Little Kern Golden Trout
(Oncorhynchus mykiss whitei)

5-Year Review:
Summary and Evaluation

Photo Courtesy of: Todd Matthews

U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
Sacramento, California

September 2011

5-YEAR REVIEW

Little Kern Golden Trout (*Oncorhynchus mykiss whitei)*

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

The Little Kern golden trout (*Oncorhynchus mykiss whitei*) is a subspecies of rainbow trout in the family Salmonidae and endemic to the Little Kern River drainage in Tulare County. The Little Kern River drainage occurs primarily within the Golden Trout Wilderness of Sequoia National Forest. Smaller areas of the drainage occur in either Sequoia National Park or the Sequoia National Forest (Service 2003). Golden trout are known for their brilliant red to red-orange colors on their belly and cheeks, golden sides, olive green backs and orange and white tipped pectoral, pelvic, and anal fins preceded by a dark band (Moyle 2002). This subspecies is closely related to the California golden trout (*O. mykiss aguabonita*) and Kern River rainbow trout (*O. mykiss gilberti*) and can be distinguished by its unique spotting characteristics (generally, additional spotting near the head and below the lateral line) and distinct parr marks (Smith 1977). Little Kern golden trout require cool, oxygenated water with significant clean gravel for reproduction. Similar to other *O. mykiss* forms, spawning occurs between May and June and is largely dependent on water temperature and snowpack runoff (Moyle 2002, Smith 1977). Most fish are relatively long lived, sexually maturing at age three or four and commonly living until age six or seven or longer (Moyle 2002). Historically, the Little Kern golden trout occupied approximately 160 km (99.4 miles) of the Little Kern River and tributaries (Moyle 2002). By 1973, its range was greatly reduced to five headwater streams (upper Soda Springs Creek, Deadman Creek, lower wet meadows creek, Willow Creek, and Fish Creek) and an introduced population in Coyote Creek, or approximately 10% of its historical range (Christenson 1984, Moyle 2002). Although the principal cause of decline of the Little Kern golden trout was due to the introduction of and subsequent hybridization with coastal rainbow trout, other causes include competition with non-native salmonids such as brook trout, and systematic habitat degradation from logging and grazing practices (Christenson 1978, Moyle 2002). Restoration efforts have focused primarily on removing introgressed populations and non-native salmonids and constructing fish barriers to prevent upstream movement of non-native fishes.

Methodology Used to Complete This Review:

This review was prepared by the Sacramento Fish and Wildlife Office (SFWO), following the Region 8 guidance issued in March 2008. We used information from the Revised Fishery Management Plan for the Little Kern Golden Trout (Christenson 1984), both historical and the most recent genetic analyses on the Little Kern golden trout, and the annual reports concerning the implementation of the Little Kern golden trout management plan. We requested information on the latest population estimates, habitat surveys, and other recovery actions as stipulated by the Revised Fishery Management Plan for the Little Kern golden trout from the California Department of Fish and Game (CDFG) and Sequoia National Forest. The Revised Fishery Management Plan, genetic analysis reports, and personal communications with experts were our primary sources of information used to update the species' status and threats. We received no information from the public in response to our Federal Register Notice initiating this 5-year review. This 5-year review contains updated information on the species' biology and threats, and an assessment of that information compared to that known at the time of listing. We focus on current threats to the species that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

Contact Information:

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Federal Register (FR) Notice Citation Announcing Initiation of This Review: A notice announcing initiation of the 5-year review of this taxon and the opening of a 60-day period to receive information from the public was published in the Federal Register on May 21, 2010 (75 FR 28636). We received no information from the public in response to our notice initiating this 5-year review.

Listing History:

<u>Original Listing</u>
FR Notice: 43 FR 15427-15429
Date of Final Listing Rule: 04/13/1978

Entity Listed: *Oncorhynchus* (= *Salmo*) *aquabonita whitei,* a fish subspecies
Classification: Threatened

Associated Rulemakings: Critical habitat for the Little Kern Golden Trout was finalized on April 13, 1978 (43 FR 15427).

Review History: We have not conducted any status reviews for this subspecies since the time of listing.

Species' Recovery Priority Number at Start of 5-Year Review: The recovery priority number for the Little Kern golden trout (*Oncorhynchus mykiss whitei)* is 9 according to the Service's 2010 Recovery Data Call for the Sacramento Fish and Wildlife Office, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Service 1983). This number indicates that the taxon is a subspecies that faces a moderate degree of threat, but has a high potential for recovery.

Recovery Plan or Outline

Name of Outline: The Revised Fishery Management Plan for the Little Kern Golden Trout
Date Issued: April 1984.
Dates of Previous Revisions: A Fishery Management Plan for the Little Kern Golden Trout (Christenson 1978)

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy

The Endangered Species Act defines "species" as including any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate wildlife. This definition of species under the Act limits listing as distinct population segments to species of vertebrate fish or wildlife. The 1996 Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Endangered Species Act (61 FR 4722, February 7, 1996) clarifies the interpretation of the phrase "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the Act.

II. A.1 Is the species under review listed as a DPS?
__ Yes
X No

II.A.2 Is there relevant new information for this species regarding the application of the DPS policy?
__ Yes
X No

Information on the Species and its Status

Spatial Distribution

The Little Kern River basin is located in a remote area of eastern Tulare County, California and covers portions of Sequoia-Kings Canyon National Park and Sequoia National Forest. Most of the basin is currently located in the Golden Trout Wilderness. Successive invasions of ancestral redband rainbow trout between 10,000 and 20,000 years ago allowed the Little Kern Golden Trout to become established in isolation of other salmonids and evolve into its current subspecies form (Benke 1992; Benke 2002; Moyle 2002). These primitive redband trout gained access to the Kern River drainage during glacial cycles and short-term interglacial wet cycles that allowed Lake Tulare to overflow and connect the Kern River drainage to the San Joaquin River and Pacific Ocean (Benke 2002). Although the distribution of the California golden trout (*Oncorhynchus mykiss aquabonita*) has been extensively expanded through introductions, the distribution of the Little Kern golden trout is almost entirely restricted to the Little Kern River and its tributaries.

Historically, the Little Kern golden trout occupied approximately 160 km (99.4 miles) of stream in the Little Kern River basin in eastern Tulare County (Moyle 2002). At the time of listing in 1978, the range of the Little Kern golden trout had been drastically reduced to approximately 16 km (9.9 miles) of stream, or 10% of its historical range and contained fewer than 5,000 individuals (Christenson 1984; Moyle 2002). Range reductions resulted from the introduction of coastal rainbow trout and subsequent hybridization with Little Kern golden trout beginning in the early 1900's (Service 1978). By 1975, remaining non-introgressed populations of Little Kern golden trout occupied only five headwater streams in the Little Kern River basin including, upper Soda Springs Creek, Deadman Creek, lower Wet Meadows Creek, Willow Creek (including Sheep Creek), and Fish Creek (Christenson 1984). Between 1974 and 1995, a series of chemical treatments were conducted by the CDFG in an effort to remove introgressed Little Kern golden trout populations throughout the basin. Little Kern golden trout were then reintroduced from a few local donor populations. Current genetic research conducted by the University of California at Davis indicate significant genetic structuring within Little Kern golden trout subpopulations, typified by low levels of heterozygosity (Stephens 2007). In addition, and likely due to hatchery contamination of Little Kern golden trout stocks previous to restocking efforts, introgressed populations continue to persist in the Little Kern River drainage. The current range of the Little Kern golden trout is therefore difficult to ascertain because while highly introgressed populations were chemically removed between 1978-1995, restocked populations continue to exhibit rainbow trout alleles at low, moderate and even high levels (genetic factors are detailed below and again under Factor E).

