Species Report

for the

Modoc Sucker

(*Catostomus microps*)

Photo credit: U.S. Fish and Wildlife Service

U.S. Fish and Wildlife Service

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SPECIES REPORT

Modoc Sucker (Catostomus microps)

Purpose

The purpose of this species report is to provide the best available scientific and commercial information about the Modoc sucker (Catostomus microps) and its habitat. The information within this report will be used by U.S. Fish and Wildlife Service (Service) staff and be part of our biological basis for any potential listing, recovery, or consultation recommendations under the Endangered Species Act of 1973 as amended (Act), (16 U.S.C. 1531 et seq.).

Executive Summary

The Modoc sucker (*Catostomus microps*), a small species of fish found in streams within the Pit River basin in northeastern California and southern Oregon, was listed as endangered under the Endangered Species Act in 1985 (50 FR 24526; June 11, 1985). Critical habitat was designated along 26 miles (mi) (42 kilometers (km)) of streams within the Turner and Ash Creek sub-basins of the Pit River basin. The species was listed as endangered because it was believed to have been extirpated from a significant portion of its limited range due to habitat degradation and loss from overgrazing, siltation, and channelization. Loss of genetic integrity of the species due to hybridization with Sacramento suckers (*Catostomus occidentalis*) also was identified as a threat at the time of listing.

Since the time of listing, the population status of the Modoc sucker has greatly improved. At the time Modoc sucker was listed in 1985, its known distribution was limited to an estimated 12.9 mi (20.8 km) of occupied habitat in seven streams in the Turner Creek and Ash Creek sub-basins of the Pit River in northeastern California. It is now recognized that the historical distribution also included one additional stream in the Turner Creek sub-basin and three additional streams in the Goose Lake sub-basin in southern Oregon, a disjoined, upstream sub-basin of the Pit River. The current known distribution of Modoc sucker includes an estimated 42.5 mi (68.4 km) of occupied habitat in 12 streams in the Turner Creek, Ash Creek, and Goose Lake sub-basins. Recent population estimates are not available, but surveys conducted in 2008 and 2012 show that Modoc suckers are still present and well established in each of the streams where the species was known to historically occur, and that they appear to occupy nearly all available suitable habitat in the streams where they do occur.

Impacts to Modoc sucker habitat from livestock grazing have been greatly reduced since the time of listing. Livestock grazing still occurs on most of the lands where Modoc suckers occur, but grazing management practices have improved since the time of listing. Land ownership throughout the species' range is 51 percent public lands (primarily U.S. Forest Service (USFS) lands within the Modoc National Forest in northeastern California and the Fremont-Winema National Forests in southern Oregon), 48 percent private lands, and 1 percent State land. Habitat impacts from livestock grazing have been reduced since the time of listing as a result of improved grazing management practices and construction of fencing to exclude cattle

from riparian areas on several of the streams occupied by Modoc suckers. While impacts to Modoc sucker habitat from livestock grazing identified at the time of listing (e.g., siltation and stream channelization) have been substantially reduced, recent surveys indicate that livestock grazing still results in high levels of streambank erosion and siltation along discrete reaches of streams occupied by Modoc sucker.

At the time of listing, habitat degradation from livestock grazing was thought to have resulted in loss of natural instream barriers which allowed the closely related Sacramento sucker access to Modoc sucker habitat, resulting in hybridization and loss of Modoc sucker genetic integrity. The Sacramento sucker is a native species sympatric with Modoc suckers in the lower-elevation and larger streams and rivers in the Pit River basin. Reevaluation of information available at the time of listing and subsequent genetic research lead us to conclude that the low levels of hybridization that occur between Sacramento suckers and Modoc suckers are not the result of habitat modification by humans. The two species remain genetically, morphologically, and ecologically distinct. Ecological differences, selective pressures, or other natural reproductive-isolating mechanisms appear to be sufficient to maintain the genetic integrity of the Modoc sucker. The low levels of hybridization between the two species may, in fact, be part of the Modoc sucker's natural evolutionary history.

The final listing rule (50 FR 24527; June 11. 1985) noted impacts to Modoc sucker numbers as a result of predation by the nonnative brown trout (*Salmo trutta*). The California Department of Fish and Wildlife (CDFW) has discontinued stocking of brown trout in streams within the Pit River basin, and Modoc suckers have coexisted with brown trout in the Ash Creek sub-basin for over 75 years, suggesting that Modoc sucker populations are resilient to existing levels of brown trout predation. Largemouth bass (*Micropterus salmoides*) is another nonnative predator on Modoc sucker, but the overlap in distribution between largemouth bass and Modoc sucker is limited because largemouth bass primarily occur in warmer, low-gradient, downstream reaches in the Turner Creek sub-basin.

In this report, we also evaluate the potential impacts of drought and climate change on Modoc sucker. Drought results in reduced availability of aquatic habitat and thus potentially impacts Modoc sucker populations. The northwestern part of the Great Basin where the Modoc sucker occurs is subject to extended droughts, with regional droughts having occurred every 10 to 20 years during the past century. Modoc suckers, however, appear to be resilient to drought as it has persisted throughout its historical range during the past century and has not declined in distribution since the time of listing in 1985, even though the region where it exists experienced several pronounced droughts since listing when total annual precipitation was approximately half of the long-term average. Climate change is likely to result in decreased snowpack, earlier spring runoff, reduced summer stream flows, and increased water temperatures. These changes may negatively affect Modoc suckers, but there is too much uncertainty at this time to know how Modoc sucker populations will respond to these changes, especially given the species' apparent resiliency to recent droughts.

At the time of listing in 1985, the Service, CDFW, and the USFS were in the process of developing an action plan for the recovery of Modoc sucker. In 1992, the Service adopted this action plan (Action Plan for Recovery of the Modoc Sucker (Revised and Updated, October

1989)) (Action Plan) as the Recovery Plan for the Modoc sucker (Service 1992, entire). The adoption precluded the need to develop a separate Recovery Plan under section 4(f)(1) of the Act. The Action Plan identified three downlisting objectives and three delisting objectives for the Modoc sucker. The downlisting objectives of the plan include: (1) maintain the integrity of the extant habitats for Modoc sucker; (2) prevent the invasion of Sacramento suckers into isolated stream reaches of the Turner-Hulbert-Washington Creek system and upper Johnson Creek to avoid potential hybridization with Modoc sucker populations; and (3) restore and maintain the quality of aquatic habitat conditions within these watersheds and thereby increase their carrying capacity for Modoc suckers. These objectives must be maintained for three consecutive years in order to meet the downlisting criteria. The delisting objectives of the plan include: (1) the remaining suitable, but presently unoccupied, stream reaches within Turner Creek, Hulbert Creek, Washington Creek, and Johnson Creek must be renovated and restored to provide habitat for Modoc suckers; (2): two additional populations within the historical range of Modoc sucker must be established; and (3): all populations must have sustained themselves through a climactic cycle that includes drought and flood events. In this report we evaluate each of the three downlisting and three delisting objectives (see the **Recovery** section below).

Background

Previous Federal Actions

Modoc suckers were listed as endangered in 1985, and critical habitat was designated concurrent with the listing (50 FR 24526, June 11, 1985). At the time of listing, the Service, the CDFW, and the USFS were developing an "Action Plan for the Recovery of the Modoc sucker." The April 27, 1983, revision of this Plan was formally signed by all participants in 1984 (Service 1984). We determined that the Action Plan and its 1989 revisions adequately fulfilled the requirements of a recovery plan, and in a 1992 memorandum from the Regional Director (Region 1) to the Service's Director, we adopted it as the Recovery Plan for the Modoc sucker (Service 1992). A notice initiating a 5-year review was published for the Modoc sucker in 2006 (71 FR 14538, March 22, 2006), and a 5-year review completed in 2009 recommended that the Modoc sucker be reclassified to threatened (Service 2009; 75 FR 28636, May 21, 2010). On December 21, 2011, we received a petition dated December 19, 2011, from The Pacific Legal Foundation, requesting the Service to reclassify Modoc sucker from endangered to threatened based on the analysis and recommendations contained in the 5-year review. In response, we published a 90-day petition finding in the **Federal Register** on June 4, 2012 (77 FR 32922), that found the petition presented substantial scientific or commercial information indicating that reclassify the Modoc sucker from endangered to threatened may be warranted.

Taxonomy and Species Description

The Modoc sucker is a small species of fish in the family Catostomidae. Individuals mature at 2.8 to 3.3 inches (in) (70 to 85 millimeters (mm)) in length with few adults exceeding 6.3 to 7.1 in (160 to 180 mm) (Boccone and Mills 1979, p. 22; Moyle 2002, p. 190). Martin (1972, p. 279) described the colors of the Modoc sucker as greenish-brown to deep gray-olive above, lighter-colored on the sides with some light yellowish pigment below, cream-colored to white ventrally, and with the caudal, pelvic and pectoral fins light yellowish-orange. A bright

orange band appears on the sides during spawning season. The original description of the species was based on specimens from Rush Creek, Modoc County, California (Rutter 1908, p. 118). No changes in taxonomy have occurred since the species description.

Habitat

Modoc suckers are primarily found in relatively small (second to fourth order), perennial and intermittent streams. They occupy an intermediate zone between the high-gradient and higher-elevation, cold-water trout zone and the low-gradient and low-elevation, warm-water fish zone. Most streams inhabited by Modoc suckers are characterized by moderate gradient (15 to 50 feet (ft) drop per mile (5 to 15 meter (m) drop per kilometer (km))), low summer flow (1 to 4 cubic ft per second (0.03 to 0.11 cubic m per second)), and relatively cool (59 to 72 °F (15 to 22 °C)) summer temperatures (Moyle *et al*. 1982, p. 44). They are most abundant in pools, especially those deeper than 1 ft (0.3 m). In the Pit River system, Modoc suckers occupy stream reaches above the Sacramento sucker (*Catostomus occidentalis*), Sacramento pikeminnow (*Ptychocheilus grandis*), and hardhead (*Mylopharodon conocephalus*) zone of the main-stem Pit River and the lower reaches of its primary tributaries (Moyle and Marciochi 1975, p. 558; Moyle *et al*. 1982, pp. 45, 47). The known elevation range of Modoc suckers is from about 4,200 to 5,000 ft (1,280 to 1,524 m) in the upper Pit River basin (Ash and Turner Creeks) and from about 4,700 to 5,800 ft (1,432 to 1,768 m) in the Goose Lake sub-basin (Reid 2007, p. 5; Reid 2008a, p. 17). However, most known populations are constrained by the effective upstream limit of permanent stream habitat.

