National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Region-wide Planning for Resurvey of Vertebrate Diversity over the Last 100 Years in the Great Basin and Mojave Desert

2012 Final Report

Natural Resource Technical Report NPS/XXXX/NRTR—2012/XXX

ON THE COVER
From top to bottom: Devils Golf Course, Death Valley NP; Lake Mead NRA; Great Basin NP.
Photograph by: Top and bottom: Karen Rowe; center: Galen R Frysinger

Region-wide Planning for Resurvey of Vertebrate Diversity over the Last 100 Years in the Great Basin and Mojave Desert

2012 Final Report

Natural Resource Technical Report NPS/XXXX/NRTR—2012/XXX

Karen M.C. Rowe[1]

Adam B. Smith[1]

Michelle S. Koo[1]

Steven J. Beissinger[1, 3]

Craig Moritz[1, 2]

[1]Museum of Vertebrate Zoology

[2]Department of Integrative Biology

[3]Department of Environmental Science, Policy, and Management

University of California

Berkeley, CA 94720

June 2012

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Technical Report Series is used to disseminate results of scientific studies in the physical, biological, and social sciences for both the advancement of science and the achievement of the National Park Service mission. The series provides contributors with a forum for displaying comprehensive data that are often deleted from journals because of page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from ***[Your Network/Division etc. and URL]*** and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/).

Please cite this publication as:

Rowe, K.M.C., C. Moritz, S.J. Beissinger, A.B. Smith, and M.S. Koo. 2012. Region-wide planning for resurvey of vertebrate diversity over the last 100 years in the Great Basin and Mojave Desert. 2012 Final Report. Natural Resource Technical Report NPS/XXXX/NRTR—20XX/XXX. National Park Service, Fort Collins, Colorado.

NPS XXXXXX, June 2012

Contents

Figures

Page

Tables

Page

Appendices

Page

Abstract

The use of model-based approaches to understand the impacts of recent global change has become an important component of the development of effective adaptive management of species on public lands. The unique resource of voucher-backed museum specimens provides the opportunity to develop species distribution models based on known historical distributions and evaluate the performance of these models using modern data collected from repeat visits to historical sites. In this project we compiled the existing historical (pre-1970) and modern (1970-present) survey and museum records and associated metadata, including historical field notes and images, of vertebrates within the Great Basin and Mojave Desert region, focusing on five national parks (Death Valley NP, Great Basin NP, Lake Mead NRA, Joshua Tree NP, and Mojave NP). In conjunction with Inventory and Monitoring Survey data, we compiled species lists for each of the parks and within the broader region. We developed multiple GIS climate layers for historical and modern time periods and combined them with museum specimen records to generate hypotheses about species distributions in the past and present using Species Distribution Models (SDMs). We also identified areas within each of the parks to represent key resurvey sites that will allow statistical modeling of changes in species occupancy through time with known presence/absence data. When combined with the output from our SDMs, future targeted on-the-ground resurveys will play a key role in understanding distributional shifts of these species. Museum of Vertebrate Zoology (UC Berkeley) data compiled in this project have been made available to NPS staff within the museum's online database, ARCTOS, along with a primer on navigating and customizing the interface. All specimen data have been prepared as a single Access database, with accompanying metadata, that can be queried and customized as needed. GIS environmental climate layers and species distribution model output are available on request from the MVZ.

Acknowledgments

The successful completion of this project relied heavily on input and feedback from many National Park staff, including Kelly Fuhrmann and Linda Manning (Death Valley National Park); Neal Darby, Debra Hughson, Robert Bryson, and David Moore (Mojave National

Study Area

Focus of this study was in the region of the Great Basin and Mojave Deserts, including five NPS units; Death Valley National Park, Mojave National Preserve, Joshua Tree National Park, Lake Mead National Recreation Area, and Great Basin National Park (Figure 1). Highlighted counties were the focus of specimen records and metadata queries (described in Methods).

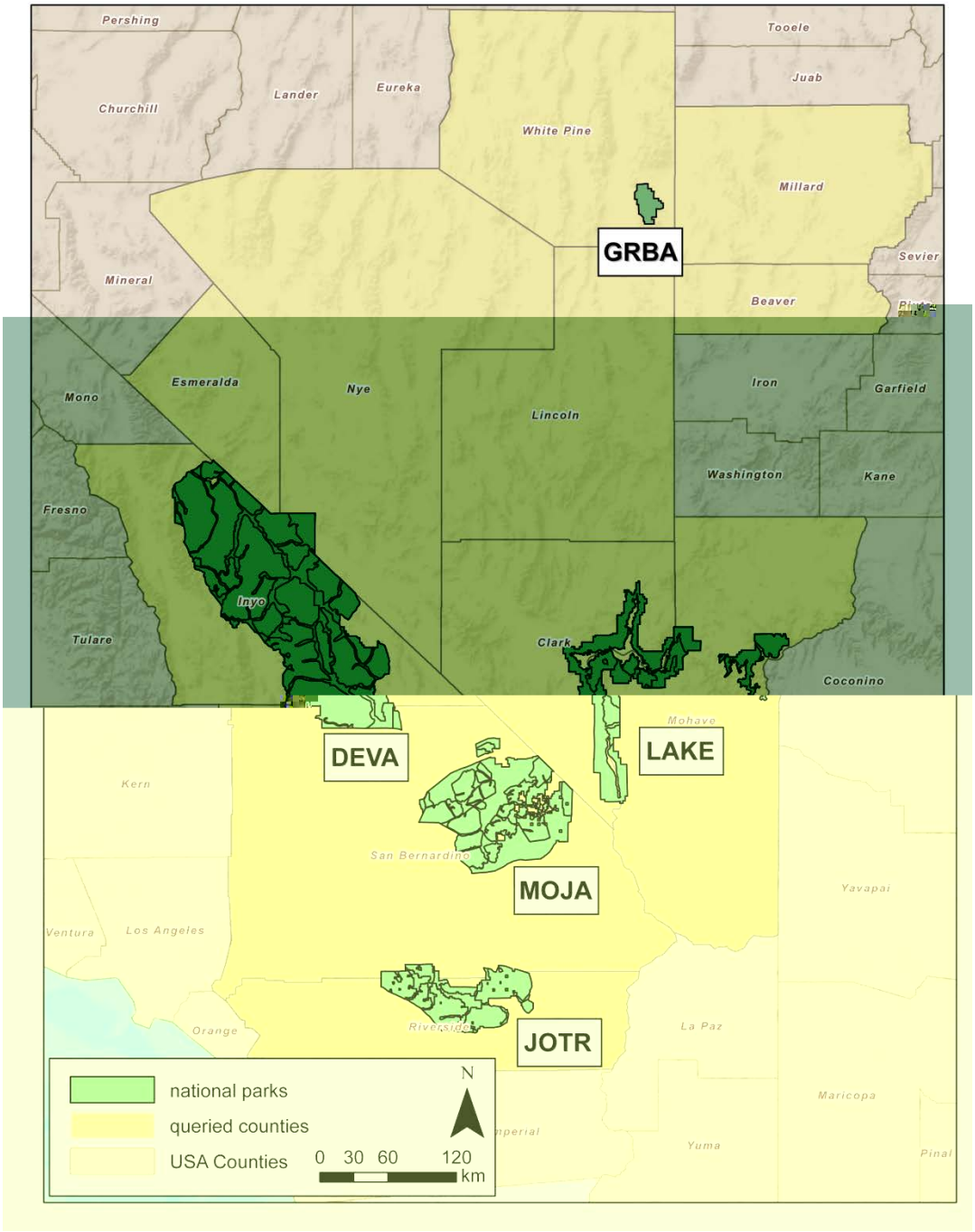


Figure 1. Spatial extent of study area examined in this project.

Introduction

The effective management of our public lands and natural areas relies on an understanding of the effects of global change on the distribution of species. Research into how species shift across the landscape over time can be particularly informative when trying to manage adaptively species that may be moving into or out of these areas from the past to now and into the future (Gonzalez 2011). Model-based approaches to recent climate change are critical to the development and implementation of adaptive management plans (Guisan and Thullier 2005, Austin 2007). By utilizing the unique resources of historical museum records, we can develop species distribution models based on known historical distributions and evaluate the performance of these models using modern data collected from repeat visits to historic sites (Elith et al. 2006). In turn, we can then improve our prediction of species distributions under models of future climate change (Smith et al. 2011). The "Grinnell Resurvey Project" at the University of California, Berkeley (UCB) Museum of Vertebrate Zoology (MVZ) aims to document the changes in the distribution of vertebrate species and in the composition of vertebrate communities in regions of the Western United States to understand their responses to observed climate change over the last century (http://mvz.berkeley.edu/Grinnell/).

Documented patterns of climate change across the western deserts of the United States have been alarming, and areas of southern California have shown extreme warming over the last 50 years (Loarie et al. 2009). However, these changes are spatially complex, and at a regional scale, show heterogeneity that has only recently been examined (Burrows et al. 2011). Understanding this heterogeneity, and the resulting shifts of species distributions through time, is critical for effective management of species in the present and into the future (Littell et al. 2012).

The MVZ has an extensive and unparalleled historic record of faunal conditions in California and the Great Basin from general vertebrate surveys conducted by Joseph Grinnell and colleagues at the MVZ in the early part of the 20th century. In addition to preserving thousands of specimens from hundreds of localities, the surveys are uniquely well documented via:

1. The publicly-available MVZ online specimen database, ARCTOS, which is fully geo-referenced including precision estimates;

2. MVZ field notes from the original collectors; and,

3. Photographic images and maps of survey sites.

In addition to the specimen records, these metadata allow for quantitative analysis of species occurrences in a statistical occupancy analysis framework. When compared to contemporary surveys conducted in the same areas and combined with trajectories of climate change in the region, we can evaluate rigorously changes in species distributions and community composition over the last one hundred years. Thus using historical metadata of faunal surveys, in conjunction with specimen records, provide an unmatched and largely unexplored opportunity to evaluate how species distributions have shifted between the past to the present on a local scale relevant to wildlife and resource managers. These results can then be used to improve our projections and planning for how species may continue to move across the landscape in the future.

Using this rich historical record, researchers at MVZ have completed resurveys of mammals and birds along five elevational transects in the regions surrounding Yosemite National Park (2003-2009), Lassen Volcanic National Park (2006-2007), Sequoia-Kings Canyon National Park (2008-2010), Lake Tahoe (2008-2009), and the White Mountains (2008-2010). The changes in the distributions of mammals and birds across Yosemite National Park have been published (Moritz et al. 2008; Tingley et al. 2009), and combined analyses for the other transects are underway. In Yosemite National Park, where night-time temperature has increased by 3° C, half of the species showed significant changes in elevational range, with an average upwards shift of approximately 500 m; low elevation species expanded upwards, and some high elevation species suffered severe range reduction. Yet, other closely related species were unaffected, changing local community composition. In regions with less temperature increase (e.g., Lassen National Park), there has been less change in the distributions of sensitive species (Rowe et al., in prep).

As part of our ongoing efforts at the MVZ to document changes in vertebrate diversity over the last one hundred years in the western United States, our main objective with this project was to establish the existing historical record of vertebrates within the Great Basin and Mojave Desert, including five NPS units in this region:

1. Death Valley National Park (DEVA)

2. Mojave National Preserve (MOJA)

3. Joshua Tree National Park (JOTR)

4. Lake Mead National Recreation Area (LAKE)

5. Great Basin National Park (GRBA)

Our objectives were to:

1. Establish the scale and scope of historic vertebrate records within the Great Basin and Mojave Desert and determine how these records relate to past NPS Inventory & Monitoring (I & M) surveys in this region;

2. Establish the pattern of climate change and shifts in species distributions across the Great Basin and Mojave Desert from the past to the present using GIS and Species Distribution Models (SDMs);

3. Develop a design and timeline for resurveying historic sites to test the predictions from the SDMs;

4. Build on existing NPS I & M Survey results and MVZ online resources to provide a data portal specifically for historical and present-day records, their associated metadata (field notes, photographs), and mapping resources, including climate layers, for Great Basin and Mojave Desert parks (and in addition, existing data for the Sierra Nevada);

5. Utilize results of this project to develop a competitive proposal to seek external funding support for on-the-ground resurvey effort at Mojave and Great Basin NPS units; and

6. Provide background data leading to an understanding of changes in faunal diversity attributed to climate change in NPS units across the Mojave and Great Basin deserts in language accessible to park managers and the general public.

Methods

This project was broken into four main phases, corresponding to the major objectives.

Phase 1: Survey Records and Metadata

Phase I of the project consisted of identifying and compiling the existing historical (defined as pre-1970) and modern (1970-present) surveys of terrestrial mammals, birds, amphibians, and reptiles within the Great Basin and Mojave Desert region, including five NPS units (Death Valley NP, Great Basin NP, Joshua Tree NP, Lake Mead NRA, and Mojave NP) and the surrounding public land.

Surveys were identified based on specimen record searches beginning with the MVZ online specimen database, ARCTOS (http://arctos.database.museum/). Search parameters were based on counties containing and surrounding each of the targeted NPS units. Three counties in California (Inyo, Riverside, and San Bernardino), five in Nevada (Clark, Esmeralda, Lincoln, Nye, and White Pine), one in Arizona (Mohave), and two in Utah (Beaver and Millard) were included in the searches. All specimen records within the queried county were downloaded on 31 May 2011 and compiled into a single Access database (Appendix D1).

Additional institutions with relevant holdings in this region, including national museums and institutions with regionally significant collections (Table 1), were also queried using the same county-based search criteria. Additional institutes associated with NPS I & M surveys and those identified from consultation with NPS staff at each of the parks were also queried. These institutions were accessed using the VertNet demonstration portal (http://vertnet.org) or the institute's own online database if records were not available through VertNet. In some cases (e.g., Marjorie Barrick Museum, University of Nevada Las Vegas), records were not available online and were obtained by contacting the curator or collection manager directly, then added to the database. Data from the Museum of Northern Arizona produced specimen records in an electronic ledger format which are available as a separate electronic appendix (Appendix D2).

Table 1. List of queried institutions included in specimen record searches. Searches were conducted using the eleven county search criteria to include records from all five parks, except in the case of museums with regionally-specific collections. These institutes are denoted with an (*) and the county(ies) encompassing the appropriate park were searched. Institutes with (†) denote collections associated with I & M surveys, and were searched for the relevant park records.

Institution	acronym	searched park					date of search
		DEVA	GRBA	JOTR	LAME	MOJA	
American Museum of Natural History	AMNH	X	X	X	X	X	2/25/2011
Brigham Young University - Monte L Bean Life Science Museum*	BYU		X				1/31/2011
California Academy of Sciences	CAS	X	X	X	X	X	2/22/2011
Cornell University - Museum of Vertebrates	CUMV	X	X	X	X	X	6/7/2011

Field Museum	FMNH	X	X	X	X	X	1/31/2011
Harvard University - Museum of Comparative Zoology	MCZ	X	X	X	X	X	6/7/2011
Los Angeles County Museum of Natural History*	LACM	X		X		X	4/7/2011
Louisiana State University - Museum of Natural Science	LSUMZ	X	X	X	X	X	1/31/2011
Michigan State University - Museum	MSUM	X	X	X	X	X	1/31/2011
Museum of Northern Arizona*	MNA				X		1/2/2012
National Museum of Natural History, Smithsonian Institution	NMNH	X	X	X	X	X	6/7/2011
Nevada State Museum, Carson City*	NSMC		X		X		6/22/2011
New Mexico Museum of Natural History and Science	NMMNH	X	X	X	X	X	1/31/2011
San Diego Natural History Museum	SDNHM	X	X	X	X	X	3/14/2011
Texas Cooperative Wildlife Collection	TCWC	X	X	X	X	X	6/7/2011
University of Arizona - Museum of Natural History	UAZ	X	X	X	X	X	6/7/2011
University of California - Museum of Vertebrate Zoology	MVZ	X	X	X	X	X	5/31/2011
University of Kansas - Biodiversity Institute	KU	X	X	X	X	X	6/7/2011
University of Michigan - Museum of Zoology	UMMZ	X	X	X	X	X	6/7/2011
University of Nevada, Las Vegas - Marjorie Barrick Museum†	MBM		X		X		6/21/2011
University of New Mexico - Museum of Southwestern Biology*	MSB	X	X				3/14/2011
University of Utah - Utah Museum of Natural History*	UMNH		X				1/31/2011
University of Washington - Burke Museum	UWBM	X	X	X	X	X	6/7/2011

Georeferences of specimens were verified using ArcMap 10. Records with geographic coordinates outside of the eleven-county search criteria were excluded from further spatial analyses, but were retained in the full specimen database.

From these georeferenced specimen records, species lists were generated for each targeted taxonomic group for the entire region and within each individual NPS unit. To account for differences among collections in species names, we updated all records to the most current nomenclature, but retaining the original species name for the record within the database (Appendix A). For birds we used the American Ornithologists' Union 7th Edition (with the 51st

supplement) checklist for North American Birds. Mammal species names were based on *Mammal Species of the World 3rd Edition* (Wilson and Reeder 2005) but followed the Helgen et al. (2009) revision of the genus, *Spermophilus*. For amphibians and reptiles, we used the Integrated Taxonomic Information System (accepted names as of 05 June 2011).

To generate region-wide and park-specific species lists, we created a species list from our georeferenced subset of specimen records within the eleven-county area (Appendix B). For each

Two 30-year future climate scenarios were also projected, to the years 2050 and 2080. These scenarios included the A2 scenario from the IPCC's 4th Assessment Report's Special Report on Emissions Scenario where greenhouse gas emissions vary among nations but continue to rise into the future. Three separate Global Climate Models (GCMs) were examined, including the CGCM3 model from the Canadian Centre for Climate Modeling and Analysis, the Mark 3.0 model from the Commonwealth Scientific and Industrial Research Organization of Australia, and the Hadley Centre for Climate Prediction and Research. See Smith et al. (2011) for more details on how the environmental data were generated.

Species Distribution Models

Using the environmental layers and the museum records compiled in Phase 1, we constructed SDMs using MaxEnt for 23 mammalian and 95 avian species for the historical (1900-1939) and modern (1970-2009) eras. Species included in the SDMs were chosen based on their detection within at least one of the five NPS units and were represented by sufficient records for effective modeling (i.e., 37 records within each era distributed more than 1 km apart; see Appendix B for list of species). Projected distributions within the historical and modern eras were made using a within-era contrast (historical data to model historical distribution) and a cross-era contrast (historical data to model modern distribution), respectively. Future distributions for both 2050 and 2080 were made using a cross-era contrast (modern data to model future distribution). See Smith et al. (2011) for more details on how the SDMs were generated.

Phase 3: Identify Resurvey Sites and Develop Research Plan

We performed a spatial density analysis using GIS (ArcMap 10) to identify localities within each park and surrounding area with high sampling densities for each taxa, using all georeferenced specimens available at the time of the analysis (1 July 2011). Included specimens were those with collecting dates prior to 1970, but with unknown quality of the georeference. Areas with high sampling densities were identified and resurvey site lists were generated by grouping neighboring localities within a 2 km diameter. This grouping criterion is used to increase sample sizes for historical to modern comparisons and to reduce spatial autocorrelation among sites (Moritz et al. 2008). For each identified resurvey site we generated an approximate centroid for the collection of localities included in that site and extracted an elevation at that coordinate using Google Earth (ver. 6.0.3), which uses a Digital Elevation Model generated from NASA's Shuttle Radar Topography Mission.

Phase 4: Create an Online Data Portal

Using MVZ's existing, publically-available online database, ARCTOS, we created an interactive web portal (within the "Projects" module) to package and make available the MVZ data for each of the parks compiled in Phase 1 to NPS Staff. Within the portal, links to specimen records (updated in real-time), media (including images of field note pages and historical photographs and maps), and publications associated with the specimen records were created. We also developed an instruction manual to assist with the use of ARCTOS and the Projects module, including multiple searching methods, mapping functions (through BerkeleyMapper), and customization of the ARCTOS interface, allowing maximum flexibility for NPS staff (Appendix D6).

Results

Phase 1: Survey Records and Metadata

MVZ Results

Using our eleven county search criteria, we obtained 62,618 specimen records from the MVZ's specimen database, ARCTOS (Table 2), with the strongest collection being mammals (48%; 29,882 specimens), followed by herps (27%; 16,893) and birds (25%; 15,843). Over 95% (60,043) of the MVZ specimen records contained geographic coordinates and were included in further spatial queries, including the development of within-park species lists and site selection (see below).

The majority of these records (78%; 48,757) were from the historical time period (pre-1970), with most collecting concentrated between 1931 and 1950 (Fig. 2). More than 50% of specimens with the broader region were collected during this time; however, sampling within individual parks and across taxa was highly variable.

Other institution results

Searches within other institutions produced an additional 65,716 records, comprising 51% of the database (Table 2). The strongest collection contributed by other institutions was for herps, with 40,396 (31%) specimen records from these institutions, followed by mammals (15,022 specimens; 23%) and birds (10,298; 16%). Similar to the MVZ, sampling was highly variable among years, with the strongest collections made in the 1930s (20,102 specimens; 31%), 1950s (15,698; 24%), and 1960s (16,713; 25%).

The proportion of specimen records from other institutions with georeferences was lower than we found for MVZ specimens. Seventy-five percent (49,330) of the specimen records had a georeferenced locality and were included in the spatial data analyses (Table 3).

Both MVZ and non-MVZ specimens were distributed throughout the region with a great deal of coverage for many of the parks (Figs. 3-8). Within Joshua Tree NP, however, Los Angeles County Museum herp specimens were numerous, and expanded the spatial coverage of sampling within this park.

Table 2. Number of specimen records returned for the eleven-county search criteria by collection and taxon. Designation of "No results" denotes a collection that was queried online, but failed to return results due to a server or access error. Results from MNA (Museum of Northern Arizona) were returned as a word document ledger (Appendix D2) and were not included in the final Access database (see Appendix D1).

Institution	Birds	Herps	Mammals	Totals
AMNH	102	2	1	**105**
BYU	0	1	19	**20**
CAS	1572	10821	709	**13102**
CUMV	46	177	107	**330**
FMNH	0	146	1593	**1739**
MCZ	864	457	205	**1526**
LACM	337	18133	**No results**	**18470**
LSUMZ	0	0	2	**2**
MSUM	0	0	7	**7**
MNA	Word document format only			
NMNH	680	2338	2120	**5138**
NSMC	410	99	380	**889**
NMMNH		**No results**		**0**
SDNHM	1127	5149	**No results**	**6276**
TCWC	1	343	222	**566**
UAZ	270	2230	**No results**	**2500**
MVZ	15843	16893	29882	**62618**
KU	98	500	193	**791**
UMMZ	663	**No results**	1771	**2434**
MBM	3901	NA	NA	**3901**
MSB	107	0	5629	**5736**
UMNH	61	2	176	**239**
UWBM	110	0	1835	**1945**
Totals	**26192**	**57291**	**44851**	**128334**

Table 3

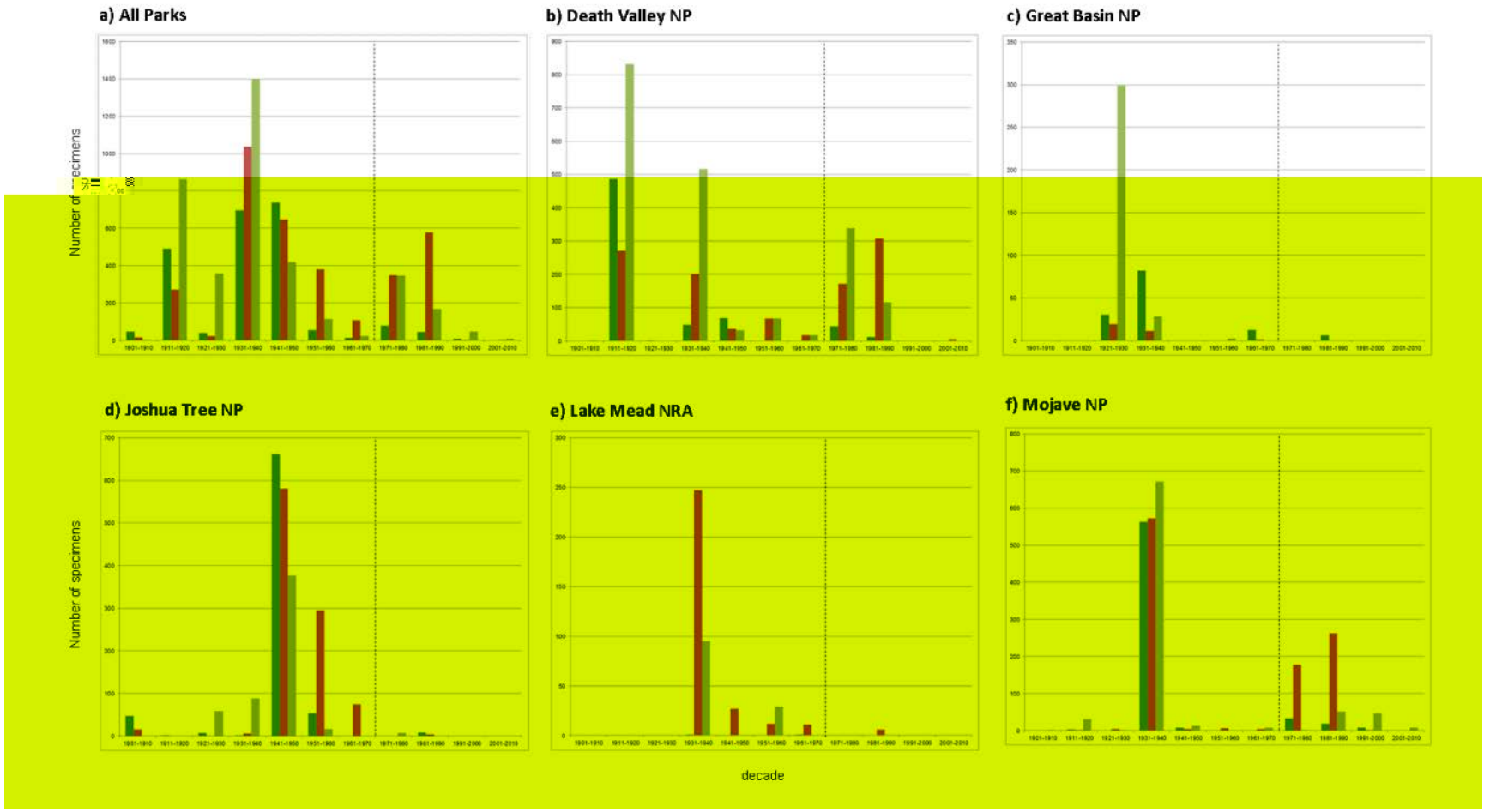


Figure 2. Number of MVZ specimens collected by decade between 1900 and 2010. Dashed line represents break between historical (pre-1970) and post (1970-present) specimen records.

