INYO CALIFORNIA TOWHEE
(*Melozone crissalis eremophila* (=*eremophilus*))

5-YEAR REVIEW:
Summary and Evaluation

Photo by Herbert Clarke

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

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5-YEAR REVIEW

Inyo California Towhee
[*Melozone crissalis eremophila* (=*eremophilus*)]

I. GENERAL INFORMATION

Purpose of this 5-year Review:

We, the U.S. Fish and Wildlife Service (Service) are required by section 4(c)(2) of the Endangered Species Act of 1973 (Act), as amended, to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not a species' status (or subspecies' status) has changed since listing (or since the most recent status review). Our original listing of a species as an endangered or threatened species is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species and focus on new information available since the species was listed or last reviewed.

Species Overview and Habitat:

On August 3, 1987, we listed the Inyo brown towhee (*Pipilo fuscus eremophilus*) as a threatened subspecies and simultaneously designated critical habitat. After subsequent taxonomic changes in 1989 and 2010 (see section titled Taxonomy), the listed subspecies is currently recognized in the scientific literature as the Inyo California towhee (*Melozone crissalis eremophila*). However, as discussed in greater detail in the Taxonomy section below, the scientific name currently used in the List of Endangered and Threatened Wildlife (List) (50 CFR 17.11) is *Melozone crissalis eremophilus*, which reflects a recent update (Service 2023, p. 49314).

The Inyo California towhee is a subspecies of the California towhee, a New World sparrow (family Passerellidae). This subspecies is geographically restricted to the southern Argus Mountains of the Mojave Desert in Inyo County, California. It requires areas of dense riparian habitat to provide nesting substrate, protection from predators, and shade from the desert sun; adjacent upland habitat provides the principal foraging grounds as well as nesting habitat. These small, isolated riparian areas are restricted to certain narrow canyon bottoms that are widely separated by a matrix of extremely arid desert with high topographical relief. The Inyo California towhee was listed as threatened as a result of habitat loss and degradation (Factor A) from grazing by feral burros (*Equus asinus*) and horses (*Equus caballus*), water diversion, mining, off-highway vehicle use, and recreation and military activities (Service 1987, p. 28782).

Methodology Used to Complete This Review:

The Carlsbad Fish and Wildlife Office prepared this review. We solicited data from the public and interested parties through a *Federal Register* notice announcing this review on June 18, 2018 (Service 2018, pp. 28251–28254). We incorporated new information sent to us by Denise LaBerteaux (EREMICO Biological Services), Inyo California towhee survey information, information from published literature, and information from experts on the subspecies. We also reviewed information from our files and comments submitted to us during the public comment period following publication of a proposed rule (Service 2013, entire) to remove the Inyo California towhee from the Federal list of endangered and threatened wildlife.

This 5-year review contains updated information on the subspecies' biology and threats, and an assessment of information compared to that known at the time of listing and since the previous 5-year review. We focus on current threats to the subspecies pursuant to the Act's five listing factors. This review synthesizes this information. Based on this synthesis and the threats identified in performing the five-factor analysis, we herein recommend recovery actions to be prioritized within the next 5 years.

Contact Information:

Lead Regional Office: Ernest Chen, Regional Recovery Biologist, Region 8; and Bjorn Erickson, Regional Recovery Coordinator, Region 8.

Lead Field Office: Stephanie Prevost and Peter Sanzenbacher, Carlsbad Fish and Wildlife Office.

Recommended Citation:

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Federal Register Notice Announcing this Status Review:

On June 18, 2018, we published a *Federal Register* notice announcing initiation of the 5-year review of this subspecies and requesting information (Service 2018, pp. 28251–28254).

Listing History:

Species: The listed entity is a subspecies of bird. It is known by the following names (format: common name (*scientific name*)) as currently used in:

- 50 CFR 17.11: Inyo California towhee (*Pipilo crissalis eremophilus*)

- 50 CFR 17.95: Inyo Brown towhee (*Pipilo fuscus eremophilus*)
- The scientific literature: Inyo California towhee (*Melozone crissalis eremophila*)

Date listed under the Endangered Species Act: August 3, 1987

Federal Register citation: Service 1987 (52 FR 28780)

Classification: Threatened

Critical Habitat Designation: Critical habitat was designated on August 3, 1987 (Service 1987, entire), concurrently with the final listing rule. Additional critical habitat was proposed in the final rule on August 3, 1987 (Service 1987, entire), but the proposed rule was never finalized and, as such, no additional areas were designated.

Associated Rulemakings:

We originally listed this subspecies as the Inyo brown towhee (*Pipilo fuscus eremophilus*) (Service 1987, p. 28780). To conform to a change in nomenclature, we changed the name of this listed subspecies to Inyo California towhee (*Pipilo crissalis eremophilus*) on the Federal list of endangered and threatened wildlife (50 CFR 17.11).

In 2011, we received a petition to delist the Inyo California towhee based on the recommendation in the 2008 5-year review (Hopper *et al*. 2011, pp. 3–4). In a 90-day finding, we found that the petition presented substantial scientific or commercial information and initiated a status review to determine if delisting the Inyo California towhee is warranted (Service 2012, p. 32922). Subsequently, in 2013 we published a 12-month finding and proposed rule to remove the Inyo California towhee from the Federal list of endangered and threatened wildlife (Service 2013, p. 65938). We have not yet finalized or withdrawn the 2013 proposed rule.

Review History:

We initiated a 5-year status review for the Inyo California towhee in 2006 (Service 2006, p. 14539). The 2008 5-year review recommended delisting of the Inyo California towhee (Service 2008, p. 20). We also reviewed the status of the subspecies in 2013 as part of a 12-month finding and proposed rule to remove the Inyo California towhee from the Federal list of endangered and threatened wildlife (Service 2013, p. 65938).

Species' Recovery Priority Number at Start of 5-year Review:

The recovery priority number for the Inyo California towhee is 15, based on a 1 to 18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Service 1983, pp. 43098–43105). This number indicates the listed entity is a subspecies that faces a low degree of threat and has a high potential for recovery.

Recovery Plan:

Name: Recovery Plan for Inyo California Towhee (*Pipilo crissalis eremophilus*).

Date: Final, April 10, 1998.

II. REVIEW ANALYSIS

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

Section 3(16) of the Act defines "species" as including any subspecies of fish or wildlife or plants, and any distinct population segments (DPS) of any species or subspecies of vertebrate fish or wildlife. The California towhee is a vertebrate, and we could potentially recognize a population of this wildlife species as a DPS under section 3(16) of the Act. The 1996 *Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Endangered Species Act* clarifies the interpretation of the phrase "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the Act (Service 1996, p. 4722).

For the purposes of section 3(16) of the Act, we recognized Inyo California towhee as a subspecies at the time of listing. We continue to do so at this time. As such, the DPS policy currently does not apply. However, as discussed in the Taxonomy section below, we acknowledge that there is conflicting information in the scientific literature about whether it is appropriate to recognize the Inyo California towhee as a distinguishable taxon at the subspecies rank. If, in the future, we conclude that it is not appropriate to recognize the Inyo California towhee as a subspecies, this may prompt us to determine, per our DPS policy, whether we should recognize the Inyo California towhee as a DPS for the purposes of section 3(16) of the Act.

Information on the Subspecies and its Status:

Taxonomy

<u>Genus and species</u>

When the Inyo California towhee was originally listed in 1987, we used the best available taxonomy of the time, recognizing it as the Inyo brown towhee (*Pipilo fuscus eremophilus*) (AOU 1957, p. 583; AOU 1983, p. 685). Since then, there have been two significant taxonomic revisions at the species and genus ranks. In 1989, based on genetic and other data from Zink (1988, entire), the Committee on Classification and Nomenclature of the American Ornithologists' Union (AOU), "split" the brown towhee (*Pipilo fuscus*) into the California towhee (*P. crissalis*) and the canyon towhee (*P. fuscus*) (AOU 1989, p. 536). This committee, now referred to as the North American Classification Committee (NACC) of the American Ornithological Society (AOS), is widely accepted as the leading authority of avian taxonomy in North America. In splitting the towhee, the committee returned to an earlier taxonomic treatment that had long recognized the Pacific coast population (California towhee) as distinct from the interior (American Southwest and Mexico) population (canyon towhee) at the species rank (for example, Ridgway 1901, p. 435). This change did not affect the subspecies taxonomy. Thus, the accepted name of the listed subspecies became Inyo California towhee (*Pipilo crissalis eremophilus*). The name was updated in the 1990 edition of the List.

In 2010, results from a phylogenetic analysis of mitochondrial DNA indicated that the four towhee species that are predominantly brown are more closely related to *Melozone* ground sparrows than they are to the other *Pipilo* towhee species (DaCosta *et al*. 2009, pp. 213–214). As a result, the NACC changed the scientific name of the California towhee from *Pipilo crissalis* to *Melozone crissalis*, with no associated changes in common names (Chesser *et al*. 2010, p. 737). As noted in the 12-month finding (Service 2013, p. 65940), this genus-level change did not affect the taxonomic status of any of the recognized subspecies, including the listed Inyo California towhee (but see below). On December 12, 2022, we proposed to revise the List at 50 CFR 17.11 and 50 CFR 17.95 (critical habitat) to reflect the currently accepted nomenclature for Inyo California towhee as *Melozone crissalis eremophilus* (Service 2022, pp. 75982, 76022–76023). The final rule for the nomenclature change was published on July 31, 2023, and became effective on August 30, 2023 (Service 2023, pp. 49310, 49314).

<u>Subspecies</u>

The Inyo California towhee subspecies was originally described by A.J. van Rossem in 1935 (van Rossem 1935, entire). Van Rossem described the subspecies based on six specimens he collected, stating that they could not "satisfactorily be placed with any of the known races…a not surprising circumstance in view of the fact that the isolated habitat lies in a region far removed faunally from the coastal and interior valley habitats of other brown towhees of the *crissalis* group" (van Rossem 1935, p. 69). Under subspecific characters, van Rossem described the Inyo California towhee as most closely resembling *Pipilo fuscus carolae* (=Melozone *crissalis carolae*) of California's Central Valley but with smaller bill, shorter tarsi and toes, and slightly darker and grayer coloration (van Rossem 1935, p. 70). He also described the Inyo California towhee as resembling *P. f. crissalis* (=*M. c. crissalis*) of the Pacific slope of southern California but with longer wing and tail, much more slender bill, and grayer coloration (van Rossem 1935, p. 70).

During the early 2000s, separate from the species-level changes mentioned above, some ornithologists suggested that the subspecific taxonomy of the California towhee, including the Inyo California towhee, needed to be reviewed. Indeed, the need for revision in the subspecies concept and its application in avian taxonomy has been noted by many authors for many years (see summary in Patten 2010, pp. 36–37). After 1957, the AOU/AOS did not present subspecies in their published summaries of North American birds. They stated that this was based, in part, on practical grounds (space limitations), but they also acknowledged that the validity (in the sense of distinguishability) of many described avian subspecies needed to be reevaluated and that there was the potential for numerous unrecognized subspecies in the North American avifauna (AOU 1983, p. 284; AOU 1998, pp. 1–19). As such, we cannot rely on the NACC's taxonomic treatment for informing our conclusions about this entity's current taxonomic status. Additionally, per our regulations (50 CFR 17.11), we are to "rely, to the extent practicable, on the Integrated Taxonomic Information System (ITIS) to determine a species' scientific name."

ITIS is an online database that serves as a "standard taxonomic system . . . [to] be used across the federal government" (ITIS 2023a, webpage), and the information it supplies helps to inform us of a taxon's current nomenclature.

While there is a body of scientific literature supporting the distinguishability of the Inyo California towhee (van Rossem 1935, p. 70; Grinnell and Miller 1944, pp. 477–478; AOU 1957, p. 583), over time, the subspecies has increasingly been questioned in other published sources. For example, Cord and Jehl (1979, p. 153) offered that it would be "debatable" whether the Inyo California towhee "would be accorded formal taxonomic recognition in a modern revision of the species." Kunzmann *et al*. (2002, p. 4) argued that earlier claims that Inyo California towhees were paler and grayer than *Pipilo* (=*Melozone*) *crissalis crissalis* did not appear to be accurate upon comparing nine fresh-plumaged Inyo County specimens to three fresh-plumaged specimens from Monterey County. Likely based on the same fresh museum specimens cited by Kunzmann *et al*. (2002, p. 4), Patten *et al*. (2003, p. 282) suggested that only three subspecies of the California towhee be recognized north of the Mexican border. They grouped all of the subspecies (including Inyo California towhee (*P.* (=*M.*) *c. eremophilus*)) from Shasta south through the western slope of the Sierra Nevada, the Central Valley, and the Pacific coast from Monterey Bay south to Oxnard into *P.* (=*M.*) *c. crissalis*, describing the subspecies as the pale gray-brown form with a dull rusty crown and a grayish breast (Patten *et al*. 2003, p. 282). The dissolution of the subspecies, *P.* (=*M.*) *c. bullatus*, *P.* (=*M.*) *c. carolae*, and *P.* (=*M.*) *c. eremophilus*, was adopted by the Birds of North America Online in their 2011 update after the genus changed from *Pipilo* to *Melozone* (Benedict *et al*. 2011, unpaginated). Benedict *et al*. (2011, unpaginated) reiterated that recent evidence contradicted earlier descriptions of phenotypic differences among these subspecies, based on San Diego Natural History Museum specimens and a personal communication with the museum's Curator of Birds & Mammals, Philip Unitt. Since this update, major taxonomic lists, including the ITIS and International Ornithological Congress (IOC) World Bird List (Gill *et al*. 2023, unpaginated; ITIS 2023b, unpaginated), and the *Identification Guide to North American Birds* (Pyle *et al*. 2022, p. 534) do not recognize the Inyo California towhee as a taxon distinguishable from the wider-ranging *Melozone crissalis crissalis* subspecies.

At this time, for the purposes of this 5-year review, we continue to recognize the Inyo California towhee at the subspecies rank, most accurately named *Melozone crissalis eremophila*[1]. We acknowledge that the listed entity's taxonomic status has been questioned in the scientific literature. As discussed in the **Application of the 1996 Distinct Population Segment (DPS) Policy** section above, we may address how the Inyo California towhee should be recognized under section 3(16) of the Act in a future action.

Genetics and Population Structure

A genomic study of the California towhee species was completed in 2023 to help inform management and conservation efforts for the Inyo California towhee (Black *et al*. 2023, entire, in

[1] The subspecies epithet (name) should have changed from *eremophilus* to *eremophila* to remain consistent with the gender of genus name when it changed from *Pipilo* (masculine) to *Melozone* (feminine) (David and Gosselin 2002, p. 259).

review for publication). This study used high-resolution genomic samples to assess the level of genetic variation (heterozygosity) across the California towhee's U.S. range, including birds from southern Oregon, central California on both sides of the San Joaquin Valley, southern California outside of Los Angeles, and from the Argus Mountains in Inyo County, California (Black *et al*. 2023, pp. 4, 22). The analyses used in this study were not intended to address taxonomic questions, although this information may help interpret the distinctiveness of California towhee populations. To better inform taxonomic questions with the Inyo California towhee in particular, it would help to have additional genomic sampling from nearby populations of related towhee species and of California towhee populations in the southern Sierra Nevada range (that is, the range of the once-recognized Kern subspecies of California towhee; see "*Pipilo fuscus kernensis*, Kern Brown Towhee" in Grinnell and Miller (1944, pp. 476–477)), as well as from the western Mojave Desert and the desert-facing portions of the Transverse Ranges.

Black *et al*. (2023, pp. 11–12, 14) suggested that the California towhee's overall genetic variation, mean individual heterozygosity, and estimates of inbreeding were "unremarkable" and typical of passerines. However, the results also suggest that the population of California towhees across California and Oregon is highly structured indicating that long-distance dispersal is limited and/or habitat discontinuity prevents gene flow among regional populations (Black *et al*. 2023, p. 12).

Two of the study's populations (i.e., Oregon and Inyo County) exhibited signs of genetic isolation in line with their geographic isolation at the outer edges of the species' range (Black *et al*. 2023, pp. 14–15). Both the Oregon and the Inyo County (i.e., Inyo California towhee) populations were the most distinct in the Principal Component Analysis of allele frequencies, admixture analyses, and phylogeographic analysis (Black *et al*. 2023, pp. 14–15). The admixture analyses identified the Oregon and Inyo County samples as discrete populations (not admixed) with the optimal number of groups being three (i.e., Inyo County, Oregon, and the rest of California) (Black *et al*. 2023, p. 26, figure 5).

The genomic study suggests that genetic health of the Inyo California towhee may be of concern. The Inyo County and Oregon populations exhibited the lowest levels of mean heterozygosity and highest levels of inbreeding (Black *et al*. 2023, pp. 8, 14–15). Notably, Inyo County birds were the most inbred of all towhees sampled, showing signs of both ancestral and contemporary (recent) inbreeding (Black *et al*. 2023, pp. 9, 15). The measure for contemporary inbreeding was four to six times higher for Inyo County samples than for the other three regions (Black *et al*. 2023, p. 12). The authors note that these results are consistent with the population size reduction that led to the listing of the towhee under the Endangered Species Act (Black *et al*. 2023, p. 12). However, the severity of inbreeding is uncertain because few data from similar species are available from which to draw conclusions about the normal range of inbreeding statistics for the towhee (Black *et al*. 2023, p. 15).

Life History

California towhees, including the Inyo California towhee, are omnivorous, feeding on seeds, grain, invertebrates and fruit, with the composition of their diet changing with food availability

(Davis 1957, pp. 129–166). Inyo California towhees are year-round residents and male-female breeding pairs defend territories, which range from 20 to 62 acres (ac) (8 to 25 hectares (ha)), year-round (LaBerteaux 1989, p. 48). The breeding season generally starts in early spring, coinciding with local plant growth and flowering periods. The most frequent clutch size is four eggs, but can range from two to four (LaBerteaux 1989, p. 45). Incubation takes about 14 days, and nestlings may fledge in 8 days after hatching (LaBerteaux 1989, p. 46). Juvenile California towhees cannot fly at fledging and instead spend several weeks running and hiding in the vegetation (Benedict *et al*. 2011, unpaginated). Parents continue to feed and care for their young for at least 4 weeks after fledging (LaBerteaux 1989, p. 46). Occasionally, Inyo California towhees pairs successfully raise two broods within the same breeding season (LaBerteaux and Garlinger 1998, p. 62).

Sex-biased Dispersal

Phylogeographic data from a genomic study of multiple California towhee populations (including Inyo California towhee) suggest that California towhee dispersal is sex-biased (Black *et al*. 2023, pp. 13–14). Based on maternally inherited mitochondrial DNA, it appears that female California towhees spread their genes across the landscape more effectively than males (Black *et al*. 2023, pp. 13–14). This suggests that females are more likely to disperse farther or disperse more frequently than males.

Precipitation During Nesting

Precipitation generally has a positive influence on Inyo California towhee abundance and productivity because, in the towhee's arid habitat, greater precipitation can lead to greater habitat quality and food availability for both adults and young. Timing of precipitation is also known to be important because towhee nesting initiation coincides with local plant growth and insect abundance (Service 1998, p. 8). A recent observation may also indicate that heavy precipitation during spring can have negative effects on the towhee. During 2020, heavy rains occurred in towhee habitat during clutch initiation and early incubation in early April (McCreedy 2020, p. ii). The heavy rainfall event appeared to have led to widespread nest failure, evidenced by the timing of subsequent nesting attempts observed in over 90 percent of pairs that were detected during surveys in May (McCreedy 2020, p. ii).

Habitat and Distribution

The Inyo California towhee occupies dense riparian vegetation and adjacent upland habitats. The riparian habitat, which the towhee relies on for nesting, protection from predators, and shade from the desert sun, is supported by groundwater-fed springs in most cases. However, the amount, quality, and location of habitat is dynamic and varies annually due to its dependence on water and location in the desert. The surrounding upland (non-riparian) habitat on adjacent slopes is used extensively for foraging, making these upland areas an important component of the towhee's habitat.

Inyo California towhees predominantly occur on Federal land: 65 percent on Department of Defense (U.S. Navy) land within the Naval Air Weapons Station, China Lake (NAWS China

Lake); 32 percent on Bureau of Land Management (BLM) land; 3 percent on California Department of Fish and Wildlife (CDFW) land; and less than 1 percent on private property (Table 1; Figure 1).

Table 1. Distribution of Sites by Land Ownership Where Inyo California Towhees Have Been Found.[1]

Landowner	Number of survey sites where towhees have been detected	Percent of total sites where towhees were detected
Department of Defense, NAWS China Lake	172	65 percent
Bureau of Land Management	84	32 percent
California Department of Fish and Wildlife	9	3 percent
Private	1	Less than 1 percent
Total	**266**	**100 percent**

[1] See Appendix A: Occurrence Table for details about each site.

Indications of dispersal or potential range expansion, outside of the Argus Range, have been noted with incidental observations of unpaired birds in the Panamint Range (Figure 2). On three occasions in 2004, Shelley Ellis (BLM) observed an individual towhee in Surprise Canyon in the Panamint Range (CDFW 2023, database), which is roughly 20 miles (mi) (32 kilometers (km)) east of the Argus Range. Ellis observed one adult in April, one juvenile with fresh plumage in May, and one adult in June (CDFW 2023, database). In April 2012, birdwatchers observed two towhees in Surprise Canyon (Ellis 2012a, pers. comm.). Although portions of the Coso Range (west of the Argus Range) and the Panamint Range (including Surprise Canyon) have been included in surveys since 1998 (Figure 2), no towhees have been detected in these areas during surveys (LaBerteaux and Garlinger 1998, p. 7; LaBerteaux 2011, pp. ii, 12, 19, 64). Evidence of breeding activity has not been reported for Inyo California towhee in Surprise Canyon or elsewhere outside of the Argus Range.

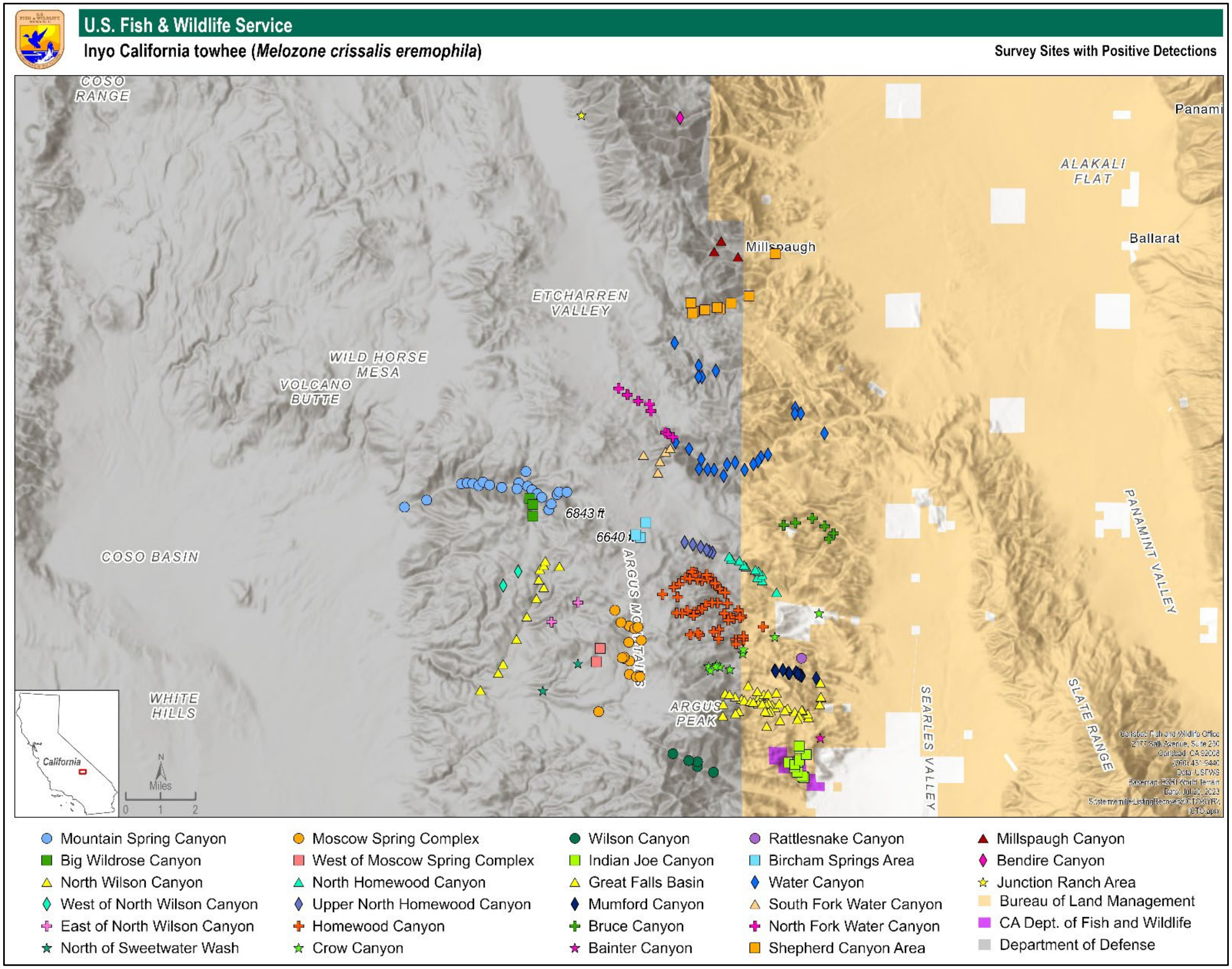

Figure 1. Map of survey sites where Inyo California towhees have been detected.

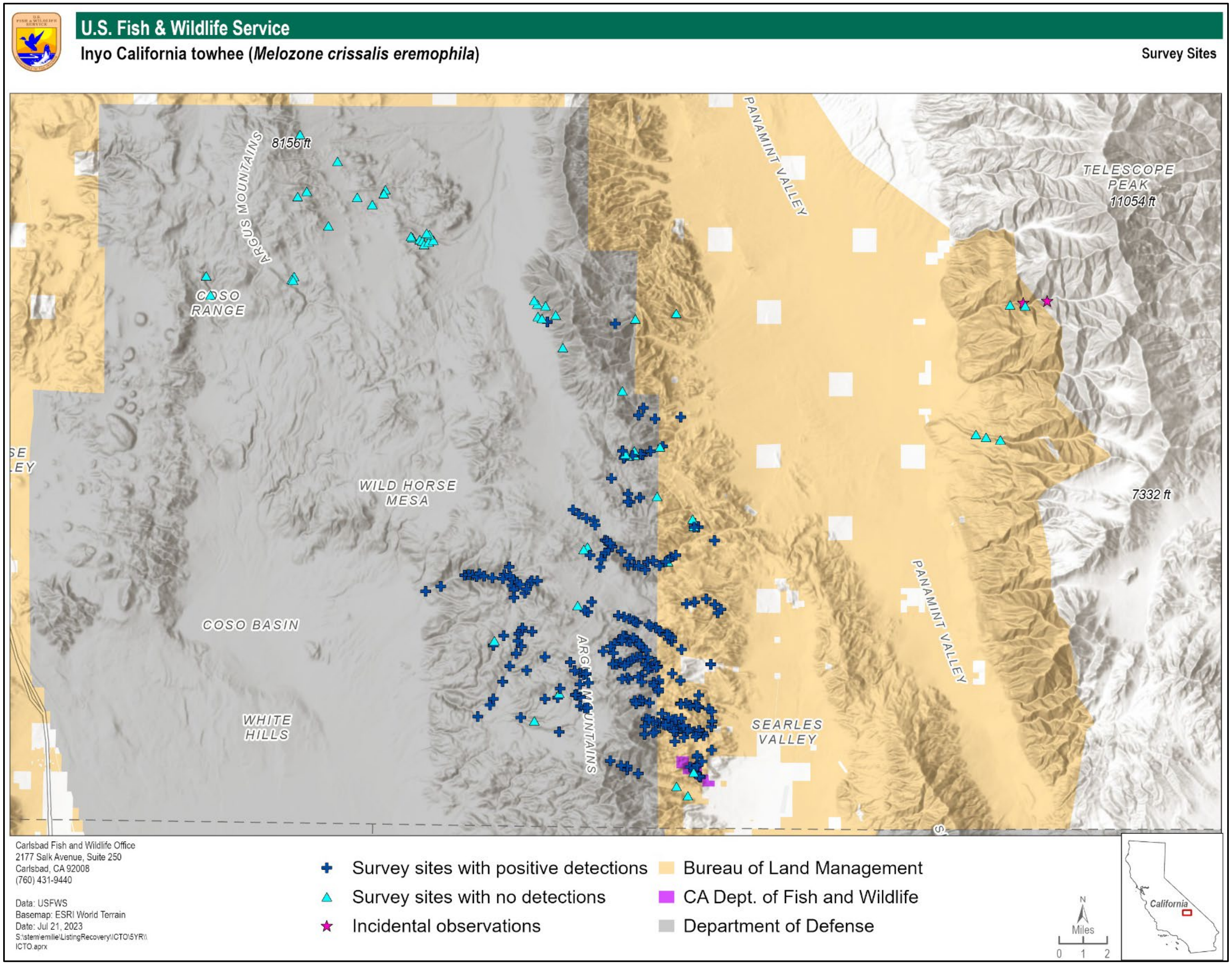

Figure 2. Map of 323 sites where Inyo California towhee has been detected or where surveys have been conducted since 1998.

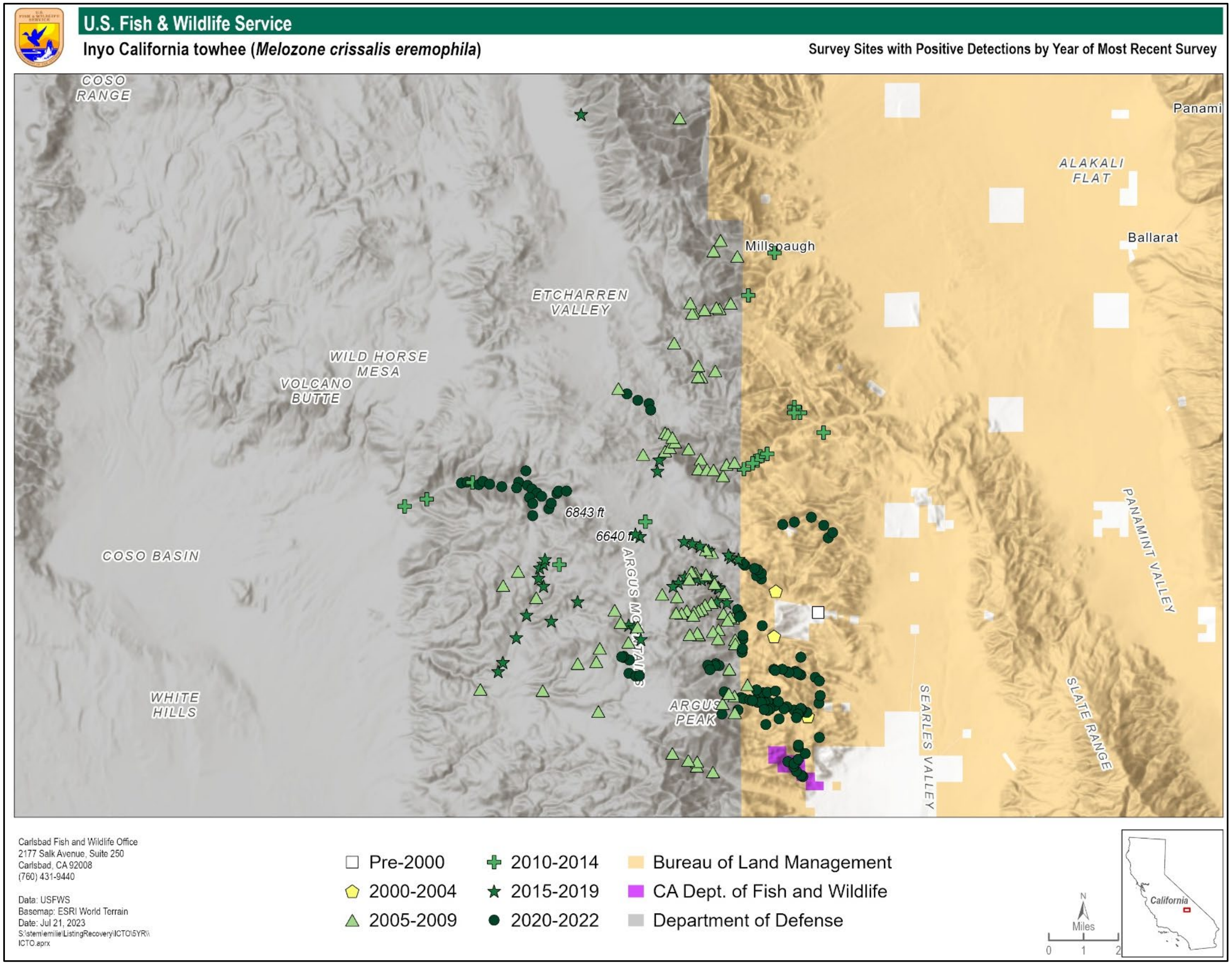

Figure 3. Map of survey sites where Inyo California towhees have been detected, displayed by survey date with dark green representing the sites surveyed most recently. Note that not all sites were surveyed in a given time period.