The pool habitat occupied by Modoc suckers generally includes fine sediments to small cobble bottoms, substantial detritus, and abundant cover. Spawning habitat appears to include gravel substrates in the relatively low energy flowing portions of pools or the protected area downstream of rocks (Reid 2008a, p. 12). During low summer flows, pools inhabited by Modoc suckers can become isolated, which eliminates interaction of suckers within and among streams. 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 1972, p. 280; Moyle and Marciochi 1975, p. 558; Moyle 2002, p. 190).

Critical habitat for the Modoc sucker was designated concurrent with the listing (50 FR 24526; June 11, 1985) and includes a total of approximately 26 mi (42 km) in the following streams and a 50 ft (15 m) riparian zone on either side of the stream channel: Turner Creek, Washington Creek (including its tributary Coffee Mill Creek), Hulbert Creek (including its intermittent tributary Cedar Creek), Johnson Creek (including its unnamed, intermittent tributaries in Rice Flat and Higgins Flat), and Rush Creek. The primary constituent elements of critical habitat include intermittent and permanent-water creeks, and adjacent land areas that provide vegetation for cover and protection from soil erosion.

Biology

Male and female Modoc suckers appear to mature at age-2+ years, at which time are they are approximately 3.1 in long (80 mm) (Martin 1967, p. 53; Boccone and Mills 1979, pp. 14–15; Moyle and Marciochi 1975, p. 559). Modoc suckers typically do not live longer than 5 years (Moyle 2002, p. 190). Spawning has been observed to occur from mid-April through early June (Boccone and Mills 1979, p. 14; Reid 2008a, p. 12).

Modoc suckers often segregate themselves by body size along the length of a stream, with larger individuals more common in lower reaches of streams. This may indicate a temperature-growth relationship or that larger Modoc suckers move downstream into larger, deeper, warmer pool habitats as they outgrow the relatively limited habitat in upper stream reaches (Reid 2008a, p. 13).

Similar to other catostomids, Modoc suckers appear to be opportunistic feeders whose primary diet consists of algae, small benthic invertebrates, and detritus (Moyle 2002, p. 190). Moyle and Marciochi (1975, p. 558) 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). Based on gut content, it appears that Modoc suckers feed in low-energy pool environments, which contain detritus and chironomids (Reid 2008a, p. 14).

No complete study of activity patterns has been done for Modoc suckers; however, they appear to exhibit diurnal 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 2008a, p. 16). 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 Modoc suckers are resting and relatively lethargic after dusk (Reid 2009, p. 7).

Distribution and Abundance

At the time of listing in 1985, the historical range of the Modoc sucker was believed to be limited to the Ash Creek and Turner Creek sub-basins, which are tributaries of the Pit River in Modoc and Lassen Counties, California (50 FR 24526; June 11, 1985). Within the Turner Creek sub-basin, Turner Creek and its tributaries, Washington Creek and Hulbert Creek, were occupied at the time of listing. Similarly, within the Ash Creek sub-basin, Johnson Creek was occupied at the time of listing. The final listing rule also recognized that four additional creeks (Ash Creek, Dutch Flat Creek, Rush Creek, and Willow Creek) were occupied historically, but 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, p. 6; Mills 1980, p. 3; 50 FR 24526, June 11, 1985), hybridization was suspected because of overlapping occurrences.

It is now recognized that the historical distribution of the Modoc sucker also included the Goose Lake sub-basin in southern Oregon and northern California, which is a disjoined, upstream sub-basin of the Pit River (Reid 2007, p. 2). Evidence indicates Goose Lake has been

hydrologically disconnected from the Pit River since the 1800s because it has only occasionally substantially overflowed into the North Fork of the Pit River (Laird 1971, pp. 57–58). Although Modoc suckers in California and Oregon are isolated from each other, Modoc suckers in the Goose Lake sub-basin in southern Oregon are morphologically and genetically similar to Modoc suckers in the Turner and Ash Creek sub-basins in northeastern California (Dowling 2005, p. 11; Topinka 2006, p. 76; S. Reid, Western Fishes, unpublished data).

Within each of the three sub-basins occupied by Modoc suckers, there are three to five occupied streams. Modoc suckers within a sub-basin have a greater potential for genetic exchange than among sub-basins and are expected to function together as one demographic unit (Hanski 1998, p. 41). Streams within a sub-basin can become separated as a result of isolation of pool habitat during summer low flows. For the purpose of this report, we therefore consider different streams within a sub-basin to represent different populations of Modoc sucker. The current distribution of the Modoc sucker includes 12 streams in three sub-basins (see Table 1 and Figure 1 below).

Table 1. Known Modoc sucker (*Catostomus microps*) distribution at the time of listing (1985) and present distribution (based on most recent survey data) within the Turner Creek, Ash Creek, and Goose Lake sub-basins.

Sub-basin	Stream	Distribution at Time of Listing	Present Distribution
Turner Creek	Turner Creek	2.0 mi (3.2 km)	5.5 mi (8.9 km)
	Washington Creek	0.5 mi (0.8 km)	3.4 mi (5.5 km)
	Hulbert Creek	0.8 mi (1.3 km)	3.0 mi (4.8 km)
	Coffee Mill Creek	Historically fishless	0.8 mi (1.3 km)
	Garden Gulch	Unknown	1.0 mi (1.6 km)
Ash Creek	Johnson Creek	1.2 mi (1.9 km)	2.7 mi (4.3 km)
	Rush Creek	4.6 mi (7.4 km)	4.6 mi (7.4 km)
	Dutch Flat Creek	0.1 mi (0.2 km)	1.4 mi (2.3 km)
	Ash Creek	3.7 mi (6.0 km)	Assumed 3.7 mi (6.0 km); no recent survey data
	Willow Creek	Unknown	Not extant
Goose Lake	Thomas Creek	Unknown	15.2 mi (24.5 km)
	Unnamed Tributary to Thomas Creek	Unknown	1.2 mi (1.9 km)
	Cox Creek	Unknown	Only collected at one sample location
Total		*12.9 mi (20.8 km)*	*42.5 mi (68.4 km)*

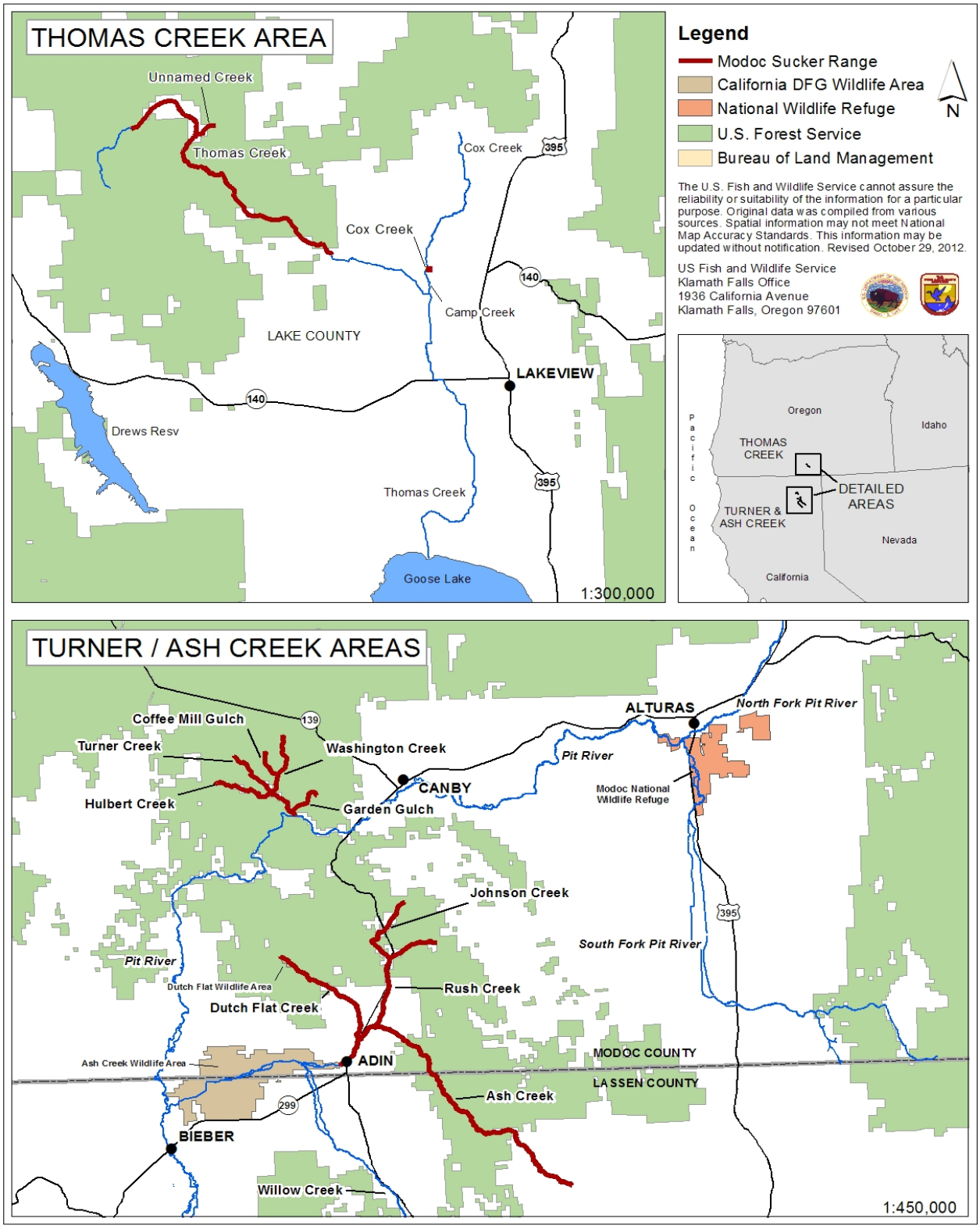

Figure 1. Distribution of Modoc sucker (*Catostomus microps*) in the Goose Lake sub-basin in Oregon (top panel) and the Ash Creek and Turner Creek sub-basins (in California). Areas in green are Fremont-Winema National Forest (top panel) and Modoc National Forest (bottom panel) and areas in white indicate private land.

Additional Populations

New information is available that documents the occurrence of additional populations not considered in the original listing (Coffee Mill Creek and Garden Gulch Creek in the Turner Creek sub-basin, Thomas Creek in the Goose Lake sub-basin, an unnamed tributary to Thomas Creek in the Goose Lake sub-basin, and Cox Creek in the Goose Lake sub-basin; Figure 1). New genetic information is also available on the four populations (Ash Creek, Dutch Flat Creek, Rush Creek, and Willow Creek) considered lost to hybridization in the original listing. Throughout the species' current distribution, land ownership at occupied streams is 51 percent Federal, 48 percent private, and 1 percent State. Information on all currently known populations is summarized below.