Abundance

Prior to restoration efforts, population estimates were reported in 1977 and 1978 for the six headwater streams known to contain non-hybridized individuals of the Little Kern Golden Trout. Approximately 90% of the historical range of the Little Kern golden trout was compromised through the introduction of coastal rainbow trout for the purpose of angling, leading to highly introgressed populations. At the time of listing, the Little Kern River drainage contained less than 5,000 Little Kern golden trout individuals (Christenson 1984). Only those streams containing natural or artificial migration barriers were thought to contained pure Little Kern golden trout populations and these areas were short reaches of headwater streams.

Little Kern golden trout population estimates have been conducted in various years and by multiple practitioners since or immediately before the time of listing. Not surprisingly, different methods have been applied when inventorying populations, making direct comparisons between population surveys difficult. Concerning the reliability of the historical and most recent Little Kern golden trout abundance data, other confounding issues include the lack of corresponding genetic analyses accompanying population surveys that might indicate whether sampled fish were pure Little Kern golden trout or hybridized individuals (see below for genetic status). Simply, historical population surveys are not necessarily indicative of the population status of the Little Kern golden trout at the time of sampling. Rather, it is likely that these estimates reflect a combination of Little Kern golden trout, rainbow trout, and introgressed Little Kern golden trout, at least in some cases. Additionally, chemical treatments of multiple tributaries and lakes from 1974 through1996 drastically reduced population numbers between surveys, further complicating year to year population comparisons.

Two population estimate approaches were used in the Little Kern drainage. Smith (1977), Konno (1986), and Eddinger (2000) used mark-recapture methods and electrofishing, while the CDFG used their standardized population inventory method (Christenson 1980). Due to inherent differences in these methods, we constructed two tables depicting the responsible agency and/or individual conducting the estimate, year of survey, and findings (see Tables 1 and 2 below). The most recent population estimates were conducted in 1995, and at the time, the CDFG was under the assumption that these populations contained pure Little Kern golden trout. Since this time, additional information concerning the genetic integrity of these populations has been released, indicating that introgressed populations continue to persist in the Little Kern drainage. Due to both inconsistent methodology and incorrect assumptions concerning the level of hybridization, the current abundance of the Little Kern golden trout cannot be determined. Recent population estimates guided by the most up to date genetic information are required in order to determine current population trends.

Life History

Little Kern golden trout require flowing water, adequate stream substrate, and a specific range of water temperatures to successfully reproduce. Little Kern golden trout spawning occurs during the late spring or early summer, normally coinciding with the snowmelt recession. Little Kern golden trout generally reach sexually maturity between three to four years old, but have been shown to mature as early as age two (Smith 1977). Bright orange coloration usually accompanies spawning in both males and females, with a decrease in coloration post spawn. The male generally establishes the spawning site territory, while the female selects the redd (spawning nest) location after courtship (Smith 1977). Generally, spawning sites are located in the area of a pool-tail crest with a water depth of 5 to 15 cm (2-5.9 inches), substrate measuring between 5 to 10mm (0.2-0.4 inches), and in close proximity to cover (Smith 1977). The act of spawning can last anywhere from two to seven days. Little Kern golden trout have been shown to produce very few eggs compared with other salmonids. Specifically, Smith (1977) showed that Little Kern golden trout females produced between 41-65 eggs during spawning and attributed low egg production to harsh environmental conditions and/or the small body size of these fish. Average development time for these eggs was approximately 26 days at water temperatures varying between 12º to 16º C and alevins (larval young) remained in bed substrate for about 14 days (Smith 1977).

Little is known about the Little Kern golden trout life history, but the California golden trout, a closely related subspecies, may be used as an informative surrogate for the purposes of comparison. In general, California golden trout, have been known to live as long as nine years, and they commonly reach six to seven years old (Knapp and Dudley 1990). This is extremely old for stream-dwelling trout, and is likely due to the short growing season, high densities of fish, and a low abundance of food in these streams. These conditions create competition for scarce resources, promoting slow growth rates and old ages of trout, due to the minimal energetic costs that are expended in low temperatures in conjunction with food depletion (Knapp and Dudley 1990). Additionally, California golden trout have small home ranges. Home ranges (calculated as a linear distance encompassing 90% of locations) of the trout, using radio-telemetry during the months of July and September, averaged 5 meters (m) (16 feet (ft)) (Matthews 1996a; Matthews 1996b). Movements of 26 to 100 m (86 to 328 ft) were observed, but these constituted less than 1% of all observations (Matthews 1996b). Similarly, Konno (1986) found that the Little Kern Golden Trout average home range was 16.5 m (54 ft) between four tributaries (Fish, Willow, Rifle, and Coyote Creek), and further, suggested that differences in range were attributed to habitat quality and population density.

Habitat or Ecosystem

The Little Kern Golden Trout is endemic to the Little Kern River and its tributaries. The drainage is generally characterized as a high gradient system constructed of bedrock canyons with some alluvial segments occurring at lower elevations (Eddinger 2000). Substrate size varies from coarse sand and gravels to cobbles and boulders with channel gradients ranging from 4-10% (Eddinger 2000; Stephens et al. 1995). Historically, the Little Kern Golden Trout co-existed with the Sacramento Sucker as the only native fish in the basin (Moyle 2002). Both brook trout (*Salvelinus fontinalis*) and coastal rainbow trout (*Oncorhynchus mykiss*) have since been introduced to the Little Kern River and its tributaries for the purposes of angling; the former, a competitively superior fish and the latter capable of hybridizing with Little Kern golden trout. Little Kern Golden Trout use a variety of habitats including lateral scour pools, plunge pools, riffle and undercut banks depending on life stage. Specifically, adult fish tend to select pool habitats, while juveniles occupy shallower habitats with higher stream velocities (Eddinger 2000). More generally, California Golden Trout have been shown to use a range of habitats including aquatic vegetation, sedges, collapsed banks, and boulders, although their preference appears to be undercut banks and sedges (Matthews 1996a). Little Kern Golden Trout primarily feed on aquatic and terrestrial invertebrates (Moyle 2002). During reproduction, Little Kern Golden Trout require pool-tail-crest habitat with water depths of 5 to 15cm (2 to 6 inches), small substrate size particles (10-15mm or .39-.59 inches), sufficient cold water and flow to remove silt and fine sediments, and overhead cover. Although riparian vegetation can be limited on the Little Kern River and its tributaries, patches of sedges and willows (*Salix sp.)* exist with transition to upland zones dominated by Jeffrey (*Pinus jeffreyi*), lodgepole (*Pinus contorta*), and ponderosa pines (*Pinus ponderosa*) (Smith 1977; Konno 1986).

Changes in Taxonomic Classification or Nomenclature

The Little Kern golden trout was originally listed as *Salmo aguabonita whitei*; however, all western North American trout have been reclassified from the genus *Salmo* to the genus *Oncorhynchus*, as summarized by Smith and Stearly (1989) and adopted by the American Fisheries Society's Committee on Names of Fishes, the accepted authority on North American fish taxonomy (Robins et al. 1991). We updated the list of threatened and endangered wildlife to conform to this change in the nomenclature.

The Little kern golden trout (*Oncorhynchus mykiss whitei*) is one of three subspecies of rainbow trout (*O. mykiss*) native to the Kern River basin. The two other native subspecies include the California golden trout (*O. mykiss aguabonita)* and the Kern River rainbow trout (*O. mykiss gilberti*). There has been historic debate on the taxonomy of golden trout in the Kern River basin. Originally, three species of trout were described: *Salmo whitei* from the Little Kern River, *Salmo aguabonita* from the South Fork Kern River, *S. roosevelti* from Golden Trout Creek. In addition, *Salmo gairdeneri gilberti* (Kern River rainbow trout) was determined to be a subspecies of rainbow trout (*Jordan* (1893) in Moyle 2002). Little Kern golden trout were later recognized as a subspecies of *S. aguabonita*, and its taxonomic name was changed to *S. aguabonita whitei* (Moyle 2002). However, most recently, genetic studies have indicated that the Little Kern golden trout and the other trout of the basin are subspecies of rainbow trout (*O. mykiss*).