Population Abundance

In this section, we summarize the results of Inyo California towhee abundance surveys with notes on population trends from pre-listing through 2022. In the next section, we provide a summary and larger discussion of overall population trends over time. Survey effort has varied over the years (Figure 3; Figure 4), so comparisons of results were sometimes made between surveys conducted many years apart. No surveys were conducted in 1999–2003, 2005, 2013, 2017–2018, and 2023; and survey effort was minimal (i.e., 5–11 sites) during 2008–2010, 2012, and 2015–2016. Additionally, 1998 was the only survey year that included all known towhee sites. When possible, survey results are compared across sites visited in all survey years.

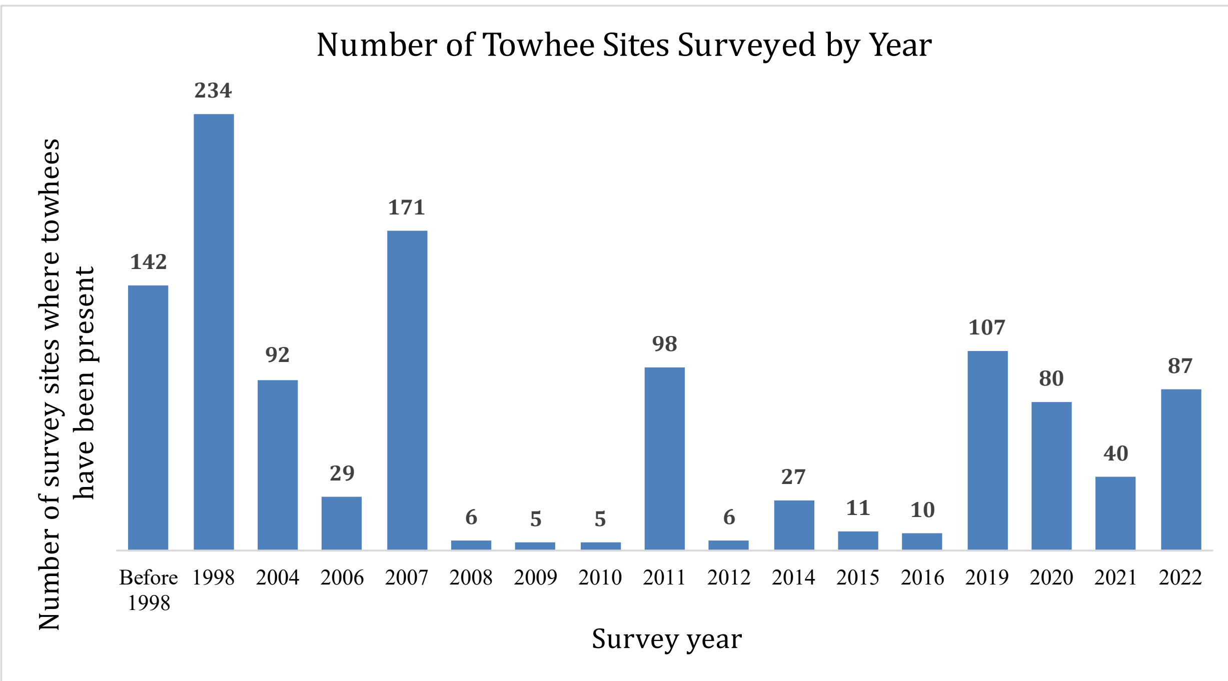

Figure 4. Numbers of Inyo California towhee sites surveyed before 1998 and from 1998 through 2022. Counts of sites do not include survey sites where towhees have never been detected. No surveys were conducted in 1999–2003, 2005, 2013, 2017–2018, and 2023.

From 1978 to 1979, towhee populations were estimated to be 72–138 individuals (Cord and Jehl 1979, p. 154). At the time of listing in 1987, we estimated the population to have been fewer than 200 individuals (Service 1987, p. 28780). LaBerteaux estimated the minimum population size of the Inyo California towhee in 1994 to be 180 adults based on a combination of her own observations and data from several other researchers (LaBerteaux 1994, p. 6). These population estimates were based on surveys across what was later recognized as a limited portion of the range of the towhee.

In 1998, LaBerteaux and Garlinger conducted the only rangewide census for the Inyo California towhee of what was then considered to be nearly all the potential habitat in the southern Argus Range, including NAWS China Lake, BLM, and CDFW lands. LaBerteaux and Garlinger (1998, p. 7) detected towhees at 210 (81 percent) of the 258 sites with suitable riparian habitat (often associated with springs) and determined the total towhee population to be 640 adults (317 breeding pairs and 23 single adults). The increase in population abundance reported in 1998 was attributed to increased survey effort including areas that had not been surveyed before within and outside of the known range, increased detection probability with the use of playback recordings, increased actual population density at sites that had been surveyed during previous years, and increased occupation of far more non-riparian sites than had been previously reported (LaBerteaux and Garlinger 1998, p. 86).

In 2004, LaBerteaux conducted systematic surveys of 93 sites located on BLM and CDFW lands (35 percent of the towhee's range) and detected towhees at 70 (75 percent) of the sites (LaBerteaux 2004, p. 11). LaBerteaux (2004, pp. ii, 57) estimated the BLM and CDFW population had increased 13.6 percent at those sites that were surveyed in both 1998 and 2004. Extrapolating the results to the remaining 65 percent of the range, LaBerteaux estimated the rangewide population to be 725 adults (LaBerteaux 2004, pp. ii, 60).

In 2007, LaBerteaux (2008, entire) conducted systematic surveys of 185 sites on NAWS China Lake land (68 percent of the towhee's range) and detected towhees at 140 (76 percent) of the sites (LaBerteaux 2008, p. 10). LaBerteaux (2008, pp. iii, 11) estimated the NAWS China Lake population had increased by 2.8 percent for those sites that were surveyed in both 1998 and 2007. Based on the results of the 2007 surveys, in combination with the 2004 surveys on BLM and CDFW lands, LaBerteaux (2008, pp. iii, 85) estimated the Inyo California towhee population to be 706 to 741 adults rangewide. LaBerteaux (2008, p. iii) noted that few of the breeding pairs reproduced in 2007, presumably because of the drought conditions, and cautioned that a population decline could occur before the next breeding season.

In 2011, LaBerteaux (2011, entire) conducted systematic surveys of 93 sites on BLM and CDFW lands and detected towhees at 74 sites (80 percent) (LaBerteaux 2011, p. 12). A total of 227 adults were detected representing 114 breeding pairs and 11 unmated individuals (LaBerteaux 2011, pp. ii, 12). This represented a population increase of 6.3 percent for those sites that were surveyed in both 2004 and 2011 (LaBerteaux 2011, pp. ii, 12, 63). Based on the results of the 2011 surveys, and in combination with the 2007 surveys on NAWS China Lake (502 adults representing an estimated 256 breeding pairs and 20 unmated adults) (LaBerteaux 2008, p. 10), the total range-wide population was estimated to be approximately 370 breeding pairs (740 mated adults) (LaBerteaux 2011, p. 66).

In 2014, LaBerteaux (2014, entire) conducted nesting surveys at 27 sites in the Argus Range (16 sites at Mountain Springs Canyon, 4 at Crow Canyon, and 7 north of Moscow Canyon) (LaBerteaux 2014, p. iii). Thirty-nine Inyo California towhees, representing approximately 18 breeding pairs and 6 unmated adults were observed (LaBerteaux 2014, p. iii). This represents a 66 percent decrease in the number of breeding pairs at these sites since 1998, with the greatest decrease observed in the Mountain Springs Canyon area (LaBerteaux 2014, p. iii). LaBerteaux (2014, p. 43) suggested that if this level of decline was occurring throughout the Inyo California towhee range, then population abundance could easily be below 400 individuals.

In 2015, LaBerteaux (2015d, entire) conducted nesting surveys at 11 sites in the Argus Range (1 site at Mountain Springs Canyon, 4 at Upper North Homewood Canyon, 2 at South Fork Water Canyon, and 4 at North Fork Water Canyon) (LaBerteaux 2015d, p. iii). Thirty-nine Inyo California towhees, representing 11 breeding pairs and 17 juveniles, were found at 8 study sites and towhees were absent from 3 sites (LaBerteaux 2015d, p. iii). Overall, the number of breeding pairs at the 11 sites was 35 percent lower in 2015 than in 1998 (LaBerteaux 2015d, p. iii). LaBerteaux (2015d, p. 44) did not estimate the rangewide population of towhees in 2015, but suggested that population abundance was likely below 400 individuals.

In 2016, LaBerteaux (2016, entire) conducted nesting surveys at 13 sites in the Argus Range (3 sites at Mountain Springs Canyon, 2 at Homewood Canyon, 2 at North Fork Water Canyon, 3 in the Bircham Springs area, and 3 in the Junction Ranch area) (LaBerteaux 2016, p. iii). Twenty-four Inyo California towhees, representing 12 breeding pairs, were found at 6 study sites and towhees were absent from 7 sites (LaBerteaux 2016, pp. iii, 25). Overall, the number of breeding pairs at the 13 sites was 33 percent lower in 2016 than in 1998, likely because of factors related to long-term drought and continued degradation of habitat by feral equines (LaBerteaux 2016, pp. iii, 26).

In 2019, LaBerteaux (2019, entire) conducted surveys at 32 sites at NAWS China Lake, including one site (Mamm Spring) where towhees had never been reported (LaBerteaux 2019, p. ES-1, 22). A total of 51 breeding pairs and 2 single towhees were observed at 28 sites, and towhees were absent from 4 sites (LaBerteaux 2019, p. 17). The breeding population in the surveyed area decreased by 22 percent since 1998 and by 28 percent since 2007, likely because of loss of core riparian habitat from drought (LaBerteaux 2019, p. ES-1, 17, 22). Decreases were not consistent among survey areas; for example, between 2007 and 2019, the breeding population decreased by approximately 5 percent in the Wilson Canyon and Yucca Spring area, while the Homewood Canyon area population decreased by 50 percent (LaBerteaux 2019, pp. 17, 23).

Also in 2019, Atwell, LLC (2020, entire) conducted surveys at 78 sites on BLM and CDFW lands and detected 104 adult towhees at 56 percent of surveyed sites (Atwell, LLC 2020, p. i). Compared to the 2011 survey of the same sites, the number of adult towhees decreased by 40 percent and the number of pairs by 48 percent in 2019 (Atwell, LLC 2020, p. i). Much of the decrease in occupancy at survey sites in 2019 was observed at lower elevation sites impacted by drought including absences at fenced springs in designated critical habitat (Atwell, LLC 2020, pp. i, 11).

In 2020, McCreedy (2020, entire) conducted surveys at 84 sites on BLM and CDFW lands and detected 134 adult towhees representing 66 pairs (McCreedy 2020, p. i; table 3). Compared to 2019 survey results, abundance increased by 14 percent and the number of pairs increased by 21 percent (McCreedy 2020, p. i). However, 2020 abundance and occupancy remained significantly lower than in 2011 (McCreedy 2020, p. i). The increase in abundance between 2019 and 2020 was attributed to above-normal precipitation during the 2018–2019 winter and resultant high productivity, which led to greater adult abundance during 2020 (McCreedy 2020, p. i).

In 2021, LaBerteaux (2021b, entire) conducted surveys at 40 sites at NAWS China Lake and detected 26 breeding pairs and 7 single towhees at 50 percent of survey sites (LaBerteaux 2021b,

p. ES-1). Compared to 2007 surveys of the same 40 sites, adult abundance decreased by an average of 44 percent but the rate of decline was not consistent among sites (LaBerteaux 2021b, p. ES-1). Like in 2019, declines were again attributed to loss of core riparian habitat from drought (LaBerteaux 2021b, p. ES-1).

Also in 2021, McCreedy (2022c, p. S-1) revisited 34 of the Inyo California towhee territories he mapped on BLM and CDFW lands during 2020 surveys (to collect blood samples for genomic analysis). Although the 2021 visits occurred “well into the Inyo California towhee nesting season,” McCreedy (2022c, p. S-1) found towhees at only 23 (68%) of the 34 territories that were occupied during 2020. Furthermore, McCreedy (2022c, p. S-1) did not encounter any new territories that were not present during 2020, did not record evidence of nesting (e.g., nesting material carries, food carries, dependent fledglings), and observed that only 5 of the 14 captured adults exhibited signs of early-stage breeding conditions (i.e., cloacal protuberance for males and brood patch for females). McCreedy (2022c, p. S-1) attributed this decrease in breeding population and breeding activity to record heat and extreme drought during 2020 and 2021.

Also in 2021, Whitfield and Jaime (2022a, entire) conducted surveys using a spot-mapping technique, spot-mapping, at select sites on NAWS China Lake that were also surveyed by LaBerteaux (2021b, entire). Spot-mapping, which is an intensive survey technique that maps territories and bird activity on the landscape, was conducted in four plots spanning parts of Mountain Spring Canyon, Big Wildrose Canyon, Crow Canyon, and North Fork Water Canyon (LaMotte Spring) (Whitfield and Jaime 2022a, pp. 1–2). A total of 13 towhee territories were mapped during the study (Whitfield and Jaime 2022a, p. 6).

In 2022, McCreedy (2022b, entire) conducted surveys at 76 sites on BLM and CDFW lands and detected 116 individuals (McCreedy 2022b, p. S-1). McCreedy estimated the rangewide population using a similar extrapolation method that LaBerteaux previously used. If the sites surveyed during 2022 were representative of the rest of the subspecies’ range, then the total population of towhees was approximately 400–450 adults in 2022 (Figure 5) (McCreedy 2022b, p. S-2). Based on his visits to BLM and CDFW sites over the previous 4 years, McCreedy (2022b, p. 9) suggests that the population increased from 2019 to 2020, decreased in 2021 (no surveys but visited to collect blood samples), and then increased in 2022 back to similar numbers seen in 2019.

Also in 2022, Whitfield and Jaime (2022b, entire) conducted spot-mapping surveys on NAWS China Lake. In the six spot-mapping plots that encompassed Mountain Spring Canyon and Big Wildrose Canyon, a total of 40 adult towhees and 19 territories were recorded (Whitfield and Jaime 2022b, p. ix). Compared to 2021 survey results, 2022 abundance appeared to decrease at half of the sites and increase at the other half. Whitfield and Jaime (2022b, p. 4.1; figure 3-2) found an overall small increase in abundance in the survey area between 2020 and 2021, which coincided with an increase in precipitation.

Population Trend and Drivers

In this section, we describe population trends and associated drivers of Inyo California towhee abundance since 1998. Drivers of towhee abundance (i.e., factors that result in increases or decreases in the adult population) appear to primarily be related to the amount and quality of available habitat. Precipitation and the amount of moisture in the environment have a strong indirect influence on the towhee because of the effect that seasonal water availability has on plant and insect productivity in a desert environment. Higher plant productivity benefits towhees by increasing food resources and increasing places to shelter from predators and heat. Higher insect productivity also benefits towhees by increasing food resources needed for rearing young. Groundwater levels likely also have influence on the towhee because of their role in supporting springs and riparian vegetation.

Over the 13-year period from 1998 to 2011, the estimated total range-wide population of the towhee ranged between 640 and 741 individuals with an increasing trend (Figure 5; Figure 6) (LaBerteaux 2011, p. 66). LaBerteaux (2021a, p. 31) attributes the increase in population between 1998 and 2011 to three above-average rainfall years and a presumed resulting increase in resources necessary for successful reproduction during those years. In support of this hypothesis, annual precipitation was much greater than the long-term average during 1998, 2005, and 2010, and also above average during 2001, 2003, and 2008 (Figure 7).

Several years of extended drought between 2012 and 2022 (Figure 7) have coincided with an estimated population decline of approximately 40 to 50 percent (Figure 5, Figure 6). LaBerteaux (2015d, p. iii) reported that the population decline observed during 2015 surveys of 11 study sites mainly occurred from 2012 through 2013 (LaBerteaux 2014, p. iii). The decline was attributed to factors associated with prolonged drought, degradation of habitats by feral equines, and possibly human disturbances (LaBerteaux 2015d, p. iii; LaBerteaux 2015d, p. iii). In 2015, LaBerteaux (2015d, p. iii) suggested that the average winter rainfall and subsequent high food abundance enabled towhees at NAWS China Lake to successfully raise young and, in some cases, produce a second clutch. Since 2019, decreased abundance and occupancy, compared to 1998–2011 surveys, has been attributed to habitat impacts from long-term drought (LaBerteaux 2019, p. 39; Atwell, LLC 2020, pp. i, 11; LaBerteaux 2021b, pp. 38, 40; McCreedy 2022b, p. S-2; McCreedy 2022c, p. S-1).

During the 2012–2022 drought, LaBerteaux observed drastic differences in towhee abundance among sites. For example, the change in total numbers of adults between 2007 and 2021 ranged from no change to an 87.5 percent decrease depending on the survey area (LaBerteaux 2021b, p. 41). LaBerteaux recommended that results of "limited survey efforts" should not be used to extrapolate across the entire range of the subspecies because of the high variability of occupancy across the range and consideration that a large portion of previously occupied sites (104 sites, 39 percent) has not been surveyed since before 2012 (Figure 3), (LaBerteaux 2021b, pp. 40–41). As a result, LaBerteaux has not provided a rangewide population estimate in her reports since 2011. However, in 2022, McCreedy (2022b, p. S-2) estimated the rangewide population using a similar extrapolation method that LaBerteaux previously used. Based on the survey of 76 sites on BLM and CDFW lands, he estimated the total population of towhees at 400–450 adults in 2022 (Figure 5) (McCreedy 2022b, p. S-2). Acknowledging LaBerteaux's caution, this estimate suggests a potential increase in abundance since 2021, when McCreedy (2022c, p. S-2) noted extremely dry habitat conditions at BLM survey sites and suggested that the towhee population may be less than 400 individuals.

The drought-related declines of the Inyo California towhee population are consistent with avian community patterns in arid regions. Songbird studies have commonly found strong positive relationships between rainfall and avian reproduction and population density (Morrison and Bolger 2002, entire; Chase *et al*. 2005, entire; McCreedy and van Riper 2015, entire; Iknayan and Beissinger 2018, entire). A 2018 study showed that Mojave Desert bird occupancy and site-level species richness both declined by about half over the past century (Iknayan and Beissinger 2018, p. 8599). This suggests a long-term decline in avian populations in the region and not just interannual variation. Models demonstrated that climate change, particularly decline in rainfall, was the most important driver of avian declines; Mojave Desert sites that received less precipitation during recent decades had higher local extinction probabilities (Iknayan and Beissinger 2018, p. 8599). Similarly, McCreedy and van Riper (2015, entire) looked at the effects of drought on Sonoran Desert birds. They found that drought delayed nest initiation and negatively affected productivity through reduced nest survival (McCreedy and van Riper 2015, pp. 241–246). Variation in annual precipitation has also been linked to bird productivity due to its positive effect on food availability and negative effect on nest predation by snakes (Morrison and Bolger 2002, pp. 315, 320–321).

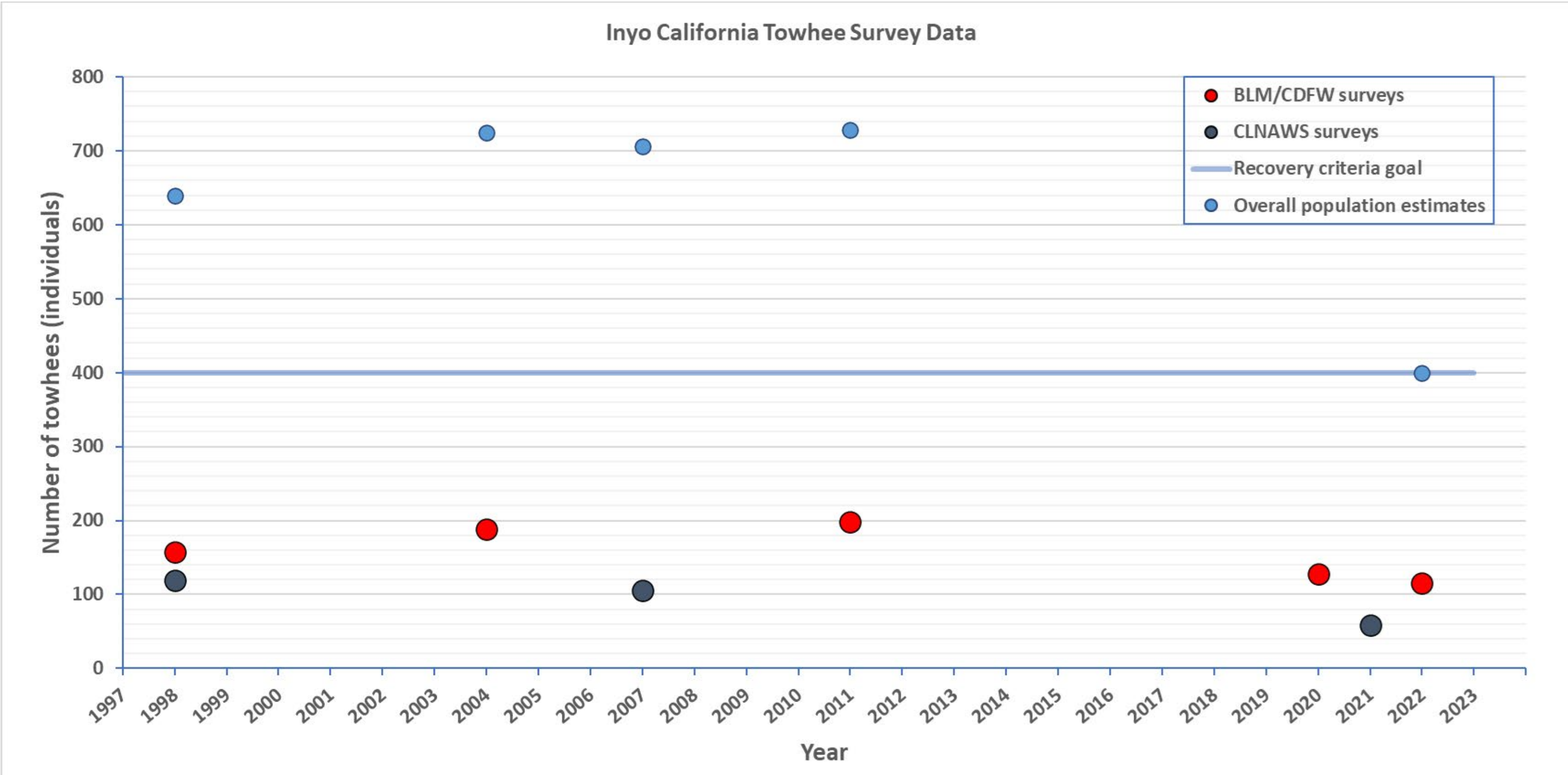

Figure 5. Rangewide population estimates and total numbers of adults counted at two subsets of survey sites. The horizontal line at 400 represents the minimum population size established in the recovery criteria. Population estimates (blue dots) are graphed for the conservative (lower) end of estimates if a range was given. Note that the overall population for 1998 is a census of the total population, not an estimate.

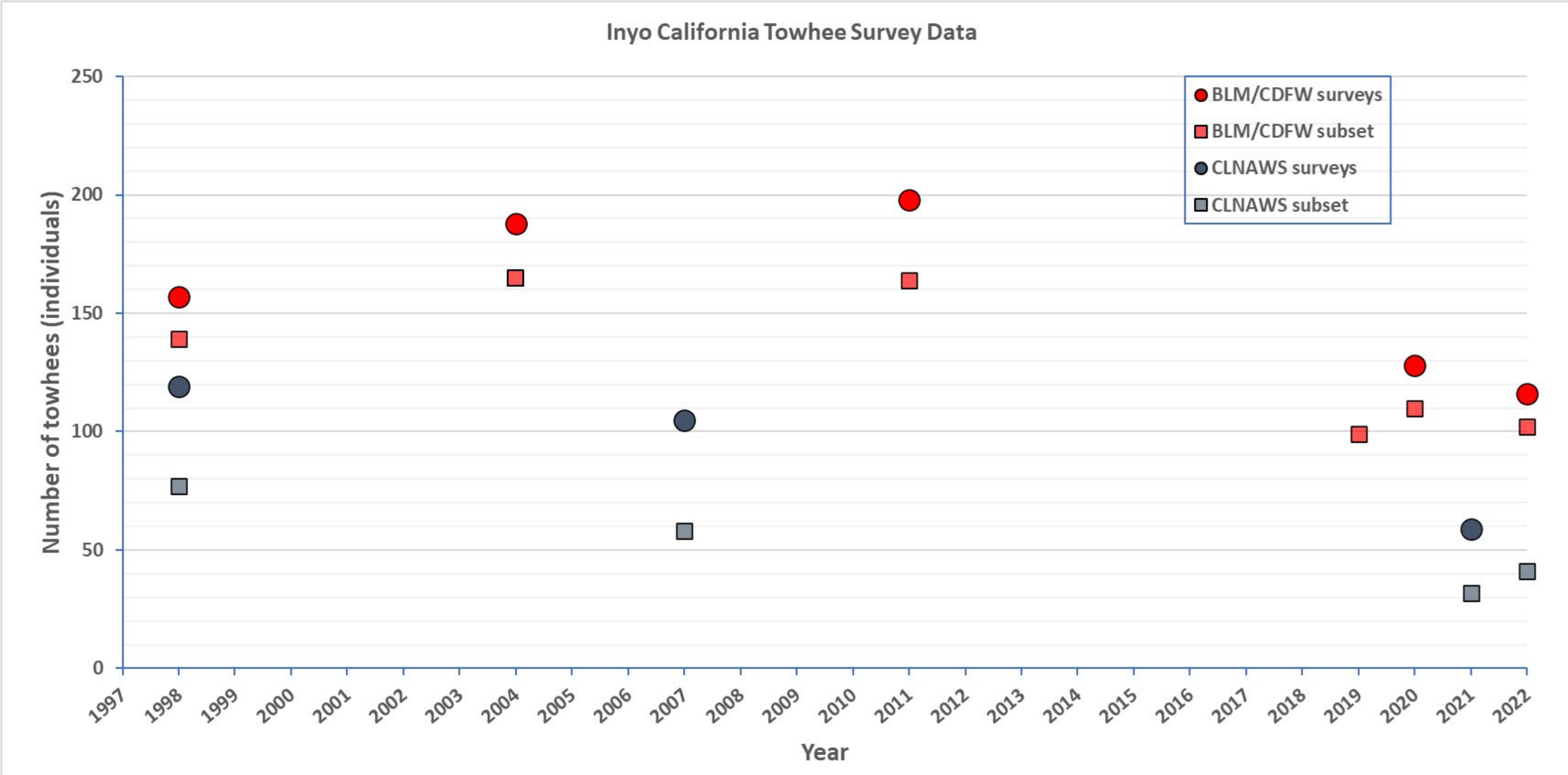

Figure 6. Total numbers of adult Inyo California towhees counted during surveys on Bureaus of Land Management (BLM) and California Department of Fish and Wildlife (CDFW) lands (in red) and on China Lake Naval Air Weapons Station land (in gray). Data series with squares show smaller subsets of survey data to show data for years when fewer sites were surveyed.

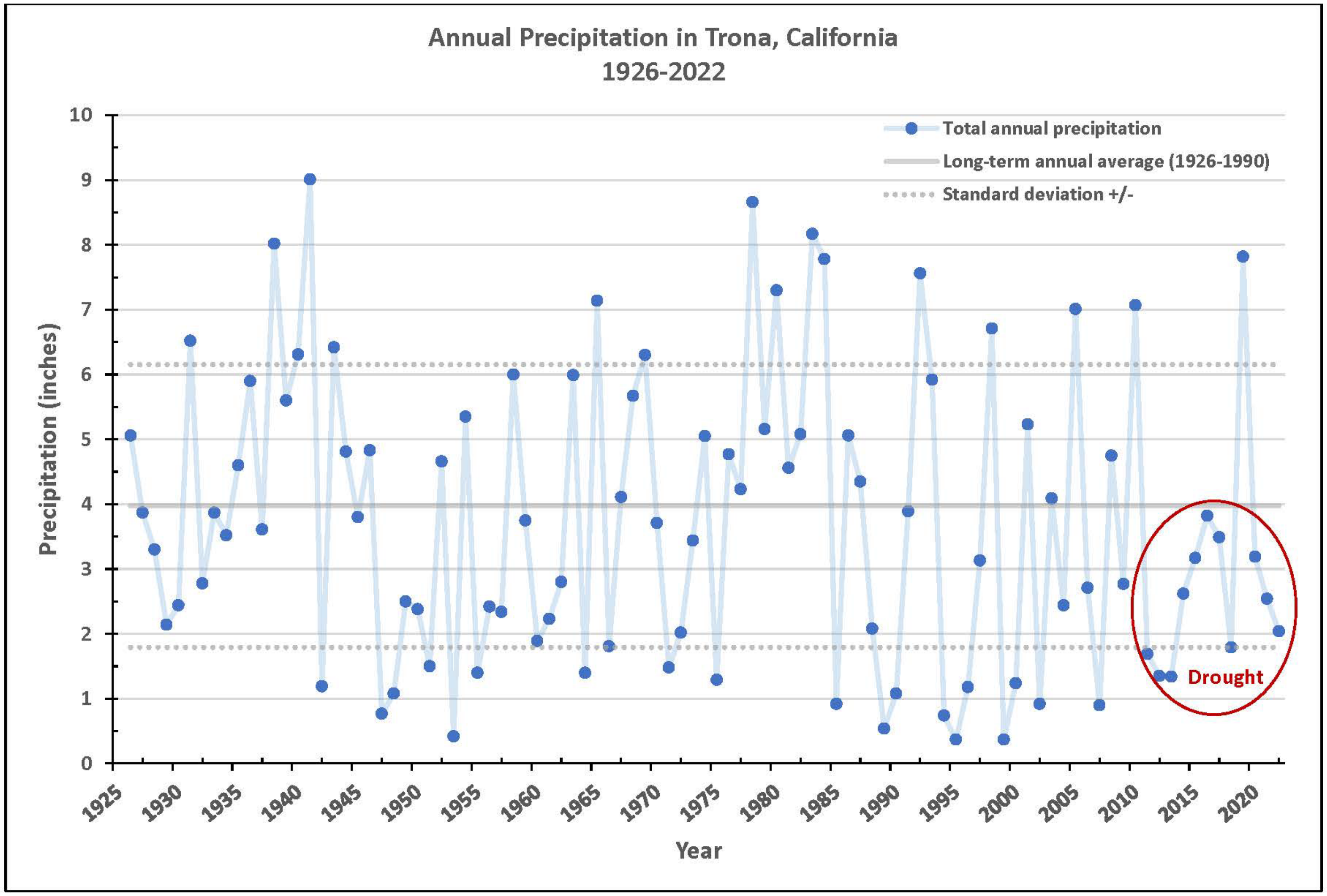

Figure 7. Annual Precipitation in Trona, California, 1926–2022, from NOAA Climate Data Online (Lawrimore *et al*. 2016, dataset).

III. FIVE-FACTOR ANALYSIS

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act. Threats identified at the time of listing were grazing by feral burros and horses, water diversion, mining, off-highway vehicle use, and recreation and military activities. In the previous 5-year review, we identified additional threats that were not discussed in the final listing rule including flooding, fire, and spread of nonnative and invasive plants (Service 2008, pp. 5, 12–13, 18–19). The 2008 5-year review described flooding and fire as Factor E threats, but we discuss them as Factor A threats below because they affect Inyo California towhee habitat. In the 2013 12-month finding and proposed rule to remove the Inyo California towhee from the Federal list of endangered and threatened wildlife, we discussed potential additional threats such as climate change, predation, and brood parasitism by brown-headed cowbirds (Service 2013, pp. 65943–65950).