Goose Lake Sub-basin

Thomas Creek

Since the time of listing, new information has documented the presence of the Modoc sucker in the Goose Lake sub-basin (Oregon), a disjoined, upstream basin of the Pit River (Reid 2007, p. 2). Field surveys and re-examination of museum specimens 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 2007, p. 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 (Reid 2007, p. 6). The Modoc sucker specimens were found in collections from five sites on Thomas Creek taken in 1954, 1974, 1993 (two collections), and 1997. Additionally, the Oregon Department of Fish and Wildlife (ODFW) and the Fremont-Winema National Forest completed surveys from 2007 to 2012 that confirmed Modoc suckers occupy approximately 15.2 mi (24.5 km) of Thomas Creek (Table 2; Service 2009, p. 13; Scheerer *et al*. 2010, p. 283; T. Smith, USFS, personal communication). In 2007, surveys were completed using multiple-pass electrofishing and passive traps. From 2008 to 2010, surveys were completed by night snorkeling and flashlight observation by a stream bank observer. Notably, in 2008 and 2009, counts included Modoc suckers greater than 1.0 in (25 mm), which may account for the higher number of observations in those years (Table 2; T. Smith, USFS, personal communication). In 2011 and 2012, surveys were completed only using flashlight observation by stream bank observers. Further, in 2011 and 2012, Modoc suckers less than 3.0 in (75 mm) were not included in the total number of observations. Thus, since survey methods and size of suckers included in observations varied, the estimates may not be directly comparable.

Unnamed Tributary to Thomas Creek

In 2007, ODFW completed sampling in the Oregon portion of the Goose Lake sub-basin to assess native fish distribution. The ODFW sampled two locations at this unnamed tributary and collected Modoc suckers from the downstream sampling location (Scheerer *et al*. 2010, p. 280). The Fremont-Winema National Forest re-surveyed the two ODFW sampling locations from 2008 to 2012 and reconfirmed the presence of Modoc suckers at the downstream location on each occasion (Table 2; USFS 2010, p. 1; T. Smith, USFS, personal communication). It is assumed Modoc suckers occupy the length of this stream from the confluence with Thomas

Creek up to the downstream sampling location. Surveys conducted between 2007 and 2012 followed the same methods as those described above for Thomas Creek.

Table 2. Number of Modoc sucker (*Catostomus microps*) observed from 2007 to 2012 in the Goose Lake sub-basin, Lake County, Oregon. "–" indicates no surveys completed. Observations from Thomas Creek and its unnamed tributary represent a sum of counts from a series of stream segments repeatedly surveyed from 2007 to 2012.

Stream	2007	2008	2009	2010	2011	2012
Thomas Creek[1]	67	84	204	60	61	56
Unnamed Tributary to Thomas Creek[1]	9	5	11	4	4	2
Cox Creek[2]	1	–	1	–	–	–

[1] Surveys completed by ODFW in 2007, Fremont-Winema National Forest from 2008 to 2012
[2] Surveys completed by ODFW

Cox Creek

Cox Creek, which is in the Thomas Creek drainage, also was sampled by ODFW in 2007 and 2009 to assess native fish distribution. The ODFW documented Modoc suckers at one sample location in lower Cox Creek approximately 4 mi (6 km) from the downstream distribution of Modoc suckers in Thomas Creek (Figure 1; Scheerer *et al*. 2010, p. 283). Additional surveys will be required to determine the extent of Modoc sucker distribution within Cox Creek.

Turner Creek Sub-basin

Turner Creek

Modoc suckers were first documented from Turner Creek in 1973 (Moyle and Marciochi 1975, p. 557). At the time of listing, Modoc suckers were known to occupy 2.0 mi (3.2 km) of Turner Creek. Based on surveys completed up to 2008, Modoc suckers have been documented in 5.5 mi (8.9 km) of Turner Creek (Reid 2008a, p. 25). Data from the Klamath Falls Fish and Wildlife Office (KFFWO) surveys in 2012 indicate 331 suckers observed, which is greater than the 265 suckers observed during the previous surveys completed in 2008 (Table 3; Reid 2008a, p. 30; KFFWO unpublished data).

Washington Creek

Modoc suckers were first documented from Washington Creek in 1973 (Moyle and Marciochi 1975, p. 557). At the time of listing, Modoc suckers occupied 0.5 mi (0.8 km) of Washington Creek. Based on surveys completed up to 2008, Modoc suckers occupied 3.4 mi (5.5 km) of Washington Creek (Reid 2008a, p. 25). Data from KFFWO surveys in 2012 indicate 96 suckers observed, which is comparable to the 100 suckers observed during the previous surveys completed in 2008 (Table 3; Reid 2008a, p. 30; KFFWO unpublished data).

Table 3. Population estimates of Modoc sucker (*Catostomus microps*) from surveys in 1974 and 1997 as well as number of Modoc suckers observed during surveys from 1989 to 2012 in the Turner Creek sub-basin and Ash Creek sub-basin, Modoc and Lassen Counties, California. Surveys in 1977, 1989, and 1992 include observations of Modoc suckers less than 60 mm. Surveys in 2008 and 2012 only include observations of Modoc suckers greater than 60 mm. "–" indicates no surveys completed. *I.S.* indicates incomplete survey (see *Johnson Creek* section, p. 19).

Sub-basin	Stream	1974[1]	1977[2]	1989[3]	1992[4]	2008[5]	2012[6]
Turner Creek	Turner Creek	–	100	–	249	265	331
	Washington Creek	–	50	–	230	100	96
	Hulbert Creek	–	500	–	106	31	54
	Coffee Mill Creek	–	–	–	50	106	81
	Garden Gulch Creek	–	–	–	–	50	28
Ash Creek	Johnson Creek	3,163	700	–	653	128	*I.S.*
	Rush Creek	535	1,000	–	–	–	–
	Dutch Flat Creek	–	40	133	1300	101	251
	Ash Creek	300	200	–	–	–	–
	Willow Creek	–	15	–	–	0	–

[1] Moyle (1974, p. 38). Extrapolated population estimate rather than count.
[2] Ford (1977, p. 12). Extrapolated population estimate rather than count.
[3] White (1989, p. 7)
[4] Scoppettone *et al*. (1992, p. 13). Probable overestimation of actual Modoc sucker numbers from inclusion of some Sacramento suckers.
[5] Reid (2009, p. 19)
[6] KFFWO, unpublished data

Hulbert Creek

Modoc suckers were first documented from Hulbert Creek in 1973 (Moyle and Marciochi 1975, p. 557). At the time of listing, Modoc suckers occupied 0.8 mi (1.3 km) of Hulbert Creek. Based on surveys completed up to 2008, Modoc suckers occupied 3.0 mi (4.8 km) of Hulbert Creek (Reid 2008a, p. 25). Data from KFFWO surveys in 2012 indicate 54 suckers observed, which is greater than the 31 suckers observed during the previous surveys completed in 2008 (Table 3; Reid 2008a, p. 30; KFFWO unpublished data).

Coffee Mill Creek

Coffee Mill Creek is a tributary of Washington Creek that, at the time of listing, appeared to have suitable habitat, but was historically fishless due to a high-gradient barrier at its mouth. In 1987, CDFW transplanted 20 Modoc suckers from Washington Creek to Coffee Mill Creek. The transplant included 12 adults and 8 juveniles, and was intended to establish an additional population in the Turner Creek sub-basin (CDFW 1986, p. 11). 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 visual surveys (Reid 2009, p. 25). Coffee Mill Creek contains 0.8 mi (1.3 km) of occupied habitat (Reid 2008a, p. 25). Data from KFFWO surveys in 2012 indicate 81 suckers observed, which is slightly less than the 106 suckers observed during the previous surveys completed in 2008 (Table 3; Reid 2008a, p. 30; KFFWO unpublished data).

Garden Gulch Creek

Garden Gulch Creek was not known to be occupied at the time of listing. In 2000, a previously unreported population of Modoc suckers was found in Garden Gulch Creek, a small tributary of Turner Creek near its confluence with the Pit River and about 2 miles downstream of Hulbert and Washington Creeks (Moyle 2002, p. 190; Topinka 2006, p. 51). Garden Gulch Creek contains about 1.0 mi (1.6 km) of occupied habitat (Reid 2008a, p. 25). Data from KFFWO surveys in 2012 indicate 28 suckers observed, which is roughly half the estimated 50 suckers observed during the previous surveys completed in 2008 (Table 3; Reid 2008a, p. 30; KFFWO unpublished data).

Ash Creek Sub-basin

Johnson Creek

Modoc sucker were first documented from Johnson Creek in 1973 (Moyle and Marciochi 1975, p. 557). Johnson Creek was considered the only occupied genetically pure creek in the Ash Creek sub-basin at the time of listing. At the time of listing, Modoc sucker occupied 1.2 mi (1.9 km) of Johnson Creek. Based on surveys completed up to 2008, Modoc suckers occupied 2.7 mi (4.3 km) of Johnson Creek (Reid 2008a, p. 25). Data from KFFWO surveys in 2012 indicate only 3 suckers observed, which is much lower than the 128 suckers observed during the previous surveys completed in 2008 (Table 3; Reid 2008a, p. 30; KFFWO unpublished data). However, the survey by the KFFWO within Johnson Creek in 2012 was incomplete and is not directly comparable to 2008. In 2012, the KFFWO encountered dense aquatic vegetation in several areas of Johnson Creek that prevented sucker observations. Further, the KFFWO was unable to survey a large portion of Johnson Creek that was closed by law enforcement officials to unauthorized entry.

Rush Creek

Rush Creek is a tributary to Ash Creek and contains the type locality of the Modoc sucker. At the time of listing, the Rush Creek Modoc sucker population was presumed lost due to hybridization with Sacramento suckers. At the time of listing, Modoc suckers were known to occupy 4.6 mi (7.4 km) of Rush Creek. Based on surveys completed up to 2008, Modoc suckers have been documented in 4.6 mi (7.4 km) of Rush Creek (Reid 2008a, p. 25). Therefore, Modoc suckers still occupy the same extent of the historically occupied reaches (Reid 2008a, p. 25). No collection of Modoc suckers from Rush Creek has been done for genetic analysis due to landowner access issues (Topinka 2006, p. 68). Modoc suckers in Rush Creek have been differentiated from Sacramento suckers based on meristic and morphometric variability. Population estimates were provided in the 1970s, but there have been no recent estimates completed at Rush Creek since that time (Table 3).