Genetics

Hybridization with non-native salmonids is the most imminent threat to the Little Kern golden trout. Beginning in the 1930s, and possibly earlier, rainbow trout were introduced to the Little Kern basin (Christenson 1984) and readily hybridized with Little Kern golden trout (Gall et al. 1976). The introductions compromised the genetic integrity of this subspecies. Several allozyme and meristic studies subsequently identified six remaining populations of Little Kern golden trout occupying approximately 10% of their historical range (Gall et al. 1976; Moyle 2002). Chemical recovery efforts between 1974 and 1995 aimed to remove introduced rainbow trout and suspected introgressed Little Kern golden trout populations in order to restore genetic viability. Little Kern River tributaries were then replanted with Little Kern golden trout from five primary source populations (Coyote Creek, Wet Meadow Creek, Deadman Creek, Soda Springs Creek, and Fish Creek) and two additional small source populations from Willow and Sheep Creek (Gall and May 1997). In many cases, the CDFG used early allozyme studies to guide reintroduction efforts (Stephens 2007). Since that time, several genetic studies on the Little Kern Golden trout have been conducted by the University of California at Davis in cooperation with the CDFG and the US Fish and Wildlife Service.

Additional genetic studies were used to gage the effectiveness of the chemical treatments and reintroductions concerning the restoration of the Little Kern golden trout genetics. Using allozyme methods, Gall showed that while several Little Kern golden trout subpopulations exhibited extremely low levels of rainbow trout genetic influence post restoration, others from the Little Kern River at Burnt Coral, Lower Clicks Creek, Middle and South Mountaineer Creeks, and Maggie Lakes showed moderate levels of introgression (from Stephens 2007). Additional work by Bagley et al. (1999) confirmed that several of these Little Kern golden trout subpopulations were introgressed with rainbow trout alleles post restoration. Although the mechanisms leading to hybridization are not fully understood, the 1997 (and possibly 1996) Deadman Creek hatchery broodstock were implicated as being contaminated with rainbow trout alleles, at least for the Maggie Lakes area, but likely for other locations as well (Stephens 2007). This suggests that the reintroduced populations of Little Kern golden trout during this time frame were already genetically compromised before stocking. Stephens (2007) states that introgression in other locations within the Basin may be the result of CDFG hatchery practices, incomplete chemical treatments or illegal transfer of rainbow trout by non CDFG personnel. The most recent genetic studies on the Little Kern golden trout, using both mitochondrial and nuclear DNA, suggest that while some populations show low levels of introgression, others continue to show moderate levels (Stephens 2007, 2010).

Post chemical treatments, Stephens et al. (2007) conducted a genetic assessment of existing Little Kern golden trout populations in order to determine their genetic variability and how successful restoration efforts were at removing the genetic influence of rainbow trout on Little Kern golden trout, using microsatellite DNA loci and SNP (Single Nucleotide Polymorphism) markers. The authors found that the reintroduction history of the Little Kern golden trout to the basin lead to significant genetic structuring of populations coupled by low levels of heterozygosity, an indication of inbreeding. Stephens (2007) also found that gene flow between subpopulations was extremely limited, likely the result of barrier construction preventing genetic mixing or founder effects and genetic drift associated with restocking efforts. Extremely low levels of introgression (less than 1%) were found in 44% of Little Kern golden trout populations, and the vast majority (85%) of populations showed less than 5% rainbow trout introgression. However, other populations including Upper Mountaineer Creek, Alpine Creek, Jacobsen Creek, South Mountaineer Creek, and Shotgun Creek showed moderate levels of introgression ranging between 6-10%. A population on the mainstem of the Little Kern River at Burnt Corral exhibited an introgression estimate of 30%, which is of particular concern because of its downstream location in the drainage and potential to disperse upstream and reproduce with pure or minimally introgressed individuals. Several of these populations were sourced for reintroduction from the Deadman Creek broodstock (Stephens 2007). This donor population was shown, via SNP markers, to inadvertently contain a "pure" rainbow trout, and, thus Little Kern golden trout genes were compromised previous to their reintroduction into the drainage. Due to limited broodstock sources and barriers to gene flow, allelic richness of several extant Little Kern golden trout populations was shown to be extremely low and genetic bottlenecks were common.

Noting that some Little Kern golden trout populations continued to show rainbow trout genetic influence post restoration efforts, Stephens and May (2010) documented the extent of hybridization in 11 "recovering" Little Kern golden trout populations using nuclear and mitochondrial SNP markers. Upper North Fork Clicks, Upper Clicks Creek, Trout meadow creek, Little Kern above Broder's cabin, and Little Kern above Wet Meadow Creek showed low rainbow trout introgression estimates of less than or equal to 2% (between 0% and 2%) by both mitochondrial and nuclear SNP estimates. These populations represent the strongest cases for non-introgressed Little Kern golden trout within the basin for this study. However, the six remaining populations showed discordant results depending on the type of marker used. The Peck's Canyon creek and lower Maggie Lake populations showed nuclear estimates of rainbow introgression at 0.2 and 0.24, respectively, but no introgression by mitochondrial markers. Conversely, Lion and Tamarack Creek exhibited extremely elevated levels of introgression at 0.83 and 0.73, respectively, by mitochondrial markers, but low levels (0.02 for both) of introgression with nuclear markers. Finally, Pistol Creek and Silver Lake showed mitochondrial estimates of rainbow trout introgression at 0.25, but only 0.01 nuclear estimates. Thus, while some populations showed elevated levels of introgression by one marker, they were not necessarily supported by the other maker. Elevated levels of rainbow trout introgression by either marker, however, signify a potential loss of Little Kern golden trout genetic integrity and could influence other populations in the basin (Stephens and May 2010), and therefore should be treated with caution when assessing the efficacy of restoration activities.

Species-specific Research and/or Grant-supported Activities

Listed below are research and restoration projects which the Service has recently funded for Little Kern golden trout recovery efforts.

Genetics-Little Kern River basin-California Department of Fish and Game (CDFG): This project continues prior Service, CDFG, and UC Davis joint efforts in recovery of Little Kern golden trout in the Little Kern drainage. Additional involved entities include the U.S. Forest Service and Sequoia Kings Canyon National Park. To prevent hybridization between native Little Kern golden trout and introduced rainbow trout, a fish migration barrier was improved on Soda Spring Creek. The project also included a genetic analysis component, and, more specifically, examined the efficacy of refined DNA techniques (including new marker development) to quantify levels of introgression between Little Kern golden trout subpopulations and rainbow trout. This work was conducted by the University of California at Davis- Genomic Variation Laboratory. The Soda Spring barrier was completed in 2003 and the DNA systematic analysis and marker development was completed in 2005. The genetic work contributed important background information for the next phase of research: genetic analysis. Funding from section 6 was in partial support of the larger project.

Genetics-Little Kern river basin-CDFG: This project continues prior Service, CDFG, and UC Davis joint efforts in recovery of Little Kern golden trout in the Little Kern drainage. Specifically, the work builds on the previous project by using more refined DNA techniques to verify that historical genetic analysis of six Little Kern golden trout populations, based on allozyme techniques, were accurate in depicting levels of introgression between Little Kern golden trout and introduced rainbow trout. Based on this information, and from a management perspective, hybridized populations will be delineated and replaced with pure Little Kern golden trout. Funding from section 6 grants was in partial support of the larger project.

Genetics-Little Kern river basin-CDFG: This project continues prior Service, CDFG, and UC Davis joint efforts in recovery of Little Kern golden trout in the Little Kern drainage. Specific objectives included determination of the extent of hybridization between Little Kern golden trout and introduced rainbow trout in 11 populations within the Little Kern drainage. Fin tissue collection was conducted by CDFG and volunteers, while genetic analysis was conducted by the UC Davis Genomic Variation Laboratory. Funding from section 6 grants was in partial support of the larger project.

