INYO CALIFORNIA TOWHEE SURVEYS
NAVAL AIR WEAPONS STATION CHINA LAKE, CA 2022

Final Report

Prepared by:
Mary J. Whitfield and Nidia Jaime
Southern Sierra Research Station
PO Box 1316
Weldon, CA 93283

Under contract with:

Wood Environment & Infrastructure Solutions Inc.
1845 Chicago Ave, Suite D
Riverside, CA 92570

and

Nicklaus Engineering, Inc
1851 W. 24th St., Suite 101
Yuma, AZ 85364

for

Naval Air Weapons Station China Lake
Environmental Management Division
429 E. Bowen Road, Stop 4014
China Lake, CA 93555

and

Naval Facilities Engineering Command, SW
1220 Pacific Highway
San Diego, CA 92132-5190

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SUMMARY

We surveyed Inyo California Towhees at the Naval Air Weapons Station China Lake by spot mapping Inyo California Towhee (*Melozone crissalis eremophilus*) territories on six plots during the spring of 2022. Additionally, we recorded all individuals of sensitive or declining bird species that we detected, as well as Brown-headed Cowbirds (*Molothrus ater*).

We recorded a total of 40 adults and 19 Inyo California Towhee territories within the spot mapping sites during two visits from May to June. For most of these territories (~70%) we detected evidence of reproduction, such as nests or fledglings.

The Inyo California Towhee population in the Mountain Springs Canyon area has significantly declined since 1998 (Figure 2, Table 4). We detected decreases at half the sites and increases at the other half; it is difficult to discern whether the changes are due to movement or differences in survey method. Overall, there was a small population increase in the study area between 2020 and 2021, which coincided with an increase in precipitation. Others have noted that Inyo California Towhee population size appears to be influenced by precipitation due to its effects on habitat and water availability (LaBerteaux 2021, Atwell 2020).

Surveys conducted in other areas outside of our study site indicate that the Inyo California Towhee has greatly declined throughout its range (LaBerteaux 2021, Atwell 2020). This is likely due to a decline in habitat quality caused by an increase in feral equine populations and hotter, drier conditions driven by climate change. However, it is difficult to know the magnitude of the population decline without a single year range-wide survey to compare it to past range-wide surveys.

Our results highlight the importance of springs in the Argus Range which support riparian vegetation that serves as nesting and/or foraging habitat for the Inyo California Towhee as well as other sensitive and declining species such as the Black-chinned Sparrow (*Spizella atrogularis*), Golden Eagle (*Aquila chrysaetos*), and Loggerhead Shrike (*Lanius ludovicianus*), and as potential stop over sites for migratory birds, such as Olive-sided Flycatcher (*Contopus cooperi*), Willow flycatcher (*Empidonax traillii*) and Yellow Warbler (*Setophaga petechia*). These habitats will likely become even more essential as water becomes scarcer in the region due to climate change. Areas with water may act as refugia during this period, increasing the importance of protecting these sites.

Lastly, we recommend several studies and management actions such as remote sensing models, movement studies combined with surveys, and population modeling that would provide information that is needed to identify the ecological factors that affect the population size and distribution of this subspecies, allowing the implementation of more effective conservation actions.

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Commented [SJSCNS3]: I don't believe GOEA have been documented breeding in riparian veg associated w/ these springs

Commented [MW4R3]: Yes, I'm aware that they don't breed in riparian habitat, however, our original sentence didn't mention breeding or riparian vegetation. I would however argue that springs are important for GOEAs because there would be a lot less prey for them if there were not springs in the area this is especially true in desert areas.

INTRODUCTION

Bird populations in the Mojave Desert have experienced a severe decline over the past century. The warming and drying conditions of the desert, particularly the decline in precipitation due to climate change, could be driving species beyond their physiological limits, resulting in the collapse of desert communities (Iknayan and Bessinger 2018).

The Inyo California Towhee (ICTO) is a desert resident restricted to riparian habitats of the southern Argus Mountains in the Mojave Desert, on lands administered mostly by Naval Air Weapons Station China Lake (NAWSCL) and the Bureau of Land Management (LaBerteaux and Garlinger 1998). Following the same pattern as other desert bird populations, ICTO numbers have been declining since 2014, even disappearing from some breeding areas. This decline is thought to be a consequence of the decrease in precipitation, degradation of riparian habitats by feral equines, and other human-related disturbances (LaBerteaux 2021)

Currently, the ICTO is listed as a threatened species by U.S. Fish and Wildlife Service (USFWS) under the Federal Endangered Species Act (USFWS 1987), and as an endangered species by the California Department of Fish and Wildlife (CDFW) under the California Endangered Species Act (CESA 1970). However, there is a petition and proposed rule to delist it if the population maintains a minimum of 400 individuals for at least five years (FWS 2013). There is an urgent need to develop a long-standing monitoring program to assess ICTO population trends as well as the condition of their habitats.

The Naval Facilities Engineering Command, Southwest (NAVFAC) funded a multi-faceted field effort to support the establishment of a long-term ICTO monitoring program in the Mojave Desert and contracted with Wood Environment and Infrastructure Services, Inc. to conduct this work. Data collected under this project will support continued management of ICTO at NAWSCL.

The Southern Sierra Research Station conducted the ICTO monitoring work at NAWSCL in accordance with the Scope of Work (SOW), Contract # N62473-20-D-0024, Task Order # N6247320F5396 as a subcontractor to Wood/Nicklaus Engineering, Inc. The project consisted of surveying ICTO using spot mapping, as well as mapping Brown-headed Cowbirds (*Molothrus ater*) and any sensitive or declining species detected on six plots located on NAWSCL.