Dutch Flat Creek

At the time of listing, the Dutch Flat Creek (tributary to Ash Creek) population of Modoc suckers was presumed lost due to hybridization with Sacramento suckers. However, recent collections and preliminary genetic analysis indicate that Modoc suckers in Dutch Flat Creek exhibit little introgression of Sacramento sucker alleles (Topinka 2006, p. 66; Reid 2008a, p. 26). The extent of habitat occupied by presumed hybrid Modoc suckers at the time of listing was

estimated to be 0.1 mi (0.2 km; Reid 2008a, p. 25). Based on surveys completed up to 2008, Modoc suckers occupied 1.4 mi (2.3 km) of Dutch Flat Creek (Reid 2008a, p. 25). Data from KFFWO surveys in 2012 indicate more than twice the number of suckers observed compared to the surveys of Dutch Flat Creek in 2008 (Table 3; Reid 2009, p. 19; KFFWO, unpublished data).

Ash Creek

At the time of listing, the Ash Creek Modoc sucker population was presumed lost due to hybridization with Sacramento suckers. Data indicate that suckers exhibiting the morphological characteristics of Modoc suckers are present in Ash Creek (Moyle and Marciochi 1975, p. 557; Moyle *et al*. 1982, p. 46). Analysis of eight genetic markers (three for Sacramento sucker and five for Modoc sucker) has revealed that the frequency of introgression with Sacramento suckers in this population ranges from 94 to 100 percent (Topinka 2006, pp. 69, 79; see Hybridization section under *Factor E*). Sacramento suckers also have been reported from upper Ash Creek since 1963 and were collected from about 10 mi downstream in 1898 (Reid 2008a, p. 23). Therefore, it is believed that Sacramento suckers did not recently invade Ash Creek and that the observed introgression is a historically natural phenomenon. Although the Ash Creek population exhibits a unique introgressed character and full sympatry with Sacramento suckers, we consider it an extant Modoc sucker population

Willow Creek

At the time of listing, the Willow Creek Modoc sucker population was presumed lost due to hybridization with Sacramento suckers. Surveys and collections in Willow Creek (tributary to Ash Creek) in the early 1970s 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 *et al*. 1982, p. 44; Topinka 2006, p. 61; Reid 2009, p. 14). Previous reports of Modoc suckers in Willow Creek are based on limited and unverifiable reports (Reid 2009, p. 14) and their present existence in Willow Creek remains questionable (Reid 2008a, p. 25). It is also evident that speckled dace (*Rhinichthys osculus*), a species typically associated with Modoc suckers, have never been recorded from the upper reaches (Reid 2008a, p. 81). 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 species report, Willow Creek is not considered to contain an extant population of Modoc suckers.

Summary of Distribution and Abundance

At the time Modoc sucker was listed as endangered in 1985, its known distribution was 12.9 mi (20.8 km) in 7 streams in the Turner Creek and Ash Creek sub-basins of the Pit River in northeastern California. It is now recognized that the historical distribution also included the Goose Lake sub-basin in southern Oregon and northeastern California, which is a disjoined, upstream sub-basin of the Pit River. Expansion of the Modoc sucker's known range is attributed to both transplanting Modoc suckers into unoccupied habitat (Coffee Mill Creek) and detection of Modoc suckers in streams not known to contain the species at the time of listing (Garden Gulch Creek, Thomas Creek, unnamed tributary to Thomas Creek, and Cox Creek). The current known distribution of Modoc sucker includes a total of 42.5 mi (68.4 km) in 12 streams in the Turner Creek, Ash Creek, and Goose Lake sub-basins. Recent population estimates are not available, but surveys conducted in 2008 and 2012 show that Modoc suckers are still present and

well established in each of the streams where they were known to historically occur, and that they appear to occupy nearly all available suitable habitat in the streams where they do occur.

The estimates of Modoc sucker abundance in the discussion above and associated tables may not be directly comparable since survey methods varied. The surveys from 2008 and 2012 are the most comparable because the same streams were sampled and sampling protocols used in both years were similar. However, in 2012, the KFFWO surveyed the entire stream channel, whereas surveys completed in 2008 focused mainly on the preferred pool habitat of Modoc suckers. Further, access to certain stream reaches was more limited in 2012 than in 2008. The numbers of Modoc suckers from 2008 and 2012 represent counts rather than estimates of abundance since the numbers reported do not account for unobserved suckers. Observations of suckers may be affected by sucker behavior, both seasonally and diurnally, extent of available habitat (wet or dry water year), and other environmental variables (Reid 2009, p. 7). Also, there is likely to be some variability among observers, even when the same protocol is used. However, these data represent the best available scientific data for this review.

Summary of Factors Affecting the Species

Factor A. Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Livestock Grazing

The listing rule stated that cattle grazing had led to a reduction in riparian vegetation causing stream incision, erosion, and siltation. An increase in silt from eroding banks may fill in the preferred pool habitat of Modoc suckers and can cover gravel substrate used for spawning (50 FR 24526, June 11, 1985; Moyle 2002, p. 190). Sediment introduced into streams can adversely affect fish populations by inducing embryo mortality, affecting primary productivity, and reducing available habitat for macroinvertebrates that Modoc suckers feed upon (Moyle 2002, p. 191).

Since listing, some of the Modoc sucker streams on public land have been fenced to exclude or actively manage cattle grazing for the benefit of Modoc sucker conservation (Reid 2008a, pp. 34–36, 85). For example, 1.5 mi of Washington Creek, 0.2 mi of Hulbert Creek, 0.5 mi of Coffee Mill Creek, and approximately 1.5 mi of Turner Creek have been fenced to protect riparian habitat (Reid 2008a, p. 85; M. Yamagiwa, USFS, personal communication). In fact, the listing rule did note improvements seen in just over 3 years at Washington Creek (50 FR 24526; June 11, 1985). Riparian fencing along occupied streams to exclude cattle during the past 25 years has resulted in continued improvements in riparian vegetative corridors, in-stream cover, and channel morphology.

In 2001, CDFW, in cooperation with the Modoc National Forest and the Service, completed habitat surveys at occupied stream reaches on public land and private lands in the Turner Creek sub-basin and lower Johnson Creek and Dutch Flat Creek in the Ash Creek sub-basin (Rossi 2001, pp. 7–9). Habitats were characterized at several cross sections at each stream and mapped using GIS, and pool characteristics (e.g., area, depth, substrate, cover) 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*. 2003, p. 1) assessment for surveyed cross sections of each stream. Proper Functioning Condition is a method of assessing the physical functioning of riparian and wetland areas. Proper Functioning Condition assessment refers to a consistent approach for considering hydrology, vegetation, and erosion and deposition attributes and processes to assess the condition of riparian areas. The team found that the surveyed cross sections of Turner Creek, Coffee Mill Creek, Hulbert Creek, Washington Creek, and Johnson Creek on public lands were in "proper functioning condition" and that Dutch Flat and Garden Gulch Creeks were "functional-at risk" with "upward trends," which is a positive condition just below proper functioning condition (CDFG 2002, pp. 1–18). On private lands at Turner, Washington, and Johnson Creeks, however, the surveyed cross sections were assessed to be "functional-at risk" with "upward trends" (Johnson Creek) or with "no apparent trends" (Turner and Washington Creeks).

Extensive landowner outreach and improved grazing management practices in Modoc and Lassen Counties have also resulted in improved protection of riparian corridors on private lands in the Turner and Ash Creek sub-basins. Since Modoc sucker was listed in 1985, fencing has been constructed to exclude cattle from all private lands designated as critical habitat on Rush Creek and Johnson Creek below Higgins Flat (Modoc National Forest). Protection of riparian habitat by excluding cattle has resulted in improved habitat conditions along these streams as a result of reduced erosion and improved vegetative and hydrologic characteristics (Reid 2008a, pp. 41, 85–86). At this time, the Service has no indication that current land management practices on public and private lands adjacent to Modoc sucker habitat will not continue into the future. Stable to upward habitat trends are expected to continue as a result. It should be noted, however, there are no formalized agreements in place with private landowners that establish protection of Modoc sucker habitat, though continued outreach is expected to occur in the near future (e.g., through the Service's Partners for Fish and Wildlife Program).

Portions of streams occupied by Modoc sucker in the Turner Creek and Ash Creek sub-basins are located on the Modoc National Forest (Figure 1). Although not quantified, the 1995 biological opinion for livestock grazing on the Modoc National Forest indicated that since the time of listing, most of the occupied habitat had been fenced to exclude grazing (Service 1995, p. 22; USFS 2004, p. 3; Reid 2008, p. 38–39, 85). Recently, a portion of upper Turner Creek on the Modoc National Forest was fenced to exclude grazing along the riparian area (M. Yamagiwa, USFS, personal communication). The current grazing management practices on the Modoc National Forest have led to improved conditions in much of the riparian areas along streams occupied by Modoc suckers. For example, on the Rush Creek grazing allotment, improved conditions have been the result of rotation, deferred, and no grazing management, a reduction of permitted use, construction and maintenance of exclosure fences, and implementation of utilization standards specified in the Forest Plan and the Biological Opinion for Modoc sucker habitat (USFS 2004, p. 37). Off-channel stock ponds also have been used to reduce grazing pressure in riparian areas (USFS 2008b, p. 15).

Since the time of listing, active habitat restoration also has led to improved habitat conditions in riparian areas along many of the streams occupied by Modoc suckers on the Modoc National Forest. Willows have been planted along portions of streams occupied by Modoc suckers in the Turner Creek and Ash Creek sub-basins to stabilize streambanks and provide

shading and cover (Reid 2008a, pp. 85–86; USFS 2008a, p. 16). As a result of riparian habitat improvements and improved grazing management practices, channel widths have narrowed and created deeper habitat preferred by Modoc suckers (USFS 2008a, p. 16). Other habitat restoration activities include juniper revetment (the use of cut juniper trees revetment to stabilize streambanks), creation and expansion of pool habitat, placement of boulders within streams to provide cover and shade, and restoration of channel headcuts to prevent further downcutting of channels (Reid 2008a, pp. 85–86; USFS 2008a, p. 16).

Portions of Thomas Creek and the unnamed tributary to Thomas Creek in the Goose Lake sub-basin are located on the Fremont-Winema National Forest (Figure 1). The 2008 biological opinion for livestock grazing on the Fremont-Winema National Forest stipulates livestock grazing is allowed to occur at "proper use levels" by using various grazing strategies that will minimize adverse effects to the watershed and listed species. Proper use is defined as a degree of utilization of current year's growth, which if continued will achieve management objectives and maintain or improve long-term productivity of the site. The Forest uses adaptive management, including annual implementation and effectiveness monitoring, to ensure the grazing of livestock reduces adverse effects to Modoc suckers (Service 2008, pp. 5–8). As part of the annual implementation monitoring, stubble height is measured along streams and monitoring data is used to determine when livestock need to be moved to ensure utilization thresholds are not exceeded. More stringent utilization standards are applied when streams and riparian areas are at-risk or non-functional based upon PFC methodology. As part of the effectiveness monitoring, data are used to determine trends in riparian and adjacent upland area conditions. The Forest relies upon effectiveness monitoring results when considering changes in grazing management techniques (strategy, utilization, and timing).