Genetics-Little Kern river basin-CDFG: This project continues prior Service, CDFG, and UC Davis joint efforts in recovery of Little Kern golden trout in the Little Kern drainage. This grant funding builds on the previous work by integrating genetic data on Little Kern golden trout populations in to a genetic management plan. The management plan will synthesize past genetic studies and make recommendations concerning future restoration actions including the role of fish migration barriers in strategically located areas. The genetic management plan will be used in combination with the 1984 Little Kern golden trout fishery management plan (Christenson 1984) to guide restoration actions in the drainage with an end goal of delisting the species. The project is ongoing, beginning in March of 2010 and schedule to end in February 2013.

Five-Factor Analysis

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

When the Little Kern golden trout was listed in 1978 (Service 1978), we identified the potential for uncontrolled use of off-road vehicles, improper road construction, careless logging activities, pollution from mining operations or overgrazing to affect water quality (temperature and sedimentation) and threaten the survival of the Little Kern golden trout. Similar threats were noted in the Revised Fishery Management plan for the Little Kern golden trout (Christenson 1984), but specifically identified Fish Creek, Lion Meadow, Grey Meadow, and Clicks Creek as areas or potential areas of habitat loss.

Although mining and logging activities were discussed as potential threats to the Little Kern Golden Trout in the original listing for the species, we are not aware of any comprehensive information indicating that these factors currently have an impact on Little Kern golden trout occupancy or population dynamics. Therefore, mining and logging are not considered further in this review. In addition, the Golden Trout Wilderness was created in 1978 and overlaps with the vast majority of the Little Kern golden trout critical habitat. Logging and mining are prohibited in federal wilderness areas.

<u>Grazing and Habitat loss</u>

Impacts of livestock grazing to stream habitat and fish populations can be separated into acute and chronic effects. Acute effects are those which contribute to the immediate loss of individuals, loss of specific habitat features (undercut banks, spawning beds, etc.) or localized reductions in habitat quality (sedimentation, loss of riparian vegetation, etc.). Chronic effects are those which, over a period of time, result in loss or reduction of entire populations of fish, or widespread reduction in habitat quantity and/or quality.

According to Minshall et al. (1989), riparian/stream ecosystems are the most threatened ecosystems. Native and domestic grazers, especially cattle, are attracted to these narrow green strips of vegetation due to the presence of water, shade, succulent vegetation, and gentle topography (Platts 1979; Marlow and Pogacnik 1985; Smith et al. 1992; Kie and Boroski 1996; Parson et al. 2003). Riparian areas, especially, are most vulnerable to the effects of overgrazing because cattle tend to concentrate in them (Platts 1979). Summer season grazing (July 1 through September 15) focuses livestock use on riparian areas because of the availability of water, green vegetation, trees and shrubs for cover and food, and the cooler microclimate associated with areas near water and shade (Platts 1979).

Livestock grazing can affect riparian areas by changing, reducing, or eliminating vegetation, and by the actual loss of riparian areas through channel widening, channel degradation, or lowering of the water table (Belsky et al. 1999). Effects on fish habitat include reduction of shade and cover and resultant increases in water temperature, changes in stream morphology, and the addition of sediment due to bank degradation and off-site soil erosion (Belsky et al. 1999). Maintaining streams and their associated riparian areas in a good to excellent condition is important for natural stream functions to occur, increases the stream's ability to respond to natural disturbances such as fires and flood events, and enables the stream to support Little Kern golden trout survival and life history traits.

Grazing has occurred in the Little Kern River drainage for more than 100 years, initially by sheep and more recently by cattle (Sequoia National Forest 1993). Both the timing and magnitude of grazing can greatly affect stream habitat conditions, adjacent riparian areas, and meadow systems with indirect effects to the Little Kern golden trout. Therefore, it is important to effectively manage grazing in terms of the number of cattle, timing of grazing (early and late season), and their exclusion from streams and riparian areas in order to minimize impacts to the Little Kern golden trout and its habitat. Historically, direct effects to stream habitat from grazing in the Little Kern River drainage included bank collapse and sedimentation, increasing stream width to depth ratios, removal of riparian vegetation, and reductions in stream pool volume. Each of these factors is known to negatively affect fish populations.

Two primary grazing allotments are located within the Little Kern river watershed: Little Kern and Jordan allotments. These allotments at least partially overlap with the Little Kern golden trout critical habitat. The biological assessment for the Little Kern and Jordan grazing allotments (Sequoia National Forest 1993) determined that grazing in the Little Kern watershed may adversely affect the habitat of the Little Kern golden trout. Pursuant to this decision, several management recommendations were provided in order to prevent further habitat degradation or loss. Allowable use of the Little Kern allotment includes 225 cow/calf pairs from June 6 to July 15 within critical habitat and from July 15 to August 15 outside critical habitat (Sequoia National Forest 1993). On August 15th, cattle are moved to the Jordan allotment where they graze until September 15th. A portion of the Jordan allotment within the critical habitat of the Little Kern golden trout excludes grazing (Clicks Creek and White Meadow). A series of conditions were put in to place in order to reduce grazing impacts on the Little Kern golden trout, including limits on streambank alteration, willow utilization, and allowable limits on herbaceous and woody species.

Long term monitoring of stream conditions in the Little Kern golden trout critical habitat area were reported by the Sequoia National Forest most recently in 2007. Data collection occurred at eight sites including lower Clicks Creek, Fish Creek, lower and upper Grey meadow, Loggy meadow, Soda Spring Creek, Tamarack Creek, and Willow Creek. Site monitoring was conducted using the Stream Condition Inventory method (SCI). With the exception of Loggy meadows, stream conditions were interpreted to suggest little impact from current grazing regimes. Preceding reports suggested that Loggy meadow appeared to be down cutting, and, therefore, a restoration project was initiated in 2006 in agreement with the USFWS, to ameliorate this issue. As a result of the restoration, channel form changed and a new cycle of baseline data collection was initiated.

Annual utilization monitoring results from 2007-2011 were reported in February 2011 by the Sequoia National Forest (Sequoia National Forest 2011). The report concludes that annual utilization for each year between 2007 and 2010 were in compliance with the terms and conditions of the biological assessment which stipulates the time of year allowable for grazing and maximum utilization rates of 40% for both the Little Kern and Jordan allotments. In 2007, cattle were dispersed early on to the Little Kern and Jordan allotments due to concerns regarding drought conditions and limited water availability for cattle.

Some progress has been made on curbing the detrimental effects of grazing on the Little Kern golden trout. However, Stephens (2007) through discussions with the California Department of Fish and Game states that habitat conditions (from grazing and other anthropogenic impacts) have not significantly changed since the time of listing in 1978. Grazing practices continue in sensitive areas such as Loggy, Lion, and Grey meadows and riparian fencing is not routinely used to exclude cattle from the streams or riparian areas unless sites are actively being restored. Data on stream conditions (abiotic or biotic) or reduction in Little Kern golden trout habitat specific to impacts associated with cattle grazing are extremely limited and should be regularly conducted in the future (see Section V-Recommendations).

<u>Recreational Use</u>

Roads and trails, especially those adjacent to streams, can contribute sediment and other potential pollutants through overland runoff processes (Bilby et al. 1989). In turn, this can negatively affect Little Kern golden trout and their habitat. Within the critical habitat for the Little Kern golden trout, there are at least 50 miles of trails and eight miles of roads (Service 2003). Of particular concern is a road network near Fish Creek and its riparian zone. Off-highway vehicles, and presumably route proliferation, were mentioned in the original listing as a potential threat. However, since the time of listing, the vast majority of the Little Kern golden trout critical habitat has been included within the Golden Trout Wilderness (1978). Motorized vehicles are prohibited in wilderness area. Recreational use associated with trails and route proliferation does not appear to be a threat at this time.

