# Modoc Sucker (*Catostomus microps*)

# 5-Year Review:
# Summary and Evaluation

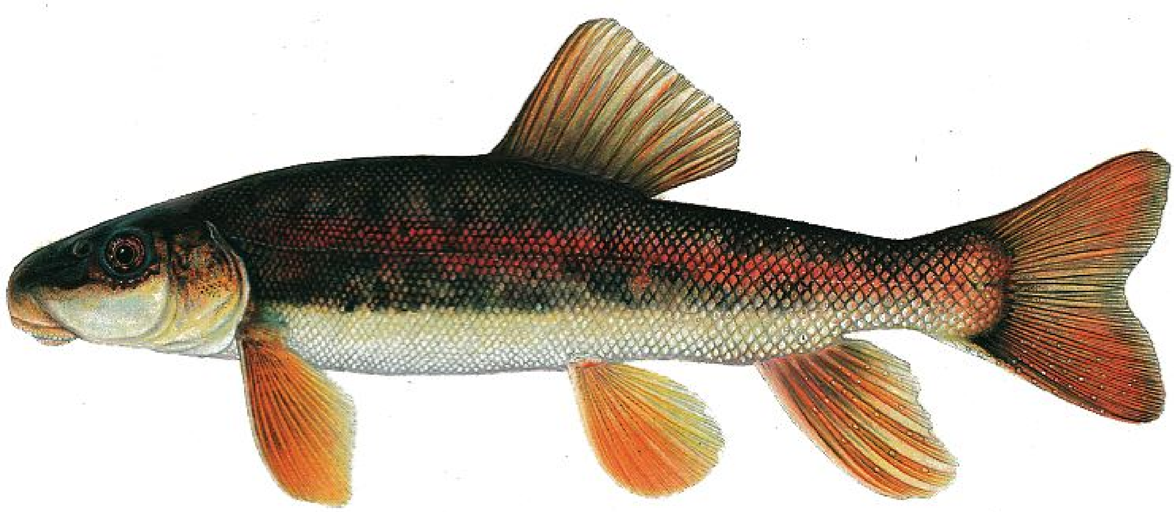

Illustration by Joe Tomelleri

Modoc sucker, *Catostomus microps* - male in spawning color

## U.S. Fish and Wildlife Service
## Klamath Falls Fish and Wildlife Office
## Klamath Falls, Oregon

**June 2009**

# 5-YEAR REVIEW
**Modoc sucker (*Catostomus microps*)**

## 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 Modoc sucker, *Catostomus microps*, is a relatively small member of the sucker family (Catostomidae), generally maturing around 3-4 inches, and usually reaching only 7 inches in total length. Its known range is limited to three stream drainages in the upper Pit River Basin, including the Goose Lake sub-basin, in northeastern California (Modoc and Lassen counties) and south-central Oregon (Lake County; Figures 1 and 2). Modoc suckers typically occupy small, moderate-gradient streams with low summer flow. They are most abundant in pools, especially those deeper than one foot, where they graze on algae and small benthic invertebrates.

### Methodology Used to Complete This Review:

This review was prepared by the Klamath Falls Fish and Wildlife Office, following the Region 8 guidance issued in March 2008. In 2007, we contracted with Stewart Reid of Western Fishes of Ashland, Oregon, to assemble all available information relevant to the conservation management of the Modoc sucker into a Conservation Review of the Modoc sucker (Reid 2008c). Dr. Reid is a recognized expert on the freshwater fishes of northern California and southern Oregon, with a decade of experience working with native fishes in the Pit River system and on Modoc sucker conservation. The Conservation Review and its citations were used as the foundation for this review.

We received no information from the public in response to our March 22, 2006, 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. In this review, we focus on current threats to the species based on the Act's five listing factors. The review synthesizes this information to evaluate the listing status of the species and provide an analysis of 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.

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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 March 22, 2006 (55 FR 14538).

**Listing History:**

> **<u>Original Federal Listing</u>**
> **FR Notice:** 50 FR 24526
> **Date of Final Listing Rule:** June 11, 1985
> **Entity Listed:** Modoc sucker (*Catostomus microps*) a fish species.
> **Classification:** Endangered
>
> **<u>State Listing:</u>** *Catostomus microps* was listed by the State of California as endangered in 1980, and is categorized by the State of Oregon as "Sensitive-Critical" (ODFW 2008a).

**Associated Rulemakings:** Critical habitat was designated in 1985 (50 FR 24526).

**Review History:** Although we have tracked the status of the Modoc sucker and evaluated threats in the context of recovery activities and biological opinions since the species was listed, no comprehensive status review (e.g., 12-month finding, 5-year review, or reclassification rule) has been completed. The June 11, 1985, final rule (50 FR 24526; USFWS 1985) is the most recent comprehensive official analysis of the species status, and it will be used as the reference point for this review.

**Species' Recovery Priority Number at Start of 5-Year Review:** The recovery priority number for *Catostomus microps* is 14 according to the Service's 2008 Recovery Data Call, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). A rank of 14 indicates that no subspecies are recognized, the species faces a low degree of threat, and it has a high potential for recovery.

### Recovery Plan or Outline

**Name of Plan or Outline:** Action Plan for the Recovery of the Modoc sucker (*Catostomus microps*).
**Date Issued:** April 27, 1983.
**Dates of Previous Revisions:** None.

At the time of proposed listing in 1984, the Service, the California Department of Fish and Game (CDFG), and the U.S. Forest Service (USFS) were developing an "Action Plan for the Recovery of the Modoc sucker" (see Reid 2008c). The April 27, 1983, revision of this Plan was formally signed by all participants in 1984, and went through a number of subsequent revisions from 1984 to 1992, none of which were signed. The signed 1984 Action Plan was used to preclude the need for a formal recovery plan at the time of listing (USFWS 1985). The 1984 Action Plan and its 1989 revisions were again designated in lieu of a formal Recovery Plan for the Modoc sucker in a memorandum (dated February 28, 1992) from the Regional Director (Region 1) to the Service's Director. The purpose of the 1984 Action Plan was to provide direction and assign responsibilities for the recovery of the Modoc sucker. It also provided action (recovery) tasks and reclassification (downlisting/delisting) criteria (see section III below).

## II. REVIEW ANALYSIS

### Application of the 1996 Distinct Population Segment (DPS) Policy

The Act defines a "species" to include any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate 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.

This species is not listed as a DPS and there is no relevant new information regarding the application of the DPS policy to this taxon.

## Information on the Species and its Status

Species Biology and Life History

Historical Range

At the time of listing, the historical range of the Modoc sucker was believed to be limited to Ash and Turner sub-drainages which are small tributaries of the Pit River in Modoc and Lassen counties, California (USFWS 1985; Figure 1). However, it is now recognized that the historical range of the Modoc sucker also includes the Goose Lake sub-basin in southern Oregon and northern California, a currently disjunct, upstream sub-basin of the Pit River (Reid 2007a; Figure 1). Goose Lake has been hydrologically disconnected from the Pit River since the 1800's because it has not substantially overflowed into the North Fork of the Pit River since occasional events in the 1800's (Laird 1971). Although the California and Oregon populations are isolated, the Modoc sucker population in the Goose Lake sub-basin is morphologically and genetically similar to the populations in the Pit River (Dowling 2005a; Topinka 2006; Reid, unpub. data 2008).

Spatial Distribution

The current distribution of the Modoc sucker within its natural range includes populations in ten streams in three sub-drainages (Reid 2008c; Figures 1 and 2, above). At the time of listing in 1985, the distribution of the Modoc sucker was considered to be restricted to the Turner and Ash Creek sub-drainages of the Pit River (i.e., Turner, Hulbert, and Washington creeks [all tributaries to Turner Creek], and Johnson Creek [a tributary of Rush Creek]). The original listing also recognized four additional creeks (Ash, Dutch Flat, Rush, and Willow creeks) as having been occupied historically. However, these populations were presumed lost due to hybridization with Sacramento suckers (*Catostomus occidentalis*). Although there was no genetic corroboration of hybridization available at that time (Ford 1977; Mills 1980; USFWS 1985), hybridization was suspected because of overlapping occurrences.

New information is available which documents the occurrence of three additional populations not considered in the original listing (i.e., Coffee Mill and Garden Gulch creeks in the Turner sub-drainage and Thomas Creek in the Goose sub-basin). New genetic information is also available on the four populations considered lost to hybridization in 1985. The seven populations that were not considered as occupied in the 1985 distribution are reviewed below. The Thomas Creek population is in the Goose Lake sub-basin of Oregon; all of the other populations are in the Pit River sub-basin in California.