Grazing on the Fremont-Winema National Forest is managed using a combination of early season; deferred; and high intensity, low frequency grazing strategies. In its biological assessment for the effects of livestock grazing on Modoc sucker, biologists on the Fremont-Winema National Forest concluded that fish habitat conditions along Thomas Creek and its unnamed tributary were considered to be functioning appropriately based on analysis of stream survey data, field reconnaissance, and professional judgment (USFS 2008a, pp. 29–31). Stream channels in the Cox Flat Allotment have proven to be stable and capable of withstanding high streamflow events (USFS 2008a, p. 31). Large storm events (1997, 2005, and 2006) and the resulting flood flows did not cause channel degradation or noticeable changes in fish habitat or channel morphology within the allotment. Stream channels are generally functioning appropriately and trending upward under the current management strategy, which has been in place for 15 years. The Service concluded in its 2008 biological opinion that stable to upward trends in Modoc sucker habitat on the Fremont-Winema National Forest were likely to continue throughout the remaining period of the grazing permit in 2018 (Service 2008, p. 34).

In 2012, the KFFWO completed habitat surveys in Washington Creek, Garden Gulch Creek, Coffee Mill Creek, Dutch Flat Creek, Turner Creek, Hulbert Creek, and Johnson Creek within the Ash Creek and Turner Creek sub-basins. Three reaches within each creek were randomly selected for a survey, each of which was 100 m in length, and occurred primarily on public lands occupied by Modoc suckers. Data collected indicated that the average percent bank erosion was low (less than 40 percent) at Garden Gulch Creek, Coffee Mill Creek, Hulbert

Creek, Washington Creek, and Johnson Creek. Bank erosion appeared moderate at Dutch Flat Creek (49 percent) and was highest at Turner Creek (75 percent). Bank erosion along these creeks has resulted in an introduction of silt, which can cover gravel substrate used for spawning by Modoc suckers (Moyle 2002, p. 191). Sediment introduced into streams can adversely affect fish populations by inducing embryo mortality, affecting primary productivity, and reducing available habitat for macroinvertebrates that Modoc suckers feed upon. One of the randomly selected reaches within Dutch Flat Creek occurred within the 160-acre (65-hectare) Dutch Flat Wildlife Area (Figure 1), which was created by CDFW in 1983 to protect 0.75 mi (1.2 km) of riparian and stream habitat. This area was previously fenced to prevent cattle from grazing in the Dutch Flat Creek riparian area. The 2012 survey revealed that bank erosion has led to failure of some of the riparian fencing, thus allowing cattle access to the creek. Bank erosion and failure of the riparian fencing also was a condition that was noted during the KFFWO Modoc sucker surveys, particularly on a 1.01 mi (1.63 km) reach of private property in lower Turner Creek. Cattle tracks and droppings were observed within the bankful width of all streams, though not at all locations. Although exclusion fences were present at some sites, some were in disrepair and, therefore, ineffective.

Thomas Creek, in the Oregon portion of the Goose Lake sub-basin, was not known to support Modoc suckers when the species was listed in 1985. The majority of the upper Thomas Creek watershed and the stream reach containing Modoc suckers are managed by Fremont-Winema National Forest. Prior to learning that there were Modoc suckers in the basin, 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. Examples of these projects include installing instream structures to collect sediment, road decommissioning, and planting willows to stabilize the stream banks, which appear to have been beneficial for Modoc sucker habitat (Service 2008, pp. 22–23). Although there are no formal agreements in place associated with the Thomas Creek Riparian Recovery Project, grazing along Thomas Creek continues to be managed under the Service's biological opinion.

There are two privately owned meadow reaches of Thomas Creek above the lower national 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 large numbers of Modoc suckers (Table 2; Reid 2008a, pp. 41–42). The upper parcel is fenced and surveys in 2009 and 2010 upstream of the private property indicate presence of Modoc suckers (T. Smith, USFS, personal communication). Although not surveyed, the suckers most likely occur in the upper private parcel as they are found upstream and downstream of this location. 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 2008a, p. 42). At this time, the Service has no indication that grazing practices on public and private lands on Thomas Creek, which are considered compatible with the conservation of the species, will not continue into the future. Further, the Lake County Watershed Council has partnered with private landowners to complete habitat restoration on the private land parcels to benefit fish passage and riparian habitat. Further, the USFS has initiated habitat restoration on public land to eliminate

channel headcuts and improve fish passage. Therefore, habitat conditions are expected to remain stable or improve in the future for the benefit of Modoc sucker.

Elimination of Passage Barriers

The listing rule 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. Other Natural or Manmade Factors Affecting Its Continued Existence*). The lack of barriers was also thought to provide exposure to nonnative 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 (Moyle 2002, p. 187). 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, pp. 190–191). However, since the time of listing, additional field surveys and an ongoing genetic assessment program have increased our understanding of the distribution and genetics of Modoc sucker populations (Dowling 2005, pp. 10–11; Topinka 2006, pp. 73–74). 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. Thus, elimination of passage barriers is no longer considered a threat to the continued existence of Modoc sucker. Additional details on hybridization are discussed under *Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence* below.

Additional Threats to the Modoc Sucker Habitat

At the time of listing, neither irrigation diversions nor groundwater withdrawals were identified as threats to the continued existence of the Modoc sucker. There are no substantial diversions affecting water quantity and flow in Modoc sucker streams, with the exception of two existing irrigation diversions in Rush Creek (Reid 2008a, p. 35; Service 2009, p. 22). Although unscreened, these diversions are low capacity and occur in an area of low Modoc sucker numbers (S. Reid, Western Fishes, personal communication). We are unaware of any groundwater withdrawals or other additional factors that are likely to threaten the Modoc sucker (S. Reid, Western Fishes, personal communication).

Regulatory Mechanisms and Conservation Efforts Relevant to Habitat Destruction, Modification, or Curtailment of Modoc Sucker's Habitat or Range

The California Fish and Game Code affords protection to stream habitats for all perennial, intermittent, and ephemeral rivers and streams. Under the California Fish and Game Code, any person, state or local governmental agency, or public utility must notify CDFW prior to conducting activities that would divert or obstruct stream flow, use or alter streambed and stream bank materials, or dispose of debris that may enter streams. This applies to streams occupied by Modoc suckers as the State of California designated the Modoc sucker as endangered and fully protected in 1980 and would apply even if the species were not listed (see

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes). The Oregon Department of Land Conservation and Development implemented a Statewide Planning Program that requires local land use planning ordinances to protect natural resources, including riparian and wetland habitats.

The National Environmental Policy Act (NEPA; (42 U.S.C. 4371 *et seq*.)) requires Federal agencies to describe a proposed action, consider alternatives, identify and disclose potential environmental impacts of each alternative, and involve the public in the decision making process. The release of documents is for disclosure, and NEPA does not require or guide mitigation for project impacts. Projects that are covered by certain "categorical exclusions" are exempt from NEPA biological evaluations. The Bureau of Land Management and USFS comply with NEPA for actions requiring an environmental assessment, including projects in or near Modoc sucker habitat. Federal agencies are not required to select the NEPA alternative having the least significant environmental impacts. A Federal agency may select an action that will adversely affect sensitive species provided that these effects were known and identified in a NEPA document.

The National Forest Management Act of 1976 (NFMA) governs the management of national forest lands. Under NFMA, the management of an individual national forest may operate under an existing land and resource management plan. The land and resource management plans guide all natural resource management activities and establish forest management standards. The Fremont-Winema National Forests and Modoc National Forest have each established land and resource management plans. These plans direct these national forests to maintain or increase the status of populations of federally endangered or threatened species and their habitats. In addition, these plans guide riparian management with a goal of restoring and maintaining aquatic and riparian ecosystems to their desired management potential (USFS 1989, Appendix p. 86; USFS 1991, pp. 4-26, Appendix pp. M-1–M-2).

Management direction for grazing on Forest-managed lands is provided through allotment management plans and permits, which stipulate various grazing strategies that will minimize adverse effects to the watershed and listed species. The allotment management plans outline grazing management goals that dictate rangeland management should maintain productive riparian habitat for threatened, endangered, and sensitive species (USFS 1995, p. 1). On the Modoc National Forest, the target utilization for cattle grazing along streams occupied by Modoc sucker is 30 to 40 percent with a minimum 5 in (12.7 centimeter (cm)) stubble height (USFS 1995, p. 6). On the Fremont-Winema National Forests, grazing is permitted along Thomas Creek. The target utilization for cattle grazing is less than or equal to 5 percent at the Lower and Upper Thomas Creek Riparian Pastures (Service 2008, p. 4). These grazing permits are valid for 10 years though operating instructions for these permits are issued on an annual basis.

Factor A Summary

Impacts to Modoc sucker habitat from livestock grazing have been greatly reduced since the time of listing as a result of improved livestock grazing management practices. Land management practices employed on public and private lands since the early 1980s are expected

to continue, or improve, thereby maintaining upward habitat trends as documented by PFC data. However, the high level of bank erosion at the parcel of private property on lower Turner Creek and the erosion and riparian fence failure in the Dutch Flat Wildlife Area remain a concern for sediment introduction and degradation of Modoc sucker habitat. Yet, these two degraded reaches combined amount to only 4.1 percent (1.76 mi/42.5 mi) of Modoc sucker's total occupied habitat. Although the 2012 habitat surveys indicate that livestock grazing still results in stream bank erosion along streams occupied by Modoc suckers, recent survey results (2008 and 2012) indicate that livestock grazing has not resulted in reduced distribution of Modoc suckers (see *Summary of Distribution and Abundance*).

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

The listing rule did not identify any threats in this category, and there is no new information indicating threats from overutilization for commercial, recreational, scientific, or educational purposes. 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 suckers is for limited scientific purposes (e.g., genetic sampling or capture, handling, and release) 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, and it is anticipated these agencies would continue monitoring scientific take if the species becomes downlisted or delisted.

The State of California designated the Modoc sucker as endangered under the California Endangered Species Act (CESA) in 1980. Under CESA, the Modoc sucker is considered a "fully protected" species. The CDFW does not authorize incidental take of fully protected species when activities are proposed in areas inhabited by those species other than incidental take for scientific research. Accordingly, non-Federal agencies and private entities must avoid take of Modoc sucker and other fully protected species when completing projects.