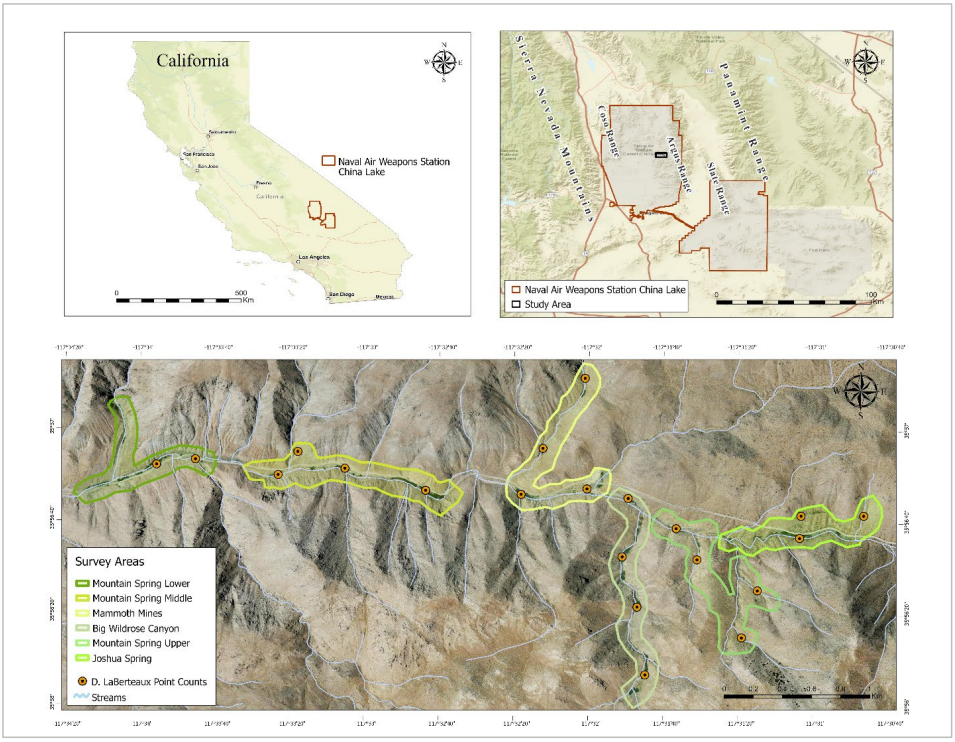
Spot mapping is an avian survey technique used to estimate the size of populations through the delimitation of territories (Gregory et al. 2004). This method creates a detailed map of the distribution of the species of interest within the study area and allows any observer to delineate the territories from the data collected, such that the results can be compared with data from future studies (Atwell 2020). C. McCreedy suggested that spot mapping would be a better alternative to the transect strip-belt method used for quantifying ICTO populations in past studies (Atwell 2020). He thought that because the strip-belt protocol did not record every location an ICTO was detected, it did not clearly show how the surveyor determined whether a

detection of an ICTO was one individual or multiple individuals, potentially affecting overall population estimates. He felt that territory (and/or individual) mapping would help improve confidence in Towhee counts and provide better comparisons between years. Thus, we decided to spot map Towhees using two visits as suggested by Atwell (2020).

STUDY AREA

The study area is in the southern Argus Mountain Range located east of the Sierra Nevada and Coso Range and west of the Slate and Panamint Ranges in the northern Mojave Desert. When choosing our sites, we gave preference to sites previously occupied by Inyo California Towhees, according to surveys conducted by D. LaBerteaux (LaBerteaux 2014, LaBerteaux 2015, and LaBerteaux 2021) (Figure 1).

Figure 1. Location of spot mapping sites within China Lake Naval Air Weapons Station.



We chose Mountain Springs Canyon including three of its side canyons, Big Wildrose Canyon, Mammoth Mine, and Joshua Spring for spot mapping Inyo California Towhees. In this area, we selected six survey sites that contained 21 sites previously surveyed by D. LaBerteaux (Figure 1, Table 1).

Mountain Springs Canyon is an 8 km long, east-west oriented canyon on the west slope of the Argus Range between 1298 to 1680 m elevation. A system of perennial streams flow through the area and its multiple side canyons which allow the establishment of several patches of riparian vegetation. The upland habitat is dominated by shrubby desert vegetation (LaBerteaux 2021).

Table 1. Inyo California Towhee spot mapping sites on Naval Weapons Station, China Lake. Coordinates and site names are given for sites from past reports from D. LaBerteaux that are encompassed within our study sites.

Site Name[1]	UTM (NAD 83) Easting	UTM (NAD 83) Northing	Elevation (m.a.s.l)
Mountain Spring Lower			
Mountain Spring	448954	3978337	1310
Mountain Springs Canyon Site 3	449221	3978372	1332
Mountain Spring Middle			
Mountain Springs Canyon Site 5	449789	3978264	1372
Mountain Springs Canyon Site 6	449925	449925	1414
Mountain Springs Canyon Site 7	450248	3978307	1405
Mountain Springs Canyon Site 8	450803	3978155	1448
Mammoth Mines			
Upper Mammoth Mine	451901	3978924	1610
Lower Mammoth Mine	451610	3978443	1525
Mountain Springs Canyon Site 9	451459	3978127	1501
Mountain Springs Canyon Site 10	451913	3978164	1526
Big Wildrose Canyon			
Mountain Springs Canyon Site 11	452195	3978099	1543
Big Wildrose Canyon Site 1	452154	3977698	1585
Big Wildrose Canyon Site 2	452256	3977352	1627
Big Wildrose Canyon Site 3	452310	3976886	1701
Mountain Spring Upper			
Wildrose Spring	452526	3977891	1570
Mountain Springs Canyon Site 12	452668	3977677	1620
Mountain Springs Canyon Site 13	452973	3977140	1703
Mountain Springs Canyon Site 14	453083	3977464	1660
Joshua Spring			
Mountain Springs Canyon Site 15	453374	3977824	1645
Mountain Springs Canyon Site 16	453384	3977976	1671
Joshua Spring	453815	3977976	1698

[1]These sites are broken down to cross-reference names from past reports by D. LaBerteaux

METHODS

Spot mapping surveys

We conducted spot mapping surveys at six plots, two times each during the 2022 breeding season, from May 05 to June 01 (Table 2, **Error! Reference source not found.**). Surveys started at sunrise and typically ended around 1100, though they sometimes ended earlier when bird activity was low, including when temperatures exceeded 100 degrees Fahrenheit. For each survey an observer walked slowly across the site, passing within 50m of every location inside the site boundary evenly by 11am, with the goal of detecting 100% of ICTO present within that survey area. We alternated the survey direction in consecutive visits to account for bias created by daily bird activity patterns. Once an ICTO individual or pair was located we spent a minimum of 20 minutes observing the bird(s), taking points and behavioral data for each location that an ICTO was sighted. For each Towhee observation we recorded the number of individuals in the group, and whether they were adult or dependent young. Although the species is not sexually dimorphic, we recorded notes about suspected sex based on behavior. Any nests found incidentally were also recorded on the map. Additionally, we recorded all individuals of sensitive or declining bird species that we detected, as well as Brown-headed Cowbirds. Lastly, we kept a list of all bird species observed at the study site.