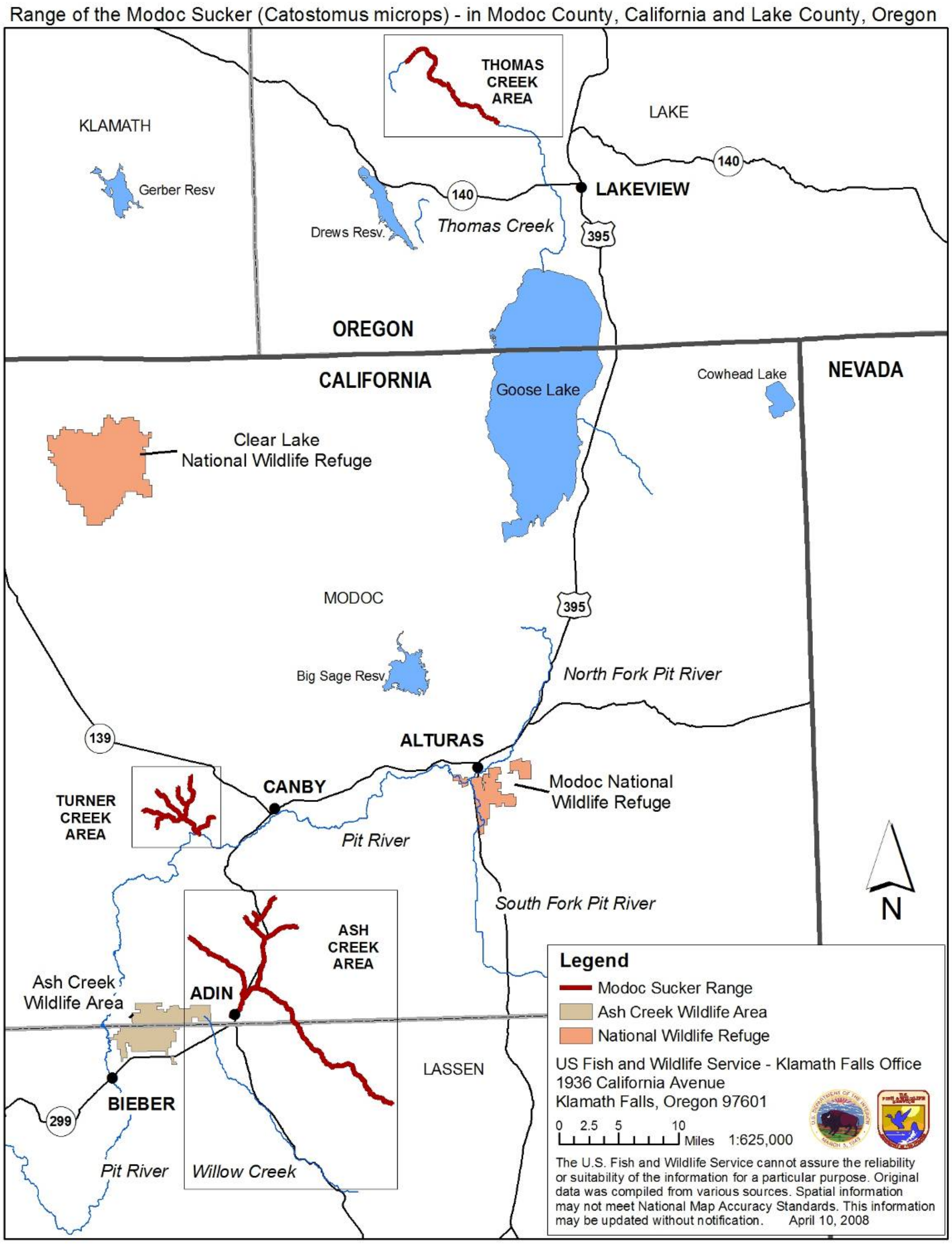


Figure 1. Map showing the range of the Modoc sucker in Lake County, Oregon, and Modoc and Lassen counties, California.

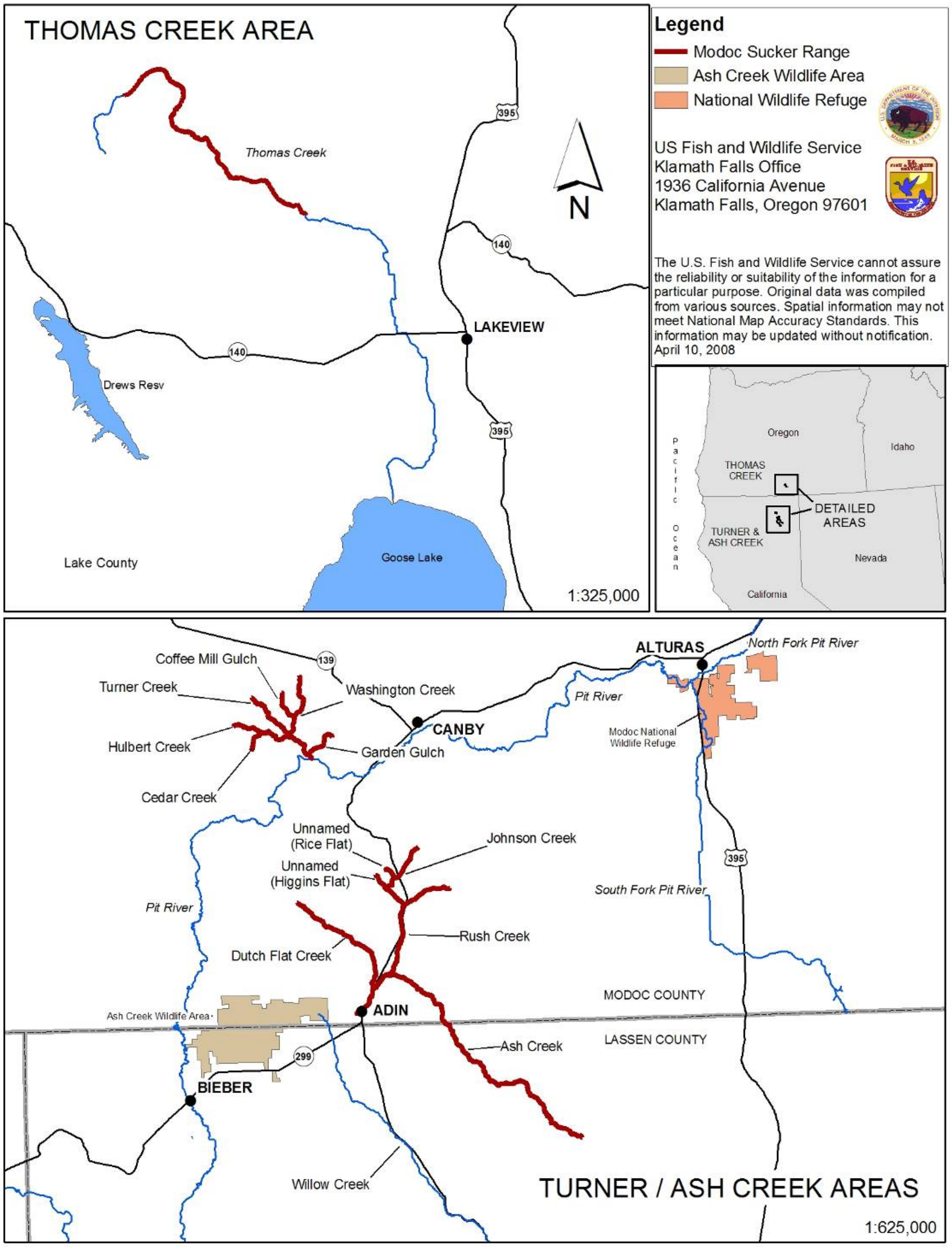


Figure 2. Map showing detailed distribution of the Modoc sucker in the Thomas Creek drainage, Oregon, of the Goose Lake sub-basin and the Turner/Ash Creek drainages, California, in the upper Pit River sub-basin.

1) *Coffee Mill Creek* – In 1987, CDFG transplanted twenty Modoc suckers from Washington Creek to Coffee Mill Creek. Mill Creek is a tributary of Washington Creek (Figure 2) that appeared to have suitable habitat but was considered historically fishless due to a high gradient barrier at its mouth. The transplant included 12 adults and 8 juveniles, and was intended to establish an additional population in the Turner Creek drainage (CDFG 1986). Modoc suckers appear to be well established and relatively abundant in Coffee Mill Creek. Spawning adult and juvenile suckers have been consistently observed there during recent visual surveys (Reid 2008c).

2) *Garden Gulch* – A previously unreported population of Modoc suckers has been found in Garden Gulch, a small tributary of Turner Creek near its confluence with the Pit River and about two miles downstream of Hulbert and Washington Creeks (Reid, unpub. data 2001; Moyle 2002; Topinka 2006; Figure 2). Garden Gulch contains about one mile of suitable habitat. A 2008 survey of the stream resulted in a population estimate of about 50, 1+ year old Modoc suckers (Reid 2008e).

3) *Thomas Creek* – At the time of listing, the historical range of the Modoc sucker was thought to have been limited to small streams tributary to the Pit River in Modoc and Lassen counties, California (USFWS 1985; Figure 2). However, new information documents the presence of Modoc suckers in the Goose Lake Basin (Oregon), a disjunct, upstream sub-basin of the Pit River (Reid 2007a). Field surveys by S. Reid (October 2001) and re-examination of museum specimens by Reid found that the species has been collected periodically, and the species is still present, in Thomas Creek, the principal northern tributary to Goose Lake (Reid 2008c; Figures 1 and 2).

Examination of the Oregon State University fish collection revealed several lots of Modoc suckers collected in Thomas Creek that were misidentified as Sacramento suckers (S. Reid, pers. comm. April 2001). Modoc sucker specimens were found in collections from five sites on Thomas Creek taken in 1954, 1974, 1993 (two collections), and 1997. Surveys conducted in 2007 confirmed Modoc suckers were present throughout 14 miles of upper Thomas Creek (Reid 2007a).

4) *Dutch Flat Creek* – Recent collections and preliminary genetic analysis indicate that, 23 years after the original listing, Modoc suckers in Dutch Flat Creek (tributary to Ash Creek) exhibit little introgression of Sacramento sucker alleles (Topinka 2006; C. Smith et al., preliminary data 2008; Figure 2).

5) *Ash Creek* – Thirty years after Moyle's collections (Moyle and Marciochi 1975; Moyle and Daniels 1982), suckers exhibiting the morphological characteristics of Modoc suckers are still present in Ash Creek. However, genetic analysis has revealed that this population has considerable introgression with Sacramento suckers (Topinka 2006; Abernathy Fish FTC, unpubl. data 2008; Figures 1 and 2). Sacramento suckers have also been reported from upper Ash Creek since 1963, and were collected from about 10 miles downstream in 1898. (Miller 1963; Rutter 1908; Reid 2008a). Therefore, it is believed that Sacramento suckers did not recently invade the Ash Creek system and that the observed introgression is a historically natural phenomenon. Due to its unique

introgressed character and full sympatry with Sacramento suckers, the Ash Creek population is treated as an extant population. However, for the purpose of evaluating the status of the species, it is not considered a secure population needed for recovery because it is uncertain how genetically secure this population is.

6) *Rush Creek* – Rush Creek is a tributary to Ash Creek (Figure 2), and contains the type locality of the Modoc sucker. Surveys indicate that Modoc suckers still occupy the historically occupied reaches (Reid 2008c), and there has been no change in the fish fauna to include warm-water fishes that would likely be associated with Sacramento suckers (e.g., Sacramento pikeminnow [*Ptychocheilus grandis*], hardhead [*Mylopharodon conocephalus*], and non-native sunfishes [family Centrachidae]; Moyle and Daniels 1982).