The Modoc sucker is not listed under the Oregon Endangered Species Act, but the State of Oregon recently added the Modoc sucker to its sensitive species list, giving it a "critically sensitive" status (ODFW 2008, p. 7). The 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 2012, p. 10). Regardless of the status of the species under the ESA, it is anticipated that ODFW and CDFW would still require a special permit for take of the species.

Factor C. Disease or Predation

Disease

The listing rule 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 basin, the Service is not aware of historical fish die-offs in the upper Pit River basin caused by disease or parasites, nor are we aware of fish diseases in the Pit River or neighboring watersheds that currently threaten Modoc sucker populations.

Predation

Predation by nonnative species is a concern within the Turner Creek and Ash Creek sub-basins. Both coldwater and warmwater nonnative fish occur within these sub-basins. Brown trout (*Salmo trutta*) are the only nonnative coldwater fish that occurs with Modoc suckers whereas largemouth bass (*Micropterus salmoides*), green sunfish (*Lepomis cyanellus*), and brown bullhead (*Ameiurus nebulosus*) are nonnative warmwater fish that occur with Modoc sucker. In the Goose Lake sub-basin, no nonnative fish are sympatric with Modoc sucker in the Thomas Creek drainage, but brown bullhead have been observed in Cox Creek and brook trout (*Salvelinus fontinalis*) occur in the Cottonwood Creek drainage, a tributary to Goose Lake. Nonnative American bullfrogs (*Rana catesbeiana*) are present in lower Turner Creek and it was suspected they may consume Modoc suckers. However, an ongoing study of bullfrog predation has revealed that few Modoc suckers were consumed by bullfrogs over a 5-year period (Reid 2008b, p. 2; S. Reid, Western Fishes, personal communication), indicating that bullfrogs are not a major predator of Modoc suckers.

The Modoc sucker typically occupies habitat where the only native predatory fish is the redband trout (*Oncorhynchus mykiss* ssp.), a primarily insectivorous species that occasionally feeds on small fishes (Moyle and Marciochi 1975, p. 558; Moyle *et al*. 1982, p. 47; Moyle 2002, p. 190). The listing rule identified the presence of nonnative brown trout as a threat that reduced sucker numbers through predation (50 FR 24526, June 11, 1985). Since the time of listing, additional predatory nonnative fishes have been recorded in streams containing Modoc suckers and is detailed below (Service 2009).

Piscivorous nonnative fishes may suppress local Modoc sucker populations through direct predation, potentially on all life stages. Not all nonnative species appear to represent a major threat to the Modoc sucker. Of the nonnative species found in Modoc sucker streams, brown trout and largemouth bass, both large, piscivorous species, may have the greatest potential for adverse impacts on local populations of smaller native fishes. Turner Creek supports a relatively large population of suckers despite the nearly continuous presence of green sunfish (*Lepomis cyanellus*), brown bullhead (*Ameiurus nebulosus*), and bluegill (*Lepomis macrochirus*) since at least the 1970s. All three species are primarily insectivorous at the sizes observed in Turner Creek (Reid 2008a, p. 45) and not capable of consuming adult Modoc suckers as they are gape limited. Although these nonnative fishes may occasionally consume larval and juvenile suckers, they also consume predatory insects (e.g., larval dragonflies and diving beetles) that may prey on young Modoc suckers. At this time, the ecological dynamics between introduced and native fishes in the Turner Creek sub-basin are not fully understood. However, the most recent survey data indicate that populations of Modoc suckers in the Turner Creek sub-basin are persisting and remain stable (Table 3), so green sunfish, bluegill, and brown bullhead do not appear to be substantially affecting Modoc sucker populations.

Brown trout – Brown trout were first introduced to Ash and Rush Creeks in the early 1930s and have established reproducing populations in both streams (VESTRA 2004, Section 9, p. 18). 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 the Modoc sucker in

Rush Creek, they found brown trout co-occurring with Modoc suckers (Hubbs 1934, p. 1). Presently, the two species are still both found in Rush Creek. Larger brown trout are piscivorous, and may have the potential to suppress sucker or other native fish populations within a co-occupied stream reach (Moyle 2002, p. 191). Observations in Rush and Johnson Creeks indicate that when large brown trout (> 8 in (203 mm)) 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 (Service 2009). However, the coexistence of suckers and brown trout in the Ash Creek sub-basin (including Rush Creek and Johnson Creek) for over 75 years suggests that predation by brown trout is 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 the Goose Lake sub-basin. Reid (2006, p. 24) reported a single brown trout reported from the Turner Creek sub-basin, indicating they have not established a population. Further, there are no streams containing populations of brown trout flowing into Turner Creek. The CDFW fish management division has discontinued stocking of brown trout into streams in the Pit River basin (P. Divine, CDFW, personal communication). One of the principal obligations of the Oregon Native Fish Conservation Policy is to conserve native fish of Goose Lake sub-basin streams (ODFW 2003, p. 2). As such, ODFW does not stock brown trout into streams of the Goose Lake sub-basin (D. Banks, ODFW, personal communication).

Largemouth bass – The largemouth bass is a nonnative predator that grows as large as 8 to 16 in (200 to 410 mm) at age 4+ years (Moyle 2002, p. 400) and is capable of consuming most sizes of Modoc suckers and other native fishes in pools they occupy. They are currently known to occur in the Turner Creek sub-basin and may be present in the Ash Creek sub-basin (Ash Creek proper), but are likely confined to the warmer, low gradient downstream reaches. Largemouth bass are not sympatric with Modoc suckers in the Goose Lake sub-basin.

Largemouth bass may be present in the lowest reaches of Ash Creek, near the Pit River, but there are no source populations of bass upstream of Modoc sucker populations in this sub-basin. Further, cool-water stream reaches downstream protect existing sucker populations (Reid 2008a, p. 46) because largemouth bass prefer to inhabit warmer waters near 80 °F (27 °C) (Moyle 2002, p. 399). In the Turner Creek sub-basin, bass exhibit a pattern where they are periodically observed in Turner Creek and Washington Creek and then apparently disappear, either through natural mortality or emigration (Reid 2008a, p. 46). They are not believed to successfully reproduce in either creek (Reid 2008a, p. 46). Largemouth bass were not encountered in the first surveys of the Turner Creek basin in 1973 (Moyle *et al*. 1982, p. 49) and were first reported in 1977 from Turner Creek (Ford 1977, p. 8) and in 1984 from Washington Creek.

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, p. 32). After that, only one bass was observed until 2004, when large numbers of bass and sunfish were flushed into the system from upstream reservoirs during particularly high spring flows (Reid 2006, p. 26). The principal source for bass, and other nonnative species, in Turner Creek above the gauge station barrier (including Washington Creek)

appears to be several reservoirs higher in the Turner Creek and Washington Creek sub-basins, and there does not appear to be significant immigration from the Pit River (Reid 2006, p. 24).

Eradication and control measures – Since 2005, the Service has supported a successful program of active management for nonnative fishes in the Turner Creek basin, targeting bass and sunfishes with selective angling and hand removal methods that do not adversely impact native fish populations (Reid 2008b, p. 1). As a result, there are no or just an occasional bass or bluegill present in upper Turner Creek or its tributaries (Reid 2008b, pp. 1–2). Green sunfish remain only in Turner Creek proper, where their numbers are greatly reduced as a result of previous removal efforts. Active removal of brown bullhead has taken place within Washington Creek and their numbers are presently low (KFFWO unpublished data). In 2006, the Modoc National Forest installed a screen to prevent nonnative fish escapement at the outflow of Loveness Reservoir, which accumulates all surface flow prior to entry into the occupied reaches of Washington Creek. No largemouth bass were seen downstream of the screen in 2012. This suggests the screen is effective at preventing adult largemouth bass from escaping the reservoir. Brown bullhead were still observed in Washington Creek in 2012 although in low numbers (KFFWO unpublished data). Brown bullhead have been greatly reduced through active management in Johnson Creek and remain in low numbers (Reid 2010, p. 2). It is the intent of the KFFWO to work with our partners to monitor for nonnative fishes and conduct eradication or suppression activities if their abundance shows a marked increase.

Regulations – Transfer of fish from one water body to another is prohibited by state regulations in both California and Oregon. However, illegal transfers of sport and bait fishes sometimes occur by fishermen intentionally "seeding" a water body with a popular sport fish. Although it is possible that someone would illegally introduce nonnative 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 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 pursue 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 sub-basins with Modoc suckers contain introduced predatory fishes. The Ash Creek sub-basin contains brown trout, which have co-existed with Modoc suckers for over 75 years, but may suppress local native fish populations in small streams. There are no sources of bass upstream of Modoc sucker populations in the Ash Creek basin, although they may be present downstream in warmer, low-gradient reaches of Ash Creek proper. The Turner Creek basin contains largemouth bass, sunfish (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. However, high flow events could clog the screens at reservoir outlets causing periodic influxes of largemouth bass if the screens are not monitored and managed. Redband trout, speckled dace, and Pit-Klamath brook lamprey (*Entosphenus lethophagus*) also occupy upper Thomas Creek, but there

are no nonnative fishes (Scheerer *et al*. 2010, pp. 278, 281). The upper reaches of Thomas Creek occupied by Modoc suckers are unlikely to be invaded by nonnative fishes given the lack of upstream source populations and presence of a natural waterfall barrier in the lowest reach.

While Modoc suckers may be negatively impacted by introduced predatory fishes, such as brown trout and largemouth bass, they have persisted in the presence of nonnative predators and populations have remained relatively stable in the Ash Creek and Turner Creek sub-basins prior to and since the time of listing. The separation of the three known basins containing Modoc suckers further reduces the probability that a new or existing nonnative predator would impact all three basins simultaneously. In some instances, there are natural constraints that limit the distribution of nonnative predators, such as cool-water habitat. In other cases, natural or manmade barriers limit potential introductions, as do policies and regulations within Oregon and California. Therefore, introduced predators do not appear to significantly affect Modoc sucker populations. 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 nonnative predators where necessary.

Factor D. Inadequacy of Existing Regulatory Mechanisms

The 1985 listing rule did not identify the inadequacy of existing regulatory mechanisms as a threat to the Modoc sucker. Regulatory mechanisms relevant to specific threats are discussed above under *Factor A. Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range*; *Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes*; and *Factor C. Disease or Predation*. Below we briefly summarize relevant regulatory mechanisms.