We recorded all ICTO, Brown-headed Cowbirds and sensitive or declining species detected using the ArcGIS Collector app (ESRI, 2018) on a tablet carried by surveyors. Each observation of individual birds, pairs or groups of birds of the same species, dependent young, and nests were recorded on the map. For each bird detected, we recorded the species, and the sex and age when possible. Additionally, we collected behavior data, including counter-singing, territorial display, territorial dispute, and courtship, to determine territoriality and breeding status (see Appendix A for more spot mapping details).

Territoriality and breeding status of each detected bird were determined as behavior data was obtained, or at the end of the season to take advantage of the surveyor's cumulative knowledge of the birds observed. Territoriality and breeding status were determined based on the following observations:

Evidence of a bird with a territory (unmated male)

- A bird observed or heard singing in the same area on both surveys.
- A territorial dispute observed between two birds, and at least one of the birds detected in the same area on both surveys.

Evidence of a pair with a territory

- Two birds of the same species observed in proximity without engaging in antagonistic behavior, and at least one of the birds detected in the same area on both surveys.
- Two birds of the same species heard vocalizing interaction sounds, and at least one of the birds detected on both surveys.

Commented [SJSCNS5]: Were broadcast surveys used? Explain why or why not.

Commented [MW6R5]: Broadcast surveys are never used for spot mapping. The purpose of spot mapping is to find birds through passive means and record them in areas they occur in with minimal disturbance. We feel we were able to detect most if not all of the individuals present in the area without broadcast surveys (with two visits).

Commented [SJSCNS7]: How was behavior data recorded? As a GIS attribute?

Commented [LRECU(8R7]: Concur. Please explain in the report.

Commented [MW9R7]: Yes, these were collected as a GIS attribute. I added a more detailed description of our methods in a new appendix.

- A bird observed silently guarding its territory and at least one of the birds detected in the same area on both surveys

Evidence of a breeding pair with a territory

- A suspected female observed repeatedly emerging from and returning to a suspected nest area, while the male foraged and/or sang nearby
- Two birds observed copulating
- A bird observed carrying nest material
- A bird observed carrying food
- A bird observed doing a distraction display
- A bird observed incubating
- A nest found in construction, with eggs, or with nestlings
- Fledglings observed

Territory Delineation

We delineated territories of ICTO and Black-chinned Sparrows by updating and revising estimated individual territory boundaries after each visit. For each plot, territories for each species were mapped in ArcGIS and uniquely and sequentially numbered.

RESULTS

Commented [SJSCNS10]: Was weather data recorded during surveys? Please include in a table

Commented [MW11R10]: Will include in Table 2.

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Our survey routes ranged between 1350 to 1800 m in length, and we spent an average of 5.0 hours (range = 3.83 to 5.68 hours) at each spot mapping site per visit (Table 2). We recorded a total of 40 adults and 19 Inyo California Towhee territories within the spot mapping sites during two visits from May to June (Tables 3 and 4, Figure 2). For 13 of those territories, we had evidence of breeding (e.g., nests, fledglings), and for the other 6, there was evidence of a pair (e.g., mate guarding, interaction calls). We did not find territorial unpaired Towhees, however, we observed two individuals (one in Big Wildrose Canyon, and one in Mammoth Mines) that were only detected once and therefore were not assigned to any territory. Mountain Springs Middle, Big Wildrose Canyon and Mountain Springs Upper had the highest number of Inyo California Towhee territories.

Additionally, we recorded a total of six sensitive or declining bird species: Black-chinned Sparrow (*Spizella atrogularis*), Golden Eagle (*Aquila chrysaetos*), Loggerhead Shrike (*Lanius ludovicianus*), Olive-sided Flycatcher (*Contopus cooperi*), Willow flycatcher (*Empidonax traillii*) and Yellow Warbler (*Setophaga petechia*). For most of the species that could be residents (i.e., the two flycatchers were migrants), we did not find enough evidence to categorize them as territorial birds. However, for Black-chinned Sparrow (BCSP) we detected 11 territories in the survey areas. For nine BCSP territories, we found evidence of breeding, and for two we found evidence of a territorial bird. Mountain Springs Upper followed by Big Wildrose Canyon had the largest number of Black-chinned Sparrow territories. Mountain Springs Upper had the largest number of sensitive or declining bird species detected.

Table 2. Inyo California Towhee spot mapping dates, times, and surveyors. Weather conditions were recorded at the beginning and end of each spot mapping visit during the second round (we did not record weather for the first round).

[1]Surveyors: NJ = Nidia Jaime, AM = Annie Meyer, AR = Alexander Robinson

[2]Weather: T = temperature (°F); W = Wind (0: Less than 1 mph, smoke rises vertically; 1: Smoke drift shows wind direction, 1-3 MPH; 2: Leaves rustle, wind is felt on face, 4-7 MPH; 3: Leaves, small twigs in constant motion, light flag extended, 8-12 MPH; 4: Raises dust, leaves, loose paper, small branches in motion, 13-18 MPH; 5: Small trees sway, white caps on lake, >18 MPH); CC = Cloud Cover (1: 0-25%; 2: 25-50%; 3: 50-75%; 4: 75-100%); S = Sky Conditions (0: Clear or few clouds, 0-15% cloud cover; 1: Partly cloudy, scattered, or variable sky, 16-50% cloud cover; 2: Cloudy, broken, or mostly overcast, 51-75% cloud cover; 3: Overcast, 76-100% cloud cover; 4: Fog or smoke; 5: Drizzle; 6: Snow; 7= Showers).