7) *Willow Creek* – Surveys and collections in Willow Creek (Lassen County, tributary to Ash Creek; Figure 2) in the early 1970's and more recently in 2000, 2002, and 2008 have documented only Sacramento suckers, although some Modoc sucker genetic markers are present in the population (Moyle and Daniels 1982; Reid 2007b, 2008b; Topinka 2006). Previous reports of Modoc suckers in Willow Creek are based on limited and unverifiable reports (Reid 2008c). It is also evident that both Sacramento suckers and Sacramento pikeminnows have been present in upper Willow Creek since at least the early 1970's and that speckled dace (*Rhinichthys osculus*), a species typically associated with Modoc suckers, have never been recorded from the upper reaches (Moyle and Daniels 1982). Therefore, it is unknown if a population of Modoc suckers was present in Willow Creek in the recent past, and for the purpose of this status review, Willow Creek is not considered to contain an extant population of Modoc suckers.

Population Estimates

There have been five attempts to estimate the population sizes of the Modoc sucker (Table 1). All of these estimates were for populations in the Pit River drainage of California. No population size estimates are available from the Oregon portion of the range.

**Table 1. Comparison of Pit River system Modoc Suckers population estimates. No population estimates are available from Thomas Creek in the Goose Lake sub-basin.**

| **Stream Drainage** | **Estimated Population Size** | | | | |
|---|---|---|---|---|---|
| | Moyle 1974 | Ford 1977 | White 1989 | Scoppettone et al. 1992 | Reid 2008 |
| **Turner Creek Drainage** | 100 | - | - | 640+ | 552+ |
| Turner | - | 100 | - | 249+ | 265+ |
| Washington | - | 50 | - | 230 | 100+ |
| Coffee Mill | - | - | - | 50 | 106+ |
| Hulbert | - | 500 | - | 106 | 31+ |
| Garden Gulch | - | - | - | - | ~50 |
| | | | - | | |
| **Ash Creek Drainage** | - | - | - | - | - |
| Johnson | 3,163 | 700 | - | 653 | 128+ |
| Rush | 535 | 1,000 | | - | - |
| Dutch Flat | - | 40 | 133-358 | 1,300+ | 101+ |
| Ash | 300 | 200 | - | - | - |
| Willow | - | 15[1] | - | - | 0 |

1. These 15 suckers are most likely Sacramento suckers based on their morphology (Reid 2007b, 2008b).

At the time of listing, it was estimated that there were less than 5,000 Modoc suckers. An estimated 1,300 of these 5,000 fish were considered genetically “pure”; the remainder were treated as hybrids with Sacramento suckers (USFWS 1985). These estimates were based on limited sampling and visual surveys along with qualitative estimates of un-surveyed stream reaches or populations (Moyle 1974; Ford 1977).

Moyle (1974) suggested that the total number of Modoc suckers in the known populations was unlikely to exceed 5,000 individuals (Table 1). This was based on his 1973 sampling of 124 stream sections (mostly about 108 feet long), primarily focused on the Rush Creek drainage (67 reaches). He estimated a population size of 3,500 Modoc suckers for most of the Rush Creek drainage, plus an additional 150 to 200 suckers in un-sampled irrigation ditches off lower Rush Creek. There was considerable uncertainty in the exact population size because the standard deviations reported generally exceeded the estimates because of the high variance in counts from each segment. Too few samples were taken in other streams to accurately estimate population sizes for these streams. However, Moyle estimated less than 300 Modoc suckers in Ash Creek and less than 100 in the entire Turner Creek drainage.

Ford (1977) estimated a total population of 2,600 Modoc suckers, with about half occurring on USFS-managed lands (Table 1). His estimates included all known populations, including:

Willow (15), Ash (200), Dutch Flat (40), Rush (1,000), Johnson (700), Turner (100), Hulbert (500) and Washington (50). Mills (1980), who was cited in the 1985 listing, did not actually survey, but cited Moyle (1974) and Ford (1977), then reduced the estimate of what he considered "pure" Modoc suckers to 1,250 (including only those from Hulbert, Washington, and Johnson Creeks). Mills' estimates were based on an assumption that all Modoc sucker populations sympatric with Sacramento suckers were lost as a result of hybridization.

Two additional attempts to estimate Modoc sucker population sizes were made in the 1980s and 1990s by Scoppettone et al. (1992) and White (1989). Scoppettone et al. (1992) carried out preliminary surveys in the Turner Creek drainage, Johnson Creek, and Dutch Flat Creek near the end of a substantial drought. They primarily did visual surveys from the bank, with snorkel surveys in the lower reaches of all but Dutch Flat Creek. Suckers were counted but not identified to species; however, it is reasonable to assume that most of the suckers, with the exception of those in the lowest stratum of Turner Creek, were Modoc suckers. Excluding the lower Turner stratum ("Stratum 6"), they counted a minimum of 640 suckers in the upper Turner drainage, over 1,300 suckers in Dutch Flat Creek, and 650 suckers in Johnson Creek. This results in a very conservative total of over 2,600 Modoc suckers, not including Garden Gulch, Rush, or Ash creeks.

The results of surveys done in the Turner Creek drainage and in Johnson Creek in 1992 by Scoppettone et al. (1992) suggest that the Modoc sucker populations in those systems were relatively stable when compared to estimates by Ford (1977). They were also much higher than those estimated by Moyle (1974) for the entire Turner Creek system (including Hulbert, Washington, and Coffee Mill creeks). A one-day survey of Dutch Flat Creek by White (1989) counted 130 definite suckers and 225 probable suckers, and Scoppettone et al.'s 1992 estimate for the Dutch Flat population substantially exceeded Ford's (1977) estimate of 40 individuals by over 1,200 individuals.

Reid (2008d) recently developed a survey protocol that has several advantages over previous methods. It was used in 2008 to survey for Modoc suckers in the Pit River portion of the range (Reid 2008e; Table 1). The surveys were done at night when suckers are most visible and counts were made of fish ≥2.4 inches standard length (distance between the snout and caudal peduncle) (1+ year old) because they are more visible and more readily identified than smaller fish. Reid's (2008d) survey protocol used visual counts rather than electro-fishing because suckers are particularly sensitive to electro-fishing. Population estimates by Reid (2008e) are similar to those of Scoppettone et al. (1992) for most streams. The primary exception is Dutch Flat where Scoppettone et al. (1992) had estimated >1,000 individuals and Reid (2008e) estimated approximately 100 individuals. It is not known what accounts for these differences, but it could be due to differences in sizes of suckers counted by the two researchers. Scoppettone et al. (1992) counted all suckers regardless of size, whereas Reid (2008e) only counted those estimated to be ≥2.4 inches standard length.

The population totals discussed above are approximations rather than absolute numbers. Because different methods were used, the estimates are not directly comparable. Estimates are affected by sucker behavior both seasonal and diurnally, as well as by changes in visibility. Also, there is likely to be some variability among observers, even when the same protocol is used. Thus, visual surveys of Modoc suckers, such as those reported above, need to be done with considerable attention to the factors affecting visual counts (Reid 2008d, e).

Although the population estimates presented above are subject to error, they do suggest that the populations have been relatively stable over the 35 years that the species has been monitored. Additionally, the species has occupied most of the available habitat. These data suggest that the populations are resilient to threats such as drought and non-native predators that affect survival and reproduction.

Habitat or Ecosystem

Modoc suckers are primarily found in relatively small (second- to fourth-order), perennial streams. They occupy an intermediate zone between the high-gradient and higher elevation, coldwater trout zone and the low-gradient and low elevation, warm-water fish zone. Most streams inhabited by Modoc suckers (Turner and Ash creek drainages) are second- to fourth-order streams with moderate gradients (15-50 feet drop per mile), low summer flows (1-4 cubic feet per second), and relatively cool (59-72° F) summer temperatures (Moyle and Daniels 1982).

In the Pit River system, Modoc suckers occupy stream reaches above the Sacramento sucker/pikeminnow/hardhead zone of the main-stem Pit River and the lower reaches of its primary tributaries (Moyle and Marciochi 1975; Moyle and Daniels 1982). The known elevational range of Modoc sucker is from about 4,200 to 5,000 feet in the upper Pit River drainage (Ash and Turner Creeks) and from about 4,700 to 5,800 feet in the Goose Lake sub-basin (Reid 2007a, b). However, most known populations are constrained by the effective upstream limit of permanent stream habitat. Only Rush and Thomas creeks extend substantially above the elevations occupied by Modoc suckers.

The pool habitat occupied by Modoc suckers generally includes fine sediments to small cobble bottoms, substantial detritus, and abundant in-water cover. Cover can be provided by overhanging banks, larger rocks, woody debris, and aquatic rooted vegetation or filamentous algae. Larvae occupy shallow vegetated margins and juveniles tend to remain free-swimming in the shallows of large pools, particularly near vegetated areas, while larger juveniles and adults remain mostly on, or close to, the bottom (Martin 1967, 1972; Moyle and Marciochi 1975).

Modoc suckers often segregate themselves along the length of a stream by size with larger individuals being more common in lower reaches of streams. This may indicate a temperature-growth relationship or it may indicate that larger Modoc suckers move downstream into larger, deeper, warmer pool habitats as they outgrow the relatively limited habitat in upper stream reaches. Spawning often occurs in the lower end of the pools over gravel-dominated substrates containing gravels, sand, silt and detritus.

Because spawning and rearing habitats are relatively non-specific and common, suitable habitat is not considered limiting except during severe droughts. There are approximately 40 miles of suitable habitat within their range and most of that is occupied (Table 2).