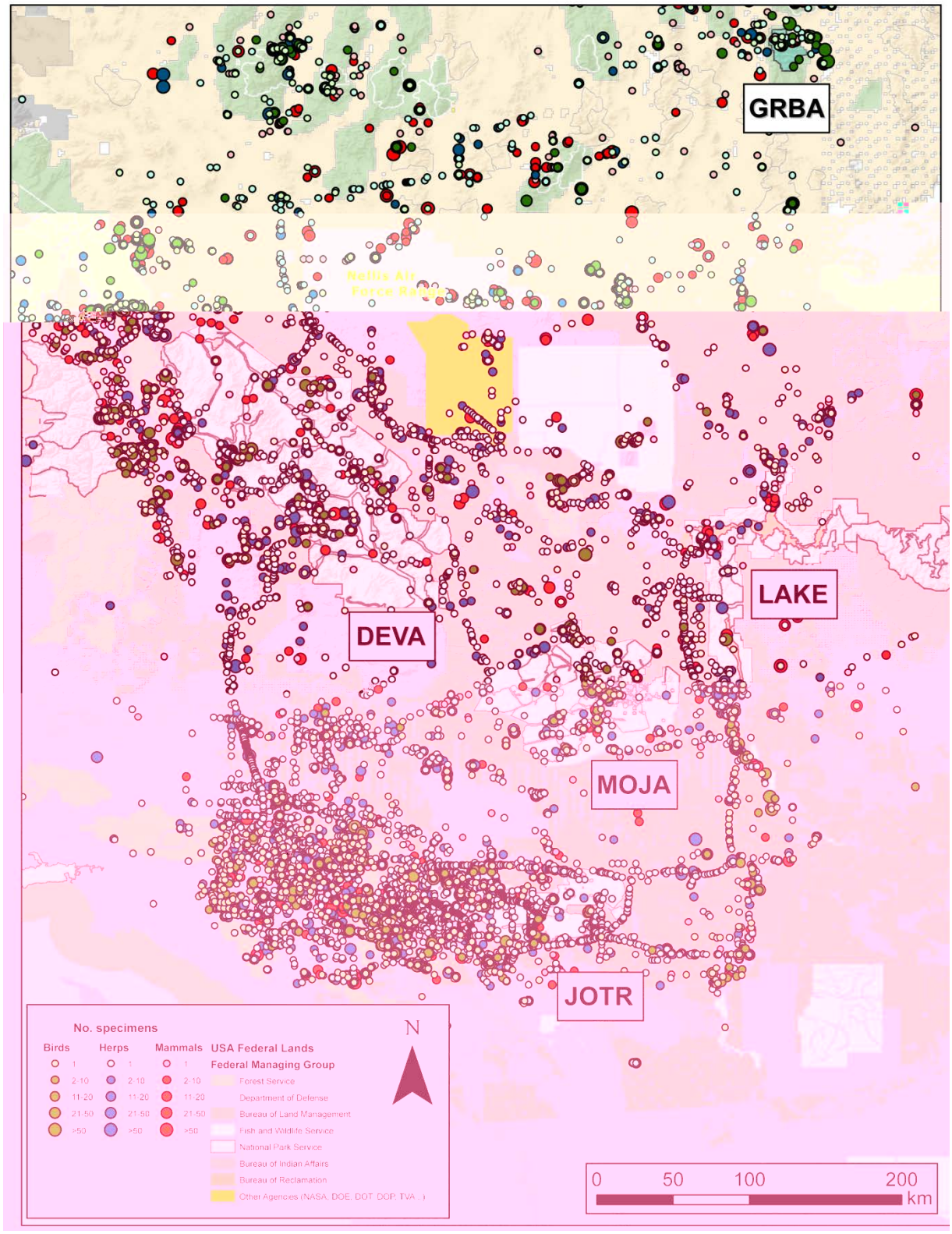


Figure 3. Sampling distribution of specimens from all institutions across the searched region. Size of the dot indicates the number of specimens of those taxa associated with that locality.

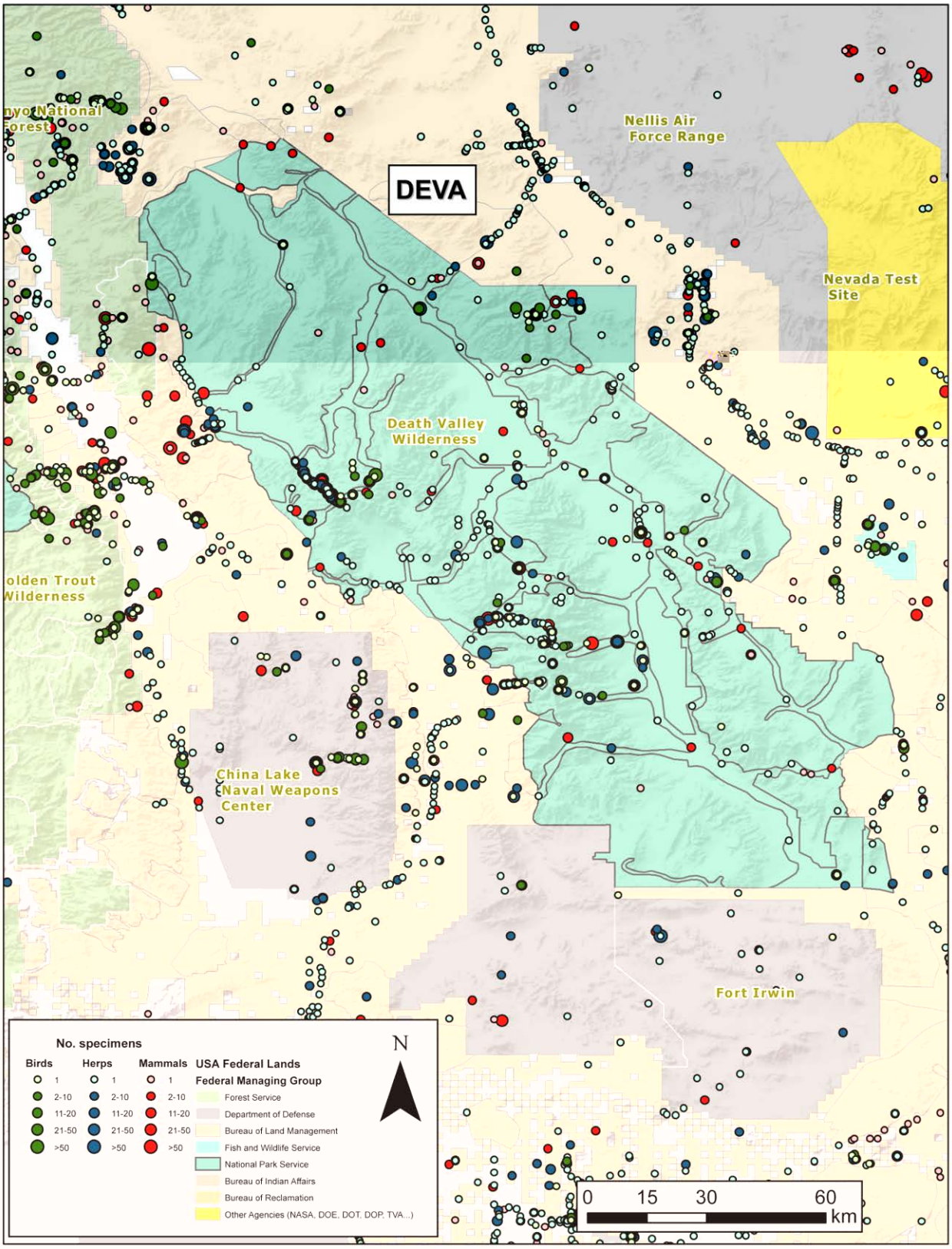


Figure 4. Sampling distribution of specimens from all institutions near Death Valley NP. Size of the dot indicates the number of specimens of those taxa associated with that locality.

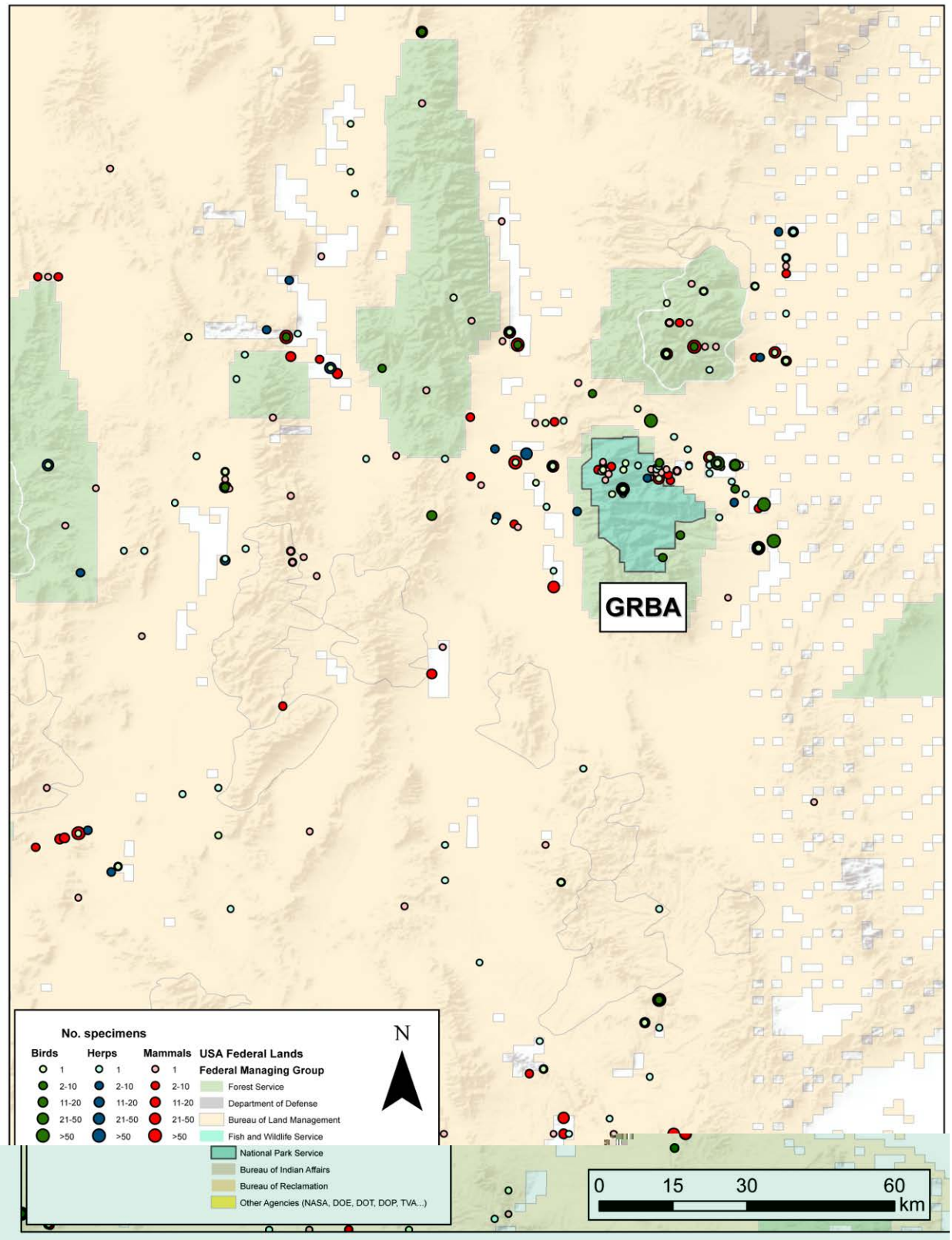


Figure 5. Sampling distribution of specimens from all institutions near Great Basin NP. Size of the dot indicates the number of specimens of those taxa associated with that locality.

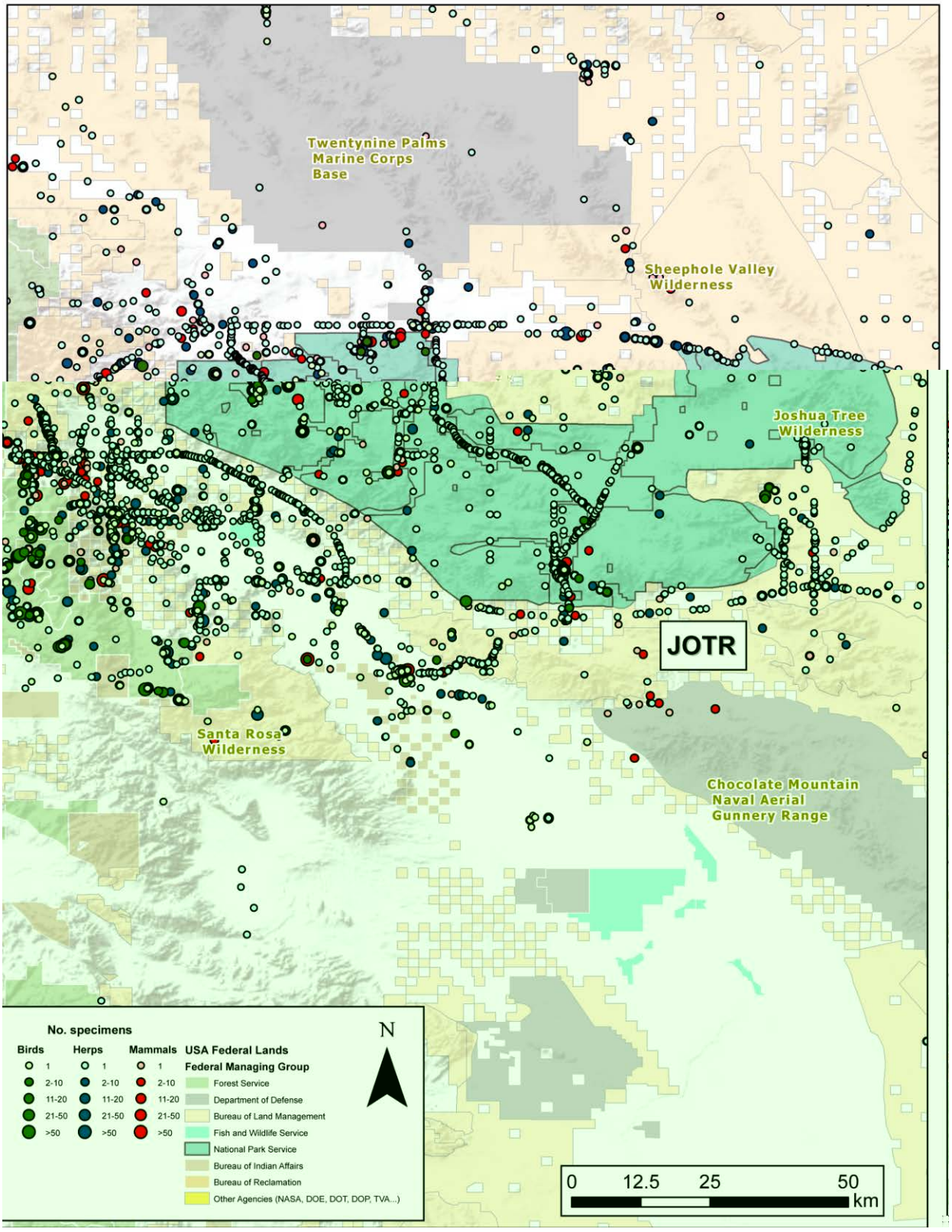


Figure 6. Sampling distribution of specimens from all institutions near Joshua Tree NP. Size of the dot indicates the number of specimens of those taxa associated with that locality.

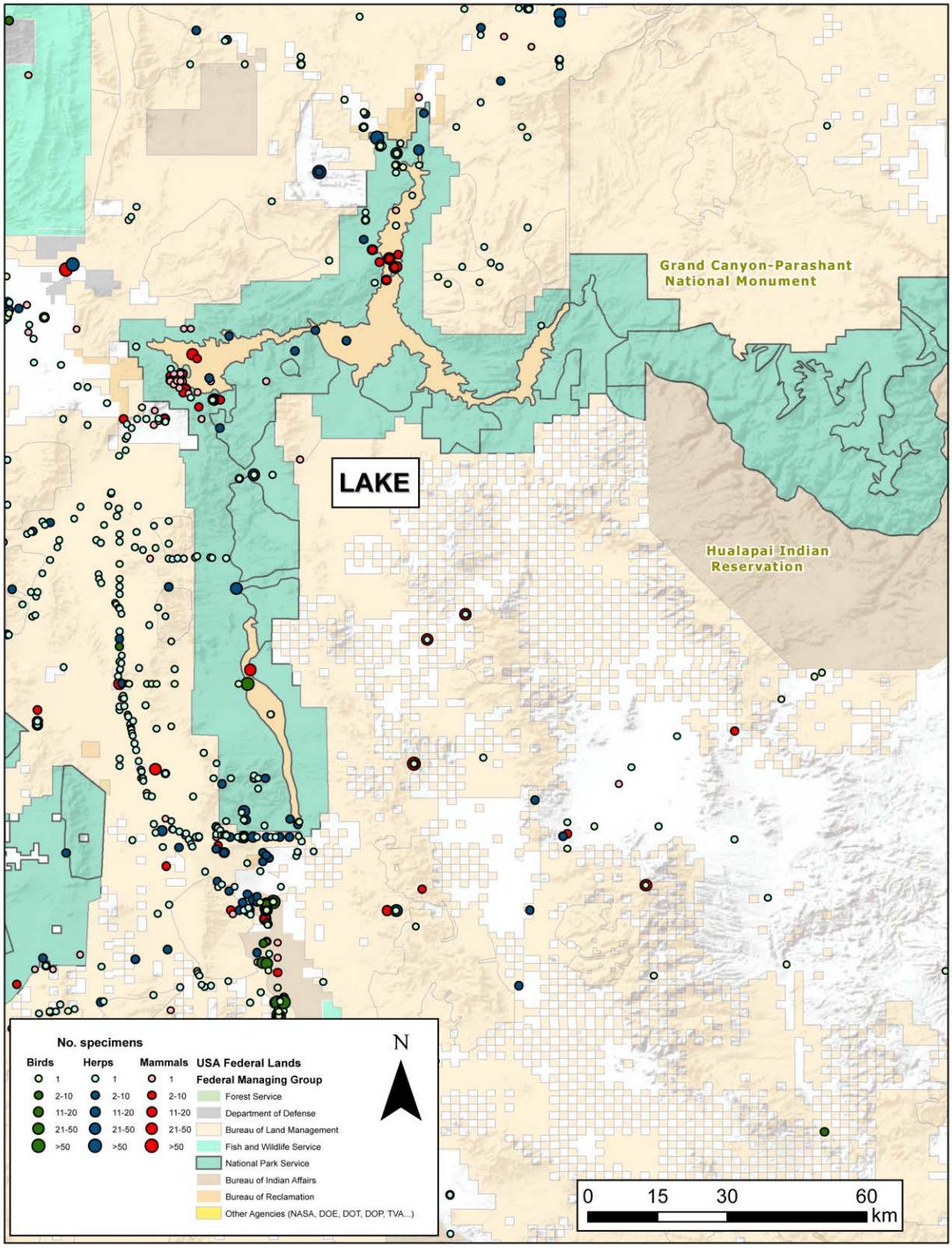


Figure 7. Sampling distribution of specimens from all institutions near Lake Mead NRA. Size of the dot indicates the number of specimens of those taxa associated with that locality.

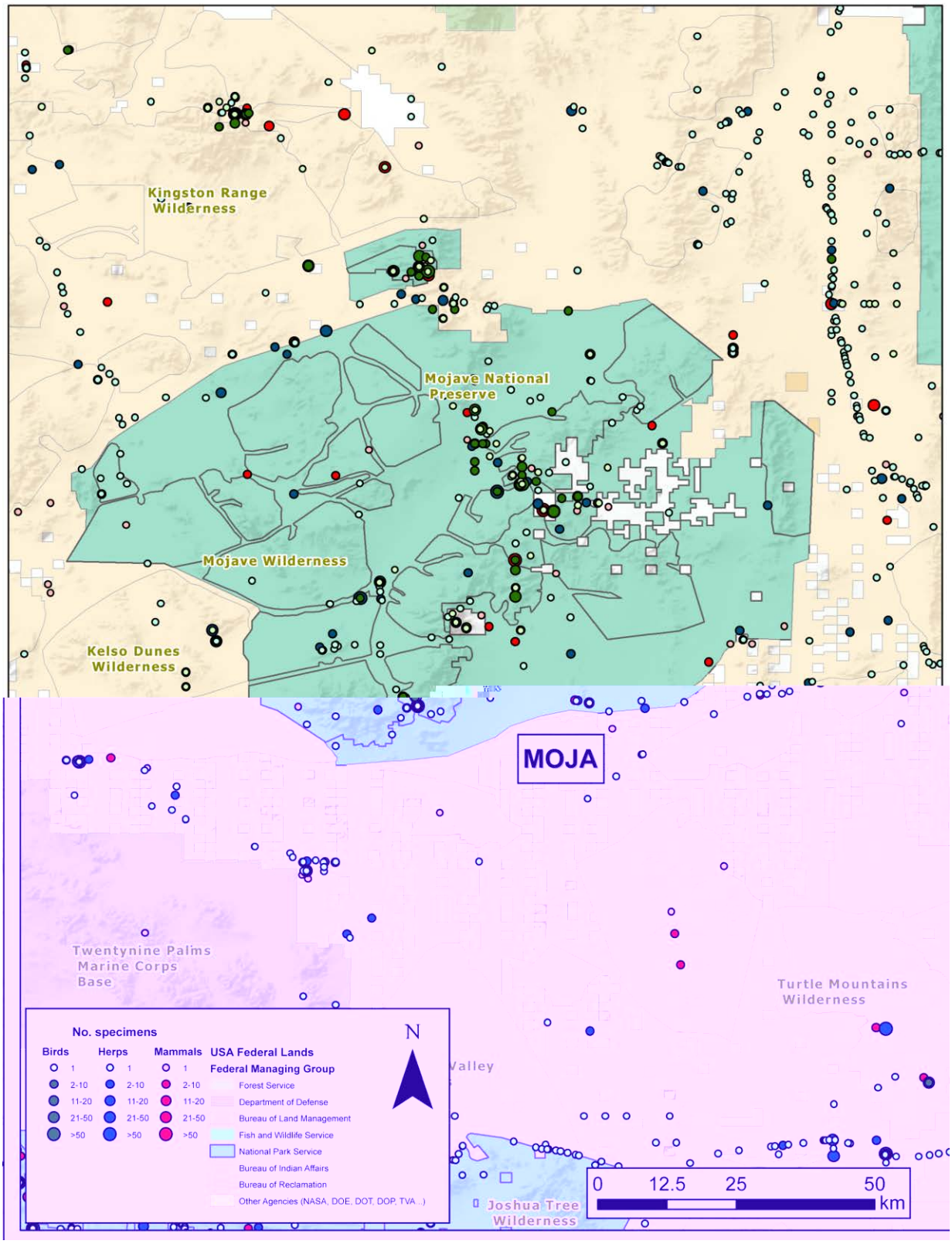
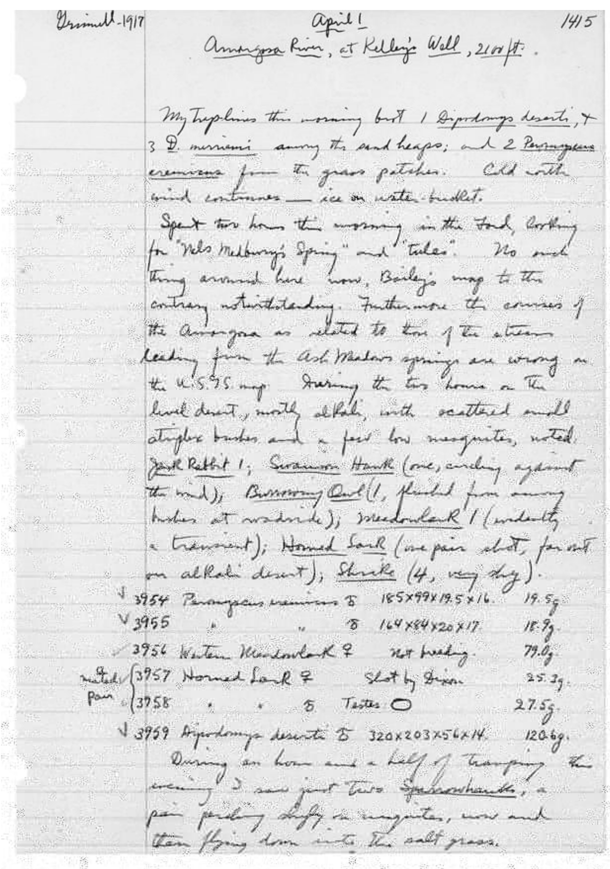


Figure 8. Sampling distribution of specimens from all institutions near Mojave NP. Size of the dot indicates the number of specimens of those taxa associated with that locality.