In this 5-year review, we discuss past, present, and potential threats that were described in our previous assessments. We also discuss newly identified threats or potential threats including, unauthorized cannabis cultivation (Factor A), drought associated with climate change (Factor A), inbreeding depression (Factor E), and disturbance related to vehicles and recreators (Factor E).

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

We listed the Inyo California towhee as threatened in 1987 because of the loss and degradation of the dense riparian habitat the towhee requires, which is naturally limited in extent in the desert. Under Factor A in the final listing rule, we stated that threats to the Inyo California towhee and its habitat included grazing by feral equines, recreational activities, water diversion, and mining. Below, we review the best available information about threats to towhee habitat from feral equines, fires and floods, climate change (particularly drought), recreational activities, invasive nonnative plants, cannabis cultivation, water diversion, and mining.

Feral Equines

Feral equines [i.e., horses (*Equus caballus*) and burros (*Equus asinus*)] have been a primary rangewide threat to the Inyo California towhee since before the subspecies was listed under the Act. Feral equines degrade towhee habit by grazing, browsing, and trampling vegetation; causing erosion; and opening gaps in dense vegetation used by towhees for nesting and sheltering from predators. Impacts are especially high in towhee habitat because feral equines are attracted to sources of water and lush vegetation. Furthermore, the patches of wet riparian habitat frequented by equines are typically banked by steep slopes of upland habitat used by towhees to forage. The steepness of the slopes accelerates erosion and vegetation damage as equines travel up and down the slopes through important towhee foraging habitat. In areas such as Homewood Canyon, the riparian zone is becoming narrower over time because of soil erosion from slopes on either side (LaBerteaux 2015b, pers. comm.).

While both horses and burros have negative impacts on towhee habitat, differences in behavior between the subspecies can lead to different distribution or types of impacts. The majority of the horse population resides in the NAWS China Lake North Range complex and west of the Argus Mountain Range, whereas most burros reside on the eastern side of Argus Mountain Range and, to some extent, both burros and horses occur together on the western side of the range (BLM 2021c, p. 53). Thus, both horses and burros occur across the towhee's range, but burros are most common in the eastern part of the range (BLM and CDFW land), and horses are more common in the western part of the range on NAWS China Lake. Anecdotally, burros also appear to occupy lower-elevation sites, while horses tend to occupy higher-elevation sites in towhee habitat (LaBerteaux 2015c, pers. comm.).

Feral burros can be especially destructive due to their practice of taking dust baths by rolling and rubbing themselves on the ground. Up to 10 feet (3 meters) in diameter, these "burro baths" destroy vegetation and create miniature dust bowls (Figure 8) (Cord and Jehl 1979, pp. 79–118). Burros were also recently identified as contributing factors for some springs and water sources in the Argus Range not meeting standards for proper functioning condition (BLM 2021c, p. 9, appendix E). However, horses may cause more damage to soil and vegetation near springs because they break from a single line formation on a trail and move cross country as they approach riparian sites, whereas burros tend to stay in a single line (LaBerteaux 2015b, pers. comm.).

During drought years over the previous decade, staff from NAWS China Lake have observed that horses and burros spend more time at increasingly limited water sources and in the nearby uplands (Arnold 2023, pers. comm.). During the recent drought, horse condition declined and, at times, horses struggled to obtain adequate water at riparian springs, which had reduced water flows (Arnold 2023, pers. comm.). Springs with available water in towhee habitat and surrounding uplands continue to be heavily impacted by equine use, particularly during these dry periods (Arnold 2023, pers. comm.). These impacts compound the negative effects of drought on riparian and upland habitat.

Figure 8. Photo of equine "dust bath" or "wallow" in Upper Homewood Canyon.[2]

Management

At the time of listing, grazing and browsing was widespread throughout the towhee's range and had substantially reduced the ability of these habitats to support towhees. In the early 1980s as

[2] Photo taken by Service staff in 2015.

many as 7,000 feral equines were estimated to occur on NAWS China Lake (NAWS China Lake 2013, p. i). The threat of feral equines to towhee habitat has been reduced since its height in the 1980s because the NAWS China Lake and BLM have worked to reduce the number of feral equines through gather and removal programs. Without active removals, the feral burro population in the region has been estimated to increase by approximately 15 percent per year (BLM 2021c, pp. 6–7). Since 1980, roundups funded by the NAWS China Lake and BLM reduced the burro population to approximately 150 animals and the horse population to approximately 300 animals in 2009 (Table 2) (NAWS China Lake 2013, p. 31).

The NAWS China Lake and BLM have also installed fences around sensitive riparian areas at some of the springs that support towhee riparian habitat. The NAWS China Lake and BLM have fenced more than 17 springs and intend to fence additional areas where high levels of impacts by feral equines occur (Service 2010, pp. 5–7). Fences are successful in protecting riparian habitat from most of the impacts of feral equines but impacts to upland habitat still occur around fenced springs, including worn trails around the fence perimeter of the fence (BLM 2021c, appendix E). Furthermore, the fences need to be monitored and repaired because of both natural and human-caused damage, and equines have accessed fenced springs following damage (LaBerteaux 2011, p. 65; Ellis 2013a, pers. comm.).

In 2010, the BLM and NAWS China Lake committed through a cooperative management agreement with the Service to continue working together to manage feral equines as funding allows (Service 2010, pp. 5–7). Although this agreement has expired and a new agreement is still in development, the landscape-level management goals for towhee habitat, set forth in agency management plans, remain unchanged. As part of their updated Integrated Natural Resources Management Plan (INRMP) (U.S. Navy 2014, entire), NAWS China Lake committed to their Wild Horse and Burro Management Plan (NAWS China Lake 2013, entire) that identifies management goals that, once accomplished will benefit the Inyo California towhee and its habitat. To summarize, these management goals include: (1) maintaining the Centennial Horse Herd within a range of 100 to 168 animals, (2) achieving and maintaining the burro population at zero, and (3) minimizing damage to water resources, riparian areas, and uplands from the Centennial Horse Herd; the plan's implementation is intended to increase the rate of plant and animal population recovery, including federally listed species (NAWS China Lake 2013, p. i). As stated in their Wild Burro Gather Plan (BLM 2021c, pp. 8, 10), the BLM plans to continue their habitat improvement program, including enhancing towhee habitat by excluding burros at Peach Spring and, over 10 years, remove all feral burros from Centennial Herd Area (which overlaps the range of the towhee) as well as the adjacent Panamint and Slate Range Herd Areas.

Historically, management of feral equines has been inconsistent in the towhee's range (Table 2); thus, management goals have not yet been achieved. Management of feral equines through roundups and removals is an ongoing challenge; agency capacity and funding are often limiting factors. However, in 2021, the BLM completed an environmental assessment for a wild burro gather plan to implement and achieve removal of all burros from the Centennial Herd Area over a 10-year period (2021–2031) (BLM 2021c, entire). Since 2021, the BLM and NAWS China Lake have removed 569 feral equines from the Centennial Herd Area, including more than 200 horses (Table 2). Therefore, management of feral equines in towhee habitat is likely to continue to increase over the next several years.

Table 2. Numbers of Centennial Herd Area Equines Removed and Population Estimates by Federal Fiscal Year, 1980–2023.[1,2]

Fiscal Year	Number of Burros Removed	Burro Population Estimate	Number of Horses Removed	Horse Population Estimate
1980	0	3,684	0	834
1981	799		0	1,120
1982	3,389		0	1,318
1983	1,644		241	1,226
1984	932		561	1,090
1985	429		691	
1986	244		0	
1987	481		507	
1988	479		0	
1989	241		100	720
1990	167	161	347	609
1991	82		293	367
1992	127		72	509
1993	119	300	136	432
1994	190	100	126	354
1995	244	100	148	208
1996	0	116	0	229
1997	45	118	23	230
1998	60	115	41	220
1999	68	55	40	300
2000	174	150	32	311
2001	220	100	66	202
2002	0	116	0	234
2003	73	62	26	241
2004	75	75	0	250
2005	39	90	43	260
2006	50		14	
2007	0		28	
2008	41		6	254
2009	20	150	0	300
2010	64		0	459
2011	80			532
2012	100		0	
2013	0	150	0	450-500
2014	5		0	
2015	17		53	350
2016	3	479	14	443
2017	0	547	0	515
2018	0	623	0	597

Fiscal Year	Number of Burros Removed	Burro Population Estimate	Number of Horses Removed	Horse Population Estimate
2019	0	710	0	692
2020	0	348	0	763
2021	327	70	214	671
2022	28	52	0	778
2023	0	521*	0	480*

[1] (NAWS China Lake 2013, p. 31; BLM 2021c, pp. 53–54; BLM 2021a, unpaginated; BLM 2021b, unpaginated; BLM 2023, unpubl. data).
[2] Asterisks (*) for the 2023 population estimates convey that the numbers are minimum population sizes based on census count data (not population estimates like other estimates in the table).

Recent Impacts and Current Status

In 2015, Service staff visited towhee habitat at several sites across the Argus Mountain Range with subspecies expert Denise LaBerteaux. Numerous types of impacts from feral equine were observed both inside and outside of riparian areas, in addition to frequent encounters with feral horses and burros (LaBerteaux 2015b, pers. comm. LaBerteaux 2015c, pers. comm.). These impacts included overgrazing (as evidenced by compacted soils and little to no native bunchgrass), numerous trails through upland habitat, trampling of shrubs and wallowing on steep-sided slopes, loose soils without evidence of soil crust, erosion of loose soil into the riparian zone where buildup along shrubs reached a height of up to 2 feet (Figure 9), browsing of shrubs including torn off branches (Figure 10), and digging at small pools of surface water (LaBerteaux 2015b, pers. comm. LaBerteaux 2015c, pers. comm.).

Figure 9. Photos of equine impacts including along the edge of a riparian zone in Upper Homewood Canyon.[3]

[3] Photos taken by Service staff in 2015.

Figure 10. Photo of damage to mountain mahogany from browsing by feral horses in Upper Homewood Canyon.[4]

Over the previous decade, feral horse and burro abundances in the Centennial Herd Area have increased (Table 2) (NAWS China Lake 2013, p. 31; BLM 2021c, pp. 7, 17). In 2020, there were an estimated 763 horses and 348 burros in the Centennial Herd Area (BLM 2021c, pp. 7, 17, 53). During 2021, 214 horses and 327 burros were removed from the Centennial Herd Area (BLM 2021a, unpaginated; BLM 2021b, unpaginated) and another 28 burros were removed in 2022 (BLM 2023, unpubl. data). As of the 2023 survey, the minimum population size is 480 horses and 521 burros (Table 2). Ongoing management is still needed to reduce feral horse and burro abundance in the area.

On NAWS China Lake, equine disturbance was observed at all 40 sites visited during 2021 towhee surveys (LaBerteaux 2021b, pp. 29–30, table 6). Equine impacts included slope erosion, equine trails, wallows, and other denuded areas (LaBerteaux 2021b, p. 29). Disturbance was most often characterized as “low” in riparian habitat and “moderate” in upland habitat (Table 3). Severe disturbance was observed at 8 sites (20 percent; Table 6) in both the riparian and upland habitats and slope erosion was described as extensive in areas with moderate or severe equine

[4] Photo taken by Service staff in 2015.

impacts (LaBerteaux 2021b, p. 29). LaBerteaux (2021b, pp. 29–30) recommended installing equine exclusionary fences around water sources at six sites.

On BLM and CDFW lands, equine impacts to riparian habitats observed during 2019 and 2020 towhee surveys were described as similar to impacts in 2011 (Atwell, LLC 2020, p. i; McCreedy 2020, p. ii). In 2011, equine impacts were less severe (only 38 percent of the sites ranked moderate to severe) than those observed during 1998 and 2004 surveys, but there was "some degree of impact" at all but three of the surveyed water sources (LaBerteaux 2011, p. 15). Equine impacts were not discussed in reports for 2021 genetic sampling (McCreedy 2022c, entire) or 2022 surveys (McCreedy 2022b, entire). Because of the static level of impacts observed on BLM and CDFW lands, Atwell, LLC (2020, p. 12) suggested that feral burros are not likely playing a leading role in the observed decline of the towhee population. The disparity of equine impacts reported between land ownership in recent years, might suggest that equine impacts on NAWS China Lake are worse than those on BLM and CDFW lands.

Table 3. Severity of Equine Disturbance at 40 Inyo California Towhee Survey Sites on NAWS China Lake in 2021.[1,2,3,4]

Habitat Type	Low[5]	Moderate[5]	Severe[5]
Riparian	45	35	20
Upland	10	70	20

[1] Data are summarized from LaBerteaux (2021b, pp. 29–30, Table 6).
[2] Severe = "widespread hedging of browse; heavy use of grasses and forbs; numerous trailing and trampling of vegetation, with an obvious increase in bare ground" (LaBerteaux 2021b, p. 15).
[3] moderate = "localized heavy use of plants; few trails and little trampling, with localized increase in bare ground" (LaBerteaux 2021b, p. 15).
[4] low = "no heavy use of plants; few trails; no trampling" (LaBerteaux 2021b, p. 15).
[5] Percent.

Summary

By impacting riparian and upland habitat, feral equines negatively affect Inyo California towhee food resources, sheltering sites, water availability, and reproduction. Feral equines are a rangewide threat but effects are not uniformly distributed because equines are not evenly distributed across the towhee's range and some riparian habitat is protected with exclusion fencing installed by NAWS China Lake and BLM. Efforts by NAWS China Lake and BLM, in particular roundups and removals of equines from the Argus Mountains area, have benefitted the Inyo California towhee. When equine numbers are low and climate conditions are favorable, such as during the period from 1998 to 2011, towhee habitat quality and abundance increases. At present, feral equine impacts to towhee habitat are mostly moderate (Table 3). With continued management (i.e., removals), habitat conditions will gradually improve over time if water availability and temperatures are conducive to recovery of vegetation and soil. We consider the current magnitude of this threat to be moderate because of its continued moderate impact on towhee habitat across the range and because of our high confidence that management will continue.

Fires and Floods

We did not identify fires or floods as a threat to the Inyo California towhee in the final listing rule. However, these natural and human-caused disturbances have impacted Inyo California towhee habitat since the subspecies was listed. Below, we expand upon the assessment of fires and floods as threats in the previous 5-year review (Service 2008, pp. 18–19) and subsequent 12-month finding (Service 2013, p. 65945). We discuss impacts from a fire and flood event that occurred in 2005 (Impacts From 2005 Fire and Flood), results of post-fire and post-flood monitoring of towhee habitat (Habitat Response Over Time), and recent fire history in towhee habitat to identify patterns or trends (Recent Fires and Trends). We discuss fires and floods as Factor A threats because they impact the Inyo California towhee by negatively affecting habitat. However, fires and floods are potentially also Factor E threats (other natural or manmade factors affecting the subspecies' continued existence) if they directly harm towhee individuals or nests.

Impacts From 2005 Fire and Flood

In 2005, a collision of Navy jets caused a brush fire that burned about 10 percent of towhee habitat on NAWS China Lake (including designated critical habitat), and subsequently was followed by a flash flood 2 weeks later that resulted in additional loss of vegetation and increased erosion (LaBerteaux 2006, entire). In 2006, LaBerteaux (2006, pp. 7–8) estimated that 48 breeding pairs were affected based on fire and flood impacts to habitat at 30 breeding sites; 13 sites were impacted by fire only, 12 sites by flash flood only, and 5 sites by both fire and flood events (LaBerteaux 2006, p. 9). An additional 5 sites may have also been impacted by the flash flood but the sites were not surveyed (LaBerteaux 2006, p. 9). One year after the 2005 fire, LaBerteaux (2006, p. 11) observed Inyo California towhees at most of the sites impacted by the fire and flood, but because of the time of year, she was unable to tell if successful nesting occurred at the sites in 2006. Towhees were seen in the recovering riparian vegetation and foraging in burned areas among dried annual plants and recovering shrubs (LaBerteaux 2006, p. 11). While Inyo California towhee individuals were not likely directly killed by the fire or flood, a few nests might have been destroyed and productivity and survival probably decreased because of loss of nesting, foraging, and sheltering habitats (LaBerteaux 2006, p. 15).

Specific habitat impacts from the 2005 fire included loss of shrubs and ground cover, increased potential for erosion, and increases in nonnative invasive grasses such as red brome (*Bromus rubens*) and cheatgrass (*Bromus tectorum*) (LaBerteaux 2006, pp. 9, 13). Impacts from the subsequent flood included erosion in the burned areas and washes, loss of shrubs in the washes, loss of riparian canopy, lowering of the streambed in some areas that exposed major roots of riparian vegetation, and deposition of sediments in other areas that flattened or buried willows (LaBerteaux 2006, pp. 9–10). In the upper portion of a tributary to Mountain Springs Canyon, the flooding caused head-cutting, undercutting, and loss of riparian habitat (LaBerteaux 2015a, pers. comm.). In the lower portion of the tributary, soils and debris were washed out of the tributary and into the main canyon, depositing approximately 3 feet of sediment on top of riparian vegetation (LaBerteaux 2015a, pers. comm.). The 2005 fire and flash flood may have altered canyon hydrology and contributed to later decreases in surface and subsurface water flows during extended drought (Southern Sierra Research Station 2013, p. 17; LaBerteaux 2014,

p. 26). Furthermore, numerous seedlings of nonnative invasive salt cedar trees (*Tamarix* sp.) were found (and removed) in washes (70–80 in North Wilson Canyon and 15–20 in Mountain Springs Canyon) (LaBerteaux 2006, p. 13). Salt cedar seedlings benefitted from the reduced competition following the fire and flood and some seedlings that were not removed became established and grew up to 6-feet tall by 2012 (Southern Sierra Research Station 2013, p. 17).

Habitat Response Over Time

Regrowth of riparian and upland vegetation progressed gradually each year (Southern Sierra Research Station 2010, p. 11). By August of 2006, some recovery was observed in the native upland and riparian perennial species (LaBerteaux 2006, p. 13). Three years after the 2005 fire and flood, fire-impacted trees and shrubs were continuing to regrow (Southern Sierra Research Station 2009, p. 13). In 2010, fire-impacted desert olive (*Forestiera pubescens*) and arroyo willow (*Salix lasiolepis*) appeared to have reached pre-fire heights and the density of young willows and rabbitbrush (*Ericameria nauseosa*) in the washes was noticeably greater than the previous year. However, shrub cover and density in upland habitat were still very low (Southern Sierra Research Station 2011a, p. 17). By 2011, stands of desert olive had nearly fully recovered and some upland shrubs nearly reached pre-fire heights (Southern Sierra Research Station 2011b, pp. 10, 14). Common plant species that still had not recovered significantly in 2011 included Great Basin sagebrush (*Artemisia tridentata*), California buckwheat (*Eriogonum fasciculatum* var. *polifolium*), and Joshua tree (*Yucca brevifolia*) (Southern Sierra Research Station 2011b, p. 10). Furthermore, the most abundant annual plant following the disturbance was the nonnative invasive red brome (Southern Sierra Research Station 2011b, p. 14), which can increase the risk of wildfire reoccurring in the future.

In 2012, the extent of riparian vegetation in the impacted Mountain Springs Canyon area was noticeably less than baseline in 1998 and there were substantial amounts of dead or dying willows (Southern Sierra Research Station 2013, p. 17). LaBerteaux suggested that the 2005 flash flood and recent drought (annual rainfall of less than 2 inches during 2011–2012) may have affected surface and subsurface water flows in these areas, subsequently impacting the willows (Southern Sierra Research Station 2013, p. 17). In the same area during 2015, Service staff observed where the flash flood scoured the tributary channel bottom by approximately 5 feet (Figure 11) and subsurface water was presumably at least 5 feet lower than pre-flood conditions (LaBerteaux 2015a, pers. comm.; Rutherford *et al*. 2015, pers. obs.). No new willow, or similar riparian vegetation, growth was observed in or adjacent to the scoured tributary bottom and many of the pre-existing willow trees had bare branches that we presumed were dead (Rutherford *et al*. 2015, pers. obs.).

Figure 11. Photo of scour and willow root exposure 10 years after the 2005 flash flood.[5]

Habitat recovery after the fire and flood could be slowed by impacts from horses and burros. While North Wilson Canyon habitat was recovering in both riparian and upland areas (Southern Sierra Research Station 2011b, pp. 10, 14), upland vegetation surrounding riparian habitat in the Bircham Springs area was not showing strong signs of recovery in 2012 (Southern Sierra Research Station 2013, p. 2). Instead, uplands areas showed heavy impacts from feral equines, included bare areas (dusting wallows) and worn trails, even though two of the springs (Bircham Springs and Ma'am Spring) were fenced to exclude equines (Southern Sierra Research Station 2013, p. 2). Riparian vegetation was still less than pre-fire levels at Bircham Springs sites except for Ma'am Spring where riparian vegetation increased from 2 m^2 (10.7 ft^2) in 1998 to 200 m^2 (2,153 ft^2) in 2012, likely because of exclusion fencing and increase in surface water (Southern Sierra Research Station 2013, p. 9).

By 2021, impacts from the 2005 fire were only noticeable in upland habitats (LaBerteaux 2021b, p. 29). The upland plant community in the 2005 burn area shifted from habitat dominated by black brush scrub (*Coleogyne ramosissima* Shrubland Alliance) to habitat dominated by needleleaf rabbitbrush, a species that readily root-sprouts after fire (LaBerteaux 2021b, p. 31). Little evidence of the flash flood in Big Wildrose Canyon remained by 2021 (LaBerteaux 2021b,

[5] Photo taken by Service staff in 2015.

p. 31). LaBerteaux (2021b, p. 31) noted that in addition to the riparian habitat recovering, willows expanded into some sections of wash that were once barren.

While habitat has continued to recover, one lasting impact to towhee habitat has been increased prevalence of nonnative invasive grasses such as red brome and cheatgrass (LaBerteaux 2006, pp. 9, 13; Southern Sierra Research Station 2011b, p. 14; Arnold 2023, pers. comm.) and fiddleneck *(Amsinckia tessellata)* (LaBerteaux 2013, pers. comm.). Fiddleneck is a native annual, which was mostly uncommon in the towhee's range but has now become common in burned areas (LaBerteaux 2013, pers. comm.). Nonnative cheatgrass has become well established in burned areas on NAWS China Lake (Arnold 2023, pers. comm.). These invasive annual species increase the likelihood of future wildfire and shorten wildfire return intervals (Keeley and Fotheringham 2003, p. 244; Keeley *et al*. 2005, entire; BLM and NPS 2018, p. 36). Changes in plant communities caused by invasive plants and recurrent fire negatively affect the towhee by altering habitat structure and species available as food plants.

Breeding and Nesting

A survey of four impacted survey sites in North Wilson Canyon during 2008 (three years after the fire and flood) found four breeding pairs (half as many pairs as in 1998) and two single males (Table 4) (Southern Sierra Research Station 2009, p. ii). All pairs attempted nesting one or more times for a total of eight nest attempts. Pairs successfully fledged young from two nests, another two nests had unknown outcomes, and the remaining four nests failed (Southern Sierra Research Station 2009, pp. ii, 13–19). The failed nest attempts in two territories were attributed to low cover around the nest site (because of fire damage) resulting in predation (Southern Sierra Research Station 2009, pp. ii, 32).

During subsequent years, numbers of breeding pairs and nest success varied at the four impacted North Wilson Canyon sites that were surveyed in 2008 (Table 4). In 2009, there were seven breeding pairs (and two single males) that made 12 nesting attempts (Southern Sierra Research Station 2010, pp. ii, 14). Of the 12 attempts, 6 (50 percent) failed, 4 (33 percent) were successful, and the remaining 2 nests had unknown outcomes (Southern Sierra Research Station 2010, p. 14). At the reference (control) site that was not impacted by flood or fire, 3 pairs made 6 nesting attempts of which half of the outcomes were successful and half unknown (Table 4) (Southern Sierra Research Station 2010, p. 14).

In 2010, only four breeding pairs were found but they all successfully fledged young (Table 4) (Southern Sierra Research Station 2011a, pp. 17–18). In 2011, nest success and failure rates were similar to control sites and the number of towhee territories was equivalent to the number observed in 1998 (Table 4) (Southern Sierra Research Station 2011b, p. 29). However, Denise LaBerteaux suggested that if habitat had not been impacted by fire and flood, plant and insect productivity in 2011 might have supported more pairs of towhees because the number of territories on the control sites increased by 75 percent compared to the 1998 and 2007 surveys (Southern Sierra Research Station 2011b, p. 29). Thus, it appears that the amount of habitat lost from the 2005 fire and flood had an impact on towhee nest productivity during subsequent years.

Table 4. Breeding and Nesting Data From Sites in North Wilson Canyon Impacted by the 2005 Fire and Flood.[1,2]

Year	Impacted or Control Site?	Number of Breeding Pairs	Number of Single Birds	Successful Nest Attempts	Failed Nest Attempts	Nest Attempts with Unknown Outcomes	Nest Attempt Success Rate (minimum)	Pair Success Rate (minimum)
2008	Impacted	4	2	2	4	2	0.25	0.25
2009	Impacted	7	2	4	6	2	0.33	0.57
2009	Control	3	Not specified	3	0	3	0.50	1.00
2010	Impacted	4	0	4	Unknown	Unknown	Unknown	1.00
2011	Impacted	8	Not specified	5	2	2	0.56	0.63
2011	Control	7	Not specified	5	2	2	0.56	0.71

[1] Southern Sierra Research Station 2009, p. 18; 2010, p. 14; 2011b, pp. 12–13, 21; 2011a, p. 31.
[2] During 2009 and 2011, control sites (breeding sites not impacted by the 2005 fire and flood) were also studied for comparison.

Recent Fires and Trends

Limited data are available on the distribution and impacts of fires that have occurred within the Inyo California towhee's range. In 2004, the naturally caused Chucker fire (875 ac) burned an area within the towhee's range (National Interagency Fire Center 2023, dataset), part of which likely reburned during the 2005 fire described above. Since 2005, we know that at least three large fires have occurred on NAWS China Lake (Table 5). Of those three, only the 2020 Parrot Peak fire (also known as the Junction Ranch or the Nadeau fire) burned a portion of Inyo California towhee habitat. Following the fire, NAWS China Lake staff assessed the burned area for damage to towhee habitat (Hopkins 2023, pers. comm.). They determined that the southern extent of the fire boundary was north of the Margaret Anne Spring Complex and did not burn any of the towhee's designated critical habitat (Hopkins 2023, pers. comm.). In 2023, Cindy Hopkins (NAWS China Lake Natural Resources Specialist) visited La Motte Spring (North Fork Water Canyon area), reportedly the only named spring within the Parrot Peak fire footprint where towhees have been documented (Hopkins 2023, pers. comm.). Hopkins (2023, pers. comm.) noted that the fire was spotty in this area and the La Motte Spring riparian vegetation and surrounding upland slopes were intact. Another wildfire, the naturally caused Argus fire, occurred within the towhee's range on NAWS China Lake in 2019, but was likely small in size (National Interagency Fire Center 2023, dataset).

Table 5. Fire History on NAWS China Lake Lands, 2004 to 2022.[1]

Date	Fire Name	Estimated Acres	Estimated Hectares
18 August 2004	Chucker	875	354
17 July 2005	Coso Rock Art NHL	8,543	3,457
18 July 2005	Bircham Spring	9,861	3,991
12 June 2006	Wild Horse Mesa	15,917	6,441
29 July 2020	Parrot Peak (Junction Ranch)	9,286	3,758
18 August 2020	Coso Flat	41,145	16,651

[1] NAWS China Lake 2023, unpubl. data.

On BLM lands, which compose the eastern portion of the towhee's range, small fires are not uncommon, likely because of greater human use and recreation. In March 2007, a human-caused wildfire burned through Ruth Mine Spring (Homewood Canyon) (Atwell, LLC 2020, p. 9; National Interagency Fire Center 2023, dataset). In May 2016, a campfire ignited a wildfire that burned Austin Spring (Great Falls Basin) (pers. comm. cited in Atwell, LLC 2020, p. 9; National Interagency Fire Center 2023, dataset). For both cases, Atwell, LLC (2020, p. 9) described that the fires "notably eliminated riparian-associated vegetation from these springs." In 2020, Atwell, LLC (2020, p. 9) reported that the Austin Spring vegetation had begun to recover in 2019 but Ruth Mine Spring remained largely devoid of vegetation. Towhee abundance at these springs had typically been low with one adult observed at Ruth Mine Spring and a breeding pair at Austin Spring in 1998 (LaBerteaux and Garlinger 1998, pp. 52, 56). An adult towhee was also recorded at Austin Spring in 2011 (LaBerteaux 2011, p. 38). However, no towhees were observed at either site during 2019 and 2020 surveys (McCreedy 2022b, table 3). In September 2021, another small human-caused fire was ignited in the Great Falls Basin area close to Austin Spring (National Interagency Fire Center 2023, dataset), but no additional information about impacts of this event are available.

Large fires and destructive floods in towhee habitat are currently infrequent and have thus far avoided the areas that are most densely populated with towhees. However, fires are likely to increase in the future with interacting threats such as drought, climate change, and invasive nonnative plants. The spread of invasive, highly flammable annual grasses such as cheatgrass and red brome, change the pattern of wildfire in desert ecosystems. These invasive, nonnative annual species increase the likelihood of future wildfire and shorten wildfire return intervals (Keeley and Fotheringham 2003, p. 244; Keeley *et al*. 2005, entire; BLM and NPS 2018, p. 36).

The NAWS China Lake, which receives fire ignitions from both lightning and military activities, is concerned about increasing incidence and size of wildfires, as vegetation type conversion moves toward nonnative annual grassland (Keeley and Fotheringham 2003, p. 244; Keeley *et al*. 2005, pp. 2109, 2115–2124; NAWS China Lake 2013, p. 56). The 2014 INRMP's wildland fire management program for NAWS China Lake is designed to reduce the effects of fire on threatened and endangered species (U.S. Navy 2014, p. 4.13), which partially alleviates wildfire risk to the Inyo California towhee. The BLM is also planning for increased fire frequency, severity, and extent in the California desert region as climate change leads to increased temperatures and changes in precipitation patterns (BLM and NPS 2018, pp. 35–37). Although the likelihood of future large wildfires occurring in towhee habitat is uncertain, the continued exposure to sources of fire ignition coupled with higher fuel loads associated with nonnative annual grasses, suggests that wildfire risk is increasing.

<u>Summary</u>

Fires and floods have the potential to cause severe long-term impacts to towhee habitat, decrease nesting success, and lead to an increased fire return interval because of the invasion of nonnative plants following disturbance. They are a threat across the towhee's entire range, but they affect habitat intermittently, in either large or small localized areas. In the localized areas, they affect food resources, nesting, sheltering, and water availability. In some cases, even large wildfires in the towhee's range, such as the 2020 Parrot Peak fire, may not directly affect riparian habitat in the burn area. However, in other cases, even small fires associated with recreation can burn through an entire riparian site, which can then take years to recover.

In towhee habitat, wildfires have been ignited by natural causes (e.g., lightning), military activities, recreation activities, or other human causes. While military activities at NAWS China Lake increase the risk of wildfire to towhee habitat, the 2014 INRMP's wildland fire management program is designed to reduce the effects of fire on threatened and endangered species, which partially alleviates this risk. On BLM land, human visitors are likely attracted to towhee habitat (desert riparian springs), which increases the risk of wildfire to towhee habitat from recreation activities or other human activities. Large fires and destructive floods in towhee habitat are currently infrequent, but they are likely to increase in the future with interacting threats such as drought, climate change, and invasive nonnative plants. Unlike small fires and floods, large-scale events are likely to have population level effects because towhee habitat is very limited and nesting success could be harmed for years after the event. Furthermore, impacts to habitat could become permanent since invasive nonnative plants can increase fire frequency and lead to ecosystem type conversion (i.e., shrubland to nonnative grassland). However, we do not know how the Inyo California towhee population will respond to type conversion of upland habitat to nonnative grassland.

In summary, we conclude that the magnitude of this threat is moderate because of fire's potential to affect a large proportion of towhee habitat at one time and cause long-term or permanent ecosystem changes. This threat is also concerning because of its likelihood to increase in magnitude in the future with increased drought and continued spread of nonnative invasive grasses.

Climate Change

We did not identify climate change as a potential threat to the Inyo California towhee in our 2008 5-year review. However, since that time, we have assessed new information about current and future projected climate change both in our 2013 12-month finding (Service 2013, pp. 65945–65946) and in this 5-year review. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 78). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature, precipitation) that persists for an extended period. We discuss climate change as a Factor A threat because it primarily threatens the towhee by impacting habitat. However, climate change is also a Factor E threat (other natural or manmade factors affecting the species' continued existence) when temperature or precipitation directly affects towhee survival or fecundity.