Regulatory mechanisms relevant to *Factor A. Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range* include the Endangered Species Act, the National Forest Management Act (NFMA) and regulations and policies implementing the NFMA, the National Environmental Policy Act (NEPA), and State water regulations in California and Oregon. The NFMA and regulations and policies implementing NFMA guide management on the Fremont-Winema and Modoc National Forests. Each of these National Forests has guidance in its Land and Resource Management Plan on livestock grazing. Additional guidance on livestock grazing management on these National Forests is provided in the allotment management plans for the grazing allotments in which streams occupied by Modoc suckers occur. Also, as Federal agencies, the Fremont-Winema and Modoc National Forests comply with the NEPA process when evaluating potential land-disturbing projects or changes in National Forest management. The California Fish and Game Code affords protection to stream habitats for all perennial, intermittent, and ephemeral rivers and streams. In addition, the Oregon Department of Land Conservation and Development requires local land use planning ordinances to protect natural resources, including riparian and wetland habitats.

Regulatory mechanisms relevant to *Factor B. Overutilization for Commercial, Recreational, Scientific or Educational Purposes* include the Endangered Species Act and the California Endangered Species Act (CESA) and their implementing regulations. Modoc sucker is listed as endangered and fully protected under CESA, and CDFW does not authorize

incidental take of fully protected species other than for scientific research. Modoc sucker is not similarly protected by State law in Oregon because it is not listed under the Oregon Endangered Species Act. However, Modoc sucker can only be taken by special permit under Oregon fishing regulations, and the species is classified as critically sensitive in Oregon, so ODFW considers potential impacts to Modoc sucker when conducting environmental reviews of projects.

Regulatory mechanisms relevant to *Factor C. Disease or Predation* include State regulations in both California and Oregon prohibiting transfer of fish from one water body to another, as well as fish stocking policies in California and Oregon. Regulations prohibiting transfer of fish between water bodies discourage the spread of predatory fish species such as brown trout and largemouth bass throughout the Modoc sucker's range. In addition, CDFW has discontinued stocking of the predatory brown trout into streams in the Pit River basin, and ODFW does not stock brown trout in the Goose Lake sub-basin. The California State regulation prohibiting transfer of fish between water bodies also could be considered as a deterrent to moving Sacramento suckers to streams where they did not historically occur and thus, could be considered relevant to the Factor E threat of hybridization between Sacramento suckers and Modoc suckers.

Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence

Hybridization

The listing rule identified hybridization with the Sacramento sucker 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, nonnative species is introduced into its range, which can lead to loss of genetic integrity or even extinction (Rhymer and Simberloff 1996, p. 83). At the time of listing, it was assumed that hybridization between Modoc suckers and Sacramento suckers had been prevented in the past by the presence of natural physical barriers, but that the loss of these stream barriers was allowing interaction and hybridization between the two species. However, the assumption that extensive hybridization was occurring was based solely on the two species occurring in the same streams, and the identification of a few specimens exhibiting what were thought to be intermediate morphological characters. At the time of listing in 1985, genetic information to assess this assumption was not available.

Modoc suckers and Sacramento suckers are naturally sympatric in the Pit River basin and there is no indication that Sacramento suckers are recent invaders to the Pit River or its tributaries. In streams where Modoc suckers are commonly found, Sacramento suckers are not common, except in the downstream portion of Turner Creek (Reid 2008a, p. 15). Both morphological and preliminary genetic data suggests that the upper Pit River population of Sacramento suckers is distinct from other Sacramento River basin populations (Ward and Fritzsche 1987, p. 175). There is also no available information suggesting Modoc suckers and Sacramento suckers were geographically isolated from each other in the recent past by barriers within the Pit River basin. 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, p.

558; Moyle *et al*. 1982, pp. 41–47). Further reproductive isolation is probably reinforced by different spawning times in the two species and their size differences at maturity (Reid 2008a, p. 48).

The morphological evidence for hybridization in the listing rule was based on a limited understanding of morphological variation in Modoc suckers 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 now not thought to be the result of genetic introgression between the two species (Kettratad 2001, pp. 52–53). Furthermore, the actual number of specimens identified as apparent hybrids by earlier authors was very small, and many of these specimens came from streams without established Modoc sucker populations.

In 1999, the Service initiated a study to examine the genetics of suckers in the Pit River basin and determine the extent and role of hybridization between the Modoc and Sacramento suckers using both nuclear and mitochondrial genes (Palmerston *et al*. 2001, p. 2; Wagman and Markle 2000, p. 2; Dowling 2005, p. 3; Topinka 2006, p. 50). The two species are genetically similar, suggesting that they are relatively recently differentiated or have a history of introgression throughout their range that has obscured their differences (Dowling 2005, p. 9; Topinka 2006, p. 65). Although the available evidence cannot differentiate between the two hypotheses, the genetic similarity in all three sub-basins, including those populations shown to be free of introgression based on species-specific genetic markers (Topinka 2006, pp. 64–65), suggests that introgression has occurred on a broad temporal and geographic scale and is not a localized or recent phenomenon. Consequently, the genetic data suggest that introgression is natural and is not caused or measurably affected by human activities.

In a separate study that analyzed nuclear DNA from each of the two species, Topinka (2006, p. 50) 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.

Topinka (2006, p. 69) found extensive bi-directional introgression in upper Ash Creek where Modoc suckers and Sacramento suckers are sympatric. Modoc suckers in this population reach 15 in (381 mm), the largest sizes encountered for the species, but are dominated by Sacramento sucker genetic markers and show extensive variability in characteristic Modoc sucker genetic 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 (*Lavinia mitrulus*), 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.

A study of gene flow between the Modoc sucker and Sacramento sucker populations in the Upper Pit River of California and Oregon found that although hybridization is present, it occurs at low levels and that introgression (loss of parental genotypes) has not occurred (Smith *et al*. 2011, pp. 72–84).

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 Ash, Turner, Rush, 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-basin (Johnson, Rush, and Dutch Flat Creeks) provides 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 basin, where four species have hybridized to varying degrees, but in general retain morphological, behavioral, and ecological separation (Markle *et al*. 2005, p. 473; Tranah and May 2006, p. 306).

The hybridization and introgression documented with the Klamath River basin sucker species is especially applicable to the federally endangered shortnose sucker (*Chasmistes brevirostris*) and Klamath largescale sucker (*Catostomus snyderi*). However, these hybridized individuals are still considered important for shortnose sucker recovery purposes (Service 2012, p. 3). Similarly, although the Ash Creek population exhibits a unique introgressed character and full sympatry with Sacramento suckers, we consider it an extant Modoc sucker population, important in the context of species recovery.

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 more than 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 and Secor 1997, pp. 612–613; Dowling 2005, p. 10; Topinka 2006, p. 73; Tranah and May 2006, p. 313).

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 in its morphological characteristics from the Sacramento sucker (Kettratad 2001, p. 3). Therefore, given the observed levels of observed introgression in streams dominated by Modoc suckers, the lack of evidence of first-generation hybrids, the fact that Modoc suckers and Sacramento suckers are naturally sympatric, and the

continued ecological and morphological integrity of Modoc sucker populations, hybridization is no longer considered a threat to Modoc sucker populations.

The Effects of Climate Change and Drought

The listing rule did not identify the effects of climate change or drought as threats to the continued existence of the Modoc sucker. However, the northwestern corner of the Great Basin is naturally subject to extended droughts, during which streams and even the larger water bodies such as Goose Lake have dried up (Laird 1971, pp. 57–58). Regional droughts have occurred every 10 to 20 years in the last century and Goose Lake went dry as recently as 1992 and 2010 (Reid 2008a, pp. 43–44; R. Larson, KFFWO, personal communication). Droughts may be a concern because they could likely constrict the amount of available habitat and reduce access to spawning habitat. However, the species has not declined in distribution since the time of listing in 1985, even though the region where it exists has experienced several pronounced droughts since listing when total annual precipitation was approximately half of the long-term average (Western Regional Climate Center, *http://www.wrcc.dri.edu/cgi-bin/cliMONtpre.pl?ca0161*, accessed 23 January 2013).

There is no record of how frequently Modoc sucker streams went dry. There is no doubt that headwater reaches of occupied streams did stop flowing in the past because some reaches have been observed to dry up (or flow goes subsurface through the gravel instead of over the surface) nearly every summer under current climatic conditions (Reid 2008, p. 42). In extreme droughts, the suckers may have withdrawn to permanent main-stem streams, such as Rush, Ash, and Turner Creeks, and later recolonized the tributaries. Suckers also take refuge in natural spring-fed headwater reaches and in deeper, headwater pools that receive sub-surface flow even when most of the stream channel is dry (Reid 2008, p. 43).

Collections of Modoc suckers from Rush Creek and Thomas Creek near the end of the "dustbowl" drought (Hubbs 1934, p. 1; Reid 2008a, p. 79) and the continued persistence of Modoc suckers throughout its known range through substantial local drought years since 1985 demonstrate the resiliency of Modoc sucker populations. Therefore, natural droughts, while likely affecting Modoc sucker populations, do not appear to be a threat to the continued existence of the species throughout its range.

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 water temperatures (Poff *et al*. 2002, p. 11; Koopman *et al*. 2009, p. 3; PRBO Conservation Science 2011, p. 15). 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 nonnative fishes that prey on or compete with Modoc suckers. Increases in the number and size of forest fires could also result from climate change (Westerling *et al*. 2006, p. 940) and could adversely affect watershed function resulting in faster runoff, lower base flows during the summer and fall, and increased sedimentation rates. It is possible that lower flows may result in increased

groundwater withdrawal for agricultural purposes and thus reduced water availability in certain stream reaches occupied by Modoc suckers. While it is possible that the Modoc sucker may be adversely affected by climate change, we lack sufficient information to accurately determine what degree of threat it poses and when the impacts may occur.

In summary, although we cannot predict future climatic conditions accurately, the persistence of Modoc sucker across its range through the substantial droughts of the last century suggests that the species is resilient to drought and reduced water availability. 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 mainstem 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 protection and enhancement of riparian corridors are positive mechanisms for maintaining the refuge habitat necessary for long-term persistence of self-sustaining Modoc sucker populations.

Factor E Summary

Hybridization with the Sacramento sucker was considered a major threat to the Modoc sucker at the time of listing. However, reexamination of information on 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 suckers, the species has sustained itself without substantial assistance through numerous droughts in the last century, including the “dustbowl” drought of the 1920s to 1930s. 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 posed by climate change. We are aware of no additional factors likely to threaten the Modoc sucker.