**Table 2. Comparison of available and occupied perennial habitat of Modoc sucker (Reid 2008c).** A + sign indicates that additional habitat is present but has not been surveyed.

| Drainage: Stream | Available Habitat (miles) | Occupied Habitat 2008 (miles) |
|---|---|---|
| Turner Creek Drainage: | | |
| Turner | 5.5 | 5.5 |
| Washington | 4.5 | 3.4 |
| Coffee Mill | 1.5 | 0.8 |
| Hulbert | ~ 3.0 | ~3.0 |
| Garden Gulch | 0.3 | 1.0 |
| | | |
| Ash Creek Drainage: | | |
| Johnson | 2.7+ | 2.7 |
| Rush | 4.6 | 4.6 |
| Dutch Flat | ~ 2.0 | ~1.4 |
| Ash | ? | ~2.0 |
| Willow | ? | ? |
| | | |
| Goose Lake Drainage: | | |
| Thomas Creek (above the falls) | 15.2+ | 15.2 |
| Thomas Creek (below the falls) | ~5.0+ | ~5.0 |
| **Totals** | **>40** | **>40** |

Modoc suckers appear to be opportunistic feeders, similar to other catostomids, feeding primarily on algae, small benthic invertebrates, and detritus (Moyle 2002). Moyle and Marciochi (1975) reported the digestive tracts contained detritus (47 percent by volume), diatoms (19 percent), filamentous algae (10 percent), chironomid larvae (18 percent), crustaceans (mostly amphipods and cladocerans; 4 percent), and aquatic insect larvae (mostly tricopteran larvae, 2 percent). The contents suggest that the suckers were feeding in low-energy pool environments, where detritus settles and chironomids live.

Although no comprehensive study of activity patterns has been done for Modoc suckers, they do appear to exhibit both diurnal and seasonal differences in activity. They are most active, and visible to creek-side observers, later in the morning and through the afternoon. At this time they are frequently seen foraging on the substrate (including rocks) and along submerged plant stems (Reid 2008c). While they spend much of their time apparently resting on the bottom, they are quick to swim away and respond to disturbance. They frequently change positions and locations within a pool even during undisturbed observations. In contrast, extensive night snorkeling observations indicate that Modoc suckers are resting and relatively somnolent after dusk (Reid 2008c).

Changes in Taxonomic Classification or Nomenclature

The taxonomy of the Modoc sucker has not changed since its original description by Rutter in 1908.

Genetics

In 1999, the Service initiated a program to examine the genetics of suckers in the upper Pit River drainage (including Goose Lake) and determine the extent and role of hybridization between the Modoc and Sacramento suckers (discussed below under Factor E). Both nuclear and mitochondrial genes (Palmerston et al. 2001 – allozymes; Wagman and Markle 2000 – nuclear genes; Dowling 2005a – mitochondrial genes; Topinka 2006 – nuclear amplified fragment length polymorphisms (AFLP's); Abernathy Fish Technology Center [FTC], unpubl. data 2008 – microsatellites) were used. The results from all approaches indicate that the two species are genetically similar. This indicates that they are relatively recently differentiated and/or have a history of introgression throughout their range that has obscured their differences (Wagman and Markle 2000; Dowling 2005a; Topinka 2006). Although the available evidence does not allow rejection of either hypothesis, the genetic similarity in all three sub-drainages, suggests that introgression has occurred on a broad temporal and geographic scale and therefore is not a localized or recent phenomenon caused or affected by human activities. This includes those populations shown to be free of introgression based on species-specific genetic markers (Topinka 2006; Abernathy Fish FTC, unpubl. data 2008).

A phylogenetic analysis using mitochondrial DNA placed Modoc and Sacramento suckers in the same lineage distinct from neighboring sucker species. However, it did not distinguish the two morphological species, suggesting either recent divergence or the broad replacement of one species' mitochondrial genome by that of the other (Dowling 2005a). The analysis did identify geographic patterns of distinctiveness between the three sub-drainages examined (Ash, Turner, Goose), suggesting relatively low levels of genetic exchange.

The analyses using nuclear AFLP's and faster evolving microsatellites also show differences between sub-drainages (Topinka 2006; Abernathy FTC, unpubl. data 2008). However, they further identified consistent species-specific alleles (different forms of a gene) indicating reproductive independence in the two species. Therefore, available information supports the distinctiveness of the two species and the management of the three sub-drainage populations of Modoc sucker as separate units. The Abernathy FTC is assessing genetic diversity and gene exchange in the various Modoc sucker populations using microsatellites, as well as working to further resolve the degree of hybridization between Modoc and Sacramento suckers. We anticipate that this work will be complete in 2009.

Preliminary microsatellite results indicate that the amount of genetic diversity observed within populations of Modoc suckers (as measured by allelic diversity at 8 microsatellite loci) is similar to, but slightly lower than, that observed in Sacramento suckers (Abernathy FTC, unpubl. data 2008). This result is reassuring given that Modoc sucker populations are considerably smaller than Sacramento sucker populations.

## 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

### Habitat

The 1985 listing rule stated that land management activities had: 1) dramatically degraded Modoc sucker habitat, 2) removed natural passage barriers allowing hybridization with Sacramento suckers and providing exposure to predaceous fishes, and 3) decreased the distribution of the Modoc sucker to only four streams (USFWS 1985).

Since listing, the majority of Modoc sucker streams on public land have been fenced to exclude or actively manage cattle grazing (Reid 2008c). The original listing noted the improvements seen over just three years and continued protection over the last 23 years has allowed substantial improvements in riparian vegetative corridors, in-stream cover, and channel morphology. In 2001, CDFG, in cooperation with the Modoc National Forest and the Service, carried out extensive habitat surveys of all known occupied stream reaches on public land and all private lands in the Turner Creek drainage and lower Johnson Creek (Rossi 2001). All stream habitat was characterized and mapped using GIS, and pool characteristics (e.g., area, depth, substrate, cover, etc.) were recorded and photographs were taken at each pool. Subsequent to stream mapping, the principal team members carried out a Proper Functioning Condition (PFC; Prichard et al. 1998) assessment for occupied reaches of each stream (CDFG 2002). Proper Functioning Condition is a method of assessing the physical functioning of riparian and wetland areas. The term PFC is used to describe both the assessment process, and a defined, on-the-ground condition of a riparian-wetland area. The team found that all streams reaches of designated Critical Habitat on public lands were in "proper functioning condition" (i.e., Turner, Coffee Mill, Hulbert, Washington, Johnson Creeks) and that Dutch Flat and Garden Gulch, two occupied streams not originally listed as Critical Habitat, were "functional-at risk" with "upward trends," which is a positive condition just below proper functioning condition. On private lands surveyed in Critical Habitat, most habitat was assessed to be "functional-at risk;" however, all habitat also showed upward trends.

Extensive landowner outreach and improved land stewardship in Modoc and Lassen counties have also resulted in improved protection of riparian corridors on private lands. Cattle are currently excluded from all private land Critical Habitat on Rush Creek and Johnson Creek below Higgins Flat (Modoc National Forest), allowing continued upward trends in habitat condition (Reid 2008c). At this time, the Service has no indication that land management practices on public and private lands adjacent to Modoc sucker habitat will not continue. Upward habitat trends are expected to continue as a result.

Thomas Creek, in the Oregon portion of the Goose Lake sub-basin, was not known to support Modoc suckers in the original listing. The majority of the upper Thomas Creek watershed and the stream reaches containing Modoc suckers are managed by Fremont-Winema National Forest. Prior to learning that there were Modoc suckers in the drainage, the USFS in 1986 established the Thomas Creek Riparian Recovery Project. The purpose of the Project is to halt erosion, stabilize stream banks, and reduce water temperatures for the benefit of native fishes. There have been numerous riparian restoration and channel improvement projects to promote deeper pool development and water retention, as well as improved grazing management. Redband trout (*Oncorhynchus mykiss* ssp.), speckled dace, and Pit-Klamath brook lamprey (*Entosphenus lethophagus*) also occupy upper Thomas Creek, but there are no non-native fishes (Reid 2007a; Scheerer et al. 2007).

There are two privately-owned meadow reaches of Thomas Creek above the lower forest boundary that are characterized by low gradient and large open pools. Both are managed for grazing by the USFS permittee. The lower parcel, which is unfenced and grazed with neighboring USFS allotments, contains substantial populations of Modoc sucker (Reid 2007a). The upper parcel is fenced and has not been surveyed; although, Modoc suckers are abundant in pools at its boundaries and therefore the suckers are likely occur on the un-surveyed stream reach. At present, Thomas Creek provides over 15 miles of habitat for Modoc suckers. During distribution surveys in 2007, Modoc suckers were abundant in pools throughout the system, even at the end of a summer of substantial drought when intervening channel reaches were dry (Reid 2007a). At this time, the Service has no indication that current land management practices on public and private lands on Thomas Creek that are compatible with the conservation of the species will not continue. Therefore upward habitat trends are expected to continue.

### Barriers

The original listing assumed that natural passage barriers in streams occupied by Modoc suckers had been eliminated by human activities, allowing hybridization between the Modoc and Sacramento suckers (see Factor E). The lack of barriers was also through to provide exposure to non-native predatory fishes. However, surveys of occupied Modoc sucker streams reveal no evidence of historical natural barriers that would have physically separated the two species. This is particularly true during higher springtime flows when Sacramento suckers make their upstream spawning migrations (Reid 2008c). The source of this misunderstanding appears to have been a purely conjectural discussion by Moyle and Marciochi (1975, p. 559) that was subsequently accepted without validation, and Moyle makes no mention of it in his most recent account of Modoc sucker status (Moyle 2002, Reid 2008c).

## Range

At the time of listing, the distribution of the Modoc sucker was thought to be restricted to portions of Turner and Rush Creeks, two small drainages in Modoc County (California), and specifically to four creeks: Turner, Hulbert, and Washington creeks (both tributaries to Turner Creek), and Johnson Creek (a tributary of Rush Creek). The listing also recognized four additional creeks (Ash, Dutch Flat, Rush, and Willow creeks) as having been occupied in the past. However, these populations were presumed lost due to hybridization with Sacramento suckers and were, therefore, excluded from the 1985 distribution of the species (Ford 1977; Mills 1980; USFWS 1985; see discussion of hybridization under Factor E).

Since listing, additional field surveys and an ongoing genetic assessment program have increased our understanding of the distribution and genetics of Modoc sucker populations (Palmerston et al. 2001; Wagman and Markle 2000; Dowling 2005a; Topinka 2006; Reid 2007a, b). The Service currently recognizes ten stream populations of Modoc suckers in three sub-drainages, including: Ash Creek drainage (Ash, Rush, Johnson, and Dutch Flat creeks), Turner Creek Drainage (Turner, Washington, Coffee Mill, Hulbert, and Garden Gulch creeks), and Goose Lake sub-basin (Thomas Creek). The historical presence of a substantial population of Modoc suckers in Willow Creek (Lassen County, California) is unlikely (Reid 2008c). The distribution of Modoc suckers within the four stream populations recognized in 1985 has either remained stable over the past 22 years, or has slightly expanded, and the ten current populations occupy all available and suitable habitat in their streams (Reid 2008c).