Climate change, specifically increasing temperatures and extended drought, has begun to impact towhee habitat (Factor A) and fecundity (Factor E). The quality of riparian vegetation and habitats is being negatively impacted by increasing temperatures and more frequent and intense droughts, along with associated changes in hydrologic regimes (Archer and Predick 2008, pp. 24–25; Perry *et al*. 2012, entire; Zhang *et al*. 2021, pp. 1, 8). In particular, the increasing magnitude, frequency, and duration of drought is directly affecting productivity of desert birds (Saracco *et al*. 2018, pp. 1778–1779) and is linked to nest failure in some species (Paxton *et al*. 2007, p. 4). Loss of riparian vegetation in towhee habitat leads to increased warming and desiccation of riparian understory, loss of suitable nesting sites, and greater likelihood that nests will succumb to predation and brown-headed cowbird brood parasitism (see section titled Brown-headed Cowbird Brood Parasitism under Factor C) because of reduced cover.

As discussed under Population Trend and Drivers, drought-related declines of the Inyo California towhee population are consistent with avian community patterns throughout the Mojave Desert. A 2018 study showed that Mojave Desert bird occupancy and site-level species richness both declined by about half over the past century (Iknayan and Beissinger 2018, p. 8599). Models demonstrated that climate change, particularly decline in rainfall, was the most important driver of avian declines; Mojave Desert sites that received less precipitation during recent decades had higher local extinction probabilities (Iknayan and Beissinger 2018, p. 8599).

In the following subsections, we assess how current, and potential future changes, in precipitation and temperature (including extended droughts) affect the Inyo California towhee and its habitat. First, we describe the effects of recent drought to Inyo California towhee habitat (see Recent Drought). Next, we compare historical climate to future projections of precipitation, temperature, and water balance (drought risk) under two climate change scenarios (see Climate Projections). Third, we describe the best available information on how towhees tolerate high temperatures and how they adapt to living in a hot desert climate (see Temperature Tolerance and Adaptation). This subsection elucidates how Inyo California towhees are reliant on habitat features (i.e., water and riparian vegetation) to withstand high temperatures. Finally, we briefly summarize the climate change information presented and apply it to our assessment of threat magnitude.

Recent Drought

Extended drought between 2011 and 2022 (Figure 7) has led to dieback of riparian vegetation and decreases in available water and food in Inyo California towhee habitat. In 2019, surface water was present at 31 of 75 (41 percent) of BLM and CDFW sites surveyed, whereas surface water was present at 35 of 73[6] (48 percent) sites in 2011 and 87 percent of all BLM and CDFW sites in 1998 (LaBerteaux 2011, p. 14; Atwell, LLC 2020, pp. i, 8–9). Access to surface water within or near breeding territories is a key component of core habitat for the Inyo California towhee (LaBerteaux 2014, p. 41). During dry years, annual and perennial plant production of flowers and fruit in towhee habitat has been notably low (Southern Sierra Research Station 2013, pp. 9, 15), reducing seed and invertebrate food sources. In the 2012 nesting study, two pairs of towhees were observed defending territories at Bircham Springs Picnic Area in early May but did not show any indications of food carrying to feed young later in the season (Southern Sierra Research Station 2013, p. 15). These observations of towhee behavior and habitat condition suggested to researchers that nest failure was highly probable and that drought conditions in the towhee's range likely contributed to widespread nest failure (Southern Sierra Research Station 2013, pp. 15, 29).

In 2019 at NAWS China Lake, dead riparian vegetation (Figure 12) was noted at 81 percent of sites, and the percentage of dead canopy ranged from 5 to 40 percent (LaBerteaux 2019, p. ES-1, 30). This prompted LaBerteaux (2019, p. ES-1, 30) to attribute the observed decrease in number of breeding pairs to this loss of core riparian habitat during the drought. Additionally, substantial dieback of willows and other riparian woody plant species was observed during 2019 surveys on BLM and CDFW lands (Atwell, LLC 2020, p. i). The period prior to the 2019 surveys comprised 8 consecutive years of below-average rainfall (Figure 7).

In contrast, following greater precipitation during the winter-spring seasons leading up to 2019 and 2020 surveys, McCreedy (2020, p. 12) noted that additional dieback of riparian vegetation did not occur between spring 2019 and spring 2020. Riparian vegetation appeared to have begun to recover but he thought it was still multiple wet years away from returning to pre-drought conditions (McCreedy 2020, p. 12).

After the wet period ending in April 2020, the Argus Mountains area again entered a multi-year period of below-average rainfall (Figure 7). During the spring 2021 surveys, dead riparian vegetation was noted at all 40 sites surveyed on NAWS China Lake and dead riparian canopy ranged from 5 to 20 percent (LaBerteaux 2021b, p. 31). LaBerteaux (2021b, p. 31) further observed that vegetation dieback was greater in plant species that were less drought tolerant. For example, red willow (*Salix laevigata*) appeared to be most vulnerable to dieback compared to arroyo willow and desert olive, the latter two being more drought tolerant (LaBerteaux 2021b, p. 31).

After an extremely dry winter (October to April) in 2020–2021 (0.43 inch (1.09 centimeters) of rainfall), riparian vegetation dieback worsened in 2022 compared to 2019 and 2020 (McCreedy 2022b, p. S-2). McCreedy (2022b, p. S-2) observed that the new willow mortality was typically

[6] Two sites that were not visited in 2011.

on riparian edges and in the highest-elevation portions of riparian habitat patches, suggesting that the water table had lowered below some of the riparian root systems (Kibler *et al*. 2021, pp. 5–6). While the proportion of survey sites with surface water in 2022 (53 percent) was similar to that in 2011, 2019, and 2020, the extent of surface water had decreased compared to 2019 and 2020 (McCreedy 2022b, p. S-2).

Climate Projections

To assess projected climate change in Inyo California towhee habitat, we used annual historical and future climate variables from AdaptWest (2021, dataset; Wang *et al*. 2016, entire) within the range of the subspecies to help assess change in climatic conditions relevant to the towhee over time. We assessed trends under two climate change scenarios, the Shared Socioeconomic Pathways (SSP), SSP2-4.5 and SSP5-8.5. Both scenarios were projected under an 8-GCM (General Circulation Model) ensemble from *ClimateNA*. We specifically assessed trends in seasonal and annual precipitation, seasonal average temperature, and maximum summer temperature under each climate change scenario. We also used two different complementary measures of water balance and drought risk: Hargreaves' climatic moisture index, and Hogg's climate moisture index.

For each metric, we summarized average values over three 20-year timeframes at each of 269 known locations[7] of Inyo California towhee. We defined these timeframes as historical (2002–2022), near term (2023–2042), and mid-century (2043–2062) to match the climate data scaling. The seasonal data available with *ClimateNA* define winter as December to February, spring as March to May, summer as June to August, and autumn as September to November. See Appendix B: Climate Projections for more details about methods.

Precipitation

Most precipitation occurs in the winter period in Inyo California towhee habitat (Figure 13; Table 12 and Table 13 in Appendix B: Climate Projections). Under both climate change scenarios, there is a projected decline in precipitation in the future from historical to near term, though the decline is more marked under the higher impact climate change scenario (SSP5-8.5). Under the lower impact climate change scenario (SSP2-4.5), there is a modest increase in autumn precipitation projected over time, which could offset declines in winter precipitation to some degree. Under the higher impact climate change scenario, there is a projected decline in spring and summer precipitation projected into the future.

Consequently, over the full annual period, there is little difference in total annual precipitation projected over the timeframes under the lower impact climate change scenario, and a decline in total annual precipitation projected over the timeframes under the higher impact climate change scenario, particularly by mid-century (Figure 14; Table 12 and Table 13 in Appendix B: Climate Projections). We further discuss the effects of precipitation in combination with the effects of other climate change characters in the Synthesis section below.

[7] Includes incidental observations.

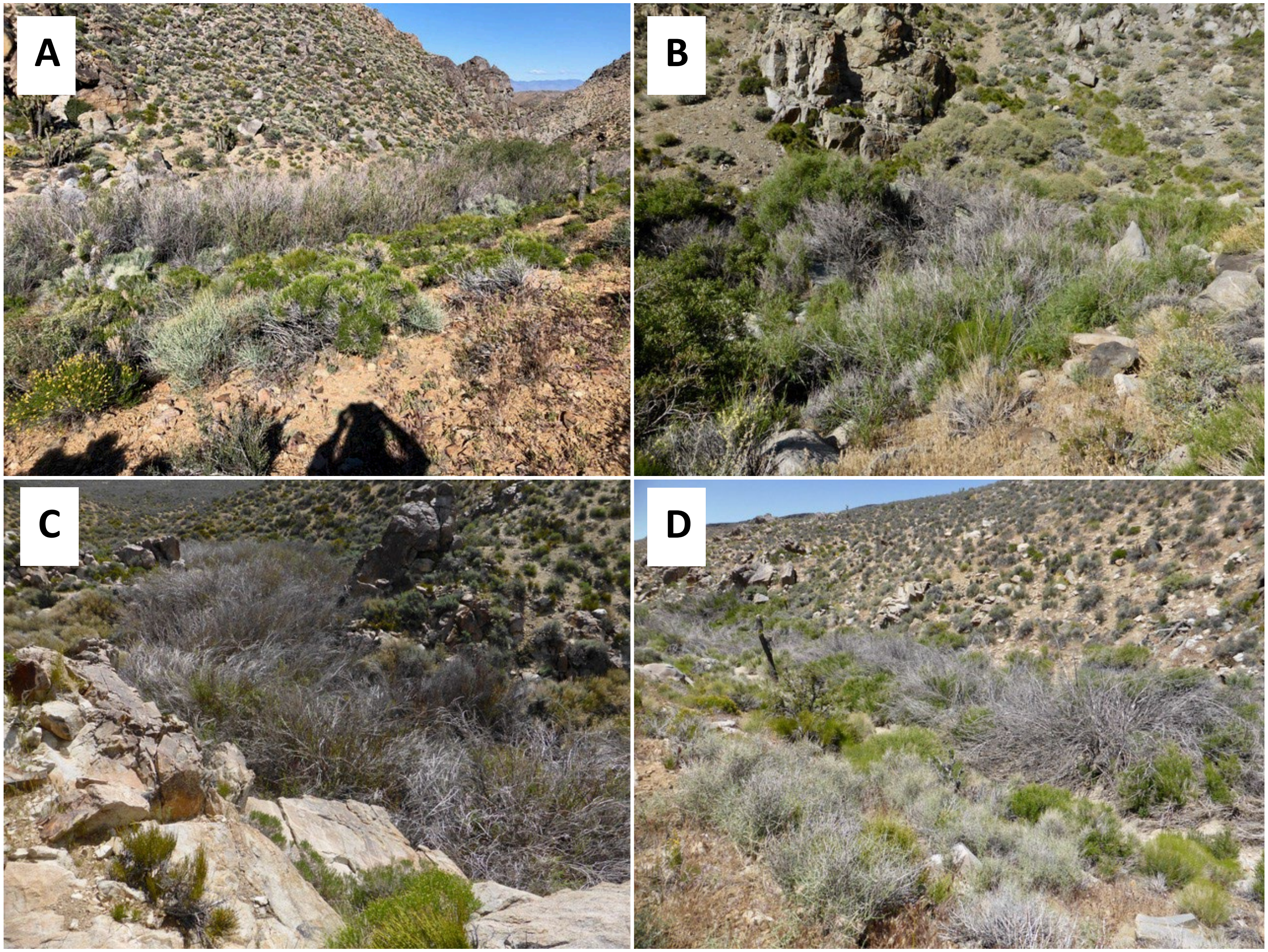

Figure 12. Photographs of dead willow (*Salix* sp.) canopy in riparian habitat patches taken during 2019 at (A) Yucca Spring Site 2 in May, (B) North Homewood Canyon Site 6 in June, (C) Moscow Springs Complex Site 6 in April, and (D) Moscow Springs Complex Site 3 in May.[8]

[8] Photographs taken by Denise LaBerteaux, EREMICO Biological Services, LLC, during NAWS China Lake towhee surveys.

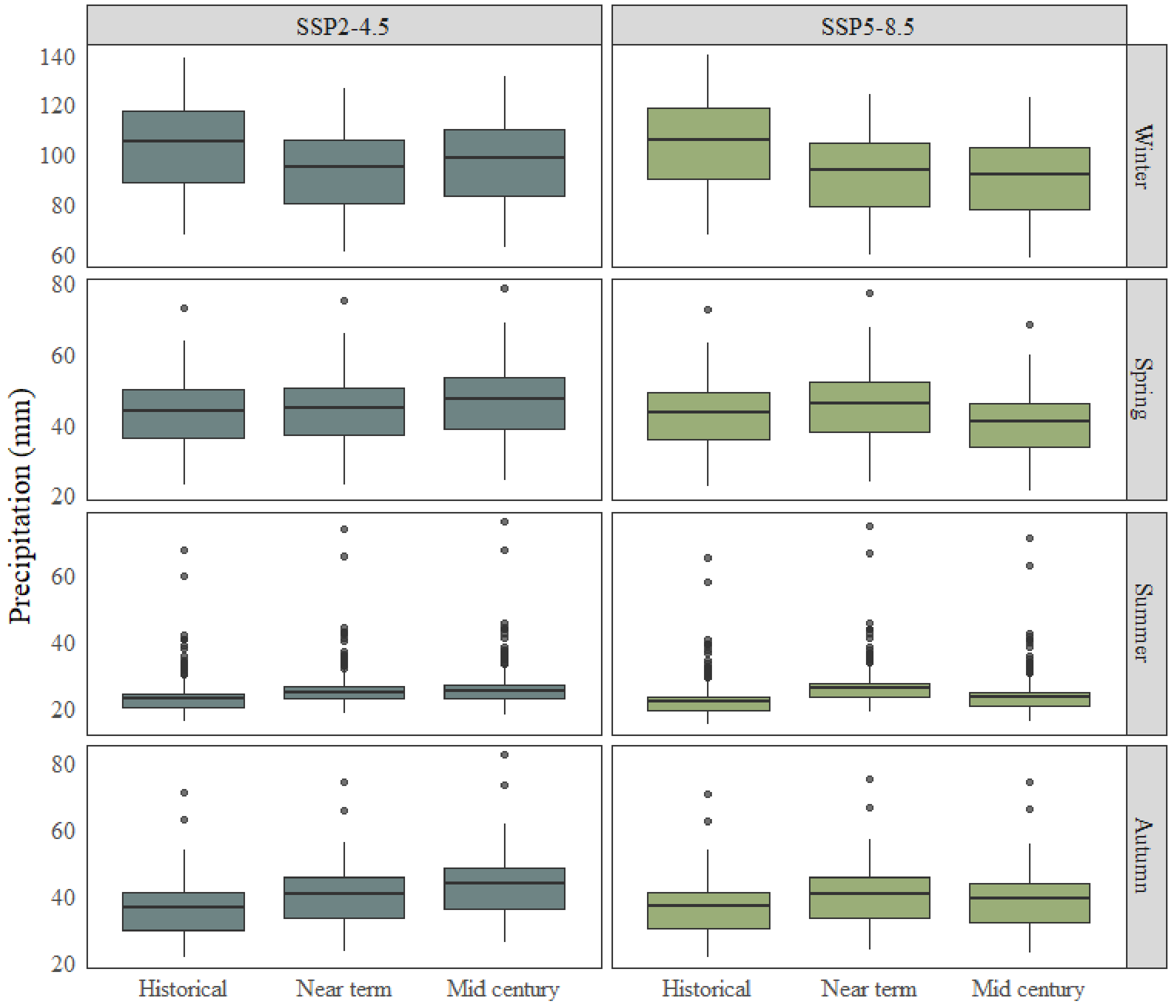

Figure 13. Seasonal precipitation projected at known locations of Inyo California towhee historically (2002–2022), and projected for the near term (2023–2042), and mid-century (2043–2062) under a lower impact climate change scenario (SSP2-4.5), and a higher impact climate change scenario (SSP5-8.5). Note differences in y-axis scale (mm of precipitation) across seasons.

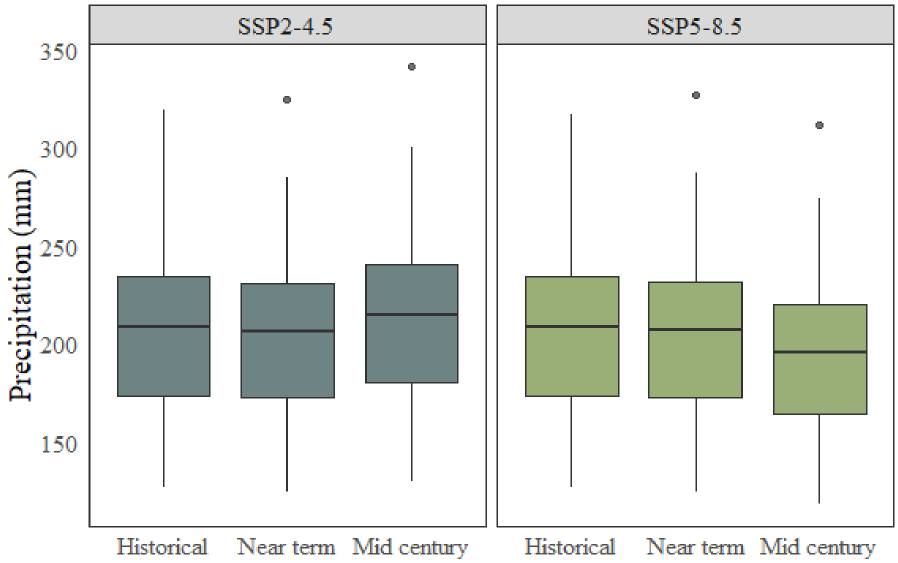

Figure 14. Total annual precipitation projected at known locations of Inyo California towhee historically (2002–2022), and projected for the near term (2023–2042), and mid-century (2043–2062) under the lower impact climate change scenario (SSP24.5).

Temperature

In areas where the Inyo California towhee occurs, average temperatures are projected to increase across all seasons into the future under both climate change scenarios (Figure 15; Table 6; Table 7), as are maximum temperatures (Figure 16; Table 8; Table 9). Overall, mean and maximum summer temperatures are projected to increase from 1 to 2 degrees Celsius (°C) across the towhee range by mid-century (Table 6; Table 7; Table 8; Table 9). We further discuss the effects temperature in combination with the effects of other climate change characters in the Synthesis section below.

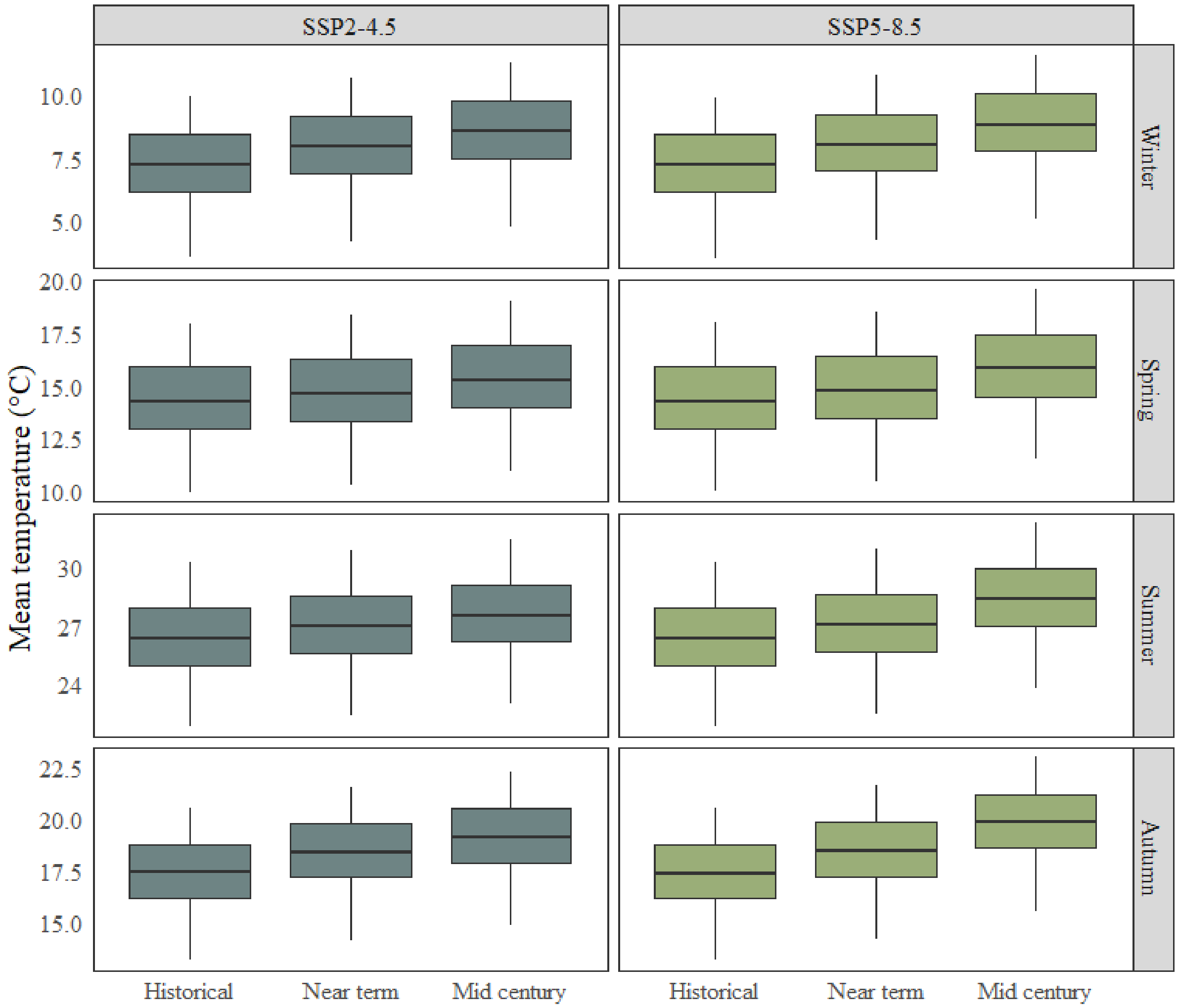

Figure 15. Mean seasonal temperature at known locations of Inyo California towhee historically (2002–2022), and projected for the near term (2023–2042), and mid-century (2043–2062) under a lower impact climate change scenario (SSP2-4.5), and a higher impact climate change scenario (SSP5-8.5). Note differences in y-axis scale (degrees Celsius) across seasons.

Table 6. Mean Temperature at Known Locations of Inyo California Towhee Historically (2002–2022), and Projected for the Near Term (2023–2042), and Mid-century (2043–2062) in Each Season Under the Lower Impact Climate Change Scenario (SSP2-4.5).[1]

Season	Period	Mean	Minimum	Maximum
Winter	Historical	7.3	3.6	10.0
Winter	Near term	8.1	4.2	10.7
Winter	Mid century	8.7	4.8	11.3
Spring	Historical	14.4	10.0	18.0
Spring	Near term	14.8	10.3	18.4
Spring	Mid century	15.5	10.9	19.0
Summer	Historical	26.5	21.9	30.2
Summer	Near term	27.1	22.4	30.8
Summer	Mid century	27.7	23.0	31.4
Autumn	Historical	17.5	13.2	20.5
Autumn	Near term	18.5	14.1	21.6
Autumn	Mid century	19.2	14.8	22.3

[1] The range in average temperature across sites is also shown as the "minimum" and "maximum." All measurements are in °C.

Table 7. Mean temperature at known locations of Inyo California towhee historically (2002–2022), and projected for the near term (2023–2042), and mid-century (2043–2062) in each season under the higher impact climate change scenario (SSP5-8.5).

Season	Period	Mean	Minimum	Maximum
Winter	Historical	7.3	3.5	9.9
Winter	Near term	8.1	4.3	10.8
Winter	Mid century	8.9	5.1	11.6
Spring	Historical	14.5	10.0	18.0
Spring	Near term	15.0	10.4	18.5
Spring	Mid century	16.0	11.5	19.6
Summer	Historical	26.5	21.9	30.2
Summer	Near term	27.2	22.5	30.9
Summer	Mid century	28.5	23.8	32.2
Autumn	Historical	17.5	13.2	20.5
Autumn	Near term	18.6	14.1	21.6
Autumn	Mid century	20.0	15.5	23.0

[1] The range in average temperature across sites is also shown as the “minimum” and “maximum.” All measurements are in °C.

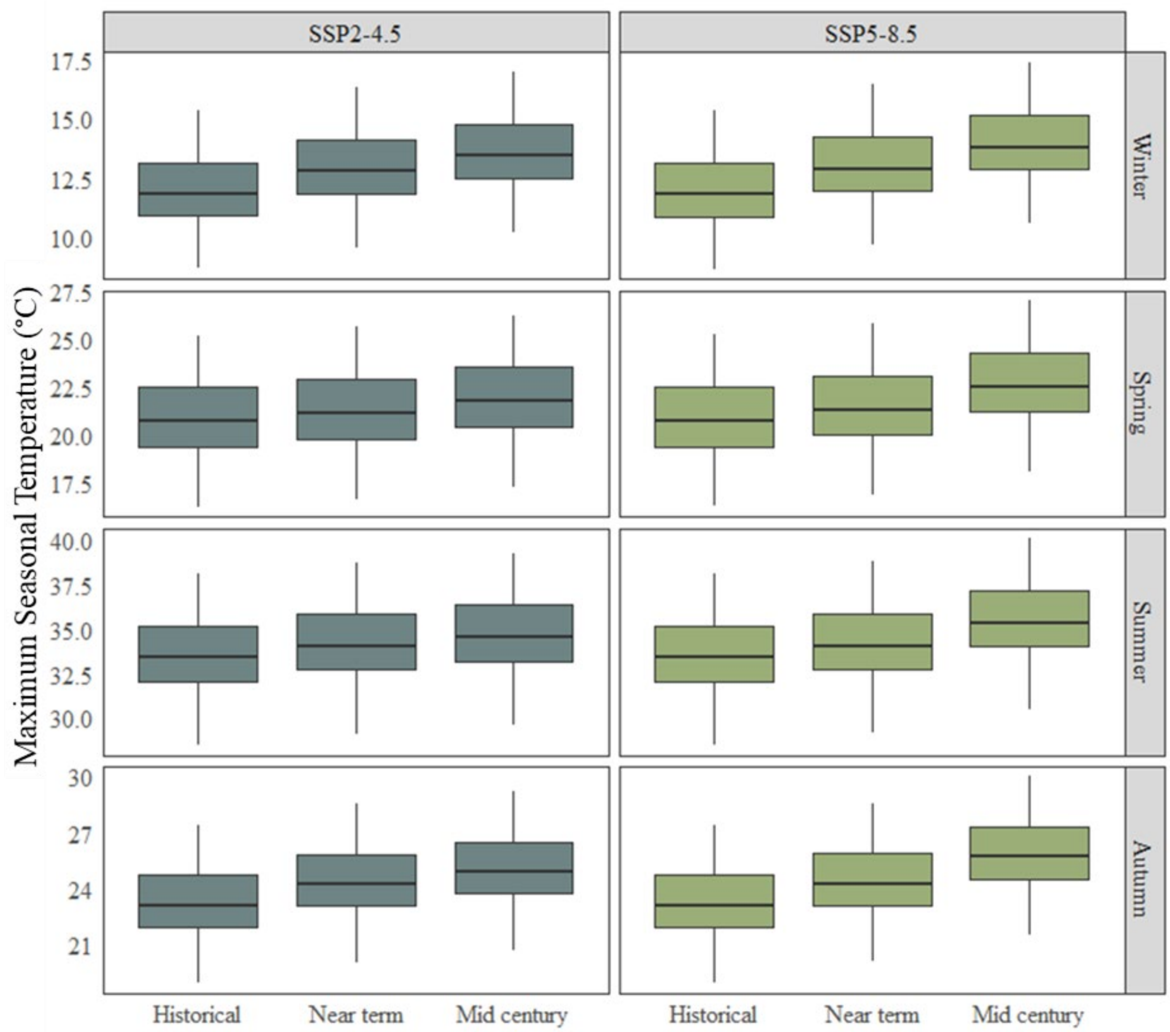

Figure 16. Maximum seasonal temperature at known locations of Inyo California towhee historically (2002–2022), and projected for the near term (2023–2042), and mid-century (2043–2062) under a lower impact climate change scenario (SSP2-4.5), and a higher impact climate change scenario (SSP5-8.5). Note differences in y-axis scale (°C) across seasons.

Table 8. Average maximum temperature at known locations of Inyo California towhee historically (2002–2022), and projected for the near term (2023–2042), and mid-century (2043–2062) in each season under the lower impact climate change scenario (SSP2-4.5).[1]

Season	Period	Mean	Minimum	Maximum
Winter	Historical	12.1	8.7	15.4
Winter	Near term	13.0	9.6	16.3
Winter	Mid century	13.6	10.2	17.0
Spring	Historical	20.9	16.2	25.2
Spring	Near term	21.4	16.6	25.6
Spring	Mid century	22.0	17.2	26.3
Summer	Historical	33.6	28.5	38.1
Summer	Near term	34.3	29.1	38.8
Summer	Mid century	34.8	29.6	39.2
Autumn	Historical	23.4	19.0	27.4
Autumn	Near term	24.5	20.0	28.5
Autumn	Mid century	25.1	20.7	29.2

[1] The range in maximum temperature across sites is also shown as the “minimum” and “maximum.” All measurements are in °C.

Table 9. Average maximum temperature at known locations of Inyo California towhee historically (2002–2022), and projected for the near term (2023–2042), and mid-century (2043–2062) in each season under the higher impact climate change scenario (SSP5-8.5).[1]

Season	Period	Mean	Minimum	Maximum
Winter	Historical	12.0	8.7	15.3
Winter	Near term	13.1	9.7	16.5
Winter	Mid century	14.0	10.6	17.4
Spring	Historical	20.9	16.2	25.2
Spring	Near term	21.5	16.8	25.8
Spring	Mid century	22.7	18.0	27.0
Summer	Historical	33.6	28.5	38.1
Summer	Near term	34.3	29.2	38.8
Summer	Mid century	35.6	30.5	40.1
Autumn	Historical	23.4	19.0	27.4
Autumn	Near term	24.5	20.1	28.6
Autumn	Mid century	25.9	21.5	30.0

[1] The range in maximum temperature across sites is also shown as the "minimum" and "maximum." All measurements are in °C.

Hargreaves' and Hogg's climatic moisture indices

Both measures of climate moisture index indicate increased drought risk in the future under both climate change scenarios. With the Hargreaves' climatic moisture index (CMD), higher values indicate a larger moisture deficit, and thus greater drought risk. Under both climate change scenarios, CMD is projected to decrease modestly into the future in the winter, and increase modestly into the future in all other seasons (Figure 17; Table 14 and Table 15 in Appendix B: Climate Projections). Thus, drought risk is projected to modestly increase in the future across all seasons except winter. With the Hogg's climatic moisture index (CMI), more negative values indicate drier climate conditions, and greater drought risk. Under both climate change scenarios, CMI is projected to become more negative into the future in all seasons, over both climate change scenarios (Figure 18; Table 16 and Table 17 in Appendix B: Climate Projections). Thus, drought risk is projected to increase in the future across all seasons. We further discuss the effects drought risk in combination with the effects of other climate change characters in the Synthesis section below.