Conclusion of the Threats Analysis

Most threats to the Modoc sucker that were considered in the 1985 listing rule have been reduced (habitat degradation resulting from livestock grazing) or are no longer considered to have been actual threats at the time of listing (hybridization). Habitat conditions on both public and private lands have benefitted since the time of listing as a result of improved grazing management practices and construction of fencing to exclude cattle from riparian areas on several of the streams occupied by Modoc suckers. We expect habitat conditions to remain stable or improve, although recent habitat surveys indicate erosion continues to be a problem along lower Turner Creek and in Dutch Flat Creek. Modoc suckers have coexisted with brown trout for over 75 years, and the overlap in distribution of largemouth bass and Modoc suckers is limited because bass are warmwater fish that occur in lower-elevation reaches downstream of many of the reaches occupied by Modoc sucker, and reservoir outflows have been screened to reduce the risk of bass being flushed into streams occupied by Modoc sucker. Thus, introduced predators do not appear to be a significant risk to Modoc sucker populations. The known range of the Modoc sucker has increased as a result of the discovery of five populations not known at the time of listing, as well as documentation of the genetic integrity of populations considered in

the 1985 listing rule to have been lost due to hybridization. Also, the distribution of occupied stream habitat for populations known at the time of listing has remained stable or expanded slightly since the time of listing, even though the region has experienced several droughts during this time period. A greater understanding of the genetic relationships and natural gene flow between the Modoc suckers and Sacramento suckers has reduced concerns over hybridization between the two naturally sympatric species.

Recovery

At the time of listing, the Service, CDFW, and the USFS were developing an "Action Plan for the Recovery of the Modoc sucker." The April 27, 1983, revision of this Plan was formally signed by all participants in 1984 (Service 1984). We determined that the Action Plan and its 1989 revisions adequately fulfilled the requirements of a recovery plan, and in a 1992 Memorandum from the Regional Director (Region 1) to the Service's Director, we adopted it as the Recovery Plan for the Modoc sucker (Service 1992).

The Recovery Plan for the Modoc sucker provided objectives that were required to be met prior to downlisting or delisting. Specifically, in order to reclassify the Modoc sucker from endangered to threatened, the following objectives are to be met: (1) the integrity of extant habitats within Turner Creek, Hulbert Creek, Washington Creek, and Johnson Creek have been maintained; (2) the invasion of Sacramento suckers into isolated stream reaches of these creeks has been prevented; and (3) populations of Modoc suckers have been maintained in these creeks for three consecutive years. The Recovery Plan for the Modoc sucker further stated the following objectives are to be met in order to delist the Modoc sucker: (1) the remaining suitable, but presently unoccupied, stream reaches within Turner Creek, Hulbert Creek, Washington Creek, and Johnson Creek must be renovated and restored to Modoc suckers; (2) two populations within the historical range of the Modoc sucker must be established; and (3) all populations must have sustained themselves through a climactic cycle that includes drought and flood events. Information on each of the above objectives within the Recovery (Action) Plan for reclassifying the Modoc sucker is provided below.

Downlisting objective (1): the integrity of extant habitats within Turner Creek, Hulbert Creek, Washington Creek, and Johnson Creek have been maintained.

Since the time of listing, actions have been taken to improve or secure Modoc sucker habitat within Turner Creek, Hulbert Creek, Washington Creek, and Johnson Creek. Habitat improvement projects within occupied habitat have been accomplished to provide effective stabilization of stream banks, fencing to exclude grazing in riparian areas, restoration of riparian vegetation, and provide increased instream habitat. One and a half miles of Washington Creek, 0.2 mi (0.3 km) of Hulbert Creek, and approximately 1.5 mi (2.4 km) of Turner Creek have been fenced to protect riparian habitat, and fencing has been constructed to exclude cattle from private lands designated as critical habitat on Johnson Creek below Higgins Flat. 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 25 years, although recent habitat surveys indicate erosion and sedimentation continue to be a problem along lower Turner Creek. However, this degraded reach amounts to only 2.4 percent (1.01 mi/42.5 mi) (1.6 km/68.4km) of

the total length of streams occupied by Modoc sucker. Land management practices employed on public and private lands since the early 1980s are expected to continue, or improve, thereby maintaining stable to upward habitat trends. Thus, we have determined that this downlisting objective has been met. Additional details are discussed above under *Factor A. Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range*.

Downlisting objective (2): the invasion of Sacramento suckers into isolated stream reaches of these creeks has been prevented.

The low levels of observed genetic 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 more than a century of habitat alteration by human activities. Reexamination of information on natural barriers, morphological characters, and new genetic information that were unavailable at the time of listing indicate that hybridization is not a threat to the Modoc sucker and may be part of its natural evolutionary history. Currently, only Ash Creek exhibits a considerable degree of introgression. 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 actually provide an adaptive advantage (Dowling and Secor 1997, pp. 612–613; Dowling 2005, p. 10; Topinka 2006, p. 73; Tranah and May 2006, p. 313). Thus, because of the new information that has become available since the time of listing, we have determined that this downlisting objective is obsolete and no longer needs to be met. Additional details are discussed above under *Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence*.

Downlisting objective (3): populations of Modoc sucker have been maintained in these creeks for three consecutive years.

Several attempts to estimate population size of Modoc suckers in Turner Creek, Hulbert Creek, Washington Creek, and Johnson Creek have been completed since the 1970s. Modoc suckers appear broadly distributed throughout suitable habitat in these streams. Although the observations during each survey may not be directly comparable due to differences in sampling methods, there does not appear to be any major changes in observations of these stream populations. Observations of Modoc suckers in Hulbert Creek and Johnson Creek prior to 2008 appear to be greater than observations made in 2008 and 2012. However, this may be explained by differences in survey methods, inclusion of young-of-the-year suckers in earlier counts, and the fact that some numbers reported are population estimates rather than counts on individuals. Although population monitoring has not been conducted on an annual basis, sucker surveys conducted in 2008 and 2012 show that Modoc sucker populations have been maintained and are still well established in Turner Creek, Washington Creek, Hulbert Creek, and Johnson Creek – as well as each of the other streams known to be occupied at the time of listing – more than 25 years after listing (Table 3). Thus, we have determined that populations of Modoc sucker have been maintained (remained stable) and that this downlisting objective has been met. Additional information is discussed above in the *Distribution and Abundance* section.

Delisting objective (1): the remaining suitable, but presently unoccupied, stream reaches within Turner Creek, Hulbert Creek, Washington Creek, and Johnson Creek must be renovated and restored to Modoc sucker.

At the time of listing, it was estimated that Modoc suckers occupied 2.0 mi (3.2 km) of habitat in Turner Creek, 0.8 mi (1.3 km) of habitat in Hulbert Creek, 0.5 mi (0.8 km) of habitat in Washington Creek, and 1.2 mi (1.9 km) of habitat in Johnson Creek (Table 1; Reid 2008a, p. 25). Since the time of listing, Reid (2008a, p. 25) estimated that there was 5.5 mi (8.9 km) of available habitat in Turner Creek, 3.0 mi (4.8 km) in Hulbert Creek, 4.1 mi (6.6 km) in Washington Creek, and 2.7 mi (4.3 km) in Johnson Creek (Table 1). Modoc suckers currently occupy all available habitats within Turner Creek, Hulbert Creek, and Johnson Creek; Modoc suckers occupy 3.4 mi (5.5 km) of the available habitat in Washington Creek (Reid 2008a, p. 25). Therefore, we have determined that this delisting objective has been met. Additional information can be found above in the *Distribution and Abundance* section. Habitat conditions along Turner Creek, Hulbert Creek, Washington Creek, and Johnson Creek have improved since the time of listing (see discussion under *Factor A*).

Delisting objective (2): two populations within the historical range of Modoc sucker must be established.

The Recovery Plan stated additional populations were needed to provide population redundancy. That is, more populations were needed to reduce the risk of any single stochastic event affecting all or the majority of populations. New information indicates the presence of Modoc sucker populations in four streams that were not known to be occupied at the time of listing (Garden Gulch Creek in the Turner Creek sub-basin and Thomas Creek, an unnamed tributary to Thomas Creek, and Cox Creek in the Goose Lake sub-basin). In addition, a population of Modoc sucker has been established as a result of transplanting in Coffee Mill Creek in the Turner Creek sub-basin. Therefore, we have determined that this delisting objective has been met. Descriptions of these populations are provided above in the *Distribution and Abundance* section.

Delisting objective (3): all populations must have sustained themselves through a climactic cycle that includes drought and flood events.

The northwestern corner of the Great Basin where the Modoc sucker occurs is naturally subject to extended droughts, during which even the larger water bodies such as Goose Lake have dried up (Laird 1971, pp. 57–58). Regional droughts have occurred every 10 to 20 years in the last century (Reid 2008, pp. 43–44). Collections of Modoc suckers from Rush Creek and Thomas Creek near the end of the "dustbowl" drought of the 1920s to 1930s (Hubbs 1934, p. 1; Reid 2008a, p. 79) indicate that the species was able to persist in those streams even through a prolonged and severe drought. Modoc suckers have persisted throughout its historical range since the time it was listed in 1985, even though the region has experienced several pronounced droughts as well as heavy precipitation, high-water years (2011), indicating that the species is at least somewhat resilient to weather and hydrologic fluctuations. Therefore, we have determined that this delisting objective has been met. Additional details are discussed above (see *Factor E*).

Additional Conservation Measures and Actions

Private landowners, ranchers, nongovernmental groups (e.g. Lake County Umbrella Watershed Council), States, and Federal partners worked to address the primary threats to the Modoc sucker and its habitat. Actions such as habitat restoration, improved grazing management practices, and construction of fencing to exclude cattle from riparian areas on several of the streams occupied by Modoc suckers are example of some of the actions being completed. These conservation measures are expected to continue and this will help reduce the ongoing potential threats posed by habitat degradation.

Post Delisting Monitoring Plan (PDM)

A post delisting monitoring plan has been developed for monitoring and coordinating efforts to conserve the Modoc sucker (Service 2015). The purpose of PDM for the Modoc sucker is to monitor the species and its habitat to ensure the status does not deteriorate to a point that re-proposing the species as threatened or endangered under the Act is necessary. The primary objective of this PDM plan is to monitor the population status of the Modoc sucker to detect any changes that may indicate negative impacts to the continued stability of the species. Monitoring under this plan will focus on Modoc sucker distribution, abundance, and recruitment. These types of surveys may overlap with ongoing surveys for other fish and serve to provide a quick overview of the status of the species. In addition to these surveys, presence of stressors will be documented during monitoring. Section 4(g) of the Act explicitly requires cooperation with States in development and implementation of PDM programs, but the Service remains responsible for compliance with section 4(g) and must remain actively engaged in all phases of PDM. Becasue Modoc suckers occur on the Modoc National Forest in California and the Fremont-Winema National Forest in Oregon, the Service will implement the PDM plan with the U.S. Forest Service (Forest Service). However, since the species is listed in California as endangered and fully protected and in Oregon as critically sensitive, the Service will also implement the PDM plan in cooperation with the California Department of Fish and Wildlife (CDFW) and the Oregon Department of Fish and Wildlife (ODFW). See the PDM plan for more details.

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