The natural distribution of the Modoc sucker is highly restricted relative to the widespread Sacramento sucker, which is also native to the upper Pit Drainage. However, there is no evidence showing that the historical range of the Modoc sucker, or its distribution within that range, has been substantially reduced in the recent past (Reid 2008c). To the contrary, continued field surveys have resulted in expansions of the species' range.

**Factor A Conclusion**

Present or threatened destruction, modification, or curtailment of its habitat by land management activities is no longer considered a threat to the continued existence of the Modoc sucker. Habitat conditions in designated Critical Habitat and other occupied streams have steadily improved since listing and have sustained populations of Modoc suckers for at least 23 years. Furthermore, land management practices employed on public and private lands since the early 1980's are expected to continue, or improve, thereby maintaining upward habitat trends. The natural distribution of the Modoc sucker is highly restricted relative to the widespread Sacramento sucker, which is also native to the upper Pit Drainage. However, there is no evidence showing that the historical range of the Modoc sucker, or its distribution within that range, has been substantially reduced in the recent past. To the contrary, recent field surveys have resulted in expansion of the species' range. Furthermore, the distribution of Modoc suckers within the stream populations recognized in 1985 has either remained stable over the past 23 years, or slightly expanded, and the ten populations appear to occupy all available and suitable habitat.

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

The listing rule (USFWS 1985) did not identify any threats in this category, and there is no new information indicating threats through overutilization for commercial, recreational, scientific or educational purposes. The State of California designated the Modoc sucker as endangered and fully protected in 1980, prohibiting unauthorized take or possession of the species. The State of Oregon has recently added the Modoc sucker to its sensitive species list, giving it a "critically sensitive" status (ODFW 2008a). The Oregon Department of Fish and Wildlife (ODFW) uses this list internally when conducting environmental project reviews. Also, under the State's angling regulations, the species can only be taken by special permit (ODFW 2008b).

The Modoc sucker is a small fish that is not attracted to lures or bait, and there is no commercial or recreational fishery. Therefore, the only expected utilization of Modoc sucker is for limited scientific purposes (e.g., genetic sampling, mark and recapture) that are unlikely to substantially affect the species. The states of California and Oregon, as well as the Service, closely monitor scientific take through a permit process to ensure that it does not become a threat.

## FACTOR C: Disease or Predation

### Disease

The original listing (USFWS 1985) did not identify any threats to the Modoc sucker due to disease or parasites, and there is no new information to indicate that such a threat exists. Although parasites (e.g., *Lernaea* sp., an introduced copepod) exist in the Pit River sucker populations, the Service is not aware of historical fish die-offs in the upper Pit River watershed caused by disease or parasites, nor are we aware of existing catastrophic fish diseases in the Pit River or neighboring watersheds that threaten the Modoc sucker.

### Predation

The Modoc sucker, which rarely exceeds 7 inches standard length in small streams, typically occupies habitat where the only native predatory fish is the redband trout, a primarily insectivorous species that occasionally feeds on small fishes (Moyle and Marciochi 1975; Moyle and Daniels 1982; Moyle 2002). The original listing identified the presence of introduced and highly piscivorous brown trout (*Salmo trutta*) as a threat that reduced sucker numbers through predation, although there is no information specifically linking this threat to Modoc suckers (USFWS 1985). Since listing, additional predatory non-native fishes have been recorded in streams containing Modoc suckers (Reid 2006).

Piscivorous non-native fishes, at the least, suppress local sucker populations through direct predation. Brown trout and largemouth bass (*Micropterus salmoides*), both large piscivorous species, can have substantial adverse impacts on local populations of smaller native fishes (discussed below). However, not all non-native species appear to represent a major threat to the Modoc sucker. Turner Creek supports a relatively large population of suckers despite the nearly continuous presence since at least the 1970's of green sunfish (*Lepomis cyanellus*) and probably brown bullhead (*Ameiurus nebulosus*), as well as periodic populations of bluegill (*Lepomis macrochirus)*. All three species are primarily insectivorous at the sizes observed in Turner Creek (Moyle 2002); green sunfish reach 5.5 inches standard length, bluegill reach 6 inches, and brown bullhead are rarely, if ever over about 7 inches in Turner Creek (Reid 2007b). Although these non-native fishes may occasionally consume larval and juvenile suckers, they also consume predatory insects (e.g., larval dragonflies and diving beetles) that prey on young fish and likely consume small Modoc suckers. At this time, the ecological dynamics between introduced and native fishes in the Turner Creek Drainage are not fully understood, and more information is needed. However, current information indicates that green sunfish, bluegill, and brown bullhead are not a substantial threat to Modoc sucker populations.

Brown trout were first introduced to Ash and Rush Creeks in the early 1930's and have established reproducing populations in both streams (VESTRA 2004). Small populations also occur in the larger tributaries of both streams, including Johnson Creek. In 1934, when early ichthyologists first revisited the type locality of Modoc sucker in Rush Creek, they found brown trout co-occurring with Modoc suckers (Hubbs and Miller 1934). Seventy years later, the two species are still both found in the Rush Creek drainage. Larger brown trout are voracious piscivores, and are likely to suppress sucker and other native fish populations within a co-occupied stream reach (Moyle 2002). Observations in Rush and Johnson creeks indicate that when large brown trout (> 8 inches standard length) are present in a pool, native Modoc suckers and speckled dace are present in relatively low numbers and stay hidden in vegetative or structural cover (Reid 2007b). However, the coexistence of suckers and brown trout in the Ash Creek drainage (including Rush and Johnson creeks) for over 70 years suggests that predation by brown trout is, on its own, unlikely to threaten the continued existence of the Modoc sucker. Brown trout have not been recorded in Dutch Flat Creek (a small tributary to Ash Creek) and are not present in either Turner Creek (one individual removed in 2005) or Thomas Creek drainages. Current CDFG policy avoids stocking of brown trout into natural streams in the Pit River drainage (Chappell, pers. comm. 2006), and the Oregon Wild Fish Management policy prohibits stocking of brown trout, or any other non-native fishes, into Goose Lake Basin streams where they would adversely impact native fishes (ODFW 2003).

Largemouth bass is a voracious, non-native predator that grows to a sufficiently large size to consume all sizes of Modoc sucker and will substantially reduce or eliminate all native fishes in pools it occupies (Moyle 2002). During extensive non-native fish surveys in 2005 and 2006 it was determined that when a single bass occupied a pool, no smaller native fishes were found in that pool and larger Modoc suckers remained hidden in the day, only emerging at night (Reid 2006).

Largemouth bass may be present (no formal records) in the lowest reaches of Ash Creek, near the Pit River, but there are no bass upstream of Modoc sucker populations, and cool-water stream reaches downstream protect existing sucker populations (Reid 2008a, 2008c). In the Turner Creek drainage, bass exhibit a pattern where they are periodically observed in the streams (Turner and Washington creeks) and then apparently disappear, either through natural mortality or emigration, but they do not successfully reproduce (Reid 2006). They were not encountered in the first surveys of the Turner Creek drainage in 1973 (Moyle and Daniels 1982) and were first reported in 1977 from Turner Creek (Ford 1977) and in 1984 from Washington Creek, but not Turner Creek (CDFG 1984).

Largemouth bass were again recorded in low numbers from only lower Turner Creek, near its mouth, in 1992 and from Washington Creek in 1990. It is probable that bass were present in 1990 in Turner Creek as well, but access was not available on the private lands at that time (Scoppettone et al. 1992; Reid 2006). After that, only one bass (2003, removed) was observed above the barrier until 2004, when large numbers of bass and sunfish were flushed into the system from upstream reservoirs during particularly high spring flows (Reid 2006). The principal source for bass, and other non-native species, in Turner Creek above the gauge station barrier (including Washington Creek) appears to be several reservoirs higher in the Turner and Washington creek watersheds, and there does not appear to be significant immigration from the Pit River (Reid 2006).

Since 2005, the Service has supported a successful program of active management for non-native fishes in the Turner Creek drainage, targeting bass and sunfishes with selective angling and hand removal methods that do not adversely impact native fish populations (Reid 2006). As a result , there are no bass or bluegill present in upper Turner Creek or its tributaries (Reid 2008f). Green sunfish remain only in Turner Creek itself, where their numbers are greatly reduced (estimated at about 75 percent in 2005), and as a small population in Garden Gulch. Brown bullheads have not been targeted yet, but their numbers are generally low in the system, and individuals over 7 inches are rare, if present. Juvenile sucker populations were observed to rebound substantially following removal of bass from the system (Reid 2006, S. Reid, Western Fishes, pers. comm. 2007). In 2006, the USFS installed a screen to prevent non-native fish escapement at the outflow of Loveness Reservoir, which accumulates all surface flow prior to entry into the occupied reaches of Washington Creek. The effectiveness of the screen is being monitored with annual surveys of Washington Creek. No largemouth bass were seen downstream of the screen in 2007 and 2008. This suggests the screen is effective, but flows were relatively low in 2007 and 2008, and it remains to be seen how the screen will function in higher flows (Reid 2008f).

Transfer of fish from one water body to another is prohibited by state regulations in both California and Oregon (CDFG 2007, ODFW 2008b). However, illegal transfers of sport and bait fishes sometimes intentionally occur by fishermen wanting to "seed" a locality. Although it is possible that someone would illegally introduce non-native fishes into a Modoc sucker stream, it is unlikely because the streams are infrequently used by fishermen, and if done it would probably represent a relatively small number of individuals when compared to dispersal events (e.g., reservoir overflows). The nine principal streams containing Modoc sucker populations (excluding Ash Creek) are generally small and are not frequented by sport fishermen. Rush Creek is the largest and supports a limited coldwater trout fishery; brown trout are already present in the stream, and its cold-water habitat is not suitable for bass. Fishermen occasionally visit the smaller streams to fish native redband trout populations. However, the small pools typical of Modoc sucker streams are generally not attractive to bass fishermen given the proximity of local reservoirs where bass are abundant.