Metadata

Initial assessment of field notes within and surrounding the parks was favorable, with 2240 collecting trips (with separate entries for each taxon) found that correspond to our suggested resurvey sites (see Results Phase 3 below). This number is an over-estimation of the “useable” data that can be found within the field notes, because field notes may not exist for all of the collectors, or the data recorded in the field notes may not contain additional information beyond the specimen data (e.g., observed species or trapping effort data). However, preliminary results suggest many of the sites identified in this report have accompanying field notes that provide additional data that can be used in statistical occupancy modeling to evaluate shifts in species distributions through time. A full list of field notes, including collectors, years, taxon, and park is given in Appendix D4.

A total of 1466 photographs taken within the seven searched counties in California were found within the MVZ archives. These images contained a wide variety of subject matter, including people, camps, habitats, buildings, and specimens. Initial assessment suggested 240 of these photos may have been taken within park boundaries, based on locality information provided with the photo (see Appendix D5).


Grinnell-1917 April 1 1415
Amargosa River, at Kelley's Well, 2100 ft.

My traplines this morning got 1 Dipodomys deserti, + 3 D. merriami among the sand heaps; and 2 Perognathus eremicus from the grass patches. Cold with wind continues — ice on water-bucket.

Spent two hours this morning in the Ford, looking for "Nels Mellbury's Spring" and "tules". No such thing around here now, Bailey's map to the contrary notwithstanding. Furthermore the courses of the Amargosa as related to those of the streams leading from the Ash Meadows springs are wrong on the U.S.G.S. map. During the two hours on the level desert, mostly alkali, with scattered small atriplex bushes and a few low mesquites, noted: Jack Rabbit 1; Swainson Hawk (one, circling against the wind); Burrowing Owl (1, flushed from among bushes at roadside); Meadowlark 1 (evidently a transient); Horned Lark (one pair shot, far out on alkali desert); Shrike (4, very shy).

✓ 3954 Perognathus eremicus ♂ 185×99×19.5×16. 19.5g.
✓ 3955 " " ♂ 164×84×20×17. 18.9g.
✓ 3956 Western Meadowlark ♀ not breeding. 79.0g.
mated pair { 3957 Horned Lark ♀ Shot by Dixon 25.3g.
3958 " " ♂ Testes ○ 27.5g.
✓ 3959 Dipodomys deserti ♂ 320×203×56×14. 120.6g.

During an hour and a half of tramping this evening I saw just two Sparrowhawks, a pair perching shyly in mesquites, now and then flying down into the salt grass.

Figure 9. Sample digital field notebook page from Joseph Grinnell at Armargosa River in 1917. Included are descriptions of daily activities, including small mammals trapped, birds seen, and details of the specimens prepared (his “Catalog”).

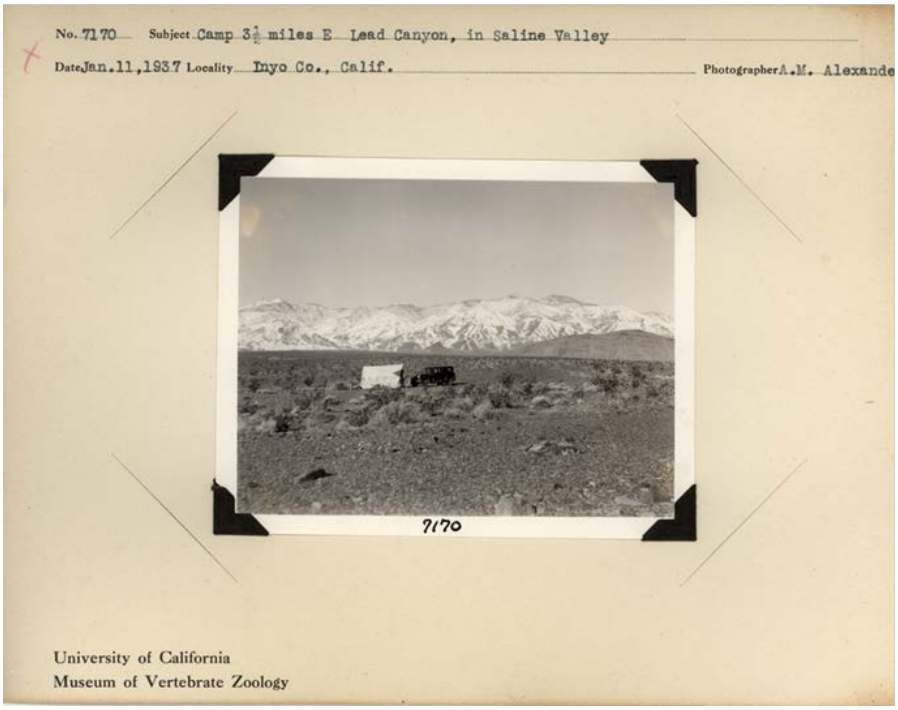


Figure 10. Sample digital historical photo taken in 1937 by Annie Alexander in Saline Valley, California. Each photograph is scanned with its associated metadata, including photo identification number, subject, locality, date, and photographer.

Phase 2: Develop GIS Climate Layers and Species Distribution Models

Environmental Data

Over the last 100 years the climate in this region has increased dramatically, particularly in the Mojave Desert parks (Fig 11). In each of the five parks, mean annual temperature has increased with an average across all parks of 6.0 °C (Table 4). This increase is nearly an order of magnitude greater than the 100-year linear trend for mean annual temperature globally (0.74°C from 1906 to 2005; IPCC 2007). The most extreme increase was in Mojave NP, with an increase of 7.4 °C, followed by Joshua Tree NP (6.3 °C), Death Valley NP (5.7 °C), and Lake Mead NRA (5.4 °C). Great Basin NP has shown the least change, but still an increase of 2.2 °C. The range of temperature change within parks was highly variable, with some areas of Joshua Tree NP increasing by 14.8 °C, along the eastern edge of the Pinto Basin and the Coxcomb Mountains.

In contrast to temperature, change in mean annual precipitation has varied across parks, with increases in some (Death Valley NP, Great Basin NP, and Mojave NP) and decreased in others (Joshua Tree NP and Lake Mead NRA). Variation in changes in mean annual precipitation within parks was high, with all showing ranges from decreases to increases except for Great Basin NP which showed only increases. Increases in precipitation were greatest along Wheeler and Baker Peaks.

Table 4. Change in mean annual temperature and precipitation between 1900 – 1939 and 1970 – 2009.

	Temperature (°C)		Precipitation (mm)	
	mean (± SD)	range	mean (± SD)	range
All Parks	6.0 (2.6)	-2.9 to 14.8	2 (13)	-27 to 153
DEVA	5.7 (2.2)	-1.2 to 10.6	4 (6)	-16 to 18
GRBA	2.2 (0.3)	1.4 to 3.0	79 (38)	15 to 153
JOTR	6.3 (3.0)	1.5 to 14.8	-11 (5)	-27 to -1
LAKE	5.4 (3.1)	-2.9 to 9.9	-7 (5)	-24 to 5
MOJA	7.4 (2.3)	2.5 to 13.4	6 (9)	-15 to 47

Species Distribution Models

A total of 118 SDMs (23 mammals and 95 birds) were generated using the MaxEnt algorithm (see Appendix B for species list), including projected historical, modern, and future distributions. Species varied widely in their predicted distributions, with species showing expansions, contractions, and/or stability between eras. Species also differed in their predicted distributions in relation to future climate scenarios.

For some species, this resulted in the loss or gain of a species within park boundaries through time. For example, the historical distribution of the Western Harvest Mouse (*Reithrodontomys megalotis)* suggested this species was widespread in Death Valley NP, in the northern region of Mojave NP, along the western portion of Joshua Tree NP, in the extreme north of Lake Mead NRA, and absent from Great Basin NP (Fig. 12). The modern projected distribution suggested slight expansion and contraction within Death Valley NP, expansion south and east in Mojave NP and Joshua Tree NP, respectively, expansion into the northern half of Lake Mead NRA, and continued absence from Great Basin NP. The 2050 future projection predicted contraction upward in elevation in Death Valley NP, dramatic contraction in Mojave NP, Joshua Tree NP, and Lake Mead NRA, but eastward colonization of Great Basin NP (Fig. 13). The 2080 projection suggests a different picture, with near complete colonization of Lake Mead NRA, Mojave NP, Death Valley NP, and western Joshua Tree NP. These results must be interpreted with caution, however, as the assumptions and chosen parameters of the models may affect the outcomes. This issue is discussed further below.

Species distribution maps for those species included in this study can be found in Smith et al. (2011). The data layers, including environmental and species distributions, are available by request through Michelle Koo at Museum of Vertebrate Zoology, UC Berkeley (mkoo@berkeley.edu).

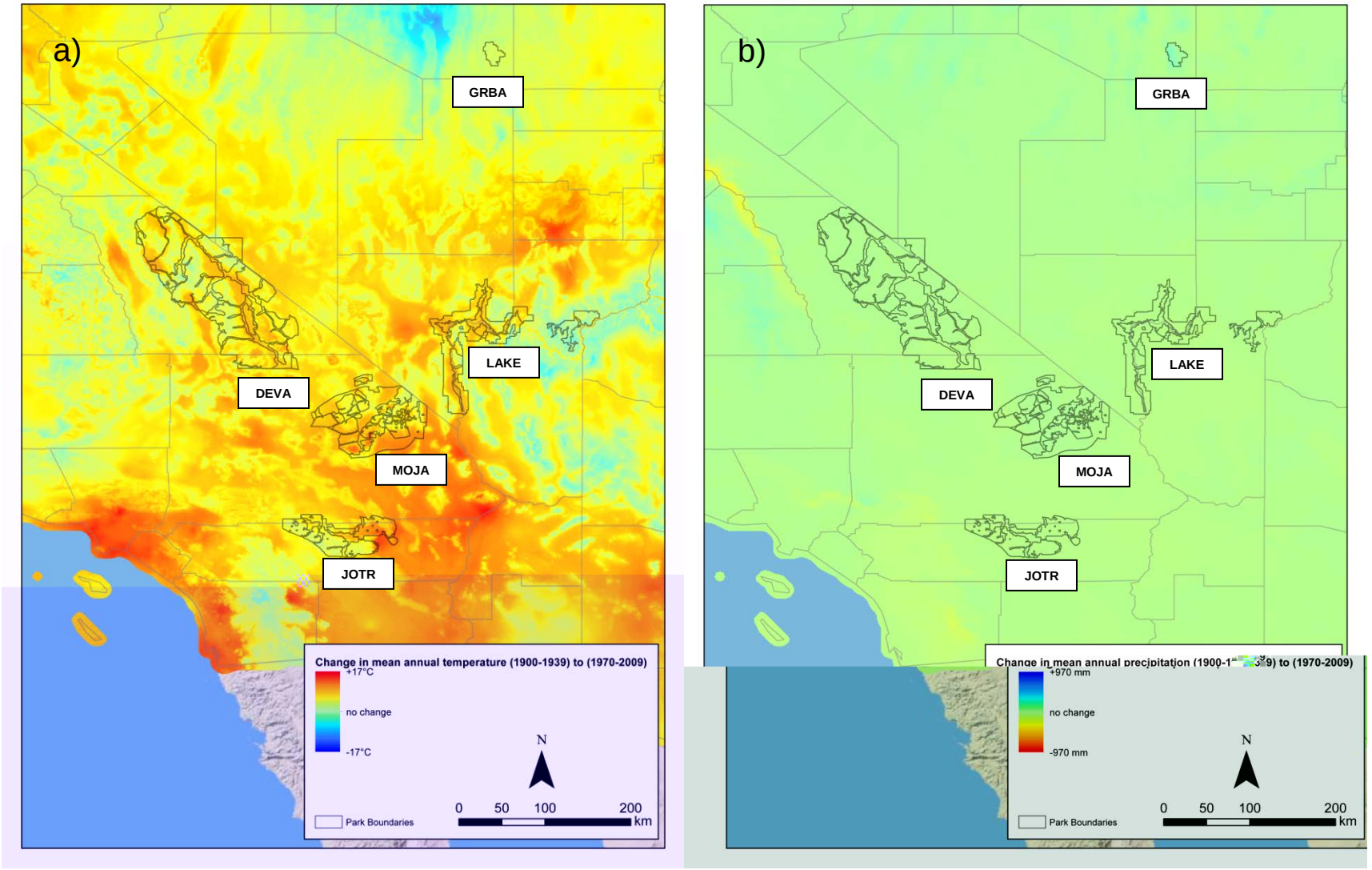


Figure 11. Change in mean annual temperature (a) and precipitation (b) across the region. Values represent the average mean annual temperature (a) or precipitation (b) from 1970 to 2009 minus that from 1900 to 1939.

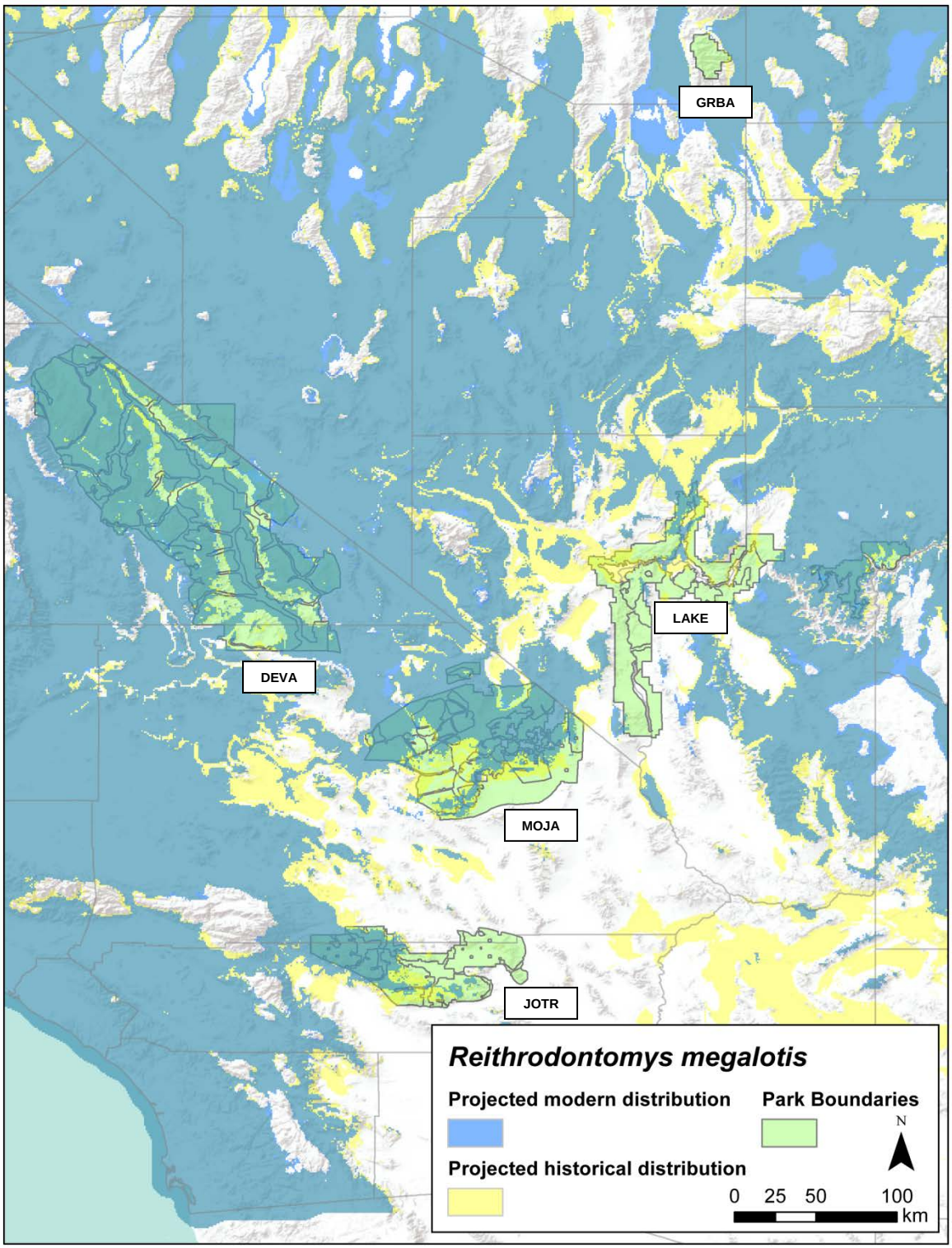


Figure 12. Projected historical (yellow) and modern (blue) distribution of the Western Harvest Mouse (*Reithrodontomys megalotis*) in the Great Basin and Mojave Desert. Distributions are based on MaxEnt models combining known historical occurrences with multiple climate parameters (see Methods).

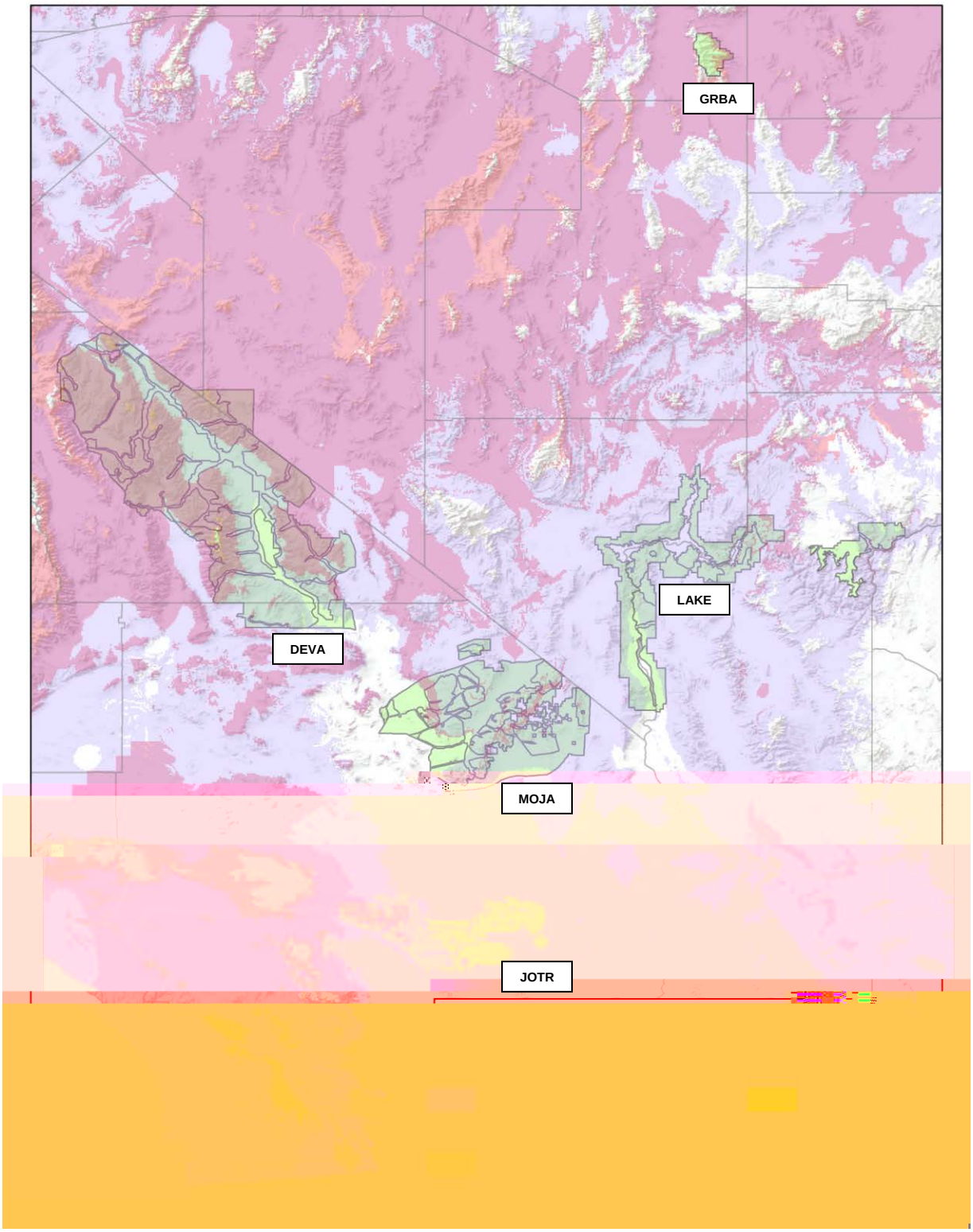


Figure 13. Projected 40-year (pink) and 70-year (purple) distribution of the Western Harvest Mouse (*Reithrodontomys megalotis*) in the Great Basin and Mojave Desert. Distributions are based on MaxEnt models combining known historical occurrences with multiple climate parameters (see Methods).

Phase 3: Identify Resurvey Sites and Develop Research Plan

We identified 163 potential resurvey sites within and nearby the parks, including public land (Figs. 14-18, Table 5). These sites where those with the highest density of sampling and provided stratified sampling over an elevational gradient to allow for tests of shifts in species distributions along this gradient. Locality names given in Table 5 represent a general collecting location, not a specific locality within the database to accommodate variation in naming across collections.

Table 5. List of proposed resurvey sites within the five national parks in the Great Basin and Mojave Desert region. Site numbers correspond to those on the maps of Figs. 14-18.