Site Name	Survey Dates	Time (PDT) Start to End	Survey Length	Surveyor[1]	Weather[2] Start to End			
					T	W	CC	S
Mountain Springs Lower	May 05 2022	0546 - 1105	1350 m	NJ				
	June 01 2022	0530 - 1056		AR	57-71	2-2	1-1	0-0
Mountain Springs Middle	May 05 2022	0558 - 1100	1400 m	AM				
	June 01 2022	0532 - 1051		NJ	57-71	1-2	1-1	0-0
Mammoth Mines	May 05 2022	0553 - 1100	1650 m	AR				
	May 31 2022	0601 - 1112		NJ	52-67	3-2	1-1	0-0
Big Wildrose Canyon	May 06 2022	0557 - 1100	1650 m	NJ				
	May 31 2022	0542 - 1030		AM	56-77	1-2	1-1	0-0
Mountain Springs Upper	May 06 2022	0555 - 1105	1800 m	AM				
	May 31 2022	0547 - 1127		AR	56-67	2-3	1-1	0-0
Joshua Spring	May 06 2022	0558 - 1116	1500 m	AR				
	June 01 2022	0541 - 0930		AM	46-67	2-2	1-1	0-0

Table 3. ICTO and BCSP territory numbers and Sensitive and Declining species detected at spot mapping sites on NAWSCL (d= detected).

Site Name	ICTO Territoriality and Breeding Status			Total # ICTO Territories	BHCO and Sensitive or Declining Species						
	Bird w Territory	Pair w Territory	Breeding Pair w Territory		BHCO	BCSP	GOEA	LOSH	OSFL	WIFL	YEWA
Mountain Springs Lower	0	1	1	**2**	*	*	*	*	**d**	*	**d**
Mountain Springs Middle	0	1	3	**4**	**d**	**1**	*	**d**	*	*	**d**
Mammoth Mines	0	1	1	**2**	*	**1**	*	*	*	**d**	**d**
Big Wildrose Canyon	0	2	2	**4**	*	**3**	*	*	*	*	**d**
Mountain Springs Upper	0	0	4	**4**	**d**	**4**	**d**	**d**	*	**d**	**d**
Joshua Spring	0	1	2	**3**	*	**2**	*	*	*	*	**d**
Total # of territories	**0**	**6**	**13**	**19**	d	11	d	d	d	d	d

Table 4. Inyo California Towhee adults detected in 1998, 2007, 2021 and 2022 in Mountain Springs Canyon, NAWSCL.

Site Name[1]	# ICTO adults detected by strip/belt method[2]			# ICTO adults detected by spot mapping method	
	1998	2007	2021	2021[3]	2022
Mountain Springs Lower	17	8	6	4	4
Mountain Springs Middle	16	6	12	-	8
Mammoth Mines	12	12	6	-	5
Big Wildrose Canyon	14	12	4	3	10
Mountain Springs Upper	8	9	0	-	8
Joshua Spring	10	11	4	-	6
Total	**77**	**58**	**32**	**-**	**41**

[1]See Table 1 for equivalences on site names.

[2]Data obtained from LaBerteaux (2021).

[3]Data obtained from SSRS (2021).

DISCUSSION

The Inyo California Towhee population in the Mountain Springs Canyon area has significantly declined since 1998 (Table 4, Figure 3). Compared to last year's survey results, we detected decreases at half the sites and increases at the other half. But overall, there was a small population increase across the entire study area between 2020 and 2021 which coincided with an increase in precipitation. Others have noted that Inyo California Towhee population size appears to be influenced by precipitation due to its effects on habitat and water availability (LaBerteaux 2021, Atwell 2020). This appears to be the case for the ICTO population in Mountain Springs Canyon (Figure 3), however, without a more detailed study it is difficult to know whether other demographic processes are also playing a role.

Spot mapping is recognized as one of the most accurate and precise methods to estimate the total number of pairs or territories of a species, and provides relatively accurate estimations of population sizes, especially if combined with nest searching (Gregory et al. 2004). During this study, this method allowed us to accurately detect the number of pairs of Inyo California Towhees, as well as determine their reproductive status by observing their behavior and opportunistically find their nests (although we did not approach or check nests). The 19 Inyo California Towhee pairs (out of 41 total individuals) found in this study represent a significantly higher percent of paired observations than the two pairs (out of 32 total individuals) found

Commented [SJSCNS13]: How else does this survey method compare with the line transect (strip/belt) method used in previous ICTO surveys at NAWSCL by LaBerteaux et al.? Why was this method used as an alternative to previous surveys? How should data be compared between different survey methods? Compare and contrast survey methods in terms of survey effort and data rigor.

Commented [LRECU(14R13]: Big time concur. This change needs to be fully explained, compared, and contrasted with other methods as Joe indicated. Thx.

Commented [MW15R13]: Done

Figure 2. Inyo California Towhee and Black-chinned Sparrow territories at the six spot mapping sites. FC = Food carry, MC = Material Carry.