In summary, two of the three known drainages with Modoc suckers contain introduced predatory fishes. The Ash Creek drainage contains brown trout, which have co-existed with Modoc sucker for over 70 years, but certainly suppress local native fish populations in small streams. There are no sources of bass upstream of Modoc sucker populations in the Ash Creek drainage, although they may be present downstream in warmer, low-gradient reaches of Ash Creek itself. The Turner Creek drainage contains largemouth bass, sunfishes (green and bluegill), and brown bullheads, of which only the bass are considered a significant predator on Modoc suckers. Bass do not appear to reproduce or establish stable populations in Turner Creek, but periodic influxes from upstream reservoirs could have substantial adverse effects on the local Modoc sucker populations if the bass are not monitored and managed. The upper reaches of Thomas Creek with Modoc suckers contain no non-native fishes, and are unlikely to acquire them, given the lack of upstream source populations and presence of a waterfall barrier in the lowest reach.

While Modoc suckers are most certainly suppressed by introduced predatory fishes, they have withstood predation in both drainages for at least 35 years. The separation of the three known drainages containing Modoc suckers further reduces the probability that a new or existing non-native predator would impact all three drainages simultaneously. Therefore, introduced predators, while a major conservation concern for Modoc sucker populations, do not appear to be a threat to the continued existence of the species throughout its range. However, there is a need to better understand the ecological interactions between Modoc suckers and introduced fishes and to support conservation measures that monitor and suppress or eliminate non-native predators from Modoc sucker drainages.

**Factor C Conclusion**

The Service is not aware of any disease that is likely to pose a substantial risk to the Modoc sucker. However, predation by existing non-native fishes is an important conservation concern for Modoc sucker populations, in particular predation by brown trout in the Rush Creek drainage and by largemouth bass in the Turner Creek drainage. It is reassuring that Modoc suckers have maintained their populations in the presence of these non-native piscivore populations for over 30 years, that ongoing suppression of non-native fishes has been highly effective, that largemouth bass are apparently not able to establish stable extensive populations in upper Turner Creek, that the Washington Creek population has been considerably protected by a reservoir screen, and that the Modoc sucker is now known to occupy three separate sub-drainages, one of which (Thomas Creek) contains no non-native fishes. Nevertheless, the continued possibility of major influxes of largemouth bass into Turner Creek from unscreened upstream reservoirs on Modoc National Forest could combine with other adverse conditions (e.g., drought and lack of active monitoring/predator suppression) to extirpate the principal Turner Creek population at a time when tributary populations dependent on refuge habitat in Turner Creek are also stressed. While the probability of this happening is low, continued monitoring and control of non-native predators can ensure that they do not pose a substantial threat to the Modoc sucker.

**FACTOR D: Inadequacy of Existing Regulatory Mechanisms**

The original listing (USFWS 1985) did not identify any threats to the Modoc sucker due to the inadequacy of existing regulations. However, it did note that while state legislation protects the species from taking, it did not provide habitat protection. Principal regulatory mechanisms currently protecting the Modoc sucker and its habitat include the Federal Endangered Species Act, California Endangered Species Act, California Fish and Game Code, Oregon Sensitive Species Rule, and Oregon Fish and Game Code. The present status review identifies only two factors that could threaten the Modoc sucker, predation by non-native fishes (specifically largemouth bass and brown trout) and natural drought (Factor E). Habitat modification is no longer considered a threat.

There are two mechanisms by which non-native fishes could be introduced into Modoc sucker streams, natural dispersal from existing populations (upstream or downstream) and intentional transport and release. The first is not subject to regulatory control. The second is already prohibited by state laws (CDFG 2007; ODFW 2008b). Although it is possible that someone would illegally introduce additional non-native fishes into a Modoc sucker stream, it is unlikely to occur (see Factor C) and, if done, would probably represent a relatively small number of individuals when compared to natural dispersal events (e.g., dispersal by reservoir overflows).

Although natural drought can adversely affect the Modoc sucker it is not subject to regulatory control. There are no substantial diversions affecting water quantity and flow in Modoc sucker streams, with exception of an existing diversion in Rush Creek (located at the lower extent of designated Critical Habitat), which maintains in-stream base flows. Reservoirs in the upper Turner Creek watershed influence winter and early spring flow regimes but are no longer connected by late spring and have little, if any, impact on flow during the dry season (July-October). Therefore, flow quantity and duration during the crucial dry season are dependent primarily on natural flows, which are subject to inter-annual variability in precipitation.

**Factor D Conclusion**

No threats have been identified as a result of inadequate of regulatory mechanisms. Throughout its range, the Modoc sucker is protected by the Act and a variety of state laws.

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

**Hybridization**

The 1985 listing identified hybridization with the Sacramento sucker, also native to the Pit River drainage, as a principal threat to the Modoc sucker. Hybridization can be cause for concern in a species with restricted distribution, particularly when a closely related non-native species is introduced into its range, and can lead to loss of genetic integrity or even extinction (Rhymer and Simberloff 1996). In 1985, it was assumed that hybridization between Modoc and Sacramento suckers had been prevented in the past by natural physical barriers, which had been recently eliminated by human activities, allowing contact between the two species. Modoc sucker populations from streams in which both species were present were considered hybrid populations and were excluded when evaluating the Modoc sucker's distribution in 1985. The assumption that extensive hybridization was occurring was based solely on the opportunity presented by co-occurrence and the identification of a few specimens exhibiting what were thought to be intermediate morphological characters. At that time, genetic information to assess this assumption was not available.

Modoc and Sacramento suckers are naturally sympatric (occurring in the same streams) in the Pit drainage. There is no indication that Sacramento suckers are recent invaders to the Pit River or its tributaries. Both morphological and preliminary genetic data suggests that the upper Pit River population of Sacramento suckers is distinct from other Sacramento River drainage populations (Ward and Fritsche 1987; Dowling, unpub. data. 2005). There is also no available information suggesting Modoc and Sacramento suckers were geographically isolated from each other in the recent past by barriers within the Pit Drainage (see Factor A – Barriers). Separation of the two species appears to be primarily ecological, with Modoc suckers occupying smaller, headwater streams typically associated with trout and speckled dace, while Sacramento suckers primarily occupy the larger, warmer downstream reaches of tributaries and main-stem rivers with continuous flow (Moyle and Marciochi 1975, Moyle and Daniels 1982, Reid 2008c). Further reproductive isolation is probably reinforced by different spawning times in the two species and their size differences at maturity (Reid 2008c).

The morphological evidence for hybridization in 1985 listing was based on a limited understanding of morphological variation in the Modoc and Sacramento suckers, derived from the small number of specimens available at that time. Subsequent evaluation of variability in the two species, based on a larger number of specimens, shows that the overlapping character states (primarily lateral line and dorsal ray counts), interpreted by earlier authors as evidence of hybridization, are actually part of the natural meristic (involving counts of body parts such as fins and scales) range for the two species and are not associated with genetic evidence of introgression (Kettratad 2001, Reid 2008c). Furthermore, the actual number of specimens identified as apparent hybrids by earlier authors was very small and in great part came from streams without established Modoc sucker populations.

In 1999, the Service initiated a program to examine the genetics of suckers in the Pit River drainage and determine the extent and role of hybridization between the Modoc and Sacramento suckers using both nuclear and mitochondrial genes (Palmerston et al. 2001; Wagman and Markle 2000; Dowling 2005a; Topinka 2006). The two species are genetically similar, suggesting that they are relatively recently differentiated and/or have a history of introgression throughout their range that has obscured their differences (Wagman and Markle 2000; Dowling 2005a; Topinka 2006). Although the available evidence cannot differentiate between the two hypotheses, the genetic similarity in all three sub-drainages, including those populations shown to be free of introgression based on species-specific genetic markers (Topinka 2006), suggests that introgression has occurred on a broad temporal and geographic scale and is not a localized or recent phenomenon. Consequently the evidence indicates that introgression is natural and is not caused or measurably affected by human activities.

In a study of nuclear anonymous frequency loci polymorphisms in the two species, Topinka (2006) did identify species-specific markers indicating low levels of introgression by Sacramento sucker alleles into most Modoc sucker populations. However, there was no evidence of first generation hybrids, and it is not clear whether introgression occurred due to local hybridization or through immigration by individual Modoc suckers carrying Sacramento alleles from other areas where hybridization had occurred (see below).

Topinka (2006) did find extensive bi-directional introgression in upper Ash Creek, where Modoc and Sacramento suckers are sympatric. Phenotypic Modoc suckers in this population reach 15 inches standard length, the largest size encountered in the species, but are dominated by Sacramento markers and show extensive variability in characteristic Modoc sucker markers. Similarly, Sacramento suckers in the stream have a relatively high frequency of Modoc sucker markers, as do populations in neighboring Willow Creek, which is not known to contain Modoc suckers. Ash Creek is a large, warm-water stream having habitat more characteristic of Sacramento suckers and includes other native species, such as Sacramento pikeminnow and Pit roach, which are not typically found with Modoc suckers. Willow Creek is ecologically similar to Ash Creek in having permanent flow from warm-water springs in its headwaters and resident Sacramento pikeminnow.

The ecological and faunal characteristics of the streams, the absence of additional permanent headwater habitat upstream, and the lack of physical barriers between the upper and lower reaches, suggest that Sacramento suckers have naturally occurred in the upper reaches of both Ash and Willow creeks and do not represent a recent invasion into Modoc sucker habitat. Likewise, the lack of barriers between these streams and those occupied principally or entirely by Modoc suckers in the same sub-drainage (i.e., Johnson, Rush, and Dutch Flat creeks) provide connectivity for Modoc suckers, particularly larger individuals, to occasionally immigrate into streams dominated by Sacramento suckers. There is no evidence that the observed hybridization has been affected by human modification of habitat, and genetic exchange between the two species under such conditions may be a natural phenomenon and a part of their evolutionary legacy. A similar situation has been observed in suckers in the nearby Klamath River drainage, where four species have hybridized to varying degrees, but in general retain morphological, behavioral, and ecological separation (Markle et al. 2005; Dowling 2005b; Tranah and May 2006).