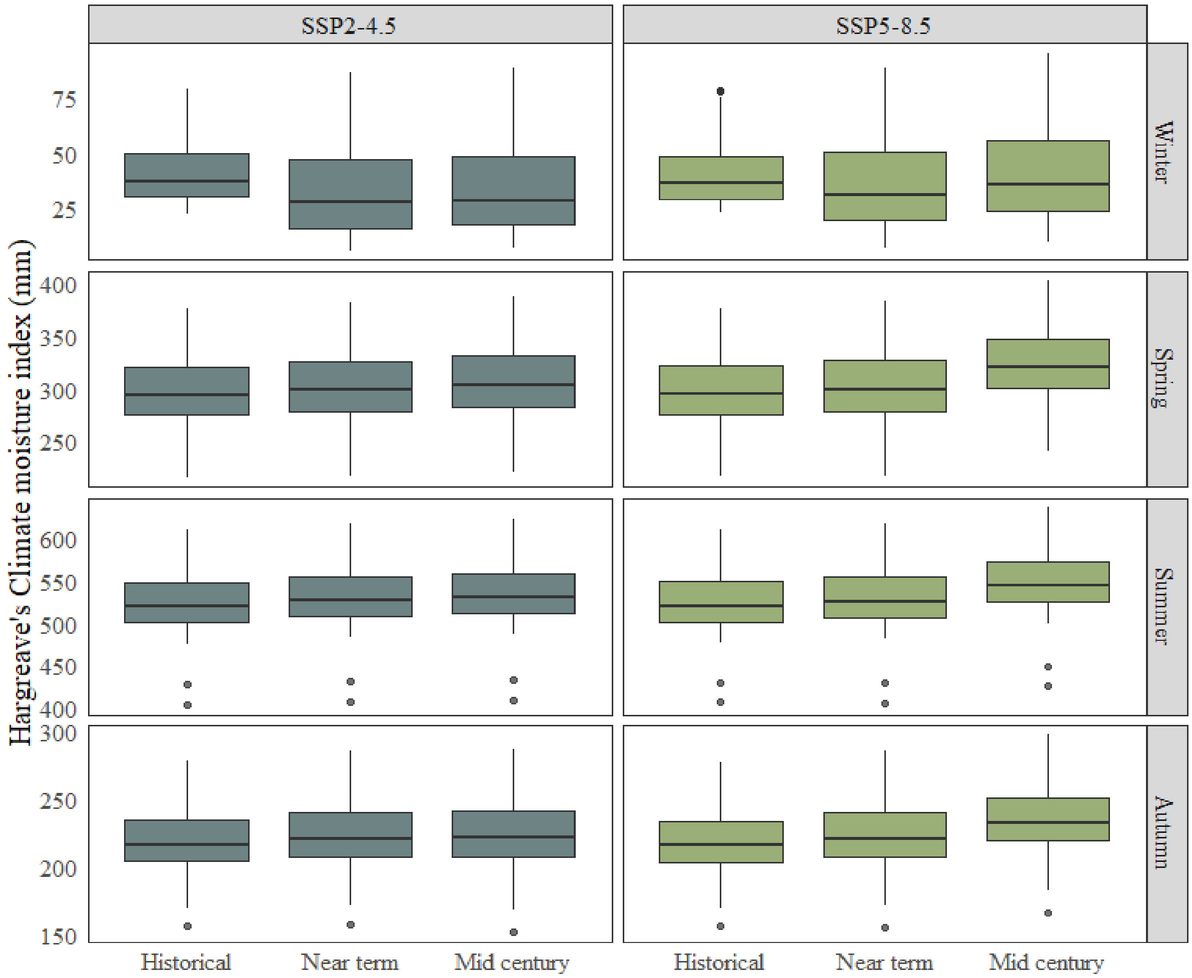

Figure 17. Hargreaves' climatic moisture index (CMD) at known locations of Inyo California towhee historically (2002–2022), and projected for the near term (2023–2042), and mid-century (2043–2062) under a lower impact climate change scenario (SSP2-4.5), and a higher impact climate change scenario (SSP5-8.5). Note differences in y-axis scale (mm CMD index) across seasons.

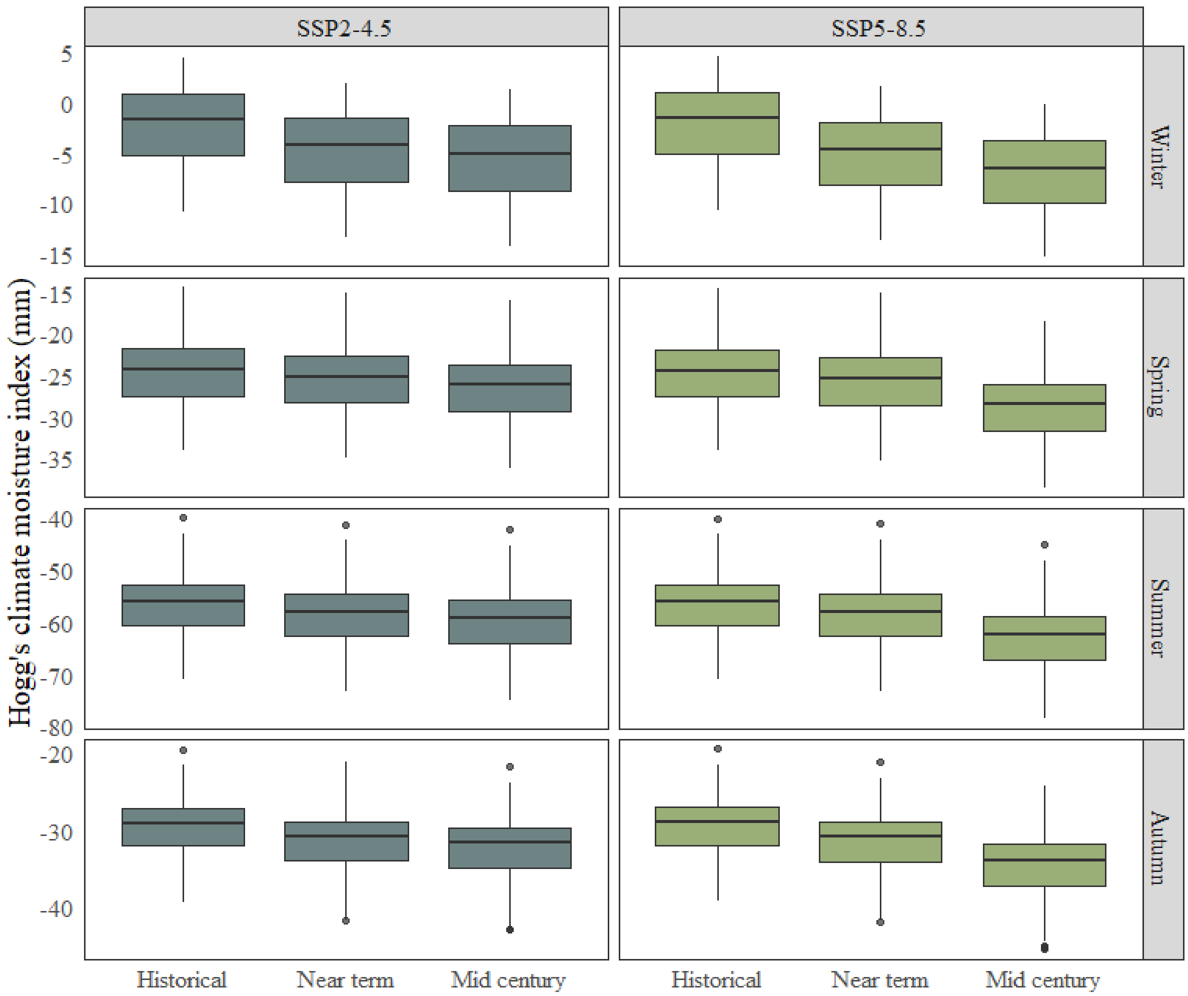

Figure 18. Hogg's climatic moisture index (CMI) at known locations of Inyo California towhee historically (2002–2022), and projected for the near term (2023–2042), and mid-century (2043–2062) under a lower impact climate change scenario (SSP2-4.5), and a higher impact climate change scenario (SSP5-8.5). Note differences in y-axis scale (mm CMI index) across seasons.

Synthesis of climate projections

In Inyo California towhee habitat, seasonal and/or annual precipitation and temperatures are projected to change. Under both the lower and higher climate change scenarios, most precipitation will continue to fall during the winter season but average winter precipitation is projected to be slightly lower in the future (0.24–0.51 inch (6–13 mm) lower; Table 12 and Table 13 in Appendix B: Climate Projections). While total annual precipitation may decrease, increase, or remain the same (depending upon the scenario and the future time period), decreases in average winter precipitation alone could negatively affect the towhee. This is because avian productivity is often linked to precipitation that falls during the months leading up to the breeding season (Rotenberry and Wiens 1991, pp. 1325–1327; McCreedy and van Riper 2015, pp. 241–246).

Summer temperatures are projected to increase from 1.8 to 3.6 °F (1 to 2 °C) across the towhee's range by mid-century (Table 6; Table 7; Table 8; Table 9). High temperatures increase drought stress to vegetation and animals. Increasing summer temperatures in the desert southwest impact bird communities through direct physiological mechanisms such as dehydration and increased cooling costs (Smith *et al*. 2017, entire; Albright *et al*. 2017, entire; Riddell *et al*. 2019, entire). High temperatures affect passerine birds by changing daily activities and by increasing metabolic rates and evaporative water loss through panting (Smith *et al*. 2017, entire; Albright *et al*. 2017, pp. 2283–2284). Particularly in Australia, heat waves have precipitated large mortality events of hundreds or thousands of birds when temperatures exceeded 113 °F (45 °C) for several days or reached 117 °F (47 °C) or greater on a single day (McKechnie *et al*. 2012b, pp. i–ii). Based on climate change projections, birds are anticipated to experience reduced survival during extreme heat waves and more frequent large mortality events in hot desert regions (McKechnie and Wolf 2010, entire; McKechnie *et al*. 2012a, entire).

Climate moisture indices, which are influenced by projected changes in temperature and precipitation and by biophysical processes (evapotranspiration through soil, water bodies, and plant respiration), indicate increased drought risk in the future and decreased moisture across all seasons in towhee habitat (see section titled Hargreaves' and Hogg's climatic moisture indices). The projected increase in drought is especially concerning because of the response of the Inyo California towhee population and habitat to recent drought (see Recent Drought above) and the reliance of towhees on water and riparian habitat to shelter from high temperatures (Dawson 1954, pp. 107, 110–111) (see Temperature Tolerance and Adaptation below). Several years of extended drought between 2012 and 2022 coincided with estimated population declines of approximately 40 to 50 percent (Figure 5, Figure 6). During 2019 and 2021 surveys, dead riparian canopy was observed at 80 to 100 percent of sites and dieback ranged from 5 to 40 percent of the canopy (LaBerteaux 2019, p. ES-1, 30; LaBerteaux 2021b, p. 31). Riparian vegetation dieback continued to worsen in 2022 and the amount of surface water available at springs continued to decrease (McCreedy 2022b, p. S-2).

Temperature Tolerance and Adaptation

As a year-round resident of the Mojave Desert, the Inyo California towhee is expected to have some natural adaptation to high desert heat (Miller 1963, entire). However, studies suggest that towhees from desert areas are not among the most adapted birds to high temperatures. A thermoregulation study of desert birds found that a species related to the California towhee, the Abert's towhee (*Pipilo aberti*), has a relatively low heat tolerance limit (118.4 °F (48 °C)) and upper critical temperature (98.1 °F (36.7 °C)) compared to the other desert birds tested, especially columbiforms and caprimulgiforms (Smith *et al*. 2017, pp. 3290–3295). Based on all of the study's results, Smith *et al*. (2017, p. 3299) concluded that "passerines are less heat tolerant than other orders of birds…[because of] the high metabolic costs of panting…making them susceptible to lethal dehydration." These results are comparable to an earlier study that compared temperature regulation and heat tolerance between birds from a population of Abert's towhees from a hot desert region in Imperial County, California, to birds from a population of California towhees (then, called brown towhees) from a cooler region in Los Angeles County, California (Dawson 1954, entire). In a series of controlled experiments, lethal body temperature for both species was 116.4 °F (46.9 °C) and metabolic rates increased sharply at air temperatures greater than 95 °F (35 °C) for the Abert's towhees or greater than 93 °F (34 °C) for the California towhees (Dawson 1954, pp. 102–104). Overall, the Abert's towhees tolerated heat slightly better than the California towhees, which were adapted to a cooler environment in the wild (Dawson 1954, pp. 112–113). Dawson (1954, p. 113) also concluded that heat tolerance of Abert's towhees was "strikingly limited for a bird which regularly encounters severe heat," especially when compared to other passerines that do not experience intense heat in nature.

Desert passerines, such as the Abert's towhee (and by extension, the desert-dwelling Inyo California towhee), are believed to survive hot climates with three behavioral adaptations. During the hottest parts of summer days, desert towhees shelter in cool shaded microclimates created by dense vegetation associated with rivers or other water sources, become inactive, and drink and bathe in water (Dawson 1954, pp. 107, 110–111). All three of these mechanisms (i.e., use of cool microhabitats, inactivity, and water use) are likely required for the continued survival of the Inyo California towhee.

First, cool microhabitats are essential for towhees to survive during hot weather because prolonged exposure to solar radiation during the summer would likely be fatal (Dawson 1954, pp. 110–113). Summer daytime high temperatures frequently exceed 100 °F (38 °C) and sometimes surpass 115 °F (46 °C) at the weather station nearest to the Inyo California towhee's range (Trona, California) (Lawrimore *et al*. 2016, dataset). Dense riparian vegetation provides shade and cooler microclimate temperatures that are used as refuge by Inyo California towhees during the hottest parts of summer days.

Inactivity, as well as taking shelter in cool microhabitats, is important because activity increases metabolism and heat, which then needs to be dissipated. In general, passerines dissipate less than half of their total heat production through evaporative cooling at temperatures above 96 °F (36 °C) (Dawson 1954, p. 118). Thus, any additional heat created by activity would further raise body temperature and increase heat stress. This held true during Dawson's temperature experiments; the body temperatures of towhees that acted "restless" when exposed to air temperatures above 102 °F (39 °C) rose higher and more quickly than body temperatures of towhees that remained inactive (Dawson 1954, pp. 94–95). From both hot conditions and high-activity levels associated with captivity stress, a total of four Abert's towhees died after capture even though two of the birds were kept in the shade and were provided food and water (Dawson 1954, p. 112).

Finally, access to water is important for towhee survival during high heat. Water-associated riparian areas are a primary habitat feature for both the desert-residing population of Abert's towhee and the Inyo California towhee (Dawson 1954, p. 82; LaBerteaux 1994, p. 6), suggesting that these towhees would not survive in hot arid climates without access to water. Towhees use water in their habitats for both drinking and bathing (Dawson 1954, p. 111; LaBerteaux 1994, p. 11); Abert's towhees have also been observed bathing during the heat of the day (Dawson 1954, p. 111), suggesting use of open water for cooling body temperature. When Dawson (1954, pp. 91–92) withheld water at air temperatures of 102 °F (39 °C) for 24 hours, half of the California towhee test subjects died from dehydration before their body temperatures rose to lethal levels.

Summary

In summary, changes in patterns of temperature, precipitation, and drought associated with climate change affect Inyo California towhee food resources, reproduction, sheltering site availability and quality, water availability, and survival. Climate change is a rangewide threat but sites are impacted to different degrees because of elevation, hydrology, distribution of interacting threats, and patchiness of precipitation. Dieback of riparian vegetation and shrinking surface water at spring sites are evidence of the current impacts of recent long-term drought on towhee habitat. If drought continues, or if there are not enough wet years for habitat and the towhee population to recover between droughts, then the population would likely decline. In addition to reduced habitat quality, the increasing incidence of extreme heat may stress the physiology of towhees, causing reductions in survival and productivity, alongside habitat quality. Other threats such as feral equines and fire also interact synergistically with the effects of climate change, exacerbating the impacts of each threat. We consider the current magnitude of the threat of climate change to be high because of recent population-level impacts and because temperatures and drought risk are projected to continue increasing in towhee habitat in the future.

Recreational Activities

Recreation (hiking, camping, hunting, and off-highway vehicle use) may result in loss and degradation of habitat through crushing by vehicles; trampling by hikers, hunters, and campers; soil compaction; cutting for firewood; and wildfire ignition. Impacts from recreational activities tend to be localized and habitat tends to recover once protection or deterrents are in place. Recreational activities may also affect towhee behavior, survival, and/or breeding productivity, but these effects are discussed under Factor E (see section titled Disturbance from Vehicles and Recreators).

Recreational impacts mainly occur on BLM and CDFW lands (approximately 35 percent of the subspecies range), which are open to the public. Most survey sites have had little to no human-caused impacts (of all sites surveyed in 1998, 52 percent had no impacts and 18 percent had "low" impacts), likely due to remoteness of the sites and lack of access (LaBerteaux and Garlinger 1998, pp. 65–78). The majority of towhee habitat occurs on NAWS China Lake and is closed to most public uses. However, evidence of recreation has been observed in towhee habitat on the installation and vehicular traffic along the paved road in Mountain Springs Canyon may be impacting towhees (LaBerteaux 2014, pp. 29, 42) (see section titled Disturbance from Vehicles and Recreators).

Depending on the year and the sites that are surveyed, reports of impacts to towhee habitat from recreation have varied from negligible to locally severe. In 1998, severe human-caused impacts on BLM and CDFW lands were reported at four sites, mainly from heavy off-highway vehicle use and camping activities (LaBerteaux and Garlinger 1998, pp. 65, 71, 72, 74). In 2004, human-caused impacts on BLM and CDFW lands were mostly low to negligible (93 percent of sites), and no springs were considered to be severely affected (LaBerteaux 2004, pp. 42–46, 47). Based on 2011 habitat surveys, recreational impacts had improved at the four sites that were severely impacted in 1998 (LaBerteaux 2011, pp. 51, 53–54), likely because three of the four springs had been fenced to exclude feral equines and recreational users. During the 2011 surveys, increased off-highway vehicle activities were also observed in Wilson Canyon (east slope of Argus), in Indian Joe Canyon, near North Ruth Springs (Homewood Canyon), at C.C. Jones Springs (Shepherd Canyon Area), in Rattlesnake Canyon, and in Water Canyon (LaBerteaux 2011, appendix C; LaBerteaux 2013, pers. comm., p. 4). However, off-highway vehicle impacts were considered minimal when observed in 2011 (LaBerteaux 2011, appendix C).

In October 2013, LaBerteaux (2013, pers. comm., p. 4) described that camping and off-highway vehicle activity in Great Falls Basin had increased greatly since 2011 and was greater than she had ever encountered. While severity of impacts to habitat were still minimal, LaBerteaux (2013, pers. comm., p. 4) concluded that the towhee's range was being visited more frequently than any time in the past. In contrast, Atwell, LLC (2020, p. 12) found that the level of recreation impacts on BLM and CDFW lands in 2019 was similar to that in 2011.

Recreational activities are likely to continue within the range of the towhee and could exacerbate other threats such as the spread of nonnative plants and wildfire. As discussed in the Fires and Floods sections, human use of BLM lands (likely recreators) caused at least one, if not two small fires that severely burned towhee riparian habitat in Great Falls Basin and Homewood Canyon (Atwell, LLC 2020, p. 9). Beyond these two small fires, current levels of recreation are not known to be having a major impact on the towhee. However, as pointed out by LaBerteaux (2013, pers. comm., p. 4), much of the subspecies' range has not been surveyed recently (Figure 3).

In summary, we conclude that the magnitude of this threat is low because it only affects a portion of the Inyo California towhee's range intermittently and does not appear to cause population-level declines.

Invasive Nonnative Plants

Encroachment of nonnative plant species is a potential threat to towhee habitat that was identified subsequent to listing (LaBerteaux 2008, pp. 66, 71; Service 2008, pp. 10, 12–13). Changes in plant communities caused by nonnative plants and recurrent fire can negatively affect the Inyo California towhee by altering habitat structure and the species available as food plants. The spread of nonnative species (or the displacement of native species) is often facilitated by other threats to towhee habitat such as off-highway vehicle activity, other recreational activities, roads, feral equines, and wildfire. Disturbed areas, such as those caused by feral equines or wildfire, allow for establishment of nonnative species including salt cedar (*Tamarix* spp.) and athel (*Tamarix aphylla*) (collectively referred to as tamarisk) and nonnative annual grasses.

<u>Tamarisk</u>

Tamarisk continues to occur in towhee habitat, but the available information suggests that the population is static and tamarisk removals have mitigated spread of the species following fire and flooding. On NAWS China Lake, the proportion of sites with tamarisk increased from 2 percent in 1998 (LaBerteaux and Garlinger 1998, pp. 66–79) to 6 percent in 2007 (LaBerteaux 2008, pp. 56–63). Subsequently, personnel at NAWS China Lake removed tamarisk from several areas (Service 2010, p. 7). Through the INRMP, NAWS China Lake operates a weed control program that addresses tamarisk invasion in towhee habitat (U.S. Navy 2014, p. 4.26).

The proportion of sites with tamarisk on BLM and CDFW lands increased from 4 percent in 1998 (LaBerteaux and Garlinger 1998, pp. 66–79) to 8 percent in 2004 (LaBerteaux 2004, pp. 42–46). However, the BLM removed the tamarisk from several sites, and, as of 2011, the proportion of sites with tamarisk was reduced to 5 percent (LaBerteaux 2011, pp. 51–56, 65–66). As of 2020, tamarisk presence on BLM and CDFW lands had not changed since 2011. The 2020 surveyor noted that each of the tamarisk individuals reported in 2011 were still present and no new individuals were found (McCreedy 2020, p. 12).

Annual Grasses

As described above in the Fires and Floods section, the prevalence of nonnative annual grasses such as red brome and cheatgrass has increased over time, especially in burned areas (LaBerteaux 2006, pp. 9, 13; Southern Sierra Research Station 2011b, p. 14; Arnold 2023, pers. comm.). During 2014 towhee surveys of 26 sites on NAWS China Lake, cheatgrass and red brome made up less than 10 percent of the total annual cover at most sites (LaBerteaux 2014, p. 26). However, these types of plants dominate the annual flora in burned areas (LaBerteaux 2013, pers. comm., p. 4). Cheatgrass has become a particular problem in burned areas on NAWS China Lake (Arnold 2023, pers. comm.).

While nonnative annual grasses do not directly change the structure of towhee breeding habitat, they are a threat to the towhee because of increased risk and spread of wildfire, which can lead to habitat type conversion in addition to other impacts (see Fires and Floods section). These invasive annual species increase the likelihood of future wildfire and shorten wildfire return intervals (Keeley and Fotheringham 2003, p. 244; Keeley *et al*. 2005, entire; BLM and NPS 2018, p. 36). Increases in nonnative annual grasses following wildfire create a positive feedback loop where both nonnative grasses and wildfire increase. Red brome and cheatgrass can also outcompete native annual plants that provide food and nesting material for towhees. However, there is no evidence that these nonnative grasses are inhibitory to towhees; in fact, *Bromus* species are used by towhees for both food and nesting material (LaBerteaux 1989, pp. 32, 69). While foraging, Inyo California towhees favor open ground, typically dominated by sand and rocks, where views are unobstructed to potential ground predators (LaBerteaux 1989, p. 76). Therefore, as grass density increases, towhees might become more exposed to predation or available foraging habitat might decrease as towhees begin to avoid dense grassy areas. These potential direct impacts of invasive nonnative grasses (outside of wildfire) to towhees and their habitats are uncertain.

Summary

There are two primary types of invasive nonnative plants that are threats to Inyo California towhee habitat, tamarisk and annual grasses. Tamarisk, which appears to spread following disturbances such as fires and floods, has the potential to overtake stands of riparian vegetation. Nonnative annual grasses are linked to increased wildfire risk and potential ecosystem type conversion (as discussed in the Fires and Floods sections), which are concerns for the future of Inyo California towhee viability. However, tamarisk spread has thus far been controlled by land managers and we do not know if either tamarisk or nonnative annual grasses affect towhee needs directly. Therefore, we conclude that the magnitude of invasive nonnative plants is either uncertain or low because the threat of wildfire is considered separately (see Fires and Floods section above).

Cannabis Cultivation

Unauthorized cannabis cultivation can be harmful to Inyo California towhee habitat (Factor A) or to towhee health and survival (Factor E). Unauthorized cultivation on public lands is of high concern because it occurs within towhee habitat and illegally diverts substantial proportions of surface water for the crop's intensive water needs (Bauer *et al*. 2015, pp. 1–2); and applies lethal, controlled, or banned pesticides (CROP Project 2019, p. unpaginated). Estimates of water demand for cannabis cultivation, even in water-rich regions of California, could exceed available surface water during the dry season (Bauer *et al*. 2015, p. 17). Furthermore, upland habitat is cleared of native vegetation for planting cannabis and riparian vegetation around water sources can also be removed or damaged while setting up and maintaining irrigation (LaBerteaux 2013, pers. comm., p. 5; LaBerteaux 2019, p. 41). Unauthorized cannabis cultivation also may increase the risk of wildfire. Operation of grow sites typically necessitate that one or more growers camp close by and tend to cannabis plants. The presence of campers in towhee habitat increases the risk of wildfire ignition.

In 2013, Denise LaBerteaux described an unauthorized cannabis growing operation had recently been discovered in the towhee's range (LaBerteaux 2013, pers. comm., p. 5). Water was being diverted from a drainage to irrigate cannabis plants in upland habitat (LaBerteaux 2013, pers. comm., p. 5). In 2019, LaBerteaux described that there were potential impacts (at unknown levels) from unauthorized cannabis operations on BLM lands in the Water Canyon area and possibly on both NAWS China Lake and BLM lands in Shepherd Canyon (LaBerteaux 2019, p. 41). LaBerteaux (2019, p. 41) did not specify the precise area of unauthorized cultivation, nor how many cultivation sites had been found. Due to safety concerns with this operation, the northern portions of BLM towhee habitat (from Water Canyon northward) have not been assessed since 2011 (McCreedy 2020, p. i; McCreedy 2022b, p. S-3, table 3). Additionally, Bruce Canyon (BLM land) was not surveyed in 2019 due to potential unauthorized cannabis operations (McCreedy 2022b, table 3).

Evidence of additional unauthorized cannabis cultivation areas was discovered in the southern part of the towhee's range by Chris McCreedy in 2021 and 2022 (McCreedy 2022a, unpubl. data). In 2021 and 2022, McCreedy (2022a, unpubl. data) observed garbage and irrigation pipes at the site 3 spring in Homewood Canyon on NAWS China Lake land. While uncertain if caused by unauthorized cultivation operations, McCreedy (2022a, unpubl. data) also noted potential evidence of diversion at another nearby spring and areas within drainages that seemed strangely devoid of vegetation.

In 2022, among some of the Great Falls Basin survey sites in Great Falls Basin Wilderness Study Area (BLM land), McCreedy (2022b, p. 11; 2022a, unpubl. data) discovered a cultivation site that was drawing water from Orchard Spring and fresh pipes extended southward toward what he assumed would be one or more additional cultivation sites. The site at Orchard Spring, McCreedy noted, had recently been cleared of shrubs and a grid of black plastic irrigation pipes had been installed (McCreedy 2022b, p. 11). An emptied bucket of herbicide or rodenticide was also found hidden under a shrub at the edge of the plot (McCreedy 2022b, p. 11).

Due to safety, McCreedy (2022b, pp. 11, S-3; 2022a, unpubl. data) did not visit Great Falls Basin site 6 or site 14, but he expressed concern about site 6 because "it is one of the best riparian areas within Great Falls Basin, with flowing water that is almost like a creek, with large willow patches but also meadow-like areas that would be much easier to clear [for growing cannabis]" (McCreedy 2022a, unpubl. data). McCreedy (2022b, p. S-3) also expressed concern about the overall effects to the Inyo California towhee because the Great Falls Basin supports a high concentration of habitat patches and supports a large proportion of the total towhee population.

The unauthorized cannabis operations have been reported to the BLM, but we have no knowledge of steps taken to address the issues. Because of safety, impacts to the towhee population or habitat from unauthorized cannabis cultivation have not been assessed. Therefore, we conclude that the magnitude of the threat of unauthorized cannabis cultivation is uncertain; however, the magnitude of the threat is not likely to be high because the threat currently only impacts localized areas in the towhee's range.

Water Diversion

Water diversion can negatively impact towhee habitat, and thus impact towhee survival and breeding success. Water diversion can reduce the amount of surface water available, which affects insect abundance and diversity, microenvironment temperature, and availability of drinking water for towhees. Water diversion can also impact subsurface water, which is needed to maintain riparian vegetation in towhee habitat.

Authorized

Water rights have been appropriated on most springs situated on BLM-administered lands for activities such as livestock grazing and mining (Service 1987, p. 28782). In 1998, water diversion was occurring at 6 (2.3 percent) of the 258 sites[9] surveyed in the Argus Range (LaBerteaux and Garlinger 1998, pp. 79, 91). The number of authorized water diversions at towhee-occupied sites has since decreased to just 3 sites. The water diversions occurring at the two sites on BLM land are for small, domestic use, for which the landowners have legal water rights (Ellis 2012b, pers. comm.), while excess water from the other site is diverted by NAWS China Lake to ponds downslope (Campbell 2012, pers. comm.). The NAWS China Lake may also occasionally use spring water for certain activities such as dust abatement during construction or maintenance activities. However, the NAWS China Lake INRMP specifies that protection and enhancement of surface and groundwater resources are a major focus for natural resource management (U.S. Navy 2014, p. 2.23, J.10; appendix M).

Water diversion to support renewable energy projects has been proposed as a potential future risk to towhee habitat in the eastern Argus range (LaBerteaux 2011, p. 67). The Searles Valley, near

[9] The 258 sites include some survey sites where towhees have never been detected; therefore, this total is larger than that presented in Figure 4.

the range of the towhee, has been proposed as a potential solar development site and is designated as a Development Focus Area (i.e., area where renewable energy generation is an allowable use, incentivized, and could be streamlined for approval) in the Desert Renewable Energy Conservation Plan (BLM 2016b, p. 56). During a tour conducted for concerned non-governmental organizations, a representative of the solar industry expressed an intention to pursue purchasing water from residents in some of the canyons in the eastern Argus range (Kerncrest Audubon Society 2013, pers. comm.). However, the Desert Renewable Energy Conservation Plan prohibits "projects that are likely to affect ground-water resources in a manner that would result in substantial loss of riparian or wetland communities or habitat for riparian or aquatic Focus and BLM Special Status Species" (BLM 2016a, p. 98), which applies to the Inyo California towhee as a BLM Special Status Species. In addition, conservation and management actions in the Desert Renewable Energy Conservation Plan further protect groundwater resources in the area the plan covers (BLM 2016a, pp. 140–147).

While there is some potential for authorized water diversion to increase in the future if renewable energy development occurs, the magnitude of the threat would be low because of the protections afforded to groundwater resources on BLM land in the Desert Renewable Energy Conservation Plan.

Unauthorized

Since our previous assessment of the subspecies, unauthorized water diversion associated with unauthorized cannabis cultivation has emerged as a threat (see section Cannabis Cultivation above). Due to safety issues, the amount or impacts of water diversion from towhee habitat has not been assessed. While the limited amount of legal water diversion is unlikely to be a significant threat to the towhee, unrestricted water diversion for unauthorized purposes could cause long-term damage to riparian habitat and could increase (with development of new sites) without land managers being aware of a problem. We are not assessing the magnitude of the threat of unauthorized water diversion because it is considered part of the threat of cannabis cultivation (see section titled Cannabis Cultivation above).

Mining

Mining was considered a threat at the time of listing but is no longer occurring within the subspecies' range. Mining operations usually require the use of water, and at the time of listing, numerous mining claims on BLM land occurred within the range of the towhee and were often associated with springs (Service 1987, p. 28782). Since our 2008 5-year status review, the one mine that remained within the Argus Mountains has been closed, and all mining claims have been relinquished (Ellis 2013b, pers. comm.). Mining was eliminated entirely from the NAWS China Lake in 1943 (Service 1987, p. 28781). Because there are no longer any mines or mining claims in Inyo California towhee habitat, we conclude that mining and associated activities, such as water diversion for the purpose of mining, are not a current threat to the Inyo California towhee.

Summary of Factor A

The primary Factor A threats currently impacting towhee habitat are feral equines and the changes in precipitation and temperature (including extended droughts) related to climate change. Fires and floods also pose a considerable risk to towhee habitat. However, the likelihoods of fire and flood events impacting a large proportion of towhee habitat at one time or of them leading to ecosystem type conversion are uncertain. Recreational activities and invasive nonnative plants may be affecting towhee habitat at a low level or in small, localized areas; but we do not have information that suggests these threats are significantly contributing to the status of the towhee. However, recreation and nonnative plants increase the risk of wildfire and thus, should be monitored and managed in and around towhee habitat. Unauthorized cannabis cultivation has emerged as a threat to towhee habitat. This threat could significantly affect towhee habitat and increase wildfire ignition risk in localized areas where the threat occurs. Two of the threats identified at listing, authorized water diversion and mining, are no longer significant threats to the towhee.

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

Overutilization for commercial, recreational, scientific, or educational uses was not considered a threat when the Inyo California towhee was listed (Service 1987, p. 28782). The best available information does not indicate such threats exist at the present time; therefore, we conclude that overutilization is not a threat to the towhee.