Commented [SJSCNS16]: Label each map by site name

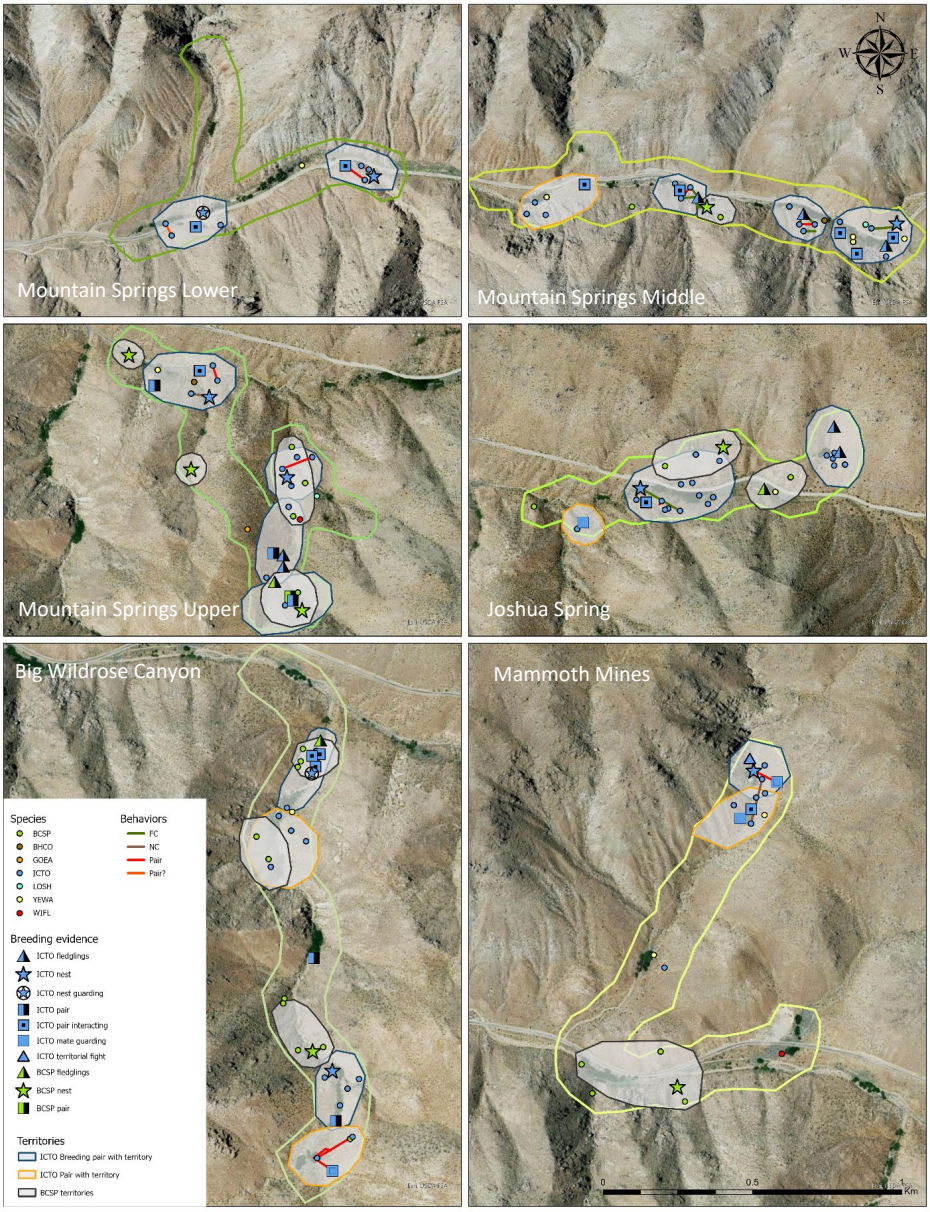
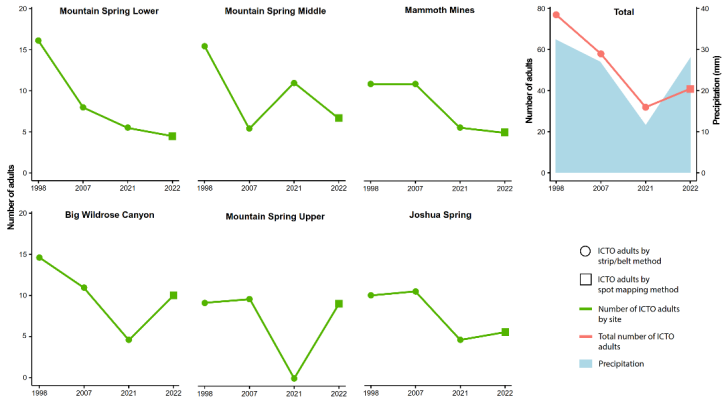


Figure 3. Inyo California Towhee (ICTO) numbers for 1998, 2007, 2021, and 2022 in the Mountain Springs Canyon area. Graph to the right shows the total estimated population in the canyon along with the total precipitation prior to the breeding season in Trona, California (*Source*: National Oceanic and Atmospheric Administration National Centers for Environmental Information (NOAA NCEI 2021; US Climate Data 2022).



through strip/belt transects by LaBerteaux (2021) in the same area. While it is possible that this is due to demographic changes between the two years, the increase in pairs observed this year is more likely due to differences in survey methods. Spot map surveyors spend significantly more time in each survey area and are able to observe breeding behaviors thus detecting more breeding pairs (Table 5). However, a hybrid approach could result in precise estimates while covering more ground. Surveyors could use the strip/belt method while recording the location of each detection in ESRI FieldMaps App; the surveyor would still spend a minimum of 20 minutes with each bird and would visit each transect area twice.

Table 5. Comparison of strip/belt and spot mapping survey methods.

	Strip/belt Method (LaBerteaux and Garlinger 1998)	**Spot Mapping Method**
Area covered	• Surveyor walks a transect running parallel to habitat • Coverage of habitat = linear (m) • Faster, less extensive walking coverage of habitat	• Surveyor walks within 50 meters of all places within the spot-mapping site boundary (polygon). Site boundary can be a variable shape depending on a study's goals, but should be small enough to cover before 11am (aim for a survey route through the site polygon of ~1500 meters) • Coverage of habitat = area (m^2) • Slower, more extensive walking coverage of habitat
Effort (site sizes differed between methods)	• Minimum 40 minutes per site • Covered average of 6 sites/8-hour day ○ Site transect length variable, almost stationary for single	• Each survey of a site lasted from sunrise to 11am. • Covered 1 site/5-hour day