Conservation Measures

The Revised Fishery Management Plan for the Little Kern golden trout (1984) identifies the protection and restoration of habitat within the critical habitat boundary as a priority for the recovery of the Little Kern golden trout. The critical habitat boundary encompasses the entire Little Kern River watershed downstream to one mile below the confluence with Trout Meadows creek. More specifically, the management plan requires: 1) periodic habitat surveys of instream, riparian, and greater landscape processes, 2) restoration of damaged habitat in portions of Fish Creek, Lion creek, Grey Meadow Creek, Coffin Meadow, Round Meadow, Jug Spring, Clicks Creek and other areas as needed and where feasible, 3) resource monitoring programs at five representative sites through periodic sampling of abiotic and biotic factors, and 4) acquisition of land area within the critical habitat boundary when possible.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for commercial, recreational, scientific, or educational purposes was not known to be a factor in the 1978 final listing rule (43 FR 15427-15429). Overutilization for any purpose does not appear to be a threat at this time.

FACTOR C: Disease or Predation

Disease or predation was not known to be a factor in the 1978 final listing rule (43 FR 15427-15429). Whirling disease caused by the nonnative myxosporean parasite, *Myxobolus cerebralis*, is found worldwide and has a long history of occurrence in the eastern Sierra Nevada (Modin 1998). Despite being present in nonnative salmonids (rainbow and brown trout) in the Owens Valley, whirling disease has not been found to impact the Little Kern golden trout. While disease is not currently a threat to the Little Kern golden trout, increased temperatures associated with climate change may cause higher stress levels in the Little Kern golden trout which may increase their susceptibility to disease. Nonnative piscivores, such as brook trout, have been shown to feed on other salmonids (Dunham et al. 2002), but their predatory effects on Little Kern golden trout are not well documented. In addition, brook trout have largely been removed from the Little Kern River basin through chemical eradiation or gill nets. Other known piscivores, such as brown trout, have not dispersed into the Little Kern River drainage (C. McGuire, personal communication 2010). Therefore, disease or predation for any purpose does not appear to be a threat at this time.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

No inadequacies of existing regulatory mechanisms were identified at the time of listing (43 FR 15427-15429). There are several State and Federal laws and regulations that are pertinent to federally listed species, each of which may contribute in varying degrees to the conservation of listed and nonlisted species. These laws, most of which have been enacted in the past 30 to 40 years, have reduced or eliminated the threat of habitat destruction. These laws are discussed below.

State Laws

California Environmental Quality Act

The California Environmental Quality Act (CEQA) requires review of any project that is undertaken, funded, or permitted by the State or a local governmental agency. If significant effects are identified, the lead agency has the option of requiring mitigation through changes in the project or to decide that overriding considerations make mitigation infeasible (CEQA Sec. 21002). In the latter case, projects may be approved that cause significant environmental damage, such as destruction of listed endangered species or their habitat. Protection of listed species through CEQA is, therefore, dependent upon the discretion of the lead agency involved.

Federal Laws

National Environmental Policy Act

The National Environmental Policy Act (NEPA) provides some protection for the Little Kern golden trout. For activities undertaken, authorized, or funded by federal agencies, NEPA requires the project be analyzed for potential impacts to the human environment prior to implementation (42 U.S.C 4371 et seq.). Instances where that analysis reveals significant environmental effects, the federal agency must propose mitigations that could offset those effects (40 CFR 1502.16). However, NEPA does not require that adverse impacts be fully mitigated, and so some impacts could still occur. Additionally, NEPA is only required for projects with a federal nexus, and, therefore, actions taken by private landowners are not required to comply with this law.

Clean Water Act

Under section 404, the U.S. Army Corps of Engineers (USACE) regulates the discharge of fill material into waters of the United States, which include navigable and isolated waters, headwaters, and adjacent wetlands (33 U.S.C. 1344). In general, the term "wetland" refers to areas meeting the USACE's criteria of hydric soils, hydrology (either sufficient annual flooding or water on the soil surface), and hydrophytic vegetation (plants specifically adapted for growing in wetlands). Any action with the potential to impact waters of the United States must be reviewed under the Clean Water Act, NEPA, and ESA. These reviews require consideration of impacts to listed species and their habitats, and recommendations for mitigation of significant impacts.

Endangered Species Act

The Endangered Species Act of 1973, as amended (ESA), is the primary Federal law providing protection for Little Kern golden trout. The Service's responsibilities include administering the ESA, including sections 7, 9, and 10 that address take. Since listing, the Service has analyzed the potential effects of Federal projects under section 7(a)(2), which requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. A jeopardy determination is made for a project that is reasonably expected, either directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its reproduction, numbers, or distribution (50 CFR 402.02). A non-jeopardy opinion may include reasonable and prudent measures that minimize the amount or extent of incidental take of listed species associated with a project. Incidental take refers to taking that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by a Federal agency or application (50 CFR 402.02). While projects that are likely to result in adverse effects often include minimization measures, the Service is limited to requesting minor modifications in the project description. In instances where some incidental take is unavoidable, the Service requires that additional measures be performed by the project proponents to compensate for negative impacts.

National Forest Management Act

The National Forest Management Act (NFMA) (36 C.F.R. 219.20(b)(i)) has required the USDA Forest Service to incorporate standards and guidelines into Land and Resource Management Plans, including provisions to support and manage plant and animal communities for diversity and for the long-term, range-wide viability of native species. Recent changes to NFMA may affect future management of listed species. On January 5, 2005, the Forest Service revised National Forest land management planning under NFMA (U.S. Forest Service 2005). The 2005 planning rule changed the nature of Land Management Plans so that plans generally would be strategic in nature and could be categorically excluded from NEPA analysis, and thus not subject to public review. Under the 2005 planning rule, the primary means of sustaining ecological systems, including listed species, would be through guidance for ecosystem diversity. If needed, additional provisions for threatened and endangered species could be provided within the overall multiple-use objectives required by NFMA. The 2005 planning rule did not include a requirement to provide for viable populations of plant and animal species, which had previously been included in both the 1982 and 2000 planning rules. On March 30, 2007, however, the United States District Court in Citizens for Better Forestry et al. v. USDA (N.D. Calif.) enjoined (prohibited) the USDA from implementing and using the 2005 rule until the Forest Service provided for public comment and conducted an assessment of the rule's effects on the environment, including listed species.

On April 21, 2008, the Forest Service published a final 2008 planning rule and a record of decision for a final environmental impact statement examining the potential environmental impacts associated with promulgating the new rule (U.S. Forest Service 2008). The 2008 planning rule also does not include a requirement to provide for viable populations of plant and animal species on Forest Service lands. As part of the environmental analysis, a biological assessment was prepared to address the 2008 planning rule's impact to threatened, endangered, and proposed species and designated and proposed critical habitat. The assessment concluded that the rule does not affect, modify, mitigate, or reduce the requirement for the Forest Service to consult or conference on projects or activities that it funds, permits, or carries out that may affect listed or proposed species or their designated or proposed critical habitat. On August 8, 2008, the Forest Service published an interim directive and requested public comment on its section 7 consultation policy for developing, amending, or revising Land Management Plans under the 2008 planning rule. Thus, the impact of the 2008 rule to listed species is unknown at this time.

Lacey Act

The Lacey Act (P.L. 97-79), as amended in 16 U.S.C. 3371, makes unlawful the import, export, or transport of any wild animals whether alive or dead taken in violation of any United States or Indian Tribal law, treaty, or regulation, as well as the trade of any of these items acquired through violations of foreign law. The Lacey Act further makes unlawful the selling, receiving, acquisition or purchasing of any wild animal, alive or dead. The designation of "wild animal" includes parts, products, eggs, or offspring.

