genes into another population could potentially reduce fitness of offspring, and the costs and benefits of such reintroductions must be carefully weighed before active translocations are considered (Finger et al. 2013).

Grazing. Historically, the Silver King Basin was subject to heavy grazing pressure from livestock and caused heavy degradation of riparian habitats, akin to the habitat of the California golden trout. For a full discussion of grazing impacts, see that species section. As part of recovery efforts, grazing allotments in Silver King basin were permanently closed in 1994, but riparian habitat is still recovering throughout much of the PCT range and has shown marked progress with narrowing and deepening channels in meadow portions of Silver King Creek (W. Somer, CDFW, pers. comm. 2016).

Factor	Rating	Explanation
Major dams	n/a	No major dams or diversions in PCT habitat.
Agriculture	n/a	Most occupied and historical habitat lies within National Forest boundaries.
Grazing	Medium	Long-term degradation of watersheds has occurred as a result of sheep and cattle grazing, but has been closed since 1994 and is slowly recovering.
Rural/ residential development	n/a	Most Paiute cutthroat trout is within National Forest boundaries.
Urbanization	n/a	
Instream mining	n/a	
Mining	Low	Gold and silver mining may have altered habitat in the past, but the impacts are largely unknown.
Transportation	n/a	Roads are not near most PCT populations.
Logging	Low	The remote locations and high elevations were logged in the past, with signs of historical dam building to convey logs downstream, but impacts on PCT are unknown.
Fire	High	Fires may increase siltation of habitat, and potentially wipe out entire populations of PCT in some areas. Climate change may increase the risk of catastrophic fire.
Estuarine alteration	n/a	
Recreation	Low	Fishing has been closed since 2006 in their native habitat.
Harvest	n/a	
Hatcheries	n/a	There are no hatcheries currently raising PCT to avoid genetic impacts from domestication of wild fish.
Alien species	High	Alien trout represent the highest threat to continued PCT recovery and persistence in the wild through competition and hybridization. Small, fragmented populations remain in close proximity to alien trout.

Table 2. Major anthropogenic factors limiting, or potentially limiting, viability of populations of Paiute cutthroat trout. Factors were rated on a five-level ordinal scale where a factor rated "critical" could push a species to extinction in 3 generations or 10 years, whichever is less; a factor rated "high" could push the species to extinction in 10 generations or 50 years whichever is less; a factor rated "medium" is unlikely to drive a species to extinction by itself but contributes to increased extinction risk; a factor rated "low" may reduce populations but extinction is unlikely as a result. Certainty of these judgments is high. See methods for explanation.

Effects of Climate Change*:* The most recent US Fish and Wildlife Service five year status review of PCT found that climate change is likely an important threat to PCT for a variety of reasons. First, climate change in the Eastern Sierra is likely to cause increases in water temperature, associated decreases in streamflow, hydrography changes, and more frequent and pronounced cycles of drought and fire (USFWS 2013). Climate change impacts in California are

likely to lengthen the fire season, while increasing frequency and intensity of fires. Extreme fire events are likely a greater threat to PCT than to many other salmonid species in California due to the fragmented, isolated habitats that currently sustain refuge populations of the species at high altitude in remote areas (Haak et al. 2010). However, the native range of PCT is characterized by patchy vegetation and granite rather than an abundance of fuels, so once established in their native range in Upper Silver King Creek, these risks may diminish.

Status Score = 2.1 out of 5.0. High Concern. PCT have a high likelihood of extirpation in their native range within the next 50 years without continued commitment to intense monitoring and management. All populations are small and isolated, and therefore highly susceptible to illegal introductions of alien trout and local stochastic events. The 2013 USFWS Recovery Plan's short-term goal is to restore PCT to their native range in Silver King Creek and continue to monitor and protect all existing populations. The newly-available native habitat may have a carrying capacity of between 4,000 to 7,000 individuals, which is more than enough to meet the recovery population goal of 2,500, giving hope for recovery of this species in the future (W. Somer, CDFW, pers. comm. 2016). Table 3 presents a snapshot in time of the various factors affecting PCT status. If the treatment is deemed successful, these scores will be adjusted upward to reflect new accessible habitat range much greater than historical habitat.