	patches of habitat to ~300-500m long for strips of habitat • Surveys lasted into afternoon, aided by use of playback • Covered roughly twice as much riparian habitat in a day as the spot mapping method (based on sites in Mountain Springs Canyon). • Typically only one survey of each site to maximize area surveyed	○ Site covered at minimum 1300-1500m of walking distance • Surveys were finished by 11am (bird detection without playback drops significantly after this point) • Covered roughly half as much riparian habitat in a day as the strip/belt method (based on sites in Mountain Springs Canyon) • Typically more than one survey of each site to refine territory delineations and breeding status
Playback	• Yes: playback was used following a survey if no Towhees were detected at the site • Surveyor(s) must possess a permit to use playback for ICTO • Fewer researchers are eligible to conduct surveys	• No: playback was never used to ensure the observation of natural ICTO behavior • Surveyors are not required to possess a permit to use playback for ICTO for spot mapping surveys • More researchers are eligible to conduct surveys
Disturbance	• Minimal time with each bird, surveyor moved more quickly through territories • Use of playback when no ICTO were detected in 40 minutes	• A minimum of 20 minutes is spent with each ICTO to record movements around the territory and behavior • No conspecific playback used to elicit a response from ICTO
Data	• GPS point taken for each bird detected, as well as method of detection, number of individuals, breeding status, age of individuals, time of observation, distance to riparian vegetation, behavior notes, habitat use and vegetation at the site • Main difference is this method records 1 location per bird, no spatial behavior data recorded • Less refined data on breeding status	• For each location an individual ICTO is detected at within the 20+ minute observation window, the following data is recorded: GPS point, number of individuals, behavior (including notes on presumed sex, breeding status, age of individuals, habitat use, and conspecific interactions), time of observation • This method records more data on territory bounds, breeding status, and spatial behavior data

The number of spot mapped ICTO territories in Big Wildrose Canyon increased from two territories last year to four territories this year. An increase in the number of territories could indicate a real change in population size or a decrease in the availability of reproductive habitat, and therefore a greater accumulation of towhees in a few suitable sites. In recent years, the decrease in precipitation and increase of temperatures in the Mojave Desert has driven birds to their physiological limits, which has caused areas with water to act as refuges for various bird species (Faaborg et al. 1984, Hinojosa-Huerta 2008, Iknayan and Bessinger 2018). In this study, one of the areas with highest number of towhee territories was also one of the last areas with standing water present.

Moreover, Neate-Clegg et al. (2022) found that the number of birds detected in riparian areas greatly increased during hotter and drier years in Utah. They also found that a significant number of the breeding birds in the riparian areas showed declines in population recruitment in

hotter, drier years, likely due to a combination of fewer resources and increased competition from the influx of non-riparian birds into the riparian zone. This illustrates why climate change can cause a decline of desert breeding birds that are tied to riparian zones.

Lastly, surveys conducted in other areas indicate that the Inyo California Towhee has greatly declined throughout its range (LaBerteaux 2021, Atwell 2021). This is likely due to factors that have caused habitat quality to decrease such as an increase of feral equine populations and hotter, drier conditions due to climate change. However, it is difficult to know the magnitude of the population decline without a single year range-wide survey to compare it to past range-wide surveys.

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

Spot mapping is a better method than single visit strip/belt surveys to accurately determine both the number of Inyo California Towhees occupying a site and their reproductive status. The population of Inyo California Towhees in Mountain Springs Canyon increased compared to the previous year (LaBerteaux 2021) but remained significantly lower than 2007 when the last range-wide survey was conducted. Since the area surveyed this year only represents a small fraction of the distribution of this subspecies, the results we obtained should not be extrapolated to estimate a total population size.

Desert springs are an important resource for Inyo California Towhees and may become even more essential as water becomes scarcer in the region due to climate change. Areas with water may act as refugia during this period (Iknayan and Bessinger 2018), increasing the importance of protecting them. Feral equines (horses and burros) are a known cause of environmental degradation in these habitats. We saw signs of equines in most of the study sites and documented sightings of herds as we encountered them. We recommend continuing and increasing the feral equine removal program on the base. Continued monitoring also can provide information on effectiveness of the feral equine removal program.

Desert springs also provide refuge for other sensitive or declining species. Our results suggest that these sites are functioning as breeding and/or foraging habitats for species such as the Black-chinned Sparrow, Golden Eagle, and Loggerhead Shrike, as well as potential stop over sites for migratory birds, such as Olive-sided Flycatcher, Willow Flycatcher and Yellow Warbler. A greater number of visits would undoubtedly allow us both a greater detection of endangered species as well as a more accurate determination of their reproductive status at the site.

There is an obvious need to conduct long-term range-wide surveys to determine population size and trends of the species. If this is currently not logistically feasible, we recommend a survey visiting all sites (staggered over multiple years) in a 3 to 5 year study using spot mapping surveys and Automated Recording Units (ARUs) to investigate whether ARUs can help with estimating towhee populations. ARUs are known to be poor at providing numerical estimates, but they may work with birds that have territories that are spaced apart and do not occur in dense concentrations such as Inyo California Towhees. If ARUs work, they may provide a way to conduct a single year range-wide survey by allowing for more flexibility of when the fieldwork

can occur (e.g. ARUs could be set out months ahead of time and programmed to turn on during the breeding season).

We are lacking critical information on the condition of Inyo California Towhee habitat on a range-wide basis. Remote sensing is one of the best ways to monitor habitat that occurs in a large area and is logistically difficult to visit. However, commercially available imagery is not at a fine enough scale for monitoring some of the small habitat patches that towhees are found in. Thus, if possible, we suggest using base resources to fly remote sensing drones over Inyo California Towhee habitat for NDVI, aerial photography, and LIDAR. This information can be used to develop remote sensing models for Towhee habitat. These models should be ground-truthed and tested at a majority of sites over a multi-year period; data from this work would be used to refine and improve the models. The model can then be used to monitor range-wide habitat without requiring physical visits; though a subset of sites should be visited on a periodic basis to continue to test and improve the model. This model could help pinpoint areas that need habitat improvement. The habitat model could be combined with survey results (if conducted the same year) and models can be developed to provide probabilistic estimates of Inyo Towhee population estimates.

In addition, there does not appear to be much information about the non-breeding season for Inyo California Towhees. It is necessary to examine the full annual cycle of declining species in order to identify limiting factors and to devise effective conservation actions (Faaborg et al. 2010, Rosenberg et al. 2019). Too often, research is focused on the breeding season, leaving few resources to identify limiting factors during the non-breeding season or to understand how seasonal interactions drive population change.