FACTOR C: Disease or Predation

At listing, disease or predation were not considered a threat to the Inyo California towhee (Service 1987, p. 28782). However, brood parasitism and predation are potential threats to the towhee, especially when towhee population abundance is low.

Brown-headed Cowbird Brood Parasitism

Brown-headed cowbirds (*Molothrus ater*) may be a threat to the Inyo California towhee because of brood parasitism, which can affect nesting success. Brood parasitism of Inyo California towhee nests by brown-headed cowbirds has been observed (LaBerteaux 1989, pp. 46–48). In a 1985–1986 study, two towhee nests were parasitized by brown-headed cowbirds, with one nest resulting in failure and the other being successful because the cowbird egg did not hatch (LaBerteaux 1989, pp. 46–48, 87). The rate of parasitism on towhee nests was estimated at 2.6 percent (2 out of 78 nests found between 1985 and 2011) (LaBerteaux 2013, pers. comm.). However, during 2019 and 2020 surveys on BLM and CDFW lands, no brown-headed cowbirds were observed (McCreedy 2020, p. 11). In all, cowbirds do not appear to be common in Inyo California towhee breeding areas (Table 10).

Moreover, the Inyo California towhee may be less affected by cowbird brood parasitism than other songbird species that migrate long distances to breeding grounds. Towhees, which are year-round residents, begin nesting earlier than migratory species and their first clutch generally hatches prior to the arrival of brown-headed cowbirds in their breeding habitat (Finch 1983, pp. 355, 357; LaBerteaux 1989, p. 86). Therefore, if first nesting attempts are successful, brood parasitism would only be able to affect a smaller subset of overall annual fecundity.

The overall effect of brood parasitism on the Inyo California towhee is likely very low. The parasitism rate is probably low because brown-headed cowbirds also target other bird species' nests and cowbird abundance in towhee habitat is low.

Table 10. Frequency of Brown-headed Cowbird Sightings Reported During Inyo California Towhee Surveys, 1998–2022.

Year	Number of cowbirds observed during towhee surveys	Notes and source of information
1998	Unknown	Cowbirds were observed at "several" sites during the rangewide census (LaBerteaux and Garlinger 1998, p. 62).
2011	3	Cowbirds (1 female and 2 males) were seen at 1 of 93 sites (LaBerteaux 2011, p. 13).
2012	2	A male and female cowbird were seen at the Bircham Springs Picnic Area site during four of five visits; it was unknown if Inyo California towhee nesting was affected (Southern Sierra Research Station 2013, pp. 19–20, appendix B).
2014	2	A male and female cowbird were seen at Mountain Springs Canyon site 15 very near to an Inyo California towhee nest; it was unknown if the towhee nest was parasitized (LaBerteaux 2014, p. 29).
2015	1	A male cowbird was seen at 1 of 11 sites; parasitism rates were not measured in 2015 (LaBerteaux 2015d, p. 29).
2019	3	Three cowbirds were seen at 2 of 32 sites; parasitism rates could not be determined since no towhee nests were observed (LaBerteaux 2019, p. 24).
2021	3 or more	Cowbirds were observed at 3 of 20 sites surveyed by LaBerteaux (2021b, p. 24). Since no towhee nests were observed during surveys, parasitism rates could not be determined (LaBerteaux 2021b, p. 24).

Predation

Predation can occur on towhees at any life stage (egg through adult) but is primarily a concern for eggs and nestlings. Potential predators include raptors, common raven (*Corvus corax*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), badger (*Taxidea taxus*), gray fox (*Urocyon cinereoargenteus*), skunks, ground squirrels, and a variety of snake species (LaBerteaux 1994, p. 11).

Snake predation of nestlings may be common during some years. McCreedy (2022b, pp. 10–11) observed only one snake (northern desert nightsnake (*Hypsiglena chlorophaea*)) in towhee habitat during three consecutive years (2019–2021). During 2022 surveys, however, McCreedy (2022b, pp. 10–11) observed four snake predators in towhee habitat, including at least two nestling predation events. On April 19, a gopher snake (*Pituophis catenifer*) was discovered inside a towhee nest in Homewood Canyon; the snake had apparently just eaten the nestlings based on the empty nest and the towhee parents actively scolding the snake with food (for the nestlings) in their beaks (McCreedy 2022b, p. 10). On April 24, a California king snake (*Lampropeltis californiae*) was found eating a 6-day-old towhee nestling in the Great Falls Basin (McCreedy 2022b, pp. 10–11). The remaining two snake observations that year were also of gopher snakes, including one found within 5 meters (16.4 feet) of a towhee nest (McCreedy 2022b, pp. 10–11). LaBerteaux (1994, p. 12) also observed a gopher snake preying on a nest containing two nestlings.

Common ravens are another potential predator of Inyo California towhee eggs and nestlings and are increasingly seen in towhee habitat. In 2011 LaBerteaux (2011, p. 14) documented common ravens at 39 sites (42 percent) surveyed on BLM and CDFW lands, which was an increase from 13 sites in 2004. Although common ravens have not been observed preying on towhee eggs or nestlings, they have at least once been observed preying on eggs and nestlings of other desert bird species that occur in the area (LaBerteaux and Garlinger 1998, pp. 62, 64).

Summary of Factor C

While brood parasitism and nest predation occur, affecting some individuals, they do not appear to be occurring at levels sufficient to cause population-level effects (i.e., population declines, extirpation from a site, reduced nesting range, etc.). However, brood parasitism and nest predation could be limiting factors to towhee population recovery during years when towhee abundances are low. Therefore, we conclude that the magnitude of Factor C threats is low.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

In addition to the Act, other regulatory mechanisms help to reduce or minimize impacts to the Inyo California towhee. These include the protective provisions of the following: the California Endangered Species Act of 1984 (CESA; California Fish and Game Code, section 2080 et seq.), the California Ecological Reserve Act of 1968 (California Code of Regulations, Title 14, Section 630), the Migratory Bird Treaty Act of 1918 (MBTA; 16 U.S.C. 703–711; 40 Stat. 755), the Sikes Act (16 U.S.C. 670), the Federal Land Policy and Management Act of 1976 (FLPMA; 43 U.S.C. 1701 et seq.), the Wilderness Act of 1964 (16 U.S.C. 1131–1136, 78 Stat. 890), and the National Environmental Policy Act of 1970 (NEPA; 42 U.S.C. 4321 et seq.).

California Endangered Species Act

The Inyo California towhee is listed as endangered under the California Endangered Species Act (CESA). CESA prohibits unpermitted possession, purchase, sale, or take of listed species. However, the CESA definition of take does not include harm, which under the Federal Act can include destruction of habitat that actually kills or injures wildlife by significantly impairing essential behavioral patterns (50 CFR 17.3). CESA requires State agencies to consult with CDFW on activities that may affect a State-listed species and mitigate for any adverse impacts to the species. The provisions of CESA protections would apply only on State or private lands, which make up about 5 percent of the subspecies' range while the remainder of the range is on Federal land where other regulatory mechanisms apply (see below).

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) affords certain regulatory protections to all native migratory bird species, including the prohibition of take, capture, killing, or possession of migratory birds, their eggs, parts, and nests. The MBTA does not protect habitat except where activities would directly kill or injure birds (such as felling a tree with an active nest) and does not provide regulatory procedures for permitting incidental take. Executive Order 13186 (January 10, 2001) was issued to address the responsibilities of Federal agencies to protect migratory birds. This Executive Order directs Federal agencies whose actions have a measurable negative impact on migratory bird populations to develop Memoranda of Understanding (MOU) with the Service to promote the conservation of migratory birds. For example, under the July 31, 2006, MOU between the Service and the Department of Defense, migratory birds will receive certain benefits on military lands by incorporation of migratory bird conservation into their INRMP, including developing and implementing monitoring programs. The MOU also provides for habitat protection on Department of Defense installations, with specific attention to riparian habitats, fire and fuels management, and invasive species management. Like INRMPs, the MOU is subject to budgetary limits; however, it provides an added level of recognition to the importance of conserving migratory birds and their habitats that are not listed under the Act. The protections of the MBTA and the requirements of the MOU will continue if the Inyo California towhee is delisted.

Sikes Act

The continued conservation of the Inyo California towhee on the NAWS China Lake lands will also be enhanced by the provisions of the Sikes Act. The Sikes Act authorizes the Secretary of Defense to develop cooperative plans with the Secretaries of Agriculture and the Interior for natural resources on public lands. The Sikes Act Improvement Act of 1997 requires Department of Defense installations to prepare INRMPs that provide for the conservation and rehabilitation of natural resources on military lands consistent with the use of military installations to ensure the readiness of the Armed Forces. INRMPs incorporate, to the maximum extent practicable, ecosystem management principles and provide the landscape necessary to sustain military land uses. INRMPs are updated every 5 years, and each version must be approved by the Service for compliance with the Sikes Act. While INRMPs are not technically a regulatory mechanism because their implementation is subject to funding availability, they are an added conservation tool for improving and maintaining wildlife populations and habitat on military lands.

The Navy owns approximately 65 percent of the range of the Inyo California towhee. The NAWS China Lake developed an INRMP that clearly defines objectives and guidelines to aid in the recovery of the Inyo California towhee (U.S. Navy 2014, p. 4.17, 4.19-4.20). Specifically, the INRMP's objectives for the Inyo California towhee are to ensure the long-term population viability; continue to resolve baseline, biological data gaps, and continue habitat enhancement efforts; and support recovery plan efforts to establish stable towhee populations or eventual delisting (U.S. Navy 2014, p. 1.21). Guidelines for the Inyo California towhee include such actions as: conduct rangewide surveys for towhees, fence springs to prevent negative impacts by horses and burros, continue to reduce horse and burro populations to designated management levels, maintain adjacent upland habitat for towhee foraging and nesting, fund and support research efforts to support towhees, survey potential habitat and riparian habitat that has not been previously surveyed for towhees, and coordinate with BLM and CDFW to manage habitat (U.S. Navy 2014, p. 4.42). Additionally, the INRMP for NAWS China Lake has an ecosystem approach that includes conservation of water resources, control of exotic tamarisk, and other activities that benefit the towhee and its habitat (U.S. Navy 2014, p. 4.1-4.43). Through implementation of the INRMP, NAWS China Lake has made significant contributions to conservation of the Inyo California towhee.

Another supportive effort stemming from the Sikes Act is the species action plan for the Inyo California towhee under the Recovery and Sustainment Partnership Initiative (RASP) (approved by the Department of Defense and the Service during 2022). The RASP is an initiative between the Department of Defense and the Department of Interior to develop and promote effective ecosystem and species conservation and recovery initiatives that will reduce or eliminate the need for Federal protection and regulation under the federal Endangered Species Act and provide for increased flexibility for military mission activities. The species action plan for the towhee identifies actions to promote the recovery of the towhee and outlines a schedule to complete the following objectives: update and renew an interagency cooperative management agreement to continue on-going, long-term conservation efforts for the benefit of the Inyo California towhee; increase the implementation of management actions to address threats to the species and its habitat; increase research and monitoring to assess the species status and threats; and secure long-term funding for management, monitoring, and research needs.

Federal Land Policy and Management Act of 1976

The Federal Land Policy and Management Act of 1976 (FLPMA) is the primary Federal law governing most land uses on BLM land, which constitutes about 26 percent of the range of the Inyo California towhee. FLPMA established a public land policy for the BLM; it provides for the management, protection, development, and enhancement of the BLM lands. FLPMA directs the development and implementation of resource management plans (RMPs), which direct management at a local level, and requires public notice and participation in the formulation of such plans and programs for the management of BLM lands. RMPs authorize and establish allowable resource uses, resource condition goals and objectives to be attained, program constraints, general management practices and sequences, intervals and standards for monitoring and evaluating RMPs to determine effectiveness, and the need for amendment or revision (43 CFR 1601.05(n)).

Through FLPMA in 1976, Congress designated 25 million acres as the California Desert Conservation Area (CDCA) (Sec 601 (c)), of which approximately half (12 million ac) is BLM property and includes the entire range of the Inyo California towhee. Congress noted the fragility of the California desert ecosystem that is "easily scarred and slow to heal; the historical, scenic, archeological, environmental, biological, cultural, scientific, educational, recreational, and economic resources in the California desert; and that certain rare and endangered species of wildlife, plants, and fishes, and numerous archeological and historic sites, are seriously threatened by air pollution, inadequate Federal management authority, and pressures of increased use, particularly recreational use, which are certain to intensify because of the rapidly growing population of southern California."

Congress charged the BLM with developing and implementing an RMP for the CDCA that provides for the immediate and future protection and administration of the public lands in the California desert within the framework of a program of multiple-use and sustained yield, and the maintenance of environmental quality. The BLM developed the CDCA Plan (BLM 1980, entire), as amended, which includes conservation goals and management actions for the ongoing protection of the Inyo California towhee (BLM 1980, table 2). Later land use plan amendments to the CDCA Plan, including the 2006 West Mojave Plan (BLM 2006, entire) and 2016 Desert Renewable Energy Conservation Plan (BLM 2016a, entire), further support conservation of the Inyo California towhee and its habitat. The West Mojave Plan amendment approved standards for rangeland health and uniform management for grazing, protection of riparian areas, fragile soils, and water quality (BLM 2006, p. 16). The Desert Renewable Energy Conservation Plan includes the goal of promoting ecological processes that "sustain vegetation types and focus BLM Special Status Species and their habitats" (BLM 2016a, p. 71). The health standards and goals in these land use plan amendments also address riparian/wetland and stream habitats to ensure maintenance of hydrologic conditions (BLM 2016a, pp. 132–134).

Further, the BLM designated Areas of Critical Environmental Concern (ACEC) as a tool to meet goals of the Wildlife Element of the CDCA Plan. The FLPMA defined ACECs as "areas within the public lands where special management attention is required ... to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources or other natural systems or processes, or to protect life and safety from natural hazards" (Sec. 103(a)). The CDCA Plan states that management prescriptions for ACECs for identified wildlife resources will include aggressive management actions to halt and reverse declining trends and to ensure the long-term maintenance of wildlife resources (BLM 1999, p. 29). Recognizing the significance of the Inyo California towhee, the BLM established the Great Falls Basin Wilderness Study Area ACEC (currently 10,300 ac, most of which overlaps designated wilderness), primarily to benefit the Inyo California towhee, with the goals of protecting and enhancing the towhee's habitat and protecting scenic resources (BLM 1987, pp. 4, 9; BLM 2016c, pp. 32–34). In the development and revision of land-use plans, the BLM is to "give priority to the designation and protection of areas of critical environmental concern" (Sec. 202(c)(3)). Management actions for the Great Falls Basin Wilderness Study Area aim to "protect riparian vegetation which is critical towhee habitat" and "protect Inyo California towhee by ensuring habitat is in a stable or improving condition" (BLM 2016c, pp. 32–34).

Through CDCA Plan amendments, the BLM has also set forth that the removal and adoption program for feral burros and horses should continue towards attainment of management goals within the range of the Inyo California towhee (BLM 2016c, p. 59). Management goals for the Centennial Herd Area (included the Argus Mountains) are zero burros and no more than 168 horses (BLM 2021c, pp. 10, 17). In 2021, the BLM completed an environmental assessment for a wild burro gather plan to implement burro removal over a 10-year period (2021–2031) from the Centennial Herd Area (and adjacent Panamint, and Slate Range Herd Areas) (BLM 2021c, entire). The BLM plans to continue their habitat improvement program, including enhancing towhee habitat by excluding burros at Peach Spring and continuing removal of all burros from the Argus Mountains (BLM 2021c, p. 10).

Wilderness Act of 1964

In 1964, Congress enacted the Wilderness Act with the intent of establishing a National Wilderness Preservation System composed of federally owned wilderness areas to be protected in their natural condition for the use and enjoyment of the people of the United States. As originally enacted, the Wilderness Act directed only the Secretary of Agriculture to identify areas suitable for wilderness in the National Forests. In FLPMA, Congress directed the Secretary of the Interior to identify areas suitable for wilderness on BLM lands. The 65,000-ac Argus Range Wilderness Area owned by BLM was designated in 1994 and includes a portion of the Inyo California towhee's range.

Biological resources in designated wilderness areas are afforded the highest level of protection due to restriction on uses. The general management goals that apply to wilderness areas require that the BLM provide for and manage wilderness areas for long-term protection and preservation of wilderness, scenic, cultural, and natural characteristics for recreational, scientific, and educational purposes. To maintain the primeval character and provide for solitude, a variety of activities are prohibited by the Wilderness Act within designated wilderness areas. Some of the activities not allowed in wilderness areas include building roads and structures, commercial activities, use of motorized vehicles or equipment (including off-highway vehicles), and landing of aircraft.

State of California's Ecological Reserve Act of 1968

In 1994, the State of California purchased Indian Joe Canyon, which was the only parcel of Inyo California towhee critical habitat under private ownership (Service 1998, p. 14). The area around Indian Joe Springs includes about 5 percent of the range of the Inyo California towhee. Under the State of California's Ecological Reserve Act of 1968, CDFW designated the acquired land as the Indian Joe Springs Ecological Reserve to protect the towhee and its habitat. Ecological Reserves are managed under the California Code of Regulations (CCR), Title 14, Section 630. The purpose of ecological reserves is "to provide protection for rare, threatened or endangered native plants, wildlife, aquatic organism and specialized terrestrial or aquatic habitat types." (14 CCR 630). Under 14 CCR 630(a)(1), it is prohibited in any Ecological Reserve to "take or disturb any bird or nest, or eggs thereof, or any plant, mammal, fish, mollusk, crustacean, amphibian, reptile, or any other form of plant or animal life." Therefore, this Ecological Reserve is to be managed consistent with the needs of the towhee, including restriction of activities that negatively impact the towhee or its habitat.

National Environmental Policy Act of 1970

All Federal agencies are required to adhere to the National Environmental Policy Act of 1970 (NEPA; 42 U.S.C. 4321 et seq.) for projects they fund, authorize, or carry out. The Council on Environmental Quality's regulations for implementing NEPA (40 CFR parts 1500–1518) state that agencies shall include a discussion on the environmental impacts of the various project alternatives (including the proposed action), any adverse environmental effects that cannot be avoided, and any irreversible or irretrievable commitments of resources involved (40 CFR 1502). NEPA does not itself regulate activities that might affect the Inyo California towhee, but it does require full evaluation and disclosure of information regarding the effects of contemplated Federal actions on sensitive species and their habitats. Although Federal agencies may include conservation measures for Inyo California towhee as a result of the NEPA process, any such measures are typically voluntary in nature and are not required by the statute.

Summary of Factor D

The inadequacy of existing regulatory mechanisms was not indicated as a threat to the Inyo California towhee at listing. Because more than 99 percent of the range of the towhee is under Federal or State ownership, existing regulatory mechanisms, including various laws, regulations, and policies administered by the U.S. Government and CDFW, aid in abating known threats and provide ongoing management and protective mechanisms for the subspecies and its habitat. Primary laws that provide some benefit for the subspecies and its habitat include the CESA, MBTA, Sikes Act, FLPMA, Wilderness Act, California's Ecological Reserve Act, and NEPA. While most of these laws, regulations, and policies are not specifically directed toward protection of towhee, they mandate consideration, management, and protection of resources that benefit towhees. Additionally, these laws contribute to and provide mechanisms for agency planning and implementation directed specifically toward management of towhees and their habitat. Therefore, the inadequacy of existing regulatory mechanisms is not a threat to Inyo California towhee now or in the future.

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

At listing, no other natural or manmade factors affecting the subspecies' continued existence were known (Service 1987, p. 28782). Below, we discuss potential threats of inbreeding depression and disturbance from vehicles and recreators. Some Factor A threats also have Factor E threats associated with them. At the end of this section, we summarize all Factor E threats, including those threats discussed under Factor A.

Inbreeding Depression

A recent study that measured genetic health of California towhees found that the Inyo California towhee subspecies exhibited the highest levels of inbreeding (Black *et al*. 2023, pp. 9, 15) (see section on Genetics and Population Structure). The Inyo California towhee showed signs of both ancestral and contemporary (recent) inbreeding, the recent of which, the authors noted, is consistent with the population size reduction that led to the listing of Inyo California towhee under the Endangered Species Act (Black *et al*. 2023, pp. 9, 12, 15). Since listing, the Inyo

California towhee population size increased and then decreased again during the past decade. This pattern of decreasing population size to few individuals, especially on multiple occasions, decreases the subspecies' adaptive capacity and increases the risk of developing inbreeding depression.

In summary, we conclude that the magnitude of this threat is uncertain. While inbreeding depression could have population-level impacts, there is no available evidence to suggest that the Inyo California towhee is currently experiencing inbreeding depression. Looking into the future, if the towhee population continues to decrease, or experiences decreases to few individuals in the future, then the risk of inbreeding depression would increase.

Disturbance from Vehicles and Recreators

Frequent disturbances in or near towhee breeding habitat by vehicles or recreators could have negative effects on Inyo California towhee survival, occupancy, and fecundity. Of particular concern is frequent vehicle traffic along a paved road in Mountain Springs Canyon on NAWS China Lake (LaBerteaux 2014, pp. 29, 42). In 2014, LaBerteaux (2014, pp. 29–30) measured the frequency of traffic on the road across 7 days and it ranged from 2.36 to 7.64 vehicles per hour, typically exceeding the speed limit. LaBerteaux (2014, p. 42) suggested that collisions with vehicles on this road may kill some towhees and the road noise could affect towhee behavior or nesting; she also suggested that the greater drop in abundance observed in the Mountain Springs Canyon area during 2014 surveys may have been associated with these road impacts (LaBerteaux 2014, p. 42). Similar to the effects of traffic noise, the physical presence of human recreators during the nesting season may also affect towhee behavior, survival, and/or breeding productivity. While the threat of disturbance (or mortality) from vehicles and recreators could be affecting individual towhees in localized areas, this threat is not likely contributing to population-level declines. Therefore, we conclude that disturbance from vehicles and recreators is a low-magnitude threat.

Summary of Factor E

Factor E includes other natural or manmade factors affecting the Inyo California towhee's continued existence. Potential Factor E threats discussed in this section are inbreeding depression and disturbance from vehicles and recreators (partially discussed under Factor A in section titled Recreational Activities). While not known to be currently affecting the towhee population, inbreeding depression is a potential future threat to population health and adaptive capacity. The threat of disturbance (or mortality) from vehicles and recreators could be affecting towhees in localized areas but are not likely contributing to population-level declines.

Some of the threats described under Factor A may also be categorized under Factor E because they can affect towhee survival or reproduction directly, in addition to affecting towhee habitat. Threats that directly affect both habitat (Factor A) and individuals (Factor E) include fires and floods (discussed under Factor A in section titled Fires and Floods), climate change (discussed under Factor A in section titled Climate Change), and cannabis cultivation (discussed under Factor A in section titled Cannabis Cultivation). While these threats primarily affect towhees by impacting habitat, they can intermittently decrease towhee survival or productivity. For example, a fire, while burning habitat, can also burn nests with eggs or young in them. Extreme heat associated with climate change can decrease survival and productivity because of the consequences of heat stress. Cannabis cultivation could impact nests during vegetation clearing or expose individuals to lethal concentrations of chemicals. See threat descriptions under Factor A for more details about effects to both habitat and individuals.

In sum, the Inyo California towhee is exposed to multiple Factor E threats but direct impacts to towhee survival or productivity have not been measured or quantified. Since listing, changes in towhee population size have been linked to visible changes in habitat quality, particularly from feral equine disturbance and riparian dieback associated with drought. Therefore, we conclude that threats associated with Factor A (present or threatened destruction, modification, or curtailment of habitat or range) are the most serious concern for the Inyo California towhee.

IV. RECOVERY CRITERIA

Pursuant to section 4(f) of the Act, recovery plans are developed to provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed species (including subspecies), and on criteria that may be used to determine when recovery goals are achieved. Recovery plans are required to contain objective, measurable criteria, which, when met, would result in a determination that the species be downlisted or delisted. Conservation (i.e., recovery) is defined in section 3 of the Act as the "use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary." In accordance with section 4(a)(1) of the Act, we determine if any species is an endangered or threatened species because of any of the five threat factors identified in the Act and evaluated in this 5-year review. Therefore, we revise the listed status of a species based on the outcome of an analysis of these five factors.

Although recovery plans are not regulatory documents, they provide a guide on how to achieve recovery based on information available at the time the recovery plan is finalized. Recovery criteria describe measurable projected outcomes or an estimated species response to a reduction or removal of the threats to a species as described in a five-factor analysis. However, reduction or removal of threats may occur without meeting all recovery criteria contained in a recovery plan, as there are many paths to accomplishing recovery of a species and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded, while other criteria may not have been accomplished. In other cases, recovery opportunities may have been recognized that were not known at the time the recovery plan was finalized. Likewise, we may learn information about the species or threats that was not known at the time the recovery plan was finalized. Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may or may not fully follow the guidance provided in a recovery plan.

Consistent with section 4 of the Act, determinations whether any federally listed species should be: (i) removed from the list; (ii) changed in status from endangered to threatened; or (iii) changed in status from threatened to endangered, will be made in accordance with an analysis of the five factors. Therefore, although we expect at the time a recovery plan is published that recovery criteria will be met, the actual determination of appropriate listing status is not based solely on whether recovery criteria have been met. Rather, progress towards fulfilling recovery criteria serves to indicate the extent to which threats have been reduced or eliminated. In absence of meeting recovery plan criteria, the Service may judge in some cases that overall, the threats have been reduced sufficiently and the species is sufficiently robust to either reclassify the species from endangered to threatened, or delist the species.

Summary of the Recovery Criteria

The Recovery Plan for the Inyo California towhee (Recovery Plan) (Service 1998, entire) included criteria for delisting the subspecies. The Recovery Plan described, in part, the need for the establishment of a population of at least 400 individuals for a 5-year period (Service 1998, pp. iii, 14). This population goal, based on the best available information, was estimated based on the estimated carrying capacity of the towhee's habitat and represented a reproductively self-sustaining population (Service 1998, p. 14). In addition, the delisting criteria stated that threats to the subspecies' habitat must be reduced and managed, and degraded habitat must be restored and maintained (Service 1998, p. iii). Therefore, the recovery criteria for the Inyo California towhee includes (1) a criterion for population size and (2) a criterion for reduction or management of threats to habitat.

Leading up to the 2013 proposed delisting rule, efforts by the BLM and NAWS China Lake contributed to improved management for the subspecies. Their efforts to protect, improve, and expand the towhee's riparian habitat corresponded with nearly a fourfold increase in towhee abundance since listing. Furthermore, in 2010, the BLM and NAWS China Lake committed through a cooperative management agreement with the Service to continue working together to manage the threat of feral equines as funding allows (Service 2010, pp. 5–7). At listing, in 1987, the towhee population was estimated to have been fewer than 200 individuals (Service 1987, p. 28780). However, with increased management, results of subsequent surveys estimated a range in the towhee population from 640 to 741 adults over the 13-year period from 1998 through 2011 (LaBerteaux 2011, p. 66), a time period that included both wet and dry years (Figure 7). Some remote parts of the range have not been surveyed recently (Figure 3); therefore, we are uncertain of the size of the current towhee population. However, we know the population has declined since 2011 and the best available estimate of the current population is 400–450 adult towhees as of 2022 (Figure 5) (McCreedy 2022b, p. S-2). The population may have dipped below 400 adults during 2014 (LaBerteaux 2014, p. 43) and/or during 2021 (McCreedy 2022b, p. S-2). Thus, towhee abundance, while likely greater than the minimum population size recommended in the recovery plan, might not have been maintained consistently over the past 5-year period (as specified in the recovery criterion for abundance).

Some threats have been substantially reduced or eliminated since the Inyo California towhee was listed (i.e., authorized water diversion and mining). However, there are still threats that are causing destruction, modification, or curtailment of Inyo California towhee habitat, including feral equines and climate change. While efforts have been made by NAWS China Lake and BLM to reduce the threat of feral equines in towhee habitat, management goals have not been achieved and habitat is still being impacted. Climate change has also emerged as a high-magnitude threat to the towhee because of its degrading effects to riparian habitat. While management is in place to minimize impacts from wildfire and nonnative tamarisk, and removal of feral horses and burros is underway, towhee habitat has not yet recovered from past disturbance and there are ongoing impacts from equines and drought that still need to be addressed.

Conclusion

While uncertain, it is probable that the quantitative population criterion of a minimum of 400 individuals has been achieved; however, the maintenance of this population size through the most recent 5-year period is uncertain. The recovery criterion that requires threats to habitat be reduced and managed, and degraded habitat be restored and maintained, has been met for some threats (i.e., authorized water diversion and mining) but not for others (i.e., feral equines, climate change, and cannabis cultivation).

V. SYNTHESIS

We listed the Inyo California towhee as a threatened subspecies in 1987 because of habitat loss and degradation (Factor A) from grazing by feral equines, water diversion, mining, off-highway vehicle use, and recreation and military activities (Service 1987, p. 28782). In 2013, we proposed to delist the subspecies on the basis of recovery (Service 2013, entire). At the time, the towhee population was estimated to be greater than 700 individuals and all substantial threats were ameliorated, reduced, or being managed.

Since the 2013 proposed delisting rule, the towhee population has declined by approximately 40 to 50 percent, and the status of some threats to the towhee have changed. Currently, the best available estimate of towhee population size (as of 2022) is 400–450 individuals (McCreedy 2022b, p. S-2), but there is some uncertainty with this estimate because of issues discussed in the section titled Population Trend and Drivers. Towhee habitat is almost entirely on Federal lands, which are being protected and managed, as funding allows, to conserve the subspecies; however, not all habitat threats have been ameliorated.

The primary threats impacting the towhee and its habitat are feral equines, fires and floods, and climate change (changes in precipitation and temperature, including extended droughts). The other threats discussed in this 5-year review appear to be minor or their impacts are localized or unknown.

While numbers of feral equines were close to management goals during the early 2000s, the population subsequently grew, exceeding 1,000 individuals in 2017 and mostly remaining above 1,000 since (Table 2). As of the 2023 survey, the minimum burro population size is 521 and minimum horse population is 480 animals (Table 2). Equine impacts to towhee habitat are frequently observed across the towhee's range and may worsen during drought, when available habitat is reduced. On a positive note, management techniques are successful at reducing impacts from the threat of feral equines; we are continuing to work with the BLM, NAWS China Lake, and CDFW to renew the 2010 cooperative management agreement to manage feral equines. Therefore, this threat can be managed and is likely to decline in the future.

Fires and floods affect habitat (Factor A) and can directly affect towhee productivity by destroying nests and young (Factor E). Recovery of towhee habitat after destructive fires and floods has been slow, but permanent damage (e.g., habitat type conversion) has not been reported. The risk of destructive wildfires (and likewise, sediment-moving floods that can follow wildfires) can potentially be partially reduced through intensive management (e.g., control of invasive nonnative grasses) and preparation (e.g., response planning). However, the risk of wildfires is likely to increase in the future and a large intense fire through the towhee's core range could affect large proportions of the occupied area with catastrophic effects to the subspecies.

Finally, climate change (changes in precipitation, increased average and maximum temperatures, and increased drought) is currently impacting towhee habitat and these effects are projected to worsen slightly through the near term and mid-century. A considerable amount (5 to 40 percent) of the riparian canopy died back because of drought conditions at nearly all (80–100 percent) of the survey sites visited in 2019 and 2021 (LaBerteaux 2019, p. ES-1, 30; LaBerteaux 2021b, p. 31). Riparian vegetation dieback reportedly continued to worsen in 2022 (McCreedy 2022b, p. S-2). Climate change also has both Factor A and Factor E impacts because it affects habitat and can directly affect towhee survival and productivity. Increased maximum temperatures, combined with less moisture and less canopy shade in riparian habitat, could lead to extirpation of important plant species and/or of the towhee from the warmest and driest sites. With ongoing drought conditions, the amount of available habitat and the towhee population would likely decline below current levels.

We are continuing to investigate the status of the Inyo California towhee. Abundance estimates have declined markedly since what was reported in the proposed rule in 2013. Despite the past series of drought years and increased abundance of feral equines, abundance estimates for the towhee have remained above 400 individuals. However, survey data has been limited, making it difficult to evaluate a trend in abundance. Because the best available scientific information does not allow us to evaluate trend and species viability, we are not recommending a change in status at this time. Over the next 3 years, we propose to conduct surveys to provide additional abundance estimates, such that a population trend and trajectory can be estimated. After these surveys, we will initiate a species status assessment to evaluate species viability, which will be completed by 2028. We recognize the efforts from our partners are helping to minimize impacts on this species and will continue to investigate delisting for the Inyo California towhee. Therefore, based on this status review, we conclude that the Inyo California towhee continues to meet the definition of a threatened species and no status change is recommended at this time.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

The recovery actions listed below are recommendations to be initiated over the next 5 years. These will help guide continuing recovery of the Inyo California towhee by providing information to better manage nesting sites. Conservation of the towhee is dependent on continued cooperation with our partners to minimize impacts from current threats and aid in recovery.