Metric	Score	Justification
Area occupied	2	Occupies several watersheds, but connectivity between headwater populations has recently been established on Silver King Creek.
Estimated adult abundance	2	The largest effective population may be less than 1,000 individuals, but most are much smaller.
Intervention dependence	2	Human assistance required to maintain and increase genetic diversity through reintroduction efforts and protect limited habitats.
Environmental tolerance	2	Actual physiological tolerances not known but adapted for small cold-water headwater streams, which suggests limited tolerance.
Genetic risk	1	Genetic diversity is very low.
Climate change	3	Vulnerable because streams very small and some may become dry during droughts.
Anthropogenic threats	3	2 High, 1 Medium.
Average	2.1	15/7.
Certainty (1-4)	4	Well documented in peer reviewed literature and agency reports.

Table 3. Metrics for determining the status of Paiute cutthroat trout, where 1 is a poor value and 5 is excellent. Each metric was scored on a 1-5 scale, where 1 is a major negative factor contributing to status; 5 is a factor with no or positive effects on status; and 2-4 are intermediate values. Certainty of these judgments is high. See methods for explanation.

Management Recommendations: The Paiute cutthroat trout is still listed as threatened under the federal Endangered Species Act but is recovering. The species is volitionally re-populating its native habitat in over 17 km of uninterrupted habitat in Silver King Creek from refuge

populations in headwater tributaries. The USFWS laid out clear recovery objectives in order to de-list PCT:

1. Remove all nonnative salmonids in Silver King Creek below Llewellyn Falls to barriers in Silver King Canyon. This was completed in the summer of 2015.
2. Introduce a viable population inhabiting all historical habitat in Silver King Creek and downstream tributaries to barriers in Silver King Canyon. Volitional recolonization from headwater refuge populations is ongoing.
3. Existing PCT should be maintained in all occupied streams, including out-of-basin streams should be maintained as refugia and secured from invasion from alien trout species. This is ongoing.
4. A long-term conservation plan agreement must be developed to manage PCT once the species is delisted. This has not yet occurred.

One of the primary management actions noted in the revised 2013 USFWS Recovery Plan was removal of non-native trout in the waters between Llewellyn Falls to Silver King Canyon. This was finally completed by piscicide treatment in 2015. Concern for the ESA-listed mountain yellow-legged frog (*Rana mucosa*), Yosemite toad (*Bufo canorus*), and opposition over the use of rotenone compounds for fear the treatments could harm invertebrates, downstream fishing in the East Fork Carson River, and the ecology of the treatment area significantly delayed removal of introgressed trout in the Silver King drainage and led to studies meant to minimize their impact (Finlayson, Somer, and Vinson 2010, USFWS 2013).

Unauthorized transfers both of PCT and the non-native trout that threaten them have been both a scourge and a savior. In 1949, an unauthorized transfer introduced rainbow trout above the natural barrier at Llewellyn Falls caused PCT to disappear as 'pure' fish; had it not been for the 1946 stocking in Cottonwood Creek and introduced populations within Silver King basin in Fly Valley and Four Mile Creeks, PCT could well have been lost. A cycle of authorized and unauthorized introductions, hybridization, and eventual culling has occurred repeatedly throughout the 20th century for PCT, and reintroduction efforts remain necessary for their conservation and recovery. Current PCT populations are fairly stable, even during drought, but have low genetic diversity (W. Somer, CDFW, pers. comm. 2016). All non-native salmonids have been eradicated from headwater streams to downstream barriers in Silver King Canyon, which was one of the most challenging aspects of recovery deemed necessary to delist the species under ESA. CDFW, U.S. Forest Service and USFWS partners continue to evaluate whether the treatment was successful, and monitor the populations in Silver King Creek to determine abundance and collect data on post-treatment stream conditions. No restocking PCT in Silver King Creek has begun as of this writing, but some individuals have been found in the treatment area that volitionally moved downstream and are starting to re-populate their native range. Paiute monitoring and re-introduction efforts will likely demand a significant portion of CDFW's wild trout efforts in the next few years.

In summer 2017, reintroduction efforts may begin using source populations from headwater streams to Silver King Creek (Finger et al. 2013, W. Somer, CDFW, pers. comm. 2016, R. Bloom, CDFW, pers. comm. 2016). Further recovery efforts entail plans by CDFG and USFWS to include monitoring and securing all existing populations of PCT and their habitat from invasions of non-native trout, as well as continued analysis on the appropriateness of utilizing out-of-basin individuals for reintroduction to their native range (USFWS 2013, W.