Park	Site no.	Locality	Latitude	Longitude	Elev (m)
GRBA	1	South Side, Baker Creek	38.96917	-114.28	2858
GRBA	2	Lehman Cave	39.002	-114.22	2100
GRBA	3	Stella Lake	39.005	-114.316	3169
GRBA	A	Lehman Creek	39.01722	-114.10722	1590
GRBA	B	1 mi N Baker	39.02783	-114.12194	1600
GRBA	C	2.5 mi E Baker	39.013	-114.071	1566
GRBA	D	Strawberry Creek	39.093	-114.229	1842
GRBA	E	Mouth of Snake Creek	39.037	-114.028	1775
GRBA	F	Lexington Creek	38.87472	-114.005	1638
GRBA	G	5 mi S Garrison	38.86195	-114.03222	1693
GRBA	H	7 mi SW Osceola, Spring Valley	39.01881	-114.47679	1757
GRBA	I	Willard Creek, Spring Valley	39.01111	-114.40833	1956
GRBA	J	Cleve Creek, Schell Creek Range	39.231	-114.471	1724
DEVA	1	Furnace Creek	36.458	-116.866	-52
DEVA	2	Emigrant Canyon, Panamint Mountains	36.376	-117.141	1495
DEVA	3	2.5 mi E + 1 mi S Grapevine Peak	36.956	-117.092	2210
DEVA	4	8 mi E Grapevine Peak	36.973	-117.003	1493
DEVA	5	Mesquite Spring	36.965	-117.367	562
DEVA	6	Saline Valley, Lower Grapevine Canyon (1)	36.473	-117.719	1905
DEVA	7	Saline Valley, Lower Grapevine Canyon (2)	36.592	-117.629	929
DEVA	8	Saline Valley, Lower Grapevine Canyon (3)	36.572	-117.612	1131
DEVA	9	Saline Valley, Lower Grapevine Canyon (4)	36.565	-117.582	1397
DEVA	10	Nelson Mountains, Grapevine Canyon	36.544	-117.57	1591
DEVA	11	2 mi SW Jackass Spring	36.532	-117.547	1855
DEVA	12	Jackass Spring	36.543	-117.519	2111
DEVA	13	3 mi NE Jackass Spring	36.581	-117.472	1969
DEVA	14	Wildrose Canyon	36.259	-117.194	1528
DEVA	15	Nemo Canyon	36.244	-117.227	1084
DEVA	16	Jail Canyon	36.18444	-117.21944	677
DEVA	17	Mahogany Flat	36.239	-117.069	2349
DEVA	18	Hanaupah Canyon (West)	36.209	-117.087	2825
DEVA	19	Hanaupah Canyon (West)	36.206	-116.982	760
DEVA	20	Hanaupah Canyon (East)	36.2089	-116.9186	203

Park	Site no.	Locality	Latitude	Longitude	Elev (m)
DEVA	21	Bennett's Well	36.158	-116.862	-69
DEVA	22	2 mi NW Ryan	36.348	-116.692	693
DEVA	23	Saratoga Springs	35.683	-116.423	60
DEVA	24	Johnson Canyon (East)	36.08019	-116.98241	938
DEVA	25	Johnson Canyon (West)	36.106	-117.041	1895
DEVA	26	Panamint City	36.12	-117.094	2009
DEVA	27	Triangle Spring/Midway Well	36.738	-117.138	16
DEVA	28	Emigrant Spring	36.43	-117.189	1270
DEVA	29	Lee Flat, 15 mi N Darwin	36.505733	-117.646657	1698
DEVA	30	South of Lee Flat, near Wilson Ranch	36.489	-117.612	1639
DEVA	31	Saline Valley	36.705	-117.825	330
DEVA	32	Saline Valley, North Sand Dunes	36.762	-117.864	363
DEVA	A	Surprise Canyon (East)	36.114	-117.146	1344
DEVA	B	Surprise Canyon (Central)	36.113	-117.169	928
DEVA	C	Surprise Canyon (West)	36.101111	-117.200833	524
DEVA	D	Panamint Valley (South)	36.14514	-117.29788	361
DEVA	E	Panamint Valley (North)	36.168828	-117.299567	401
DEVA	F	Craig Canyon Pass	36.626	-117.899	2817
DEVA	G	New York Butte	36.647922	-117.931694	3239
DEVA	H	Big Hunter Canyon	36.684	-117.895	1737
DEVA	I	Beveridge Canyon	36.708208	-117.895473	1437
DEVA	J	Paiute Creek	36.872095	-117.979751	1223
DEVA	K	Mazourka Canyon	36.942	-118.07	2616
DEVA	L	Deep Springs Valley, 8 mi S Deep Springs School	37.259	-117.98	1816
DEVA	M	Deep Springs Lake (East)	37.287	-118.022	1511
DEVA	N	Deep Springs Lake (Southeast)	37.263	-118.033	1509
DEVA	O	Deep Springs Lake (West)	37.283	-118.045	1501
DEVA	P	Deep Springs Valley (West)	37.287	-118.077	1542
DEVA	Q	Deep Springs Valley (Central)	37.328	-118.021	1534
DEVA	R	Deep Springs	37.38	-117.981	1593
DEVA	S	Pigeon Spring	37.415	-117.666	1970
DEVA	T	Magruder Mountain	37.411	-117.547	2745
DEVA	U	Grapevine Canyon, 10 mi NE Scotty's Castle	37.112	-117.216	1263
DEVA	V	Bullfrog Mine, 0.5 mi N of Rhyolite	36.901	-116.832	1163
DEVA	W	Armargosa River, 3.5 mi NE Beatty	36.945	-116.715	1064
DEVA	X	Hwy US 95, 7.9 mi N Beatty	37.002	-116.723	1112
DEVA	Y	Armargosa River, 2 mi E Springdale	37.038	-116.716	1167
DEVA	Z	Armargosa River, 1 mi NE Springdale	37.033	-116.751	1178
DEVA	AA	Shoshone	35.971	-116.27	478
DEVA	AB	Granite Mountains	35.549	-116.824	1200
JOTR	1	3.5 mi N + 2.5 mi E Desert Hot Springs	34.016	-116.447	739

Park	Site no.	Locality	Latitude	Longitude	Elev (m)
JOTR	2	Black Rock Spring	34.056	-116.395	1355
JOTR	3	Upper Covington Flat	34.013	-116.309	1483
JOTR	4	Lower Covington Flat (South)	34.034	-116.311	1461
JOTR	5	Lower Covington Flat (North)	34.06	-116.328	1378
JOTR	6	Quail Spring	34.042	-116.258	1123
JOTR	7	13 mi SW Twentynine Palms	34.013766	-116.241221	1525
JOTR	8	Stubby Spring	33.962	-116.235	1380
JOTR	9	Indian Cove (North)	34.109	-116.153	883
JOTR	10	Indian Cove (South)	34.083	-116.157	1141
JOTR	11	Fortynine Palms	34.11	-116.113	1032
JOTR	12	Pinyon Well	33.898	-116.085	1261
JOTR	13	1.5 mi NE Pinyon Well	33.921	-116.066	1003
JOTR	14	5 mi NW Old Dale Junction	33.895	-115.829	560
JOTR	15	Pinto Peak	33.934	-115.7	454
JOTR	16	Pinto Wash West	33.95681	-115.60458	391
JOTR	17	Pinto Wash Well	33.943	-115.422	329
JOTR	18	Cottonwood Spring (North)	33.755	-115.809	982
JOTR	19	Cottonwood Spring (South)	33.727	-115.817	881
JOTR	20	3 mi S Cottonwood Spring	33.7	-115.807	708
JOTR	21	Lost Palm Canyon	33.701072	-115.73925	782
JOTR	A	Colorado River, Riverside Mountains	33.683	-115.967	525
JOTR	B	Mecca (West)	33.571	-116.085	-58
JOTR	C	Mecca (East)	33.563	-116.058	-53
JOTR	D	Indio	33.725	-116.219	-3
JOTR	E	0.5 mi SE Hwy 71 at junction Hwy 74	33.752	-116.205	31
JOTR	F	Curtis Palms	33.785526	-116.216728	262
JOTR	G	Dillon Road	33.873	-116.309	276
JOTR	H	Thousand Palms	33.836	-116.311	159
JOTR	I	Edom	33.821	-116.394	77
JOTR	J	Palm Springs	33.834	-116.54	149
JOTR	K	Whitewater	33.925	-116.638	417
JOTR	L	22 mi E Twentynine Palms	34.11	-115.678	411
JOTR	M	N side of Eagle Mountain	33.855	-115.481	395
LAKE	1	Colorado River, 31 mi N + 2.5 mi E Camp Mohave	35.4927	-114.6658	232
LAKE	2	Colorado River, 18 mi NE Searchlight	35.64991	-114.64991	346
LAKE	3	Colorado River, 1.5 mi W and 0.5 mi S Willow Beach	35.86275	-114.68673	203
LAKE	4	Willow Beach, Colorado River	35.8703	-114.6586	212
LAKE	5	Hot Spring, Ringbolt Rapids, Black Canyon, Colorado River	35.9606	-114.725	250
LAKE	6	Hoover Dam	36.016	-114.732	450
LAKE	7	Boulder City (South)	36.032	-114.794	390
LAKE	8	Boulder City (West)	36.053	-114.811	367

Park	Site no.	Locality	Latitude	Longitude	Elev (m)
LAKE	9	Boulder City (North)	36.067	-114.799	442
LAKE	10	Callville, Colorado River	36.138671	-114.706705	367
LAKE	11	Boulder Lake, 20 mi above Dam	36.15	-114.54	367
LAKE	12	Ramshead Island	36.24672	-114.40194	367
LAKE	13	Heron Island	36.27306	-114.3825	380
LAKE	14	Bighorn Island	36.28917	-114.39722	398
LAKE	15	Overton	36.30556	-114.42944	367
LAKE	16	1 mi S Rogers Spring	36.372	-114.442	461
LAKE	17	Saint Thomas	36.462	-114.379	367
LAKE	18	5 mi SE Overton	36.49205	-114.38257	367
LAKE	19	Boulder Lake, near mouth of Virgin River	36.49944	-114.34	367
LAKE	20	Kaolin	36.516	-114.414	370
LAKE	A	14 mi E Searchlight	35.464	-114.681	218
LAKE	B	Searchlight	35.471	-114.912	1128
LAKE	C	Boulder City (proper)	35.977	-114.84	761
LAKE	D	Valley of Fire	36.45611	-114.53222	734
MOJA	1	Cedar Canyon (West), Providence Mountains	35.16	-115.4612	1335
MOJA	2	5 mi SE Cima	35.186	-115.431	1708
MOJA	3	Cedar Canyon (East), Providence Mountains	35.175	-115.418	1539
MOJA	4	5 mi NE Granite Well (West), Providence Mountains	35.136	-115.391	1586
MOJA	5	5 mi NE Granite Well (East), Providence Mountains	35.127222	-115.369446	1615
MOJA	6	Rock Spring	35.145	-115.325	1538
MOJA	7	2 mi NE Cima	35.26	-115.48	1230
MOJA	8	3 mi N Cima	35.287	-115.501	1324
MOJA	9	2.5 mi SW Kelso	34.984	-115.687	605
MOJA	10	Kelso	34.998	-115.651	643
MOJA	11	Mitchel Caverns	34.943	-115.52	1433
MOJA	12	Essex	34.940529	-115.47481	1019
MOJA	13	Colton Well, Providence Mountains	34.93414	-115.42354	964
MOJA	14	5 mi S Granite Well, Providence Mountains	34.996	-115.432	1498
MOJA	15	6 mi S Granite Well, Providence Mountains	35.04	-115.432	1347
MOJA	16	SE side Clark Mountain	35.512	-115.58	1921
MOJA	17	N side Clark Mountain	35.526	-115.585	2309
MOJA	18	NE Clark Mountain	35.54	-115.577	2044
MOJA	19	Pass between Granite and Providence Mountains	34.819	-115.61	1229
MOJA	20	8.5 mi NW Essex	34.822	-115.352	670
MOJA	21	7 mi NW Essex	34.8171	-115.3311	638
MOJA	A	Yucca Grove	35.402	-115.79	1261
MOJA	B	Colton Well, Providence Mountains	34.9347	-115.9236	801
MOJA	C	2 mi N junction Hwy 192 and Hwy 60	34.91668	-115.91754	563
MOJA	D	9 mi W + 5 mi S Searchlight	35.343	-115.123	1382

Park	Site no.	Locality	Latitude	Longitude	Elev (m)
MOJA	E	no consistent specific locality	34.842649	-115.966751	777
MOJA	F	Ludlow	34.722	-116.162	538
MOJA	G	Amboy Crater Lava Flow (West)	34.547	-115.793	226
MOJA	H	Amboy Crater Lava Flow (East)	34.553	-115.76	191
MOJA	I	2 mi N Horse Spring, Kingston Range	35.795	-115.889	1334
MOJA	J	1 mi E Horse Spring, Kingston Range	35.778	-115.867	1260
MOJA	K	Horse Spring, Kingston Range	35.767	-115.887	1506

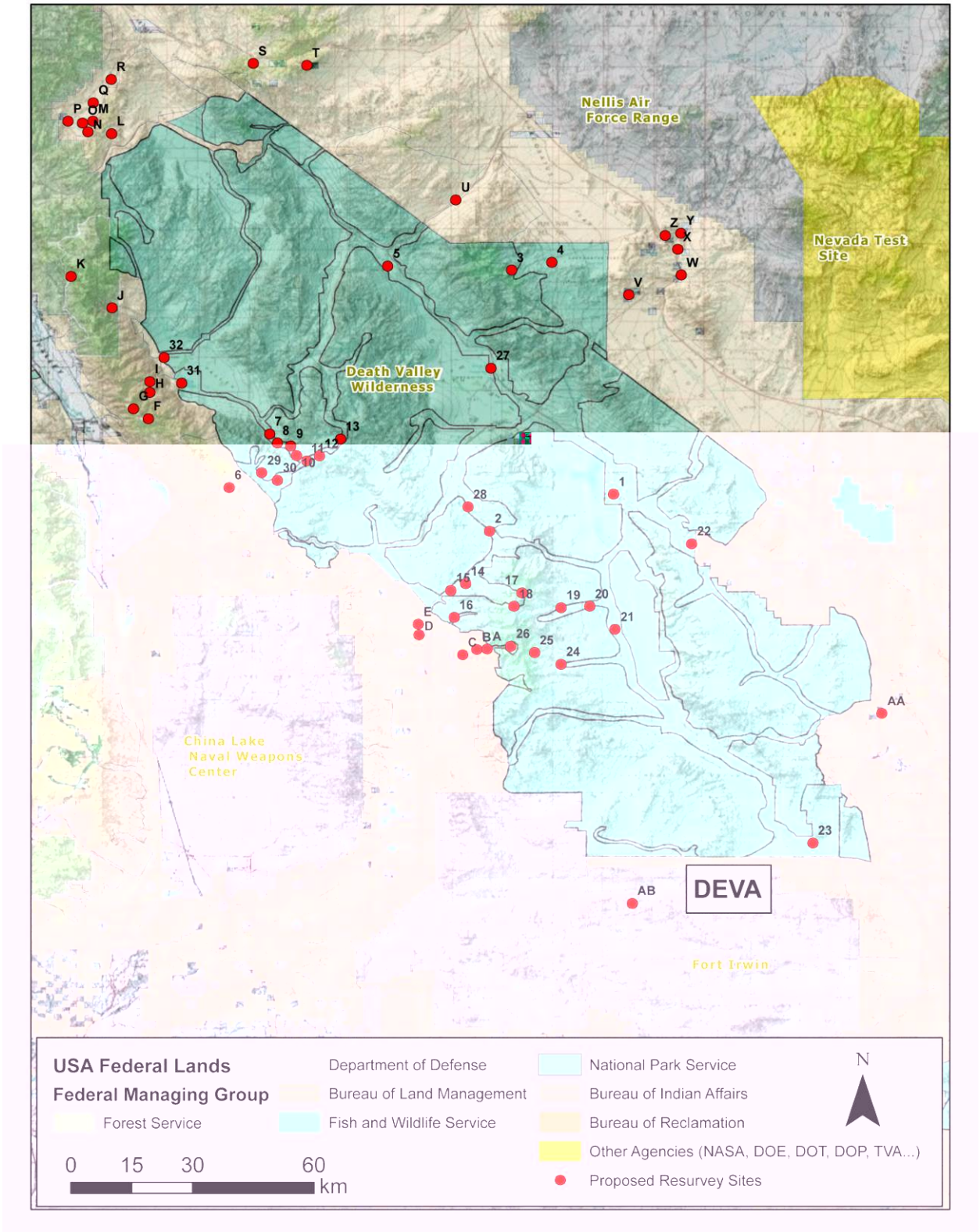


Figure 14. Map of proposed resurvey sites within and surrounding Death Valley NP.

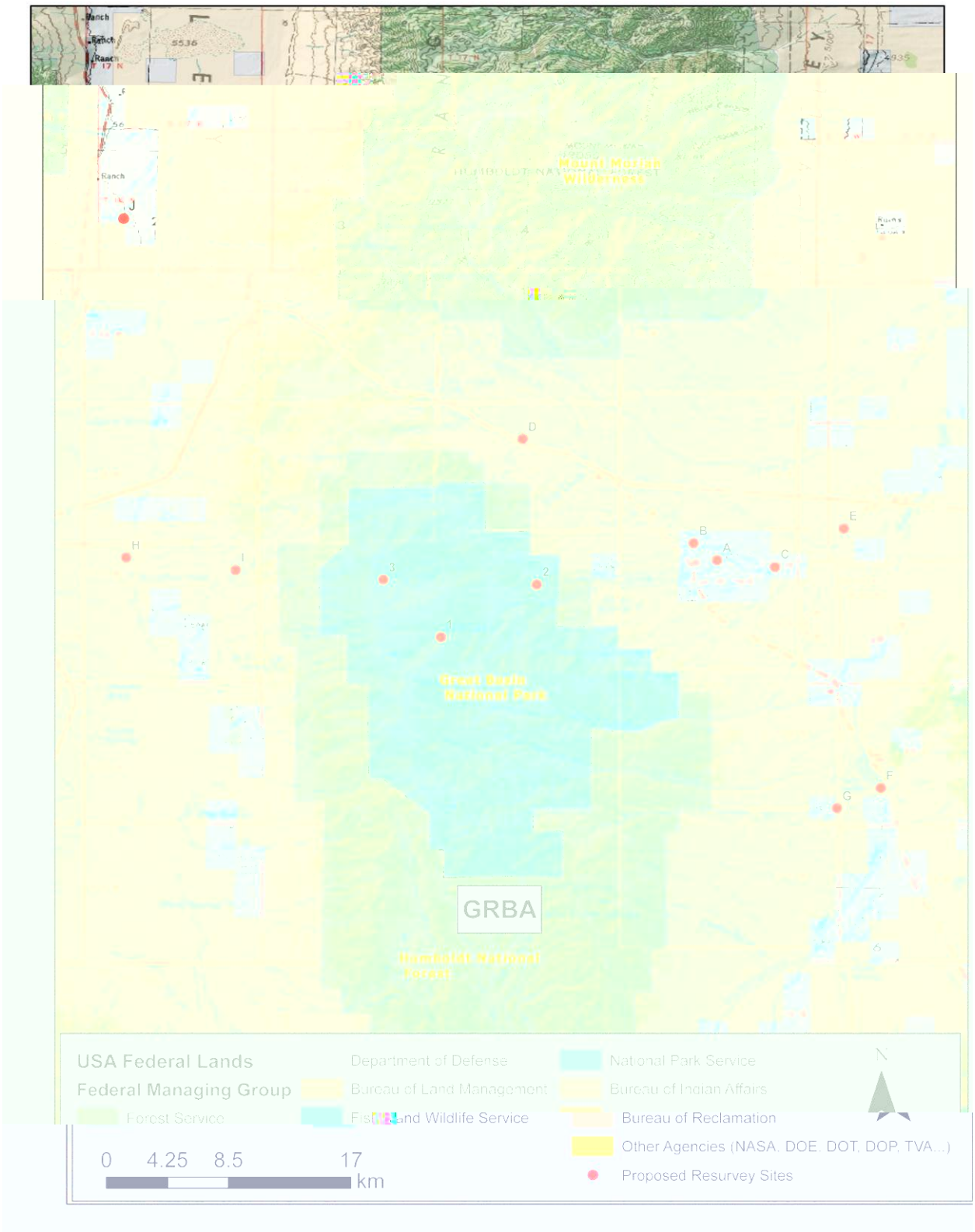


Figure 15. Map of proposed resurvey sites within and surrounding Great Basin NP.

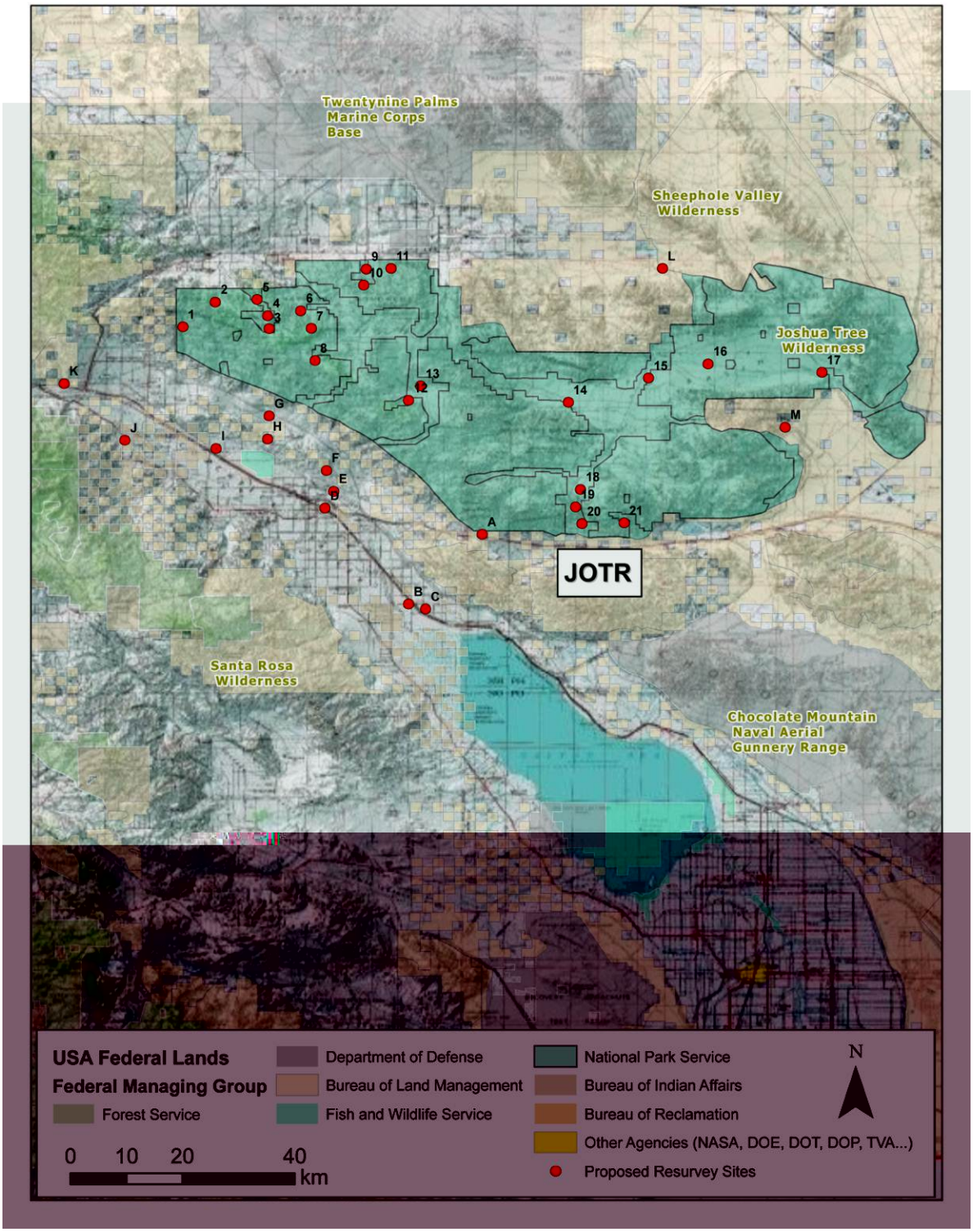


Figure 16. Map of proposed resurvey sites within and surrounding Joshua Tree NP.

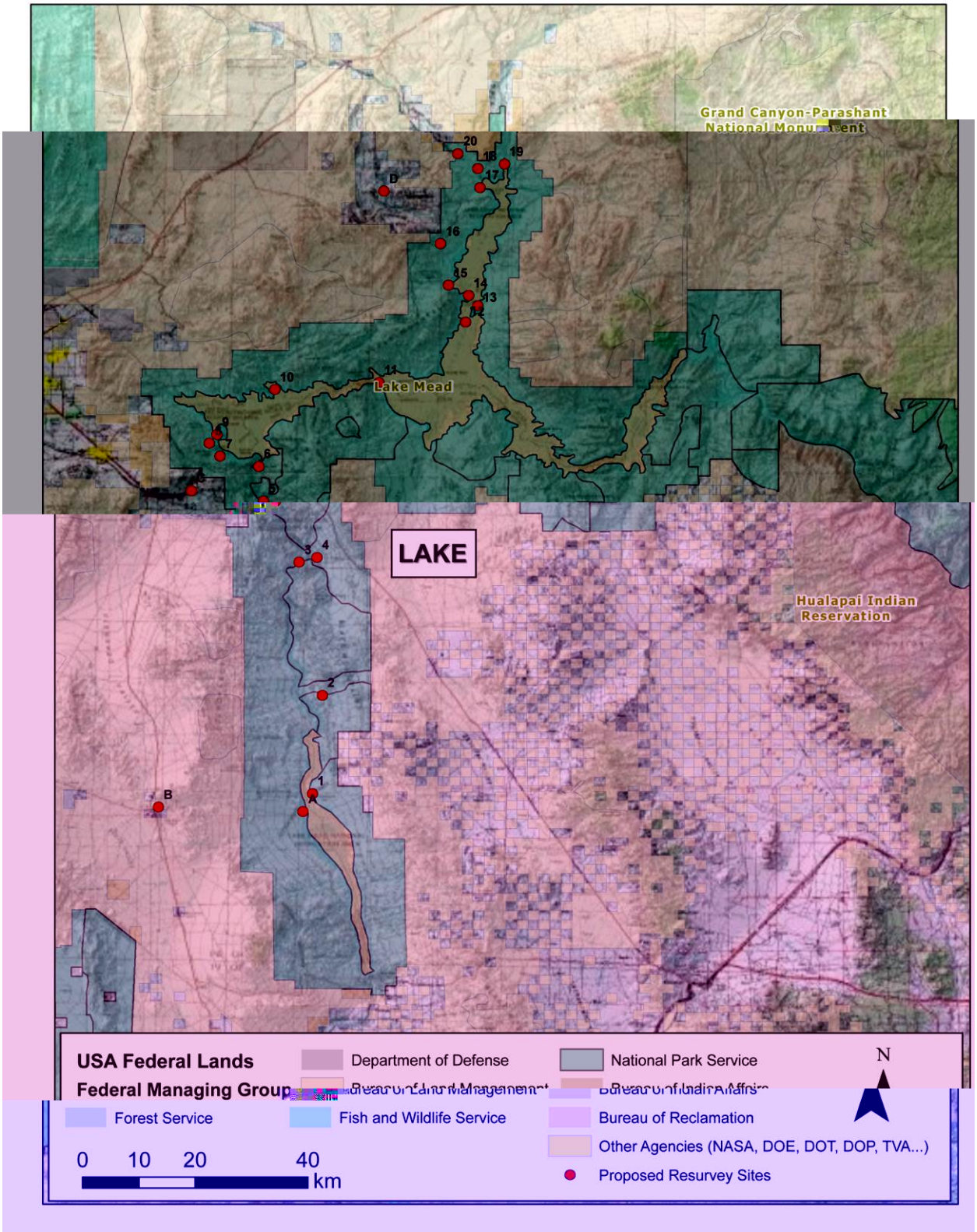


Figure 17. Map of proposed resurvey sites within and surrounding Lake Mead NRA.