Full life-cycle population modeling is another critical need for the Inyo California Towhee, and we need to collect more data such as survival and dispersal, in order to build these models. Very little is known about their movements within a year as well as between years. We recommend a study using Motus (an automated telemetry system) to track birds in a few different study areas. This research method can obtain information on survival and more information on habitat use.

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If these studies are conducted, they would clarify the links between the towhees and their habitats, as well as their distribution dynamics. This information is required to identify the ecological factors that affect the population size and distribution of this subspecies, which will allow the implementation of more effective conservation actions.

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Appendix A. Detailed spot mapping survey methods

Inyo California Towhee surveys will be conducted at select sites in the Argus Mountains of NAWS China Lake. The survey area will be selected based on the Navy's preference and accessibility, survey sites will be selected based on previous survey locations. We will conduct spot mapping surveys to document Inyo California Towhee territories and other sensitive or declining avian species using these areas. Spot mapping will be conducted at the sites twice during the 2022 breeding season (April-June) and all birds detected will be mapped using ArcGIS Collector or FieldMaps on a tablet. Each observation of individual birds, pairs or groups of birds of the same species, dependent young, and nests will be recorded on the map. We will attempt to record each pair, which involves using behavioral cues to decide if birds detected near each other are of the same or different pair. The suspected sex (based on behavior) of each bird and bird behavior, to classify breeding status, will also be recorded. Territories of Inyo California Towhees will be delineated to the best of the biologist's ability after the required visits. For each plot, territories will be uniquely and sequentially numbered.

Surveys will start at sunrise and we will set no definite end time, though surveys will end when bird activity is low (usually around 11am) or when temperatures exceed 100 degrees Fahrenheit. Biologists will spend enough time conducting area searches to detect 90-100 percent of towhees and their breeding status.

Breeding and non-breeding designations for each detected bird or pair on each plot will be made as breeding confirmation is obtained, or at the end of the field season to take advantage of the surveyor's cumulative knowledge of the birds observed. Breeding status will be classified based on behaviors observed. Designating detected birds as breeding will be based on several factors. This includes:

- If confirmed breeding evidence is detected on one or both of the surveys.
- If probable or possible breeding evidence is detected on both surveys for a species that may be both resident breeders or migrants.
- If probable or possible evidence is detected on one survey for known local breeders.
- If supporting evidence is not observed yet the biologist suspects a breeding territory is present, a detailed explanation will be provided

Using the ESRI ArcGIS Collector application for Android tablets we are able to extend the reach of ArcGIS into the field, and improve the accuracy of the spatial data collected. Using ArcGIS Collector starts with creating a base map to be used on the tablets. This base map will be an up-to-date aerial image of the area, with 50m gridlines and plot boundary delineations. Next, a template (a geodatabase) for the spatial data to be collected is created. This is a simple ESRI file geodatabase with inclusive domains and subtype that will determine the dropdown menu options available when data is recorded on the tablet (e.g. breeding behavior codes). These options allow us to create in the field: *point* shapefiles of bird observations with attribute data for all bird species; *polyline* data to display behavior interactions between individual birds; and *polygon* data of birds' territories as needed.

With the geodatabase configured and complete, it will be loaded to SSRS's password-protected ArcGIS Online account or a local computer (located at SSRS) running ESRI's ArcServer software. From either ArcGIS Online or ArcServer, specific geodatabase components are synced to specific ArcGIS Collector logins (tablets).

All bird observations will be recorded onto the tablet by simply selecting to record a new bird observation; touching the tablet screen/aerial image at the bird's location; and then using drop down menus to select from predetermined drop down options - the bird species, behavior, sex, and breeding codes; lastly text notes can also be recorded if needed and the observation finalized by pushing the submit button. Recording a new bird on the tablet can be done quickly, in less than 5-10 seconds, once practiced. In a similar fashion, additional bird survey

data we plan to record on the tablet include, conspecific interaction polyline features that can be related (within the shapefile) to specific bird data points, polygon territory estimations for the towhees based on bird observations, and all survey summary data including: the survey date, visit number, survey start time, stop time, start temperature, and stop temperature. However, it should be noted that we probably will not have accurate territory extent or sizes with only two visits.

After the survey is complete, field biologists will sync their data when they return to the field house and have a wifi connection. The shapefile data will then be downloaded for use in ArcGIS desktop. At this time ArcGIS Desktop does not have the built-in capabilities to directly accept data uploads from ArcGIS Collector. The bird data will then be viewed, queried and sorted for data proofing. All bird data recorded on the map will be entered and summarized into the project database within two days post-survey. For each site, after the last site survey is completed, the number of breeding territories for the towhee will be determined, and recorded in the database.

ArcGIS Spatial Data

Data entered into ArcGIS Collector will be exported as shapefiles and proofed for correctness and accuracy prior to being input into the project database. All bird observations will be in a point shapefile format with inclusive attribute data. Recorded conspecific behavioral observations will be in a polyline shapefile format and each associated to specific point (bird) observations. This data will be used to draw territory polygons following the completion of all plot surveys.

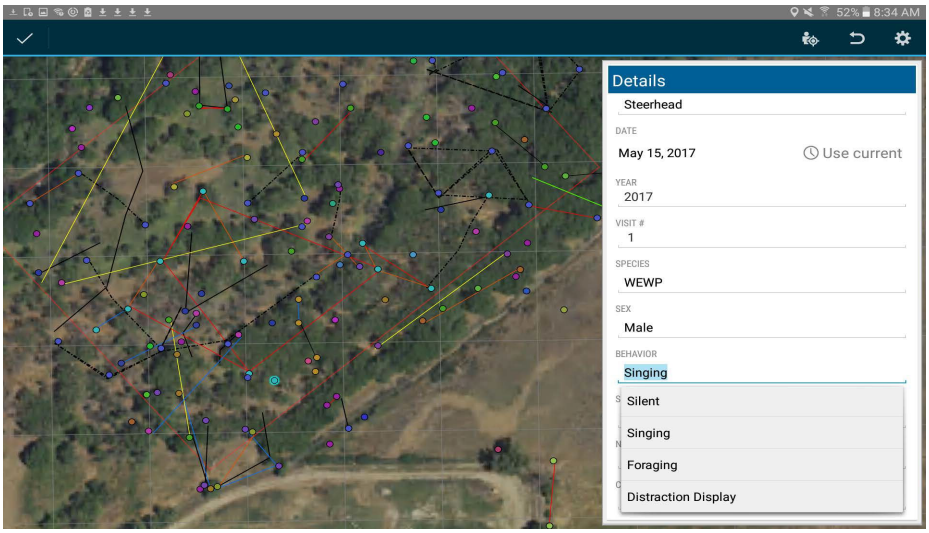

Figure 2. Example of dropdown menu and map for spot mapping when obtaining territories of all birds.