Wilderness Act

The Wilderness Act (P.L 88-577), as amended in 16 U.S. C. 1131-1136 established the National Wilderness Preservation System. This act affords protection to natural areas by preserving wilderness character and prohibiting roads, motor vehicles, motorized equipment entering these areas except under extremely rare circumstances. Mineral extraction and logging from wilderness areas are also prohibited. Grazing of livestock prior to the inception of the Act is allowed to continue.

In summary, the Endangered Species Act is the primary Federal law that provides protection for this species since its listing as threatened in 1978. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Act.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

Introduced species

Introductions and/or invasions of non-native fishes are widely seen as on one of the major causes of decline in a number of stream dwelling biota, including the Little Kern golden trout. Numerous species were historically introduced into the Little Kern drainage including the Eastern brook trout (*Salvelinus fontinalis)*, rainbow trout (*O. mykiss*), and brown trout (*Salmo trutta*). Eastern brook trout were introduced to several waters within the drainage including Silver Lake, Bullfrog lakes, Hidden Lake, Maggie Lake, Frog Lake, Twin Lake, and Clicks Creek from 1930 through 1941 (Christenson 1984). These fish show strong variability in their life history strategies, thermal tolerance, and habitat preference and range when compared with native fishes such as the Little Kern golden trout. Brook trout are fierce competitors and have been shown to displace native trout through competitive actions (Moyle 2002). Due to their highly competitive nature and overall historical pervasiveness in the drainage, Christenson (1984) listed brook trout as a major concern with respect to Little Kern golden trout persistence in the Clicks Creek area, and more broadly, within the Little Kern River drainage. However, a series of chemical treatments between 1975 and 1996, and the subsequent restocking of Little Kern golden trout have largely eliminated brook trout populations from the Little Kern River subwatershed (C. McGuire, personal communication 2010).

Some evidence suggests that brown trout were introduced to the Little Kern drainage (Twin Lakes) around 1906, but few if any encounters with this species have been reported (Christenson 1984). Although the effects of brown trout on California golden trout are clearly substantial, fish barriers within the Little Kern River basin have largely inhibited brown trout dispersal into this drainage from the larger Kern River basin (C. McGuire, personal communication 2010). Rainbow trout were likely transplanted in the Little Kern River drainage as early as 1870, but historical records indicate a widespread planting regime from 1930 through 1941 in order to mitigate fishing pressure on native populations (Christenson 1984). Rainbow trout are known to hybridize with Little Kern Golden trout, and, thus, compromise their genetic integrity. Similar to brook trout, rainbow trout have also largely been removed from the Little Kern basin due to chemical treatments over the last several decades.

In summary, introduced populations of brook and rainbow trout have been greatly reduced via chemical treatments in the Little Kern drainage, and it is unlikely that brown trout occupy the drainage due to effective fish barriers on the Little Kern River. However, chemical treatments used to eradicate these fishes ended in 1995 and more recent data on the distribution of these introduced fishes in the Little Kern River and its tributaries are not currently available. Furthermore, significant effects to the Little Kern golden trout subpopulations from rainbow trout introductions continue to persist within the drainage (i.e., introgressed Little Kern golden trout populations).

<u>Hybridization and Low Genetic Diversity</u>

Hybridization with non-native salmonids is a common threat to all native western salmonid species (Gresswell 1988; Young 1995). Non-native rainbow trout (*O. mykiss*) readily hybridize with Little Kern golden trout and produce fertile offspring. Extensive genetic mixing of natives, non-natives, and hybrids contributes to the loss of locally adapted genotypes and can lead to the extinction of a species (Rhymer and Simberloff 1996). At the time of listing, introductions of coastal rainbow trout in the Little Kern River and its tributaries were implicated as the primary reason for this subspecies' decline. Hybridization between the introduced rainbow trout and Little Kern golden trout resulted in a reduction in pure populations and their overall range. Pure populations were thought to only persist in the upper-most headwater reaches of five tributaries to the Little Kern River and management efforts focused on chemical eradication of introgressed populations and restocking of Little Kern golden trout between 1975 and 1996. Restoration efforts have largely been successful in removing severely introgressed populations of Little Kern golden trout and the broader influence of non-native fishes (e.g., *Salvelinus fontinalis*).

Little Kern golden trout populations, however, continue to show low, moderate, and even high levels of hybridization with non-native rainbow trout, likely due to prior contamination of the stocked source populations in the Little Kern River drainage, illegal introductions of coastal rainbow trout, and/or holdover introgressed populations post chemical treatment (Stephens 2007, 2010). With respect to the moderate and high levels of hybridization, Upper Mountaineer Creek, Alpine Creek, Jacobson Creek, South Mountaineer Creek, Shotgun Creek, Peck's Canyon Creek, Lion Creek, Tamarack Creek, Little Kern River at Burnt Corral, Lower Maggie Lake, and Silver Lake all provide serious concerns for the genetic integrity of the Little Kern golden trout.

In addition, chemical eradication and restocking have also come with consequences to the Little Kern golden trout genetics. Reestablished populations currently exhibit significant genetic structuring typified by low levels of heterozygosity (Stephens 2007), the likely result of loss of genetic variation associated with founder effects of restocked populations. The prevalence of genetic bottlenecks and reduced gene flow, as noted by Stephens (2007), suggest a further potential for reductions in genetic heterozygosity through genetic drift, likely leading to overall loss of adaptive potential. This suggests that Little Kern golden trout populations may be particularly vulnerable to stochastic events and/or changing habitat conditions associated with climate change.

Limited range and small population sizes

The majority of extant Little Kern golden trout populations show introgression levels less than or equal to 5%, but moderate to highly introgressed populations continue to persist within the basin (Stephens 2007, Stephens 2010). The most recent genetic evidence suggests that the least genetically compromised Little Kern golden trout populations (exhibiting between 0-2% introgression levels) exist in Upper North Fork Clicks Creek, Upper Clicks Creek, Trout Meadow Creek, Little Kern River above Broder's cabin, and Little Kern River above Wet Meadow Creek. Although our knowledge on the relative distribution of pure or introgressed populations is limited by the temporal and spatial scope of the research design conducted over the last several years (Stephens 2007, 2010), the aforementioned populations currently represent the most pure Little Kern golden trout in the entire drainage. These locations, however, only account for a small proportion of the historical range of the Little Kern golden trout and could potentially be compromised by moderate to highly introgressed populations if barriers are not sufficient or during high water years when stream segments are hydraulically connected. In addition, because the current distribution of pure Little Kern golden trout is limited to a few small populations, these populations are vulnerable to stochastic extinction events. With the exception of Coyote Creek, a stream immediately adjacent to the Little Kern River drainage, no known populations of Little Kern golden trout occur outside of the Little Kern River watershed (C. McGuire, personal communication 2011). Ultimately, to achieve recovery, pure Little Kern golden trout should be reestablished throughout their entire historical range (i.e., the Little Kern River drainage).

Climate change

Research has shown that the annual mean temperature in North America has increased from 1955 to 2005. However, the magnitude varies spatially across the continent and is most pronounced during spring and winter months, and has affected daily minimum temperatures more than daily maximum temperatures (Field et al. 2007). Other effects of climate change on stream salmonids may include changes in types of precipitation (i.e., rain vs. snow), earlier spring run-off flow regimes, increased stream temperatures, and more generally, changes in the components of the stream hydrograph.