1. Monitor habitat and status of Inyo California towhees.

    a. Work with partners to develop a systematic approach to conduct rangewide surveys of towhee abundance, habitat condition, and threats.

    b. Investigate whether aerial or satellite imagery or spectral data can be used to efficiently monitor annual habitat conditions across the range.

2. Protect and manage habitat.

    a. Continue to work with BLM, DoD, and the State to remove feral equines from the towhee's range to achieve management goals of zero burros and no more than 168 feral horses.

    b. Work with State and Federal partners, including law enforcement, to improve early detection of unauthorized grow operations, deter future cannabis grow activities, and improve remediation and restoration of existing and past grow operations.

    c. Work with partners to protect riparian areas with fencing when necessary and maintain existing fences.

    d. Patrol recreational use of sensitive towhee habitats. If prudent, install signs and conduct outreach to reduce impacts from recreational activities.

    e. Work with partners to monitor and control, or eliminate, invasive nonnative plants in towhee habitat, especially nonnative annual grasses.

REFERENCES CITED

AdaptWest Project. 2021. Gridded current and future climate data for North America at 1km resolution, interpolated using the ClimateNA v7.01 software (T. Wang *et al*. 2021), *adaptwest.databasin.org*.

Albright, T.P., D. Mutiibwa, Alexander.R. Gerson, E.K. Smith, W.A. Talbot, J.J. O'Neill, A.E. McKechnie, and B.O. Wolf. 2017. Mapping evaporative water loss in desert passerines reveals an expanding threat of lethal dehydration. Proceedings of the National Academy of Sciences 114: p. 2283–2288.

[AOU] American Ornithologists' Union. 1957. Check-list of North American birds: Lord Baltimore Press, Inc., Baltimore, Maryland.

[AOU] American Ornithologists' Union (Ed.). 1983. Check-list of North American birds: Allen Press, Lawrence, Kansas, 877 pp.

[AOU] American Ornithologists' Union. 1989. Thirty-Seventh supplement to the American Ornithologists' Union check-list of North American birds. Auk 106: pp. 532–538.

[AOU] American Ornithologists' Union. 1998. Check-list of North American Birds. The American Ornithologists' Union Seventh edition: p. 829.

Archer, S.R., and K.I. Predick. 2008. Climate change and ecosystems of the southwestern United States. Rangelands 30: pp. 23–28.

Arnold, A. 2023. Naval Air Weapons Station China Lake. Telephone conversation with Stephanie Prevost, U.S. Fish and Wildlife Service, Carlsbad Fish and Wildlife Office. Dated June 29, 2023. Subject: Arnold 2023 pers comm_20230629 Phone call with Arlene_CLNAWS.pdf.

Atwell, LLC. 2020. Inyo California towhee 2019 survey, Argus Range and Panamint Range, Inyo County, CA. Unpublished report prepared for Point Blue Conservation Science.

Bauer, S., J. Olson, A. Cockrill, M. Van Hattem, L. Miller, M. Tauzer, and G. Leppig. 2015. Impacts of surface water diversions for marijuana cultivation on aquatic habitat in four northwestern California watersheds. PloS one 10: p. e0120016.

Benedict, L., M.R. Kunzmann, K. Ellison, L. Purcell, R.R. Johnson, and L.T. Haight. 2011. California Towhee (*Melozone crissalis*) (A. F. Poole, Ed.). The Birds of North America Online.

Black, A.N., S. Janjua, C. McCreedy, J.Y. Jeon, E.J. Heenkenda, S. Mathur, E. Ferree, A.L. Fesnock-Parker, and J.A. DeWoody. 2023. Conservation genomics of California towhees. Unpublished report prepared for the Department of the Interior Bureau of Land Management.

[BLM] Bureau of Land Management. 1980. The California Desert Conservation Area plan 1980, as amended.

[BLM] Bureau of Land Management. 1987. Management plan for the Great Falls Basin area of critical environmental concern.

[BLM] Bureau of Land Management. 1999. The California desert conservation area plan of 1980 as amended.

[BLM] Bureau of Land Management. 2006. Record of Decision, West Mojave Plan Amendment to the California Desert Conservation Area Plan.

[BLM] Bureau of Land Management. 2016a. Land Use Plan Amendment to the California Desert Conservation Plan, Bishop Resource Management Plan, and Bakersfield Resource Management Plan. Department of the Interior.

[BLM] Bureau of Land Management. 2016b. Desert Renewable Energy Conservation Plan, Land Use Plan Amendment to the California Desert Conservation Plan, Appendix A - California Desert National Conservation Lands Ecoregion Descriptions and Maps.

[BLM] Bureau of Land Management. 2016c. Desert Renewable Energy Conservation Plan, Land Use Plan Amendment to the California Desert Conservation Plan, Appendix B - Basin and Range Subregion.

[BLM] Bureau of Land Management. 2021a. 2021 Centennial Herd Area emergency wild horse gather, Website viewed June 20, 2023, *https://www.blm.gov/programs-wild-horse-and-burro-herd-management-gathers-and-removals-california-2021-centennial-0*.

[BLM] Bureau of Land Management. 2021b. 2021 Centennial Herd Area wild burro gather, Website viewed June 20, 2023, *https://www.blm.gov/programs-wild-horse-and-burro-herd-management-gathers-and-removals-california-2021-centennial-herd*.

[BLM] Bureau of Land Management. 2021c. Centennial, Panamint and Slate range herd areas wild burro gather plan, FY2021-FY2031. Environmental Assessment.

[BLM] Bureau of Land Management. 2023. Bureau of Land Management unpublished data sent by Alexander Neibergs of the Bureau of Land Management Ridgecrest Field Office via email correspondence to Stephanie Prevost of the U.S. Fish and Wildlife Service Carlsbad Fish and Wildlife Office. Dated July 25, 2023. Subject: Horse and Burro numbers in the Argus Range.

[BLM and NPS] Bureau of Land Management and National Park Service. 2018. California desert interagency fire program fire management plan.

Campbell, T.G. 2012. Naval Air Weapons Station China Lake. Email correspondence to Erin Nordin of the U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office. Dated August 30, 2012. Subject: Towhee questions.

[CDFW] California Department of Fish and Wildlife. 2023. California Natural Diversity Database occurrence information for *Melozone crissalis eremophilus*, Website viewed June 15, 2023, *https://www.wildlife.ca.gov/data/cnddb*.

Chase, M.K., N. Nur, and G.R. Geupel. 2005. Effects of weather and population density on reproductive success and population dynamics in a Song Sparrow (Melospiza melodia) population: A long-term study. The Auk 122: pp. 571–592.

Chesser, R.T., R.C. Banks, F.K. Barker, C. Cicero, J.L. Dunn, A.W. Kratter, I.J. Lovette, P.C.R. Asmussen, J.V. Remsen, J.D. Rising, D.F. Stotz, and K. Winker. 2010. Fifty-first supplement to the American Ornithologists' Union check-list of North American birds. The Auk 127: pp. 726–744.

Cord, B., and J.R. Jehl. 1979. Distribution, biology, and status of a relict population of brown towhee (*Pipilo fuscus eremophilus*). Western Birds 10: pp. 131–156.

CROP Project. 2019. Trespass grow fact sheet, Website viewed July 31, 2023, *https://www.cropproject.org/resources*.

DaCosta, J.M., G.M. Spellman, P. Escalante, and J. Klicka. 2009. A molecular systematic revision of two historically problematic songbird clades: Aimophila and Pipilo. Journal of Avian Biology 40: pp. 206–216.

David, N., and M. Gosselin. 2002. The grammatical gender of avian genera. Bulletin-British Ornithologists Club 122: pp. 257–281.

Davis, J. 1957. Comparative Foraging Behavior of the Spotted and Brown Towhees. The Auk 74: pp. 129–166.

Dawson, W.R. 1954. Temperature Regulation and Water Requirements of the Brown and Abert Towhees, Pipilo Fuscus and Pipilo Aberti.[With Plates.].: University of California Press.

Ellis, S. 2012a. Wildlife Biologist, Bureau of Land Management Ridgecrest Field Office. Email correspondence to Erin Nordin of the U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office. Dated October 2, 2012. Subject: Last April Inyo CA Towhees seen in Surprise Canyon.

Ellis, S. 2012b. Wildlife Biologist, Bureau of Land Management Ridgecrest Field Office. Telephone conversation with Erin Nordin of the U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office. Dated December 18, 2012. Subject: Discussion about Bainter and Alpha.

Ellis, S. 2013a. Wildlife Biologist, Bureau of Land Management Ridgecrest Field Office. Email correspondence to Erin Nordin of the U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office. Dated June 20, 2013. Subject: Questions about wild horses and burros, and fence monitoring.

Ellis, S. 2013b. Wildlife Biologist, Bureau of Land Management Ridgecrest Field Office. Email correspondence to Erin Nordin of the U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office. Dated June 24, 2013. Subject: Remaining mine in Inyo California towhee habitat.

Finch, D.M. 1983. Brood Parasitism of the Abert's Towhee: Timing, Frequency, and Effects. The Condor 85: p. 355.

Gill, F., D. Donsker, and P. Rasmussen. 2023. IOC World Bird List 13.1.

Grinnell, J., and A.H. Miller. 1944. The distribution of the birds of California: Pacific Coast Avifauna, Cooper Ornithological Club, Berkeley, CA.

Hopkins, C.M. 2023. Natural Resources Specialist, Naval Air Weapons Station China Lake. Email correspondence to Stephanie Prevost of the U.S. Fish and Wildlife Service Carlsbad Fish and Wildlife Office. Dated June 28, 2023. Subject: Hopkins 2023, pers comm Email 20230628 Summary of Junction Ranch Fire.pdf.

Hopper, M.R., B.M. Middleton, and D.A. Himebaugh. 2011. Petition of Pacific Legal Foundation, California Farm Bureau Federation, Oregon Cattlemen's Association, and California Cattlemen's Association to delist the Inyo California towhee and downlist the arroyo toad, the Indian Knob mountain balm, the lane mountain milk-vetch, the Modoc sucker, and the Santa Cruz cypress under the Endangered Species Act. Petition prepared for the U.S. Department of the Interior and U.S. Fish and Wildlife Service.

Iknayan, K.J., and S.R. Beissinger. 2018. Collapse of a desert bird community over the past century driven by climate change. Proceedings of the National Academy of Sciences 115: pp. 8597–8602.

[ITIS] Integrated Taxonomic Information System. 2023a. Integrated Taxonomic Information System - About, Website viewed July 19, 2023, *https://www.itis.gov/about_itis.html*.

[ITIS] Integrated Taxonomic Information System. 2023b. ITIS DwCA Download for *Melozone crissalis eremophila*, Website viewed June 6, 2023, *http://www.itis.gov*.

Keeley, J.E., M. Baer-Keeley, and C.J. Fotheringham. 2005. Alien plant dynamics following fire in Mediterranean-climate California shurblands. Ecological Applications 15: pp. 2109–2125.

Keeley, J.E., and C.J. Fotheringham. 2003. Impact of past, present, and future fire regimes on North American Mediterranean shrublands Pages 218–262 *in* Fire and climatic change in temperate ecosystems of the Western Americas, Veblen, T.T., W.L. Baker, G. Montenegro, and T.W. Swetnam eds. Springer.

Kerncrest Audubon Society. 2013. Letter submitted to the U.S. Fish and Wildlife Service in response to the 2013 12-month finding and proposed rule to delist the Inyo California Towhee. Letter received January 3, 2014. Dated December 30, 2013. Subject: Information and comments on the 12-month finding on a petition and proposed rule to remove the Inyo California towhee (*Melozone crissalis eremophilus*) from the Federal list of endangered and threatened wildlife (12-month finding).

Kibler, C.L., E.C. Schmidt, D.A. Roberts, J.C. Stella, L. Kui, A.M. Lambert, and M.B. Singer. 2021. A brown wave of riparian woodland mortality following groundwater declines during the 2012–2019 California drought. Environmental Research Letters 16: p. 084030.

Kunzmann, M.R., K. Ellison, K.L. Purcell, R.R. Johnson, and L.T. Haight. 2002. California towhee (*Pipilo crissalis*) *in* The Birds of North America, No. 632, Poole, A. and F. Gill eds. The Birds of North America, Inc., Philadelphia, PA.

LaBerteaux, D.L. 1989. Morphology, foraging behavior, and nesting biology of the Inyo California towhee (*Pipilo crissalis eremophilus*).

LaBerteaux, D.L. 1994. LaBerteaux 1994 Management recommendations for Inyo California towhee (*Pipilo crissalis eremophilus*) on Naval Air Weapons Station, China Lake, California. Unpublished report prepared for Naval Air Weapons Station China Lake under contract with MHA Environmental Consultants, Inc. (Contract N60530-90-D-0071 (0018)).

LaBerteaux, D.L. 2004. Inyo California towhee (*Pipilo crissalis eremophilus*) survey in·the Argus Range, Inyo County, California. Unpublished report prepared by EREMICO Biological Services for the Bureau of Land Management Ridgecrest Field Office.

LaBerteaux, D.L. 2006. Assessment of fire and flash flood impacts on Inyo California towhees at the Naval Air Weapons Station, China Lake, California. Unpublished report prepared for Epsilon Systems Solutions, under government contract.

LaBerteaux, D.L. 2008. Inyo California towhee (*Pipilo crissalis eremophilus*) survey in·the Argus Range on the China Lake Naval Air Weapons Station, Inyo County, California. Unpublished report prepared by EREMICO Biological Services for U.S. Fish and Wildlife Service, Ventura Fish and Wildlife Office.

LaBerteaux, D.L. 2011. Inyo California towhee (*Melozone crissalis eremophilus*) survey in the Argus Range and Panamint Range, Inyo County, California, spring 2011. Unpublished report prepared for the Bureau of Land Management Ridgecrest Field Office.

LaBerteaux, D.L. 2013. Letter submitted to the U.S. Fish and Wildlife Service in response to the 2013 12-month finding and proposed rule to delist the Inyo California Towhee. Dated

December 23, 2013. Subject: Information and comments on the 12-month finding on a petition and proposed rule to remove the Inyo California towhee (*Melozone crissalis eremophilus*) from the Federal list of endangered and threatened wildlife (12-month finding).

LaBerteaux, D.L. 2014. Nesting Inyo California towhee surveys at the Naval Air Weapons Station China Lake, China Lake, California, spring 2014. Unpublished report prepared for Naval Air Weapons Station China Lake and Naval Facilities Engineering Command, Southwest.

LaBerteaux, D.L. 2015a. Eremico Consulting. Site visit with Judy Hohman, Tara Callaway, and Connie Rutherford of the U.S. Fish and Wildlife Service. Dated June 4, 2015. Subject: Towhee Site Visit, Tributary of Mountain Springs Canyon & Mountain Springs Canyon.

LaBerteaux, D.L. 2015b. Eremico Consulting. Site visit with Judy Hohman, Tara Callaway, and Connie Rutherford of the U.S. Fish and Wildlife Service. Dated June 4, 2015. Subject: Towhee site visit, Upper Homewood Canyon.

LaBerteaux, D.L. 2015c. Eremico Consulting. Site visit with Judy Hohman, Tara Callaway, and Connie Rutherford of the U.S. Fish and Wildlife Service. Dated June 5, 2015. Subject: Towhee Site Visit, Great Falls Basin.

LaBerteaux, D.L. 2015d. Nesting Inyo California towhee surveys at the Naval Air Weapons Station China Lake, China Lake, California, spring 2015. Unpublished report prepared for Naval Air Weapons Station China Lake and Naval Facilities Engineering Command, Southwest.

LaBerteaux, D.L. 2016. Nesting Inyo California towhee surveys at the Naval Air Weapons Station China Lake, China Lake, California, spring 2016. Unpublished report prepared by Southern Sierra Research Station for Naval Air Weapons Station China Lake and Naval Facilities Engineering Command Southwest under Cooperative Agreement No. N6247313-2-4909.

LaBerteaux, D.L. 2019. Inyo California towhee (*Melozone crissalis eremophilus*) survey at the Naval Air Weapons Station China Lake, China Lake, California, spring 2019 (final report). Unpublished report prepared by EREMICO Biological Services, LLC for Naval Facilities Engineering Command Southwest and the Environmental Management Division, Naval Air Weapons Station China Lake, under contract No. N6247314D1423.

LaBerteaux, D.L. 2021a. Inyo California Towhee (*Melozone crissalis eremophila*) Survey at the Naval Air Weapons Station China Lake, China Lake, California, Spring 2021. Unpublished report prepared for Naval Air Weapons Station China Lake and Naval Facilities Engineering Command, Southwest.

LaBerteaux, D.L. 2021b. Inyo California towhee (*Melozone crissalis eremophila*) survey at the Naval Air Weapons Station China Lake, China Lake, California, spring 2021 (final report). Unpublished report prepared by EREMICO Biological Services, LLC, for Naval Facilities Engineering Command Southwest and Naval Air Weapons Station China Lake, under contract No. N6247314D1423.

LaBerteaux, D.L., and B.H. Garlinger. 1998. Inyo California towhee (*Pipilo crissalis eremophilus*) census in the Argus and Coso Mountain Ranges, Inyo County, California. Unpublished report prepared for Naval Air Weapons Station China Lake and Naval Facilities Engineering Command, Southwest.

Lawrimore, J.H., R. Ray, S. Applequist, B. Korzeniewski, and M.J. Menne. 2016. NOAA Climate Data Online, daily summaries and global summary of the month, 1920-2022, version 1.0.3, for Trona, California, United States. NOAA National Centers for Environmental Information.

McCreedy, C. 2020. Inyo California towhee 2020 survey, Argus Range and Panamint Range, Inyo County, CA. Unpublished report prepared by Atwell, LLC, for Point Blue Conservation Science.

McCreedy, C. 2022a. Point Blue Conservation Science. Unpublished data submitted to the U.S. Fish and Wildlife Service Carlsbad Fish and Wildlife Office. Dated 2022. Subject: ICTO marijuana grows_2022.

McCreedy, C. 2022b. Inyo California towhee 2022 drought assessment survey, combined report. Unpublished report prepared by Point Blue Conservation Science.

McCreedy, C. 2022c. Inyo California towhee genomic assessment and territory summary, April 2021. Unpublished report prepared by Point Blue Conservation Science.

McCreedy, C., and C. van Riper. 2015. Drought-caused delay in nesting of Sonoran Desert birds and its facilitation of parasite- and predator-mediated variation in reproductive success. The Auk 132: pp. 235–247.

McKechnie, A.E., P.A. Hockey, and B.O. Wolf. 2012a. Feeling the heat: Australian landbirds and climate change: Taylor & Francis.

McKechnie, A.E., P.A.R. Hockey, and B.O. Wolf. 2012b. Feeling the heat: Australian landbirds and climate change. Emu - Austral Ornithology 112: pp. i–vii.

McKechnie, A.E., and B.O. Wolf. 2010. Climate change increases the likelihood of catastrophic avian mortality events during extreme heat waves. Biology Letters 6: p. 253–256.

Miller, A.H. 1963. Desert adaptations in birds Pages 666–674 *in* Proceedings of the XIII International Ornithological Congress.

Morrison, S.A., and D.T. Bolger. 2002. Variation in a sparrow's reproductive success with rainfall: food and predator-mediated processes. Oecologia 133: pp. 315–324.

National Interagency Fire Center. 2023. InFORM fire occurrence data records and historic perimeters, Website viewed July 11, 2023, *https://services3.arcgis.com/T4QMspbfLg3qTGWY/arcgis/rest/services/InFORM_FireOccurrence_Public/FeatureServer*.

NAWS China Lake. 2013. NAWS China Lake wild horse and burro management plan, Final. Report prepared by Resource Concepts Inc. (under contract to Tierra Data) for Naval Air Weapons Station China Lake under contract with Naval Facilities Engineering Command Southwest.

NAWS China Lake. 2023. Unpublished data sent by Arlene Arnold of Naval Air Weapons Station China Lake via email correspondence to Stephanie Prevost of the U.S. Fish and Wildlife Service Carlsbad Fish and Wildlife Office. Subject: NAWS 2014 Responses to proposed delisting rule. Dated June 30, 2023. Subject: Fire history.

Patten, M.A. 2010. Chapter 3 Null expectations in subspecies diagnosis Pages 35–41 *in* Avian subspecies, Winker, K. ed. American Ornithologists' Union, Washington, D.C.

Patten, M.A., G. McCaskie, and P. Unitt. 2003. Birds of the Salton Sea: status, biogeography, and ecology: University of California Press, Berkeley, p. 363.

Paxton, E.H., M.K. Sogge, S.L. Durst, T.C. Theimer, and J.R. Hatten. 2007. The ecology of the Southwestern Willow Flycatcher in central Arizona: a 10-year synthesis report. US Geological Survey Open-File Report 1381: p. 143.

Perry, L.G., D.C. Andersen, L.V. Reynolds, S.M. Nelson, and P.B. Shafroth. 2012. Vulnerability of riparian ecosystems to elevated CO_2 and climate change in arid and semiarid western N orth A merica. Global Change Biology 18: pp. 821–842.

Pyle, P., S.N.G. Howell, and D.F. DeSante. 2022. Identification guide to North American birds: Slate Creek Press, Forest Knolls, California.

Riddell, E.A., K.J. Iknayan, B.O. Wolf, B. Sinervo, and S.R. Beissinger. 2019. Cooling requirements fueled the collapse of a desert bird community from climate change. Proceedings of the National Academy of Sciences 116: pp. 21609–21615.

Ridgway, R. 1901. The birds of North and Middle America: a descriptive catalogue of the higher groups, genera, species, and subspecies of birds known to occur in North America, from the Arctic lands to the Isthmus of Panama, the West Indies and other islands of the Caribbean sea, and the Galapagos Archipelago: US Government Printing Office, Washington D.C., USA.

van Rossem, A.J. 1935. A new race of brown towhee from the Inyo region of California. Transactions of the San Diego Society of Natural History 8: pp. 69–72.

Rotenberry, J.T., and J.A. Wiens. 1991. Weather and Reproductive Variation in Shrubsteppe Sparrows: A Hierarchical Analysis. Ecology 72: pp. 1325–1335.

Rutherford, C., J. Hohman, and T. Callaway. 2015. U.S. Fish and Wildlife Service. Personal observations made by U.S. Fish and Wildlife Service staff during site visits to Inyo California towhee habitat on June 4 and 5, 2015. Dated June 5, 2015. Subject: USFWS 2015 towhee site visit.

Saracco, J.F., S.M. Fettig, G.L. San Miguel, D.W. Mehlman, B.E. Thompson, and S.K. Albert. 2018. Avian demographic responses to drought and fire: a community-level perspective. Ecological Applications 28: pp. 1773–1781.

[Service] U.S. Fish and Wildlife Service. 1983. Endangered and threatened species listing and recovery priority guidelines. Federal Register 48: pp. 43098–43105.

[Service] U.S. Fish and Wildlife Service. 1987. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status and Critical Habitat Designation for the Inyo Brown Towhee. Federal Register 52: pp. 28780–28786.

[Service] U.S. Fish and Wildlife Service. 1996. Policy regarding the recognition of distinct vertebrate population segments under the Endangered Species Act. Federal Register 61: pp. 4722–4725.

[Service] U.S. Fish and Wildlife Service. 1998. U.S. Fish and Wildlife Service. Recovery plan of the Inyo California towhee (*Pipilo crissalis eremophilus*). U.S. Fish and Wildlife Service, Region 1.

[Service] U.S. Fish and Wildlife Service. 2006. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Reviews of 56 Species in California and Nevada. Federal Register 71: pp. 14538–14542.

[Service] U.S. Fish and Wildlife Service. 2008. U.S. Fish and Wildlife Service. Inyo California Towhee (*Pipilo crissalis eremophilus*) [=Inyo Brown Towhee (*Pipilo fuscus eremophilus*)] 5-Year Review: Summary and Evaluation. Prepared by the Ventura Fish and Wildlife Office.

[Service] U.S. Fish and Wildlife Service. 2010. U.S. Fish and Wildlife Service. Cooperative management agreement between the U.S. Department of Interior Fish and Wildlife Service Ventura Fish and Wildlife Office and the Bureau of Land Management, Naval Air Weapons Station China Lake; and the California Department of Fish and Game for the management of the Inyo California towhee (*Pipilo crissalis eremophilus*).

[Service] U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants; 90-Day Finding on a Petition To Delist or Reclassify From Endangered to Threatened Six California Species. Federal Register 77: pp. 32922–32927.

[Service] U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition and Proposed Rule To Remove the Inyo California Towhee (Pipilo crissalis eremophilus = Melozone crissalis eremophilus) From the Federal List of Endangered and Threatened Wildlife. Federal Register 78: pp. 65938–65953.

[Service] U.S. Fish and Wildlife Service. 2018. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 50 Species in California, Nevada, and the Klamath Basin of Oregon. Federal Register 83: pp. 28251–28254.

[Service] U.S. Fish and Wildlife Service. 2022. General provisions; revised list of migratory birds. Federal Register 87: pp. 75977–76023.

[Service] U.S. Fish and Wildlife Service. 2023. General provisions; revised list of migratory birds. Federal Register 88: pp. 49310–49355.

Smith, E.K., J.J. O'Neill, A.R. Gerson, A.E. McKechnie, and B.O. Wolf. 2017. Avian thermoregulation in the heat: resting metabolism, evaporative cooling, and heat tolerance in Sonoran Desert songbirds. Journal of Experimental Biology p. jeb.161141.

Southern Sierra Research Station. 2009. Inyo California towhee nesting survey at the Naval Air Weapons Station China Lake, California. Unpublished report prepared for Naval Facilities Engineering Command, Southwest.

Southern Sierra Research Station. 2010. Inyo California towhee nesting survey at the Naval Air Weapons Station China Lake, California, spring 2009. Unpublished report prepared for Naval Facilities Engineering Command, Southwest.

Southern Sierra Research Station. 2011a. Inyo California towhee nesting survey at the Naval Air Weapons Station China Lake, California, spring 2010. Unpublished report prepared for Naval Facilities Engineering Command, Southwest.

Southern Sierra Research Station. 2011b. Inyo California towhee nesting survey at the Naval Air Weapons Station China Lake, California, spring 2011. Unpublished report prepared for Naval Facilities Engineering Command, Southwest.

Southern Sierra Research Station. 2013. Inyo California towhee nesting survey at the Naval Air Weapons Station China Lake, California, spring 2012. Unpublished report prepared for Naval Facilities Engineering Command, Southwest.

U.S. Navy. 2014. Integrated natural resources management plan, Naval Air Weapons Station China Lake, California. Management plan (INRMP) for plan period 2012–2032 prepared by Tierra Data, Inc. for Naval Air Weapons Station China Lake and Naval Facilities Engineering Command, Southwest.

Wang, T., A. Hamann, D. Spittlehouse, and C. Carroll. 2016. Locally downscaled and spatially customizable climate data for historical and future periods for North America. PloS one 11: p. e0156720.

Whitfield, M.J., and N. Jaime. 2022a. Avian monitoring for species at risk, Naval Air Weapons Station China Lake, Inyo County, California, 2021.

Whitfield, M.J., and N. Jaime. 2022b. Inyo California towhee surveys 2022, Naval Air Weapons Station China Lake, CA. Unpublished report prepared by Hercules JV for Naval Facilities Engineering Command Southwest, under contract No. HJV-0024-4791-0004.

Zhang, F., J.A. Biederman, M.P. Dannenberg, D. Yan, S.C. Reed, and W.K. Smith. 2021. Five Decades of Observed Daily Precipitation Reveal Longer and More Variable Drought Events Across Much of the Western United States. Geophysical Research Letters 48.

Zink, R.M. 1988. Evolution of Brown Towhees: Allozymes, Morphometrics and Species Limits. The Condor 90: pp. 72–82.