Appendix B. Sensitive and declining species detected in China Lake NAWS Spot map locations in 2022.

Bird species		Status designation		
Common name	Scientific name	FWS	California	Partners in Flight
Golden Eagle	*Aquila chrysaetos*	-	Fully protected	-
Olive-sided Flycatcher	*Contopus cooperi*	Species of conservation concern	Species of concern	Species of continental concern
Willow Flycatcher	*Empidonax traillii*	Species of conservation concern	Endangered	-
Loggerhead Shrike	*Lanius ludovicianus*	-	Species of concern	-
Yellow Warbler	*Setophaga petechia*	-	Species of concern	-
Inyo California Towhee	*Melozone crissalis eremophylus*	Threatened	Endangered	-
Black-chinned Sparrow	*Spizella atrogularis*	Species of conservation concern	-	Species of continental concern

Appendix C. Number of territories, detections, and breeding status of all birds detected (d=detected) in Mountain Springs Canyon spot mapping sites in 2022.

Species	Breeding Status	Mountain Springs Lower	Mountain Springs Middle	Mammoth Mines	Big Wildrose Canyon	Mountain Springs Upper	Joshua Spring
Chukar	Breeding	d	d	d	d	d	d
California Quail	Breeding	d	d	d	d	d	d
Golden Eagle	Breeding					d	
Mourning Dove	Breeding	d	d	d	d	d	d
Greater Roadrunner	Breeding				d		
Lesser Nighthawk	Breeding			d		d	
Common Poorwill	Breeding						d
Anna's Hummingbird	Migratory					d	
Costa's Hummingbird	Breeding	d	d	d	d	d	d
Olive-sided Flycatcher	Migratory	d					
Western Wood-Pewee	Migratory	d	d		d	d	
Willow Flycatcher	Migratory					d	
Hammond's Flycatcher	Migratory	d	d	d	d	d	d
Gray Flycatcher	Migratory		d	d		d	d
Dusky Flycatcher	Migratory			d		d	d
Pacific-slope Flycatcher	Migratory	d	d	d	d	d	d
Say's Phoebe	Breeding				d		
Ash-throated Flycatcher	Breeding	d	d	d	d	d	d
Western Kingbird	Breeding			d			
Loggerhead Shrike	Breeding					d	
Cassin's Vireo	Migratory	d	d			d	
Warbling Vireo	Migratory	d	d	d		d	d
California Scrub-Jay	Breeding						d
Common Raven	Breeding	d	d	d	d	d	
Bushtit	Breeding			d		d	
Rock Wren	Breeding	d	d	d	d	d	d
Bewick's Wren	Breeding	d	d	d	d	d	d
House Wren	Migratory		d				
Townsend's Solitaire	Migratory		d				
Swainson's Thrush	Migratory				d	d	
Hermit Thrush	Migratory	d	d	d	d	d	d
Northern Mockingbird	Breeding		d				
European Starling	Breeding		d				

Appendix C. Continued

Species	Breeding Status	Mountain Springs Lower	Mountain Springs Middle	Mammoth Mines	Big Wildrose Canyon	Mountain Springs Upper	Joshua Spring
Townsend's Warbler	Migratory			d	d	d	d
Phainopepla	Breeding	d	d		d	d	d
Yellow Warbler	Breeding		d	d	d	d	d
Yellow-rumped Warbler	Migratory		d	d		d	d
Black-throated Gray Warbler	Migratory		d				
Hermit Warbler	Migratory					d	
Black-and-white Warbler	Migratory				d		
MacGillivray's Warbler	Migratory	d	d	d	d	d	d
Common Yellowthroat	Migratory		d		d		
Wilson's Warbler	Migratory	d	d	d	d	d	d
Green-tailed Towhee	Migratory				d	d	d
Spotted Towhee	Breeding			d	d	d	d
Inyo California Towhee	Breeding	2	4	2	4	4	3
Chipping Sparrow	Migratory	d					
Brewer's Sparrow	Breeding		d	d	d	d	d
Black-chinned Sparrow	Breeding	d	1	1	3	4	2
Black-throated Sparrow	Breeding	d	d	d	d	d	d
White-crowned Sparrow	Migratory	d		d	d	d	d
Rose-breasted Grosbeak	Migratory				d		
Black-headed Grosbeak	Breeding	d	d	d	d	d	d
Blue Grosbeak	Breeding		d				
Lazuli Bunting	Breeding	d	d	d	d	d	d
Brown-headed Cowbird	Breeding					d	d
Bullock's Oriole	Breeding			d			
Scott's Oriole	Breeding	d					
Pine Siskin	Migratory				d		
Lesser Goldfinch	Breeding		d	d	d	d	d
Western Tanager	Migratory	d	d	d	d	d	d
Blue-gray Gnatcatcher	Breeding	d	d	d	d	d	d
Bell's Sparrow	Breeding	d	d	d	d	d	d
House Finch	Breeding	d	d	d	d	d	d
Ladder-backed Woodpecker	Breeding					d	d

Appendix C. Continued

Species	Breeding Status	Mountain Springs Lower	Mountain Springs Middle	Mammoth Mines	Big Wildrose Canyon	Mountain Springs Upper	Joshua Spring
Orange-crowned Warbler	Migratory	d	d	d		d	
Nashville Warbler	Migratory	d	d				
Ruby-crowned Kinglet	Migratory	d					