Warming trends observed over the past 50 years in the United States are predicted to continue (Field et al. 2007). The Intergovernmental Panel on Climate Change (IPCC) states that of all ecosystems, freshwater systems may have the highest proportion of species impacted by climate change (Kundzewicz et al. 2007). Species with narrow thermal tolerances, and, more generally, cold-water species such as salmonids, are anticipated to be severely impacted by climate change (Meisner 1990). Several studies have modeled the effects of increased water temperature from climate change on North American salmonids (Keleher and Rahel 1996; Jager et al. 1999; Rahel 2002; Mohseni et al. 2003; Flebbe et al. 2006; Preston 2006; Rieman et al. 2007). The extent of habitat predicted to become unsuitable for salmonids (from climate induced impacts) ranges from 17 to 97%, depending on the magnitude of the temperature increase, the climate model used, and the region of North America in which the species exists (Rahel 2002; Flebbe et al. 2006; Preston 2006; Rieman et al. 2007).

Water temperature influences the survival and distribution of salmonids and all aquatic life (Allan 1995). Alterations in the temperature regime from climate change can broadly affect population dynamics at both the watershed and stream scale (McCullough 1999). High stream temperatures have been shown to suppress appetite and growth (Meeuwig et al. 2004), influence behavioral interactions (De Staso and Rahel 1994), increase susceptibility to disease (McCullough 1999; Schisler et al. 2000), or induce mortality in stream fishes (Dickerson and Vinyard 1999). Salmonids inhabiting warm stream segments have higher probabilities of mortality due to stress (McCullough 1999; Meeuwig et al. 2004). Loss of downstream habitat due to increases in water temperature may result in population declines and restrict subpopulations to smaller headwater reaches near cold water sources.

Climate models also predict an increase in precipitation over most of North America except for the southwestern United States (Christensen et al. 2007). In western North America, predicted increases of precipitation have a strong north-south orientation with higher precipitation expected in northern latitudes and lower precipitation in southern latitudes (Christensen et al. 2007). Due to predicted increases in warming, future precipitation events may be more likely to constitute rain than snow, especially during the spring. This may result in a reduced snowpack, earlier snowmelt, decrease spring runoff, and extension of the base flow period in the summer and fall (Hayhoe et al. 2004; Stewart et al. 2005; Knowles et al. 2006, Bates et al. 2008).

For salmonids and other stream dwelling organisms, flow regimes determine the amount and availability of water and habitat, and more generally, the dominant disturbance regime (Swanston 1991; Spence et al. 1996; Marchetti and Moyle 2001). Low flow conditions can reduce the amount of available habitat and food, while increasing competition for space and food resources (Harvey et al. 2006; Spence et al. 1996). Reduced flow can also strand fish in isolated pools and increase their susceptibility to predation and disease, while also exposing them to high water temperatures and low dissolved oxygen concentrations (Spence et al. 1996). Declines in stream flow can also alter biotic composition, structure, and function of aquatic and riparian communities (Richter et al. 1996; Poff et al. 1997).

Finally, changes in air temperature and precipitation will likely lead to changes in the magnitude, timing, and duration of runoff events (Bates et al. 2008). Salmonid life histories are closely aligned with natural flow regimes (Bjornn and Reiser 1991). A change in timing or magnitude of floods could scour the streambed, destroy eggs, or displace recently emerged fry downstream (Erman et al. 1988; Kondolf et al. 1991). Like many Western North America salmonids, Little

Kern golden trout are spring spawners, and, thus, changes in the timing, magnitude, or duration of spring runoff could disrupt recruitment and survival with significant population level consequences.

In summary, the impacts of climate change on the Little Kern golden trout are not known with certainty. Predicted outcomes of climate change imply that negative impacts will occur through increases in stream temperatures, decreases in stream flow, and broader changes to the stream hydrograph. The extent to which these physical factors affect Little Kern golden trout populations is difficult to ascertain, but maintaining spatially robust populations and maximizing genetic diversity should help buffer the negative effects of climate change on Little Kern golden trout populations.

III. SYNTHESIS

At the time of listing, the range of the Little Kern golden trout was reduced to six headwater streams in the Little Kern River drainage, or a reduction of approximately 90% of their historical range. This range reduction was mostly notably reduced due to the presence of introduced salmonids, and, to some extent, habitat loss associated with grazing, logging, and mining activities among other anthropogenic activities (OHV route proliferation, road building, etc.). Habitat loss due to human induced disturbance has been greatly reduced due to the protections of Little Kern golden trout critical habitat area associated with the Golden Trout Wilderness. However, while grazing management has improved, grazing still regularly occurs within the critical habitat boundary of the Little Kern golden trout and streams are not routinely fenced to minimize detrimental effects of grazing on Little Kern golden trout habitat.

By far, the greatest historical threat to the Little Kern golden trout was loss of genetic diversity through hybridization with introduced coastal rainbow trout populations (*O. mykiss*). Severely introgressed Little Kern golden trout populations and the competitive influence of non-native brook trout on Little Kern golden trout populations have been reduced through chemical treatments within the drainage and the subsequent restocking of Little Kern golden trout hatchery broodstock progeny. However, several streams continue to show moderate and even high levels of introgression including Upper Mountaineer Creek, Alpine Creek, Jacobson Creek, South Mountaineer Creek, Shotgun Creek, Peck's Canyon Creek, Lion Creek, Tamarack Creek, Little Kern River at Burnt Corral, Lower Maggie Lake, and Silver Lake. The source of genetic contamination is not fully understood. Some authors have implicated the 1997 Deadman Creek hatchery broodstock as being contaminated with rainbow trout alleles previous to stocking (Bagley et al. 1999), while other authors have also suggested hold over introgressed populations post chemical treatment or illegal introductions (Stephens 2007). Regardless of the mechanisms, introgressed Little Kern golden trout populations continue to persist in the Little Kern River drainage. The reintroduction history of the Little Kern golden trout into the drainage post chemical treatment has also led to significant genetic structuring coupled by low levels of heterozygosity, an indication of inbreeding. Gene flow between subpopulations has been greatly reduced due to barrier construction and/or founder effects and genetic drift associated with restocking efforts. Reduced gene flow between populations, and more generally, reductions in genetic heterogeneity resulting from reintroductions and founder effects decrease the adaptive potential of Little Kern golden trout subpopulations, while also making their long term persistence and ability to recover from stochastic events tenuous. Finally, the impacts to the Little Kern golden trout from climate change are not fully understood. Predicted outcomes include increased stream water temperatures, decreased stream flow especially during base flow periods, and more generally, changes in the annual hydrograph. These impacts may exacerbate the current threats to the Little Kern golden trout and affect their long term persistence. Based on the continued threats of limited range and small population sizes and low genetic diversity, the Little Kern golden trout still meets the definition of threatened and no change in status is recommended at this time.

IV. RESULTS

Recommended Listing Action:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (indicate reason for delisting according to 50 CFR 424.11):
    ____ *Extinction*
    ____ *Recovery*
    ____ *Original data for classification in error*
_X_ No Change

New Recovery Priority Number and Brief Rationale: No change

Listing and Reclassification Priority Number and Brief Rationale:

V. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

1. Update the current Fishery Management Plan with a formal genetics management plan for the Little Kern River drainage with specific actions that increase genetic diversity and restore pure populations of Little Kern golden trout throughout their entire historical range. Regularly monitor Little Kern golden trout population trends throughout the drainage as guided by the most recent genetic information. If Little Kern golden trout hatchery programs are reinitiated, ensure facilities are entirely separated from rainbow trout production programs.

2. Initiate a systematic habitat monitoring program in the Little Kern drainage that regularly (every five years) assesses stream conditions throughout the drainage, including both abiotic (temperature, water quality, bank stabilization, sediment distribution, riparian vegetation recruitment, etc.) and biotic (macroinvertebrate surveys and Little Kern golden trout population surveys) factors. More sensitive stream sites, such as those located in the Little Kern and Jordan grazing allotments should be monitored more regularly (every two years).

3. Install and regularly maintain riparian fencing on streams in the Little Kern and Jordan grazing allotments, especially those in low gradient meadow reaches such as Lion, Grey, and Loggy meadows.