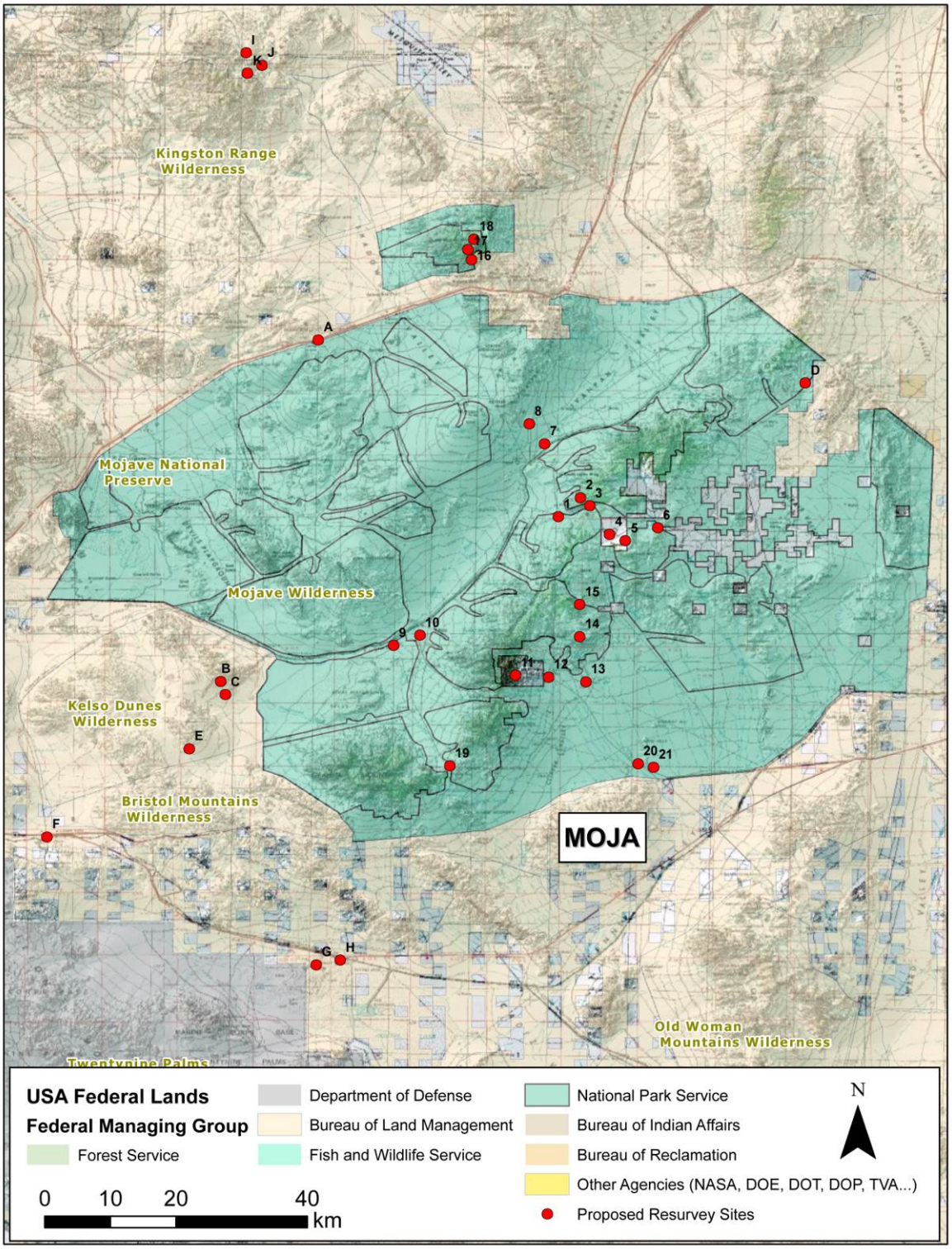


Figure 18. Map of proposed resurvey sites within and surrounding Mojave NP.

Phase 4: Create an Online Data Portal

Individual projects within MVZ's ARCTOS online database were created for each of the parks (http://arctos.database.museum/SpecimenUsage.cfm; see Fig. 19 for an example) as well as instructions for searching, downloading, mapping, and customizing the interface (Appendix D6). Currently, the Projects interface provides a list of collectors and years of collecting, a brief description of the project, links to the specimens associated with the project, and other projects that have resulted from specimens contributed as part of that project. Links to metadata, including photographs, field notes, publications and media coverage, are also available within this interface and are shown as thumbnails at the bottom of the project page. These thumbnails link to various other databases where the relevant data are held (e.g., CalPhotos for images, http://calphotos.berkeley.edu/) and where additional data are available, including photo number, date, locality, subject, and photographer for images. Further links to the high resolution image are available on this website.

Specimens within the boundaries of the parks have been identified and can be separately queried using the "Geographic Feature" option within the specimen database (Appendix D6, "Method 2: Searching under Geographic Feature"). As new specimens and projects are added to the MVZ's collection, these results will be updated dynamically within the "Projects" interface.

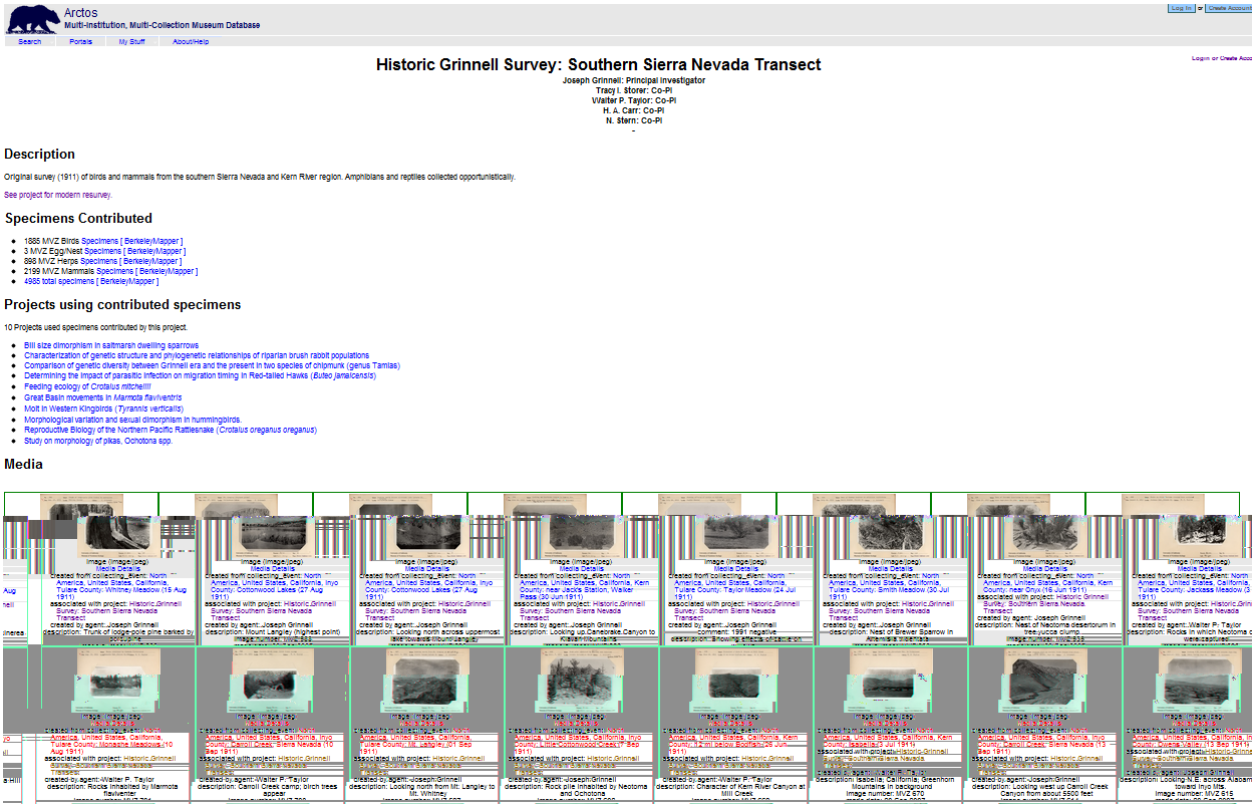


Figure 19. Screen capture of sample project within the ARCTOS online database.

Discussion

Historical museum records provide the foundation for investigating hypotheses into how species have shifted their ranges on spatial and temporal scales, which in turn can be used to develop effective management plans for animal communities inhabiting public lands, and specifically within the Great Basin and Mojave Desert. Our findings show there are a significant number of specimen records from both MVZ's collection and other national and regional institutes that provide broad coverage within this area. Our initial investigation into historical metadata housed within the MVZ's archives suggests sufficient data exist for evaluating occurrences of non-vouchered species and for statistical occupancy analysis to evaluate the probability of a false absence of a species at a site, given repeated visits to that site. Combined, these data form a strong basis for the development of a research plan to test hypotheses of changes in species distributions from the past to the present and to predict how species are expected to respond to change into the future. In addition, these data will allow scientists to evaluate the accuracy of these models when combined with on-the-ground resurveys.

We identified numerous sites within and nearby each of the parks with high sampling intensity in the past that could serve as resurvey sites. These sites occur over a range geographic space and elevation and of predicted change in climate. In addition, our initial assessment of field notes associated with these resurvey sites suggests the potential for evaluating changes in species occupancy at sites using the statistically rigorous method of occupancy modeling (MacKenzie et al. 2006, Tingley et al. 2009). This method has been used to demonstrate elevational shifts in birds (Tingley et al. in prep) and mammals (Moritz et al. 2008) in the Sierra Nevada Mountains. Other methods using field notes (e.g., Rowe et al. 2010) have also been able to address range shifts in mammal communities in Nevada. Our initial assessment of field notes was restricted to the MVZ's archives. Whether other museums house relevant field notes (i.e., those with data on the frequency and effort of collecting, maps of original sampling locations) remains to be evaluated. However, with an increase in digitization of historical data, including field notes (e.g., California Academy of Sciences' "Connecting Content" Project; http://research.calacademy.org/library/fieldnotes), the ability of researchers to access these metadata will continue to grow. These data may also provide important information that can be used to statistically evaluate range shifts within this region.

Using the historical specimen records combined with multiple climate predictors we generated distribution models of where we predicted species of birds and mammals to have occurred both in the past and where we expect them to occur in the present day. These distribution models act as a series of hypotheses of species presence or absence that can be tested by identifying and surveying locations where we predict individual or groups of species to occur or not occur. We can also use these models to select sites that can act as benchmarks for evaluating changes in species distributions into the future, for example by identifying areas that are likely to have high species turnover between now and then. While these models act as an important tool to help predict species responses to past and future climate change, their interpretation must consider several limitations and assumptions (Graham et al. 2009). Our series of models incorporated only climate data to predict where species should occur and deals only with presence data (i.e., museum specimen records). Other factors, including incorporation of land use variables (Jetz et al. 2007), "absence" data (Smith et al. 2011), different modeling frameworks (Smith et al. 2011), and species interactions (Rubidge et al. 2011) can affect the accuracy SDMs. For example, with

our example of the SDM for the Western Harvest Mouse, although historical and modern specimen records of this species occurred within Great Basin NP, only our model of future distributions (2050 and 2080) showed their predicted presence within the park. We therefore caution that the SDMs generated as part of this project be used as a starting point to develop a resurvey plan within the region rather than act as an absolute prediction of where species have occurred in the past, where they occur now, and where they are predicted to occur in the future.

With the use of large-scale specimen databases using GIS based analyses, careful attention must be paid to the quality of the georeferenced localities within the records. While more than 95% of MVZ's specimen records contained geographic coordinates, significantly fewer (75%) specimen records from other museums also contained georeferences. Furthermore, many contained textual errors (e.g., degrees minutes seconds incorrectly converted to decimal degrees) or other errors (e.g., coordinates do not map to within the identified county). Many lacked an estimate of error around the geographic coordinates (a coordinate's "extent"). Automated georeferencing programs (e.g., BioGeomancer and GeoLocate) can assist with large-scale georeferencing of datasets, but proper vetting of georeferences, ideally with associated field notes or local knowledge of the region, is critical to the development of accurate SDMs as well as providing greater confidence in evaluating true shifts in species over elevational gradients, particularly in areas where mistakes in point locations can result in dramatic differences in elevation. Repatriation of any corrections to the host museum can improve the quality of those records for the use by future researchers.

The creation of the Projects within the MVZ's online database provides a data clearinghouse for park staff to consult regarding MVZ holdings relating to the park. The interface has been designed to maximize functionality for a variety of needs and will continue to be updated. As individual records are updated, or new specimens are added, parks staff will have access to these changes immediately after they have taken place. Furthermore, digitization of the archives will continue, increasing public access to MVZ's vast collection of historical and modern natural history data.

One of our main objectives with this project was to develop the foundation for a competitive proposal to seek external funding for on-the-ground resurveys, allowing us to test hypotheses relating to the responses of terrestrial vertebrates to rapid climate change in this region over the last 100 years. A preliminary proposal has been submitted to the National Science Foundation building on the specimen records, field notes, and other metadata compiled as part of this grant, focusing on the California parks (Death Valley NP, Mojave NP, and Joshua Tree NP). This project would address the effects of rapid warming and drying on community composition and dynamics, test the relative influence of climate, land use, and species interactions on these changes, and evaluate the performance of modeling methods using known colonizations and extinctions across the landscape. Additional proposals may be submitted in the future, depending on grant opportunities.

Literature Cited

Austin, M. 2007. Species distribution models and ecological theory: a critical assessment and some possible new approaches. *Ecological Modelling* 200:1-19.

Burrows, M. T., D. S. Schoeman, L. B. Buckley, P. Moore, E. S. Poloczanska, K. M. Brander, C. Brown, J. F. Bruno, C. M. Duarte, B. S. Halpern, J. Holding, C. V. Kappel, W. Kiessling, M. I. O'Connor, J. M. Pandolfi, C. Parmesan, F. B. Schwing, W. J. Sydeman, and A. J. Richardson. 2011. The pace of shifting climate in marine and terrestrial ecosystems. *Science* 334:1024-1026.

Daly, C., G. H. Taylor, W. P. Gibson, T. W. Parzybok, G. L. Johnson, and P. Pasteris. 2001. High-quality spatial climate data sets for the United States and beyond. *Transactions of the American Society of Agricultural Engineers* 43:1957-1962.

Elith, J., C. H. Graham, R. P. Anderson, M. Dudik, S. Ferrier, A. Guisan, R. J. Hijmans, F. Huettmann, J. R. Leathwick, A. Lehmann, J. Li, L. G. Lohmann, B. A. Loiselle, G. Manion, C. Moritz, M. Nakazawa, J. M. M. Overton, A. T. Peterson, S. J. Phillips, K. Richardson, R. Scachetti-Pereira, R. E. Schapire, J. Soberón, S. Williams, M. S. Wisz, and N. E. Zimmermann. 2006. Novel methods improve prediction of species' distribution from occurrence data. *Ecography* 29:129-151.

Graham, C. H., B. A. Loiselle, J. Velásquez-tibatá, and Cuesta C., F. 2009. Species distribution modeling and the challenge of predicting future distributions. Pages 295-310 *in* S. K. Herzog, R. Martínez, P. M. Jørgensen, and H. Tiessen, editors. Climate change and biodiversity in the tropical Andes. IAI-SCOPE.

Gonzalez, P. 2011. Science for natural resource management under climate change. *Issues in Science and Technology*. The University of Texas at Dallas.

Guisan, A. and W. Thuiller. 2005. Predicting species distribution: offering more than simple habitat models. *Ecology Letters* 8:993-1009.

Helgen, K. M., F. R. Cole, L. E. Helgen, and D. E. Wilson. 2009. Generic revision in the Holarctic ground squirrel genus *Spermophilus*. *Journal of Mammalogy* 90:270-305.

IPCC. 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller, editors. Cambridge University Press, New York, New York.

Jetz, W., D. S. Wilcove, and A. P. Dobson. 2007. Projected impacts of climate and land-use change on the global diversity of birds. *PLoS Biology* 5:1211-1219.

Littell, J. S., D. L. Peterson, C. I. Millar, K. A. O'Halloran. 2012. U.S. National Forests adapt to climate change through science-management partnerships. *Climatic Change* 110:269-296.

Loarie, S. R., P. B. Duffy, H. Hamilton, G. P. Asner, C. B. Field, D. D. Ackerly. 2009. The velocity of climate change. *Nature* 462:1052-1055.

MacKenzie, D. I., J. D. Nichols, J. A. Royle, K. H. Pollock, L. L. Bailey, and J. E. Hines. 2006. Occupancy Estimation and Modeling. Academic Press, Burlington, Vermont.

Moritz, C., J. L. Patton, C. J. Conroy, J. L. Parra, G. C. White, and S. R. Beissinger. 2008. Impact of a century of climate change on small-mammal communities in Yosemite National Park, USA. *Science* 322:261-264.

Rowe, K. C., K. M. C. Rowe, M. Koo, M. W. Tingley, J. L. Patton, C. J. Conroy, J. Perrine, S. R. Beissinger, and C. Moritz. Regional variation in elevation shifts of small mammal species over the last century in California. *In preparation.*

Rowe, R. J., J. A. Finarelli, and E. A. Rickart. 2010. Range dynamics of small mammals along an elevational gradient over an 80-year interval. *Global Change Biology* 16:2930-2943.

Rubidge, E. M., W. B. Monahan, J. L. Parra, S. E. Cameron, and J. S. Brashares. 2011. The role of climate, habitat, and species co-occurrence as drivers of change in small mammal distributions over the past century. *Global Change Biology* 17:696-708.

Smith, A. B., M. Koo, K. M. C. Rowe, J. Patton, S. Beissinger, and C. Moritz. 2011. Testing methods for predicting mammalian species' responses to 20th century climate change in California. California Institute for Energy and Environment. (accessed at: http://uc-ciee.org/all-documents/a/521/113/nested)

Tingley, M. W., M. S. Koo, C. Moritz, A. C. Rush, and S. R. Beissinger. Temperature alone does not explain patterns of avian elevational range change. *In preparation.*

Tingley, M. W., W. B. Monahan, S. R. Beissinger, and C. Moritz. 2009. Birds track their Grinnellian niche thorugh a century of climate change. *Proceedings of the National Academy of Science* 106:19637-19643.

Wilson, D. E. and D. M. Reeder, editors. 2005. Mammal Species of the World. A Taxonomic and Geographic Reference, 3rd edition. Johns Hopkins University Press. Baltimore, Maryland.

Appendix A: Species Names

Species names given within the specimen records of the database (see Appendix E) and their corresponding corrected taxonomy (see Methods) used in the regional and park-specific species lists (Appendix B).

Genus species name	Corrected genus species name
BIRDS	
Accipiter cooperii	*Accipiter cooperii*
Accipiter gentilis	*Accipiter gentilis*
Accipiter striatus	*Accipiter striatus*
Actitis macularia	*Actitis macularius*
Actitis macularius	*Actitis macularius*
Aechmophorus clarkii	*Aechmophorus clarkii*
Aechmophorus occidentalis	*Aechmophorus occidentalis*
Aechmophorus sp.	*Aechmophorus sp.*
Aegolius acadicus	*Aegolius acadicus*
Aeronautes saxatalis	*Aeronautes saxatalis*
Aeronautes saxtalis	*Aeronautes saxatalis*
Agelaius phoeniceus	*Agelaius phoeniceus*
Agelaius tricolor	*Agelaius tricolor*
Aimophila ruficeps	*Aimophila ruficeps*
Aix sponsa	*Aix sponsa*
Alectoris chukar	*Alectoris chukar*
Alectoris graeca	*Alectoris graeca*
Ammodramus savannarum	*Ammodramus savannarum*
Amphispiza belli	*Amphispiza belli*
Amphispiza bilineata	*Amphispiza bilineata*
Anas acuta	*Anas acuta*
Anas americana	*Anas americana*
Anas clypeata	*Anas clypeata*
Anas crecca	*Anas crecca*
Anas cyanoptera	*Anas cyanoptera*
Anas discors	*Anas discors*
Anas platyrhynchos	*Anas platyrhynchos*
Anas strepera	*Anas strepera*
Anthus rubescens	*Anthus rubescens*
Anthus spinoletta	*Anthus spinoletta*
Anthus spragueii	*Anthus spragueii*
Aphelocoma californica	*Aphelocoma californica*

Genus species name	Corrected genus species name
Aphelocoma coerulescens	*Aphelocoma coerulescens*
Aphriza virgata	*Aphriza virgata*
Aquila chrysaetos	*Aquila chrysaetos*
Archilochus alexandri	*Archilochus alexandri*
Ardea alba	*Ardea alba*
Ardea herodias	*Ardea herodias*
Arenaria interpres	*Arenaria interpres*
Arenaria melanocephala	*Arenaria melanocephala*
Asio flammeus	*Asio flammeus*
Asio otus	*Asio otus*
Asyndesmus lewis	*Melanerpes lewis*
Athene cunicularia	*Athene cunicularia*
Auriparus flaviceps	*Auriparus flaviceps*
Aythya affinis	*Aythya affinis*
Aythya americana	*Aythya americana*
Aythya collaris	*Aythya collaris*
Aythya marila	*Aythya marila*
Baeolophus inornatus	*Baeolophus inornatus*
Baeolophus ridgwayi	*Baeolophus ridgwayi*
Bombycilla cedrorum	*Bombycilla cedrorum*
Bombycilla garrulus	*Bombycilla garrulus*
Botaurus lentiginosus	*Botaurus lentiginosus*
Branta bernicla	*Branta bernicla*
Branta canadensis	*Branta canadensis*
Branta hutchinsii	*Branta hutchinsii*
Bubo virginianus	*Bubo virginianus*
Bucephala albeola	*Bucephala albeola*
Bucephala clangula	*Bucephala clangula*
Bucephala islandica	*Bucephala islandica*
Buteo jamaicensis	*Buteo jamaicensis*
Buteo lagopus	*Buteo lagopus*
Buteo lineatus	*Buteo lineatus*
Buteo regalis	*Buteo regalis*
Buteo swainsoni	*Buteo swainsoni*
Butorides virescens	*Butorides virescens*
Calamospiza melanocorys	*Calamospiza melanocorys*
Calcarius ornatus	*Calcarius ornatus*
Calidris alba	*Calidris alba*
Calidris alpina	*Calidris alpina*
Calidris bairdii	*Calidris bairdii*