Somer, CDFW, pers. comm. 2016). One possible option under an adaptive management approach is to translocate individuals from different reaches and size classes from in-basin refuge populations to their native range. This could be done during spawning to increase exchange of genetic material (Finger et al. 2013).

The idea to employ a conservation hatchery to help recover PCT was discussed, but ultimately rejected (W. Somer, CDFW, pers. comm. 2016). The very low numbers of individuals, coupled with very limited and difficult access into Silver King basin, make this inappropriate. In addition, fishery managers are leery of altering the genetics of these fish through domestication (W. Somer, CDFW, pers. comm. 2016). The very remote and publicly owned habitat of PCT has limited degradation, giving the species a good chance of recovery and delisting in the future. However, illegal introductions of alien trout continue to be a major threat to the continued existence of this species, especially because of the close proximity of PCT to introgressed and non-native trout in lower Silver King Creek and the East Fork Carson River downstream of the barriers in Silver King Canyon (USFWS 2013). Fishing was closed in Silver King Creek in 2006 to help aid species recovery following chemical treatment (USFWS 2013). In addition, small beaver dams were removed during treatment of the Silver King creek to facilitate chemical treatment. The dams have since been naturally rebuilt by beavers and have created valuable pool habitat. During the time of initial listing of PCT, beaver control and dam removal were thought to be required actions necessary to recover the species in its native habitat, but recent evidence suggests that beaver are actually native to the Eastern Sierra and could have positive impacts on the species through creation of dams and valuable pool refuge.

New References:

Bloom, R. 2016. Pers. Comm. CDFW Acting Director of Inland Fisheries.

Mellison, C. 2016. Pers. comm. USFWS Aquatic Biologist, Western Region, Reno, NV.

Somer, W. 2016. Pers. comm. CDFW Wild Trout Biologist, North Central Region.

California Department of Fish and Game. 2014. "A Synopsis of Recent History of California's Inland Trout Management Programs: Litigation and Legislation." *California Fish and Game* 100(4): 727-739.

Finger, A. Mahardja, B. and May, B. 2013. "Genetic Management Plan for the Paiute Cutthroat Trout (*Oncorhynchus clarkii seleniris*)." Genomic Variation Lab, UC Davis. 76pp.

Finger, A. et al. 2011. "Application of a Method for Estimating Effective Population Size and Admixture using Diagnostic Single Nucleotide Polymorphisms (SNPs): Implications for Conservation of Threatened Paiute Cutthroat Trout (*Oncorhynchus clarkii seleniris*) in Silver King Creek, California." *Canadian Journal of Fisheries and Aquatic Sciences*. 68: 1369-1386.

Finlayson, B., Somer, W., and Vinson, M. 2010. "Rotenone Toxicity to Rainbow Trout and Several Mountain Stream Insects." *North American Journal of Fisheries Management* 30(1):102-111.

Lusardi, R. et al. 2015. "Threat evolution: Negative feedbacks between management action and species recovery in threatened trout (*Salmonidae*)." *Reviews in Fisheries Biology* 25: 521-535.

Mehalick, S., and J. Weaver. 2007. "Paiute Cutthroat Trout Survey Report – 2007, Silver King Creek and Coyote Creek, July 31 – August 3, 2007." California Department of Fish and Game, Heritage and Wild Trout Program. 9 pp.

Pritchard, V. et al. 2013. "Discovery and Characterization of Novel Genetic Markers for use in the Management of Lahontan Cutthroat Trout (*Oncorhynchus clarkii henshawi*)." *Molecular Ecology Resources* 13:2. 276-288.

Titus, R. and Calder, L. 2009. "Age and Growth of Paiute Cutthroat Trout, *Oncorhynchus clarkii seleniris*, in the Silver King Creek Drainage, California." Technical Completion Report. California Department of Fish and Game, Sacramento, California. 15pp.

U.S. Fish and Wildlife Service. 2013. "Paiute Cutthroat Trout (*Oncorhynchus clarkii seleniris*) 5-Year Review: Summary and Evaluation." 80pp.