4. Regularly evaluate the structural integrity of stream barriers and their ability to inhibit the dispersal of non-native salmonids throughout the Little Kern River drainage (especially during high water years) and make improvements where necessary. Assess the benefits of barriers in terms of preventing non-native salmonid dispersal and compare with the potential genetic costs of these barriers in terms of reducing gene flow between naturally occurring populations of Little Kern golden trout.

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Table 1: Little Kern golden trout population estimates at multiple tributary sites in the Little Kern River drainage (trout/km likely includes both pure and hybridized individuals). Mark/recapture estimates conducted via electrofishing were used by each individual. If multiple reaches were used during the sampling period, the number of trout/km was averaged. Average number of trout/km is indicated by an asterisk. Visual population estimates (Eddinger 2000) were not included.

Individual	**Stream**	**Date**	**Trout/km**
Smith	Fish Creek	4/12/1977	960
Konno	Fish Creek	6/21/82	163.2
Konno	Fish Creek	8/13/1982	182.4
Konno	Fish Creek	7/25/1983	140.8
Konno	Fish Creek	9/2/1983	115.2
Smith	Willow Creek	4/30/1977	433*
Smith	Willow Creek	6/22-6/30/1977	433*
Smith	Willow Creek	9/17/1977	520*
Eddinger	Lower Willow Creek	1997	235
Eddinger	Lower Willow Creek	1997	200
Konno	Willow Creek	6/25/1982	240
Konno	Willow Creek	8/10/1982	563.2
Konno	Willow Creek	11/4/1982	342.4
Konno	Willow Creek	7/27/1983	460.8
Konno	Willow Creek	9/13/1983	492.8
Smith	Deadman Creek	6/9/1977	687*
Smith	Deadman Creek	7/13/1977	427*
Smith	Deadman Creek	10/7/1977	560*
Smith	Upper Soda Spring Creek	6/2-6/7/1977	680*
Smith	Upper Soda Spring Creek	7/12/1977	680*
Smith	Upper Soda Spring Creek	10/6/1977	300*
Eddinger	Lower Soda Spring Creek	1997	340
Eddinger	Middle Soda Spring Creek	1997	250

Individual	Stream	Date	Trout/km
Eddinger	Jacobsen Creek	1997	455
Eddinger	Lion Creek	1997	530
Eddinger	Mountaineer Creek	1997	185
Eddinger	Sheep Creek	1997	305
Eddinger	Lower Tamarack Creek	1997	385
Eddinger	Upper Tamarack Creek	1997	295
Konno	Coyote Creek	7/17/1982	336
Konno	Coyote Creek	9/4/1982	467
Konno	Coyote Creek	9/7/1983	320
Konno	Rifle Creek	7/19/1982	256
Konno	Rifle Creek	9/2/1982	691.2
Konno	Rifle Creek	11/7/1982	534.4
Konno	Rifle Creek	9/16/1983	428.8

Table 2: Little Kern golden trout population estimates conducted by the CDFG using their standardized population inventory method (Christenson 1980) at multiple tributary sites in the Little Kern River drainage (trout/km likely includes both pure and hybridized individuals). Notes: asterisks indicate recovering population from chemical treatment; () indicates pre-restoration index; [] indicates sample size; # indicates that inventory does not represent true condition of trout population. Table adapted from Christenson 1997.

Site	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Lower Wet Meadows	.98	2.44	1.18	1.36	1.08	--	1.41 [5]	--	--	--		--	.64		--	--
Upper Wet Meadow	--	--	--	.26*	.22*	.80	.43* [3]	--	--	--	--	--	.22	--	--	--
Upper Little Kern	--	--	--	.06	.02*	--	.26*	1.73	--	2.34	--	--	.74	--	--	.42
Little Kern River (Rifle)	--	--	--	--	--	(2.06)	(2.06)	--	--	--	--	--	--	--	--	--
Rifle	--	--	(1.31)	--	.10*	.02*	.02*	--	--	--	--	.56*	--	--	--	--
Pistol	--	--	barren	--	--	--	barren	--	--	--	--	--	--	--	--	--
Lower Shotgun	--	--	(1.10)	--	--	--	(1.10)	--	--	--	--	.24*	--	--	--	--
Upper Shotgun	--	--	--	--	--	--	--	(.71)	--	--	--	--	--	--	--	--
Lower Willow	.91	1.05	1.13	.84	.58	--	1.48	--	--	--	--	1.8	--	--	--	--
Upper Willow	--	1.10	.94	.64	.72	--	1.08	--	--	--	--	1.08	--	--	--	--
Lower Tamarack	--	.12*	.30*	1.0*	.94	1.0	.80	--	--	--	--	.92	--	--	--	1.16
Upper Tamarack	--	--	.06*	0	--	--	--	--	--	--	--	--	--	--	--	--
Sheep	--	1.06	1.16	1.3	.64	--	1.33	--	--	--	--	--	1.3	--	--	--
Lower Lion	--	(1.57)	.01*	.50*	--	--	--	--	--	--	--	--	--	--	--	2.0
Upper Lion	--	barren	.01*	.02*	--	--	--	--	--	--	--	--	--	--	--	--
Table	--	--	barren	--	LKGT	--	--	--	--	--	--	--	--	--	--	--

Meadow Cr.					established											
Lower Soda Spring	--	--	(2.51)	--	--	--	--	--	(2.24)	--	--	--	--	--	--	--
Middle Soda Spring	--	(1.26)	.18*	.28*	.13*	.63	.64*	--	--	1.64*	--	--	--	--	--	--
Upper Soda Spring	1.82	2.26	1.96	1.08	.78	.38	1.48	--	--	0.74	--	--	--	--	--	--
Upper Mountaineer	--	--	(2.84)	--	--	(3.31)	--*	--	--	--	--	--	--	--	--	--
Upper Alpine	--	--	--	--	--	--	--	--	1.51	--	--	--	--	--	--	--
Deadman	.45	.93	.98	.60	.70	--	--	--	--	--	--	--	--	--	--	--
South Mountaineer	--	--	(.75)	--	--	(1.52)	.86	--	.6	--	--	--	--	--	--	--
Jacobsen	--	--	(2.92)	.24*	--	--	.25*	--	--	--	--	--	--	--	--	--
Pecks Canyon Cr.	--	--	(1.36)	--	--	--	--	--	--	--	--	--	--	--	--	2.4
Lower Fish	--	.26	.7	.08	.28	.92	2.24	.94	--	--	--	--	--	--	--	--
Middle Fish	.06	.47	.76	1.06	.24	1.31	6.88	1.24	--	--	--	--	--	--	--	--
Upper Fish	--	Barren	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lower Trout Meadows	--	--	(2.17) --	--	--	--	(2.17)	--	--	--	--	--	--	--	--	--
Upper Trout Meadow	--	--	(2.27)	.74	--	--	(1.51)[2]	--	--	--	--	--	--	--	--	--
Upper Deep	--	.31	1.08	.88	--	.56	.71* [4]	--	--	--	--	--	--	--	--	--
Middle Deep	Barren	.07*	.2*	.56*--	.76*	--	.4* [4]	--	--	--	--	--	--	--	--	--
Lower Deep	--	.83	.32*	.1*	.26*	.32*	.37* [5]	--	--	--	--	--	--	--	--	--
North Fork Clicks	--	--	(1.10)	.22*	--	--	.07*	--	--	--	--	--	--	--	--	--

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

Little Kern golden trout (*Oncorhynchus mykiss whitei*)

Current Classification: Threatened

Recommendation Resulting from the 5-Year Review:

_____ Downlist to Threatened
_____ Uplist to Endangered
_____ Delist
_X_ No change needed

Review Conducted By: Robert A. Lusardi, Sacramento Fish and Wildlife Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve [signature] Date 8 Sept 2011