Genus species name	Corrected genus species name
Calidris canutus	*Calidris canutus*
Calidris fuscicollis	*Calidris fuscicollis*
Calidris mauri	*Calidris mauri*
Calidris melanotos	*Calidris melanotos*
Calidris minuta	*Calidris minuta*
Calidris minutilla	*Calidris minutilla*
Calidris pusilla	*Calidris pusilla*
Callipepla californica	*Callipepla californica*
Callipepla gambelii	*Callipepla gambelii*
Calypte anna	*Calypte anna*
Calypte costae	*Calypte costae*
Calypte sp.	*Calypte sp.*
Campylorhynchus brunneicapillus	*Campylorhynchus brunneicapillus*
Capella delicata	*Gallinago delicata*
Caprimulgus vociferus	*Caprimulgus vociferus*
Cardinalis cardinalis	*Cardinalis cardinalis*
Carduelis flammea	*Acanthis flammea*
Carduelis lawrencei	*Spinus lawrencei*
Carduelis pinus	*Spinus pinus*
Carduelis psaltria	*Spinus psaltria*
Carduelis tristis	*Spinus tristis*
Carpodacu cassinii	*Carpodacus cassinii*
Carpodacu mexicanus	*Carpodacus mexicanus*
Carpodacus	*Carpodacus sp.*
Carpodacus cassinii	*Carpodacus cassinii*
Carpodacus mexicanus	*Carpodacus mexicanus*
Carpodacus purpureus	*Carpodacus purpureus*
Cathartes aura	*Cathartes aura*
Catharus fuscescens	*Catharus fuscescens*
Catharus guttatus	*Catharus guttatus*
Catharus ustulatus	*Catharus ustulatus*
Catherpes mexicanus	*Catherpes mexicanus*
Catoptrophorus semipalmatus	*Tringa semipalmatus*
Centrocercus urophasianus	*Centrocercus urophasianus*
Certhia americana	*Certhia americana*
Certhia familiaris	*Certhia familiaris*
Ceryle alcyon	*Megaceryle alcyon*
Chaetura vauxi	*Chaetura vauxi*
Chaetura vauxii	*Chaetura vauxi*
Chamaea fasciata	*Chamaea fasciata*

Genus species name	Corrected genus species name
Charadrius alexandrinus	*Charadrius alexandrinus*
Charadrius montanus	*Charadrius montanus*
Charadrius semipalmatus	*Charadrius semipalmatus*
Charadrius vociferus	*Charadrius vociferus*
Chen caerulescens	*Chen caerulescens*
Chen rossii	*Chen rossii*
Chlidonias niger	*Chlidonias niger*
Chondestes grammacus	*Chondestes grammacus*
Chordeiles acutipennis	*Chordeiles acutipennis*
Chordeiles minor	*Chordeiles minor*
Chroicocephalus philadelphia	*Chroicocephalus philadelphia*
Cinclus mexicanus	*Cinclus mexicanus*
Circus cyaneus	*Circus cyaneus*
Cistothorus palustris	*Cistothorus palustris*
Coccothraustes vespertinus	*Coccothraustes vespertinus*
Coccyzus americanus	*Coccyzus americanus*
Colaptes auratus	*Colaptes auratus*
Colaptes cafer	*Colaptes auratus*
Colaptes chrysoides	*Colaptes chrysoides*
Columba fasciata	*Patagioenas fasciata*
Columbina passerina	*Columbina passerina*
Contopus borealis	*Contopus cooperi*
Contopus cooperi	*Contopus cooperi*
Contopus pertinax	*Contopus pertinax*
Contopus sordidulus	*Contopus sordidulus*
Corvus brachyrhynchos	*Corvus brachyrhynchos*
Corvus corax	*Corvus corax*
Coturnicops noveboracensis	*Coturnicops noveboracensis*
Cyanocitt stelleri	*Cyanocitta stelleri*
Cyanocitta stelleri	*Cyanocitta stelleri*
Cypseloides niger	*Cypseloides niger*
Dendragapus obscurus	*Dendragapus obscurus*
Dendrocopos albolarvatus	*Picoides albolarvatus*
Dendrocopos nuttalli	*Picoides nuttallii*
Dendrocopos nuttallii	*Picoides nuttallii*
Dendrocopos pubescens	*Picoides pubescens*
Dendrocopos scalaris	*Picoides scalaris*
Dendrocopos villosus	*Picoides villosus*
Dendrocygna bicolor	*Dendrocygna bicolor*
Dendroica caerulescens	*Dendroica caerulescens*

Genus species name	Corrected genus species name
Dendroica coronata	*Dendroica coronata*
Dendroica graciae	*Dendroica graciae*
Dendroica magnolia	*Dendroica magnolia*
Dendroica nigrescens	*Dendroica nigrescens*
Dendroica occidentalis	*Dendroica occidentalis*
Dendroica petechia	*Dendroica petechia*
Dendroica townsendi	*Dendroica townsendi*
Dendroica virens	*Dendroica virens*
Dumetella carolinensis	*Dumetella carolinensis*
Egretta rufescens	*Egretta rufescens*
Egretta thula	*Egretta thula*
Elanus leucurus	*Elanus leucurus*
Empidonax difficilis	*Empidonax difficilis*
Empidonax hammondii	*Empidonax hammondii*
Empidonax oberholseri	*Empidonax oberholseri*
Empidonax occidentalis	*Empidonax occidentalis*
Empidonax trailii	*Empidonax traillii*
Empidonax traillii	*Empidonax traillii*
Empidonax wrightii	*Empidonax wrightii*
Eremophila alpestris	*Eremophila alpestris*
Eudromia elegans	*Eudromia elegans*
Euphagus carolinus	*Euphagus carolinus*
Euphagus cyanocephalus	*Euphagus cyanocephalus*
Eupoda montana	*Charadrius montanus*
Falco columbarius	*Falco columbarius*
Falco mexicanus	*Falco mexicanus*
Falco peregrinus	*Falco peregrinus*
Falco sparverius	*Falco sparverius*
Fregata magnificens	*Fregata magnificens*
Fulica americana	*Fulica americana*
Gallinago delicata	*Gallinago delicata*
Gallinago gallinago	*Gallinago gallinago*
Gallinula chloropus	*Gallinula chloropus*
Gavia immer	*Gavia immer*
Gavia pacifica	*Gavia pacifica*
Gavia stellata	*Gavia stellata*
Geococcyx californiana	*Geococcyx californianus*
Geococcyx californianus	*Geococcyx californianus*
Geothlypis tolmiei	*Oporornis tolmiei*
Geothlypis trichas	*Geothlypis trichas*

Genus species name	Corrected genus species name
Glaucidium gnoma	*Glaucidium gnoma*
Grus canadensis	*Grus canadensis*
Guiraca caerulea	*Passerina caerulea*
Gymnogyps californianus	*Gymnogyps californianus*
Gymnorhinus cyanocephala	*Gymnorhinus cyanocephalus*
Gymnorhinus cyanocephalus	*Gymnorhinus cyanocephalus*
Helmitheros vermivorus	*Helmitheros vermivorum*
Himantopus mexicanus	*Himantopus mexicanus*
Hirundo rustica	*Hirundo rustica*
Hydrocoloeus minutus	*Hydrocoloeus minutus*
Hydroprogne caspia	*Hydroprogne caspia*
Icteria virens	*Icteria virens*
Icterus bullockii	*Icterus bullockii*
Icterus cucullatus	*Icterus cucullatus*
Icterus galbula	*Icterus bullockii*
Icterus parisorum	*Icterus parisorum*
Icterus spurius	*Icterus spurius*
Ixobrychus exilis	*Ixobrychus exilis*
Ixoreus naevius	*Ixoreus naevius*
Junco caniceps	*Junco hyemalis*
Junco hyemalis	*Junco hyemalis*
Junco oreganus	*Junco hyemalis*
Junco sp.	*Junco sp.*
Lanius excubitor	*Lanius excubitor*
Lanius ludovicianus	*Lanius ludovicianus*
Larus atricilla	*Leucophaeus atricilla*
Larus californicus	*Larus californicus*
Larus canus	*Larus canus*
Larus delawarensis	*Larus delawarensis*
Larus L.	*Larus sp.*
Larus occidentalis	*Larus occidentalis*
Larus philadelphia	*Chroicocephalus philadelphia*
Leucophaeus pipixcan	*Leucophaeus pipixcan*
Leucosticte arctoa	*Leucosticte arctoa*
Leucosticte atrata	*Leucosticte atrata*
Leucosticte tephrocotis	*Leucosticte tephrocotis*
Limnodromus griseus	*Limnodromus griseus*
Limnodromus scolopaceus	*Limnodromus scolopaceus*
Limosa fedoa	*Limosa fedoa*
Lophortyx californica	*Callipepla californica*

Genus species name	Corrected genus species name
Lophortyx gambelii	*Callipepla gambelii*
Loxia curvirostra	*Loxia curvirostra*
Megascops kennicottii	*Megascops kennicottii*
Melanerpes formicivorus	*Melanerpes formicivorus*
Melanerpes lewis	*Melanerpes lewis*
Melanerpes uropygialis	*Melanerpes uropygialis*
Melanitta fusca	*Melanitta fusca*
Melanitta perspicillata	*Melanitta perspicillata*
Melospiza georgiana	*Melospiza georgiana*
Melospiza lincolnii	*Melospiza lincolnii*
Melospiza melodia	*Melospiza melodia*
Melozone aberti	*Melozone aberti*
Melozone crissalis	*Melozone crissalis*
Mergus serrator	*Mergus serrator*
Micrathene whitneyi	*Micrathene whitneyi*
Mimus polyglottos	*Mimus polyglottos*
Mimus polyglottus	*Mimus polyglottos*
Molothrus ater	*Molothrus ater*
Myadestes townsendi	*Myadestes townsendi*
Mycteria americana	*Mycteria americana*
Myiarchus cinerascens	*Myiarchus cinerascens*
Myiarchus tyrannulus	*Myiarchus tyrannulus*
Myioborus pictus	*Myioborus pictus*
Nephoecetes niger	*Cypseloides niger*
not recorded	*UNKNOWN*
Nucifraga columbiana	*Nucifraga columbiana*
Numenius americanus	*Numenius americanus*
Nycticorax nycticorax	*Nycticorax nycticorax*
Oceanodroma microsoma	*Oceanodroma microsoma*
Oporornis philadelphia	*Oporornis philadelphia*
Oporornis tolmiei	*Oporornis tolmiei*
Oreortyx picta	*Oreortyx pictus*
Oreortyx pictus	*Oreortyx pictus*
Oreoscoptes montanus	*Oreoscoptes montanus*
Oreothlypis celata	*Oreothlypis celata*
Oreothlypis ruficapilla	*Oreothlypis ruficapilla*
Otus asio	*Megascops asio*
Otus flammeolus	*Otus flammeolus*
Otus kennicottii	*Megascops kennicottii*
Oxyura jamaicensis	*Oxyura jamaicensis*

Genus species name	Corrected genus species name
Pandion haliaetus	*Pandion haliaetus*
Parula americana	*Parula americana*
Parus atricapillus	*Poecile atricapillus*
Parus gambeli	*Poecile gambeli*
Parus inornatus	*Poecile inornatus*
Parus rufescens	*Poecile rufescens*
Passer domesticus	*Passer domesticus*
Passerculus sandwichensis	*Passerculus sandwichensis*
Passerella iliaca	*Passerella iliaca*
Passerina amoena	*Passerina amoena*
Passerina caerulea	*Passerina caerulea*
Passerina cyanea	*Passerina cyanea*
Patagioenas fasciata	*Patagioenas fasciata*
Pelecanus occidentalis	*Pelecanus occidentalis*
Petrochelidon pyrrhonota	*Petrochelidon pyrrhonota*
Phainopepla nitens	*Phainopepla nitens*
Phalacrocorax auritus	*Phalacrocorax auritus*
Phalaenoptilus nuttallii	*Phalaenoptilus nuttallii*
Phalaropus fulicarius	*Phalaropus fulicarius*
Phalaropus lobatus	*Phalaropus lobatus*
Phalaropus tricolor	*Phalaropus tricolor*
Phasianus colchicus	*Phasianus colchicus*
Pheucticus ludovicianus	*Pheucticus ludovicianus*
Pheucticus melanocephalus	*Pheucticus melanocephalus*
Phoebastria immutabilis	*Phoebastria immutabilis*
Pica hudsonia	*Pica hudsonia*
Pica pica	*Pica hudsonia*
Picoides albolarvatus	*Picoides albolarvatus*
Picoides nuttallii	*Picoides nuttallii*
Picoides pubescens	*Picoides pubescens*
Picoides scalaris	*Picoides scalaris*
Picoides scalarisx	*Picoides scalaris*
Picoides tridactylus	*Picoides dorsalis*
Picoides villosus	*Picoides villosus*
Pipilo aberti	*Melozone aberti*
Pipilo alberti	*Melozone aberti*
Pipilo chlorurus	*Pipilo chlorurus*
Pipilo crissalis	*Melozone crissalis*
Pipilo erythrophthalmus	*Pipilo erythrophthalmus*
Pipilo fuscus	*Melozone fusca*

Genus species name	Corrected genus species name
Pipilo maculatus	*Pipilo maculatus*
Piranga flava	*Piranga flava*
Piranga ludoviciana	*Piranga ludoviciana*
Piranga rubra	*Piranga rubra*
Plectrophenax nivalis	*Plectrophenax nivalis*
Plegadis chihi	*Plegadis chihi*
Pluvialis squatarola	*Pluvialis squatarola*
Podiceps auritus	*Podiceps auritus*
Podiceps grisegena	*Podiceps grisegena*
Podiceps nigricollis	*Podiceps nigricollis*
Podilymbus podiceps	*Podilymbus podiceps*
Poecile gambeli	*Poecile gambeli*
Polioptila caeruelea	*Polioptila caerulea*
Polioptila caerulea	*Polioptila caerulea*
Polioptila californica	*Polioptila californica*
Polioptila melanura	*Polioptila melanura*
Pooecetes gramineus	*Pooecetes gramineus*
Porzana carolina	*Porzana carolina*
Progne subis	*Progne subis*
Protonotaria citrea	*Protonotaria citrea*
Psaltriparus minimus	*Psaltriparus minimus*
Pyrocephalus rubinus	*Pyrocephalus rubinus*
Quiscalus mexicanus	*Quiscalus mexicanus*
Quiscalus quiscula	*Quiscalus quiscula*
Rallus limicola	*Rallus limicola*
Rallus longirostris	*Rallus longirostris*
Recurvirostra americana	*Recurvirostra americana*
Regulus calendula	*Regulus calendula*
Regulus satrapa	*Regulus satrapa*
Riparia riparia	*Riparia riparia*
Rissa tridactyla	*Rissa tridactyla*
Rynchops niger	*Rynchops niger*
Salpincte obsoletus	*Salpinctes obsoletus*
Salpinctes mexicanus	*Catherpes mexicanus*
Salpinctes obsoletus	*Salpinctes obsoletus*
Sayornis nigricans	*Sayornis nigricans*
Sayornis phoebe	*Sayornis phoebe*
Sayornis saya	*Sayornis saya*
Scolopax minor	*Scolopax minor*
Seiurus aurocapillus	*Seiurus aurocapilla*

Genus species name	Corrected genus species name
Seiurus motacilla	*Parkesia motacilla*
Seiurus noveboracensis	*Parkesia noveboracensis*
Selasphorus platycercus	*Selasphorus platycercus*
Selasphorus rufus	*Selasphorus rufus*
Selasphorus sasin	*Selasphorus sasin*
Selasphorus sp.	*Selasphorus sp.*
Setophaga ruticilla	*Setophaga ruticilla*
Sialia currucoides	*Sialia currucoides*
Sialia mexicana	*Sialia mexicana*
Sitta canadensis	*Sitta canadensis*
Sitta carolinensis	*Sitta carolinensis*
Sitta pygmaea	*Sitta pygmaea*
Speotyto cunicularia	*Athene cunicularia*
Sphyrapic nuchalis	*Sphyrapicus nuchalis*
Sphyrapicus nuchalis	*Sphyrapicus nuchalis*
Sphyrapicus ruber	*Sphyrapicus ruber*
Sphyrapicus thyroideus	*Sphyrapicus thyroideus*
Sphyrapicus varius	*Sphyrapicus varius*
Spinus lawrencei	*Spinus lawrencei*
Spinus pinus	*Spinus pinus*
Spinus psaltria	*Spinus psaltria*
Spinus tristis	*Spinus tristis*
Spizella arborea	*Spizella arborea*
Spizella atrogularis	*Spizella atrogularis*
Spizella breweri	*Spizella breweri*
Spizella passerina	*Spizella passerina*
Stelgidopteryx serripennis	*Stelgidopteryx serripennis*
Stellula calliope	*Stellula calliope*
Stercorarius longicaudus	*Stercorarius longicaudus*
Stercorarius pomarinus	*Stercorarius pomarinus*
Sterna caspia	*Hydroprogne caspia*
Sterna forsteri	*Sterna forsteri*
Sterna hirundo	*Sterna hirundo*
Streptopelia chinensis	*Streptopelia chinensis*
Strix occidentalis	*Strix occidentalis*
Sturnella neglecta	*Sturnella neglecta*
Sturnus vulgaris	*Sturnus vulgaris*
Sula leucogaster	*Sula leucogaster*
Sula nebouxii	*Sula nebouxii*
Tachycine thalassina	*Tachycineta thalassina*

Genus species name	Corrected genus species name
Tachycineta bicolor	*Tachycineta bicolor*
Tachycineta thalassina	*Tachycineta thalassina*
Thryomanes bewickii	*Thryomanes bewickii*
Toxostoma bendirei	*Toxostoma bendirei*
Toxostoma crissale	*Toxostoma crissale*
Toxostoma dorsale	*Toxostoma crissale*
Toxostoma lecontei	*Toxostoma lecontei*
Toxostoma redivivum	*Toxostoma redivivum*
Toxostoma rufum	*Toxostoma rufum*
Tringa flavipes	*Tringa flavipes*
Tringa melanoleuca	*Tringa melanoleuca*
Tringa solitaria	*Tringa solitaria*
Troglodyt aedon	*Troglodytes aedon*
Troglodytes aedon	*Troglodytes aedon*
Turdus migratorius	*Turdus migratorius*
Tyrannis verticalis	*Tyrannus verticalis*
Tyrannus crassirostris	*Tyrannus crassirostris*
Tyrannus forficatus	*Tyrannus forficatus*
Tyrannus melancholicus	*Tyrannus melancholicus*
Tyrannus tyrannus	*Tyrannus tyrannus*
Tyrannus verticalis	*Tyrannus verticalis*
Tyrannus vociferans	*Tyrannus vociferans*
Tyto alba	*Tyto alba*
Vermivora celata	*Oreothlypis celata*
Vermivora luciae	*Oreothlypis luciae*
Vermivora peregrina	*Oreothlypis peregrina*
Vermivora pinus	*Vermivora cyanoptera*
Vermivora ruficapilla	*Oreothlypis ruficapilla*
Vermivora virginiae	*Oreothlypis virginiae*
Vireo belli	*Vireo bellii*
Vireo bellii	*Vireo bellii*
Vireo cassinii	*Vireo cassinii*
Vireo flavifrons	*Vireo flavifrons*
Vireo gilvus	*Vireo gilvus*
Vireo huttoni	*Vireo huttoni*
Vireo plumbeus	*Vireo plumbeus*
Vireo solitarius	*Vireo solitarius*
Vireo vicinior	*Vireo vicinior*
Wilsonia canadensis	*Wilsonia canadensis*
Wilsonia pusilla	*Wilsonia pusilla*

Genus species name	Corrected genus species name
X x	*UNKNOWN*
Xanthocephalus xanthocephalus	*Xanthocephalus xanthocephalus*
Xema sabini	*Xema sabini*
Zenaida asiatica	*Zenaida asiatica*
Zenaida macroura	*Zenaida macroura*
Zenaidura macroura	*Zenaida macroura*
Zonotrichia albicollis	*Zonotrichia albicollis*
Zonotrichia atricapilla	*Zonotrichia atricapilla*
Zonotrichia coronata	*Zonotrichia atricapilla*
Zonotrichia leucophrys	*Zonotrichia leucophrys*
Zonotrichia querula	*Zonotrichia querula*
Zonotrichia sp.	*Zonotrichia sp.*
HERPS	
Actinemys marmorata	*Actinemys marmorata*
Ambystoma californiense	*Ambystoma californiense*
Ambystoma macrodactylum	*Ambystoma macrodactylum*
Ambystoma tigrinum	*Ambystoma tigrinum*
Anaxyrus boreas	*Bufo boreas*
Anaxyrus californicus	*Bufo californicus*
Anaxyrus cognatus	*Bufo cognatus*
Anaxyrus exsul	*Bufo exsul*
Anaxyrus microscaphus	*Bufo microscaphus*
Anaxyrus nelsoni	*Bufo nelsoni*
Anaxyrus punctatus	*Bufo punctatus*
Anaxyrus woodhousii	*Bufo woodhousii*
Aneides lugubris	*Aneides lugubris*
Anniella pulchra	*Anniella pulchra*
Apalone spinifera	*Apalone spinifera*
Arizona elegans	*Arizona elegans*
Aspidoscelis	*Aspidoscelis sp.*
Aspidoscelis flagellicauda	*Cnemidophorus flagellicaudus*
Aspidoscelis hyperythra	*Aspidoscelis hyperythra*
Aspidoscelis tigris	*Aspidoscelis tigris*
Aspidoscelis velox	*Aspidoscelis velox*
Batrachoseps aridus	*Batrachoseps aridus*
Batrachoseps attenuatus	*Batrachoseps attenuatus*
Batrachoseps campi	*Batrachoseps campi*
Batrachoseps gabrieli	*Batrachoseps gabrieli*
Batrachoseps major	*Batrachoseps major*
Batrachoseps nigriventris	*Batrachoseps nigriventris*

Genus species name	Corrected genus species name
Batrachoseps pacificus	*Batrachoseps pacificus*
Batrachoseps regius	*Batrachoseps regius*
Batrachoseps robustus	*Batrachoseps robustus*
Batrachoseps sp.	*Batrachoseps sp.*
Bufo	*Bufo sp.*
Bufo alvarius	*Bufo alvarius*
Bufo boreas	*Bufo boreas*
Bufo californicus	*Bufo californicus*
Bufo canorus	*Bufo canorus*
Bufo cognatus	*Bufo cognatus*
Bufo exsul	*Bufo exsul*
Bufo exul	*Bufo exsul*
Bufo functatus	*Bufo punctatus*
Bufo halophilus	*Bufo nelsoni*
Bufo microscaphus	*Bufo microscaphus*
Bufo nelsoni	*Bufo nelsoni*
Bufo punctatus	*Bufo punctatus*
Bufo sp.	*Bufo sp.*
Bufo woodhousei	*Bufo woodhousii*
Bufo woodhousii	*Bufo woodhousii*
Callisaurus draconides	*Callisaurus draconoides*
Callisaurus draconoides	*Callisaurus draconoides*
Callisaurus ventralis	*Callisaurus draconoides*
Chamaeleo hohnelii	*Chamaeleo hoehnelii*
Charina bottae	*Charina bottae*
Charina trivirgata	*Charina trivirgata*
Charina umbratica	*Charina umbratica*
Chionactis occipitalis	*Chionactis occipitalis*
Clemmys marmorata	*Actinemys marmorata*
Cnemidophorus flagellicaudus	*Cnemidophorus flagellicaudus*
Cnemidophorus hyperythrus	*Aspidoscelis hyperythra*
Cnemidophorus sonorae	*Aspidoscelis sonorae*
Cnemidophorus sp.	*Aspidoscelis sp.*
Cnemidophorus stejnegeri	*Cnemidophorus tigris*
Cnemidophorus tesselatus	*Cnemidophorus tesselatus*
Cnemidophorus tigris	*Cnemidophorus tigris*
Cnemidophorus velox	*Cnemidophorus velox*
Coleonyx variegatus	*Coleonyx variegatus*
Coluber constrictor	*Coluber constrictor*
Coluber flagellum	*Masticophis flagellum*

Genus species name	Corrected genus species name
Coluber sp.	*Coluber sp.*
Cophosaurus texanus	*Cophosaurus texanus*
Crotalus atrox	*Crotalus atrox*
Crotalus atrox=cinereus	*Crotalus atrox*
Crotalus cerastes	*Crotalus cerastes*
Crotalus cinereous	*Crotalus atrox*
Crotalus mitchelli	*Crotalus mitchellii*
Crotalus mitchellii	*Crotalus mitchellii*
Crotalus molossus	*Crotalus molossus*
Crotalus oreganus	*Crotalus oreganus*
Crotalus ruber	*Crotalus ruber*
Crotalus scutulatus	*Crotalus scutulatus*
Crotalus sp.	*Crotalus sp.*
Crotalus stephensi	*Crotalus mitchellii*
Crotalus viridis	*Crotalus viridis*
Crotaphytus baileyi	*Crotaphytus collaris*
Crotaphytus bicinctores	*Crotaphytus bicinctores*
Crotaphytus collaris	*Crotaphytus collaris*
Crotaphytus insularis	*Crotaphytus insularis*
Crotaphytus vestigium	*Crotaphytus vestigium*
Crotaphytus wislizenii	*Gambelia sila*
Diadophis amabilis	*Diadophis punctatus*
Diadophis punctatus	*Diadophis punctatus*
Dipososaurus dorsalis	*Dipsosaurus dorsalis*
Dipsosaurus dorsalis	*Dipsosaurus dorsalis*
Elgaria coerulea	*Elgaria coerulea*
Elgaria mulicarinata	*Elgaria multicarinata*
Elgaria multicarinata	*Elgaria multicarinata*
Elgaria panamintina	*Elgaria panamintina*
Emys marmorata	*Actinemys marmorata*
Ensatina eschscholtzi	*Ensatina eschscholtzii*
Ensatina eschscholtzii	*Ensatina eschscholtzii*
Eumeces gilberti	*Eumeces gilberti*
Eumeces skiltonianus	*Eumeces skiltonianus*
Gambelia wislizenii	*Gambelia wislizenii*
Gerrhonotus multicarinatus	*Elgaria multicarinata*
Gopherus agassizi	*Gopherus agassizii*
Gopherus agassizii	*Gopherus agassizii*
Heloderma suspectum	*Heloderma suspectum*
Hemidactylus turcicus	*Hemidactylus turcicus*