In summary, the low levels of observed introgression by Sacramento suckers in streams dominated by Modoc suckers, even when there are no physical barriers between the two species, suggests that either ecological differences, selective pressures, or other natural reproductive-isolating mechanisms are sufficient to maintain the integrity of the species even after at least a century of habitat alteration by human activities. Scientists who have studied suckers in western North America consider that, throughout their evolutionary history, hybridization among sympatric native fishes is not unusual and may provide an adaptive advantage (Dowling 2005a, b; Dowling and Secor 1997; Smith et al. 2002; Tranah and May 2006; Topinka 2006).

Despite any hybridization that has occurred in the past, the Modoc sucker maintains its morphological and ecological distinctiveness, even in populations showing low levels of introgression, and is clearly distinguishable from the Sacramento sucker using morphological characteristics (Kettratad 2001). Therefore, given the observed low-levels of observed introgression in nine known streams dominated by Modoc suckers, the absence of evidence for extensive ongoing hybridization in the form of first generation hybrids, the fact that Modoc and Sacramento suckers are naturally sympatric, and the continued ecological and morphological integrity of Modoc sucker populations, hybridization is not considered a threat to Modoc sucker populations.

## Drought and Climate Change

The listing rule did not identify drought or climate change as threats to the continued existence of the Modoc sucker (USFWS 1985). However, the northwestern corner of the Great Basin is naturally subject to extended droughts, during which even the larger water-bodies such as Goose Lake have dried up (Laird 1971). Regional droughts have occurred every 10 to 20 years in the last century (Reid 2008c). The "dustbowl" drought of the 1920's to 1930's appears to have been the most extreme regional drought in at least the last 270 years and probably the last 700 years (Keen 1937; Knapp et al. 2004).

There is no record of how frequently Modoc sucker streams went dry except for occasional pools. There is no doubt that reaches of these streams did stop flowing in the past because some reaches dry up (or flow goes through the gravel instead of over the surface) nearly every summer under current climatic conditions (Reid 2008c). In extreme droughts, the suckers may have withdrawn to permanent main-stem streams, such as Rush and Turner creeks, and later recolonized the tributaries. They also take refuge in natural spring-fed reaches and in deeper pools that receive sub-surface flow even when most of the stream channel is dry (Reid 2008c).

Collections of Modoc sucker from Rush Creek and Thomas Creek near the end of that drought (Hubbs and Miller 1934; Merriman and Soutter 1933), and the continued persistence of Modoc sucker throughout its known range through substantial local drought years since 1985 without active management, demonstrate the resiliency of the population given availability of suitable refuge habitat. Based on this, we do not believe drought poses a substantial threat to the species.

Human-induced climate change could exacerbate low-flow conditions in Modoc sucker habitat during future droughts. A warming trend in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, reduce summer stream flows, and increase summer temperatures (IPCC 2007). Lower flows as a result of smaller snowpack could reduce sucker habitat, which might adversely affect Modoc sucker reproduction and survival. Warmer water temperatures could lead to physiological stress and could also benefit non-native fishes that prey on or compete with Modoc suckers. Increases in the numbers and size of forest fires could also result from climate change (Westerling et al. 2006) and could adversely affect watershed function resulting in faster runoff, lower base flows during the summer and fall, and increased sedimentation rates. While it appears reasonable to assume that the Modoc sucker will be adversely affected by climate change, we lack sufficient information to accurately determine what degree of threat it poses and when the changes will occur.

In summary, although we cannot predict future climatic conditions accurately, the Modoc sucker's range-wide persistence through the substantial droughts of the last century indicates that drought is not likely to threaten the Modoc sucker with extinction. We are unable at this time to predict how climate change will exacerbate the effects of drought. Conservation of perennial spring-fed stream reaches and connectivity to perennial main stem streams, as well as promotion of subsurface-fed pool habitats that hold water through drier periods, are crucial to the long-term survival of the Modoc sucker. Current land management by both public and private land-managers and focus on protecting and enhancing riparian corridors are positive mechanisms for maintaining the refuge habitat necessary for long-term persistence of self-sustaining Modoc sucker populations.

### Factor E Conclusion

Hybridization with the Sacramento sucker was considered a major threat to the Modoc sucker at the time of listing. However, reexamination of natural barriers, morphological characters, and new genetic information that were unavailable at the time of listing indicate that hybridization is not a substantial threat to the Modoc sucker and may be part of its natural evolutionary history. Although drought represents a major challenge for Modoc sucker, the species has sustained itself through numerous droughts in the last century, including the "dustbowl" drought of the 1920's to

1930's, without substantial assistance, and neither land nor water management in Modoc sucker streams is likely to change in the near future. Climate change is likely to make droughts worse and have other adverse effects on Modoc suckers, but current data are insufficient to identify the level of threat it poses. We are aware of no additional factors likely to threaten the Modoc sucker.

## III. RECOVERY CRITERIA

**Recovery Criteria from the 1984 Recovery (Action) Plan (USFWS 1984):**

Downlisting Criteria – "Consider reclassification to 'threatened' upon establishment of pure, safe populations (for 3 to 5 years) throughout Rush and Turner Creeks watersheds."

Delisting Criteria – "Consider delisting upon establishment of pure, safe populations (for 3 to 5 years) throughout Rush and Turner Creeks watersheds (downlisting criteria), and in two additional streams within historic range."

These downlisting and delisting criteria address the listing factors that are relevant to this species (Factors A, C, and E). Recovery tasks identified in the 1984 recovery action plan can be divided into 5 categories: 1) improve and secure habitat; 2) reduce threats from hybridization and perform genetic studies to assess degree of introgression; 3) expand range; 4) monitor populations; and 5) perform recovery-related administrative tasks. All recovery tasks from the signed 1984 recovery action plan and subsequent draft action plans are completed, ongoing, or have been deemed inappropriate, based on current information or policy (Reid 2008c). A summary of the recovery tasks and the status of the tasks is presented in Appendix A.

## IV. SYNTHESIS

Most threats to the Modoc sucker that were considered in the 1985 listing rule (e.g., habitat modification, range reduction, and hybridization) have undergone substantial improvements or been ameliorated by new information and improved technology such that they no longer threaten the continued existence of the species. Habitat conditions on both public and private lands have shown substantial improvement, with continuing upward trends and a reasonable expectation that similar land management practices will continue. The distribution of known populations has remained stable or expanded slightly over the last 20 years, through a number of regional droughts. In addition, the range of the Modoc sucker has been expanded with the discovery of additional populations and documentation of genetic integrity in populations originally considered lost through hybridization. A greater understanding of the genetic relationships and natural gene flow between the Modoc and Sacramento sucker has reduced concerns over hybridization between the two naturally sympatric species.

The principal remaining threat to the Modoc sucker is predation by non-native fishes, in particular brown trout in the Ash Creek sub-drainage and largemouth bass in the Turner sub-drainage. While the Modoc sucker has survived for decades in the presence of non-native fish, if left unchecked introduced fish predators have the potential to threaten the Modoc sucker with local extinction in at least one of three sub-drainages. Additional work is needed to understand the effects of non-native fish to the survivability of Modoc suckers and to develop a long-term management plan to address these effects.

The best available information indicates the Modoc sucker is not in imminent danger of extinction because populations are more widespread than at the time of listing, most of the threats have either been eliminated or are no longer pertinent because of new information (e.g., range reduction and hybridization), or the threats are being addressed and conditions are improving (e.g., habitat modification and non-native fish predation). Therefore, we conclude that the Modoc sucker is no longer in danger of extinction and we recommend that the species be downlisted to threatened. In section VI below, we recommend actions that, if successfully implemented over the next 5 years, will further improve the conservation status of the species and provide additional information that would enable us to recommend delisting in our next 5-year review.

## V. RESULTS

**Recommended Listing Action:**

_X_ 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*
____ No Change

**New Recovery Priority Number and Brief Rationale:** In the 2008 recovery data call we recommended that the priority number be increased from 8 to 14 because the species has a low degree of threat and a high potential for recovery).

**Listing and Reclassification Priority Number and Brief Rationale:** Based on the Service's Endangered and Threatened Species Listing and Recovery Priority Guidelines (48 FR 43098), a reclassification priority number of 4 is appropriate because the action would have a moderate management burden and would be an unpetitioned action.

## VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

Implementation of these recommendations over the next 5 years would provide information that would allow us to consider delisting of the Modoc sucker in our next 5-year review:

**Predation by Non-native Fishes**

Predation by non-native fishes in the Turner (largemouth bass) and Rush Creek (brown trout) drainages is recognized as a potential threat to Modoc sucker populations if it is not monitored and active management carried out. Amelioration of this threat could be crucial to ensuring the long-term viability of self-sustaining Modoc sucker populations in the Turner and Rush Creek drainages. Recommended actions (some already initiated) include:

1) Suppression of existing non-native populations through monitoring and active removal in the Turner and Rush Creek (Johnson Creek, in particular) drainages. [ongoing]

2) Screening the outflows of Beeler Reservoir and Reservoir J in the upper Turner Creek watersheds of the Modoc National Forest to prevent largemouth bass from dispersing downstream into Modoc sucker habitat. Loveness Reservoir outlet was screened by the Forest in 2006 and that effort appears successful.

3) Assessment of existing constructed barriers in lower Turner and Johnson Creeks to determine their role in preventing upstream invasion of non-natives and balancing this with the constraints they may put on connectivity between Modoc sucker populations and upstream spawning migrations. Necessary repairs to the barriers should be made if warranted.

4) Development of a long-term management plan the is highly likely to be implemented to assure the continued monitoring and management of non-native fish as well as monitoring and management to maintain the effectiveness of the fish barriers.

**Genetics**

The ongoing Modoc sucker genetics program has helped resolve the relationships of Pit River suckers, as well as the occurrence and distribution of introgression between Modoc and Sacramento sucker populations. Future projects should address questions of genetic diversity, effective population size, and population bottlenecking, as well as better resolving the degree of introgression within local populations and monitoring changes over time. The Abernathy FTC is continuing to explore the genetic diversity within populations and possible species-specific markers for studying introgression using nuclear microsatellites (expected conclusion 2009).