APPENDIX A

OCCURRENCE TABLE

Table A1. Occurrence Table for Inyo California Towhee, Including Adult Abundance Observed During Surveys, 1998–2022, at the 266 Sites Where Towhees Have Been Found.[1,2,3]

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Bainter Canyon	Bainter Spring	BLM	Riparian	1	2	2						1					0	2			2020
Bendire Canyon	Site 2	NAWS	Riparian		1			0													2007
Big Wildrose Canyon	Site 1	NAWS	Riparian	4	6		8	6						4					0	4	2022
Big Wildrose Canyon	Site 2	NAWS	Riparian	2	2		2	0								2			0	2	2022
Big Wildrose Canyon	Site 3	NAWS	Riparian	2	4		4	4								8			2	4	2022
Bircham Springs Area	Bircham Springs	NAWS	Riparian	0	0		0	1					4			0					2016

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Bircham Springs Area	Bircham Springs Site 2	NAWS	Riparian		0		0	0					0			0					2016
Bircham Springs Area	Picnic Area	NAWS	Riparian	0	2		2	2					4								2012
Bruce Canyon	Cabin Spring	BLM	Riparian	2	6	6						6						4		4	2022
Bruce Canyon	Dripping Spring	BLM	Baccharis	2	2	5						5						2		2	2022
Bruce Canyon	Peach Spring	BLM	Wash	0	2	2						1						2		0	2022
Bruce Canyon	Rock Spring	BLM	Riparian	2	4	6						4						4		4	2022
Bruce Canyon	Site 1	BLM	Wash	0	2	2						4						2		2	2022
Bruce Canyon	Site 2	BLM	Riparian	0	2	2						4						4		2	2022
Canyon East of North Wilson Canyon	Site 1 (Yucca Spring)	NAWS	Riparian	0	2		1	2									0				2019

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Canyon East of North Wilson Canyon	Site 2 (Yucca Spring)	NAWS	Riparian		3			4									2				2019
Canyon North of Sweetwater Wash	Site 1	NAWS	Riparian	0	0			2													2007
Canyon North of Sweetwater Wash	Site 3	NAWS	Riparian		1			2													2007
Canyon West of Moscow Spring Complex	Site 1	NAWS	Riparian		1			0													2007
Canyon West of Moscow Spring Complex	Site 3	NAWS	Riparian		1			0													2007

Study Area	**Site Name**	**Land-owner**	**Habitat Type**	**Before 1998**	**1998**	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2014**	**2015**	**2016**	**2019**	**2020**	**2021**	**2022**	**Most Recent Survey Year**
Canyon West of North Wilson Canyon	Site 1	NAWS	Riparian		4			2													2007
Canyon West of North Wilson Canyon	Site 3	NAWS	Riparian		0		1	1													2007
Crow Canyon	Lower Crow Canyon	BLM	Wash		3	0															2004
Crow Canyon	Residential	Private	Exotic		2																1998
Crow Canyon	Site 1	NAWS	Riparian		2			2						0					4		2021
Crow Canyon	Site 2	NAWS	Riparian		2			2						2					2		2021
Crow Canyon	Site 3	NAWS	Baccharis		2			0											0		2021
Crow Canyon	Site 4	NAWS	Riparian	1	8			4						2					4		2021

Study Area	**Site Name**	**Land-owner**	**Habitat Type**	**Before 1998**	**1998**	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2014**	**2015**	**2016**	**2019**	**2020**	**2021**	**2022**	**Most Recent Survey Year**
Crow Canyon	Site 5	NAWS	Riparian	1	4			2						3					4		2021
Crow Canyon	Skull Spring	BLM	Riparian		0	2						2					0	2		1	2022
Crow Canyon	Skull Spring 2	BLM	Riparian		2	1						0					0	0		0	2022
Crow Canyon	Trail into Great Falls Basin	NAWS	Upland		2			2	3												2008
Great Falls Basin	Argus Spring	NAWS	Riparian		2			4											4		2021
Great Falls Basin	Austin Spring	BLM	Baccharis	2	2	0						1					0	0			2020
Great Falls Basin	Between Deep Canyon Spring and Deep Canyon Site 2	NAWS						2													2007
Great Falls Basin	Deep Canyon Site 2	NAWS	Riparian		2			4											4		2021

Study Area	**Site Name**	**Land-owner**	**Habitat Type**	**Before 1998**	**1998**	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2014**	**2015**	**2016**	**2019**	**2020**	**2021**	**2022**	**Most Recent Survey Year**
Great Falls Basin	Deep Canyon Spring	NAWS	Riparian		3			4											2		2021
Great Falls Basin	East of Argus Spring	NAWS	Wash		2			0													2007
Great Falls Basin	Elliot Spring	BLM	Riparian	2	2	4						6					4	4		2	2022
Great Falls Basin	Mumford Springs (North Spring)	BLM				0						2					0	0			2020
Great Falls Basin	Mumford Springs (South Spring)	BLM	Riparian	0	0	2						0					0	0			2020
Great Falls Basin	Nadeau Spring	BLM	Baccharis	0	2	0						2					0	0			2020
Great Falls Basin	North Fork Spring	BLM	Riparian	1	1	2						2					2	2		2	2022
Great Falls Basin	Orchard Spring	BLM	Riparian	2	2	4						2					3	0		2	2022

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Great Falls Basin	Site 1	BLM	Riparian	2	4	4						0					2	2		2	2022
Great Falls Basin	Site 10 (Arrastra Spring)	BLM	Riparian	2	6	6						5					2	4		2	2022
Great Falls Basin	Site 11	BLM	Riparian	3	2	2						2					0	2		0	2022
Great Falls Basin	Site 12	BLM	Riparian	2	1	1						2					2	2		2	2022
Great Falls Basin	Site 13A	BLM	Riparian	0	2	2						2					2	0		2	2022
Great Falls Basin	Site 13B	BLM	Riparian	2	2	4						1					2	2		2	2022
Great Falls Basin	Site 13C	BLM	Riparian	2	2	2						2					2	2		0	2022
Great Falls Basin	Site 14	BLM	Riparian		2	2						4					0	2			2020
Great Falls Basin	Site 15	BLM	Riparian		2	4						4					4	6		6	2022
Great Falls Basin	Site 16	BLM	Riparian		2	2						2					2	2		2	2022

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Great Falls Basin	Site 17	BLM	Riparian		2	3						4					6	2		2	2022
Great Falls Basin	Site 18	BLM	Riparian		2	2						2					2	5		2	2022
Great Falls Basin	Site 19	BLM	Riparian		6	4						3					2	2		3	2022
Great Falls Basin	Site 2A	BLM	Riparian	4	4	5						2					2	0		0	2022
Great Falls Basin	Site 2B	BLM				2						2					0	2		2	2022
Great Falls Basin	Site 2C	BLM				2						2					2	2		2	2022
Great Falls Basin	Site 3	BLM	Riparian	1	4	6						4					3	2		2	2022
Great Falls Basin	Site 4A	BLM	Riparian	0	2	1						2					0	2		2	2022
Great Falls Basin	Site 4B	BLM	Riparian	4	6	8						6					5	2		2	2022
Great Falls Basin	Site 5	BLM	Riparian	2	4	4						3					2	2		2	2022

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Great Falls Basin	Site 6	BLM	Riparian	2	2	2						2					2	2			2020
Great Falls Basin	Site 7	BLM	Riparian	2	4	2						4					2	2		2	2022
Great Falls Basin	Site 8	BLM	Riparian	2	0	2						2					0	0		2	2022
Great Falls Basin	Site 9	BLM	Riparian	3	6	10						11					2	8		4	2022
Great Falls Basin	South of Argus Spring	NAWS	Upland		2			4	2												2008
Great Falls Basin	South of Site 1	BLM	Upland		1	0															2004
Great Falls Basin	Spring at Site 9	BLM	Riparian	0	2	0						2					2	2		0	2022
Great Falls Basin	Twin Springs (East Spring)	BLM	Riparian	2	2	2						2					2	2		1	2022
Great Falls Basin	Twin Springs (West Spring)	BLM				0						0					0	0		2	2022

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Great Falls Basin	Up Canyon from North Fork Spring	BLM	Upland		4			0													2007
Great Falls Basin	West of Site 15	NAWS	Upland		2			2	0												2008
Great Falls Basin	Willow Spring	BLM	Riparian	2	6	10						4					3	3		4	2022
Homewood Canyon	Benko 2 (Lower Willow Patch)	BLM	Riparian	0	3	2						3					0	2		2	2022
Homewood Canyon	Benko 2 (Upper Willow Patch)	NAWS				2						2					2	1		0	2022
Homewood Canyon	Benko Spring	NAWS	Riparian	1	4	5						4					0	2		3	2022
Homewood Canyon	Between Quail Spring and Site 4	NAWS						2													2007

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Homewood Canyon	Between Side Canyons B & C	NAWS	Baccharis		2			2													2007
Homewood Canyon	Between Site 5 and Side Canyon B Site 9	NAWS						4													2007
Homewood Canyon	Down Canyon from Site 1	NAWS						2													2007
Homewood Canyon	North of North Ruth Spring	BLM	Baccharis		1	0						2					0	4		3	2022
Homewood Canyon	North Ruth Spring	BLM	Riparian	1	2	2						2					2	2		1	2022
Homewood Canyon	North-facing slope above Side Canyon A	NAWS						6													2007
Homewood Canyon	Quail Spring	NAWS	Riparian	6	4			8									4				2019

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Homewood Canyon	Ruth Mine Spring	BLM	Riparian		1	0						0					0	0		0	2022
Homewood Canyon	Side Canyon A, Site 1	NAWS	Riparian		2			4													2007
Homewood Canyon	Side Canyon A, Site 2	NAWS	Riparian		2			1													2007
Homewood Canyon	Side Canyon A, Site 3	NAWS	Riparian		4			2													2007
Homewood Canyon	Side Canyon A, Site 4-1	NAWS	Riparian	1	4			3													2007
Homewood Canyon	Side Canyon A, Site 4-2	NAWS	Riparian	1	2			2													2007
Homewood Canyon	Side Canyon A, Site 5	NAWS	Baccharis		5			4													2007
Homewood Canyon	Side Canyon A, Site 6	NAWS	Riparian	0	2			2													2007

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Homewood Canyon	Side Canyon A, Site 7	NAWS	Riparian		2			0													2007
Homewood Canyon	Side Canyon A, Site 8	NAWS	Riparian	0	7			6													2007
Homewood Canyon	Side Canyon B, Parsons Spring	NAWS	Riparian	0	6			8								6					2016
Homewood Canyon	Side Canyon B, Site 1	NAWS	Riparian	1	2			2								2					2016
Homewood Canyon	Side Canyon B, Site 10	NAWS	Riparian	0	2			4													2007
Homewood Canyon	Side Canyon B, Site 2	NAWS	Riparian	1	6			6													2007
Homewood Canyon	Side Canyon B, Site 3	NAWS	Riparian	2	2			3													2007

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Homewood Canyon	Side Canyon B, Site 4	NAWS	Riparian	0	2			2													2007
Homewood Canyon	Side Canyon B, Site 5	NAWS	Riparian	1	4			2													2007
Homewood Canyon	Side Canyon B, Site 6	NAWS	Riparian	0	2			2													2007
Homewood Canyon	Side Canyon B, Site 7	NAWS	Riparian	3	8			8													2007
Homewood Canyon	Side Canyon B, Site 8	NAWS	Riparian	0	2			3													2007
Homewood Canyon	Side Canyon B, Site 9	NAWS	Riparian	0	2			2													2007
Homewood Canyon	Side Canyon C, Site 1	NAWS	Riparian	0	2			2									0				2019
Homewood Canyon	Side Canyon C, Site 2	NAWS	Riparian	2	2			1									2				2019

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Homewood Canyon	Side Canyon C, Site 3	NAWS	Riparian		4			6									2				2019
Homewood Canyon	Side Canyon D, Site 1	NAWS	Riparian	0	4			6													2007
Homewood Canyon	Side Canyon D, Site 2	NAWS	Riparian		2			2													2007
Homewood Canyon	Side Canyon D, Site 3	NAWS	Riparian		2			2													2007
Homewood Canyon	Side Canyon D, Site 4	NAWS	Riparian	2	3			2													2007
Homewood Canyon	Site 1	NAWS	Riparian	4	4			3									4				2019
Homewood Canyon	Site 2	NAWS	Riparian	0	2			2									2				2019
Homewood Canyon	Site 2	NAWS	Riparian	0	2			3													2007
Homewood Canyon	Site 3	NAWS	Riparian	0	2			2									2				2019

Study Area	**Site Name**	**Land-owner**	**Habitat Type**	**Before 1998**	**1998**	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2014**	**2015**	**2016**	**2019**	**2020**	**2021**	**2022**	**Most Recent Survey Year**
Homewood Canyon	Site 3	NAWS	Riparian	0	0			2													2007
Homewood Canyon	Site 4	NAWS	Riparian	2	8			5									2				2019
Homewood Canyon	Site 5	NAWS	Riparian	0	5			5									4				2019
Homewood Canyon	Site 6	NAWS	Riparian	1	3			6									3				2019
Homewood Canyon	Southwest of Site 6 (over a ridge)	NAWS						2													2007
Indian Joe Canyon	Allen Springs Site 1	BLM	Riparian	2	2	4						4					4	3		2	2022
Indian Joe Canyon	Allen Springs Site 2	BLM	Riparian	0	2	0						0					2	0		0	2022
Indian Joe Canyon	Indian Joe Spring	CDFW	Riparian	2	2	5						4					3	2		2	2022
Indian Joe Canyon	Site 1A	CDFW	Baccharis		1	0						0					0	0		0	2022

Study Area	**Site Name**	**Land-owner**	**Habitat Type**	**Before 1998**	**1998**	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2014**	**2015**	**2016**	**2019**	**2020**	**2021**	**2022**	**Most Recent Survey Year**
Indian Joe Canyon	Site 1B	CDFW	Riparian	2	0	2						0					0	0		0	2022
Indian Joe Canyon	Site 2	CDFW	Riparian	0	0	1						0					0	0		0	2022
Indian Joe Canyon	Site 3	CDFW	Riparian	2	2	2						2					1	0		0	2022
Indian Joe Canyon	Site 4	CDFW	Riparian	2	2	2						1					0	2		0	2022
Indian Joe Canyon	Upper Canyon Site 1	CDFW	Riparian	0	2	1						1					2	2		1	2022
Indian Joe Canyon	Upper Canyon Site 1B	CDFW	Riparian	0	0	1						1					1	0		0	2022
Indian Joe Canyon	Upper Canyon Site 2	CDFW	Riparian	2	2	2						2					0	0		0	2022
Indian Joe Canyon	Upper Canyon Site 3	BLM	Riparian	0	2	2						2					2	2		0	2022
Junction Ranch Area	New House Springs	NAWS	Riparian	0	0			0			0		0			0					2016

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Millspaugh Canyon	Site 1	NAWS	Baccharis		0			2													2007
Millspaugh Canyon	Site 2	NAWS	Riparian		4			2													2007
Millspaugh Canyon	Site 3	NAWS	Riparian		1			7													2007
Moscow Spring Complex	Along Road into Moscow Springs Complex	NAWS						1													2007
Moscow Spring Complex	Between Site 2 and Site 3	NAWS						2													2007
Moscow Spring Complex	Moscow Spring	NAWS	Baccharis	0	0			1											0		2021
Moscow Spring Complex	Site 1	NAWS	Riparian	2	2			3						0			2				2019
Moscow Spring Complex	Site 10	NAWS	Riparian		3			3													2007

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Moscow Spring Complex	Site 11	NAWS						1													2007
Moscow Spring Complex	Site 2	NAWS	Riparian	2	1			4						2			2				2019
Moscow Spring Complex	Site 3	NAWS	Riparian	7	14			16						8			15				2019
Moscow Spring Complex	Site 4	NAWS	Riparian		2			1						0					0		2021
Moscow Spring Complex	Site 5	NAWS	Riparian	1	2			0						0			4		0		2021
Moscow Spring Complex	Site 6	NAWS	Riparian	0	3			2									2		0		2021
Moscow Spring Complex	Site 7	NAWS	Riparian	0	0			2											0		2021
Moscow Spring Complex	Site 8	NAWS	Baccharis		0			0						0					1		2021

Study Area	**Site Name**	**Land-owner**	**Habitat Type**	**Before 1998**	**1998**	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2014**	**2015**	**2016**	**2019**	**2020**	**2021**	**2022**	**Most Recent Survey Year**
Moscow Spring Complex	Site 9	NAWS	Riparian	1	0			2						0					0		2021
Moscow Spring Complex	Up Canyon from Site 1	NAWS						2													2007
Mountain Spring Canyon	Joshua Spring	NAWS	Riparian	2	2			1						1					2	2	2022
Mountain Spring Canyon	Lower Mammoth Mine	NAWS	Riparian	2	2			2				4							2		2021
Mountain Spring Canyon	Mountain Springs	NAWS	Riparian	2	15		1	8					5	4		4			6	2	2022
Mountain Spring Canyon	Site 1	NAWS	Riparian	1	2		2	0						0							2014
Mountain Spring Canyon	Site 10	NAWS	Riparian		2		1	2						0					0		2021
Mountain Spring Canyon	Site 11	NAWS	Riparian		2		0	2						1					2		2021

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Mountain Spring Canyon	Site 12	NAWS	Riparian		2			2											0	2	2022
Mountain Spring Canyon	Site 13	NAWS	Riparian		2		0	2											0	4	2022
Mountain Spring Canyon	Site 14	NAWS	Riparian		2			4											0	2	2022
Mountain Spring Canyon	Site 15	NAWS	Riparian	6	8			10						2					2	4	2022
Mountain Spring Canyon	Site 16	NAWS	Riparian		0			0						0					0		2021
Mountain Spring Canyon	Site 2	NAWS	Riparian		2		0	2						0							2014
Mountain Spring Canyon	Site 3	NAWS	Riparian		2		1	0						0					0	2	2022
Mountain Spring Canyon	Site 4	NAWS	Riparian		2		0	2						0							2014

Study Area	**Site Name**	**Land-owner**	**Habitat Type**	**Before 1998**	**1998**	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2014**	**2015**	**2016**	**2019**	**2020**	**2021**	**2022**	**Most Recent Survey Year**
Mountain Spring Canyon	Site 5	NAWS	Riparian	2	2		2	0						1					2	2	2022
Mountain Spring Canyon	Site 6	NAWS	Riparian		2			0						0					0		2021
Mountain Spring Canyon	Site 7	NAWS	Riparian	2	4		1	2						2					4	2	2022
Mountain Spring Canyon	Site 8	NAWS	Riparian	2	8		4	4					1	5					6	4	2022
Mountain Spring Canyon	Site 9	NAWS	Riparian	2	2		3	2						2					0		2021
Mountain Spring Canyon	Upper Mammoth Mine	NAWS	Riparian	4	6			6		6		10							4	5	2022
Mountain Spring Canyon	Wild Rose Spring	NAWS	Riparian	2	2			1							2				0		2021

Study Area	**Site Name**	**Land-owner**	**Habitat Type**	**Before 1998**	**1998**	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2014**	**2015**	**2016**	**2019**	**2020**	**2021**	**2022**	**Most Recent Survey Year**
Mumford Canyon	Between No Name and Rattlesnake Springs	BLM	Baccharis		2	0						1					0	0		0	2022
Mumford Canyon	Mumford Canyon Seep	BLM				1						2					2	2		2	2022
Mumford Canyon	No Name Spring	BLM	Baccharis	2	2	0						0					0	0		0	2022
Mumford Canyon	Pothole Spring	BLM	Upland		2	2						0					0	0		0	2022
Mumford Canyon	Rattlesnake Springs (East Spring)	BLM				2						2					0	0		0	2022
Mumford Canyon	Rattlesnake Springs (West Spring)	BLM	Riparian	3	4	0						1					2	2		2	2022
Mumford Canyon	Site 1	BLM				2						2					0	0		0	2022
Mumford Canyon	Site 2	BLM				2						2					0	0		0	2022

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Mumford Canyon	Site 3	BLM				2						2					2	2		2	2022
Mumford Canyon	Site 4	BLM				1						2					0	0		0	2022
North Fork Water Canyon	La Motte Spring	NAWS	Riparian	0	4			6							2	2			6		2021
North Fork Water Canyon	Site 1	NAWS	Riparian		5			4							0	0			2		2021
North Fork Water Canyon	Site 2	NAWS	Riparian		0			2							0				0		2021
North Fork Water Canyon	Site 3	NAWS	Riparian		1			5							0				0		2021
North Fork Water Canyon	Site 4	NAWS	Riparian		1			0													2007
North Fork Water Canyon	Site 5	NAWS	Riparian		2			2													2007

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
North Fork Water Canyon	Site 6	NAWS	Riparian	0	2			4													2007
North Fork Water Canyon	Up Canyon from La Motte Spring	NAWS						1													2007
North Homewood Canyon	Alpha Spring	BLM	Riparian	2	4	1						2					0	0		2	2022
North Homewood Canyon	Bobcat Spring	BLM	Riparian	2	2	0						4					2	2		2	2022
North Homewood Canyon	Residential	BLM	Exotic		2	2															2004
North Homewood Canyon	Ruby Spring	NAWS	Riparian	2	6			3									4				2019
North Homewood Canyon	Site 1	BLM	Riparian	2	1	2						2					2	2		2	2022

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
North Homewood Canyon	Site 1B	BLM	Riparian		3	2						2					0	0		0	2022
North Homewood Canyon	Site 2	BLM	Riparian	0	1	0						1					0	0		2	2022
North Homewood Canyon	Site 3	BLM	Riparian	2	0	2						2					2	2		2	2022
North Homewood Canyon	Site 4	BLM	Riparian	2	2	4						2					2	2		2	2022
North Homewood Canyon	Site 5	NAWS	Riparian	4	6			4									4				2019
North Homewood Canyon	Site 6	NAWS	Riparian		2			3									2				2019
North Wilson Canyon	East of Site 9	NAWS						2				0									2011
North Wilson Canyon	Mouth of Canyon	NAWS	Wash		1			1													2007

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
North Wilson Canyon	Site 1	NAWS	Riparian	0	3			2									2				2019
North Wilson Canyon	Site 10	NAWS	Riparian		2		5	2		2	2	2					4				2019
North Wilson Canyon	Site 2	NAWS	Riparian	2	6			3									2				2019
North Wilson Canyon	Site 3	NAWS	Riparian	2	12			8									8				2019
North Wilson Canyon	Site 4	NAWS	Riparian	1	6			2									2				2019
North Wilson Canyon	Site 5	NAWS	Riparian	0	6		0	10													2007
North Wilson Canyon	Site 6	NAWS	Riparian		2			0									0				2019
North Wilson Canyon	Site 7	NAWS	Riparian	1	4		6	6	3	3	0	4					4				2019

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
North Wilson Canyon	Site 8	NAWS	Riparian	2	8		5	10	5	9	6	8					10				2019
North Wilson Canyon	Site 9	NAWS	Riparian		2		5	4	2	2	0	2					2				2019
Rattlesnake Canyon	Sidehill Spring	BLM	Baccharis		2	0						3					1	2		2	2022
Shepherd Canyon Area	C.C. Jones (WSW of Onyx Mine)	BLM	Baccharis	0	0	2						0									2011
Shepherd Canyon Area	Site 1	BLM	Baccharis	0	2	0						2									2011
Shepherd Canyon Area	Site 10	NAWS	Baccharis	0	2			0													2007
Shepherd Canyon Area	Site 11	NAWS	Riparian		0			2													2007
Shepherd Canyon Area	Site 13	NAWS	Riparian	0	1			0													2007

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Shepherd Canyon Area	Site 3	NAWS	Baccharis		2			0													2007
Shepherd Canyon Area	Site 4	NAWS	Riparian	0	2			1													2007
Shepherd Canyon Area	Site 5	NAWS	Riparian	0	2			2													2007
Shepherd Canyon Area	Site 8	NAWS	Riparian	0	2			2													2007
South Fork Water Canyon	Site 1	NAWS	Riparian	2	5			7							4						2015
South Fork Water Canyon	Site 2	NAWS	Riparian	2	2			6							2						2015
South Fork Water Canyon	Site 3	NAWS	Riparian	0	2			3													2007
South Fork Water Canyon	Site 4	NAWS	Riparian	0	1			5													2007

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
South Fork Water Canyon	South of Coyote Springs	NAWS						2													2007
Upper North Homewood Canyon	Between Sites 1 and 2	NAWS	Upland		2			0													2007
Upper North Homewood Canyon	Site 1	NAWS	Riparian		2			4							4		2				2019
Upper North Homewood Canyon	Site 2	NAWS	Riparian	2	2		2	4							2		4				2019
Upper North Homewood Canyon	Site 3	NAWS	Riparian	6	6		7	8							4		4				2019
Upper North Homewood Canyon	Site 4	NAWS	Riparian	4	2		6	5							2		4				2019

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Upper North Homewood Canyon	Southeast of Site 1	NAWS	Upland		2			0													2007
Water Canyon	Margaret Ann Spring	NAWS	Riparian	2	2			2													2007
Water Canyon	Side Canyon A Spring	BLM	Wash	0	2	0						0									2011
Water Canyon	Side Canyon B Site 1	BLM	Riparian	1	1	0						0									2011
Water Canyon	Side Canyon B Site 2	BLM	Riparian	0	0	2						3									2011
Water Canyon	Side Canyon B Site 3B	BLM										1									2011
Water Canyon	Side Canyon B Site 5	NAWS	Riparian		6			8													2007
Water Canyon	Side Canyon B Site 6	NAWS	Riparian		2			1													2007

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Water Canyon	Side Canyon B Site 7	NAWS	Riparian		5			4													2007
Water Canyon	Side Canyon B Site 8	NAWS						2													2007
Water Canyon	Side Canyon B Site 9	NAWS						2													2007
Water Canyon	Site 1	NAWS	Riparian	2	6			2													2007
Water Canyon	Site 2	NAWS	Riparian	0	6			6													2007
Water Canyon	Site 3	NAWS	Riparian		4			4													2007
Water Canyon	Site 4	NAWS	Riparian		2			4													2007
Water Canyon	Site 4B	NAWS	Riparian		0			2													2007
Water Canyon	Site 5	NAWS	Riparian		10		2	10													2007

Study Area	Site Name	Land-owner	Habitat Type	Before 1998	1998	2004	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016	2019	2020	2021	2022	Most Recent Survey Year
Water Canyon	Site 6	NAWS	Riparian		4			4													2007
Water Canyon	Site 7	BLM	Riparian		4	4						4									2011
Water Canyon	Site 8A	BLM				2						1									2011
Water Canyon	Site 8B	BLM				2						2									2011
Water Canyon	Site 8D	BLM				0						2									2011
Water Canyon	Site 9	BLM										2									2011
Water Canyon	Snooky Spring	NAWS	Riparian		2			2													2007
Wilson Canyon	Between Site 2 and Site 3	NAWS						6													2007
Wilson Canyon	East of Site 1	NAWS	Upland		1			2													2007
Wilson Canyon	Site 1	NAWS	Baccharis		2			2													2007

Study Area	**Site Name**	**Land-owner**	**Habitat Type**	**Before 1998**	**1998**	**2004**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2014**	**2015**	**2016**	**2019**	**2020**	**2021**	**2022**	**Most Recent Survey Year**
Wilson Canyon	Site 2	NAWS	Baccharis		2			2													2007
Wilson Canyon	Site 3	NAWS	Baccharis		4			0													2007
Total Adults				**192**	**640**	**204**	**71**	**502**	**15**	**22**	**8**	**232**	**14**	**39**	**22**	**24**	**208**	**130**	**65**	**148**	

[1] Habitat type was defined by Laberteaux and Garlinger (1998, table 4); thus sites discovered after 1998 do not specify habitat type.
[2] Blank table cells indicate that the site was not surveyed during the corresponding year.
[3] Data compiled by the Carlsbad Fish and Wildlife Office from survey reports (1998–2022).

APPENDIX B

CLIMATE PROJECTIONS

To assess potential future climate in Inyo California towhee habitat, we gathered climate variables projected under an 8-GCM (General Circulation Model) ensemble from *ClimateNA*, under the Shared Socioeconomic Pathways (SSP), SSP2-4.5 and SSP5-8.5, climate change scenarios (Wang *et al*. 2016, entire; AdaptWest Project 2021, dataset). SSP2-4.5 is an intermediate greenhouse gas emissions scenario with carbon dioxide (CO_2) emissions remaining at current levels to mid-century while socioeconomic factors follow historical trends. The SSP 5-8.5 is a very high greenhouse gas emission scenario with no additional climate policies; CO_2 emissions roughly double from current levels by 2050. These scenarios represent the recommended lower and upper bounds scenarios for use in Service conservation planning and decision-making.

We specifically assessed trends in seasonal and annual precipitation, seasonal average temperature, and maximum summer temperature. We also used two different measures of water balance and drought risk: Hargreaves' climatic moisture index, and Hogg's climate moisture index, measured in millimeters (mm). The Hargreaves' climatic moisture index (CMD) is calculated as the difference between *reference* evapotranspiration relative to precipitation. For this metric, higher values indicate a larger moisture deficit, and thus greater drought risk. The *Hogg's climate moisture index (mm)* is calculated as the difference between precipitation and *potential* evapotranspiration, where more negative values indicate drier climate conditions, and greater drought risk. These metrics differ in how evapotranspiration (water loss from the environment through direct evaporation and through transpiration by plants) is defined, with reference evapotranspiration defined in terms of water loss from a grass surface that is well-watered, and potential evapotranspiration as that from a surface with unlimited water. Thus, these metrics serve as complementary measures of projected moisture trends over time.

For each metric, we summarized average values over three 20-year timeframes at each of 269 known locations of Inyo California towhee. We defined these timeframes as historical (2002-2022), near term (2023-2042), and mid-century (2043-2062) to match the climate data scaling.

The seasonal data available with *ClimateNA* define winter as December to February, spring as March to May, summer as June to August, and autumn as September to November.

Table B1. Mean, Minimum, and Maximum Precipitation (in mm) at 269 Known Locations of Inyo California Towhee Historically (2002–2022), and Projected for the Near Term (2023–2042), and Mid-century (2043–2062) in Each Season Under the Lower Impact Climate Change Scenario (SSP2-4.5). Total Annual Precipitation is also Shown.

Season	Period	Mean	Minimum	Maximum
Winter	Historical	103	67	138
Winter	Near term	94	60	126
Winter	Mid century	97	63	131
Spring	Historical	43	23	73
Spring	Near term	43	23	75
Spring	Mid century	46	24	78
Summer	Historical	23	16	67
Summer	Near term	26	18	73
Summer	Mid century	26	18	76
Autumn	Historical	36	21	71
Autumn	Near term	39	23	74
Autumn	Mid century	43	26	82
Annual	Historical	205	127	319
Annual	Near term	202	124	324
Annual	Mid century	211	130	341

Table B2. Mean, Minimum, and Maximum Precipitation (in mm) at 269 Known Locations of Inyo California Towhee Historically (2002–2022), and Projected for the Near Term (2023–2042), and Mid-century (2043–2062) in Each Season Under the Higher Impact Climate Change Scenario (SSP5-8.5). Total Annual Precipitation is Also Shown.

Season	Period	Mean	Minimum	Maximum
Winter	Historical	104	68	140
Winter	Near term	92	59	124
Winter	Mid century	91	58	123
Spring	Historical	42	22	73
Spring	Near term	45	24	77
Spring	Mid century	40	21	68
Summer	Historical	23	15	65
Summer	Near term	27	18	75
Summer	Mid century	24	16	71
Autumn	Historical	36	21	71
Autumn	Near term	40	23	75

Season	Period	Mean	Minimum	Maximum
Autumn	Mid century	38	23	74
Annual	Historical	205	127	317
Annual	Near term	203	125	326
Annual	Mid century	193	119	312

Table B3. Hargreaves' Climatic Moisture Index (CMD) at 269 Known Locations of Inyo California Towhee historically (2002–2022), and Projected for the Near Term (2023–2042), and Mid-century (2043–2062) in Each Season Under the Lower Impact Climate Change Scenario (SSP2-4.5). The Range in CMD Across Sites is Also Shown as the "Minimum" and "Maximum."[1]

Season	Period	Mean	Minimum	Maximum
Winter	Historical	41.0	22.4	79.4
Winter	Near term	32.8	5.6	86.8
Winter	Mid century	34.1	6.9	88.6
Spring	Historical	299.5	216.1	375.7
Spring	Near term	304.1	217.8	381.8
Spring	Mid century	308.6	221.5	387.8
Summer	Historical	525.3	404.3	609.4
Summer	Near term	532.6	407.4	617.2
Summer	Mid century	536.6	409.6	622.0
Autumn	Historical	221.0	157.3	278.1
Autumn	Near term	225.3	157.9	285.8
Autumn	Mid century	225.9	152.6	287.4

[1] All Measurements are in MM.

Table B4. Hargreaves' Climatic Moisture Index (CMD) at 269 Known Locations of Inyo California Towhee Historically (2002–2022), and Projected for the Near Term (2023–2042), and Mid-century (2043–2062) in Each Season Under the Higher Impact Climate Change Scenario (SSP5-8.5). The Range in Maximum Temperature Across Sites is Also Shown as the "Minimum" and "Maximum."[1]

Season	Period	Mean	Minimum	Maximum
Winter	Historical	40.0	22.6	78.5
Winter	Near term	35.9	6.8	88.8
Winter	Mid century	40.5	9.3	95.3
Spring	Historical	300.1	216.5	376.0
Spring	Near term	304.5	217.6	383.1
Spring	Mid century	325.2	241.4	402.2

Season	Period	Mean	Minimum	Maximum
Summer	Historical	526.4	406.8	610.3
Summer	Near term	531.5	406.1	616.5
Summer	Mid century	550.0	425.9	635.3
Autumn	Historical	220.5	157.3	277.8
Autumn	Near term	225.5	156.3	286.0
Autumn	Mid century	237.0	167.0	297.6

[1] All measurements are in mm.

Table B5. Hogg's climatic moisture index (CMI) for the historical (2002–2022), and projected for the near term (2023–2042), and mid-century (2043–2062) periods in each season under the lower impact climate change scenario (SSP2-4.5). The range in CMI across sites is also shown as the "minimum" and "maximum."[1]

Season	Period	Mean	Minimum	Maximum
Winter	Historical	-2.2	-10.8	4.4
Winter	Near term	-4.7	-13.4	2.0
Winter	Mid century	-5.5	-14.2	1.3
Spring	Historical	-24.8	-34.0	-14.4
Spring	Near term	-25.6	-35.0	-15.0
Spring	Mid century	-26.7	-36.2	-15.9
Summer	Historical	-56.9	-70.9	-40.0
Summer	Near term	-58.9	-73.3	-41.2
Summer	Mid century	-60.2	-74.9	-42.1
Autumn	Historical	-29.8	-39.3	-19.5
Autumn	Near term	-31.6	-41.7	-21.2
Autumn	Mid century	-32.4	-42.9	-21.7

[1] All measurements are in mm.

Table B6. Hogg's Climatic Moisture Index (CMD) at 269 Known Locations of Inyo California Towhee Historically (2002–2022), and Projected for the Near Term (2023–2042), and Mid-century (2043–2062) in Each Season Under the Higher Impact Climate Change Scenario (SSP5-8.5). The Range in CMD Across Sites is also Shown as the "Minimum" and "Maximum."[1]

Season	Period	Mean	Minimum	Maximum
Winter	Historical	-2.0	-10.7	4.6
Winter	Near term	-5.1	-13.7	1.6
Winter	Mid century	-6.8	-15.3	-0.2
Spring	Historical	-24.9	-34.0	-14.5
Spring	Near term	-25.9	-35.3	-15.1
Spring	Mid century	-29.0	-38.5	-18.5
Summer	Historical	-57.1	-71.0	-40.3
Summer	Near term	-58.9	-73.3	-41.1
Summer	Mid century	-63.3	-78.4	-45.1
Autumn	Historical	-29.7	-39.2	-19.5
Autumn	Near term	-31.7	-41.8	-21.2
Autumn	Mid century	-34.7	-45.3	-24.3

[1] All measurements are in mm.

U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW

Inyo California towhee
[*Melozone crissalis eremophila* (=*eremophilus*)]

Current Classification: Threatened

Recommendation Resulting from the 5-Year Review:

- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☐ Delist
- ☒ No Change Needed

Review Conducted By: Carlsbad Fish and Wildlife Office

FIELD OFFICE APPROVAL:

- ☒ Approved

SCOTT SOBIECH
Digitally signed by SCOTT SOBIECH
Date: 2024.02.15 14:49:17 -08'00'

Lead Field Supervisor
U.S. Fish and Wildlife Service