Genus species name	Corrected genus species name
Hydromantes platycephalus	*Hydromantes platycephalus*
Hyla arenicolor	*Hyla arenicolor*
Hyla cadaverina	*Pseudacris cadaverina*
Hyla californiae	*Pseudacris cadaverina*
Hyla regilla	*Hyla wrightorum*
Hyla sp.	*Hyla sp.*
Hypsiglena torquata	*Hypsiglena torquata*
Kinosternon sonoriense	*Kinosternon sonoriense*
Lampropeltis getula	*Lampropeltis getula*
Lampropeltis getulus	*Lampropeltis getula*
Lampropeltis multicincta	*Lampropeltis zonata*
Lampropeltis pyromelana	*Lampropeltis pyromelana*
Lampropeltis zonata	*Lampropeltis zonata*
Leptotyphlops dulcis	*Leptotyphlops dulcis*
Leptotyphlops humilis	*Leptotyphlops humilis*
Lichanura rosefusca	*Charina trivirgata*
Lichanura roseofusca	*Charina trivirgata*
Lichanura trivirgata	*Charina trivirgata*
Masticophis bilineatus	*Masticophis bilineatus*
Masticophis flagellum	*Masticophis flagellum*
Masticophis lateralis	*Masticophis flagellum*
Masticophis taeniatus	*Masticophis taeniatus*
Micruroides euryxanthus	*Micruroides euryxanthus*
Petrosaurus mearnsi	*Petrosaurus mearnsi*
Petrosaurus mearnsii	*Petrosaurus mearnsi*
Phrynosoma -	*Phrynosoma sp.*
Phrynosoma baluivillei	*Phrynosoma coronatum*
Phrynosoma blainvilli	*Phrynosoma coronatum*
Phrynosoma cornutum	*Phrynosoma cornutum*
Phrynosoma coronatum	*Phrynosoma coronatum*
Phrynosoma douglasi	*Phrynosoma douglasii*
Phrynosoma douglasii	*Phrynosoma douglasii*
Phrynosoma douglassi	*Phrynosoma douglasii*
Phrynosoma hernandesi	*Phrynosoma hernandesi*
Phrynosoma m'calli	*Phrynosoma mcallii*
Phrynosoma mcallii	*Phrynosoma mcallii*
Phrynosoma m'callii	*Phrynosoma mcallii*
Phrynosoma platyrhinos	*Phrynosoma platyrhinos*
Phrynosoma solare	*Phrynosoma solare*
Phyllodactylus xanti	*Phyllodactylus xanti*

Genus species name	Corrected genus species name
Phyllorhynchus decurtatus	*Phyllorhynchus decurtatus*
Pituophis catenifer	*Pituophis catenifer*
Pituophis melanoleucus	*Pituophis melanoleucus*
Plestiodon gilberti	*Plestiodon gilberti*
Plestiodon skiltonianus	*Plestiodon skiltonianus*
Plestiodon sp.	*Plestiodon sp.*
Pseudacris cadaverina	*Pseudacris cadaverina*
Pseudacris regilla	*Pseudacris regilla*
Pseudoboa neuweedii	*Pseudoboa neuwiedii*
Rana aurora	*Rana aurora*
Rana berlandieri	*Rana berlandieri*
Rana boylei	*Rana boylii*
Rana catesbeiana	*Rana catesbeiana*
Rana draytonii	*Rana draytonii*
Rana fisheri	*Rana fisheri*
Rana luteiventris	*Rana luteiventris*
Rana muscosa	*Rana muscosa*
Rana onca	*Rana onca*
Rana pipiens	*Rana pipiens*
Rana pipiens-complex	*Rana pipiens*
Rana sierrae	*Rana sierrae*
Rana sphenocephala	*Rana sphenocephala*
Rana yavapaiensis	*Rana yavapaiensis*
Rena humilis	*Leptotyphlops humilis*
Rhinocheilus lecontei	*Rhinocheilus lecontei*
Salvadora hexalepis	*Salvadora hexalepis*
Sauromalus ater	*Sauromalus ater*
Sauromalus obesus	*Sauromalus ater*
Scaphiopus couchi	*Scaphiopus couchii*
Scaphiopus couchii	*Scaphiopus couchii*
Scaphiopus hammondi	*Spea hammondii*
Scaphiopus hammondii	*Spea hammondii*
Sceloporus biseriatus	*Sceloporus occidentalis*
Sceloporus clarkii	*Sceloporus clarkii*
Sceloporus cyanogenys	*Sceloporus cyanogenys*
Sceloporus graciosus	*Sceloporus graciosus*
Sceloporus magister	*Sceloporus magister*
Sceloporus occidentalis	*Sceloporus occidentalis*
Sceloporus orculti	*Sceloporus orcutti*
Sceloporus orcutti	*Sceloporus orcutti*

Genus species name	Corrected genus species name
Sceloporus sp.	*Sceloporus sp.*
Sceloporus undulatus	*Sceloporus undulatus*
Sceloporus vandenburgianus	*Sceloporus graciosus*
Sonora episcopa	*Sonora semiannulata*
Sonora semiannulata	*Sonora semiannulata*
Spea hammondii	*Spea hammondii*
Spea intermontana	*Spea intermontana*
Spea intermontanus	*Spea intermontana*
Spea multiplicata	*Spea multiplicata*
Tantilla hobartsmithi	*Tantilla hobartsmithi*
Tantilla planiceps	*Tantilla planiceps*
Taricha torosa	*Taricha torosa*
Terrapene carolina	*Terrapene carolina*
Thamnophis couchi	*Thamnophis couchii*
Thamnophis couchii	*Thamnophis couchii*
Thamnophis cyrtopsis	*Thamnophis cyrtopsis*
Thamnophis elegans	*Thamnophis cyrtopsis*
Thamnophis hammondii	*Thamnophis hammondii*
Thamnophis marcianus	*Thamnophis marcianus*
Thamnophis sirtalis	*Thamnophis sirtalis*
Trimorphodon biscutatus	*Trimorphodon biscutatus*
Trionyx sp.?	*Apalone sp.*
Trionyx spiniferus	*Apalone spinifera*
Uma inornata	*Uma inornata*
Uma notata	*Uma notata*
Uma scoparia	*Uma scoparia*
Uma sp.	*Uma sp.*
Unknown	*UNKNOWN*
Urosaurus graciosus	*Urosaurus graciosus*
Urosaurus ornatus	*Urosaurus ornatus*
Uta mearnsi	*Petrosaurus mearnsi*
Uta stansburiana	*Uta stansburiana*
Xantusia henshawi	*Xantusia henshawi*
Xantusia vigilis	*Xantusia vigilis*
Xantusia wigginsi	*Xantusia wigginsi*
Xenopus laevis	*Xenopus laevis*
Xenopus sp.	*Xenopus sp.*
MAMMALS	
Ammospermophilus harrisii	*Ammospermophilus harrisii*
Ammospermophilus leucurus	*Ammospermophilus leucurus*

Genus species name	Corrected genus species name
Antilocapra americana	*Antilocapra americana*
Antrozous pallidus	*Antrozous pallidus*
Bassariscus astutus	*Bassariscus astutus*
Bos taurus	*Bos taurus*
Brachylagus idahoensis	*Brachylagus idahoensis*
Callospermophilus lateralis	*Callospermophilus lateralis*
Canis familiaris	*Canis familiaris*
Canis latrans	*Canis latrans*
Canis lupus	*Canis lupus*
Castor canadensis	*Castor canadensis*
Cervus elaphus	*Cervus elaphus*
Chaetodipus baileyi	*Chaetodipus baileyi*
Chaetodipus californicus	*Chaetodipus californicus*
Chaetodipus fallax	*Chaetodipus fallax*
Chaetodipus formosus	*Chaetodipus formosus*
Chaetodipus intermedius	*Chaetodipus intermedius*
Chaetodipus penicillatus	*Chaetodipus penicillatus*
Chaetodipus sp.	*Chaetodipus sp.*
Chaetodipus spinatus	*Chaetodipus spinatus*
Choeronycteris mexicana	*Choeronycteris mexicana*
Citellus beecheyi	*Otospermophilus beecheyi*
Citellus lateralis	*Callospermophilus lateralis*
Corynorhinus rafinesquii	*Corynorhinus rafinesquii*
Corynorhinus townsendii	*Corynorhinus townsendii*
CYNOMYS GUNNISONI	*Cynomys gunnisoni*
Didelphis virginiana	*Didelphis virginiana*
Dipodomys agilis	*Dipodomys agilis*
Dipodomys deserti	*Dipodomys deserti*
Dipodomys merriami	*Dipodomys merriami*
Dipodomys microps	*Dipodomys microps*
Dipodomys ordii	*Dipodomys ordii*
Dipodomys panamintinus	*Dipodomys panamintinus*
Dipodomys simulans	*Dipodomys simulans*
Dipodomys sp.	*Dipodomys sp.*
Dipodomys stephensi	*Dipodomys stephensi*
Eptesicus fuscus	*Eptesicus fuscus*
Equus asinus	*Equus asinus*
Erethizon dorsatum	*Erethizon dorsatum*
Euderma maculatum	*Euderma maculatum*
Eumops perotis	*Eumops perotis*

Genus species name	Corrected genus species name
Eutamias merriami	*Tamias merriami*
EUTAMIAS PANAMINTINUS	*Tamias panamintinus*
Eutamias speciosus	*Tamias speciosus*
Felis concolor	*Felis concolor*
Felis silvestris	*Felis silvestris*
Glaucomys sabrinus	*Glaucomys sabrinus*
Gulo gulo	*Gulo gulo*
Lagurus curtatus	*Lagurus curtatus*
Lasionycteris noctivagans	*Lasionycteris noctivagans*
Lasiurus blossevilli	*Lasiurus blossevilli*
Lasiurus borealis	*Lasiurus borealis*
Lasiurus cinereus	*Lasiurus cinereus*
Lasiurus ega	*Lasiurus ega*
Lemmiscus curtatus	*Lemmiscus curtatus*
Leopardus pardalis	*Leopardus pardalis*
Leptonycteris curasoae	*Leptonycteris curasoae*
Lepus californicus	*Lepus californicus*
Lepus townsendii	*Lepus townsendii*
Lontra canadensis	*Lontra canadensis*
Lynx rufus	*Lynx rufus*
Macrotus californicus	*Macrotus californicus*
Macrotus waterhousii	*Macrotus waterhousii*
Marmota flaviventris	*Marmota flaviventris*
Martes americana	*Martes americana*
Mephitis mephitis	*Mephitis mephitis*
Microdipodops megacephalus	*Microdipodops megacephalus*
Microdipodops pallidus	*Microdipodops pallidus*
Microdipodops sp.	*Microdipodops sp.*
Microtus californicus	*Microtus californicus*
Microtus longicaudus	*Microtus longicaudus*
Microtus montanus	*Microtus montanus*
Microtus sp.	*Microtus sp.*
Mus musculus	*Mus musculus*
Mustela erminea	*Mustela erminea*
Mustela frenata	*Mustela frenata*
Mustela vison	*Mustela vison*
Myotis californicus	*Myotis californicus*
Myotis ciliolabrum	*Myotis ciliolabrum*
Myotis evotis	*Myotis evotis*
Myotis leibii	*Myotis leibii*

Genus species name	Corrected genus species name
Myotis lucifugus	*Myotis lucifugus*
Myotis occultus	*Myotis occultus*
MYOTIS SUBULATUS	*Myotis subulatus*
Myotis thysanodes	*Myotis thysanodes*
Myotis velifer	*Myotis velifer*
Myotis volans	*Myotis volans*
Myotis yumanensis	*Myotis yumanensis*
Neotamias merriami	*Neotamias merriami*
Neotamias speciosus	*Neotamias speciosus*
Neotoma	*Neotoma sp.*
Neotoma albigula	*Neotoma albigula*
Neotoma bella	*Neotoma bella*
Neotoma bryanti	*Neotoma bryanti*
Neotoma cinerea	*Neotoma cinerea*
Neotoma devia	*Neotoma devia*
Neotoma fuscipes	*Neotoma fuscipes*
Neotoma lepida	*Neotoma lepida*
Neotoma macrotis	*Neotoma macrotis*
Neotoma sp.	*Neotoma sp.*
Neotoma stephensi	*Neotoma stephensi*
Neurotrichus gibbsii	*Neurotrichus gibbsii*
Notiosorex crawfordi	*Notiosorex crawfordi*
Nyctinomops femorosaccus	*Nyctinomops femorosaccus*
Nyctinomops macrotis	*Nyctinomops macrotis*
Ochotona princeps	*Ochotona princeps*
Ochotona sp.	*Ochotona sp.*
Odocoileus hemionus	*Odocoileus hemionus*
Ondatra zibethicus	*Ondatra zibethicus*
Onychomys leucogaster	*Onychomys leucogaster*
Onychomys torridus	*Onychomys torridus*
Otospermophilus beecheyi	*Otospermophilus beecheyi*
Otospermophilus variegatus	*Otospermophilus variegatus*
Ovis aries	*Ovis aries*
Ovis canadensis	*Ovis canadensis*
Parastrellus hesperus	*Parastrellus hesperus*
Perognathus	*Perognathus sp.*
Perognathus alticola	*Perognathus alticola*
Perognathus alticolus	*Perognathus alticolus*
Perognathus amplus	*Perognathus amplus*
Perognathus fallax	*Perognathus fallax*

Genus species name	Corrected genus species name
Perognathus formosus	*Perognathus formosus*
Perognathus inornatus	*Perognathus inornatus*
PEROGNATHUS INTERMEDIUS	*Perognathus intermedius*
Perognathus longimembris	*Perognathus longimembris*
Perognathus paniminthus	*Perognathus longimembris*
Perognathus paraminthus	*Perognathus longimembris*
Perognathus parvus	*Perognathus parvus*
Perognathus penicillatus	*Chaetodipus penicillatus*
Perognathus penicllatus	*Chaetodipus penicillatus*
Perognathus sp.	*Perognathus sp.*
Perognathus spinatus	*Chaetodipus spinatus*
Perognathus xanthonotus	*Perognathus parvus*
Peromyscus	*Peromyscus sp.*
Peromyscus boylii	*Peromyscus boylii*
Peromyscus californicus	*Peromyscus californicus*
Peromyscus crinitus	*Peromyscus crinitus*
Peromyscus eremicus	*Peromyscus eremicus*
Peromyscus fraterculus	*Peromyscus fraterculus*
Peromyscus maniculatus	*Peromyscus maniculatus*
Peromyscus sp.	*Peromyscus sp.*
Peromyscus truei	*Peromyscus truei*
PHENACOMYS INTERMEDIUS	*Phenacomys intermedius*
Pipistrellus hesperus	*Pipistrellus hesperus*
Plecotus townsendii	*Plecotus townsendii*
Procyon lotor	*Procyon lotor*
Puma concolor	*Puma concolor*
Rattus norvegicus	*Rattus norvegicus*
Rattus rattus	*Rattus rattus*
Reithrodontomys megalotis	*Reithrodontomys megalotis*
Saimiri sciureus	*Saimiri sciureus*
Scapanus latimanus	*Scapanus latimanus*
Sciurus griseus	*Sciurus griseus*
Sigmodon arizonae	*Sigmodon arizonae*
Sorex merriami	*Sorex merriami*
Sorex monticolus	*Sorex monticolus*
Sorex ornatus	*Sorex ornatus*
Sorex palustris	*Sorex palustris*
Sorex sp.	*Sorex sp.*
Sorex tenellus	*Sorex tenellus*
Sorex vagrans	*Sorex vagrans*

Genus species name	Corrected genus species name
Spermophilus	*Spermophilus sp.*
Spermophilus beecheyi	*Otospermophilus beecheyi*
Spermophilus lateralis	*Callospermophilus lateralis*
SPERMOPHILUS LEUCURUS	*Ammospermophilus leucurus*
Spermophilus sp.	*Spermophilus sp.*
Spermophilus tereticaudus	*Xerospermophilus tereticaudus*
Spermophilus variegatus	*Otospermophilus veriegatus*
Spilogale gracilis	*Spilogale gracilis*
Spilogale putorius	*Spilogale putorius*
Sus scrofa	*Sus scrofa*
Sylvilagus	*Sylvilagus sp.*
SYLVILAGUS AUDUBONI	*Sylvilagus audubonii*
Sylvilagus audubonii	*Sylvilagus audubonii*
Sylvilagus bachmani	*Sylvilagus bachmani*
SYLVILAGUS NUTTALLI	*Sylvilagus nuttallii*
Sylvilagus nuttallii	*Sylvilagus nuttallii*
Tadarida brasiliensis	*Tadarida brasiliensis*
Tamias alpinus	*Tamias alpinus*
Tamias amoenus	*Tamias amoenus*
Tamias dorsalis	*Tamias dorsalis*
Tamias merriami	*Tamias merriami*
Tamias minimus	*Tamias minimus*
Tamias obscurus	*Tamias obscurus*
Tamias palmeri	*Tamias palmeri*
Tamias panamintinus	*Tamias panamintinus*
Tamias quadrimaculatus	*Tamias quadrimaculatus*
Tamias sp.	*Tamias sp.*
Tamias speciosus	*Tamias speciosus*
Tamias umbrinus	*Tamias umbrinus*
Tamiasciurus douglasii	*Tamiasciurus douglasii*
Taxidea taxus	*Taxidea taxus*
Thomomys bottae	*Thomomys bottae*
Thomomys cabezonae	*Thomomys cabezonae*
Thomomys perpallidus	*Thomomys perpallidus*
Thomomys sp.	*Thomomys sp.*
Thomomys talpoides	*Thomomys talpoides*
Thomomys umbrinus	*Thomomys umbrinus*
UNKNOWN X	*UNKNOWN*
Urocitellus beldingi	*Urocitellus beldingi*
Urocitellus mollis	*Urocitellus townsendii*

Genus species name	Corrected genus species name
Urocitellus townsendii	*Urocitellus townsendii*
Urocyon cinereoargenteus	*Urocyon cinereoargenteus*
Ursus americanus	*Ursus americanus*
Vulpes macrotis	*Vulpes macrotis*
Vulpes velox	*Vulpes velox*
Vulpes vulpes	*Vulpes vulpes*
Xerospermophilus mohavensis	*Xerospermophilus mohavensis*
Xerospermophilus tereticaudus	*Xerospermophilus tereticaudus*
Zapus princeps	*Zapus princeps*

Appendix B: Regional and park-specific species lists

List of species detected within the eleven-county region and those recorded within individual park boundaries, based on museum records compiled from this project and any available I & M survey reports. Each "X" represents a species detected (P) from museum records and when information on collection date was available, whether it was detected in the historical (H) or modern (M) era. Bolded "**X**" represents a museum specimen record detected within park boundaries from this report and confirmed within the park based on I & M survey reports. An "O" represents a museum record-based species detection reported in an I & M survey but not from our search results. Detections reported from I & M surveys based on only observation (O*) or literature (O^) or both (O*^) are noted. "SDM" denotes whether the species fit the criteria for species distribution modeling (see Methods). Species names reflect the most current taxonomy and not necessarily the nomenclature of the actual museum record (see Appendix A and Methods).

		DEVA			GRBA			LAKE			MOJA			JOTR
Species	SDM	P	H	M	P	H	M	P	H	M	P	H	M	P

Species	SDM	DEVA			GRBA			LAKE			MOJA			JOTR		
		P	H	M	P	H	M	P	H	M	P	H	M	P	H	M
Anthus rubescens		X	X		O*^			X		X	X	X				
Anthus spinoletta																
Anthus spragueii																
Aphelocoma californica	Y	X	X		O						X	X		X	X	
Aphelocoma coerulescens																
Aphriza virgata																
Aquila chrysaetos					O*^											
Archilochus alexandri		X	X		O*^									X	X	
Ardea alba																
Ardea herodias	Y													X	X	
Arenaria interpres																
Asio flammeus		X	X		O*^											
Asio otus		X	X	X	O*^									X	X	
Athene cunicularia		X	X		O*^						X	X				
Auriparus flaviceps		X						X		X	X	X		X	X	
Aythya affinis																
Aythya americana																
Aythya collaris																
Aythya marila																
Baeolophus inornatus	Y													X	X	X
Baeolophus ridgwayi		X	X		O						X	X	X			
Bombycilla cedrorum					O						X	X		X	X	
Bombycilla garrulus																
Botaurus lentiginosus		X	X					X		X						
Branta bernicla																
Branta canadensis																
Branta hutchinsii																
Bubo virginianus	Y	X	X		O						X	X	X			
Bucephala albeola																
Bucephala clangula																
Bucephala islandica																
Buteo jamaicensis	Y	X	X		**X**	**X**					X	X				
Buteo lagopus																
Buteo lineatus																
Buteo regalis					O*^											
Buteo swainsoni		X	X		O*^											
Butorides virescens																
Calamospiza melanocorys														X	X	
Calcarius ornatus		X	X													
Calidris alba																
Calidris alpina								X		X						

		DEVA			GRBA			LAKE			MOJA			JOTR		
Species	**SDM**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**
Calidris bairdii																
Calidris canutus																
Calidris fuscicollis																
Calidris mauri																
Calidris melanotos																
Calidris minuta																
Calidris minutilla								X		X						
Calidris pusilla																
Callipepla californica	Y	X	X													
Callipepla gambelii		X	X		O*									X	X	
Calypte anna	Y										X		X	X	X	
Calypte costae		X	X					X		X	X	X		X	X	X
Campylorhynchus brunneicapillus	Y										X	X		X	X	
Caprimulgus vociferus																
Cardinalis cardinalis																
Carpodacus cassinii	Y	X	X		**X**	**X**								X	X	
Carpodacus mexicanus	Y	X	X		O*^			X		X	X	X		X	X	
Carpodacus purpureus	Y	X	X											X	X	
Cathartes aura	Y				O*^						X	X		X	X	
Catharus fuscescens																
Catharus guttatus	Y	X	X	X	**X**	**X**					X	X	X	X	X	
Catharus ustulatus		X	X		O^						X	X		X	X	
Catherpes mexicanus		X	X		O*^						X	X	X	X	X	
Centrocercus urophasianus					O*	O*										
Certhia americana	Y				**X**	**X**										
Certhia familiaris																
Chaetura vauxi														X	X	
Chamaea fasciata	Y															
Charadrius alexandrinus																
Charadrius montanus																
Charadrius semipalmatus																
Charadrius vociferus	Y	X	X					X		X				X	X	
Chen caerulescens																
Chen rossii																
Chlidonias niger																
Chondestes grammacus	Y	X	X		O*^									X	X	
Chordeiles acutipennis		X	X								X	X		X	X	
Chordeiles minor	Y				**X**	**X**										
Chroicocephalus philadelphia																
Cinclus mexicanus					O											
Circus cyaneus		X	X		O*^											

		DEVA			GRBA			LAKE			MOJA			JOTR		
Species	**SDM**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**
Cistothorus palustris		X	X					X		X				X	X	
Coccothraustes vespertinus	Y	X	X		O^						X	X				
Coccyzus americanus																
Colaptes auratus	Y	X	X		**X**	**X**		X		X	X	X		X	X	
Colaptes chrysoides											X	X				

Species	SDM	DEVA			GRBA			LAKE			MOJA			JOTR		
		P	H	M	P	H	M	P	H	M	P	H	M	P	H	M
Falco peregrinus					O*											
Falco sparverius	Y	X	X		O*^						X	X				
Fregata magnificens																
Fulica americana																
Gallinago delicata		X	X		**X**	**X**										
Gallinago gallinago																
Gallinula chloropus																
Gavia immer																
Gavia pacifica																
Gavia stellata																
Geococcyx californianus	Y										X	X		X	X	
Geothlypis trichas		X	X					X		X				X	X	
Glaucidium gnoma		X	X		O*											
Grus canadensis																
Gymnogyps californianus																
Gymnorhinus cyanocephalus		X	X	X	O*^						X	X		X	X	
Hailaeetus leucocephalus					O*											
Helmitheros vermivorum																
Himantopus mexicanus																
Hirundo rustica	Y	X	X		O									X	X	
Hydrocoloeus minutus																
Hydroprogne caspia																
Icteria virens					O*^									X	X	
Icterus bullockii	Y	X	X		O*^									X	X	
Icterus cucullatus		X	X								X	X		X	X	
Icterus parisorum		X	X								X	X		X	X	
Icterus spurius																
Ixobrychus exilis																
Ixoreus naevius																
Junco hyemalis	Y	X	X	X	**X**	**X**					X	X	X	X	X	
Lanius excubitor																
Lanius ludovicianus	Y	X	X		O*^						X	X		X	X	
Larus californicus																
Larus canus																
Larus delawarensis																
Larus occidentalis								X		X						
Leucophaeus atricilla																
Leucophaeus pipixcan																
Leucosticte arctoa																
Leucosticte atrata					X		X									
Leucosticte tephrocotis																