**Recovery Planning**

The 1984 recovery action plan for the Modoc sucker is outdated. One of the threats that guided many of the original recovery goals and actions (i.e., hybridization) has been reassessed, and the threat of non-native fishes needs to be more actively addressed. Therefore, if appropriate, the Service should consider development of a revised recovery plan.

## VII. ACKNOWLEDGEMENTS

The Service acknowledges that the improved status of the Modoc sucker would not have occurred without substantial efforts by private landowners and the Modoc and Fremont National Forests to protect and restore riparian and stream habitats in the Pit River and Thomas Creek sub-basins. Their continued stewardship of land and water resources is crucial to the future conservation of the Modoc sucker and the Service acknowledges and applauds these efforts.

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**Appendix A.** Status of recovery tasks for the Modoc sucker, including all tasks identified in the signed 1984 recovery action plan and additional tasks suggested in subsequent draft action plans.

| RECOVERY TASKS | STATUS | COMMENTS |
|---|---|---|
| **A) Improve and Secure Habitat** | | |
| 1. Plan, conduct, and evaluate habitat improvement projects (fencing, weir construction, pool excavation, etc.) within occupied habitat and potential reintroduction/recolonization sites to accomplish effective stabilization of stream banks, restoration of riparian vegetation, and increase instream cover. | Completed | Habitat conditions for occupied stream reaches within Critical Habitat evaluated (PFC) in 2001-2002 and generally determined to be functioning with upward trends. See Reid (2007) for specifics. |
| 2. Perform habitat improvements needed on Forest Service lands:<br>a) Turner drainage (Coffee Mill, Hulbert, Turner, Washington)<br>b) Rush drainage (Rush and Johnson Creeks) | Completed | see Reid (2007) for summary |
| 3. Determine habitat improvement potential for private lands:<br>a) Turner drainage (Hulbert and Turner Creeks).<br>b) Rush drainage (Rush and Johnson Creeks). | Completed | see Reid (2007) for summary |
| 4. Identify parcels of private lands with essential habitat and initiate actions necessary to improve habitat (e.g. easements, exchange, acquisition, habitat management by landowners).<br>a) Turner drainage (Hulbert and Turner Creeks).<br>b) Rush drainage (Rush and Johnson Creeks). | Generally completed, or ongoing | Current efforts focused on landowner stewardship, rather than acquisition. |
| 5. Evaluate Coffee Mill Gulch (tributary to Washington Creek) for possible introduction of Modoc suckers. | Completed | 1986. Modoc suckers successfully introduced to Coffee Mill Gulch. |
| 6. Fence streamside zone on Washington Creek. | Completed | 1980's |
| 7. Acquire 160 acre parcel of occupied habitat on Dutch Flat Ck. | Completed | 1991. Acquired by CDFG and designated as the Dutch Flat Wildlife Area in 1993. |
| **B) Reduce Threats from Hybridization and Perform Genetic Studies to Assess Degree of Introgression** | | |

| | | |
|---|---|---|
| 1. Install and maintain fish barriers at key locations on historic Modoc sucker streams to prevent exotic fishes from invading Modoc sucker habitats. | General (see below) | Barriers installed on Turner and Johnson creeks (1982-1983). |
| 2. Reestablish historical barriers, or construct new barriers, to isolate “pure” Modoc sucker populations from Sacramento suckers. | General, no longer appropriate | Hybridization no longer considered a threat |
| 3. Evaluate need and location for artificial barrier on Turner Creek and construct barrier, if necessary. | Completed | 1982. Barrier placed at constriction between Upper and Lower Turner Meadows. |
| 4. Evaluate durability and effectiveness of Turner Creek barrier. | Ongoing, current | 2007 maintenance project in progress (USFS). |
| 5. Evaluate condition of natural barriers on Washington and Hulbert creeks; enhance natural barrier at Hulbert Creek if needed. | Completed | Current opinion is that these are not actual barriers to upstream movement at moderate flows. |
| 6. Evaluate options for constructing a fish barrier on Rush Creek (Hwy 299) to exclude Sacramento suckers, construct barrier if appropriate. | Completed | Setting and logistics were not appropriate for barrier, which was constructed upstream on Johnson Creek. Sacramento suckers do not reach Hwy. 299 bridge. |
| 7. Evaluate condition of natural barriers on Johnson and Dutch Flat Creeks; enhance natural barriers, as necessary. | Completed | No natural barriers exist. |
| 8. Evaluate need and location for artificial barrier on Johnson Creek; construct barrier, if necessary. | Completed | 1983. Barrier constructed at lower USFS boundary, 1 mile up from Rush Creek |
| 9. Evaluate durability and effectiveness of Johnson Creek barrier. | Ongoing, current | Barrier remains effective (2007) |
| 10. Sample suckers in Turner, Hulbert, and Washington Creeks to determine reaches for eradication and reintroduction; determine need for temporary holding facilities during eradication; file pesticide use applications; rejuvenate Turner Creek system; evaluate effectiveness of rejuvenation (within 2 weeks of treatment); retreat and reevaluate if treatment is not totally effective; reestablish Modoc sucker population using fish from Turner Creek system. If necessary reestablish additional suckers in unpopulated portions of the creek. | Completed | 1983-1984. Turner Creek was rotenoned to remove all fish from headwaters downstream to constructed barrier and restocked with Modoc suckers and redband trout from Washington Creek (Van Woert 1983, 1984). The stream now contains a full suite of native fishes. |
| 11. Sample populations in Rush/Johnson creeks to determine stream reaches for rejuvenation; determine need for temporary holding facilities during rejuvenation; file pesticide use application; rejuvenate Johnson Creek system, if necessary; evaluate effectiveness of rejuvenation (within 2 weeks); retreat and reevaluate if treatment is not totally effective; reestablish Modoc sucker population using fish from Johnson Creek if necessary. | Cancelled | No chemical eradication was ever carried out on Rush or Johnson Creeks. Recent genetic results indicate that the population is genetically secure, and other approaches are being used for reduction of the brown trout population, the only non-native species in the drainage. |

| | | |
|---|---|---|
| 12. Evaluate alternative to chemical treatment of Rush Creek. | Completed | (see above) |
| 13. Control the introduction and distribution of exotic fishes within drainages currently occupied by, or targeted for the reintroduction of Modoc suckers. | Ongoing, current | Turner Creek project (Reid 2006), continuing non-native fish evaluation & removal, Loveness Pond screen (USFS), CDFG, and ODFW management |
| 14. Perform genetic studies to determine whether hybridization is occurring between Modoc and Sacramento suckers, and if so, the degree of introgression and its threat to Modoc suckers. | Completed initial phases, ongoing studies | Nuclear AFLP study, U.C. Davis (Topinka 2006); MtDNA study, Univ. Arizona (Dowling 2005); Microsatellites, USFWS Abernathy (in progress). |
| 15. Evaluate the systematic status and relationships of the various sucker populations in the Pit drainage. | Completed initial phases, ongoing | (Kettratad 2001; Topinka 2006; Dowling 2005; Reid in progress, funded) |
| **E) <u>Expand Range</u>** | | |
| 1. Survey Willow Creek watershed for suitability as habitat and location of barrier sites. | Survey completed (Reid 2008b) | translocation is not currently being considered for recovery efforts |
| 2. Evaluate Howard's Gulch as possible introduction site. | - on hold | at this time translocation is not being considered for recovery efforts |
| **F) Monitor Populations** | | |
| 1. Monitor population trends in known populations.<br>a) Turner drainage (Coffee Mill, Hulbert, Turner, Washington).<br>b) Ash drainage (Johnson, Dutch Flat and Rush Creeks). | Ongoing, current | No specific population surveys since listing, monitoring of distribution indicates stable with some expansion of known populations into all suitable habitat. Survey protocol development planned and funded for 2008. |
| 2. Monitor habitat conditions and population levels to evaluate effectiveness of recovery and habitat restoration. Revise methods as appropriate. | Ongoing, current | Proper Functioning Condition surveys (CDFG 2001), Conservation and 5-year status reviews |
| 3. Secure habitat and establish viable Modoc sucker populations:<br>a) throughout the Turner and Rush Creek drainages.<br>b) in at least two additional drainages within historic range (examples were Ash or Willow creeks). | a) completed<br>b) completed | a) Modoc suckers currently occupy all suitable habitat within the Rush and Turner drainages. Habitat secure, currently addressing non-native species.<br>b) additional populations include Dutch Flat (Ash Creek drainage) and Thomas Creek (Goose sub- |

| | | |
|---|---|---|
| | | basin). Ash Creek population is also still present; high level of introgression is probably natural. |
| 4. Cooperate with private land owners to develop land management programs that protect Modoc suckers, provide suitable habitat for recovery, and address the needs of the landowners. | Ongoing, current | Outreach and collaboration is a major component of current recovery efforts. (Clark and Reid 2004; Pit River Native Fishes Stewardship Program) |
| **G) Recovery-related Administrative Tasks** | | |
| 1. Document the completion of action plan tasks to establish an administrative record for use in determining if and when the objectives have been accomplished. | Ongoing, current | 2007. A component of the present Conservation Review and 5-year status review. |
| 2. Review the plan periodically to determine if additional tasks are needed to accomplish action plan objectives, or whether the plan needs to be updated to reflect new scientific findings. | Ongoing, current | 2007. A component of the present Conservation Review and 5-year status review. |
| 3. Consider reclassification to Threatened upon establishment of pure, safe populations (for 3-5 years) throughout Rush and Turner creeks watersheds. | Pending | 2007. A component of the present 5-year status review. |
| 4. Consider delisting upon establishing safe, 'pure' populations in two additional historic streams. | Pending | 2007. A component of the present 5-year status review. |
| 5. Reclassify when downlisting/delisting criteria have been met. | Future Action | |

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

**Modoc sucker (*Catostomus microps)***

**Current Classification**: Endangered

**Recommendation Resulting from the 5-Year Review**:

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

**Appropriate Listing/Reclassification Priority Number: 4**

**Review Conducted By**: Ron Larson

**Date Submitted to Region 8**: August 3, 2009

**FIELD OFFICE APPROVAL**:

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

Approve ____________________ Date 8/3/09

**REGIONAL OFFICE APPROVAL**:

**Assistant Regional Director, U.S. Fish and Wildlife Service, Region 8**

Approve ____________________ Date 8/17/09