		DEVA			GRBA			LAKE			MOJA			JOTR		
Species	**SDM**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**
Limnodromus griseus																
Limnodromus scolopaceus								X		X						
Limosa fedoa																
Loxia curvirostra	Y	X	X		**X**	**X**					X	X	X			
Megaceryle alcyon					O*											
Megascops asio		X	X													
Megascops kennicottii	Y	X	X		O*						X	X		X	X	
Melanerpes formicivorus	Y										X			X	X	
Melanerpes lewis					O^						X	X		X	X	
Melanerpes uropygialis																
Melanitta fusca																
Melanitta perspicillata																
Melospiza georgiana																
Melospiza lincolnii		X	X	X										X	X	
Melospiza melodia	Y	X	X		O			X		X	X	X		X	X	
Melozone aberti								X		X				X	X	
Melozone crissalis	Y															
Melozone fusca																
Mergus serrator																
Micrathene whitneyi														X	X	
Mimus polyglottos	Y	X	X	X	O*						X	X		X	X	
Molothrus ater	Y	X	X	X	O*^			X		X	X	X				
Myadestes townsendi	Y	X	X		**X**	**X**					X	X		X	X	
Mycteria americana																
Myiarchus cinerascens	Y	X	X		O*^						X	X	X	X	X	
Myiarchus tyrannulus																
Myioborus pictus														X	X	
Nucifraga columbiana		X	X		O			X	X					X	X	
Numenius americanus					O*^											
Nycticorax nycticorax		X	X		O*											
Oceanodroma microsoma																
Oporornis philadelphia																
Oporornis tolmiei		X														

Species	SDM	DEVA			GRBA			LAKE			MOJA			JOTR		
		P	H	M	P	H	M	P	H	M	P	H	M	P	H	M
Oxyura jamaicensis																
Pandion haliaetus																
Parkesia motacilla																
Parkesia noveboracensis																
Parula americana																
Passer domesticus	Y	X	X		O^						X	X		X	X	
Passerculus sandwichensis		X	X		O*^			X		X				X	X	
Passerella iliaca	Y	X	X		O						X		X	X	X	
Passerina amoena	Y				O*^						X	X		X	X	
Passerina caerulea		X	X													
Passerina cyanea		X	X													
Patagioenas fasciata											X		X			
Pelecanus occidentalis																
Petrochelidon pyrrhonota	Y	X	X		O											
Phainopepla nitens		X	X					X	X	X	X	X	X	X	X	
Phalacrocorax auritus																
Phalaenoptilus nuttallii	Y	X	X		**X**	**X**					X	X	X	X	X	
Phalaropus fulicarius																
Phalaropus lobatus																
Phalaropus tricolor					O*^											
Phasianus colchicus																
Pheucticus ludovicianus																
Pheucticus melanocephalus	Y	X	X	X	O						X		X	X	X	
Phoebastria immutabilis																
Pica hudsonia		X	X	X	O*^											
Picoides albolarvatus	Y															
Picoides dorsalis					**X**	**X**										
Picoides nuttallii	Y															
Picoides pubescens	Y				**X**	**X**										
Picoides scalaris											X	X		X	X	
Picoides villosus	Y	X	X		**X**	**X**					X	X				
Pipilo chlorurus	Y	X	X		**X**	**X**					X	X	X	X	X	
Pipilo erythrophthalmus		X	X													
Pipilo maculatus	Y	X	X	X	O						X	X		X	X	
Piranga flava											X		X			
Piranga ludoviciana	Y	X	X		**X**	**X**					X	X		X	X	
Piranga rubra																
Plectrophenax nivalis																
Plegadis chihi		X	X					X		X						
Pluvialis squatarola																
Podiceps auritus																

		DEVA			GRBA			LAKE			MOJA			JOTR		
Species	**SDM**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**
Podiceps grisegena								X		X						
Podiceps nigricollis		X	X					X		X	X		X			
Podilymbus podiceps		X	X													
Poecile atricapillus																
Poecile gambeli	Y	X	X		**X**	**X**					X	X	X	X	X	
Poecile inornatus		X	X								X			X	X	
Poecile rufescens	Y															
Polioptila caerulea	Y	X	X		O*^			X		X	X	X		X	X	
Polioptila californica																
Polioptila melanura								X		X				X	X	
Pooecetes gramineus		X	X		**X**	**X**								X	X	
Porzana carolina		X	X													
Progne subis																
Protonotaria citrea																
Psaltriparus minimus	Y	X	X		O						X	X		X	X	
Pyrocephalus rubinus		X	X													
Quiscalus mexicanus					O^											
Quiscalus quiscula																
Rallus limicola								X		X				X	X	
Rallus longirostris																
Recurvirostra americana		X	X					X		X						
Regulus calendula		X	X		**X**	**X**		X		X	X	X	X	X	X	
Regulus satrapa	Y				**X**	**X**								X	X	
Riparia riparia																
Rissa tridactyla																
Rynchops niger																
Salpinctes obsoletus	Y	X	X	X	O*^						X	X		X	X	
Sayornis nigricans	Y	X	X													
Sayornis phoebe																
Sayornis saya		X	X		O*^			X		X	X	X		X	X	
Scolopax minor																
Seiurus aurocapilla																
Selasphorus platycercus					**X**	**X**					X	X				
Selasphorus rufus					O									X	X	
Selasphorus sasin																
Setophaga ruticilla											X		X			
Sialia currucoides	Y	X	X		**X**	**X**					X	X				
Sialia mexicana	Y	X	X		O*^						X	X		X	X	
Sitta canadensis	Y	X	X		**X**	**X**					X	X		X	X	
Sitta carolinensis	Y	X	X		**X**	**X**					X		X			
Sitta pygmaea	Y	X	X		**X**	**X**								X	X	

		DEVA			GRBA			LAKE			MOJA			JOTR		
Species	**SDM**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**	**P**	**H**	**M**
Sphyrapicus nuchalis		X	X		**X**	**X**								X	X	
Sphyrapicus ruber	Y															
Sphyrapicus thyroideus					O*^						X	X				
Sphyrapicus varius																
Spinus lawrencei														X	X	
Spinus pinus					**X**	**X**					X	X		X	X	
Spinus psaltria					O*^			X		X	X	X		X	X	
Spinus tristis		X	X		O*			X		X						
Spizella arborea																
Spizella atrogularis		X	X								X	X	X	X	X	
Spizella breweri		X	X		O			X		X	X	X		X	X	
Spizella passerina	Y	X	X		**X**	**X**								X	X	
Stelgidopteryx serripennis		X	X		O*^			X		X						
Stellula calliope					O*^									X	X	
Stercorarius longicaudus																
Stercorarius pomarinus																
Sterna forsteri																
Sterna hirundo																
Streptopelia chinensis																
Strix occidentalis																
Sturnella neglecta	Y	X	X		O*^						X	X		X	X	
Sturnus vulgaris					O*^											
Sula leucogaster																
Sula nebouxii																
Tachycineta bicolor	Y	X	X		O*^			X		X						
Tachycineta thalassina	Y	X	X		O*^						X	X		X	X	
Thryomanes bewickii	Y	X	X		O*^						X	X		X	X	
Toxostoma bendirei											X	X				
Toxostoma crissale											X	X	X	X	X	
Toxostoma lecontei		X	X	X				X	X		X	X	X	X	X	
Toxostoma redivivum	Y													X	X	
Toxostoma rufum														X	X	
Tringa flavipes																
Tringa melanoleuca																
Tringa semipalmatus																
Tringa solitaria		X	X											X	X	
Troglodytes aedon	Y	X	X		O			X		X				X	X	
Turdus migratorius	Y	X	X		O									X	X	
Tyrannus crassirostris																
Tyrannus forficatus																
Tyrannus melancholicus																

		DEVA				GRBA				LAKE				MOJA				JOTR		
Species	**SDM**	**P**	**H**	**M**		**P**	**H**	**M**		**P**	**H**	**M**		**P**	**H**	**M**		**P**	**H**	**M**
Tyrannus tyrannus																				
Tyrannus verticalis	Y	X	X			O*^				X		X		X	X			X	X	
Tyrannus vociferans														X	X					
Tyto alba																				
Vermivora cyanoptera																				
Vireo bellii		X	X																	
Vireo cassinii	Y	X	X	X						X		X		X	X			X	X	
Vireo flavifrons																				
Vireo gilvus	Y	X	X			**X**	**X**							X	X			X	X	
Vireo huttoni	Y																			
Vireo plumbeus		X		X										X		X				
Vireo solitarius						O^														
Vireo vicinior		X	X											X	X			X	X	
Wilsonia canadensis																				
Wilsonia pusilla		X	X			**X**	**X**							X	X			X	X	
Xanthocephalus xanthocephalus		X	X							X		X								
Xema sabini																				
Zenaida asiatica																		X	X	
Zenaida macroura	Y	X	X			O*^								X	X			X	X	
Zonotrichia albicollis																				
Zonotrichia atricapilla														X		X		X	X	
Zonotrichia leucophrys	Y	X	X			**X**	**X**			X		X		X	X	X		X	X	
Zonotrichia querula																				
Ten counties = 376	**95**	**1 4 3**				**140**				**51**				**10 6**				**12 5**		

		HERPS																		
A A														O	O					
A A																				
A A																				
A A										X	X									
A A																				
A A																		X		X
A A																				
A A		**X**	X							X	X			**X**	X	**X**		X	X	X
A A																				
A A																				
A A		X	X	X						X	X			X	X	X		X	X	
A A																				
A A																				
A A																				

Species	SDM	DEVA			GRBA			LAKE			MOJA			JOTR		
		P	H	M	P	H	M	P	H	M	P	H	M	P	H	M
A A		X		X												
A A																
A A																
A A																
A A																
A A																
A A																
A A																
A A		**X**		X												
A A																
A A																
A A								X	X							
A A		O	O													
A A								X								
A A																
A A		**X**	X	X				X	X		**X**	X	**X**	X	X	X
A A								X	X							
A A		**X**	X	X				X	X	X	**X**	X	**X**	X	X	X
A A																
A A																
A A		**X**	X	X							**X**	X	**X**	X	X	X
A A																
A A		**X**	X	X							**X**		**X**	X	X	X
A A																
A A																
A A		**X**	X	X	X	X					**X**	X	**X**	X	X	X
A A																
A A		**X**	X	X				X	X	X	**X**	X	**X**	X	X	X
A A																
A A																
A A														X	X	
A A		**X**	X	X				X	X	X	**X**	X	**X**	X	X	X
A A		**X**	X	X				X	X	X	**X**	X	**X**	X	X	X
A A																
A A														X		X
A A														X	X	X
A A											**X**	X	**X**	X	X	
A A					X	X								X	X	X
A A		**X**	X	X							**X**	X	**X**	X	X	X
A A		X	X								X	X	X	X	X	X
A A																

Species	SDM	DEVA			GRBA			LAKE			MOJA			JOTR		
		P	H	M	P	H	M	P	H	M	P	H	M	P	H	M
A A																
A A		X		X							X		X			
A A		X	X	X				X	X		X	X	X	X	X	X
A A																
A A		O														
A A		X	X	X												
A A																
A A		X	X	X							X	X	O	X	X	X
A A					X	X										
A A																
A A		X	X	X				X	X		X	X	X	X	X	X
A A		O									X	X	X	X	X	
A A											O					
A A																
A A																
A A																
A A		X	X													
A A		X	X	X	X	X					X	X	X	X	X	X
A A																
A A		X	X	X				X			X	X	X	X	X	
A A																
A A		O														
A A																
A A		X	X	X							X		X	X	X	X
A A																
A A		X	X	X				X	X		X	X	X	X	X	X
A A		X	X	X	X	X					X	X	X			
A A																
A A																
A A																
A A														X	X	X
A A																
A A																
A A																
A A		X	X	X	X	X					X	X	X	X	X	X
A A																
A A																
A A		X	X	X				X	X		X		X	X	X	X
A A		X		X				X	X		X	X	X	X	X	X
A A		X	X		X	X					X	X	X	X	X	X
A A		X	X	X							X	X	X	X	X	

Species	SDM	DEVA			GRBA			LAKE			MOJA			JOTR		
		P	H	M	P	H	M	P	H	M	P	H	M	P	H	M
A A		X	X		X	X										
A A														X	X	X
A A		**X**	X	X										X		X
A A																
A A																
A A																
A A																
A A		**X**	X								O	O				
A A																
A A																
A A																
A A																
A A								X	X							
A A																
A A																
A A																
A A								X		X						
A A		**X**	X	X				X		X	**X**	X	**X**	X	X	X
A A		**X**	X	X				X			**X**	X	**X**	X	X	X
A A		**X**	X	X							**X**	X	**X**	X	X	X
A A																
A A																
A A																
A A		**X**	X	X	X	X										
A A		**X**	X	X				X	X		**X**	X	**X**	X	X	X
A A		**X**	X	X	X	X					**X**	X	**X**	X	X	X
A A																
A A																
A A																
A A		**X**	X	X							**X**		X			
A A																
A A																
A A																
A A		**X**	X	X							O			X	X	
A A																
A A																
A A																
A A																
A A					X	X		X	X							
A A																
A A																

Species	SDM	DEVA P	DEVA H	DEVA M	GRBA P	GRBA H	GRBA M	LAKE P	LAKE H	LAKE M	MOJA P	MOJA H	MOJA M	JOTR P	JOTR H	JOTR M
A A		**X**		X							**X**		X	X	X	
A A														X		X
A A																
A A		O									**X**	X	**X**	X	X	X
A A								X	X		**X**	X	**X**	X	X	X
A A																
A A		**X**	X	X	X	X		X	X		**X**	X	**X**	X	X	X
A A																
A A		**X**	X	X							**X**	X	**X**	X	X	X
A A																
A A																
Ten counties = 148		**49**			**12**			**25**			**44**			**46**		

MAMMALS																
A A								O		O						
A A		**X**	X	X	**X**	**X**	O	**X**	X		**X**	X	O	**X**	X	**X**
A A					O	O *	*	O^								
A A		**X**	X	X				O^			**X**	X	O	**X**	X	O
A A		O			O		O *	O^			O^			O^		
A A		O						O*		O*	O*		O *			
A A																
A A	Y	**X**	X		**X**	**X**	**X**									
A A							O						O			O
A A		**X**	X		**X**	**X**	*	**X**	X		**X**	X	*	**X**	X	*
A A											**X**	X				
A A								O^								
A A					O		O *									
A A					O		O *									
A A																
A A	Y															
A A											O		O	**X**	X	**X**
A A		**X**	X	**X**				**X**	X	O	**X**	X	**X**	**X**	X	O
A A								**X**	X							
A A		**X**	X	O				**X**	X		**X**		**X**	**X**	X	O
A A								O		O	**X**		**X**	**X**	X	O
A A																
A A								O^								
A A																
A A		**X**	X	X	X	X		O^			**X**	X	**X**	O^		

Species	SDM	DEVA			GRBA			LAKE			MOJA			JOTR		
		P	H	M	P	H	M	P	H	M	P	H	M	P	H	M
A A																
A A																
A A	Y															
A A		**X**	X	**X**				**X**	X	O	**X**	X	**X**	**X**	X	
A A		**X**	X	**X**				**X**	X	O	**X**	X	**X**	**X**	X	O
A A		**X**	X	X	O	O	O				**X**		X	**X**	X	X
A A					**X**	**X**	O									
A A		**X**	X	X							**X**	X	**X**			
A A																
A A																
A A		X	X					**X**	X		**X**	X	O	**X**	X	O
A A		O						O*		O*	O*		O*	O^		
A A		O^						O^			O^					
A A		O^			**X**	**X**	O*	O^			O^					
A A		O^												O^		
A A								O^						O		
A A																
A A																
A A																
A A																
A A								O^								
A A																
A A		**X**	X					O^								
A A		O														
A A											O^			**X**	X	
A A														O		O
A A					**X**	**X**										
A A																
A A							O*	O* ^		O*	**X**	X	X	**X**	X	X
A A																
A A								O^								
A A		**X**	X	O*	X	X	O*	O^			**X**	X		**X**	X	
A A								O^						O^		
A A																
A A					O	O*	O*									
A A																
A A					O		O*	O								

Species	SDM	DEVA			GRBA			LAKE			MOJA			JOTR		
		P	H	M	P	H	M	P	H	M	P	H	M	P	H	M
A A																
A A																
A A	Y															
A A	Y				X	X	X									
A A	Y				X	X	X									
A A		O^			O	O	O*	X	X	O				O^		
A A					X	X	O*									
A A					X	X	O*							O^		
A A																
A A		X	X	X				O			X	X	X	X	X	O
A A		X	X	X	X	X					X	X	X			
A A					X	X										
A A		X		X												
A A																
A A																
A A		X	X													
A A		X		X				O^			O		O	X	X	
A A																
A A		X	X		X	X					X	X	O	X	X	
A A		O						O								
A A								X	X					O		
A A																
A A																
A A	Y	X	X		X	X	X									
A A								X	X	O						
A A	Y															
A A		X	X	X	X	X	O	X	X	O	X	X	X	X	X	O
A A	Y	O									X	X	X	X	X	
A A																
A A																
A A		X	X					O^			X		X	O		O
A A								O^								
A A		O						O^								
A A								O*		O*						
A A		O			X	X	O*	^		^	O^			X	X	
A A					O		O*	O^								
A A					O	O	O									
A A		X	X	X				X	X		X	X	X	X	X	O
A A	Y	X	X											X	X	
A A					X	X	X	O*		O*	X	X				

Species	SDM	DEVA			GRBA			LAKE			MOJA			JOTR		
		P	H	M	P	H	M	P	H	M	P	H	M	P	H	M
A A		O			X	X										
A A		X	X	X	X	X	O*	X	X	O*	X	X	X	X	X	
A A		X		X												
A A																
A A																
A A								X	X							
A A																
A A		X	X													
A A																
A A																
A A		X	X	X				O		O	X	X	X	X	X	O
A A		X	X	X	X	X	O									
A A	Y	X	X	O				O		O	O		O	O		O
A A	Y															
A A		X	X	X	X	X	O	X	X	O	X	X	O	X	X	O
A A		X	X	X				X	X	O	X	X	X	X	X	X
A A																
A A	Y	X	X	X	X	X	X	X	X		X	X	O	X	X	O
A A	Y	X	X	X	X	X	X	O		O	X	X	O	X	X	O
A A																
A A		X	X	X				X	X	O*	X	X	O	X	X	O
A A		X		X												
A A								O^								
A A		O			O		O*	O^			O^			O		
A A																
A A																
A A	Y	X	X	X	X	X	X	O			X	X		O		O
A A																
A A																
A A																
A A																
A A	Y															
A A	Y															
A A					X	X										
A A					O		O									
A A	Y				X	X	X									
A A		O		O				O^			O^			O		O*
A A					O	O	O*									
A A																

Species	SDM	DEVA			GRBA			LAKE			MOJA			JOTR		
		P	H	M	P	H	M	P	H	M	P	H	M	P	H	M
A *A*		**X**	X	X				O^			**X**	X	O *	**X**	X	
A *A*																
A *A*		**X**	X		**X**	**X**	**X**									
A *A*		**X**	X					O^			O^					
A *A*																
A *A*	Y															
A *A*	Y				**X**	**X**	O	O		O						
A *A*														X	X	
A *A*					**X**	**X**	**X**									
A *A*																
A *A*																
A *A*		**X**	X	**X**							**X**	X	X			
A *A*																
A *A*	Y															
A *A*		O			**X**	**X**	**X**									
A *A*																
A *A*							O *	O								
A *A*		**X**	X		O	O	O *	O			**X**	X		**X**	X	
A *A*		**X**	X	X	**X**	**X**	O	O			**X**	X	X	**X**	X	O
A *A*																
A *A*																
A *A*																
A *A*																
A *A*	Y															
A *A* *A*							O *	O								
A *A*		**X**		X	O	O	O	O^			**X**	X		**X**	X	
A *A*														O^		
A *A*		**X**	X	X				O^			**X**	X		**X**	X	
A *A*					O		O *									
A *A*																
A *A*		O														
A *A*		**X**	X					O			**X**	X		O		O
A *A*	Y															
Ten counties = 177	**23**	**66**			**51**			**63**			**51**			**52**		

Appendix C: Additional data sources for species records

Additional data on species distributions across the region and within the parks may be available in other museum databases or outside of museum specimen records, including large-scale observation databases. We have included a brief description and links on accessing these data below.

1. **VertNet**

   VertNet is a global museum database of vertebrate natural history collections, including multiple taxonomically-based networks, including MaNIS, HerpNET, ORNIS, and FishNet. New institutions are added regularly and may contribute further to species lists.

   http://vertnet.org/index.php

2. **Avian Knowledge Network**

   The Avian Knowledge Network (AKN) is an international organization of government and non-government institutions focused on understanding the patterns and dynamics of bird populations across the Western Hemisphere. Datasets include bird observations from bird-monitoring, bird-banding, and broad-scale citizen-based bird-surveillance programs.

   http://www.avianknowledge.net/content

3. **eBird**

   eBird provides rich data sources for basic information on bird abundance and distribution at a variety of spatial and temporal scales. Datasets include recreational and professional bird watcher observations and are recorded through checklist data. These data are added directly to AKN.

   http://ebird.org/content/ebird

Appendix D: Supplemental Electronic Appendices

Appendix D1: Electronic database of museum specimen records

All museum records compiled as part of this project have been formatted and assembled within a Microsoft Access Database.

File Name: *AppendixD1_NPSGreatBasinMojaveDesertDB_01June2012.accdb*

Appendix D2: Additional data from Museum of Northern Arizona

Data from Museum of Northern Arizona (MNA) were provided as electronic ledger sheets, separate from the database (generated 2 September 2011). These records include their holdings from Mohave County, Arizona. Specific questions regarding their data can be directed to Janet Gillette, Associate Collection Manager (see contact details below). Each file has been provided in the original format received by Janet.

File Names: *AppendixD2_MNA_holdings_MohaveCoAZ_Birds_2Sept2011.doc*
AppendixD2_MNA_holdings_MohaveCoAZ_Mammals_2Sept2011.doc
AppendixD2_MNA_holdings_MohaveCoAZ_Reptiles_2Sept2011.doc

Janet Whitmore Gillette; Assoc. Collection Manager; Museum of Northern Arizona; 3101 N, Fort Valley Road; Flagstaff, AZ 86001; (928) 774-5211 ext. 265; jgillette@MNA.mus.az.us

Appendix D3: NPSpecies data from regional parks

Data received from NPSpecies that have undergone preliminary certification (as of 13 August 2011).

File Folder: *AppendixD3 NPSpecies Data*

File Names: *MOJA_LAKE_Mammals.accdb*
MOJN_DEVA_Mammals.accdb
MOJN_JOTR_Mammals.accdb
MOJN_MOJA_Mammals.accdb
NPSpecies Data – JOTR_birds_final.xls

Appendix D4: Summary of Museum of Vertebrate Zoology field notes

Field notes identified based on collector, collection, and years have been assembled into multiple spreadsheets for each park. Data also includes the locality and corresponding site number (see Table 5, Figs. 14-18). Preliminary data mining notes have been included (“survey type”, repeat

days/nights?", "general survey", and "time of year"; results as of 19 March 2012). A key to color coding of fields and contact details for researchers are included as separate worksheets.

***File Name**: Appendix D4_MVZ_historical_FieldNotes_summary.xls*

Appendix D5: Summary of Museum of Vertebrate Zoology images

All images identified by searching under relevant counties (those containing part or the entire park) were included in this list. Fields include image number, subject, locality, date and photographer. Preliminary results of determining whether the image was likely taken within or outside of the park boundaries are also included. A key is added as a separate spreadsheet in the workbook. Each county is included as a separate worksheet.

***File Name**: Appendix D5_MVZ_Images_summary.xls*

Appendix D6: Museum of Vertebrate Zoology ARCTOS user manual

Step-by-step instructions for using the MVZ's online database, ARCTOS, to access MVZ specimen data records and metadata. Instructions include methods of searching, downloading, mapping, and customizing the interface.

***File Name**: AppendixD6_ARCTOS_WebPortal_Instructions_08March2012.doc*

Access to ARCTOS: http://arctos.database.museum/

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS XXXXXX, Month Year

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov